THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Student Activity Guide

What Can Live Here?

From the poles to the tropics, environmental factors like sunlight, temperature, and moisture, vary. Some of these variations are vast, like the differences between the cool, crisp conditions at the top of a mountain and the warmth at the bottom of a valley. These variations can also be more subtle, like the differences in temperature and moisture underneath and around a tree. Whether they are large or small, variations in environmental factors affect the distribution of organisms.

Many students have memorized a standard definition of environmental factors, but have not applied the concept to organisms or places they have observed directly. In *What Can Live Here?* students have the opportunity to learn this concept in context, connecting it to concrete observations and using it to think about the organisms that can live in an area. They also use technology in the form of Science Journal app and other tools to take their thinking deeper and take precise measurements. This is a powerful way for students to develop translatable skills and a curiosity mindset that can drive their own explorations and learning in the future.

Over the course of three sessions, which could be led on the same day or separately, students learn how to use tools to measure environmental factors, record the distribution of environmental factors in an outdoor area on a map, use their observations to identify patterns, make possible explanations for variations they observe, and develop understanding of how organisms can survive only where their needs are met. Students also reflect on their learning, recognizing the approaches they used as transferable skills to explore nature anywhere.

Guiding Question: What are environmental factors, how can they vary, and how can this influence organisms?.

Grade Level:
3-5.

Timing:
Intro and Practicing with Sensors: 20 minutes. Collecting data: 25 minutes. Discussing results and reflection: 30 minutes.

NEXT GENERATION SCIENCE STANDARDS

FEATURED PRACTICE

Obtaining, Evaluating, and Communicating Information, Constructing Explanations

FEATURED CROSSCUTTING CONCEPT

Patterns, Cause and Effect

DISCIPLINARY CORE IDEAS

Life Sciences (Interdependent Relationships in Ecosystems; Ecosystem Dynamics, Functioning, and Resilience; and Adaptation.)

COMMON CORE ELA

Speaking and listening, reading technical text.

COMMON CORE MATHEMATICS

Measurement and Data

For additional information about NGSS, go to page 19 of this guide.

What Can Live Here?

ACTIVITY OVERVIEW

What Can Live Here?	Learning Cycle Stages	Estimated Time
Session 1: Thinking about Environmental Factors and Practicing Measurements	Engage/Explore	20 minutes
Session 2: Mapping Environmental Factors	Explore/Explain	25 minutes
Session 3: Discussing Environmental Factors and Thinking about Organisms	Explain, Elaborate, Evaluate	30 minutes
TOTAL		**75 minutes**

In Session 1, students learn to use a thermometer, then practice measuring temperatures within the classroom. They also use the Google Science Journal app to record variations in the amount of ambient light in an area.

In Session 2, students use skills developed in the first session to identify high and low points of temperature and sunlight in an outdoor area, recording their results on a map.

In Session 3, students identify patterns in environmental factors they observed, then make explanations about what might have caused those variations. Students then discuss how environmental factors influence organisms, using their observations, prior knowledge, and grade-level appropriate text to make meaning about the location of the specific organisms they saw as well as wider patterns of the distribution of living things. Students may also make predictions about how environmental factors in the area might change, how organisms could respond to those changes, and how to mitigate those effects. Finally, students reflect on their learning and how the process was similar to or different from what a scientist might do.

TEACHING TIPS

Read the Background section. Beginning on page 15, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Observation first. Science depends on the ability to make, record, and think about accurate observations. It might seem like a simple skill, but it's worth spending some directed time teaching students how to make accurate observations. The activity *I Notice, I Wonder, It Reminds Me Of* (beetlesproject.org/resources/for-field-instructors/notice-wonder-reminds/) sets students up with the skills to make observations outside, and generates excitement for exploring nature. It is a great precursor to this activity and all outdoor science activities.

Weather. Students should be able to see some variation in temperature and light even on days where fog or clouds obscure the sun. It's possible to do this activity in the rain by covering tablets in plastic ziploc bags and using waterproof paper. In winter in colder climates, students may not see many organisms living but might see evidence of them (i.e., tracks, dead plants, etc.) that could help them make sense of their observations during the discussion. Doing the activity twice in different weather conditions can lead to different insights and sense-making about change over time.

A sequential, full learning experience. These sessions build on one another, and should be led in the sequence laid out in this writeup. They could be led one right after another or at separate times. Students' observations will be more accessible to them just after they have been outside, so the "flow" of learning will be best for students if the Sessions 2 and 3 are led together.

A more rigorous approach to investigation. Students could perform a more rigorous investigation by measuring variation in sunlight and temperature along a cross section transect (a straight line across an area of varying environmental conditions), and mapping the organisms they find along the same line. This more precise data could lead to higher level analysis and thinking with older students.

TEACHING NOTES

Materials created by The Lawrence Hall of Science
For more activities like these, visit the Lawrence Hall of Science BEETLES project at http://beetlesproject.org

MATERIALS

Session 1:

For each pair of students:

- Tablet with Science Journal app downloaded
- Thermometer

For the class:

- Environmental factors definition sign

Session 2:

For each pair of students:

- Tablet with Science Journal app downloaded
- Clipboard with map of survey area
- Pencil
- Thermometer

For the class:

- Environmental factors definition sign

Session 3:

For each pair of students:

- Clipboard with map of survey area (students filled this out in Session 2)
- Organism sheet or grade-level appropriate text about environmental factors (see example and instructions for preparation in Background section)

For the class:

- Large copy of map on butcher paper or projected version of the map
- Environmental factors definition sign
- *Optional:* wet erase markers or small and large red and blue stickers for recording class data.

