IS3 Grade Three Instructional Segment 3: Surviving in Different Environments

While genetics plays an important role in shaping organisms, IS3 focuses on the organism's interaction with the environment. Every organism has its needs met by the surrounding environment, but not all organisms can survive in all environments. Some plants and animals have traits that allow them to survive better in a specific environment, which ties directly to the concepts of the variation in traits from IS2 and forms the foundation for understanding natural selection in later grades. At this level, students gather specific evidence of **cause and effect relationships [CCC-2]** where the environment affects which organisms survive (EP&C II). They draw on observations of both living organisms and fossils.

GRADE THREE INSTRUCTIONAL SEGMENT 3: SURVIVING IN DIFFERENT ENVIRONMENTS

Guiding Questions

- How does the environment affect living organisms?
- How do organisms' traits help them survive in different environments?
- What happens to organisms when the environment changes?

Performance Expectations

Students who demonstrate understanding can do the following:

3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment. [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted, and a pet dog that is given too much food and little exercise may become overweight.]

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. [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]

3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organism and the environments in which they lived long ago. [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [*Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.*]

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.* [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [*Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.*]

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3–5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

**The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.*

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
[SEP-1] Asking Questions and Defining Problems [SEP-2] Developing and Using Models [SEP-3] Planning and Carrying Out Investigations [SEP-4] Analyzing and Interpreting Data [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering) [SEP-7] Engaging in Argument from Evidence [SEP-8] Obtaining, Evaluating, and Communicating Information	LS3.A: Inheritance of Traits LS3.B: Variation of Traits LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.A: Evidence of Common Ancestry and Diversity LS4.C: Adaptation LS4.D: Biodiversity and Humans ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions	[CCC-1] Patterns [CCC-2] Cause and Effect: Mechanism and Explanation [CCC-3] Scale, Proportion, and Quantity [CCC-4] Systems and System Models

Highlighted California Environmental Principles and Concepts:
Principle II The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.

Principle V Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

CA CCSS Math Connections: MP.2, MP.5; 3.MD.3

CA CCSS for ELA/Literacy Connections: W.3.1, 7; RI.3.1, 3, 5, 7; SL.3.1

CA ELD Standards Connections: ELD.PI.3.1, 10, 11

Students are likely to have some prior knowledge that if they eat unhealthy food, they might become overweight even if their parents are very thin. Could the foods they eat also affect their height, even if their parents are both tall? Some traits seem to depend on what happens to us during our lives. Does the availability of food affect the traits of other plants and animals? Can human-caused changes to the environment affect the traits of plants and animals?

Students can explore what happens when the same type of plant grows in places that have different environmental conditions on their schoolyard. First they must find two plants in different locations that are the same type and make specific observations of the individual plants and their environments, measuring specific **quantities [CCC-3]** when possible (number of leaves or flowers, height, largest leaf size for plants, temperature for environment; students can even quantify the soil hardness by measuring how far a nail penetrates when hitting it three times with a hammer). How does each of the environmental conditions they describe affect the plant's ability to meet its needs? Teachers can focus on having students identify specific living and nonliving factors of the environment as well as human-caused changes (EP&C II), building on observations they made about habitats in grade two (2-LS4-1). Would they expect the plant to be more successful in one of the environments rather than the other (because its needs are met better there)? Based on their observations, is there evidence that one plant was growing more successfully than the other? While this activity motivates questions about the role of the environment in determining traits, students do not have enough information to **support an argument [SEP-7]** that the environment causes different growth rates. Maybe the differences in plant traits have a different **cause [CCC-2]**, like one plant being much older than the other or that the individual plants came from different parents with different traits. Teachers can explicitly emphasize the nature of science and discuss how investigations sometimes begin by making "imperfect" observations that lead to questions. Scientists then refine their **questions [SEP-1]** and make more systematic observations to answer them. Students should be ready to **plan such an investigation [SEP-3]**.

