SEPTEMBER 2019 | EVALUATION REPORT #9

Environmental Instruction Catalyzes Standards-Based Science Teaching

How Environmental Literacy Aids Implementation of the NGSS

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NGSS EARLY IMPLEMENTERS

WestEd

NGSS Early Implementers Initiative: Bringing science to life as a core subject in K–8 classrooms

A diverse group of eight California school districts and two charter management organizations is actively implementing the Next Generation Science Standards (NGSS). Their progress, experiences, and lessons can inform others implementing the NGSS. The NGSS Early Implementers are supported by the K–12 Alliance at WestEd, and work in partnership with the California Department of Education, the California State Board of Education, and Achieve. Initiative funding is provided by the S. D. Bechtel, Jr. Foundation, with the Hastings/Quillin Fund supporting participation by the charter organizations.

The Initiative spans 2014 to 2020. It focuses on NGSS implementation in grades K–8 and incorporates the integrated course model (preferred by the California State Board of Education) for middle school.

Teachers are supported with strategies and tools, including an instructional framework that incorporates phenomena-based learning. This framework aligns with the three NGSS dimensions: disciplinary core ideas, crosscutting concepts, and science and engineering practices. Using science notebooks, questioning strategies, and other approaches, students conduct investigations, construct arguments, analyze text, practice descriptive skills, articulate ideas, and assess their own understanding.

Teachers engage in science lesson studies twice each year through a Teaching Learning Collaborative. In each district, the Initiative is guided by a Core Leadership Team of Teacher Leaders and administrators who participate in additional professional learning and coaching activities. Together, this core team and an extended group of Teacher Leaders are the means for scaling NGSS implementation throughout the district.

Learn more about this multi-year initiative and access evaluation findings as well as instructional resources at k12alliance.org/ca-ngss.php.

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Evaluation of the NGSS Early Implementers Initiative

The S. D. Bechtel, Jr. Foundation has commissioned WestEd's STEM Evaluation Unit to evaluate the NGSS Early Implementers Initiative in the eight participating public school districts. This independent evaluation is advised by a technical working group that includes representatives of the California Department of Education and the State Board of Education. Evaluators investigate three main aspects of the Initiative's NGSS implementation:

- districts' local implementation,
- implementation support provided by K–12 Alliance, and
- the resulting science teaching and leadership growth of teachers and administrators, as well as student outcomes.

In addition to this current Report #9, evaluators previously released:

- *The Needle Is Moving in California K–8 Science: Integration with English Language Arts, Integration of the Sciences, and Returning Science as a K–8 Core Subject* (Evaluation Report #1, October 2016)
- *The Synergy of Science and English Language Arts: Means and Mutual Benefits of Integration* (Evaluation Report #2, October 2017)
- *Administrators Matter in NGSS Implementation: How School and District Leaders Are Making Science Happen* (Evaluation Report #3, November 2017)
- *Developing District Plans for NGSS Implementation: Preventing Detours and Finding Express Lanes on the Journey to Implement the New Science Standards* (Evaluation Report #4, February 2018)
- *Next Generation Science Standards in Practice: Tools and Processes Used by the California NGSS Early Implementers* (May 2018)
- *Making Middle School Science Whole: Transitioning to an Integrated Approach to Science Instruction* (Evaluation Report #5, October 2018)
- *Engaged and Learning Science: How Students Benefit from Next Generation Science Standards Teaching* (Evaluation Report #6, November 2018)
- *Investing in Science Teacher Leadership: Strategies and Impacts in the NGSS Early Implementers Initiative* (Evaluation Report #7, February 2019)
- *Collaborative Lesson Studies: Powerful Professional Learning for Implementing the Next Generation Science Standards* (Evaluation Report #8, September 2019)

Executive Summary

This report describes how effective environmental literacy can be for catalyzing Next Generation Science Standards (NGSS) teaching, and how the California K–8 NGSS Early Implementers Initiative has provided professional learning about environmental literacy to prompt and support this synergy. The report also outlines how the California Science Framework and the Human Impacts standards of the NGSS clearly call for such synergy.

This is the ninth report in a series of evaluation reports about the Initiative, which are all intended for school and district administrators, leaders of science professional learning, and state policymakers. It draws on surveys, interviews, and observations of environmental literacy–focused lessons.

Exemplars of Teachers Addressing Environmental Literacy in Science Instruction

The report begins by describing how Initiative teachers are addressing environmental literacy in science, in four ways:

- Addressing environmental literacy during lesson studies (known in the Initiative as Teaching Learning Collaboratives) for planning and teaching NGSS lessons
- Incorporating environmental literacy instruction outside of the classroom
- Partnering with local organizations to support environmental literacy
- Encouraging environmental literacy in their schools and districts

To help readers better understand the evaluation's findings, the report shares quotes from the Initiative's participants, including the following quotes illustrating how teachers are incorporating environmental literacy into science instruction in the ways listed above.

> *We threw a bunch of California poppy seeds out last winter and we have California poppies growing in some places. As we're learning about parts of a plant, about what plants need to survive, we're experiencing what they need to survive...It's stuff like that. It's stuff that we can be aware of and we can learn about. It's marvelous. (Elementary school teacher)*

> *We discovered that we didn't have a recycling program. So, we created a program for the entire school. The students were so proud of themselves. They wrote to the PTA asking for $1,000 for recycling bins. We brought in the custodians to get their seal of approval and did public service announcements for the school that described the human impact on the local community without recycling. (Kindergarten teacher)*

This section also includes two vignettes: one of middle school teachers using an environmental scenario as the phenomenon for NGSS instruction during a Teaching Learning Collaborative, and the other of a science educator and third grade students getting outside of the classroom to explore the local natural environment during a field trip.

Effects of the Initiative's Professional Learning About Environmental Literacy

The next section of the report discusses how the Initiative is encouraging and modeling a voluntary synergy of science and environmental literacy, teachers' resulting understanding of how to address environmental literacy in their science instruction, and their reported frequency of doing so.

Initiative leaders have taken steps to encourage teachers to incorporate environmental literacy into their science instruction by frequently pointing out and illustrating that environmental scenarios can serve as particularly effective phenomena and by modeling how to build instruction around environmental phenomena. Summer Institutes and Teaching Learning Collaboratives sometimes included this synergy of environmental literacy and science.

The Initiative's participants first needed to understand environmental literacy before they could substantially integrate it into their science instruction. Annual surveys of participants in both 2017–18 and 2018–19 indicated that the majority of the Initiative's most highly involved participants reported that they understood how to address environmental literacy in a science unit at least "fairly well." In addition, many of the Initiative's Core Administrators (nearly half) "thoroughly" understood how to address environmental literacy.

When asked in the spring 2019 survey *how often* they addressed environmental literacy in their classrooms during the 2018–19 school year, there were substantial differences among teachers based on their role in the Initiative. For teachers who were the most central to the Initiative, for example, 29 percent of Core Teacher Leaders responded that they addressed environmental literacy "weekly" or "2–5 times per week" compared to 13 percent of Teacher Leaders and only 9 percent of expansion teachers (i.e., teachers not substantially involved in the Institute's professional learning).

Challenges to Incorporating Environmental Literacy in Science Instruction

The report briefly discusses two challenges related to incorporating environmental literacy into science instruction. First, there is a perception that environmental literacy is readily integrated with life or earth science, but less so with physical science. For example, a grade K–5 teacher remarked, "I don't think of environmental ed as integrated into anything other than the earth and life sciences." Second, it can be difficult to reconcile school calendars and schedules with the timing of environmental phenomena occurring around us.

Recommendations for Administrators

The report concludes with a list of brief recommendations for administrators to help them support implementation of environmental literacy:

- Acknowledge that environmental literacy is new to many teachers. In order to teach about it, teachers first need professional learning experiences to gain familiarity with environmental literacy.
- Present environmental literacy as a key connection to the NGSS. How environmental literacy can catalyze NGSS implementation needs to be showcased explicitly.
- Encourage teachers to seek out professional learning opportunities outside of their school or district and take advantage of other opportunities available regionally in which experts are leading this charge.
- Support the incorporation of environmental literacy into the NGSS by making it a priority throughout the school and district. In addition to teachers, administrators themselves need to gain an understanding of the shifts required, empowering them to prompt, lead, and support their school site and district in implementing these changes.

Introduction

California is a national leader in safeguarding the environment and taking steps to ensure that residents and decision-makers are environmentally literate. In keeping with that tradition, teachers and students in the California NGSS K–8 Early Implementers Initiative are forging a powerful synergy of environmental literacy instruction and science instruction that fulfills the Next Generation Science Standards (NGSS; NGSS Lead States, 2013b).

The grant supporting the Early Implementers Initiative does not require a focus on environmental literacy. Increasingly, however, the Initiative's leadership and participating administrators and teachers are finding this: **Environmental literacy is a particularly strong context for implementing the key aspects of the NGSS, can be especially engaging for students, and spurs meaningful student attitudes and actions toward helping the environment**.

Relevant standards documents clearly support this synergy. For example, the California Science Framework prominently contains specific content about environmental literacy, such as the NGSS Human Impacts standards (NGSS Lead States, 2013a). Similarly, even a quick look at the state's current blueprint for environmental literacy reveals that its Environmental Principles and Concepts (EP&Cs)[1] naturally relate to science instruction (California Department of Education, 2016; Environmental Literacy Task Force, 2015).

> "Addressing both science standards and environmental education is a natural fit!" [Science educator]

In the past, state leaders positioned environmental literacy as content that teachers would address somewhat separately from instruction in other subjects. Today's California policy calls for environmental literacy to be integrated with and embedded in other school subjects. The policy envisions integration with all school subjects — not just science. (Readers wanting information about relevant environmental literacy standards and policies can learn more in this report's section, **Examples of California's Specifications for Environmental Literacy and Science Instruction**).

Intrinsic Motivations for Addressing Environmental Literacy

While state documents call for synergy between science instruction and environmental literacy instruction, they seldom are the driving catalyst for teachers to pursue the integration of science and environmental literacy. Rather, in interviews for this evaluation report, teachers and other Initiative participants most often described intrinsic motivations to address environmental literacy.

1 The five Principles of the EP&Cs are the following: People Depend on Natural Systems, People Influence Natural Systems, Natural Systems Change in Ways that People Benefit from and Can Influence, There Are No Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems, and Decisions Affecting Resources and Natural Systems Are Complex and Involve Many Factors.

