beetles
Science and Teaching for Field Instructors

Student Activity Guide

Discovery Swap

This student-centered Exploration Routine can be used in many different ecosystems, and provides a way for students to search for, observe, research, and share discoveries about organisms. It can be used with any type of organism or phenomenon you choose for students to focus on, such as macro-invertebrates in streams or ponds, under-log organisms, insects caught with nets, or plants.

First, students explore an ecosystem, collecting and examining many organisms, then they choose one to study through drawing, recording observations and questions in writing. They also use tools such as field guides or identification keys (if you have them) to identify and further research their organisms. One member of each pair stays with their organism, while the other member circulates to check out the other organisms. Students discuss their discoveries, questions, and ideas with each other, and then, after a few minutes, the pairs swap so everyone has a chance to look at other organisms and share about their own.

Students will:

- **Practice making and recording observations through drawing and writing.**
- **Identify and research organisms using dichotomous keys and field guides.**
- **Present their findings to their peers.**
- **Optional: Think about organisms in an ecosystem through the lens of structure and function.**

Grade Level:
Grades 3-8. Adaptable for younger or older students.

Timing:
about 60 minutes

Related Activities:
I Notice, I Wonder, It Reminds Me Of
NSI: Nature Scene Investigators
Walk & Talk

Materials:
Equipment for catching, containing, and observing organisms, e.g., cups or bug boxes, nets, hand lenses, etc. Equipment needed depends on what kinds of organisms you're looking for and the ecosystem you're investigating. Also: field guides or keys to relevant organisms.

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

Setting:
Any area where there are many organisms and space for students to explore, then gather in a group to share and discuss.

NEXT GENERATION SCIENCE STANDARDS

For additional information about *NGSS*, go to p. 10 of this guide.

FEATURED PRACTICE
Obtaining, evaluating, & communicating information

FEATURED CROSSCUTTING CONCEPT
Structure & Function *(if using optional steps)*

DISCIPLINARY CORE IDEAS
Interdependent Relationships in Ecosystems, Structure and Function

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Discovery Swap

ACTIVITY OVERVIEW

Discovery Swap	Learning Cycle Stages	Estimated Time
Introducing the Activity	Invitation	**5 minutes**
Let's Go Exploring!	Exploration	**15 minutes**
Journaling About an Organism	Concept Invention	**10 minutes**
Identification and Further Research	Concept Invention	**10 minutes**
Cool Organism Convention	Application	**15 minutes**
Wrapping Up	Reflection	**5 minutes**
TOTAL		**60 minutes**

TEACHING TIPS

Field Card. On p. 12 of this guide, you'll find a condensed, pocket-sized outline of the activity you can use in the field.

Read the Instructor Support Section. Beginning on p. 7, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Use this routine to support a theme or build student literacy with an ecosystem, type of organism, or phenomenon. In this activity, students explore organisms in an ecosystem and gain knowledge through focused study and research. You can easily alter the instructions and materials to support different themes or to further student understanding of any ecosystem or type of organism. That's why instructions in this write-up are general and don't refer to specific organisms or ecosystems. The students' observations could focus on plants, invertebrates, leaves, pond organisms, or other groups of organisms. Connect to a theme—such as adaptations, ecosystems, structure and function, interdependent relationships, food webs, biodiversity, etc.—by encouraging students to focus on those types of observations while they're studying and researching their organisms. Repeat the routine in a different ecosystem or with different organisms to give students the opportunity to make comparisons. For more ideas on how to use this routine, see the Instructor Support Section on page 6.

Introducing the Activity

1. **Get students excited about exploring by telling them there's cool stuff all around us!** Gather them at or near your exploration site. Point out that there's interesting stuff to explore all around them—places for organisms to hide, different plants, and intriguing landscape features.

