



beetles

Science and Teaching for Field Instructors

# Ecosystems (and Matter) Theme Field Experience: Introduction

Note: For Ecosystems (and Matter): Introduction, Ecosystems (and Matter): Instructor Support, full write-up of *Ecosystems Theme Field Experience Script (2-3 Hours)*, and full write-up of *Ecosystems and Matter Theme Field Experience Script (3-6 Hours)*, see: <http://beetlesproject.org/resources/for-field-instructors/ecosystems-matter-theme-field-experience>



THE LAWRENCE  
HALL OF SCIENCE  
UNIVERSITY OF CALIFORNIA, BERKELEY



# Ecosystems (and Matter) Theme Field Experience: Introduction

## Contents

<b>INTRODUCTION</b> .....	<b>04</b>
<b>Why lead a theme field experience on ecosystems?</b>	
<b>Why lead a theme field experience on ecosystems and matter?</b>	
<b>Why isn't energy included in the ecosystems and matter field experience theme?</b>	
<b>Next Generation Science Standards (NGSS)</b>	
<b>Science and Engineering Practices</b>	
<b>Crosscutting Concepts</b>	
<b>Disciplinary Core Ideas</b>	
<b>What's in this guide?</b>	
<b>Choosing optional activities and adjusting the length of your field experience</b>	
<b>Time constraints</b>	
<b>Your group of students</b>	
<b>The natural phenomena at your site</b>	
<b>Outdoor conditions at your site</b>	
<b>Your goals for students</b>	
<b>Making changes</b>	

# Ecosystems (and Matter) Theme Field Experience: Introduction

## Contents (continued)

**IMPORTANT TEACHING NOTES** .....07

- Prepare yourself as an instructor to facilitate your students in engaging, discussing, and exploring
- Prepare your students to engage, discuss, and explore
- Take some breaks
- Materials and Preparation

**FIELD EXPERIENCE OPTIONS** .....08

- Field Experience Overviews
  - Ecosystems Theme Field Experience (2–3 hours)
  - Ecosystems and Matter Theme Field Experience (3–6 hours)
- Sample Schedule: Ecosystems Theme Field Experience (~2 hours)
- Sample Schedule: Ecosystems and Matter Theme Field Experience (~4 hours)
- Sample Schedule: Ecosystems, Matter, and Energy Theme Field Experience (~5 hours)

**ABOUT BEETLES™** .....12



## Introduction

It's awesome when an activity leaves students excited about a science topic, interesting ideas, and some aspect of nature. It can be even more rewarding to lead a *series* of activities, starting out by getting a sense of where students are at to begin, taking them on a journey of learning, and tying everything together throughout a themed field experience. A thoughtfully sequenced series of activities can help students build understanding of key science concepts, and having a theme that weaves through the activities can make the field experience more coherent. The more coherent the experience, the more likely it is that students will walk away with meaningful and memorable learning. However, it can also be more challenging to lead a themed field experience than it is to lead a bunch of disconnected activities.

This introduction is our attempt to document how a field instructor who has 2–3 hours available could lead a field experience built around the theme of ecosystems; or, if they have 3–6 hours, they could lead a field experience built around the theme of ecosystems and matter. (Optional activities are also suggested at the end for those who want to include energy in the theme.) If you're not yet familiar with the individual activities, leading an entire themed field experience all at once can be a lot to take on. Review the individual activities listed in the field experience descriptions in the Field Experience Overviews table (on pages 9–10) and start teaching them with students until you feel comfortable. Then, come back and use this introduction to help you put together a fully thematic experience.

**Why lead a theme field experience on ecosystems?** A fundamental part of outdoor science and environmental education is learning about the living parts of nature (including humans) as well as the nonliving parts of nature and how those parts interact. Studying an ecosystem means looking at how living and nonliving things interact within a particular environment. Every individual organism in an ecosystem is incredibly complex and impossible to ever fully understand, and a whole ecosystem is so much more complex than that. We can learn a lot, though, about organisms and ecosystems through our own observations and through engaging with sources of information such as books and field guides. The more we do understand, the more we're equipped to make thoughtful decisions about policies and actions within our personal lives that impact Earth, other organisms, and humans.