Opportunities for Mathematics Connections

Students can measure the effects of environment on the growth of seedlings. They **plan an investigation [SEP-3]** to **measure [CCC-3]** the **effect [CCC-2]** of one single nonliving factor in the environment on one single trait of a plant. They can simulate drought conditions, compare the growth in soil versus a *hydroponic* environment where the seed only has access to water, or vary the amount of sunlight hours per day. They measure the volume of water added (3.MD.2). As students make regular observations of each plant, they make numerical measurements of the height (3.MD.4) or number of leaves alongside descriptions and sketches. They should be able to report their findings as graphs (3.MD.3) and **explain [SEP-6]** how their observations are evidence of the DCI that environment can influence specific traits (3-LS3-2).

CA CCSSM: 3.MD.2-4, MP 2, 5

Thus far in grade three, students have developed a conceptual **model [SEP 2]** that both genetic inheritance and environmental factors, including human activities (EP&C II), affect traits (figure 4.5). There is an important difference between inherited traits and traits altered by the environment (*acquired traits*): only inherited traits are passed on to offspring. A mother whose skin is red from sunburn will not give birth to a sunburned baby. In an interesting demonstration of the nature of science, new discoveries in genetics are finding that there are some additional relationships between inherited traits and acquired traits where environmental conditions can deactivate certain genes in DNA. Understanding this new field of science, called *epigenetics*, is well beyond the third-grade level, but teachers should be aware that whenever scientists use labels to distinguish between categories (like inherited versus acquired traits), the distinction is often more complicated. Grade three teachers lay the groundwork by explicitly describing the scientific models as being subject to revision and refinement.

Figure 4.5. Conceptual Model of Factors that Affect Traits

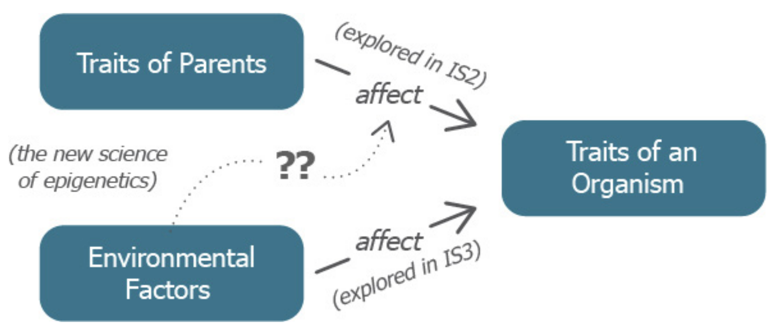
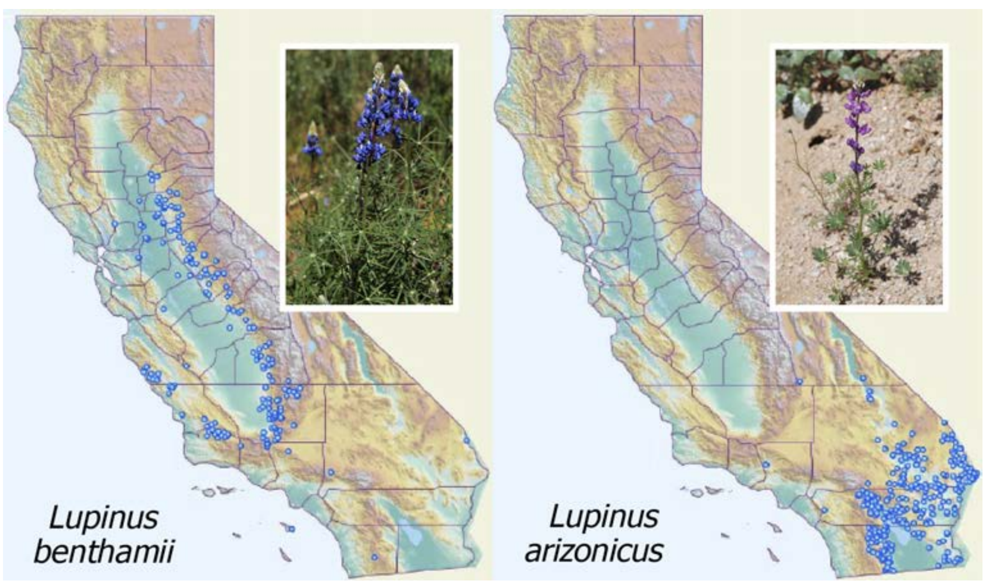


Diagram by M. d'Alessio
Long description of Figure 4.5.