Participants recounted personal stories of why they care about environmental literacy, how they encourage and empower students to make a difference in their world, and how seeing students care about the environment spurred their environmental instruction:

- One teacher shared his personal story about connecting with nature and how it informed his belief that students would have similar experiences by going on field trips: "I realized the world was alive. If that happened to me, that would happen to another human being. When kids go on field trips, they come back and look at things differently. It really changes them."
- Another teacher said she will only teach something if there is something students can do to make a positive change. "I'm never going to teach something about the environment that kids cannot do something to make a difference. In the garden, you can have them compost, or even recycle. There's things you can do — there is overlap with civics — you can change the world, make a positive change."
- A Project Director discussed how student buy-in through participation in environmental experiences can motivate teachers to include environmental literacy into their instruction: "I think what will motivate [teachers] is the student buy-in. Having it be concrete for students, having a concrete example of something to then think about. That is right in front of them by keeping it local."
- A teacher described how she started to recycle water bottles when she noticed her students were throwing them away. The money from recycling went into classroom supplies: "I just take them in and I recycle them, and then I use the money to buy books. They're always loving books. I'm like, 'Okay, this is our book fund. We're raising funds for books this way.'" Recycling the water bottles led to students' considerations of other types of recycling, including having a bin for paper. Students also explored other outcomes of recycling, such as finding an article on turning recycled water bottles into shoelaces, and "they were all excited that they saw this article."
- Another Project Director shared how connections students made to a reading resulted in their awareness of how others are impacted by the environment: "A *Long Walk to Water*, which is about people in Africa that . . . don't have access to clean water — these people had to walk miles for water. That's an environmental concern, a human impact . . . some of the kids took their shoes off to see what it is like walking barefoot carrying 25 pounds of water for however many miles."

Ways That Environmental Literacy Fulfills NGSS Calls for Science Teaching

Teachers and other educators highlighted several ways that environmental literacy can effectively serve the purposes of implementing NGSS teaching. For instance, they noted that environmental literacy can:

- Provide scenarios that strongly meet criteria for good science phenomena or engineering design challenges that serve as the drivers of science instruction
- Effectively address the NGSS science and engineering practices (SEPs)
- Make effective use of the NGSS crosscutting concepts (CCCs)
- Prompt students to be actively addressing NGSS Human Impacts and additional NGSS disciplinary core ideas (DCIs) related to the environment

A key criterion for identifying any science phenomenon[2] or engineering design challenge to serve as the basis of NGSS instruction is that it be truly relevant to students' lives. Sometimes teachers identify phenomena or challenges that they believe will interest and engage students, but in fact they are not as relatable to their students' daily lives as the teachers had hoped. In contrast, environmental issues that surround every person's life can deeply engage a student. Further, environmental literacy strongly advocates for students to interact directly with their immediate natural environment. Choosing a phenomenon or challenge that students can see or experience themselves will have more relevance to their own lives and therefore have more meaning for them.

The environmental literacy lessons observed by the evaluators, both in the classroom and in the field, involved active student learning, employing a mode of instruction that is recommended both for teaching environmental literacy and the NGSS. In this kind of active, student-driven learning, there are frequent and rich opportunities for students to engage in NGSS SEPs, such as "planning and carrying out investigations," "constructing explanations" (for science), "designing solutions" (for engineering), and "engaging in argument from evidence." There also are ample opportunities to illustrate the ideas and usefulness of the NGSS CCCs, such as looking for "patterns" among different kinds of trees or understanding "cause and effect" in relation to humans' influence on the environment.

Interviewees commonly saw the potential for the synergies between science and environmental literacy, as illustrated by these remarks:

> *Addressing both science standards and environmental education is a natural fit!*

> *NGSS is self-directed learning — putting skills to work. If students become accustomed to making environmental observations, figuring out what to do about what they observed, and seeing the effects of those changes, they will become [environmental] stewards and scientists at the same time. [Science educator]*

> *Once we do our experiments at the end, when we do the process, that's one of the questions. I was like, "Okay, how are we helping Earth? How are we helping our environment? How can we reduce human impact?" I always wrap it up with those questions. [Fourth grade teacher]*

Report Overview

This report is drawn from extensive evaluation data obtained from teachers, administrators, district Project Directors, and Regional Directors of the Initiative. Evaluators collected data through several surveys with hundreds of respondents, dozens of interviews, and a few in-person observations of teaching. Appendix A provides more details about the evaluation methods, including the questions posed in the surveys and interviews.

The report is organized as follows:

- The report leads off with **Exemplars of Teachers Addressing Environmental Literacy in Science Instruction.** This section, which includes two illustrative vignettes, briefly but vividly describes a variety of ways that some Initiative teachers are making it possible for

2 The Early Implementers Initiative defines *phenomena* as "occurrences in the natural and human-made world that can be observed and cause one to wonder and ask questions."

students to do exciting hands-on investigations of environmental questions in concert with science instruction.

- The next section, **Effects of the Initiative's Professional Learning about Environmental Literacy**, discusses the following questions: How is the Initiative calling for and modeling the use of environmental literacy instruction to implement the NGSS? To what extent are participants understanding how environmental literacy can address the NGSS, and taking up this approach in their science instruction?
- This is followed by the section, **Challenges to Incorporating Environmental Literacy in Science Instruction**, which describes some participants' perception that it is difficult to integrate environmental literacy with topics in physical science and that it can be a challenge to sync the timing of the curriculum with events of interest in nature.
- Next is a short section, **Examples of California's Specifications for Environmental Literacy and Science Instruction**, about relevant California vision, policy, and standards.
- The report concludes with a brief **Recommendations** section that shares ways that administrators can support teachers' synergy of the two related fields.

Exemplars of Teachers Addressing Environmental Literacy in Science Instruction

This section focuses on four ways that Initiative teachers are addressing environmental literacy in science:

- Addressing environmental literacy during a version of lesson studies for planning and teaching NGSS lessons, known in the Initiative as Teaching Learning Collaboratives[3]
- Carrying out environmental literacy instruction outside the classroom
- Partnering with local organizations that support environmental literacy
- Encouraging environmental literacy in Initiative schools and districts

Addressing Environmental Literacy during the Initiative's NGSS Lesson Studies

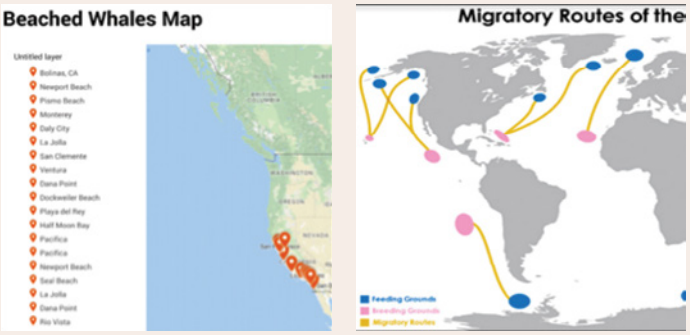
Participation in lesson studies is one venue for teachers to gain understanding of and experience with both the NGSS and environmental literacy. While many of the lesson studies in the Initiative were not focused on environmental phenomena, more and more teachers began choosing to utilize the NGSS human impact standards and the EP&Cs within the standards during their lesson study time. The following vignette describes teachers working together in a lesson study format, known as a Teaching Learning Collaborative in the Initiative. As part of their work together in the Teaching Learning Collaborative, the teachers taught a lesson using the environmental phenomenon of whales beaching along the California coast.

Vignette: Teaching Learning Collaborative Uses an Environmental Scenario as the Phenomenon for NGSS Instruction

A Core Teacher Leader facilitated a Teaching Learning Collaborative for six middle school teachers in Year 4 of the Initiative. The evaluator observed how the lesson, planned and taught by the teachers in the Teaching Learning Collaborative, clearly and effectively addressed both the NGSS and environmental literacy. During the planning time, the Core Teacher Leader introduced the phenomenon of whales that beach themselves along the California coast because of human-caused disruptions to their migratory

3 A separate evaluation report focuses entirely on the Initiative's Teaching Learning Collaboratives: *Collaborative Lesson Studies: Powerful Professional Learning for Implementing the Next Generation Science Standards*, which particularly emphasizes strong and extensive collaboration. In this report, evaluators often use the more generic term, "lesson studies," because some readers may not be familiar with Teaching Learning Collaboratives.

Figure 1. Whale maps used during a Teaching Learning Collaborative lesson that addressed environmental literacy



Source: December 2017 Teaching Learning Collaborative observation.

route. The lesson study focused on incorporating the following NGSS three dimensions: Human Impacts on Earth Systems (Earth and Space Sciences — DCI), Analyzing Data and Asking Questions (SEPs), and Cause and Effect, Patterns, and Systems (CCCs).

In the lesson study, the teachers followed the 5E model (an instructional model that follows five stages: Engage, Explore, Explain, Elaborate, and Evaluate).[4] As an Explore stage, teachers had their students use Google Classroom to look at two maps, one showing where beached whales had been found along the California coast and the other showing whale migratory routes (see Figure 1). The teacher prompted students to think about any patterns they saw between the two maps. Students used notebooks throughout to record questions and facilitate their thinking. Students also recorded observations they were making about the maps and questions they had about them.

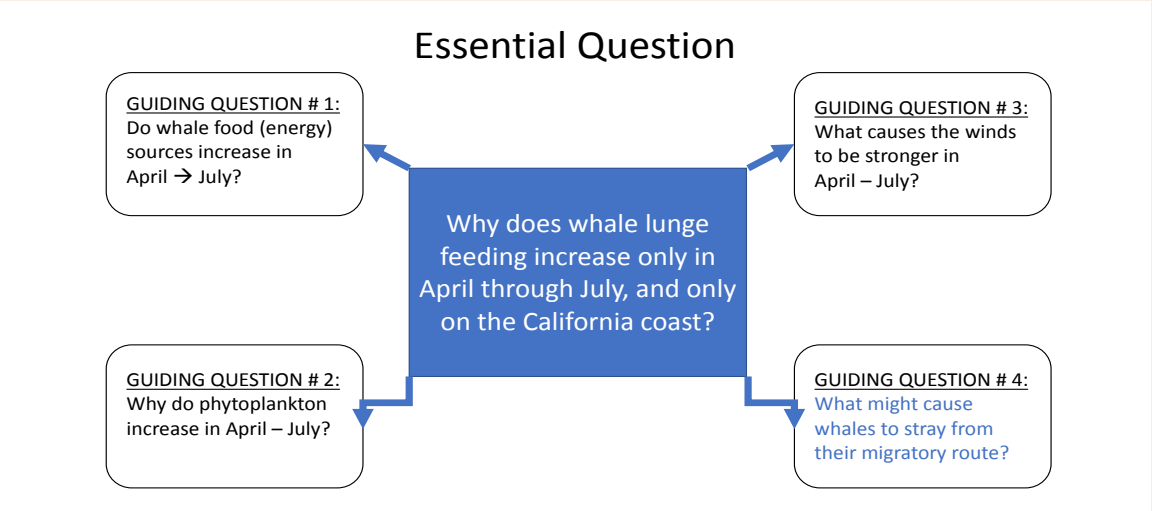
After students investigated the data, they were asked to write in their notebooks and discuss the following: "What questions do you have (or that you think a scientist might have) about the Beached Whales Map (or about the comparison between the two maps)?" Students shared their questions with the whole class, including the following ones:

- Why do whales get stranded on the beach?
- Why were more whales found alive in 2017 than in the previous year?
- Does pollution have anything to do with the whales found along the coast?