It's also fun and interesting to learn about an ecosystem! As we each develop our ecosystem literacy, we become more comfortable being in nature and more curious about it. To understand an ecosystem, you've got to explore it, and students tend to love engaging directly with nature by making observations and getting up close and personal with organisms. As students try to figure out what lives in the ecosystem, observe interactions between its parts, and think together about how those parts affect one another, they are also developing critical science and life skills, such as making observations, making explanations from evidence, working together as a team, and thinking from a systems point of view.

**Next Generation Science Standards (NGSS).** To develop your own understanding of NGSS Science and Engineering Practices and Crosscutting Concepts, as well as content related to matter and ecosystems, see pages 13–15 of the *Ecosystems (and Matter) Theme Field Experience: Instructor Support* document and the Instructor Support sections in each individual BEETLES activity listed in the field experience script.

**Why lead a theme field experience on ecosystems and matter?** As environmental educators, we often say that everything is connected. Once students begin to understand how matter cycles through ecosystems and how everything in an ecosystem is literally connected to everything else, the natural world will never seem the same again. We breathe in oxygen that was released by plants. Plants take in carbon dioxide that we exhale and build carbon-based plant parts such as leaves, fruit, and stems. We get carbon by eating plant parts or other animals that have eaten plant parts. When things die, they decompose into carbon in soil or water and carbon dioxide in the air. These are a few examples of matter cycling through an ecosystem, and students can see examples of these connections through the study of ecosystem models, organisms' interactions with the environment, and matter cycling among organisms and into air. Understanding the cycling of matter ties together core ideas of environmental education such as food chains, food webs, food pyramids, predator–prey relationships, and photosynthesis. It also can give students a foundation for understanding the carbon cycle, which is crucial to understanding climate change.

**Why isn't energy included in the ecosystems and matter field experience theme?** Unlike matter, energy doesn't take up space or have mass. Energy is not a substance. It is a property of matter that makes things happen. If that sounds confusing, that's because it is! Understanding both matter cycling and energy flow *is* important to understand ecosystems, but it works well to start out with matter, which is more concrete, and then work up to energy, if you think your students are up for it. If you *do* want to include energy, see [Optional] *Extending the Ecosystems and Matter Theme Field Experience Script to Include Energy*—on pages 18–19 in *Ecosystems and Matter Theme Field Experience Script (3–6 Hours)*—for suggested activities.

**Next Generation Science Standards (NGSS).** This model field experience incorporates the three-dimensional learning that is called for in the NGSS. Three-dimensional learning weaves together Science and Engineering Practices (what scientists do), Crosscutting Concepts (thinking tools that scientists use), and Disciplinary Core Ideas (what scientists know).

- **Science and Engineering Practices.** The abilities involved in using Science and Engineering Practices (combined with Crosscutting Concepts)—looking at nature and figuring things out, using certain lenses to guide thinking, and understanding ecosystems more deeply—are mindsets and tools that students can take with them and apply anywhere to deepen their understanding of nature, and they're interesting and fun to do! There are many Science and Engineering Practices featured in the *Ecosystems (and Matter) Theme Field Experience*, some more fully than others. The sequence of activities and discussions included in the field experience gives students deeper opportunities to engage, particularly in the Science and Engineering Practices of *Developing and Using Models* and *Constructing Explanations*.
- **Crosscutting Concepts.** These are the big ideas in science that can be used in all science disciplines. The Crosscutting Concept of *Systems and System Models* (and, to a lesser extent, *Energy and Matter: Flows, Cycles,*

## TEACHING NOTES

*and Conservation*) are the two lenses featured here to deepen student understanding of the processes at work in the natural world in these themed field experiences.

- **Disciplinary Core Ideas.** These The sequences of BEETLES activities included in this model field experience are intended to help students in building their own understanding of the Disciplinary Core Ideas of *Interdependent Relationships in Ecosystems* and *Cycles of Matter and Energy Transfer* throughout the field experience.