2. **Explain what their focus of study will be (organisms in stream, plants on cliff etc.)**

   ▶ *We're going to explore and study organisms kind of like scientists do.*

   ▶ *To think like scientists we need to know a little background information about this ecosystem before we begin.*

3. **Orient students to the ecosystem using *Think-Pair-Share* or *Walk & Talk*.** Ask students to talk with a partner about the ecosystem they'll be studying. Pose questions to help them develop some ecosystem literacy. Focus their attention on environmental conditions that might be challenging for organisms found there. For example:

   ▶ **General:** *What do you notice about our surroundings? How are the environmental conditions here different or similar to other places you've been? What would be potential dangers or difficulties for organisms living in this ecosystem? What are body structures or behaviors organisms might have to help them survive here?*

   ▶ **Stream:** *The organisms we find in this stream live underwater. How is living underwater different from living out of water? How do they breathe? How do they deal with currents? How do they protect themselves from predators?*

   ▶ **Intertidal:** *Let's think about what it means to be an intertidal creature. These organisms must survive under water for many hours at a time and out of water for many hours at a time. How do you think they might do that? How might they deal with being hit by 8,000 waves per day? What structures and behaviors might these organisms have to help them survive here?*

   ▶ **Cliff:** *All the plants we're checking out here are growing straight out of this cliff. How do you think their shape might be different from plants of the same kind that grow on flat ground? What are some situations that might cause these plants harm? How might they avoid harm?*

Let's Go Exploring!

1. **Tell pairs of students to find and/or catch as many of the type(s) of organisms you've chosen as they can.** Tell students their first goal will be to explore the area and find (plants, fungi, etc.) or catch (animals) as many organisms as possible. If you want your students to focus on a particular kind of organism in the ecosystem, make that clear.

   ▶ *In pairs, you'll have 12 minutes to explore this area and collect as many organisms (pond creatures, invertebrates, small plants, etc.) as you can.*

TEACHING NOTES

See BEETLES activity *Walk & Talk* or the BEETLES resource, *Discussion Routines,* for logistics on the *Think-Pair-Share* routine.

Build your own "ecosystem literacy." To be an effective co-explorer with your students it's best to know a bit about the ecosystem and organisms you'll be investigating. Scouting ahead to make sure there are organisms to find helps, too.

More information about developing ecosystem literacy. For additional details and examples of these types of questions please see the BEETLES *Ecosystem Literacy and Ecosystem Exploration Strategies.*

Giving instructions. Some instructors find it easier to give the instructions for exploring, catching, sketching, identifying, and researching organisms all at once at the beginning of the activity, so as not to interrupt the momentum and energy students build while exploring. Other instructors choose to call students back in after each phase of the activity to give the next set of the instructions. Do what feels right for your instructional style and your group of students.

TEACHING NOTES

Use *I Notice, I Wonder, It Reminds Me Of* routine beforehand. This powerful routine helps set students up with tools for making scientific observations. Whether or not your students have experienced that routine, ask students these questions: "What do you notice about it?" "What do you wonder about it?" "What does it remind you of?"

Introducing the Optional *NGSS* Crosscutting Concept. The optional steps here are for instructors who want to integrate the *Next Generation Science Standard (NGSS)* crosscutting concept of Structure and Function into this activity. For students to appreciate this big idea of science, they'll need to have multiple experiences using this lens to explore nature. See the Instructor Support section for more information about making connections between this activity and the *NGSS*.

Importance of students observing & drawing *before* identification. Often, when students find organisms, they ask, "What is it?" and then, when told the name, they move on to finding the next organism (while forgetting the previous organism and its name). It's part of human nature to "move on" once we know the name of something. By giving students time to focus, observe, and draw an organism without an identification key, they tend to become more truly engaged with the individual organism, and ask their own questions about it. When identification keys are passed out later, they'll have an organism they already know a little bit about, to relate to the new information.

You don't need field guides. If you don't have identification keys or guide books for students to use, you can have them come up with their own descriptive name for the organism and share some of their key observations. You can also encourage students to write down questions and detailed observations, to use to consult resources, such as books or the Internet, later.

2. **Introduce techniques, safety, & boundaries.** If there are specific techniques that would be useful for students, like kick-netting for streams, or using other tools for catching small organisms, introduce them here. Describe any safety rules and boundaries that are necessary for your site.