During the whole-class discussion at the end of the lesson, the teachers talked through with students the patterns in the kinds of questions that were asked and prompted students to think about how these questions could be synthesized into a single guiding question that the class could investigate next. At the end of the class, the teacher wrote: "What might cause whales to stray from their migratory route?" (see Guiding Question #4 in Figure 2). The teachers followed this process in developing all four guiding questions in the unit.

4 To learn about the tools used by Early Implementer leaders, including the 5E instructional model, see the report *Next Generation Science Standards in Practice: Tools and Processes Used by the California NGSS Early Implementers*: https://www.wested.org/resources/next-generation-science-standards-in-practice/.

Figure 2. Unit guiding questions from environmental literacy Teaching Learning Collaborative lesson on beached whales



Source: December 2017 Teaching Learning Collaborative observation.

The unit continued by having students investigate reasons why whales may stray from their migratory routes and become beached on the coast, which included noise pollution and strikes from large cargo ships in the busy shipping lane off the California coast. The class also discussed what part students may play with this cargo traffic (e.g., their Christmas wish list items must be shipped here on cargo ships); why it is important to protect the whale population; and how students may impact the whole ecosystem. Last but not least, students developed potential solutions to help minimize human impacts on the ocean environment.

In addition to teaching the lesson as part of the Teaching Learning Collaborative, some of the participating teachers went on to teach this same lesson in their regular classroom instruction. One teacher was even observed teaching this lesson one year later, which had been modified and improved over time by her site team.

Incorporating Environmental Literacy Instruction Outside of the Classroom

Another way that Early Implementers are incorporating environmental literacy into their NGSS instruction is getting students outside of the classroom and into the natural world, and asking them to explore and interpret what they observe and discover. This is illustrated in the following vignette, which describes a field trip to a nature preserve that was observed by an evaluator.

Vignette: Students Explore Local Natural Environment on Field Trip

A science educator was acquainting third grade students with their local natural environment and teaching them about the importance of such places (e.g., the importance of the natural environment on ecosystems and global climate). He

pointed out trees to students on the trail and asked them to explain whether they encountered new trees, based on their examination of the characteristics of the leaves. Therefore, students were engaged in the SEP of **obtaining, evaluating, and communicating information** as they used prior knowledge to decide whether attributes of leaves were evidence of new types of trees that were not reviewed earlier in the lesson. In addition, the educator explicitly referred to the CCC of **patterns** as an important method to classify tree leaves:

> Teacher: "These are valley oak trees planted by students 20–22 years ago. They're doing pretty well. Valley oak trees have lobes. Everybody grab your lobes — earlobes. (Holds a valley oak leaf.) Take a valley oak leaf in your envelope. If it's got a lobe, what is it?"
>
> *Students: "Valley oak."*
>
> Teacher: "Is this a valley oak?" (Holding up another leaf.)
>
> *Students: "No."*
>
> Teacher: "Why?"
>
> *Students: "Because it doesn't have lobes."*
>
> Teacher: "It's an Oregon Ash. It has leaflets. It's a California native, but Oregon got credit for it. We're going to be looking for **patterns**. Poison oak — 'leaves of three, let them be' — [they] look like valley oak, but always in threes. Don't want to touch poison oak." (Teacher points out Oregon ash and poison oak as students pass by adjacent trees.) "Is this Oregon ash, poison oak, valley oak?" (Pointing to a new kind of tree.)
>
> *Students: "No."*
>
> Teacher: "All of the long skinny leaves are willows. (Pulls off a leaf.) We're looking for **patterns**. It's all about **patterns**."

As illustrated in this vignette, being in the field and seeing different examples of leaves enabled students to identify patterns in what they were seeing. Throughout the lesson, the science educator asked several "how" and "why" questions while students were out on the trail that involved bigger picture topics: "How does this habitat look different?" "Think about climate change — why does [the city] plant trees on a warming planet?" "Why do we take care of trees?" "Why is it important to take care of places like this? How do you feel about all this?"

By asking "how" and "why" questions, the science educator helped to promote student sense-making around environmental phenomena observed on the trail. Further, by also asking students about their feelings, the educator appealed to students' connections to the environment, toward prompting them to potentially lessen human impact.

* * *

In an interview, an elementary school teacher from a large urban school district discussed how the environment is all around us and teachers can take advantage of having their students notice, question, and learn in the local community, even in and around a big-city school:

> *Because I teach in [an urban city], kids tend to be very limited to their neighborhood. Even getting up to the [local] parks can be challenging for some of our families [and] can be difficult because . . . at certain times of the day they are not safe . . .*
>
> *With a grant from a local organization, we took a side yard and planted a dozen fruit trees along the side of our school. Now we've got a native plant garden out there with fruit trees growing — they're small, only planted a year ago — but all of these things the kids can now go out to a garden area instead of a patch of weeds. But even with a patch of weeds, we can talk about what's growing here, what wants to grow here, what seeds are brought in by the wind. . . . It's a huge wake-up to them to realize there is nature right outside. "Look we found this slug! Look we found this salamander!" So the idea is that, "Wait a minute, we're out here in the city, but look at all this stuff that's all over the place."*
>
> *We threw a bunch of California poppy seeds out last winter and we have California poppies growing in some places. As we're learning about parts of a plant, about what plants need to survive, we're experiencing what they need to survive. We found caterpillars right before Thanksgiving break. It's pouring rain, my students are out in the garden and somebody said, "What are these?" I go, "What are those?" and they were six swallowtail caterpillars. They were sitting on this stub of a plant and there were no leaves left at all. We brought them inside. We raised them and we eventually released them.*
>
> *It's stuff like that. It's stuff that we can be aware of and we can learn about. It's marvelous. I love environmental education for that reason because everything is the environment.*

Similarly, after an Initiative Summer Institute focused on environmental literacy in one district, teachers made connections with the NGSS and a local park to which they often take students for field trips, as illustrated by this teacher's comment: "*The [local park] can provide context for earth, life, and physical science (plus some writing!). The [local park] is a place full of phenomena with questions to explore.*"

Location, however, also can be viewed as a limiting factor in teaching about the environment. One elementary school principal discussed how her school site is not near natural areas where one can learn about science in the community:

> *Our community, it's hard where we're located. We're kind of out in the middle of the cow fields, but not in the type where we can actually go out in those fields, which would be great. It's the pesticides all around us. It's actually a very busy street.*

Although this principal expressed that her school site has constraints in the ability to learn about

the environment out in nature, she recognizes the importance of environmental phenomena and stated that environmental literacy is her passion and is one of the things that excites her the most.

Partnerships with Local Organizations to Support Environmental Literacy

One critical method that several Early Implementer districts have employed to support environmental literacy is developing and fostering partnerships with local organizations. An elementary school principal in one district discussed the value of partnering with a variety of organizations so that students can experience environmental literacy instruction in the outdoors:

> *We have a partnership with Cal Waste, or Cal Recycle, and then we have one with Bureau of Land Management and the [local preserve]. It's right in our backyard. The wetlands we're going out to, the preserve.*
>
> *Our students across the district get to go out, and they do things like plant acorns for oak trees. The Bureau of Land Management brings the canoe-mobile every year, and our intermediate students have access to go canoeing in the preserve and all of our sixth graders do it as a field trip. . . .*
>
> *We do a lot of environmental ed kinds of things. We do a lot of things with Cal Recycle and . . . those partnerships are invaluable for our students.*

Through facilitating connections with organizations, this administrator is supporting a cultural shift at the school site toward making the inclusion of environmental literacy a priority.

Another district works with several organizations focusing on the environment, including a local park where students often go for field trips. Through the partnership with the district, teachers at multiple grade levels have convened to plan cohesive, NGSS-aligned lessons centered around this local lake environment at the park. Students can build on what they did, learn from one grade to the next, and see the impact they are making in their local community through the work they do (e.g., planting trees) as part of their science class. In addition, the district's Project Director remarked that partners (e.g., the California Regional Environmental Education Community Network) are providing support to teachers to develop environmental literacy lessons and are even offering them a stipend. These lessons will be shared more broadly.

A third district, one that serves a primarily agricultural community, is also working on developing partnerships with local businesses. The district is fostering students' learning about their food, the impacts certain farming practices have on the environment and their community, and how to farm more sustainably. The Core Administrator who is working on developing these partnerships wants his elementary school students to have a greater understanding of where their food comes from, the science and engineering that goes into agriculture, and the career and education opportunities they have in these areas right in their own community.

Encouraging Environmental Activities in the School or District

By teaching the impacts of human activities on the environment, the NGSS have great potential to catalyze students into becoming active "science citizens," and, further, foster their ability to take action in ways that can make a difference in the world around them. Environmental scenarios can serve not only initially as phenomena that engage students in learning, but they can also move students into taking action in their lives, as described by one kindergarten teacher:

> *We discovered that we didn't have a recycling program. So, we created a program for the entire school. The students were so proud of themselves. They wrote to the PTA asking for $1,000 for recycling bins. We brought in the custodians to get their seal of approval and did public service announcements for the school that described the human impact on the local community without recycling.*

Referring to environmental phenomena, such as pollution, within the community is one way to engage students in science learning. In addition, discussing environmental changes such as wildfires may encourage students to consider how their behaviors have an impact, or to act to solve environmental problems. Some Early Implementer districts not only sought to expose students to these ideas, but teachers and administrators also began engaging in actions to promote environmental literacy or help solve local environmental problems.

An elementary school administrator (who is also a member of his district's Core Leadership Team for NGSS) cited that several of his teachers were commenting on the use of the recycling bins at their school after students noticed the contents of the recycling bins were being thrown away in the same dumpster as the regular trash. Teachers and students felt like the efforts they were making were not making an impact and turned to this administrator for help. This Core Administrator immediately took up the charge and implemented a new recycling policy that was rolled out schoolwide, ensuring that all recyclable materials were, in fact, being recycled. He also educated his staff and students on the benefits of recycling and the impacts it has on the environment. The teachers and students at his school felt like their voice was heard by an administrator who took swift action, and that their environmentally friendly actions were now making a difference.