GETTING READY

1. **Download the Google Science Journal app onto tablets, and familiarize yourself with it.** Download and familiarize yourself with the Science Journal app before you instruct students to use it. Practice using the different sensors, logging experiments, and navigating between the different features in the app so you are prepared to help students with the app during the lesson. The Science Journal website (makingscience.withgoogle.com/science-journal?lang=en) includes some activities, such as "Getting Started with Light," that are helpful for this purpose.
2. **Check thermometers.** Different types of thermometers can take different amounts of time to read air temperature. Do a "test run" with the thermometers you will be using to see how long it takes them to read temperature so you can prepare students for what to expect. It's hard to get accurate readings with some types of thermometers, especially those that are detachable from the scale (these are prone to sliding around, throwing off the reading). Try to find potential challenges with your thermometers in advance, so you can help students work through them.
3. **Decide on a survey area.** This activity is dependent on finding an area with some variation in environmental factors (i.e., sunlight, moisture, etc.), and some organisms (i.e., visible plants and/or animals) present. Look ahead of time to find a location that will work. A schoolyard, garden, or other landscaped space will do, but a space that has not been managed heavily by humans is ideal. Choose an area that is fairly small. In too large an area, students' data will be unfocused, making it difficult to notice any patterns or trends. Still, make sure the survey area is large enough that students will be able to move around comfortably and find several different points of variation in temperature and sunlight.
4. **Make a simple map of the survey area.** Use an aerial site photo or Google Maps satellite image to begin. Print out a copy and tape it to a window or drafting table. Then place a blank piece of paper over it, and trace the outlines of major landmarks, recognizable man-made objects, and larger plants. It is also possible to trace lines over a photograph in a program like Adobe Illustrator or Photoshop. The map doesn't need to show everything, just enough detail so students can recognize where they are and record data points properly. Make enough copies for one map per pair of students.
5. **Make a larger copy of the map for students to reference during the discussion.** Draw a large copy of the map, or project the image of the map onto the wall or a whiteboard. If you project from a document camera, tape the map in place on the table so it doesn't shift when students add their data. To draw the map, project the image onto butcher paper and trace it ahead of time. If you plan to use this map for multiple sessions, laminate it to protect it.
6. **Make organism sheet.** This resource with simple, grade-level appropriate text is used during students' discussion and thinking about how environmental factors influence the distribution of organisms in the study area. Even one sentence each about a couple of organisms is enough to help students think deeper. For more information and an example of what this resource can look like, see pages 14 and 24 in the Background section.
7. **Optional: Make a plan for how students will record data on the large map.** Depending on the attention span and dynamics of your group, their grade level, and your learning goals, decide whether or not to record class data on the large map. Students can usually speak to the general patterns they observed while looking at a copy of the map without placing their data there. If you want more accurate evidence to drive the discussion, or focus on the skill of looking for patterns, set up an efficient process for recording data. Students can show points of high and low temperature and sunlight with stickers of different sizes and colors, or symbols like "^T" for high temperature. A couple students can record data on the map at a time while others write reflections on their observations in the field, or while the class completes some other task.

Session 1: Thinking about Environmental Factors and Practicing Measurements

1. **Ask students to think about the desert and the arctic, and to *Think, Pair, Share* about what might be different between the two places.**
   a. Think about the desert and what it might be like there.
   b. Now think about the arctic, and what it might be like there.
   c. Talk with a partner, then share with the group: What are some ways the desert and arctic might be different from one another? (Students might say: *The desert would be hot, dry, no water, etc; the arctic snowy, cold, windy, etc.*).
2. **Define environmental factors.**
   a. Hold up a sign with this definition: Environmental factors are conditions in an area that influence living things.
   b. Explain that things like temperature, amount of water, and wind are environmental factors.
3. **Explain how environmental factors can be very different in different environments.**
   a. Environmental factors can be different in different types of places, like the desert vs. the arctic vs. the rainforest.
   b. But environmental factors can also be different within a smaller area, like in a schoolyard or a park, or around and underneath a tree.
4. **Explain that, like scientists, students will get to explore and look for differences in the environmental factors in the area, using tools to help them.**
   a. When scientists want to learn about a place and better understand the living things there, they sometimes measure the environmental factors in an area.
   b. You're going to get to study the environmental factors in this area, focusing on light and temperature.
5. **Explain that students will use a thermometer and the Google Science Journal app to take measurements outdoors, and will start off by practicing using the tools indoors.**
   a. We are going to use thermometers to measure temperature, and the Google Science Journal app (on a tablet) to measure the amount of sunlight in an outdoor area.
   b. First, we will practice using these tools inside the classroom so we're ready to take measurements when we go outside.
6. **Explain how to use a thermometer to measure temperature.**
   a. You will use a thermometer to measure temperature.
   b. Go to a few places you think might have higher or lower temperatures.

TEACHING NOTES

Students strike poses for desert and arctic. If you think it will help engage your students, you might want to ask them to strike a pose showing what they might look like first in the desert (students might fan themselves or put a hand on their foreheads), then in the arctic (students may pretend to shiver or curl up their bodies, imagining the cold).

Hard words. Research shows students need to encounter a new word at least seven times in context before it becomes part of their vocabulary. Ideally, they should hear it, read it, write it, and say it. Whenever you use the term "environmental factors," refer back to the written definition so students are reminded of its meaning as it's used in context.

Previous thermometer experience. If your students already know how to use a thermometer, you can skip the instructions on how to use them, and just let students practice taking measurements. Regardless, make sure students pay close attention to how long it takes for the thermometers to register the current temperature.

Fahrenheit (F.) or Celsius (C.)? While most scientific temperature measurements are recorded in Celsius, recording environmental temperatures in Fahrenheit can be useful because students tend to have an idea of what these temperatures "feel" like, and can relate the numbers they record to their prior experiences.

TEACHING NOTES

Doing it the wrong way. To review the procedure in an engaging way, it can be helpful to act out the "wrong" way to take measurements, and have students call out what to do to correct your approach. For instance:

- "I'm going to not work with my partner and just do it all myself."
- "OK, I'm going to hold the thermometer out for different amounts of time at every place."
- "I'm going to hold the thermometer like this (put fingers over bulb)."
- "I'm going to not do as good a job of moving the tablet around to find the highest sunlight reading here because I don't like this place as much as the other one I saw."

c. Wait for the thermometer to read the temperature, when the red line stops moving.

d. To read the temperature, look at the number next to the top of the red (or blue) line.

7. **Using a tablet as an example, show students how to use the Google Science Journal app to measure ambient light.** Explain:
    a. You'll use the Google Science Journal app to measure the amount of light.
    b. Open the Science Journal app, and go to the light sensor.
    c. Press the red button to begin recording the light data, then move the angle of the tablet around until you see the highest possible reading.
    d. Then, press the "stop experiment" button, and look at the Maximum light reading.
    e. Write a title for the location, such as, "under the rose bush."
    f. Hit the "back" arrow to return to the home screen and take another sunlight measurement in a different spot.

8. **Explain the importance of a "fair test" when taking measurements, and ask students how they can make sure they have a consistent approach to taking measurements.**
    a. Scientists need to get accurate data.
    b. To get data that's as accurate as possible, they try to do a "fair test" when taking measurements or conducting an experiment.
    c. In this case, we will try to take measurements exactly the same way each time.
    d. How can you make sure to take measurements the same way every time?