3. **Tell students they'll get to pick a favorite & remind them not to let their organisms go, since they'll study them during the next step.**

    - *Your goal during the exploration time is to be gentle with these organisms and to find as many different kinds as possible, so you can pick a favorite to focus on..*
    - *Don't release organisms you collect, because you'll need them later.*

4. ***Optional crosscutting concept:* Tell students to pay attention to the structures of different organisms as they explore.** Tell them to look at organisms' structures (the materials something is made of and how it's shaped) while they explore, and to pay attention to the differences and similarities between them.

5. **Facilitate student exploration—circulate and troubleshoot.** While they're exploring, engage them in observation and conversation about what they find, and remind them to catch as many different organisms as possible so they can choose a favorite. Help students who are struggling with finding organisms or with working together.

Journaling About An Organism

1. **Each pair chooses one organism to focus on.** When energy lags or when you think students are ready to move on, remind students to choose one organism to focus on. Tell them to place the other organisms back where they came from (or as close as possible). They will become the group's "experts" on that individual organism by studying it and recording what they find in their journals.

2. **Introduce sketching & recording information as a scientific tool.** For example, say:

    - *In your journal, you'll make a sketch of your organism and write as many observations and questions as you can, like a scientist would.*
    - *It's not about making a pretty picture. It's about noticing things accurately and writing them down.*
    - *Sometimes a drawing will help show what you noticed, sometimes words will communicate it better. Use both drawing and writing in your study.*

3. ***Optional—crosscutting concept:* Explain to students that looking at structures & thinking about how they function is something scientists do.**

    - *When scientists study an organism (or anything else in the natural world), sometimes they focus on its structures, and how those structures might function.*

- *Thinking about the structures in the natural world and how they might function is something many different kinds of scientists do.*
- *As you record your observations in drawing and writing in your journal, pay attention to the structures your organism has, and think about how they might help it survive in its habitat.*

4. **Pass out materials—students record observations through writing & drawing.** Hand out journals and pencils, and help students focus on their designated organisms. Engage struggling pairs by asking questions about what they observed, and encouraging them to write these down.

Identification and Further Research

1. **Explain resources for identification & further study; ask them to record their source.** After students have had at least 10 minutes to record information in journals, gather the group and show them a key, field guide, or other resource they'll use for identification, and explain how to use it. Tell them that now that they've had a chance to observe and study their organism a bit, this additional resource will help them identify their organism and find out more about it. Say they can write this information in their journals if they want to remember it—**and they should also write down their source(s).**
2. **Encourage students to make careful identifications & gather information to answer their questions.** If students have quickly identified (or misidentified) an organism, encourage them not jump to conclusions. Ask them to share evidence for why they made this identification (it has spots on its sides, etc.). If students came up with questions about their organisms, encourage them to look in the provided resources for possible explanations or related helpful information.
3. **Give students the chance to review and write down their research.** If they haven't already, encourage them to write down 2 or 3 compelling observations or ideas to share, and possibly a question for future study.

Cool Organism Convention

1. **Students/scientists discuss their findings, questions, & ideas.** Gather the group and remind them that part of acting like a scientist is sharing ideas. Scientists do research, ask questions, read and write papers, go to conferences and conventions, and discuss interesting ideas with one another. Explain they'll be participating in a "Cool Organism Convention," and will be discussing one another's research, like scientists do.
2. **Assign each pair of students to a different group—one will be in the "Student A" group, & the other in "Student B" group.**
3. **The "A" group stays with organism to share & discuss findings; the "B"group circulates among the "A" group students.** Tell all A students they'll stay with their organism to share their findings and discuss their organism with B students who come by. Explain that, after a bit, they'll switch roles and the B's will stay with the organisms while the A's

TEACHING NOTES

Informal assessment check-in. Participate in the "Cool Organism Convention" by asking questions and engaging in discussion. To find out how they're doing with science practices, such as making explanations from evidence, look at their drawings and notes, listen to what students are sharing, and ask them about their explorations and explanations.

