Serpentine Species
Teacher Guide
Unit for Smith River Alliance and BFT Youth Stewardship Project

Statement of Inquiry: "The mineral and chemical composition of serpentine-derived soils is unusual and extreme, leading to high levels of plant speciation and endemism."- USFS 2018 Conservation Strategy Report

Essential Questions:

- What are endemic species?
- Why do some species live on serpentine?
- How does serpentine soil give rise to new species?
- How does serpentine affect competition among plants?

Objectives: I can…

- Explain the relationship between soil nutrients and plants (knowing/understanding)
- Describe why species are rare or endemic (knowing/understanding)
- Use and reflect on data collection methods (processing/evaluating)

Rationale: The Klamath Mountains are known for their high biodiversity including rare and endemic plant species. Initial survey results for the Bigfoot Trail Youth Stewardship Project indicated a need for Ecology, real world skills such as data collection and analysis, and integration of math and ELA.

Concepts: biodiversity, endemism, ecology, botany, botanical illustration (RUBRIC), chemistry, geology

Skills: Science and math: data collection and analysis, graphing, making observations; ELA: interpreting and presenting text, written reflections; Arts: illustration and making observations; Social/emotional: collaboration, cooperation

Overview: Students will determine the requirements of (most) plants. Students will determine why certain plants grow in certain locations by researching plants that grow on serpentine soils. Students will practice the science skills of data collection and analysis by conducting soil tests. Students will analyze class data and reflect on the results of their survey. Students will observe specific plant adaptations to serpentine soil on the Field Trip. **NOTE:** this unit includes a Field Trip, please plan accordingly.

NGSS Alignment:

MS-LS2-4. **Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.** [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]
**change in soil types from schoolyard to field trip site

MS-LS2-1. **Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]
**resources available in specific soil types

MS-LS1-5. **Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.** [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.]
**environmental factors: resources available in specific soil types

Outline:

*aligned to middle school standards. All activities can be up or down leveled for different grades by providing more or less student-led inquiry (vs. teacher provided information), depth of ecology content, depth of data analysis content, and depth of field trip.

Day 1: **Engage**
- Schoolyard soil survey
- Guiding Questions and discussion

Day 2: **Explore**
- Soil tests comparisons
- Preliminary data analysis

Day 3-4: **Explain**
- Study serpentine soils and associated species through video and Jigsaw Activity

Day 5: **Elaborate**
- Darlingtonia Fen Field Trip: Guided Walk, Arts Integration, Plant Dissection and Soil Test

Day 6: **Evaluate**
- Data analysis and reflection

Day 7+ : **Extend**

- Optional activities

5Es Lesson Plan

ENGAGE

Overview: In the schoolyard students will explore soil in the schoolyard

Goal: I can make observations about soil.

Set-up & Materials:

- Schoolyard where it is okay to disturb an area
- trowels/small shovels
- Plastic bag or collecting class soil sample for next section
- Serpentine Species: editable data sheet
- Large paper and pen for writing down brainstorms (or use the board back in the classroom)

Procedure:

1) Take students out into the schoolyard. Give them boundaries and trowels/small shovels.
2) Working individually or in teams of 2-3, students will dig a small hole in the schoolyard-encourage them to spread out to different sections of the schoolyard (variability in soil will make sharing more engaging).
3) For each "sample" students will record as many detailed observations as they can (Examples: color, texture, moisture, smell…)
4) Regroup and tour students sample sites. Students will share 3+ observations. Collect 1-2 samples in a plastic bag to be used in the next section. Be sure students fill in holes after they have shared their sample.
5) Ask using Think-Pair-Share: How did soil samples compare-where some similar/different and how so? What do you think causes the differences in color, texture, moisture, smell?
6) Go over student ideas as a class. Write down ideas on a big sheet of paper or inside on the board-don't give any answers yet, just let students brainstorm. Save this to return to in future classes.

EXPLORE

Overview: Students will test soil from the schoolyard and from home.

Goal: I can use a scientific technique to collect data.

Set-up & Materials:

- Previous brainstorms from Engage Activity
- Nitrogen soil test such as Lusterleaf RapiTest or LaMotte NPK Soil Test
- Plastic bags for students to bring soil from home or common location
- Serpentine Species: editable data sheet

Procedure:

1) In addition to your schoolyard sample(s), ask students to bring soil samples from home or a common location students all know, enjoy, and agree upon like a nearby park or riverspot. As noted below, the number of samples will be contingent on the number of tests you have available.
2) Make visual observations of the new soil sample(s).
3) Ask students what nutrients they need to survive and how they obtain them. Ask students what nutrients plants need to survive and how they obtain them. Briefly explain that Nitrogen is an essential nutrient for plants used to make proteins and chlorophyll (among other important functions). Explain that today you will test your soil samples to see if they contain a healthy amount of Nitrogen for plants to survive and thrive.
4) Follow the manufacturer's instructions for your specific Nitrogen test for the schoolyard and chosen location samples. Depending on the number of tests available you may run this as a demo, split students into groups, or have different groups do different parts of the test.
5) Students should record the class data on their own copies of the class datasheet.
6) Discuss the results: are they similar/different? Why do you think this might be?
7) Save this data to compare in the Elaborate Section.

Note: the number of soil tests you purchase will determine how many soil tests you can conduct. The tests linked above contain Nitrogen tests as well as tests for P and K which you can also include or save for another time. You will need to ration tests to use on samples from the schoolyard, the neighborhood/home spot your students choose, and the field trip site.