9. **Explain any of the following suggestions that students do not bring up.**
    a. For temperature, make sure to wait for the thermometer to rise or drop in temperature after moving to a new place, before taking a reading.
    b. For temperature, avoid holding the bulb of the thermometer, because that is where the temperature is sensed and the heat from your hand would throw off the measurement.
    c. For sunlight, move the tablet until you get the highest possible reading in an area.
    d. For sunlight, be careful not to cover the light sensor on the tablet because it will give you a reading that is too low.

10. **Explain that students will work in pairs to try to find areas of higher or lower temperature and light around the classroom.**
    a. Let's try this out. With a partner, use the tablet to find areas of high and low light.
    b. Use the thermometer to try to find areas of higher or lower temperature.
    c. Instead of just beginning to measure randomly, look around the classroom for areas you think might be higher or lower in light or temperature.
    d. Go to these places, take measurements, then move on to other areas, and see what you can figure out about the way light and temperature vary in the classroom.
    e. If you run into issues with using the thermometer or tablet, ask for help.

11. **Pass out materials, set any necessary boundaries or give reminders of classroom rules, and tell students to begin.**

12. **As students work, circulate, troubleshoot, and ask them questions about what they are noticing.**

13. **After students have had enough time to practice taking measurements, but before they lose interest, call them back and ask them to share any tricks they learned to take measurements efficiently and accurately.**

TEACHING NOTES

TEACHING NOTES

Measuring moisture and wind speed. The Google Science Journal app has an attachment that can be used to measure wind speed. Relatively inexpensive "moisture meters," available at most hardware stores, can measure soil moisture. If you think your students will be able to manage taking more types of measurements, consider including these in the activity, giving students the opportunity to practice with these instruments before using them in the field.

Taking photographs. To take photographs, students can use the photography function in the Google Science Journal app or the basic photography feature of the tablet.

Session 2: Mapping Environmental Factors

1. **Refer back to the definition of environmental factors, and explain that students will work in pairs to find high and low points of temperature and sunlight outside.**
    a. Environmental factors are conditions in an area that influence living things.
    b. We will now study the environmental factors in the [schoolyard, park, etc.] and use what you discover to think about the organisms that live there.
    c. In your teams of two, you're going to look for high and low points of temperature and sunlight outside.
    d. Go to areas you think might have higher or lower temperature or sunlight, and use the thermometer and the Google Science Journal app to measure the temperature and sunlight.
2. **Show students the map of the area and orient them to a few key landmarks.**
    a. Refer to a couple of key landmarks on the map to help orient students.
    b. Point these out to students both on the map and in the real world.
3. **Explain how to record temperature and light data.**
    a. You will record your temperature and light measurements on this map.
    b. When you take a measurement, put a dot on the map where you are and write down the number to show degrees Fahrenheit lux (for Android) or EV (iOS).Explain that when "time" is called, they should look back at their maps, circle the two highest and lowest points of temperature and sunlight, then photograph the environment and the living things in those places.
    a. After you've had time to take measurements, I will call "time."
    b. When I call time, look back at your map and circle the two highest and lowest points of temperature and sunlight.
    c. Then, return to those places and take photos of what the environment looks like there, and any living things that are there.
4. **Explain to students that they will make observations and while measuring they should pay attention to what it's like in the areas that are warmer or cooler, or brighter or less bright.**
    a. While you are taking measurements, pay attention to what it's like in the areas that are warmer or cooler, or brighter or less sunlight. What can you notice about these places?
    b. How are these areas similar? How are they different?
5. **Set expectations for sharing jobs.**
    a. One partner should take measurements on the tablet while the other measures temperature and records data on the map.
    b. You may switch jobs if you would like, to make sure each person gets the chance to use the tablet and record information the map.
6. **Based on your students' needs, set boundaries for exploration and describe rules for using the tablets and thermometers.**
7. **Ask if there are questions, then send students out to explore.**
8. **As students work, circulate, troubleshoot, and ask them questions about what they're noticing.**
9. **When students have had time to take several measurements of temperature and sunlight, call "time" and remind them to circle the two high and low points, and to take photographs of the environment and the living things in those places.**
10. **Tell students to meet up with another pair to become a group of four, and to take a couple of minutes to discuss patterns, observations or interesting things they noticed while taking measurements.**
    a. Meet with another group of two, and talk about what you noticed while taking measurements.
    b. Did you notice any patterns, similarities, or differences among places of higher or lower temperature or sunlight?
    c. What kinds of organisms did you see in which places?
    d. Was there anything that surprised you?

TEACHING NOTES

Adjustments for younger and older students. Younger students may need more time to take measurements, or could be directed to find just one high or low point for each environmental factor. Older students could be challenged to find several points, to be more thorough in their observations of organisms, or to complete a cross section of an area mapping the environmental factors at predetermined points.

Writing down observations if the activity will be completed on another day. If students will begin using their observations to make meaning about the distribution of environmental factors immediately after being outside, they will be able to call on recent memories and observations. If time passes between Sessions 2 and 3, students will likely forget details. If you will be leading Session 3 on a different day, or later in the day, give students about five minutes to write down any patterns or interesting observations they made while taking measurements.

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For more activities like these, visit the Lawrence Hall of Science BEETLES project at http://beetlesproject.org

TEACHING NOTES

Jumping into explanations. When students talk about patterns and observations, they sometimes begin making explanations (e.g., I think that all the low temperature parts are there because they are in places where the light is being blocked.) If a student makes an explanation, run with it. Call the group's' attention to it, and move on to the making explanations part of the discussion. For example: Did you all notice that? Carla was talking about a pattern she noticed, and she began to explain the pattern when she talked about what she thought was causing those places to be low in temperature. Let's all do that now—turn and talk with someone next to you, sharing explanations for what you think might have caused the different patterns of environmental factors we saw.

Modeling explanations and discussions. For all students, and particularly English learners, modeling what they will be doing during a discussion by "narrating" an example thought process out loud can be a way to help them know how to engage. When you model making an explanation, be sure to use language of uncertainty (i.e., saying Maybe or I think that...) For more information about supporting students in engaging in discussion and making explanations, see the Background Section.

Session 3: Discussing Environmental Factors and Thinking about Organisms

1. **OPTIONAL: If you've chosen to collect data on the large class map, instruct students to record their highs and lows there.**
   a. We are going to put all our data on a map.
   b. The big red stickers are for high temperature, the small ones for low temperature.
   c. The big blue ones are for high sunlight, the blue ones for low sunlight.
   d. Take the number you need of each, and put them on the big map.
   e. If someone already put their sticker where yours belongs, then put yours right next to it.
   f. You don't need to write the numbers you labeled or the number showing the temperature or sunlight reading.