Why not do a timed rotation? Many educators consider it standard fare to use timed rotations in situations where students move through stations. Some are convinced students won't stay engaged without a structure to guide their movement. Try the activity in this write-up's more student-directed way and pay attention to what happens. The advantages of having free-choice rotation is that students get to pursue their own curiosity, which is worth A LOT both in terms of authentic engagement and deeper learning. The goal here is student-centered exploration, sharing, and discussion, which is more likely to occur when students have some control over what they're looking at and who they're talking to. It's true that students may cluster a bit around the more fascinating organisms, but that's because they are *interested,* which is not a bad thing. It's also possible that a student may not have anyone talking to them for a little bit, but that usually doesn't last long, and they always have their organism buddy to study. Disadvantages of timed rotations are that some student discussions are cut off before they're finished talking about an organism, while others may have to wait and "idle" when they're ready to move on. Lack of choice can also lead to students becoming more passive, which is hugely detrimental to cognitive engagement and real learning. There are situations when a timed rotation may be the better choice, but generally we've found that a more free-flowing, student-driven rotation format provides a greater opportunity for students to be active learners.

TEACHING NOTES

circulate.

4. **Let students know they'll be discussing their discoveries & questions—not just "lecturing" each other on what they found.**
   - *This should be a discussion, not a one-way lecture.*
   - *Person "A" will share observations, questions, ideas, & ask the "B" person what they think. "What do you think of that idea?" "Do you have a different thought?"*
   - *Person "B" will ask questions such as: "What do you mean by that?"* or, *"Did you notice anything about..."*
5. **Begin the Convention with "B" students circulating & instructor participating.** Go around and visit the "A" students yourself by going up to them and asking questions about what they've discovered.
6. **After ~10 minutes, call for the groups' attention & ask pairs to switch roles.** When you call time, the "B" students will remain with their organisms and the "A" students will circulate.

Wrapping Up

1. **Tell students to carefully release organisms.** After the convention finishes, tell students to carefully return their organisms to their habitats, as close as possible to where they found them.
2. **Revisit questions about ecosystems.** Re-ask some of the questions you asked about the environmental pressures on organisms found in this area. Have students' answers changed? Consider writing down student observations and reflections on a whiteboard to share and record their understanding of the ecosystem as a whole.
3. **Lead *Walk & Talk*—students reflect on the experience of acting like a scientist.**
   - *What was it like acting like a scientist, making discoveries, and doing research?*
   - *In what other ecosystems might you find your organism, or similar organisms?*
   - *What questions do you still have about the organism you studied?*
   - *How could you find more information about these organisms?*
   - *What other organisms would you like to study in this way?*
   - *What helped you to learn today?*

Instructor Support

Teaching Knowledge

Timing for *Discovery Swap* is flexible. The overall timing for *Discovery Swap* can be fairly flexible. Let students continue exploring or discussing ideas if they're actively engaged, but be mindful of time constraints and be on the lookout for the moment just before energy and capacity for attention begins to wane.

Introducing Content. In this activity, students construct their own understandings through exploration, observation, organism study, and peer teaching. It's helpful if instructors have a general knowledge of the ecosystem students are exploring, and are familiar with the organisms they're likely to find. But instructors should take care to be the "Guide on the Side" and to encourage students to make their own observations and gain new knowledge by using resources like field guides instead of immediately telling students the names of organisms or information about them. An instructor should try to restrict the content they share to information that they think will stimulate further curiosity, or provide a different perspective, and they should hold off on introducing it till after students are well on their way finding out and discussing information themselves.

Scientific Language. Science is about coming up with the best explanation for all the available evidence. It's also about being open-minded about examining other explanations that might be better. In science, nothing is ever finally "proven." This is why scientists tend to use language that demonstrates a healthy amount of uncertainty when discussing their ideas and explanations. To help students maintain this mindset, try to offer sentence starters, such as, "Maybe..." "I wonder if..." "That evidence makes me think..." "The evidence seems to show..." Use this type of language yourself when discussing ideas, and encourage students to phrase their statements in a like manner, particularly during the "Cool Organism Convention."

Conceptual Focus. The conceptual focus of Discovery Swap will vary based on the organisms or ecosystem you choose. Gather field guides, keys, or useful resources and do a bit of research yourself, before taking students out to explore. To learn how to develop questions that offer students some ecosystem literacy when introducing this activity, refer to the *BEETLES Ecosystem Literacy and Exploration Strategies.*

Common Relevant Misconceptions

Misconception. If you let students share their ideas, they'll learn inaccurate information from one another, so instead of encouraging student discussion, instructors should just communicate the accurate information.