Some districts incorporated environmentally friendly actions and processes into their teacher professional learning events. Attendees were encouraged to be more mindful of their own behavior, especially when learning in these NGSS sessions about the impacts that humans have on the local environment and how their students can help make a difference. For example, they were encouraged to bring coffee mugs, plates, and utensils from home instead of using disposable items.

Effects of the Initiative's Professional Learning about Environmental Literacy

This section discusses the effects of the Initiative's professional learning on teachers' integration of environmental literacy and science, including the following:

- How the Initiative is encouraging and modeling a voluntary synergy of science and environmental literacy
- Teachers' resulting understanding of how to address environmental literacy, and their reported frequency of doing so

How the Initiative Is Fostering Environmental Literacy Without Being an Add-On

The Initiative has not formally requested that teachers focus on environmental literacy because it was not a focus of the grant. For example, Institute sessions prior to 2018 were focused on the basics of the NGSS and the pedagogical shifts they called for, and therefore did not explicitly familiarize teachers with the EP&Cs of environmental literacy or the connections to EP&Cs found in the California Science Framework; such discussions occasionally surfaced ad hoc in the local lesson study sessions. Initiative leaders felt that including a request for a synergy of science and environmental literacy could overload teachers and administrators. The Initiative already was conveying its substantial central charge to address the many significant shifts needed for NGSS implementation. That is, leaders focused at first on empowering participants to meet the significant challenges of getting the new science teaching right, although any participant could opt to infuse environmental literacy with science instruction at any point. In interviews, evaluators encountered overload concerns among teachers, such as the sentiments below expressed by an "expansion teacher" (not involved to date in much of the Initiative's professional learning opportunities):

> *I mean, right now, it just seems like [the EP&Cs are] another thing on top of all the NGSS stuff that I have to think about . . . I'm just barely trying to get a grasp of NGSS itself. I mean, I do talk about environmental topics in the units, but I haven't cross-referenced with the new environmental stuff to make sure that I'm including everything that needs to be talked about in there. (Expansion teacher, Middle school)*

While the Initiative has not formally pushed teachers to integrate environmental literacy into their curriculum, it has taken steps — primarily through two project elements — to encourage teachers to incorporate environmental literacy instruction without it feeling like an add-on. The first element, as described previously, is the Initiative's overarching emphasis on building instruction around phenomena. When discussing and illustrating phenomena in professional learning sessions and other Initiative events, **Initiative leaders frequently point out and illustrate that environmental scenarios can serve as particularly effective phenomena**.

The second element involves **the Initiative modeling how to build instruction around environmental phenomena for teachers.** During the extensive Cadre time at Summer Institutes,[5] many of the scientists have focused hands-on investigations on environmental phenomena. Most districts, as part of the Summer 2018 Institutes (grant year 5), added more explicit attention to the relationship between science and environmental literacy as a rich context that can aid NGSS implementation. For example, one district held environmental literacy-focused cadre sessions for every grade level (a vignette in Appendix B provides a rich description of this district's work).

In a physical science NGSS K–12 cadre session observed by a WestEd evaluator, teachers read about and discussed the relationship between amounts of the chemical element lead in community water systems and students' academic achievement. Acting as their students would, the teachers designed engineering solutions for removing lead and tested different local sources of water. At the end of the week's investigation, the facilitator asked teachers to put back on their teacher hat and think about where they could see this instruction go with their students. In small groups, teachers discussed how real-world environmental problems can be used as a context for NGSS instruction. In the whole-group share-out, a teacher talked about "getting buy-in for the real world . . . you get buy-in when you are affected by something."

A few districts also put an elevated focus on environmental literacy throughout the 2018–19 school year. For instance, in two districts, teachers partnered with their county office of education to develop environmentally focused science lessons to share with all teachers in the county.

Understanding How to Address Environmental Literacy in Science Instruction

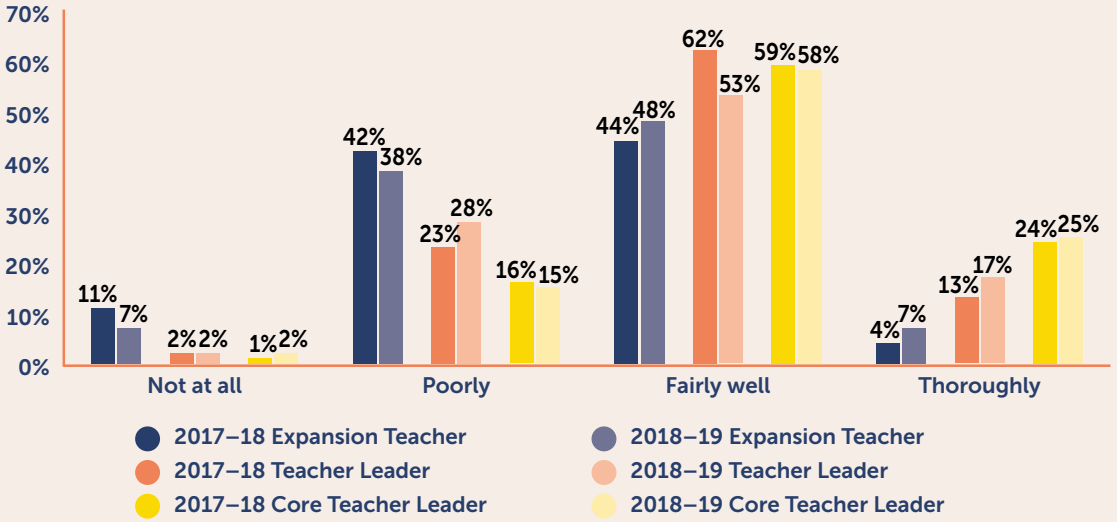
As with anything, before being able to fully address and implement new topics, you must first understand them. Across several surveys in spring 2018 and spring 2019, evaluators asked teachers and administrators how well they understand how to address environmental literacy in a science unit. The question was asked of both participants who have received extensive professional development in the Initiative (i.e., Core Teacher Leaders, Teacher Leaders, and Core Administrators) and participants who have been less involved with the Initiative (i.e., expansion teachers and other administrators).

In both 2017–18 and 2018–19, the majority of participants, with the exception of 2017–18 expansion teachers, reported that they understood how to address environmental literacy in a science unit at least "fairly well" (see Figures 3 and 4). However,

5 The Summer Institute is a multiday professional learning event for Teacher Leaders held every summer. Through Year 4 of the Initiative, about half of the Summer Institute time was devoted to NGSS lessons planned and delivered to groups of teachers by a "Cadre" of science experts, including K–8 teachers and one professional scientist or university professor.

Figure 3. Depth of participating and expansion teachers' understanding of how to address environmental literacy in a science unit during the 2017–18 and 2018–19 school years

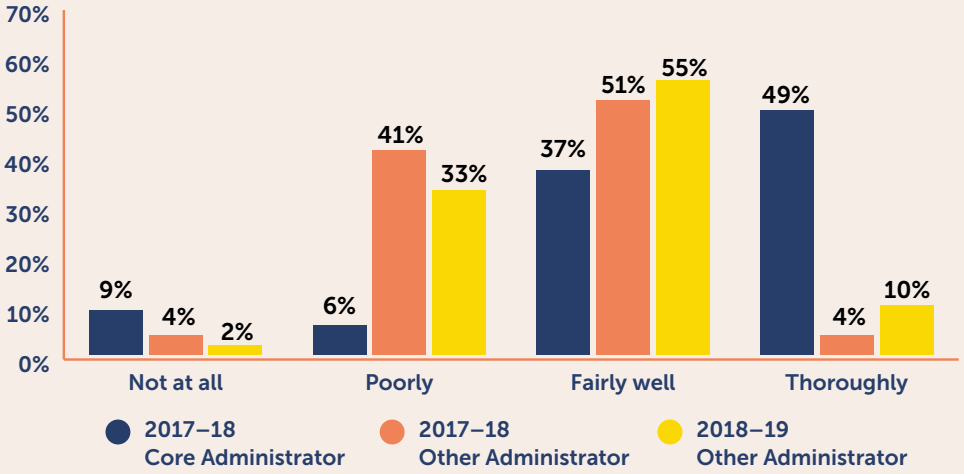
How well would you say you understand how to address environmental literacy in a science unit?



Sources: 2017–18 Teacher Leadership Survey (N=383), 2017–18 Survey for K-8 Science Teachers (N=759), and 2018–19 Spring Survey (N=832).

Figure 4. Depth of participating and other administrators' understanding of how to address environmental literacy in a science unit during the 2017–18 and 2018–19 school years

How well would you say you understand how to address environmental literacy in a science unit?

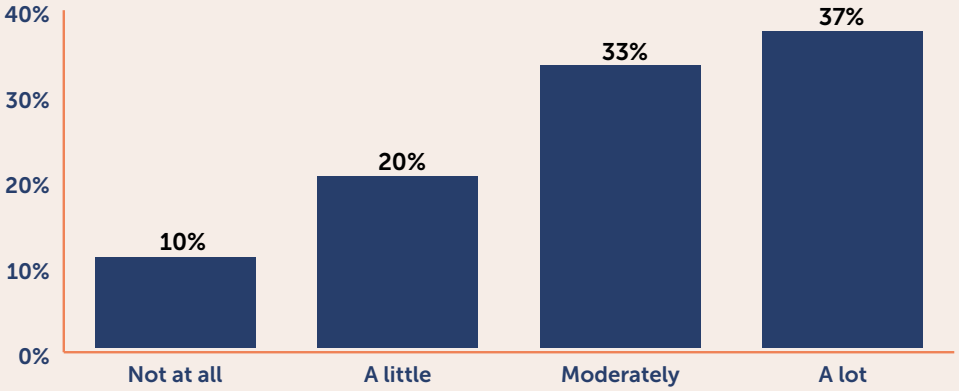


Sources: 2017–18 Core Administrator Leadership Survey (N=35), 2017–18 Survey for Principals (N=80), and 2018–19 Spring Survey (N=60).

Note: Because there was a significant turnover of Core Administrators in many districts from 2017–18 to 2018–19, there was little overlap in these survey respondents across these two years; therefore, Core Administrator results are provided only for the 2017–18 Core Administrators, who by that time had spent substantial time in the Initiative's professional learning and support for administrators.

Figure 5. Impact of the lesson study experience on participants' understanding of how to address environmental literacy in a science unit, for participants who attended a lesson study with an environmental literacy focus

To what extent did the lesson study experience deepen your understanding of how to address environmental literacy in a science unit?