2. **Using the map and the questions below, lead a discussion about high and low points, and any patterns that they notice now or while exploring.**
   a. Where did you find the the low and high points of each environmental factor? How does that compare with the rest of the class's data?
   b. What did you notice when you were taking measurements? Was there anything similar or different about the areas that were all "high" or "low" in one environmental factor?
   c. Ask students to identify patterns of one or more environmental factors, and think further about them, asking follow-up questions to elicit student thinking. For example:
   - *Let's look at all of the hottest areas. Where were they? Did the areas that were hottest have anything in common among them? Oh, interesting, Dimitri says the hottest areas are also the areas with the highest amounts of sunlight. Based on our map, would you all agree with Dimitri's statement?*
   - *What about sunlight? Which areas had the most or least sunlight?*
   - *Were there any highs or lows of environmental factors that seemed connected?*

3. **Briefly summarize any patterns the group noticed, or main points of the discussion.** For example:
   - *OK, so it seems like we all agree that, based on our observations, the coolest areas were next to the stream, and the hottest areas were on the blacktop.*
   - *It also seems like we agree that the areas with the most sunlight also were the hottest.*

4. **Ask students to make possible explanations for the patterns and variations of environmental factors on the map, modeling an example by talking out loud to yourself.**
   a. Scientists try to come up with possible explanations for patterns they have noticed, thinking about what might have caused them.
   b. In this case, that means we should think about what might have caused the hot areas to be hot, cool areas to be cool, bright areas to be bright, or dark areas to be dark.
   c. An example of what this might sound like is: "I think the shade of the building caused it to be cooler over there, because it was blocking the sun." or "I think the area behind the tree had the highest temperature, because it wasn't windy there but it was windy everywhere else."
   d. Think for a moment, then turn and talk about these questions:
   - *What might have caused one of the patterns, or high or low points, of temperature or sunlight?*
   - *Why are those spots hot, and others aren't?*

5. **Remind students of the definition of environmental factors and ask students to Turn & Talk about how one environmental factor might affect organisms, and model what the discussion could look like.**
   a. Environmental factors are conditions in an area that influence living things.
   b. Because different organisms need different amounts of moisture, temperature, sunlight, etc., the differences in environmental factors in an area influence which organisms can live there.
   c. Pick one environmental factor, and *Turn & Talk* with a partner about how it might influence organisms, by restricting where the organism could grow or be, aiding its survival, or in some other way.
   d. Here's an example of what that might sound like:
   - *OK, so let's think about wind. What does wind do? It can blow things over or make it hard to be up straight. Oh, and it makes it cold sometimes, but also dries things out sometimes. So I think that since wind dries things out or makes it hard to stand up straight, if there were a lot of wind somewhere it could be hard for plants to grow tall. And also, it might be bad for things like worms because they would dry out. But birds might be able to be there, or plants that need the wind to move their seeds.*

   e. Another way you might think about this could be by picking a couple different types of living things, and thinking about how environmental factors might influence them.

6. **Lead a discussion with the group about how environmental factors influence organisms, following students' interests and encouraging agreement, disagreement, and building on one another's ideas.**
   a. Ask students to respond to each others' ideas. For example:
   - *Carla said she thinks high winds could make it hard for slimy creatures like salamanders or worms, because the wind could dry them out. Does anyone agree? Disagree? Have a different idea?*
   - *Jamal just wondered whether burrowing animals like gophers would be able to survive in very dry soil. What do you all think about that?*

7. **Explain that because organisms can only survive where their needs for survival are met, the presence of certain organisms can be indicators of patterns of environmental factors on a longer scale.**
   a. We measured environmental factors during one moment of a day.
   b. But these environmental factors will change throughout the day, and over weeks, months, and years.

TEACHING NOTES

Keep it moving. The main points about conceptual development in this section happen in steps 5 and 6, when students start to think about how environmental factors influence organisms. To make sure you get to it, keep their discussion about explanations of patterns fairly brief, moving on while students still have momentum and attention for more discussion.

Assessment opportunity. Hearing what students say after this pair discussion is an opportunity to assess their learning on several levels. Listen to their statements. Do they seem to understand what environmental factors are? What kind of outside knowledge are they bringing in about organisms to support their explanations? How are they doing with their ability to create reasonable explanations based on evidence? What's the group's ability like to think together and build on each others' ideas?

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TEACHING NOTES

Bioindicators. Organisms that have very specific needs for water, sunlight, temperature, soil pH, or other environmental factors are called "bioindicators" because their presence indicates a specific range of one or more environmental factors. If you think your students can handle learning another term, introduce it here, and be sure they have repeated opportunities to use it and encounter it in context.

b. Organisms can only survive where their needs are met over time, not just during a moment.

c. If we find a certain type of plant or animal in a place, and we know the kinds of conditions it needs to survive, it can tell us something about the environmental factors in that place over the long term.

d. For example, if there is a plant somewhere and you know that type of plant needs a lot of water to survive, that usually means there is a consistent amount of water there over time, even if it might be drier at the time you observe it.

e. We'll use our observations of organisms and some other information to think about environmental factors in this area.

8. **Give students the organism sheet and explain that they can use the information on the cards, and their photographs and observations from their explorations, to make explanations about the patterns of long-term environmental factors in the area.**

   a. You will each get an organism sheet that has information about the needs of organisms you might have seen while recording data on your map.

   b. Use that information, and your photos and observations, to make explanations about the long-term patterns of environmental factors in the area.

   c. For example, if you found native grasses where there was high sunlight but not where there was low sunlight, you could use that information, along with what the sheet says about native grasses, to make an explanation that there is probably a consistent amount of sunlight there.