**What's in this guide?** This is a sequence of BEETLES activities tied together with additional material (discussions, questions, and teaching instructions) that help create a cohesive learning experience. Suggested activities and transitions between activities that are not published elsewhere are written up here. For the activities included that are published, see the individual BEETLES activity write-ups at [beetlesproject.org](http://beetlesproject.org). These themed field experiences work as overall scripts that you can print for the field experience and then supplement with field cards from individual activities as they appear in the script.

**Choosing optional activities and adjusting the length of your field experience.** The same exact field experience won't work with every group. Learning experiences should be somewhat flexible, based on learners and conditions. Consult the Field Experience Overviews table on pages 9–10. The structure of this outline includes the main activities of the theme field experience, as well as optional activities at each stage that you might or might not include to deepen your students' experience or to help them focus on a specific part of the ecosystem. We don't recommend including every option listed—that would make for a very long field experience! Pick one option (or two at most) from each section. Choose the option(s) that works within your time constraints; meets your goals; will be successful at your site; and best suits your group of students in terms of their age, background knowledge, and group dynamics. Specifically, think about the following when deciding on what to include in your field experience:

- **Time constraints.** How long will you have with students? How much time will you need to spend walking between locations for activities? How much time will you need for breaks? How much time will that leave to do activities? Refer to the Field Experience Overviews table to see approximately how long each activity and phase of the field experience will take as you do your planning.
- **Your group of students.** How much discussion can your students engage with productively? What are things they'd be excited to do? What prior knowledge about the topic do you think they might have? Which optional activities would help them grow their understanding of these concepts? See the Teaching Notes (in the page margins) next to each activity listed in the field experience to help you make decisions about which optional activities to include or omit. Be responsive to students' needs. Omit or shorten an optional activity if it doesn't seem right in the moment, but don't skip any in the main "trunk" or the in-between transition steps outlined in the field experience. Students really tend to benefit from doing some active hiking between activities.

- **The natural phenomena at your site.** If you're going to include any listed optional activities, make sure the part of nature it focuses on is present at your site. (It's kind of difficult to do the *Case of the Disappearing Log* if you don't have a rotting log!) Make sure it's at a location along your route where it will fit in within the sequence of the field experience. See the Field Experience Overviews table, as well as the individual descriptions for each activity, to help you make these decisions.
- **Outdoor conditions at your site.** If it's cold and raining or snowing, if it's blazing hot, if there are a lot of mosquitoes, or if your students didn't sleep well the night before, then it can be more challenging to sit down and discuss something for a while. Pay attention to students' physical comfort needs and adjust the field experience accordingly.
- **Your goals for students.** Think about your experiential and conceptual goals for your group of students and use these to inform the decisions you make. If you have the goal of helping students become excited about being in nature, think about what would be engaging for them and what would make them want to explore more. Think through other questions such as: *What is their conceptual understanding of ecosystems and matter? Which optional activities would be best to engage them, confront any misconceptions they may have, and help take their understanding further? Do you hope they gain an understanding of ecosystem functioning at a matter level?*

**Making changes.** Try not to substantially change the overall *order* of the activities or to leave out learning cycle stages of an activity. Avoid changing broad questions into narrow questions. The sequence within each of these activities is important and has been thoughtfully created to best support students in developing skills and conceptual understanding. Make minor adjustments to activities to meet the needs of your students (e.g., shorten a discussion if the group becomes antsy), but try to stick to the overall structure of the individual activities. As far as the overall theme field experience goes, more flexibility may be needed. If it feels like your group is dragging, or if it seems like there's too much discussion for your group to handle, switch things up. It's difficult to learn when you are not engaged, and it's usually better to move on to something else or a different modality, rather than force students to keep doing something they're not into at the moment.