EXPLAIN

Overview: Students will access information about serpentine geology and the rare and endemic plant associations.

Goal: I can collaborate with my peers to explain why certain plants grow on serpentine soils.

Set-up & Materials:

- Video clip Science Today: Serpentine Soil | California Academy of Sciences
- Serpentinite rock sample
- Serpentine Readings Jigsaw Handouts (4 topics)

Procedure:

1) Introduce serpentine soils with a photo or rock sample. Explain that in the Klamath Mountains there are plant species that are adapted to living without the same amounts of nutrients-specifically Nitrogen- as most plants require. These plants live on serpentine soils.
2) Show the following video from the California Academy of Sciences to continue to build general background on serpentine soils Science Today: Serpentine Soil | California Academy of Sciences
3) Students will read the Serpentine Readings Jigsaw Handouts using the Jigsaw Method. Divide students into groups of 4 and assign one of the following topics to each group member.
    a) Geology
    b) Plant Adaptations
    c) Rare and Endemic Species
    d) Plant Communities
4) After reading independently, students will form Expert Groups meeting with all other students who had their topic. Expert Groups will compare ideas and determine what information each member will share with their original team.
5) Students will return to their original teams and present the information decided upon in their Expert Group. As the expert teaches, the other team members take notes and ask questions.
6) Check for understanding through a short quiz or exit ticket covering content from all 4 topics.

ELABORATE

Overview: Field Trip! The class will observe serpentine associated plants on a Guided Walk, explore the adaptations of *Darlingtonia californica* through botanical illustration and dissection, and conduct a soil test at the field trip site.

Goal: I can make observations and explain how form equals function. I can use a scientific technique to collect data.

Procedure:

Depending on the size of your class, you may complete each activity as a whole class or reconfigure the lessons to create a rotation of smaller groups. If rotating through

smaller groups please note that the Arts Integration section is longer and can be separated into two parts, but students will need to complete the Botanical Illustration portion before the Dissection.

1) Guided Walk: I Notice, I Wonder, It Reminds Me Of
2) Arts Integration: Botanical Illustration and Dissection
3) Data Collection: Nitrogen Soil Test

Part 1: Guided Walk: I Notice, I Wonder, It Reminds Me Of

See the Serpentine Species Field Trip Guide for lesson plan.

This resource Notice, I Wonder, It Reminds Me Of - Beetles Project includes more detailed instructions and a video of how to expand on this strategy:

Set-up & Materials:

- (Optional) Hand lens or magnifying glasses can be helpful and fun
- (Optional) Plant field guides

Part 2: Arts Integration: Botanical Illustration and Dissection

See the Serpentine Species Field Trip Guide for lesson plan

Set-up & Materials:

- Art supplies: water containers, watercolor paints or pencils, watercolor paper for each student
- Dissection kit for teacher

Part 3: Nitrogen soil test

Follow the same procedures as in the Explore section on the Teacher Guide where students tested for Nitrogen in soil samples at school.

Set-up & Materials:

- Nitrogen test
- Serpentine Species: editable data sheet

Field trip sites for Del Norte schools

Darlingtonia Trail

- Google Map from Gasquet
- Simplified Trail Map
- https://smithriveralliance.org/darlingtonia-trail/
- 5 minutes past Gasquet
- 0.2 mile loop
- gravel trail with two viewing platforms (wheelchair accessible)

Stony Creek Trail

- in Gasquet
- Connection to SRA
- https://smithriveralliance.org/stony-creek/

- 0.5 mile out and back hike
- Includes potential water crossing
- Not wheelchair accessible

EVALUATE

Overview: Students will demonstrate their understanding of the unit by analyzing their data from inclass and the Field Trip and writing a short summary reflection.

Goal: I can interpret my data to demonstrate my understanding of serpentine soils.

Set-up & Materials:

- Serpentine Species: Evaluate Section-Unit Reflection

Procedure:

1) Using the datatables from their in class samples and Field Trip samples students will describe the data they collected.
2) Students will interpret their data explaining the relationship between soil conditions and serpentine species by drawing on the background information they gained from the Explain Section Jigsaw activity and the Field Trip.
3) Note: the Unit Reflection handout is editable so teachers may modify based on their class needs and established strategies. The handout includes example sentence starters and an example rubric.

EXTEND

- Lab Experiment: Why do certain plants grow in serpentine while others don't? Grow and measure seedlings grown in a variety of soils-serpentine, potting soil, soil brought from schoolyard or home. Compare nutrients present. Compare plant growth. Inquiry-based: provide students with guiding question, materials. Students design their own procedure-identify own variables and control.
- Students organize a local Bioblitz. Record data via iNaturalist

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Additional Information

Resources for Students

US Forest Service. Klamath-Siskiyou Serpentines

Teacher feedback

If you've used this curriculum we'd love your feedback. Please email sarah.bursteinsinnott@gmail.com

Sources

Beetles Project. I Notice, I Wonder, It Reminds Me Of - Beetles Project

Botany.org Darlingtonia californica, Carnivorous Plants Online

California Academy of Sciences. Science Today: Serpentine Soil | California Academy of Sciences

Smithsonian In Your Classroom. Smithsonian in Your Classroom: Botany & Art and Their Roles in Conservation

US Forest Service. Klamath-Siskiyou Serpentines

US Forest Service. California Pitcherplant (Darlingtonia californica)

US Forest Service. 2018 Conservation Strategy Report

This unit was created by Sarah Burstein (Smith River Alliance) for the Bigfoot Trail Alliance Youth Stewardship Project through funding from the S.H. Cowell Foundation