9. **After a few minutes, lead a discussion by asking students to share the explanations they made, eliciting their reasoning, then possibly offering more questions.**

   a. During the discussion, ask students what they think of each others' ideas, and encourage agreement, disagreement, or building on one another's thinking.

   b. Use the questions below to guide the discussion on their interest and level of knowledge, and your learning goals for them.

   c. Intersperse whole-group discussion with Turn & Talks, so all students have the chance to discuss their ideas. This can also help reengage the group if the energy is beginning to lag.

   d. Possible questions:

   - *What were some of the explanations you made about the long-term patterns of environmental factors here based on the information on the sheet and where you saw these organisms?*
   - *What does the presence of that organism make you think about the long-term patterns of sunlight in the area?*

   Other possible questions:

   - *How will the environmental factors in this area change throughout the day? Throughout the year?*
   - *What does the presence of that organism make you think about the long-term patterns of moisture in that area?*
   - *How will those changes affect the organisms you just saw/learned about?*
   - *What if it got much drier than it is now? Which organisms would be impacted? Which wouldn't?*
   - *Which organisms would be most impacted by a change in the water level? What about the amount of sunlight?*
   - *If we wanted more of X type of organism, what might we do to make the environmental factors ideal for it? What if we wanted less of X type of organism?*
   - *How could we change environmental factors in an area, and what effects might that have on organisms, or other environmental factors?*

10. **After students have had time for discussion, but before they lose steam, close the conversation by summarizing some of the main points talked about.**

11. **Explain that this conversation is similar to one that scientists might have, but it would require much more data to truly understand environmental factors and organisms in the area.**

    a. This conversation is similar to one scientists might have when they are trying to understand an area, the things that live there, and how they might respond to changes in environmental factors.

    b. But to truly understand the patterns and variations in environmental factors and living things in an area, scientists would need to do more studies and get a lot more data from different places over a longer period of time.

    c. They would also need to think about how humans may have influenced the distribution of organisms in this area, either directly, by planting a plant or moving an animal, or indirectly, by altering the environmental factors like moisture.

12. **Explain that students used transferable learning tools like looking for patterns, thinking about cause and effect, making explanations, and recording observations.**

    a. When you were looking for patterns of environmental factors, recording them on maps and making explanations for how the patterns might influence organisms, you were using some of the tools and approaches scientists might use.

    d. You can use these tools and approaches to learn more about organisms and their surroundings anywhere you go.

    e. When you see an organism, it can be interesting to think about what kinds of environmental factors influence it, or to read about organisms and learn what kinds of conditions they can live in.

    f. It can also be interesting to observe patterns of environmental factors when you get to a new place, and to think about how they might be connected to the organisms you see there.

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Summarizing main points at the end of a discussion. A complex, open-ended discussion like this can sometimes feel unresolved since there is often no "right answer" to arrive at. Taking a moment at the end to summarize the points discussed can help participants trace their thinking and provide a feeling of accomplishment.

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Organism Sheet

The organism sheet helps students use general information about how environmental factors influence organisms. This allows them to think more deeply about their observations and make possible explanations about long-term trends in environmental factors in the area. This resource does not need to be complicated. A list of just 5 to 10 organisms that students will see during their explorations, as well as information about how one environmental factor influences each type of organism, is enough to take students' thinking deeper.

To decide which organisms to include, poke around in your study area and see what's there. Organisms like slugs, lizards, or spiders are easy to identify without a field guide. If you find organisms you are unfamiliar with that are present in large numbers, check a local field guide for them. Use books or online resources on ecology to find information about the needs and survival constraints of each organism.

This example is written for coastal California. Some of the species, like native grasses and rushes, have specific requirements unique to this area. Other more general organisms, like spiders and worms, have similar environmental needs no matter where they are. If there is not time to create an organism sheet specific to your area, use the organisms from the example sheet that are found in most places (e.g., worms, lichens, spiders), and add a couple of plants in your area.

Examples of possible organisms include:

- **Spiders:** Need to live where there are things to attach their webs to, and where there are plenty of insects to eat.
- **Lizards:** Can't produce heat to warm their bodies, which is why they need sunlight, especially morning sunlight.
- **Slugs:** Might dry out and die if in sunlight too long, which is why they tend to come out at night and spend the daytime in moist places.
- **Dandelions:** Need sunlight to survive, and eventually, need wind to disperse their seeds.
- **Worms:** Need moisture and darkness. If in sunlight or in a dry area for too long, they die.
- **Salamanders:** Have slimy, moist skin. Since they breathe through their skin, if they get too dry they can't survive.
- **Lichens:** Are part plant so they need sunlight to survive. If you find lichen somewhere, it means sunlight is there for at least part of the day and year.
- **Ferns:** Need some light just like every plant, but they also need to live in a place that is a little darker and damper than most other plants.
- **Fungi:** Fungi usually only grow where there is a lot of moisture.

Background

Teaching Knowledge

Building understanding of a definition through real world experience. Many students have memorized the standard definition of environmental factors, but have not applied the concept to organisms or places they have observed directly. In What Can Live Here? students have the opportunity to connect this definition to concrete observations and ideas, spurring a deeper and more meaningful understanding of the concept. It is essential in this context that students are given ample time to explore, learn to use the tools, and struggle with ideas in order to develop their understanding of environmental factors and how they influence organisms. Even if the result of student's observations is that there was little to no variation in environmental factors or that the organisms seem to be randomly distributed, this is valuable information; in science it is as important to understand what is not happening as it is to figure out what is happening. Whenever students discuss ideas, it is an opportunity to listen and get a sense of where their understanding is. Use these moments to figure out where they are with their understanding, and to make decisions about whether it is important for students to engage in more learning experiences to further develop their conceptual understanding.

Using tools and developing transferable skills. In this series of activities, students learn how to use physical tools (a thermometer and the Science Journal app) to take measurements. By using these instruments to study environmental factors, students also learn "thinking tools," or approaches they can use in the future to explore the world around them. The reflection is critical for helping students think about how they might explore environmental factors in other areas, and use the Science Journal app in the future to record their observations, measure variation in light, and learn.

The Sequence of the Activity: The 5 E's or Learning Cycle

This activity was designed using the Learning Cycle or 5 E's model. It has been thoughtfully sequenced to help students build understanding based on their prior knowledge, observations, and information encountered during the activity. Keeping this sequence of learning will lead to deeper and "stickier" learning on the part of the students.

Engaging students in meaning-making discussions. Participating in discussions can be challenging for students for all sorts of reasons. Students may be socially shy, need processing time to formulate their ideas, or be learning the language spoken in the classroom. But all students can participate in discussions with the right support.

Build up to whole-group discussions about science content by doing pair talk and offering routines and scaffolding to support participation. Offering writing time before discussion, using scaffolds like sentence frames (such as those below), and modeling an example of a possible discussion just before students talk about a question are ways to support students in engaging in discussion. It is also important to build your own skills in leading discussions and developing instructor "moves" that elicit student thinking, create an equitable environment for conversation, and guide the flow of the discussion. *See the TERC Talk Science Primer* and *BEETLES Discussion Resources* (beetlesproject.org/

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resources/integrating-discussion-instruction/) to help build skills in leading meaning-making scientific discussion.