## Important Teaching Notes

**Prepare yourself as an instructor to facilitate your students in engaging, discussing, and exploring.** This field experience shouldn't be the first BEETLES activity you lead as an instructor. Work up to leading a full theme field experience by separately trying out some of the individual activities listed within the field experience a few times in order to familiarize yourself with them first. Develop your capacity as an instructor to facilitate student exploration and discussion by incorporating routines such as *Thought Swap*; *Turn & Share*; and *I Notice, I Wonder, It Reminds Me Of* into your practice. See the Instructor Support sections of each BEETLES student activity as well as other BEETLES Instructor Support Resources to help develop your practice, such as:

## TEACHING NOTES

- Discussion Strategy Videos (<http://beetlesproject.org/resources/for-field-instructors/#1452105513095-6b9e796a-4527>)
- *Engaging and Managing Students in Outdoor Science* (<http://beetlesproject.org/engaging-and-managing-students/>)
- *Encouraging Student Discussion and Productive Talk* (<http://beetlesproject.org/resources/integrating-discussion-instruction/>)

**Prepare your students to engage, discuss, and explore.** Students will be able to engage with this field experience more successfully if they have developed some skills for discussion, exploration, and learning beforehand. If possible, do some *Turn & Shares*; *Thought Swaps*; and activities such as *I Notice, I Wonder, It Reminds Me Of* before the field experience. This theme field experience does not include activities for tone-setting and creating an inclusive learning culture, although these are critical for successful student learning. See the *Engaging and Managing Students in Outdoor Science* resource and the BEETLES Discussion Strategy Videos for more on these.

**Take some breaks.** There's a lot going on in these themed field experiences, and students need breaks now and then. Breaks are not included in the field experiences, but be sure to plan some in or add them according to your group's needs. In addition to breaks to use the restroom, drink water, eat, and so on, consider including some unstructured time in nature or time hiking without any structured conversation or activities.

**Materials and Preparation.** Choose either the *Ecosystems Theme Field Experience Script (2–3 Hours)* or the *Ecosystems and Matter Theme Field Experience Script (3–6 Hours)* and print the write-up for that theme field experience. (There is duplication between parts of the two field experiences, so there's no need to carry around both field experience write-ups.) There is a minimal amount of materials and preparation described at the beginning of each field experience write-up. You'll also need to print the write-ups/field cards for each of the individual BEETLES activities you decide to include. Look at those write-ups for preparation notes and materials you'll need for each of those activities. Carry the field cards with you to use as you teach.

## Field Experience Options

The main “trunk” of the field experience is about 2 hours. Optional activities can extend the field experience to anywhere from 3 hours (students get the added benefit of looking at a couple of parts of the ecosystem in depth) to 6 hours (students get to check out multiple parts of the ecosystem and look at how matter moves among parts of the ecosystem). Refer to the Field Experience Overviews table to see two options of field experience sequences: a 2–3 hour field experience on ecosystems and a 3–6 hour field experience on ecosystems and matter. If you want to incorporate the concept of energy into your field experience, see Sample Schedule: Ecosystems, Matter, and Energy Theme Field Experience at the end of this introduction. For suggested energy activities and sequencing, see [Optional] Extending the *Ecosystems and Matter Theme Field Experience Script* to Include Energy, which is located on pages 18–19 of the *Ecosystems and Matter Theme Field Experience Script (3–6 Hours)*.