In their investigations, students find that some environmental conditions are so poor that certain plants are not able to survive. In grade two, students observed a correlation, a **pattern [CCC-1]** that showed different levels of biodiversity in different habitats (2-LS4-1). Students extend this idea in grade three by **arguing [SEP-7]** that this pattern can be explained by a **cause and effect relationship [CCC-2]** between environmental conditions and survival. To construct this argument, they need evidence. Their experimental results are important pieces of evidence, but they also need to show that certain habitats have characteristics that match the needs of different organisms. Students can **obtain information [SEP-8]** about the different habitats in California and the needs of organisms that live within them. How do the traits of animals that live in the desert differ from those that live in the mountains? What special traits do marine plants and animals have that land organisms do not? Students could compare the growth of a California native salt marsh grass to turf grass in soils with different salt content. Students can gather evidence about the geographic distribution of specific organisms that show that not only do physical conditions affect survival of plants in the classroom, but they also have a real effect on where plants can survive in nature. Students can use online maps to identify patterns in where different species live throughout the state (California Education and the Environment Initiative 2013). A database of native plants such as lupines (Calflora 2016) reveal that some species live across many parts of California but only in certain narrow elevation ranges or bands along the coast, while others live in only an isolated region where very specific conditions enable its survival (figure 4.6). Examining the maps requires students to draw on their understanding of representations of landform shapes from grade two (2-ESS2-2). Students can describe how the traits of each plant differ in order to survive in these different conditions. Some databases even allow teachers to contribute photos and locations of plants and animals that they have observed in their local area so that students can be citizen scientists.

Figure 4.6. Snapshots from a Web Database of California Plants



Sources: Calflora 2015a; Christie 2002; Calflora 2015b; Andre 2011
Long description of Figure 4.6.

Interpreting Fossils

As an assessment of students' models of the relationship between organisms' traits and the locations where they live, students can play a matching game where they decide which different organisms are likely to live in which different environments. The assessment is not whether the student has identified an organism that actually lives in a specific setting, but rather that the student has **engaged in arguments from the evidence [SEP-7]** in the photos or information. This assessment sets the stage for introducing fossil evidence of past environments.

Fossils, usually found in layers of rock, are evidence of the existence of ancient life. Fossils preserve the shape of parts of ancient organisms' bodies that lived and died in the place where the fossil was found. The standard classroom activity where students create an impression of a plant or animal body part, gives students a tangible understanding of what a fossil is (or at least one type of fossil), but the emphasis in the CA NGSS is on the stories fossils tell about ancient environments and not simply on how a fossil forms. From the previous activities, students know that the shape and size of different parts of an organism depend upon the environmental conditions in which they live. Interpreting fossils is very much like the matching game assessment in the previous paragraph. The **structures [CCC-6]** of organisms preserved by fossils provide clues about the environmental conditions that were present when the fossil formed. Even if the fossilized organism is long extinct, it may show evidence of the same adaptations as those found in modern plants or animals. On the other hand, if students observe that a fossil at one location looks very different from the organisms that live in that spot today, they have evidence that the environment must have changed since the ancient organism was alive (3-LS4-1).

Urban examples that resemble fossils are imprints of leaves or footprints of a dog trapped in the concrete (U.S. Geological Survey [USGS] 2015b). Students can investigate imprints left in concrete surrounding the school, a local fossil, or pictures of fossils and come up with a story about what the local community may have been like when the modern-day fossil formed. In the case of a sidewalk impression, the environment has not changed much since the concrete dried (dogs still roam the neighborhood and the same tree may still be growing beside the sidewalk). The fossils that students can discover in California include some organisms that are very different from those that live here today. For example, the fossils of giant sea creatures are found in the hills and mountains around California, telling us that these pieces of land were once under water (e.g., Plesiosaur fossil found near Fresno). Teachers can obtain a list of fossils found in their county using an online database (University of California Museum of Paleontology n.d.) or have students explore more user-friendly online databases that may contain less detailed information (The Paleontology Portal n.d.). Then they can analyze a collection of fossils found in the same place to determine what the environment was like in the geologic past (3-LS4-1).