Source: 2018–19 Participant Post-Lesson Study Survey (N=454).

understanding was substantially higher among the participants that have been more involved in the Initiative's professional development. For example, 83 percent of Core Teacher Leaders indicated that they understood "fairly well" or "thoroughly" how to address environmental literacy in 2018–19. In contrast, among the participants less involved in the Initiative to date (expansion teachers), about half (48 percent in 2017–18 and 55 percent in 2018–19) expressed understanding at least "fairly well," and less than a tenth of these expansion teachers stated that they understood "thoroughly" (four percent in 2017–18 and seven percent in 2018–19, respectively).

Similar to the Initiative's Core Teacher Leaders, many of its Core Administrators (nearly half) "thoroughly" understood how to address environmental literacy. There was a modest increase in the percentage of other administrators who "thoroughly" understood how to address environmental literacy — from 4 percent in 2017–18 to 10 percent in 2018–19.

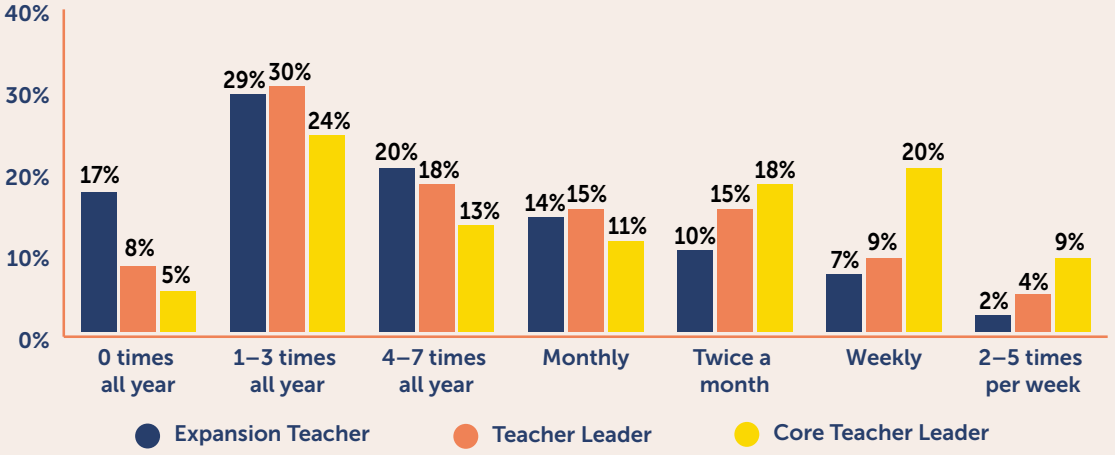
As described previously in one of this report's vignettes, creating a synergy of environmental literacy and science sometimes occurred during the Initiative's Teaching Learning Collaboratives for planning and teaching lessons and units. In the 2018–19 Participant Post-Lesson Study Survey, evaluators asked participants to what extent the lesson study experience deepened their understanding of how to address environmental literacy in a science unit. A majority of participants reported that the lesson study experience deepened their understanding at least "moderately" (70 percent) and over a third responded that the lesson study experience enhanced their understanding "a lot" (see Figure 5).

Frequency of Implementing Environmental Literacy Instruction

After teachers are made aware of, and understand the connections between science and

Figure 6. How often participating and expansion teachers addressed environmental literacy in a science unit during the 2018–19 school year

During the 2018–19 school year, how often did you address environmental literacy in a science unit when teaching in your own classroom?



Source: 2018–19 Spring Survey (N=815).

environmental literacy, they are more apt to align the two areas in their instruction. In the spring 2019 survey, evaluators asked teachers *how often* they addressed environmental literacy in their classrooms during the 2018–19 school year. The results showed substantial differences among teachers based on their role in the Initiative (see Figure 6). For example, 29 percent of Core Teacher Leaders responded that they addressed environmental literacy "weekly" or "2–5 times per week" compared to 13 percent of Teacher Leaders and only 9 percent of expansion teachers.

Because Teacher Leaders (and especially Core Teacher Leaders) have much more knowledge of and practice with the NGSS under their belt, they may feel more confident and ready to incorporate yet another dimension into their science instruction, and have the knowledge to know what they are doing in each domain (i.e., NGSS and EP&Cs). The difference in the frequency that Core Teacher Leaders and Teacher Leaders address environmental literacy in their classrooms is interesting given that both groups have participated extensively in the Initiative's professional development. However, Core Teacher Leaders do receive even more training and support, and express more familiarity with the NGSS and the connections to the EP&Cs (discussed in the section above). It is possible that the more knowledge of the NGSS and EP&Cs that teachers have and the more they see how environmental literacy is embedded throughout the NGSS standards, the more they may recognize and report that they are in fact teaching some environmental literacy.[6]

In interviews, expansion teachers related that they are likely to incorporate environmental literacy only after they feel they understand NGSS and if they feel that environmental literacy is an important topic to cover. They expressed that they focus on making sure they do what is expected in

6 Analogously, participants having less understanding of the formally specified relationships between environmental literacy and the NGSS *could* be doing elements of environmental literacy but might not recognize that they are doing so.

the NGSS and hope that environmental literacy is covered to some extent. Some teachers also reflected that they may have taught environmental topics, but they were not doing so intentionally. One grade 6 Teacher Leader said,

> *Environmental education was not the goal. When I do the ocean things, it might relate. But I wasn't looking at the environmental ed objectives. . . . Not on purpose — I could look back on the lesson and say "Oh, did it there," but it was not intentional.*

Challenges to Incorporating Environmental Literacy in Science Instruction

This section discusses challenges related to incorporating environmental literacy into science instruction, including the following:

- Perceived challenges of integrating environmental literacy with lessons in physical science
- The challenge of sometimes needing to align the timing of science topics in the curriculum with when events are occurring in nature

Perception That Physical Science Is Not Amenable for Incorporating Environmental Literacy

During teacher interviews, evaluators encountered the perception that environmental literacy is readily integrated with life or earth science, but less so with physical science. For example, a grade K–5 teacher remarked, "I don't think of environmental ed as integrated into anything other than the earth and life sciences." A middle school teacher talked about the difficulty of connecting Newtonian physics to environmental literacy, how it is easier to make environmental connections to DCIs in other science disciplines, and how teachers need collaborative planning time to figure out how to do this.

This challenge also surfaced during a technical assistance session in a companion project to the Initiative. When participants evaluated candidate instructional materials as part of the *Next Gen Toolkit for Instructional Materials Evaluation* process, the facilitator told participants that implementation of the EP&Cs depends on content: "Don't forget that if you have physical science you might not find EP&Cs because physical science usually doesn't have it."

In contrast, an analysis of Appendix 2 of the California Science Framework revealed that there are environmental connections in some of the physical science standards. However, considerably fewer are noted compared to the other science and engineering disciplines (see Table 1). Furthermore, those connections between physical science standards and the EP&Cs are made only in the upper elementary and middle school grades (i.e., grades 5–8).

The perception of a disconnect between environmental literacy and physical science may be a broader outcome of some teachers' general discomfort with physical science compared to life or earth science. However, physical science can be integrated with environmental literacy instruction, as shown in the earlier example about lead in community water systems.

Table 1. EP&C connections to California NGSS Performance Expectations, by science field and grade level

Grade Level / Grade Band	Earth and Space Sciences	Engineering, Technology, and the Application of Science	Life Science	Physical Science	Total
K	2		1		3
1			1		1
2			2		2
K–2		3			3
3			3		3
4	1		1		2
5	2		2	1	5
3–5		3			3
Middle school	2	1	3	2	8
Total	7	7	13	3	30

Navigating the Calendars of Schools and Nature

It can be difficult to reconcile school calendars and schedules with the timing of environmental phenomena, as described by one interviewee:

"A challenge is scheduling lessons when certain phenomena are happening in the natural world — the monarch butterfly migration, ladybug hibernation, or maple leaves turning color." Similarly, taking students on field trips requires resources that may not be readily available to all schools.

Examples of California's Specifications for Environmental Literacy and Science Instruction

In 2015, the Environmental Literacy Task Force[7] issued *A Blueprint for Environmental Literacy: Educating Every California Student In, About, and For the Environment* (*Blueprint*), which describes the charge for K–12 environmental literacy:

> *Through lived experiences and education programs that include classroom-based lessons, experiential education, and outdoor learning, students will become environmentally literate, developing the knowledge, skills, and understanding to analyze environmental issues and make informed decisions. (p. 11)*

In the past, environmental literacy champions advocated for the incorporation of environmental literacy into the school day as a somewhat stand-alone curriculum element. However, the Glen Price Group (GPG, 2015) describes how the *Blueprint* now recommends a different approach for incorporating environmental literacy (emphasis added):

> *The* Blueprint *lays out a vision* ***for integrating environmental literacy instruction with all other academic subjects****, including social-science instruction, health, and new California standards for English, math, and science.*

State leaders and environmental advocates recognize that new and developing standards in science (i.e., the Next Generation Science Standards) and other subjects present an enhanced opportunity to incorporate environmental literacy in K–12 education.[8] That is, they say that framing instruction around environmental issues is a powerful, authentic way of addressing essential elements demanded by all of the various standards, such as problem-solving and critical thinking. Note that the intention of these state leaders and environmental advocates is to integrate environmental literacy with all school subjects, not just science. For example, one of the Initiative's district Project Directors described an opportunity that district teachers will have to address local environmental literacy issues through social studies:

7 In 2014, California State Superintendent of Public Instruction Tom Torlakson convened the 47-member Environmental Literacy Task Force to "evaluate the state of environmental education," and think deeply about how to achieve "environmental literacy for all California students" (CDE, 2015, 2018). In 2016, Superintendent Torlakson designated an Environmental Literacy Steering Committee charged with implementing the recommendations outlined in the *Blueprint* (Ten Strands, 2018).

8 In 2018, the California Science Teachers Association partnered with a variety of organizations to design and deliver the California Science Education Conference Climate Summit. In fall 2019, there will be California NGSS Statewide Rollouts on Environmental Literacy at several county office of education locations around the state.

Table 2. Principle 1 and its three Concepts (from California's Environmental Principles and Concepts)

Principle 1: People Depend on Natural Systems	The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
Concept A	The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.
Concept B	The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
Concept C	That the quality, quantity, and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.