## FIELD EXPERIENCE OVERVIEWS

Learning Cycle Stage	Ecosystems Theme Field Experience (2–3 hours)	Ecosystems and Matter Theme Field Experience (3–6 hours)
<b>Invitation</b>	<p>Introduction</p> <ul style="list-style-type: none"> <li>• <i>You Are What You Eat</i> Name Game (5 min.)</li> <li>• <i>Thought Swap</i> (5 mins.)</li> <li>• [Optional] <i>Systems Game</i> (8 min.)</li> <li>• [Optional] <i>Mind Pie</i> (7 min.)</li> <li>• Introduction to Ecosystems Theme (5 min.)</li> <li>• [Optional] <i>I Notice, I Wonder, It Reminds Me Of</i> (25 min.)*</li> </ul> <p><b>Total (not including options): 15 min.</b></p> <p>* <i>I Notice, I Wonder, It Reminds Me Of</i> is a great curiosity tool to use at the beginning of any outdoor science experience, but it is listed as optional here in case students have already been exposed to it during an earlier field experience.</p>	<p>Introduction</p> <ul style="list-style-type: none"> <li>• <i>You Are What You Eat</i> Name Game (5 min.)</li> <li>• <i>Thought Swap</i> (5 mins.)</li> <li>• [Optional] <i>Systems Game</i> (8 min.)</li> <li>• [Optional] <i>Mind Pie</i> (7 min.)</li> <li>• Introduction to Ecosystems and Matter Theme (5 min.)</li> <li>• [Optional] <i>I Notice, I Wonder, It Reminds Me Of</i> (25 min.)*</li> </ul> <p><b>Total (not including options): 15 min.</b></p> <p>* <i>I Notice, I Wonder, It Reminds Me Of</i> is a great curiosity tool to use at the beginning of any outdoor science experience, but it is listed as optional here in case students have already been exposed to it during an earlier field experience.</p>
<b>Exploration</b>	<i>What Lives Here?</i> , Parts 1–2 (~40 min.)	<i>What Lives Here?</i> , Parts 1–2 (~40 min.)
<b>Concept Invention</b>	<p>[Optional] Additional BEETLES Activities to Explore Parts of the Ecosystem (~1 hour + 10 minutes of discussion)</p> <p>Choose 1 activity, if it fits your needs:</p> <ul style="list-style-type: none"> <li>• <i>Discovery Swap</i></li> <li>• <i>Lichen Exploration</i></li> <li>• <i>Fungi Exploration</i></li> <li>• <i>Bark Beetle Exploration</i></li> </ul>	<p>[Optional] Additional BEETLES Activities to Explore Parts of the Ecosystem (~1 hour + 10 minutes of discussion)</p> <p>Choose 1 activity, if it fits your needs:</p> <ul style="list-style-type: none"> <li>• <i>Discovery Swap</i></li> <li>• <i>Lichen Exploration</i></li> <li>• <i>Fungi Exploration</i></li> <li>• <i>Bark Beetle Exploration</i></li> </ul>
	[Optional] <i>Thought Swap</i> (~10 min.)	[Optional] <i>Thought Swap</i> (~10 min.)
		<p><i>Case of the Disappearing Log</i> (60 min.)</p> <p>OR</p> <p><i>Decomposition Mission</i> + 20 minutes of discussion (110 min.)</p> <p>OR</p> <p>Both (170 min.)</p>
<b>Application</b>	<i>What Lives Here?</i> , Parts 3–4 (~25 min.)	<i>What Lives Here?</i> , Parts 3–4 (adapted) (~25 min.)
		<p>[Optional] <i>Extending the Ecosystems and Matter Theme Field Experience Script to Include Energy</i> (~120 min.)</p> <ul style="list-style-type: none"> <li>• <i>Bunny Question</i> (~10 min.)</li> <li>• <i>Food, Build, Do, Waste</i> (~50 min.)</li> <li>• <i>Energy and Matter Theme Card Hike</i> (~60 min.)</li> </ul>

(continued on next page)

### TEACHING NOTES

**Activity titles.** In the Field Experience Overviews table (this page and page 10) for the *Ecosystems Theme Field Experience (2–3 Hours)* and the *Ecosystems and Matter Theme Field Experience (3–6 Hours)*, the activity titles in italics are published BEETLES activities. Therefore, those write-ups are not included in either of the field experience scripts (see [beetlesproject.org](http://beetlesproject.org)). Write-ups for titles not in italics are included within the two field experience scripts. The vocabulary and learning objectives in both field experiences mostly overlap, but *Ecosystems and Matter Theme Field Experience (3–6 hours)* includes a few more, shown in bold font.

TEACHING NOTES

**Choosing vocabulary.** It can be confusing for students to hear a lot of difficult words during a field experience, especially when those words are only used one or two times. It's more effective to choose a few words to use that you think are particularly important for the concepts (such as the words listed in the table) and encourage students to use them many times throughout the field experience. See the "Vocabulary" section on page 4 in the *Ecosystems (and Matter) Theme Field Experience: Instructor Support* for more information about why this is important. Ideally, these words should be heard, said, read, and written by students.