Predicting and Minimizing Human Impacts on Ecosystems

Fossils provide evidence that ecosystems can change over millions of years, but students can also predict the impact of shorter-term changes to ecosystems. By analyzing pictures or paintings of their local community from historical documents, students can describe how humans changed the environmental conditions when they developed the land (EP&C II). How have these changes influenced the organisms within the ecosystem? The key to answering this question lies in defining the different components of the **system [CCC-4]** and how they interact with one another, in this case focusing on the impacts of humans on local natural systems. Once they have this information students can predict how human-caused changes to the ecosystem will affect the plants and animals that live there.

Students can **investigate [SEP-3]** ecosystem interactions in real life by visiting the schoolyard, a local garden or park, or taking a field trip to an aquatic environment (stream, lake, river, or beach). If this is not possible, students can examine these interactions through literature and media, and simulations. They can ask questions about the living and nonliving components of the ecosystem such as what kinds of plants live there, how the plants adapted to the current conditions, where the water comes from, and what changes to the natural environment were made by humans. Students share their notes and place elements into a chart with human-made and natural components in the system. Students then read informational texts and gather evidence about how a natural habitat has changed as a result of one or more human activities (CA CCSS for ELA/Literacy RI.3.1; W.3.7). Teachers help students identify the types of environmental changes described in the text, including changes in land characteristics, water distribution, temperature, soil, and plant and animal life. How will these changes affect the rest of the ecosystem? Students select one of the described environmental changes and make a list of the series of events they think might have caused these changes, using language that pertains to time, sequence, **cause and effect [CCC-2]** (CA CCSS for ELA/Literacy RI.3.3.), and to EP&C II. Lastly, students can use computer simulations of ecosystems to directly manipulate the amount of resources such as water or space and see how populations react (grade three students should not be expected to create their own simulations). Using simulations like these give students the opportunity to test out different scenarios and instantly see the results. This will enhance their mental models of ecosystem changes. Students can then illustrate different cause and effect connections, including the results of human activities, they identify in the simulations using simple **pictorial models [SEP-2]** such as concept maps.

Grade Three Snapshot 4.4: Living Things in Changing Environments

Anchoring Phenomenon: Some places on the schoolyard have lots of plants and animals while other places have fewer.

Ms. J introduced her students to the idea of environmental changes (EP&C II) by taking her class on a field trip to visit the campus, surrounding neighborhood, and a local park. In preparation for this activity, Ms. J identified three areas near the school where her students could see plants and animals, and observe the effects of human activities; she also enlisted a parent volunteer to go along. Before going outside, Ms. J explained to the students that they would be going on a local field trip to make observations and collect evidence about environmental changes on campus and in the local neighborhood. She told them to bring pencils and their science journal so that they could make notes about their observations.

While walking around campus, the students observed and **asked questions [SEP-1]** about why there were very few plants and animals on the school grounds. Ms. J had them make notes about their observations and record any questions in their science notebooks during their **investigation [SEP-3]** of environmental changes in the local area. The class walked down the street, making observations and taking notes as they went by houses and apartment buildings in the neighborhood. They observed that some areas had green spaces with different kinds of plants and animals, and saw many birds sitting on the branches of the bushes and squirrels running through the yards. Finally, Ms. J took them to visit a local park where they saw even more plants and animals. As they walked back to the school, Ms. J kicked off a discussion by asking students if they observed any **patterns [CCC-1]** regarding the variety and numbers of plants and animals they observed in the three different areas.

Back in their classroom, Ms. J guided a student discussion of similarities and differences among the areas they visited during their field trip. She made a four-column list on the board labeled “Place,” “Description of Area,” “Plants We Saw,” and “Animals We Saw.” With their data recorded, Ms. J asked the students to contribute to a list of the differences in plants and animals among the three habitats: campus, neighborhood, and park. The class then began a discussion to **analyze and interpret [SEP-4]** the data they collected and began thinking about the **causes [CCC-2]** of these differences. Students identified several human activities, such as removing trees, making streets, paving the campus, and building houses. Once they completed their list, Ms. J asked students to identify the evidence they saw during their field trip that supports the **argument [SEP 7]** that changes in habitats affect the organisms living there. Some organisms can survive well, some survive less well, and some cannot survive at all. Ms. J recorded the students’ evidence on the board.