Sentence starters to support participation in meaning-making science discussions:

Language of uncertainty:

- I think that…
- Maybe…
- Based on my experience…
- The evidence seems to show that…
- Perhaps…or…
- I wonder if…

Thinking together:

- To add to what ______________ said…
- I disagree with ______________ because…
- I agree with ______________ because…
- Another idea could be…
- To go back to what ______________ was saying…
- Could you say more about what makes you think that?

Engaging students in constructing explanations. These sentence starters can be a way to ease students into making explanations. This is a skill that can be confusing for students at first, but coaching them to move from observation to explanation is a helpful way to support students in learning. Introduce the idea of explanations to students and provide plenty of examples initially. When students identify an observation, or pick up on a pattern, use this as an opportunity to prompt them to make explanations.

For example: "Alondra noticed that there is a pattern of brown dots appearing around the edges of every one of these leaves. Scientists make observations and look for patterns, and sometimes, once they have found a pattern, they try to make an explanation for what might be causing it. Let's give that a try. What are some possible explanations for what might have caused those brown dots around the edge of the leaves?"

When a student shares an explanation, ask them "What makes you think that?" or "What's your evidence for that?" to help them learn to include their evidence and reasoning. Then ask the group, "Does anyone want to react to that explanation or propose a different explanation?

It's often helpful to focus on making observations first, especially in nature, because it is so easy to "jump the gun" and start making explanations without basing them on any observations or evidence (or on very little evidence). Some directed practice with making observations, and some focused observations of a phenomena can then become the base of evidence students draw on, or the thing they are trying to explain. The BEETLES activity *I Notice, I Wonder, It Reminds Me Of* (//beetlesproject.org/resources/for-field-instructors/notice-wonder-reminds/) focuses on helping students develop the capacity to make observations. The activity *Nature Scene Investigators* is great for helping students build skills in making explanations, and offers the opportunity for the instructor to coach them along the way.

Conceptual Knowledge

Environmental Factors

Environmental factors include sunlight, temperature, water, wind, soil pH, soil composition, and elevation. Each of these factors vary on small and large scales, and the causes of these variations are different on different scales. In a larger sense, regional weather patterns lead to the general trends of temperature, moisture, and wind, while geographic features affect the patterns of sunlight and the composition of soil.

On a smaller scale, the amount of sunlight in an area can be altered by geographic features or manmade structures. Moisture is partly tied to the amount of rainfall in an area, and is also affected by the landscape, collecting in lower areas or sticking around in places with little to no sunlight, and no means of evaporation.

Habitat

A habitat is where an organisms' needs for survival are met—where the organism can find food and water, and survive in the environmental conditions. Different organisms have different habitats, based on the range of environmental factors they can tolerate, and the proximity of food sources, water, and shelter.

Impacts on Organisms

Each of these factors affects different types of organisms in different ways. Understanding how environmental factors affect organisms in general, and what kinds of habitats different organisms prefer, can provide valuable information to share with students to help them deepen their thinking. This can also help you make decisions about which local organisms to put on your information sheet for students.

Sunlight

Plants use sunlight to photosynthesize and produce food. Sunlight also regulates and promotes the growth and development of basic plant structures, as well as flowers and fruiting bodies. The distribution of plants is affected by access to sunlight; where there isn't sunlight, there likely won't be many plants. Patterns students might notice include broader leafed plants lower to the ground, with the larger leaf surfaces functioning to absorb limited sunlight. Areas with low ambient sunlight, whether due to the light being blocked by man-made structures or other plants, are likely to also have fewer plants.

Animals are less affected by sunlight, but their rates of metabolism and breeding are somewhat tied to the amount of light in a day. "Cold-blooded" animals like reptiles that get their warmth from outside sources need a certain amount of sunlight (and temperature) in order to be able to move, and their presence in relation to shade or sun is directly influenced by these environmental factors. For example, you'll find reptiles in warm, sunny areas in winter or in the morning, and in shady areas during hotter periods.

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Temperature

Temperature and ambient sunlight are environmental factors that are often linked, with hotter areas found in higher sunlight and cooler areas where the light is blocked. Temperature can have similar effects on "cold-blooded" animals as sunlight does, restricting their whereabouts to warmer or colder areas depending on the ambient temperature.

Water

There is a wide spectrum of the amount of water plants need. Some need far more water than others and are only found along the edges of established bodies of water or in highly moist areas. Others are only in more arid areas with consistently less water. Still others are able to live in a broad range of moisture conditions. Doing research on the water needs of the specific plants in your area can help frame the conversation when students begin to make explanations about the patterns of distribution of organisms.

All animals need water in some form. Some are more affected by the amount of moisture in the environment than others. Animals like worms, salamanders, millipedes, and other kinds of insects and invertebrates need a certain level of moisture to avoid drying out. The presence or absence of these types of organisms is a good indicator of the moisture level in the area.

Wind

Wind can dry out plants, affecting the top part of the plant where growth is generated and limiting the plant's growth. This and the strain put on plants structurally can also make it difficult for taller plants to establish themselves in very windy areas. Wind is also a form of dispersal for the seeds of many plants, including grasses, dandelions, many trees, and some kinds of shrubs. If there are plants in an area that have wind-dispersed seeds, it is a good indicator of the somewhat consistent presence of wind.

Other Environmental Factors

Factors like elevation, slope, and soil pH could be topics for investigation for older students, or classes wanting to do a "deeper dive" into thinking about environmental factors.

Study and Use of Environmental Factors

Studying environmental factors and the distribution of organisms in relation to them is one of the ways scientists think about the potential impacts of human activities in ecosystems. In learning about the current patterns and trends in an area, they can make predictions about how organisms might respond if one or more environmental factors change. These studies are usually conducted over months or years by using very precise methods for data collection and in multiple locations.

The observations students make tell them about the environmental factors at a point in time, but it's important they understand the difference between their studies and the long-term studies that a scientist would need in order to make any solid conclusions about the environmental factors in an area and their effects on organisms. Reflecting on the nature of science is critical to students' understanding of the discipline.

Connections to Next Generation Science Standards (NGSS)

This activity is designed to incorporate the "three-dimensional" learning that is called for in the Next Generation Science Standards (NGSS). Three-dimensional learning weaves together Science 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 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. They're interesting and fun, too!