More accurate information. All learners entertain many ideas about the natural world, some of which are accurate, and some of which are not. But even inaccurate ideas can be based on reasoned thinking. Whether or not learners have opportunities to share these ideas out loud, they exist and can persist if they remain unchallenged. Thoughtful educators

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"I love this activity because it can be used to teach almost anything—students can focus on stream macro-invertebrates, leaves, types of tree bark, insects, chaparral plants, even rock types. Students leave the experience with literacy in an aspect of nature and are ready to engage with more concepts, to make connections to other ideas, and to use the skills they've gained as they continue exploring nature. " – Emilie Lygren, Exploring New Horizons Outdoor Schools

An alternative to a *Professor Hike*. This activity was designed as an alternative to *Each One Teach One/Professor Hike*, in which students repeat information to other students that they've learned from an instructor or that they read off of a card. *Discovery Swap* puts learning in student hands by giving them the opportunity to choose what to focus on, and to make their own discoveries. They also are encouraged to discuss their organism with peers, like scientists, rather than lecture about it, which tends to be more engaging and productive. This empowers students—helping them develop mindset and skills to investigate the natural world throughout their lives.

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About the *Next Generation Science Standards (NGSS)* The development of the *Next Generation Science Standards* 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 towards 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 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 (DCIs). The DCIs 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

recognize the importance of surfacing learners' ideas, and bringing them forward for discussion and analysis. Without opportunities to discuss their inaccurate ideas, students may be able to memorize facts and concepts they hear about (and can even use them to pass tests), but can still privately maintain their original inaccurate thinking. Sharing ideas in a group can draw attention to conflicting ideas and inconsistencies, and provide the opportunity to evaluate ideas based on the available evidence. Furthermore, hearing learners' misconceptions provides information about the group that can be used to adjust and enhance your instruction. There are research studies that show improvement of student understandings—even when learners are discussing inaccurate ideas together.

Connections to the Next Generation Science Standards (NGSS)

BEETLES student activities are designed to provide opportunities for the "three-dimensional" learning called for in the *NGSS*. To experience three-dimensional learning, students need to engage in scientific practices to learn important science concepts (Disciplinary Core Ideas) and make connections to the big ideas in science (Crosscutting Concepts). In short, students should be using the tools of science to explore and investigate rich phenomena, trying to figure out how the natural world works.

In *Discovery Swap*, students engage in the practice of *Obtaining, Evaluating, and Communicating Information* and have the opportunity to relate what they learn to the crosscutting concept of *Structure and Function*. Depending on their observations, prior knowledge, and the instructor's focus, students can build a foundational understanding of disciplinary core ideas related to *Structure and Function*, *Interdependent Relationships in Ecosystems*, or *Adaptations*. *(Note: "Structure and Function" is a crosscutting concept and it's also a category of Disciplinary Core Ideas within the Life Sciences).*

Featured Science and Engineering Practices

Engaging students in obtaining, evaluating, and communicating information. It's important for scientists and, according to the *NGSS*, for students to encounter scientific information from many sources, to try to interpret this information, to communicate their own ideas in written and spoken form, and to discuss their observations and explanations with their peers. Students are exposed to different sources of information during every step of *Discovery Swap*. Their initial source of information is their own observations as they explore different organisms, then focus in on a particular organism and generate questions about it. Students receive an outside resource like a key or field guide to build upon their own observations and answer some of their questions. It's important to do the activity in this order, as opposed to giving students tools for identifying organisms first. As an instructor, you can also act as a "source" during this activity by sharing relevant, interesting ideas or facts about organisms. A good rule of thumb is to think of sharing only whatever students won't be able to learn from their own observations or through a resource like a field guide.