Source: http://www.californiaeei.org/curriculum/whatistaught/epc/

> *An exciting development that we have is through social studies in our district. A few social studies teachers have teamed up with the [local] band of mission Indians that are native to the region. And they're building a unit that incorporates the history, and how they were able to survive and thrive here. And the whole story is about the land. And making use of the land. And so that's just being piloted, but I can already see tie-ins, right? That is environmental ed right there.*

Today, the most common schema for the field of environmental literacy in California is the Environmental Principles and Concepts,[9] commonly referred to as "EP&Cs":

1. People depend on natural systems
2. People influence natural systems
3. Natural systems change in ways that people benefit from and can influence
4. There are no permanent or impermeable boundaries that prevent matter from flowing between systems
5. Decisions affecting resources and natural systems are complex and involve many factors

Each Principle above contains several Concepts, as listed in Table 2. The table lists the Concepts of Principle 1, "people depend on natural systems" (Appendix C provides the Concepts for all five Principles).[10]

In the science education field, the NGSS similarly include Human Impacts standards that have an environmental focus (NGSS Lead States, 2013a);

9 Governor Brown signed Senate Bill No. 720 in 2018, which put the EP&Cs into the California Education Code. The EP&Cs are also used as a criterion in the evaluation of NGSS-aligned instructional materials through the *Next Gen Toolkit for Implementation through Materials Evaluation* process.

10 A curriculum was also developed called the California Education and the Environment Initiative Curriculum. This report does not discuss it because this older, pre-NGSS curriculum is not well designed for aiding the implementation of NGSS.

these human impacts are listed as disciplinary core ideas (DCIs) within the earth sciences portion of NGSS:

- MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Further, Appendix 2 of the California Science Framework (CDE, 2016) explicitly shows, for every specific NGSS standard, which EP&Cs have natural links to that standard. This is illustrated in Figure 7, which is a sample NGSS standard for kindergarten (K–LS1) taken from the Framework's Appendix 2. For this specific standard, the bottom-right portion of this page provides the language of the most relevant EP&Cs (Principle I, Concept a, and Principle II, Concept a).

Figure 7. Appropriate alignments among Environmental Principles and Concepts and the California NGSS, for kindergarten

K-LS1 From Molecules to Organisms: Structures and Processes

Performance Expectations	Connections between EP&Cs, CCCs, and SEPs	Clarifications and Connections between DCIs and EP&Cs	Relevant EEI Units That Can Support NGSS Instruction
K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]	**Principle I**: The continuation and health of individual human lives and of human communities and societies depends on the health of the natural systems that provide essential goods and ecosystem services. **Principle II:** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Crosscutting Concepts** **Patterns** Patterns in the natural and human-designed world can be observed and used as evidence. (K-LS1-1) **Science and Engineering Practices** **Analyzing and Interpreting Data** Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-LS1-1) **Connections to Nature of Science** **Scientific Knowledge Is Based on Empirical Evidence** Scientists look for patterns and order when making observations about the world. (K-LS1-1)	**Disciplinary Core Ideas** As students learn that: **LS1.C: Organization for Matter and Energy Flow in Organisms** "All animals need food in order to live and grow; they obtain their food from plants or from other animals; and plants need water and light to live and grow." (K-LS1-1) **Environmental Principle and Concept(s)** Students should be developing an understanding: **Principle I Concept a:** "that the goods produced by natural systems are essential to human life and to the functioning of our economies and cultures." *and,* **Principle II Concept a:** "that direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems."	*The World around Me* *A Day In My Life*

Recommendations

Based on the findings from this report, the evaluators present the following recommendations for administrators and policymakers.

- **Acknowledge that environmental literacy is new to many teachers.** Teachers range in their knowledge of how to address environmental literacy in their science instruction.
  - Make your school or district a space where teachers can be comfortable expressing their need to understand more about teaching environmental literacy.
  - In order to teach about it, teachers first need professional learning experiences to gain familiarity with environmental literacy.
- **Present environmental literacy as a key connection to the NGSS.**
  - As they view NGSS teaching as the priority, some teachers have stated that they consider environmental literacy as an add-on. Districts should integrate environmental literacy into NGSS professional learning so that it is viewed as connected to the standards rather than as a separate topic to teach.
  - How environmental literacy can catalyze NGSS implementation needs to be showcased explicitly. For instance, professional learning should include how environmental literacy can be taught together with the NGSS three dimensions, how environmental phenomena can drive a unit of science instruction, and how students can engage in sense-making during investigations of environmental phenomena or in solving problems related to human impacts in their communities.
  - Professional learning experiences that explicitly familiarize participants with the basics of the Environmental Principles and Concepts and their relationship to NGSS implementation only require about an hour.
- **Encourage teachers to seek out professional learning opportunities outside of their school or district.** As it might take time for districts to develop professional learning in-house that incorporates environmental literacy into the NGSS, take advantage of other opportunities available regionally in which experts are leading this charge. For example:
  - In fall 2019, there will be California NGSS Statewide Rollouts on Environmental Literacy at a number of county offices of education around the state.
  - Explore local partnerships with outside organizations to enhance understanding of environmental literacy and its connection to the NGSS.
  - Observing environmental phenomena in the field can be a powerful and transformative experience for teachers and students.
- **Support the incorporation of environmental literacy into the NGSS by making it a priority throughout the school and district.** For long-lasting change to occur, implementation must extend beyond the classroom level and be supported by all tiers.
  - To develop teachers' understanding and incorporation of environmental literacy into science instruction, they

need the support of their site and district administrators.

- Aside from providing release time for participation in professional learning, administrators themselves need to briefly understand the shifts required, empowering them to prompt, lead, and support their school site and district in implementing these changes.

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Appendix A. Evaluation Methods, Including Interview Questions

Methods Overview

This report draws upon a variety of data sources. Evaluators directly observed a few exemplar lessons integrating environmental literacy and science. They also carried out several surveys and many interviews with all classes of participants in the Initiative; these surveys and interviews included questions specifically about integrating environmental literacy and science instruction.

- Surveys
  - A question included across spring 2018 surveys of administrators and teachers
  - Three questions for teachers and one question for administrators in the spring 2019 survey
  - One question for facilitators in the 2018–19 Facilitator Post-Lesson Study Survey
  - One question for participants in the 2018–19 Participant Post-Lesson Study Survey
- Interviews
  - Several questions in spring 2018 interviews with three regional directors, six project directors, 17 case study teachers, and 10 expansion teachers
  - Several questions in fall 2018 interviews with nine project directors and 14 case study teachers
  - Several questions in spring 2019 interviews with nine project directors, five case study teachers, eight core administrators, five site administrators, and 10 expansion teachers
  - Extensive environmental literacy-specific interviews with six personnel recommended as strong implementers of environmental literacy: three teachers, two science educators, and one project director

Interview Questions

2017–18 Environmental Literacy Interview Questions

Environmental Education Post-Observation Reflection Questions

- How did you address the NGSS while teaching about environmental topics in your lesson?
- Did you incorporate the EP & Cs into your lesson? If so, in what ways?
- Do you typically integrate the EP & Cs into your environmental education instruction? If so, please describe.
- How did your students engage in environmental education during your lesson?

- Do you feel that students were learning new concepts about the environment? If so, how do you know?
- If you could teach this lesson again, is there anything that you would do differently? If so, please describe.
- Do you face any challenges that affect your ability to provide environmental education instruction? If so, please describe.
- What is your definition of environmental literacy? How do you think it can relate to the NGSS?
- What do you think is needed to expand environmental education in your district, if anything?
- Do you use the California Education and the Environment Initiative (EEI) Curriculum? If so, in what ways?

Case Study Teacher Interview #4 (End-of-Year) Protocol
May/June 2018

The NGSS both directly and indirectly integrate environmental education principles and concepts. Although EE has not been an area of focus of the Early Implementer professional learning, we want to understand to what extent EE is being taught in the context of NGSS in Early Implementer districts.

1. Would you say you taught any EE during the 2017–2018 school year?
   a. If yes: How often?
   b. Did you integrate EE into your science instruction?
   c. Can you briefly describe an example of an EE lesson or learning sequence you taught this year (or send me a lesson plan)?
   d. Are you familiar with the Environmental Principles and Concepts (EP&Cs)?
      i. If so, how did you learn about them?
      ii. How, if at all, do you connect them to your NGSS instruction?
2. How, if at all, has the topic of EE been included in any Early Implementer professional learning you have attended so far?

EII Expansion Teacher Interview #2 Protocol
May–June 2018

1. Would you say you teach environmental education?
   a. If yes: How often?
   b. If yes: Can you describe an example of an EE lesson you taught this year?
   c. Are you familiar with California's Education and the Environment Initiative (EEI) curriculum? If yes, do you use the curriculum? If yes, how do you use the curriculum?
   d. How about the Environmental Principles and Concepts (EP&Cs)? If so, do you use them in your instruction? How?

Regional Director Interview #4
January 2018

1. For each of the following components of the district plan, can you briefly tell me what kind of guidance you/K–12 Alliance provided to the CLTs?
   a. PEM
   b. Integration with CCSS
   c. MS Integrated Model
   d. Environmental Ed
   e. Monitoring and evaluation plan
   f. Budget

Environmental Education Interview Protocol

Thank you for speaking with me today. We are researching environmental ed that is happening in the Early Implementer districts, and you were specifically recommended as a person to talk to about this.

Environmental Education Teaching

1. How would you define EE?
2. Thanks for sending me materials from what have you taught this year that someone would consider Environmental Ed. Can you please walk me through this lesson (one of these lessons)?
3. How often would you say you teach EE?
   a. Where do you conduct EE instruction (regular classroom, EE classroom, science room, off campus)?
4. How does your EE instruction relate to the NGSS?
   a. **Ask classroom teacher:** How, if at all, are you addressing environmental topics while teaching NGSS? Please be specific and/or give specific examples.
   b. **Ask resource teacher:** What academic subjects are you addressing in your EE instruction?
      i. How, if at all, are you addressing NGSS while teaching EE?
5. We are interested in seeing in person a lesson that exemplifies environmental ed. Will you be teaching an EE lesson in the next 2-4 weeks that we could observe?
6. How, if at all, has the Early Implementers Initiative affected how you teach environmental education?
   a. How has EI affected your **approach or pedagogy** when teaching EE? Please contrast before and after EI.
   b. How has EI affected what **EE topics** you teach? Please contrast topics you taught before and after EI.
7. How do you choose what topics to teach?
8. How familiar are you with California's Environmental Principles and Concepts (EP&Cs) and the Environmental Initiative Curriculum?
   a. How, if at all, do you use the Environmental Principles & Concepts (EP&Cs) in your instruction?
   b. How, if at all, do you use the EEI (Education and the Environment Initiative) Curriculum in your instruction?
   c. How did you learn of these things? Did you incorporate them in your teaching before you joined the Early Implementers?
9. Do you intend to teach EE any differently in the future? Please explain.

Background Information

10. What is your background as it relates to environmental education?
11. How long have you been teaching environmental education?
    a. Are you charged specifically with teaching environmental education in your district?