In *What Can Live Here?*, students:

- Engage in the practices of Constructing Explanations and Obtaining, Evaluating, and Communicating Information.
- Relate what they learn to the Crosscutting Concepts, Patterns, and Cause and Effect.
- Build understanding of Disciplinary Core Ideas related to Interdependent Relationships in Ecosystems, Ecosystem Dynamics, Functioning, Resilience, and Adaptation.

Featured Science and Engineering Practices

Engaging students in Constructing Explanations. According to the National Research Council's (NRC) 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 natural phenomena.

In *What Can Live Here?*, students:

- Construct explanations of the patterns of environmental factors they noticed, using their own observations and background knowledge as evidence.
- Engage in this practice when they discuss how organisms are influenced by environmental factors.
- Depending on the questions asked in the discussion portion of the activity, students might construct explanations in a predictive way, thinking about what might happen to organisms in the future given possible changes in environmental factors.

For students to fully engage in this practice, they need to go beyond just making this kind of explanation. They also need to consciously use tentative language ("I think that…"), base their explanations on evidence, and consider alternate explanations based on that evidence. The large group discussion in which students share their ideas about possible causes of variation in environmental factors and impacts on organisms is a critical step in this activity because it's an opportunity to coach students to include their

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evidence and reasoning when they give an explanation, to use the language of uncertainty, and to consider alternate explanations.

Engaging students in Obtaining, Evaluating, and Communicating Information. *According to the NGSS, it's important for scientists 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.*

In *What Can Live Here?*, students:

- Practice obtaining and recording information as they use sensors to measure environmental factors and write this information on their maps.
- Make use of this information in discussion with peers, practicing key skills of communication of their ideas.
- Practice accessing technical text while reading the Organism Sheet, using this information to further their understanding and processing it in their subsequent discussions.

For students to fully engage in this practice, they must learn to evaluate the quality of sources based on different criteria, and learn to communicate their ideas in different modes, adjusting for the needs of different audiences. Be sure to provide these opportunities for students in other learning experiences to deepen their capacity with this practice.

Featured Crosscutting Concepts

Learning science through the lens of Patterns. The idea that patterns exist everywhere, and that taking note of them can lead to questions about what causes them, is an important lens for scientific investigations. According to the NRC's A Framework for K–12 Science Education, students should be using patterns to think about their observations and explanations across different disciplines of science (and mathematics!).

- In *What Can Live Here?*, students first use the lens of patterns when they are taking measurements, as they attempt to notice differences and similarities between areas of higher or lower temperature or sunlight.
- Later, they deepen their use of this idea when they look for patterns in the distribution of environmental factors and organisms.
- On a larger scale, students think about patterns when they think generally about how environmental factors affect where organisms can and cannot survive.

Learning Science through the lens of Cause and Effect. When scientists make explanations for how or why something happens, they're thinking about the connection between cause and effect. What we can observe of the natural world are the "effects" of many potential "causes." Understanding relationships between cause and effect leads to a deeper understanding of the world, which is helpful in making predictions and explanations about what might happen in similar conditions in the future.

- In *What Can Live Here?*, students begin applying the idea of Cause and Effect when they attempt to explain the possible causes for the patterns of environmental factors they measured.
- Students continue to think about Cause and Effect relationships when they think and talk about how environmental factors influence the distribution of organisms.
- They also make some predictions of possible future effects on organisms if there were to be changes in environmental factors.

If students don't get the chance to think about how the ideas of Patterns and Cause and Effect connect to the explanations they're making, they miss the opportunity to recognize that these are scientific thinking tools, and important ways of looking at the natural world. They also might not realize that the ideas of Patterns and Cause and Effect are also helpful in other situations, like classifying organisms or making predictions about the merits of different environmental solutions. Emphasize this with students, and give them more opportunities in their experiences to apply these "big ideas" in other contexts, reflecting afterward on how they helped them to think.

Featured Disciplinary Core Ideas

Building a foundation for understanding Disciplinary Core Ideas. Students need multiple learning experiences to build their understanding of Disciplinary Core Ideas. In *What Can Live Here?* students have an opportunity to develop understanding of some Disciplinary Core Ideas related to *Interdependent Relationships in Ecosystems* (LS2.A), *Ecosystem Dynamics, Functioning, and Resilience* (LS2.D), and *Adaptation* (LS4.C).

- As students look at patterns of environmental factors and think about how they might affect organisms, they build understanding of the idea that organisms can only survive where their needs are met, and how organisms depend on their interactions with nonliving factors (LS2.A).
- As students think about what might happen to organisms when environmental factors in the area shift, they build understanding of how environmental changes that affect a place's physical characteristics cause some organisms to survive and reproduce, while others to move and some die (LS2.C).
- As students read and think about organisms they observe and how they are influenced by environmental factors, they develop foundational understanding of the idea that in any particular environment, some organisms survive well, some survive less well, and others cannot survive at all (LS4.C).

You can informally assess student understanding of these concepts during different stages of the activity through individual interactions with students, and by listening carefully during the group discussions. This information can help decide which ideas to focus on in future lessons, so follow-up activities or discussions can be used to further student understanding in these content areas.

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Performance Expectations to Work Toward

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 Disciplinary Core Ideas and Science Practices, as well as their ability to apply the Crosscutting Concepts. They do not represent a "curriculum" to be taught to students. Below are some of the performance expectations that this activity could 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.

3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

4-ESS2-2 Earth's Systems

Analyze and interpret data from maps to describe patterns of Earth's features.

5-ESS3-1 Earth and Human Activity

Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Common Core Connections

Time spent engaging in NGSS-designed science activities does not distract from working to meet Common Core requirements; it actually supports students' fulfillment of the standards. As students discuss ideas with each other, they are practicing key speaking and listening skills.

As students consult grade-level text and use it to further their understanding of science concepts, they are learning how to read subject technical writing and developing literacy in science. Giving students repeated opportunities to engage in this kind of scientific learning will further support their learning in other aspects of the Common Core Standards. Using tools to measure sunlight and temperature and thinking about patterns in data also help students fulfill the standards related to Measurement and Data.

Optional Extensions

- Students conduct a more rigorous study of changes in environmental factors over time by measuring them in a cross section or transect (a survey along a straight line across an area of varying environmental conditions, vegetation, or elevation) of an area once every week.
- Students go back outside to look for organisms, noticing the environmental conditions where they are found, and return to observe them over a subsequent period of time.
- Students pick one place around the classroom and briefly record environmental factors there once a week at the same time of day, noticing trends.
- Students could use tools and other methods to study variation in environmental factors that impact their community, like sound pollution, air pollution, or heat islands (urban areas with increased temperatures due to the heat-absorbent properties of asphalt).
- Students use the information gathered from observations and sources to engage in argument from evidence about some local environmental management decision, like where to plant a garden or how to create an environment more ideal for a certain type of organism.