Students also communicate about the information they learn in a variety of ways throughout *Discovery Swap*. When they record their observations and ideas in drawing and writing in their journals, they generate scientific text that prepares them to engage in conversation with their peers. During the rest of the activity, students communicate observations and explanations in conjunction with their peers. The "Cool Organism Convention" is a significant opportunity for students to fully engage in this practice because they have the chance to evaluate many different ideas and explanations of their peers through open-ended discussion. Make sure to give students the opportunity to discuss each other's discoveries by providing enough time for those conversations to really take off, and by encouraging students to discuss their ideas instead of delivering a lecture to one another. If, instead, students are asked to present about their organism, one after the other, to the entire group, then they miss the chance to have the kinds of scientific discussions where they can fully engage in this practice..

Featured Crosscutting Concepts.

*Learning science through the lens of structure and function***.** Crosscutting concepts are useful thinking tools in science that are applicable across disciplines. When scientists use the idea of *Structure and Function* they consider how "the way in which an object or living thing is shaped… determine[s] many of its properties and functions." (*NGSS*). In the optional crosscutting concept steps for *Discovery Swap*, students begin to think about this concept when they gather many different organisms and compare their structures. Students aren't fully introduced to the terms, "Structure and Function" until they begin to make their own diagrams of a particular organism in their journals, and think about how that organism's structures help it survive in its habitat. If thinking about structure and function is a learning goal for your students, use this language at multiple points throughout the activity and remind them to think about their organisms using this lens, particularly before they discuss ideas with their peers during the "Cool Organism Convention." Emphasize that a field scientist might also think in this way, and that scientists in all disciplines use the idea of *Structure and Function* to better understand all parts of the world.

Learning science through the lens of other crosscutting concepts. Students may make particular kinds of observations and engage with different ideas if they focus on a different crosscutting concept during *Discovery Swap*. You may choose another crosscutting concept, if there is one that matches a theme you have for your field experience, or a big idea that will lead students to make observations and explanations related to content you wish for them to understand. The crosscutting concept of *Systems and System Models* relates well to helping understand the interactions in an ecosystem. To integrate the concept of *Systems and System Models,* ask students to focus on how their organism interacts with its surroundings when they're observing it. Point out that students are examining a system by exploring one of its components (individual organisms) and its interactions with other parts of the system. Emphasize that this is an approach many types of scientists take to better understand how parts of the natural world are interconnected, and how they affect one another.

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Importance of teaching science practices. "Engaging in the practices of science helps students understand how scientific knowledge develops...It can also pique students' curiosity, capture their interest, and motivate their continued study..." -National Research Council, *A Framework for K-12 Science Education*. Focus on these science practices will help to ensure a more scientifically literate public who will be better able to make thoughtful decisions.

About Crosscutting Concepts in the NGSS. Crosscutting concepts are considered powerful thinking tools for how scientists make sense of the natural world. The seven "big ideas" listed as crosscutting concepts are: Patterns; Cause & Effect; Scale, Proportion & Quantity; Systems and System Models; Energy & Matter: Flows, Cycles and Conservation; Structure & Function; and Stability & Change. These concepts may sound familiar, as they are quite similar to the themes referred to in science literacy documents as being important ideas that unify all disciplines of science and engineering.

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. *Discovery Swap* provides students with an opportunity to develop understanding of the life science core ideas LS1.A *Structure and Function*, LS2.A *Interdependent Relationships in Ecosystems*. The specific DCIs for which students might build understanding will, of course, vary depending on the organisms students explore and the crosscutting concept that guides their thinking.

Beginning the activity by discussing "ecosystem literacy" is an important step in students' conceptual development and understanding of these core ideas. This discussion provides a context for students' observations of organism structures and their explanations about how those structures might function in the habitat in which they live (LS1.A). Students have the opportunity to deepen their understanding of this DCI in multiple ways, as they consult different resources, such as field guides, and engage in discussion about each other's observations and questions about the organisms. When students consider questions about how their organism deals with survival pressures, they also begin to build an understanding of how organisms depend on their interactions with living and non-living parts of their ecosystems (LS2.A).

Performance Expectations to Work Toward

When examined closely, it's clear that the *NGSS* represent complex knowledge and multifaceted thinking abilities for students. No single activity can adequately prepare someone for an *NGSS* performance expectation. Performance expectations are examples of things students should be able to do, after engaging in multiple learning experiences or long-term instructional units, to demonstrate their understanding of important core ideas and science practices, as well as their ability to apply the crosscutting concepts. As such, they do not represent a "curriculum" to be taught to students. Below are some of the performance expectations that this activity can help students work toward:

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-LS1-4.Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Activity Connections

Doing an activity like *I Notice, I Wonder, It Reminds Me Of,* or *NSI: Nature Scene Investigators,* before *Discovery Swap* will prepare students to engage more deeply in the activity.