Grade Three Snapshot 4.4: Living Things in Changing Environments

Investigative phenomenon: Sweetwater Marsh is changing.

Ms. J recognized the importance of developing her students' awareness that environmental changes they observe locally also occur throughout California. She used the leveled reader *Sweetwater Marsh National Wildlife Refuge* as the basis for student investigations of how humans have changed a rapidly disappearing coastal habitat (EP&C II), which serves as a breeding ground and nursery for many of the fish that people eat (EP&C I).

Using information the students gathered from the reading, the class made a mural with "before" and "after" sections where some students drew the original habitat and others showed the habitat after human activity. The students' drawings illustrated some changes, for example, the addition of buildings, roads, and levees. This reading and mural served as the context for a discussion of how the functioning and health of ecosystems are influenced by their relationships with human societies.

To reinforce the crosscutting concept about **systems and system models [CCC-4]**, Ms. J reminded the students that ecosystems are an example of a system. She asked them to identify the salt marsh ecosystem components on their mural. Several students pointed out the birds nesting in the plants as an example of an interaction among the components of the ecosystem.

After completing their mural, Ms. J asked the students several questions about the marsh, its plants and animals, and how the habitat might change if more human-activity occurs there. She focused the students on environmental changes asking them to predict answers to questions such as, Which plants or animals will be affected if the water becomes saltier? and If the water in all of the San Diego Bay becomes muddier, what might happen? Based on their notes and the class discussion, students identified the main idea of the lesson: human activities had resulted in changes to the natural habitat, which in turn had decreased the number and variety of plants and animals in the area.

Resources

California Education and the Environment Initiative. 2013. *Sweetwater Marsh National Wildlife Refuge*. Sacramento: Office of Education and the Environment. https://www.cde.ca.gov/ci/sc/cf/ch4.asp#link2.

Through these activities, students enhance their understanding of the EP&Cs. They can identify direct and indirect changes to natural systems due to the growth of human populations and their consumption rates. Some communities may feel the impacts from resource extraction, harvest, transport or consumption. Other communities might be able to observe the effects of expansion and operation of human activities on the geographic extent, composition, biological diversity, and viability of natural systems. In the end, the focus should be on possible solutions that minimize the impacts of humans on the natural system.

Engineering Connection: Minimizing the Effects of a Levy Break on the Environment

Environmental changes happen all the time and are a part of natural cycles, but human activities can influence those cycles resulting in profound changes to the natural environment (EP&C III). Many ecosystems become unstable as a result of these changes (EP&C II). For example, before human development, animals could migrate out of an area affected by a wildfire into an adjacent area where they could survive. If the wildfire area is now adjacent to human development, there is no natural habitat left where the animals can move in order to survive. Recognizing these impacts, humans have come up with technologies and solutions to minimize the **effects [CCC-2]** of their activities on the environment or to help organisms respond to natural changes that they might previously been able to survive.

Students should **obtain information [SEP-8]** about a locally relevant environmental change (flood, wildfire, drought, new housing development, freeway expansion, etc.), ideally by observing an environmental change in their local community. Based on this information they should be able to **define the problem [SEP-1]**, identifying the changes that will happen in the environment and predicting their possible impacts on the ecosystem (3–5-ETS1-1). Using this information students can establish criteria for comparing solutions to the problem based on what they have learned about decision-making related to natural resources (EP&C V). Having established the criteria, they can begin to generate and compare multiple possible solutions to the problem, and evaluate the pros and cons of each (3–5-ETS1-1).

In one farming community near the Sacramento River, a teacher brings in a news article that warns the next flood might breach the levy and wash harmful pesticides from the fields into the river. Students predict that this will kill all the fish and they want to stop this. Different groups come up with different solutions. One group recommends that they strengthen the levy while another group suggests that they stop using the harmful chemicals on their crops. A third group suggests that they can develop a new technology to clean up the chemicals (“like a giant sponge”). In the end, students must make an argument in favor of one of the class’ solutions (3-LS4-4).