**Spanish translations of vocabulary.**  
*ecosistema, conexiones, organismo, interactuar, evidencia, explicación, modelo, observación, materia, descomponedor, descomposición, ciclo*

FIELD EXPERIENCE OVERVIEWS (continued)

Learning Cycle Stage	Ecosystems Theme Field Experience (2–3 Hours)	Ecosystems and Matter Theme Field Experience (3–6 Hours)
Reflection	<i>What Lives Here?</i> , Part 5: Wrapping Up (~5 min.)	<i>What Lives Here?</i> , Part 5 (adapted): Reflecting On and Wrapping Up the Field Experience (~20 min.)
	<p><b>Vocabulary</b>  <i>ecosystems, connections, organism, interact, evidence, explanation, model, observation</i></p> <p><b>Learning Objectives</b></p> <ul style="list-style-type: none"> <li>• A system is made up of interconnected parts—when one part of the system is affected, other parts can also be affected.</li> <li>• An ecosystem is made up of living and nonliving things, including a community of organisms and their habitat.</li> <li>• Plants and animals, including humans, depend upon the living and nonliving environment in important ways.</li> <li>• Scientists use ecosystem models to explain how parts of nature work, to think about the connections between parts of an ecosystem, and to make predictions about what might happen if certain environmental conditions were to change.</li> </ul>	<p><b>Vocabulary</b>  <i>ecosystems, connections, organism, interact, evidence, explanation, model, observation, matter, decomposer, decomposition, cycle</i></p> <p><b>Learning Objectives</b></p> <ul style="list-style-type: none"> <li>• A system is made up of interconnected parts—when one part of the system is affected, other parts can also be affected.</li> <li>• An ecosystem is made up of living and nonliving things, including a community of organisms and their habitat.</li> <li>• Plants and animals, including humans, depend upon the living and nonliving environment in important ways.</li> <li>• Scientists use ecosystem models to explain how parts of nature work, to think about the connections between parts of an ecosystem, and to make predictions about what might happen if certain environmental conditions were to change.</li> <li>• <b>When an organism dies, decomposers break it down into simpler forms of matter, like nutrients that become part of soil, the air, or large bodies of water.</b></li> <li>• <b>Matter cycles between air and soil and among organisms when they live and die.</b></li> <li>• <b>Decomposers restore some materials back to the soil.</b></li> </ul>

**Sample Schedule: Ecosystems Theme Field Experience (~2 hours)**

- *Thought Swap* (5 minutes)
- Introduction to Ecosystems Theme (10 minutes)
- *What Lives Here?*, Part 1 (30 minutes)
- *Interview an Organism* (40 minutes)
- *What Lives Here?*, Part 2 (25 minutes)
- *What Lives Here?*, Part 5: Wrapping Up (10 minutes)

**Sample Schedule: Ecosystems and Matter Theme Field Experience (~4 hours)**

- *You Are What You Eat* Name Game (5 minutes)
- *Thought Swap* (5 minutes)
- Introduction to Ecosystems and Matter Theme (15 minutes)
- *What Lives Here?*, Parts 1–2 (40 minutes)
- *Discovery Swap*: Focus on one part of ecosystem (e.g., macroinvertebrates in a creek) (60 minutes)
- *Case of the Disappearing Log* (60 minutes)
- *What Lives Here?*, Parts 3–4 (30 minutes)
- *What Lives Here?*, Part 5 (adapted): Reflecting On and Wrapping Up the Field Experience (20 minutes)