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Translating the codes for the *NGSS* performance expectations. Each standard in the *NGSS* is organized as a collection of performance expectations (PEs) for a particular science topic. Each PE has a specific code, 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, 2 - second,etc...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...MS-LS2-2 means it's part of a middle school standard (MS) for life science (LS), addressing the second core idea (2) *Ecosystems: Interactions, Energy & Dynamics*, within the life science standards, that deals with Interdependent Relationships in Ecosystems. It's also the second performance expectation (2) that makes up the complete LS2 standard at this grade level.

Discovery Swap is a flexible routine that can be used to have students explore and deepen their understanding of almost any natural phenomenon, organism, or ecosystem, and can be repeated in different places or with different organisms.

Instructors could also choose one crosscutting concept to use as a recurring theme of a field experience. For example, on an adaptations-themed field experience, an instructor might choose to focus on the crosscutting concept of *Structure and Function*, weaving language and questions about structure and function throughout all activities, including *Discovery Swap.* Other BEETLES activities that could fit with this theme include *Adaptation Intro—Live!* and *Structures and Behaviors*.

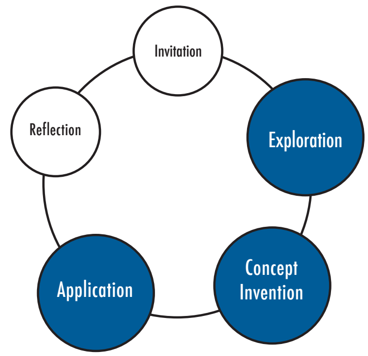
***Discovery Swap* & the Learning Cycle.** On its own, this activity completes a full learning cycle. It's a way of taking any interesting ecosystem, or type of organisms, or phenomenon, plugging them into this write-up, and lo and behold, you've got a learning cycle-based activity! This activity can also be used during different phases of a longer Learning Cycle-based experience, depending on your goals and the needs of your students. It obviously works really well during exploration phase, but also during concept invention, and it's great for application too:

*Exploration***.** Students are provided with lots of exploration time focused on one type of organism or ecosystem in this activity. For example, during a field experience that focuses on various plant types and biodiversity, you can have students explore different kinds of plants in the area using *Discovery Swap,* before moving on to having students develop their understanding of those concepts.

*Concept Invention***.** *Discovery Swap* can work very well during a concept invention phase, as students are identifying organisms, building connections between organisms and the ecosystem, and deepening their understanding about what it means to act like scientists.

Application. Alternatively, *Discovery Swap* can be used as an application in the course of a field experience that's focused on a topic such as adaptations. By having students visit a pond, catch macro-invertebrates, note differences between their structures, and develop explanations about possible adaptations, they can apply their understanding of this important idea in science. It's also a great application of science practices.

NOTES



FIELD CARD

Cut out and fold along the centerline. This makes a handy reference card that will fit in your pocket.

Discovery Swap

Introducing the Activity

1. Get students excited about exploring by telling them there's cool stuff all around us!
2. Explain what their focus of study will be.
   - ▶ *We're going to explore and study organisms kind of like scientists do.*
   - ▶ *To think like scientists, we need to know a little background information about this ecosystem before we begin.*
3. Orient students to the ecosystem using *Think-Pair-Share* or *Walk & Talk* about ecosystem literacy for this ecosystem. Use some general questions, & questions specific to the ecosystem.
   - ▶ **General questions:** *What do you notice about our surroundings? How are the environmental conditions here different or similar to other places you've been? What would be potential dangers or difficulties for organisms living in this ecosystem? What are body structures or behaviors organisms might have to help them survive here?*

Let's Go Exploring!