Connected Activities

- BEETLES (www.beetlesproject.org) *Classroom Activities: Evaluating Sources, Evaluating Evidence,* and *Food Web*
- BEETLES Activities: *What Lives Here, I Notice, I Wonder, It Reminds Me Of,* and *Argumentation Routine* (used to focus on a question about how to manage an organism)

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What Lives Here? Example Organism Sheet

image © Anita Ritenour

Spiders need to live where there are things to attach their webs to, and where there are plenty of insects to eat.

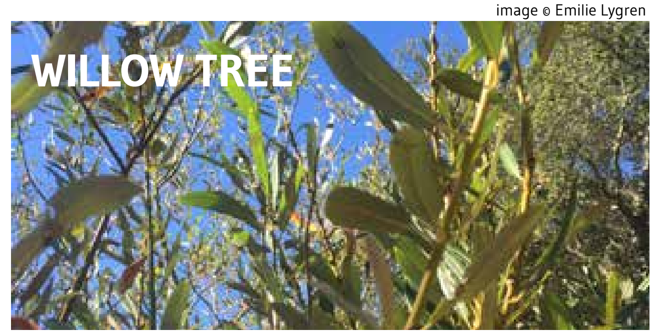
image © Emilie Lygren

Many native grassess from California are able to grow where it is dry and hot, and survive without much water.

image © pfly

Worms need moisture and darkness. If in the sun or a dry area for too long, they die.

image © Emilie Lygren

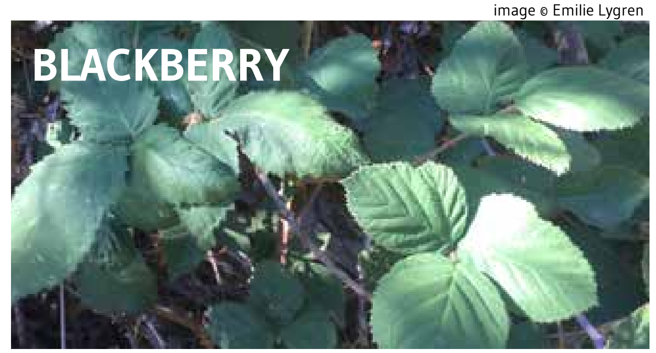


Willows need more water than many other types of trees.

image © Emilie Lygren

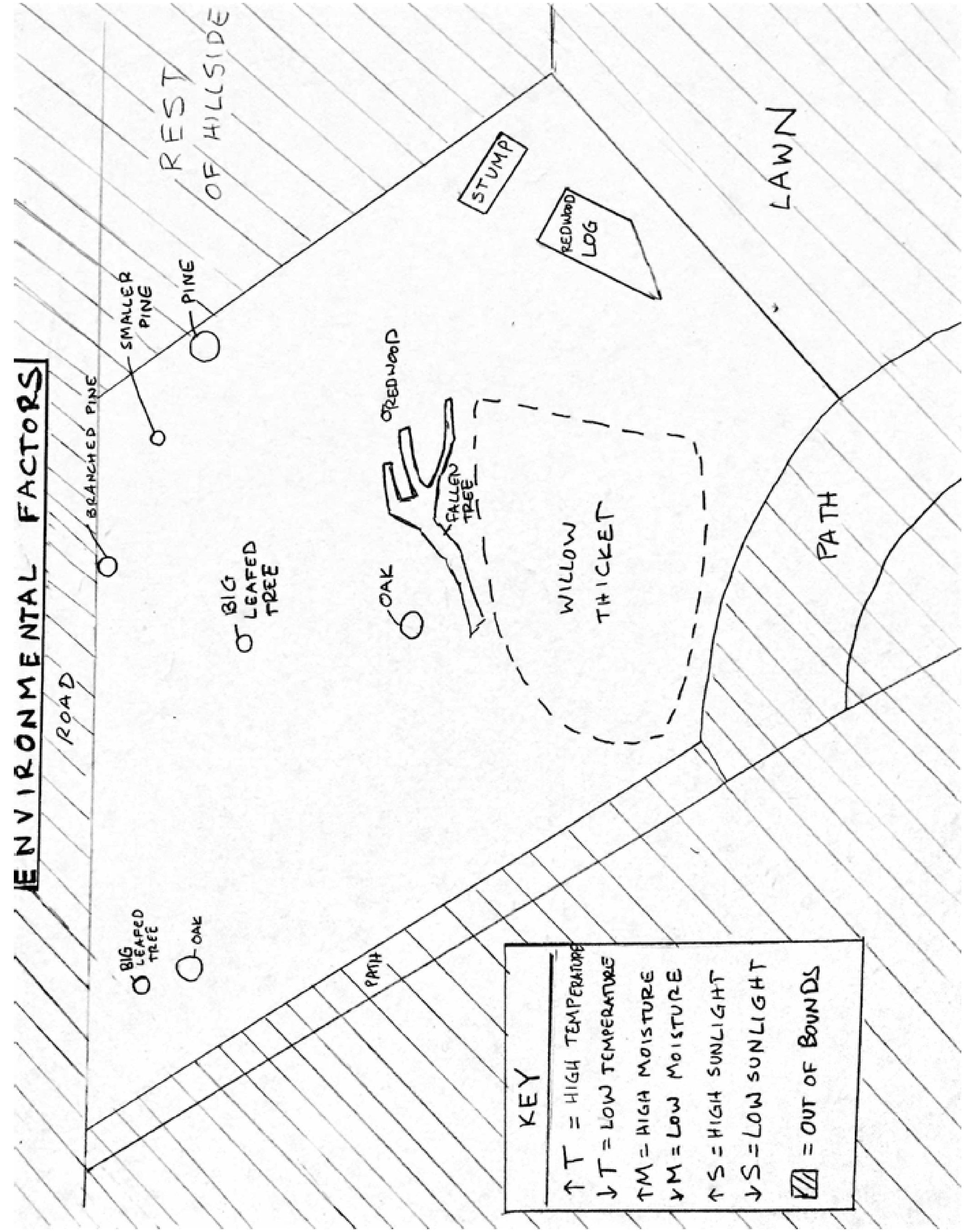
A rush is similar to a grass, but usually needs more water and less sun than grasses do.

image © Emilie Lygren



Blackberry can grow almost any-where. They need some light, and can live where it is too dry for some other plants.

Sample Map



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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