**Sample Schedule: Ecosystems, Matter, and Energy Theme Field Experience (~5 hours)**

- Combine: *Ecosystems and Matter Theme Field Experience Script (3–6 Hours)* as written and [Optional] *Extending the Ecosystem and Matter Theme Field Experience Script to Include Energy*—pages 18–19 in the *Ecosystems and Matter Theme Field Experience Script (3–6 Hours)*.
  - *You Are What You Eat* Name Game (5 minutes)
  - *Thought Swap* (5 minutes)
  - Introduction to Ecosystems, Matter, and Energy Theme (15 minutes)
  - *What Lives Here?*, Parts 1–2 (40 minutes)
  - *Systems Game* (8 minutes)
  - *Bunny Question*: Introduce during any *Thought Swap* when it seems appropriate (5 minutes)
  - *Food, Build, Do, Waste* (50 minutes)
  - *Case of the Disappearing Log* (60 minutes)
  - *What Lives Here?*, Parts 3–4 (30 minutes)
  - *Card Hike*: Ecosystems, Matter, and Energy Theme (60 minutes)
  - *What Lives Here?*, Part 5 (adapted): Reflecting On and Wrapping Up the Field Experience (including revisiting the *Bunny Question*) (20 minutes)

## ABOUT BEETLES™

**BEETLES™** (Better Environmental Education Teaching, Learning, and Expertise Sharing) provides environmental education programs nationally with research-based approaches and tools to continually improve their programs.

[www.beetlesproject.org](http://www.beetlesproject.org)

**Lawrence Hall of Science** is the public science center of the University of California, Berkeley. [www.lawrencehallofscience.org](http://www.lawrencehallofscience.org)

**BEETLES Team:** Craig Strang, Kevin Beals, Jemma Foreman, and Emilie Lygren

**Additional Contributors:** Emily Arnold, Lynn Barakos, José González, Catherine Halversen, Valeria Romero, and Emily Weiss

**Research Team:** Mathew Cannady, Melissa Collins, Rena Dorph, Aparajita Pande,

Valeria Romero, and Aujanee Young. Emeritus: Bernadette Chi, Juna Snow

**Project Consultants:** John (Jack) Muir Laws, Penny Sirota, and Mark Thomas

**Advisory Board:** Nicole Ardoin, Kevin Crowley, José González, Maggie Johnston, Celeste Royer, Bora Simmons, and Art Sussman. Emeritus: Kathy DiRanna, Kathryn Hayes, April Landale, John (Jack) Muir Laws, Jack Shea, Penny Sirota, Drew Talley, and Mark Thomas

**Editor:** Trudihope Schlomowitz

**Designer:** Barbara Clinton

The following programs contributed to the development of these materials by field testing and providing invaluable feedback. For a complete list of contributors and additional partners, please see [beetlesproject.org/about/partners/](http://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 Journeys, San Joaquin Outdoor Education, YMCA Camp Arroyo, Shady Creek Outdoor School, San Mateo Outdoor Education, Walden West Outdoor School, Westminster Woods.

**Other locations:** Balarat Outdoor Education, CO; Barrier Island Environmental Education Center, SC; Chincoteague Bay Field Station, VA; Eagle Bluff Environmental Learning Center, MN; Great Smoky Mountains Institute at Tremont, TN; Wellfleet Bay Wildlife Sanctuary Mass Audubon, MA; Mountain Trail Outdoor School, NC; NatureBridge (CA, WA, VA); Nature's Classroom (CT, MA, ME, NH, NY, RI); North Cascades Institute Mountain School, WA; NorthBay, MD; Outdoor Education Center at Camp Olympia, TX; The Ecology School, ME; UWSP Treehaven, WI; Wolf Ridge Environmental Learning Center, MN; YMCA Camp Mason Outdoor Center, NJ; and YMCA Erdman, HI.

**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; & Diversity by Cara Foster all from The Noun Project.

**Funding from 2012-2020 for BEETLES publications such as this one has been generously provided by the S.D. Bechtel, Jr. Foundation, The Dean Witter Foundation, Pisces Foundation, the Mary A. Crocker Trust.**



© 2020 by The Regents of the University of California. All rights reserved. These materials may be reproduced, copied, and distributed in their entirety for non-commercial educational purposes, but may not be sold, rented, or otherwise distributed. Neither text nor illustrations may be modified, excerpted or republished into other material without the prior express written consent of the copyright holder. The existing trademark and copyright notices may not be removed or obscured.

To contact BEETLES™, email [beetles@berkeley.edu](mailto:beetles@berkeley.edu)

