Kumu ʻŌhiʻa: The Diversity of ʻŌhiʻa

Grade	Unit Length
1st-2nd Grade	6 lessons

Anchoring Phenomena

ʻŌhia trees are all ʻŌhiʻa but look very different from one area to the next.

Unit Overview

Focused on the development and diversity of ʻŌhiʻa lehua in Hawaiʻi, your students will begin by observing the shapes and functions of ʻŌhiʻa lehua on their school campus. They will learn about the life cycles of these culturally and biologically important trees, and develop evidence that parents look similar to their offspring. Students will then explore the different varieties of Ohia across Hawaiʻi and discover how differences in water and soil affect how plants grow.

NGSS Performance Expectations (PE) addressed in Unit

1.LS3.1: Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
2.LS4.1: Make observations of plants and animals to compare the diversity of life in different habitats

- View the Kumu ʻŌhiʻa Lesson Plan for a detailed breakdown of NGSS standards

Materials List

- White board/chart paper
- Kilo journals
- Pencils
- ʻŌhiʻa Seeds
- ʻŌhiʻa Cuttings
- Starter Pots
- Soil
- Water
- Location to put starter pots
- *Optional:* Clipboards

Introduction to the RDC

The **Hawaiʻi PK-12 Research and Development Consortium (RDC)** was initiated in 2018 through a partnership with the Volcano School of Arts and Sciences (VSAS). The partnership continued in 2019-2020 through a USDA Forest Service and NOAA Ocean Guardian School grant and expanded to a state-wide program in 2021-2022 with funding from a Governor Ige

GEER Innovation Grant. The objective of the RDC is the establishment of lasting, mutually beneficial collaborations between the conservation community and Hawai‘i schools. These collaborations endeavor to align conservation research with the needs of the community through the development of Hawai’i-based, Next Generation Science Standards (NGSS). This strategy makes community outreach scalable for researchers while addressing student science learning objectives for schools.

In Spring of 2022, the RDC partnered with Dr. Lori Andersen, an NGSS curriculum specialist with the College of Education at the University of Hawai‘i at Mānoa, to host a teacher professional development (PD) workshop series entitled *Developing 3D Science Units for Hawai‘i-based Phenomenon*. With the collaborative support 14 cultural and scientific organizations, the RDC guided 28 teachers associated with 14 schools across 5 islands in the development of Hawai‘i-based, NGSS science units. The resulting 20 NGSS science units incorporate Hawaiian culture, research datasets, and emerging conservation research.

For lesson plans and additional information regarding these units, visit the RDC website at www.kopuahawaii.org

Nā Hopena A‘o (HĀ) Outcomes

The HĀ framework was created to develop the skills, behaviors and dispositions that are reminiscent of Hawai‘i’s unique context, and to honor the qualities and values of the indigenous language and culture of Hawai‘i. Click here to learn more about Nā Hopena A‘o

Strengthened Sense of Belonging: Care about my relationships with others. Students will learn to care about ‘Ohi’a as our kupunas and kumus.

Strengthened Sense of Responsibility: Reflect on the quality and relevancy of the learning. Students will reflect on how ‘Ohia is all around us and it is important for our culture.

Strengthened Sense of Hawai‘i: Learn the names, stories, special characteristics and the importance of places in Hawai‘i. Students will learn about ‘Ohia in Hawai‘i.

Biocultural Context

The ‘ōhi‘a lehua is by far the most bioculturally important tree species in Hawai‘i. The ‘ōhi‘a is truly the ecological keystone of Hawai‘i’s native forests and watersheds, covering more than one million acres statewide, and providing habitat for countless other native species of plants, birds and insects. The ‘ōhi‘a is also the cultural keystone for native Hawaiian people, supporting beliefs and traditional lifeways and practices. The relationship between Pele, the deity of fire and lava who is both a destroyer and creator of land, with her youngest and most cherished sister, Hi‘iakaikapoliopele, a healer and nurturer of new growth, is one of cycles and a system in balance.The ‘ōhi‘a emerging from a fresh lava flow is perhaps the most iconic representation of the ‘ōhi‘a relationships with Hawai‘i and her people.

‘Ōhi‘a lehua is critical to maintaining the diversity, structure, and function of Hawai‘i’s native forests. This ecological foundation provides food and habitat to numerous native plant, animal, and invertebrate species, and also affects our watersheds by capturing water,

reducing erosion and sediment runoff into our streams and reefs, and providing countless goods and services to the people of Hawai‘i.

This description of ‘Ōhi‘a lehua is provided by the Akaka Foundation for Tropical Forests

Teacher Background Information According to Lesson	
Lesson 1:	**Kilo ‘Ōhi’a:** ‘Ōhi’a Lehua, also called ‘Ōhi’a, is a tree endemic to Hawai‘i, meaning it is native to Hawaii and only naturally found here. It is a culturally important species, as its red lehua flower is symbolic of Pele and it is the subject of numerous mo’olelo. These trees are also biologically significant, as are the first plant to begin growing on new lava flows and are the most abundant in most Hawai‘i forests. The taxonomic name for Ōhi'a Lehua is *Metrosideros polymorpha*: which means “many forms” after the many different ways ‘Ōhi‘a can look. Read more about Ōhi'a Lehua here
Lesson 2:	**Patterns of ‘Ōhi’a:** Scientists use patterns to identify and explain cause and effect relationships and use graphs and charts to identify patterns in data. Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena.‘Ōhi’a trees have patterns of similarities and differences in their appearance (i.e., trunks, height, shape, flower color, etc.). The mature leaves are generally leathery and smooth dark green, but some forms are woolly or hairy underneath and may appear grayish. The leaf buds (*liko*) can range in color from pale green to pink to yellow to red. They ranges in height from a lowlying shrub to a 100 foot tree. Young bark is smooth and light gray and becomes rough and scaly with age.
Lesson 3:	**How do ‘Ōhi’a Trees grow?** All living things have life cycles. For ‘Ōhi’a, their life cycle is similar to most flowering trees (i.e. seed, seedling, sapling, tree, etc.). Phenology is the study of observing the timings and seasonality of certain life cycle events. Just like other trees, ‘Ōhi’a need soil, sun, water and light to grow and reproduce. ‘Ōhi’a reproduce through seeds, and the offspring and parent of a given ‘Ōhi’a tree will share certain similarities. Heredity explains why offspring resemble, but are not identical to, their parents. Heredity refers to specific mechanisms by which characteristics or traits are passed from one generation to the next via genes. Offspring get traits from both their mother and their father. Some look more like their mother and some look more like their father. When looking closely it is most common to have traits from both parents. Which traits are passed down from the parents are often a matter of chance. For example, young tree samplings will grow to have features which resemble their parents (examples of traits that are passed down from parents: flower color, leaf shape and texture).