Student Response to Environmental Education

12. Do you find that students are interested in environmental issues?
13. Does EE affect students' understanding of science/engineering content or practices?
    a. Would you say that EE affects student interest in science overall? If so, in what way?
14. Are you noticing **increased** student interest in the connections between their lives and the environment as a result of EE instruction? Are they more interested in the impacts they and others make on the environment at the local and/or global level?

   a. Please explain your answer or give an example if possible.

15. Are you noticing that students are recognizing their own potential for addressing environmental issues (social agency)?

16. Do you know of another teacher or two you'd recommend we talk to about EE?

2018–19 Environmental Literacy Interview Questions

Case Study Teacher Interview #5
October-November 2018

The NGSS both directly and indirectly incorporates environmental education. We want to understand to what extent EE is being taught in the context of the NGSS in Early Implementer districts.

1. Did you attend your district's 2018 summer institute?
   a. If yes: Was there an emphasis on EE at the Institute?
   b. If yes: Did you feel encouraged at the summer institute to incorporate EE into your NGSS instruction this year?
2. Have you been encouraged by your district or by any Early Implementer Initiative leaders to teach EE or to incorporate environmental ed into your NGSS science teaching? (If yes, please explain.)
3. Have you received training in EE? If so, could you please describe it?
   a. Was it provided at a centralized (multiple district) Early Implementer event, in the district, or other?
   b. When was it?
   c. Was it valuable? What did you take away from it?
4. Are you planning to incorporate more EE into your NGSS lessons this year? (If yes, please explain how and why.)
5. What, if anything, do you find compelling about teaching EE?
   a. How have students in your classes responded to EE?
6. What is the biggest obstacle to incorporating (more) EE into your NGSS instruction?

Project Director Interview #6
October-November 2018

You may have been involved in reviewing the recent internal brief about environmental ed in Early Implementer districts. And if you were at the last RDPD meeting, you talked about the fact that there will be a full report on environmental ed, for our regular readership of policy makers and other districts, later this year.

1. How, if at all, did your Summer Institute incorporate EE? Please be specific.
   a. Did you specifically instruct Cadre to incorporate EE?
   b. Was there a review of the EP&Cs for participants? If so, in what context (pedagogy, Cadre, other)?
2. Do you have a strategy for encouraging and/or supporting teachers to incorporate EE into their teaching this year? (Probe: How, if at all, have you communicated to teachers about teaching EE this school year?)
   a. Which teachers, if any, are expected to teach EE during the school year this year?
   b. What thoughts do you have about what motivates teachers to teach EE?
3. Do you have any idea what percentage of K–8 students are getting some kind of EE this year?
   a. Are all schools and students in the district equally involved in EE? Is there much

variability across schools? (Are some doing a lot, while others are doing very little?) If so, what does this depend on?

4. Are there any local field study destinations that teachers in your district regularly take advantage of for NGSS or EE? (Please describe what students do there, which teachers or how many teachers take advantage of this destination)

5. Would you say there are any barriers to incorporating EE in the district?

6. We are looking again this year for examples of what EE looks like in the classroom. Can you recommend any new teachers whose classes we might observe?

Project Director Interview #7
January–February 2019

As you know, later this year there will be a full report on environmental ed for our regular readership of policy makers and other districts.

1. Do you have any updates or corrections to the information about how teachers are teaching the EP&Cs or environmental ed that was in the transcript or the table we sent you?

2. Is there any new information from your district relating to environmental ed? (For example, are lesson studies in the spring incorporating EE?)

3. (If you want to ask about gaps and clarifications, do so now.) I have some clarifying questions for you about EE in your district. . . *(look at row 10 in EE matrix tab)*

4. Have you been able to observe any EE instruction in your district this year?

   a. If yes, what did you think about its quality (e.g., teachers' EE knowledge, student engagement, and student learning)?

   b. Have you had a chance to collect any feedback from participants or principals that have participated in or observed these events or activities this year?

      i. If so, can you share it? What was said?

Core Administrator Interview #1 Protocol
Spring 2019

1. Have you seen any examples of instruction in which environmental education is used as a context for NGSS implementation?

   a. (If yes) Please describe. (Probe: Are there any particular content areas (e.g., ESS, LS, PS, engineering) or mechanisms (e.g., using environmental phenomena) that you feel enable teachers to incorporate environmental education into their science instruction? How well does this context engage students and catalyze their interest in science?

   b. Would you say your school (*if not a principal* – district) has a focus on incorporating environmental education into science instruction? (If yes) How did that start? What is being done?

School Principal Interview #1 Protocol
Spring 2019

1. Have you seen any examples of instruction in which environmental education is used as a context for NGSS implementation?

   a. (If yes) Please describe. (Probe: How well does this context engage students and catalyze their interest in science?)

   b. Would you say your school has a focus on incorporating environmental education into science instruction? (If yes) How did that start? What is being done?

2. Has your school actively involved the larger community in science education in any way? (e.g., facilitating community partnerships—including businesses, partnering with locations for environmental ed, etc.)

   a. In what ways, if any, has your school increased parents' awareness of NGSS?

(Probe: What activities, if any, have parents participated in to support NGSS learning in the home?)

Case Study Teacher Interview #6 Protocol April–May 2019

As you know, we are interested in how EE is being taught in the context of the NGSS.

1. In the fall, you reported that you (did/did not) plan to incorporate more environmental ed into your NGSS science teaching this year. How is that going/Has that changed?
   a. (If doing more) Have you discovered any instructional materials related to EE since we talked in the fall?
   b. (If doing more) How have students responded to your environmental ed instruction?
   c. Last year, you said you ___(were/were) not familiar with California's Environmental Principles and Concepts (EP&Cs).
      i. (If familiar last year) Did you use them in your instruction this year? If so, how?
      ii. (if not familiar last year) Would you say that has changed? If so, do you use them in your instruction? How?
2. Do you think there are particular content disciplines (e.g., ESS, LS, PS, engineering) or mechanisms (e.g., using phenomena) that you feel enable teachers to incorporate environmental education into their science instruction?
3. Have there been any new obstacles to your incorporating (more) EE into your NGSS instruction? (If so, please describe.) (Probe for role of instructional materials as appropriate.)
   a. Have there been any new supports? (If so, please describe.) (Probe for role of instructional materials or principal as appropriate.)

EII Expansion Teacher Interview #3 Protocol April–June 2019

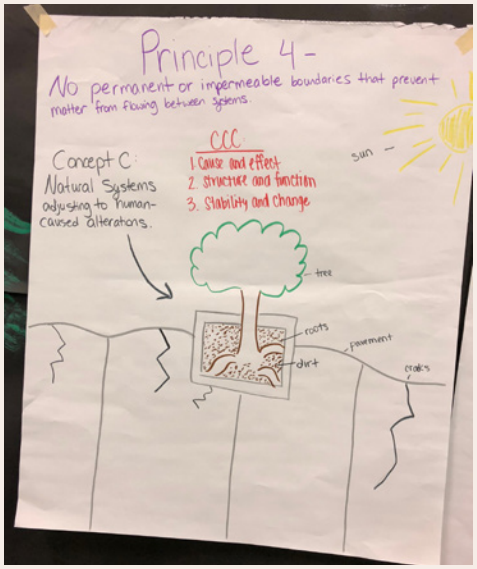
1. Are you familiar with California's Environmental Principles and Concepts (EP&Cs)?
   a. If so, do you use them in your instruction? How?
      i. How often would you say you teach environmental education? (definition if needed: EE applies to any lesson that involves the relationship between natural systems and human societies.)
      ii. Can you describe an example of an EE lesson you taught this year? How did students respond to it?
   b. What about the NGSS supports EE?
   c. Is there anything about the NGSS that makes it challenging to incorporate into EE?
   d. Have there been any obstacles to your incorporating (more) EE into your NGSS instruction? (If so, please describe.) (Probe for role of instructional materials as appropriate.)
   e. Have there been any supports? (If so, please describe.) (Probe for role of instructional materials or principal as appropriate.)

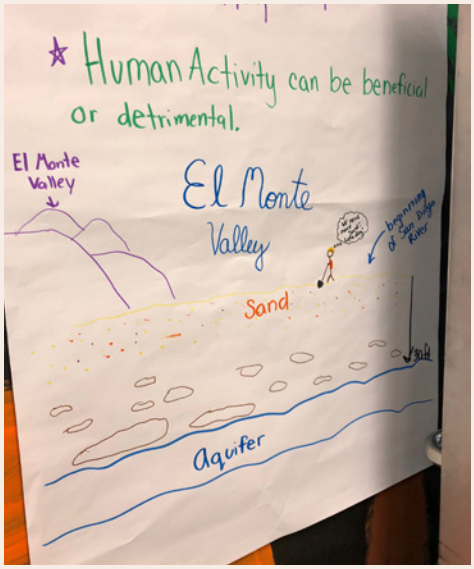
Appendix B. Vignette: Outdoor-Themed Summer Institute Includes Focus on Environmental Literacy

Each summer, the Early Implementers Initiative holds a Summer Institute, which is a week-long professional learning event to kick off the new Early Implementer school year. One of these Institutes was an outdoor-themed Summer Institute at which teachers learned about California's Environmental Principles and Concepts (EP&Cs), natural spaces in their communities, and ways to make connections between science and other subject areas (such as English language arts [ELA] and social studies) through environmental topics and activities. The room was decorated like a campground with each table in the multipurpose room named after a national park.

During the first day of the Institute, all teachers (including middle school ELA teachers) attended a session on California's EP&Cs, and were asked to brainstorm phenomena that would highlight a principle that they were assigned. They wrote and drew about their phenomena, which included making connections with the NGSS three dimensions, on large posters. Many of these posters highlighted phenomena that students could observe in their school or community, and some teachers also included potential connections with other subject areas such as social studies and ELA (see Figure 8). These posters were displayed on a wall with painted pine trees.