1. Tell pairs to explore & find/catch as many of the type of organisms you've chosen as they can.
   - ▶ *In pairs, you'll have (X) minutes to explore this area and collect as many organisms as you can.*
2. Introduce techniques, safety, & boundaries.
3. Tell them they'll get to pick an organism & not to release organisms they collect.
   - ▶ *Your goal during exploration time is to be gentle with these organisms and to find as many different kinds as possible, so you can pick a favorite.*
4. *Optional—crosscutting concept:* Focus on structures.
5. Facilitate student exploration; circulate & troubleshoot.

Journaling About An Organism

1. Each pair chooses one organism to focus on.
2. Introduce sketching & recording information as a scientific tool.
   - ▶ *In your journal, you'll make a sketch of your organism and record as many observations and questions as you can, like a scientist would.*
   - ▶ *It's not about making a pretty picture. It's about noticing things accurately and writing them down.*
   - ▶ *Sometimes a drawing will help show what you noticed, sometimes words will communicate it better. Use both in your study.*
3. *Optional—crosscutting concept:* Explain that looking at structures and how they function is something scientists do.
4. Pass out materials, students record observations through writing & drawing.

Identification and further research

1. Explain resources for identification & further study; ask them to record their source.
2. Encourage students to make careful identifications & gather information to answer their questions.
3. Give students the chance to review/write down their research.

Cool Organism Convention

1. Student/scientists discuss their findings, questions, & ideas.
2. Assign each student pair to a different group, one will be "Student A," the other "Student B."
3. The "A" students stay with organism to share findings, "B" students will circulate among the "A" students..
4. Let students know they'll be discussing their discoveries & questions, not just lecturing each other on what they found.
   - ▶ *This should be a discussion, not a one-way lecture.*
   - ▶ *Person "A" will share observations, questions, and ideas, & ask the "B" person what they think. "What do you think of that idea?" "Do you have a different thought?"*
   - ▶ *Person "B" will ask questions, such as, "What do you mean by that?" or "Did you notice anything about..."*
5. Begin convention with "B" students circulating & instructor participating.
6. After ~10 min. call for the group's attention & ask pairs to switch roles–"B" group stays with organism, A's circulate.

Wrapping Up

1. Students carefully release organisms.
2. Revisit questions about ecosystems.
3. Lead *Walk & Talk*—students reflect on experience of acting like scientists.
   - ▶ *What was it like acting like a scientist, making discoveries, and doing research?*
   - ▶ *In what other ecosystems might you find your organism, or similar organisms?*
   - ▶ *What questions do you still have? How could you find more information?*
   - ▶ *How could you find more information about these organisms?*
   - ▶ *What other organisms would you like to study in this way?*
   - ▶ *What helped you to learn today?*

ABOUT BEETLES™

BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) is a program of The Lawrence Hall of Science at the University of California, Berkeley, that provides professional learning sessions, student activities, and supporting resources for outdoor science program leaders and their staff. The goal is to infuse outdoor science programs everywhere with research-based approaches and tools to science teaching and learning that help them continually improve their programs.

www.beetlesproject.org

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The following programs have contributed to the development of these materials by field testing and providing invaluable feedback to the development team. For a complete list of contributors and additional partners, please see our website at beetlesproject.org/about/partners/

California: YMCA Camp Campbell, Rancho El Chorro Outdoor School, Blue Sky Meadow of Los Angeles County Outdoor Science School, YMCA Point Bonita, Walker Creek Ranch, Santa Cruz County Outdoor Science School, Foothill Horizons Outdoor School, Exploring New Horizons Outdoor Schools, Sierra Nevada Journey's School, San Joaquin Outdoor Education, YMCA Camp Arroyo, Shady Creek Outdoor School, San Mateo Outdoor Education, Walden West Outdoor School, Westminster Woods.

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Photos: Pages 1 and 2 by Kevin Beals. *Icons*: Backpack by Rémy Médard; Growth by Arthur Shlain; Cut by Nathan Thomson; Outside by Petr Holusa; Park by Antar Walker; &Time by Wayne Middleton all from The Noun Project.

Funding from 2012-2015 for BEETLES publications such as this one has been generously provided by the S.D. Bechtel, Jr. Foundation, The Dean Witter Foundation, and the Mary A. Crocker Trust.

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