Figure 8. Examples of EP&C posters from Summer Institute



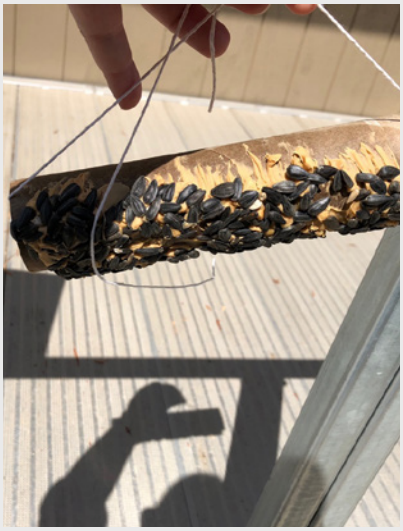
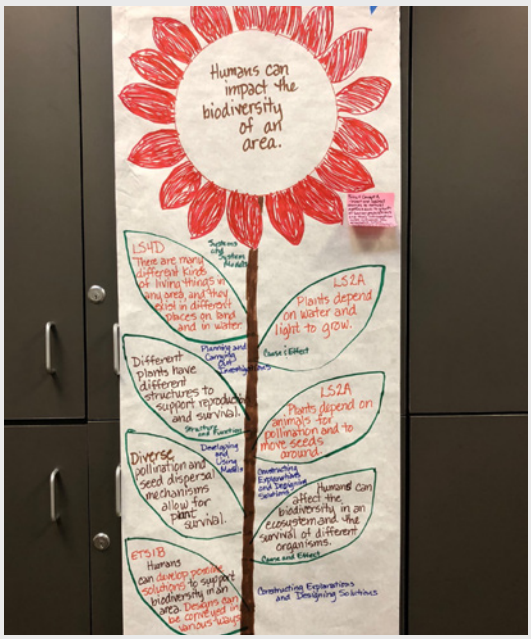


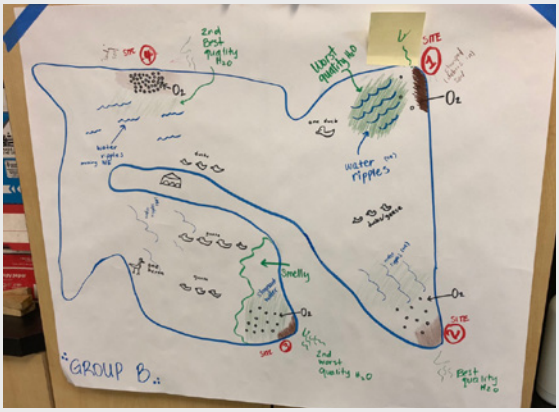
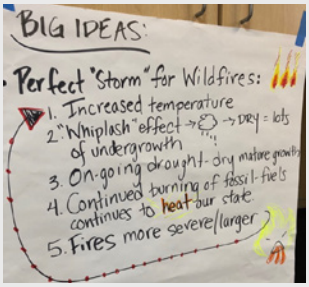
Source: 2018 Summer Institute observation.

The last, but arguably most important, part of the Summer Institute that focused on environmental literacy was the Cadre sessions. Each grade across K–5 had its own environmentally focused Cadre session in which the grade-level participants engaged in an NGSS-aligned environmental literacy lesson, learned about the science content from professional scientists and expert educators, and discussed how they could translate this lesson for their own students. The middle school participants also had grade-level Cadre sessions in which science teachers were learning alongside their ELA teacher colleagues, and working through an integrated ELA/science lesson sequence linking recent California wildfires to the book *The Giver* (Lowry, 1993). Table B1 provides an overview of some of the main science topics or phenomena teachers engaged in during the Cadre sessions.

In these sessions, teachers were confronted with the notion that they should teach even young children about the sometimes negative impacts humans can have on the environment, even though some teachers expressed concern: "When I learned about environmental education in college, they said 'no catastrophes before fourth grade' and I could see how this would be depressing for my fifth graders." By talking through these concerns and having a dialogue on teaching such potentially sensitive subjects to small children, the teachers walked away understanding the importance of having their students "at least [knowing] about these things so they can be aware of their actions and the effects they can have on the environment, as well as getting others (such as their parents) to think about this." Many teachers wanted to develop lessons that incorporated environmental education after these professional learning opportunities to give their students "stewardship opportunities that can help them make a difference [in their community] now, and not have to wait until they grow up."

Table B1. Science topics or phenomena during Cadre sessions, by grade level

Grade	Science Topic or Phenomenon
K	Living and nonliving things: what they need to survive   (Birdhouse and bird feeder made from recycled materials)
2	Plants and pollinators: Engineering a better pollinator  (EP&C and NGSS aspects covered in lesson sequence)

Grade	Science Topic or Phenomenon
3	Investigating the smell at a local lake  (Group-developed map of lake with observations and water samples labeled)
5	Human interaction and impact on the local environment  (Group model of system showing interaction between human and natural environment)
MS	California wildfires have increased in frequency and intensity  (Group poster of big ideas explaining phenomenon of CA wildfires)

Appendix C. Environmental Principles and Concepts

Below are *California's Environmental Principles and Concepts* (EP&Cs) from the California Department of Recycling and Recovery (2018). These EP&Cs are available at http://www.californiaeei.org/curriculum/whatistaught/epc/.

Principle/concept	Description
Principle I: People Depend on Natural Systems	The continuation and health of individual human lives and of human communities and societies depends on the health of the natural systems that provide essential goods and ecosystem services.
Concept A	The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.
Concept B	The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
Concept C	That the quality, quantity, and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.
Principle II: People Influence Natural Systems	The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
Concept A	Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.
Concept B	Methods used to extract, harvest, transport, and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.
Concept C	The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.
Concept D	The legal, economic, and political systems that govern the use and management of natural systems directly influence the geographic extent, composition, biological diversity, and viability of natural systems.

Principle/concept	Description
Principle III: Natural Systems Change in Ways that People Benefit from and Can Influence	Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
Concept A	Natural systems proceed through cycles and processes that are required for their functioning.
Concept B	Human practices depend upon and benefit from the cycles and processes that operate within natural systems.
Concept C	Human practices can alter the cycles and processes that operate within natural systems.
Principle IV: There Are No Permanent or Impermeable Boundaries that Prevent Matter from Flowing between Systems	The exchange of matter between natural systems and human societies affects the long-term functioning of both.
Concept A	The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.
Concept B	The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.
Concept C	The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.
Principle V: Decisions Affecting Resources and Natural Systems Are Complex and Involve Many Factors	Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.
Concept A	There is a spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.
Concept B	The process of making decisions about resources and natural systems, and how the assessment of social, economic, political, and environmental factors has changed over time.

Glossary

5E Instructional Model — A valuable model for NGSS instruction driven by student questioning and discussion. At each stage of the lesson — Engage, Explore, Explain, Elaborate/Extend, Evaluate — students practice and develop literacy skills. They record and discuss their prior knowledge of a phenomenon; share ideas with peers; conduct investigations; read texts, watch video clips, or otherwise take in new information; and revise and articulate their new thinking.

Core Leadership Team (CLT) — Group of three to five administrators and five to eight teachers established at each district at the beginning of the Initiative. The CLT meets with their Project Director regularly during each school year to plan and lead all Early Implementers Initiative activities. They meet with their K–12 Alliance Regional Director for six Technical Assistance Days each school year.

Core Teacher Leader (CTL) — Teacher member of the Core Leadership Team. Provides professional learning to Teacher Leaders, other teachers, and/or administrators in their district or at project-wide events such as the Summer Institute.

Crosscutting Concepts (CCCs) — One of the three NGSS dimensions and a way of linking the different domains of science. CCCs include patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change.

Dimensions of the NGSS — The NGSS includes three dimensions: Disciplinary Core Ideas (what scientists know), Crosscutting Concepts (how scientists make connections among the sciences), and Science and Engineering Practices (what scientists and engineers do, and how scientific knowledge develops).

Disciplinary Core Ideas (DCIs) — One of the three NGSS dimensions. According to National Research Council's Framework for K–12 Science Education, disciplinary core ideas are the important concepts in each of four domains: physical sciences; life sciences; Earth and space sciences; and engineering, technology, and applications of science.

Expansion teacher — Teacher who has not directly received significant professional learning or support from the Initiative but who is benefiting through the shared expertise of those who have. In larger districts, expansion teachers are typically in schools with at least one Teacher Leader.

K–8 NGSS Early Implementers Initiative — Six-year Initiative (summer 2014 to spring 2020) supporting implementation of the NGSS by eight public school districts and two charter management organizations in California. Developed by the K–12 Alliance at WestEd in collaboration with the California State Board of Education, California Department of Education, and Achieve, the Early Implementers Initiative builds capacity of participating local education agencies to fully implement the NGSS in grades K–8.

The K–12 Alliance — A WestEd program of science education leaders and professional learning providers who plan and deliver all project-wide activities for the Early Implementers Initiative.

Learning Sequence — Three-dimensional (3D) NGSS phenomenon-based instruction lasting several lessons. A learning sequence is based on an investigative phenomenon and represents part of a conceptual flow. Learning sequences can be designed using the "5E" instructional model.

Lesson — Three-dimensional (3D) NGSS phenomenon-based instruction lasting for a single class period, typically 45 to 90 minutes, but potentially longer.

NGSS — A set of K–12 science content standards developed by states to improve science education for all students. They are composed of three dimensions based on the National Research Council's Framework for K–12 Science Education.

Phenomena — Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict. There are two types of phenomena, anchoring and investigative.

Project Director — District person responsible for leading all Early Implementers Initiative activities for the district and representing the district at monthly Initiative-wide planning meetings with Regional Directors.

Science and Engineering Practices (SEPs) — One of the three NGSS dimensions, SEPs are the behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. They include asking questions (for science) and defining problems (for engineering); developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations (for science) and designing solutions (for engineering); engaging in argument from evidence; and obtaining, evaluating, and communicating information.

Summer Institute — Weeklong professional learning event held every summer to kick off the new Early Implementer school year. In years 1 through 4, regional Summer Institutes, typically one in the north and one in the south, were attended by all Initiative participants, some as leaders (Regional Directors, Project Directors, Core Leadership Team members) and others as learners (Teacher Leaders). Typically, principals of schools with Teacher Leaders were encouraged to attend for at least one day. Beginning in Year 5, a separate Summer Institute was held in each district that was open to any interested principal or teacher of science.

Teacher Leader (TL) — One of 30–70 teachers in each district who joined the Early Implementers Initiative in year 2, one year after the Core Teacher Leaders. Teacher Leaders attend annual Summer Institutes and participate in two TLCs each school year (one in the fall and one in the spring) and other district-level professional learning.

Teaching Learning Collaborative (TLC) — Lesson-study activity of years 1 to 4 of the Early Implementers Initiative. Each TLC brings together three to four same-grade Early Implementers Initiative teachers from different schools within the district. Teachers plan and teach a lesson to two classrooms of students and debrief after each lesson is taught, during which they examine student work from the lesson. Each Teacher Leader participates in two TLCs per year.

Toolkit for Instructional Materials Evaluation (TIME) — A suite of tools and processes for curriculum-based professional learning, designed to help educators evaluate, select, and implement instructional materials aligned to the NGSS.

NGSS EARLY IMPLEMENTERS
WestEd

Environmental Instruction Catalyzes Standards-Based Science Teaching

EVALUATION REPORT 9

How Environmental Literacy Aids Implementation of the NGSS

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