	***Note*:** For this grade level, just simply understanding that specific traits are passed down from parents is enough. The objective is for students to notice that traits are shared from the parents to the offspring. Although not discussed in this lesson, many traits are influenced by the environment, and some traits are dominant or recessive.
Lesson 4:	**Differences in ʻŌhiʻa:** In many species, special genetic variations may occur which help the organisms better survive in their environment. A variety is a naturally occurring variation of a plant within a species. The physical characteristics found in a variety are usually reproduced/passed down through sexual reproduction. In other words, seedlings sown from a plant will possess the same (or only slightly different) physical characteristics as the mother plant. There are ~8 different varieties of ʻŌhiʻa (*Metrosideros polymorpha*) with unique characteristics and found in unique habitats. Check out this powerpoint of the different ʻŌhiʻa varieties here in Hawaiʻi This youtube playlist has a quick, 1 min videos of different ʻŌhiʻa varieties found on Maui
Lesson 5:	**Modeling ʻŌhiʻa- Parents vs. Keiki:** Tree growth is a response to the environment and is dependent on its genetic make-up. The environment of a tree is a complex interaction of physical and biological elements. The physical elements are related to climate and soil and include sunlight, precipitation, and the movement and composition of air, as well as soil texture, structure, depth, moisture capacity, drainage, nutrient content, and topographic position. Biological elements are the plant associates; the larger animals that use the forest as a source of food and shelter; the many small animals, insects, and insectlike animals; the fungi to which the trees are hosts; and the microorganisms in the soil. These all impact physiological processes such as photosynthesis, root and limb growth, flowering/seeding, and speed of growth. See this scientific paper for a more in depth break-down of how environment can affect tree growth A tree's genetic make-up also influences the way a tree grows. A trees genetic traits are passed down from the many generations before them. Overtime, different genetic traits can evolve in populations that help them better survive in their environment. The mechanism that best explains this development and passing down of traits (also called evolution) is a phenomenon known as natural selection. Natural selection is the process by which certain inherited traits—such as the color of a flower, height of a tree, or shape of a leaf—are favored within a population. In general, traits persist in a population because they contribute to the success of the organism, or traits are eliminated because they detract from the success of the organism. A quick article on evolution by natural selection It can be difficult to separate out effects of environment and genetics, but you can always conclude that both are affecting the growth of the tree you are observing. Examples of Ohia responses to environmental factors: ● In perfect conditions- grow up to 100ft tall ● In boggy (wet) soil- growth is stunted and are shorter ● In poor soil or little rain- grow more like bushes

	• In areas with high moisture content in the air- can have roots above ground to gather moisture from the air. See this worksheet for 3rd grade by Haleakalā National Park about Ohia adaptations
Lesson 6:	**Planting ʻŌhiʻa:** **Gathering cuttings:** When gathering cuttings of ohia plants, it is important to keep the cuttings hydrated. Bring a bucket of water to place the cut ends of the cuttings in it. Cuttings are taken from the tips of plants and are cut into pieces about 5 to 10 inches (7 to 12 cm) in length. Avoid tips with flowers or young growth. Tips with expanded mature leaves are the best. If tips with flowers, buds, or young leaves are gathered, then remove them, at the time when cuttings are prepared for planting **Preparing cuttings for planting:** Take each cutting, gathered from the field and cut into smaller pieces, each with about 8 to 12 leaves. The lowest leaves on the cuttings are removed, as well as any buds, flowers or young shoots. The remaining leaves are cut in half to reduce transpiration from the cutting. The cut stem ends are dipped into a Rooting Powder that contains indole-3-butyric acid at 0.3%. Cuttings are then inserted in potting mix. For the potting mix, placed it in a clean, large container, add water, and mixed until the medium is wet. Place the mix into pots (e. g. 4" in diameter), filling the pots then pressing the medium into a firm layer. The medium should fill about ¾ of the pot. Insert the cuttings into these pots. Place numerous cuttings in each pot (about 10-15). The greater the number of cuttings, the higher the humidity will be. This will discourage water loss and help the cuttings to retain water and initiate new roots. **Location:** Place cuttings in a cool location, with light, and preferably on a completely clean bench at least 24 to 30 inches above the ground. Cuttings should be placed in a shade house or under solid cover. Gently water the cuttings at least once a day. Avoid areas that are windy as this will increase water loss from the cuttings. Drainage should be excellent and holes should be made on the bottom of the plastic bag to allow for good drainage. **Avoid pests:** Be sure that there are no insects (ants, millipedes, fungal gnats) or snails or slugs. These pests will move pathogens into the pots and the cuttings will be contaminated. Even weak pathogens will cause problems for these tender cuttings. Thus, use new potting mix, clean pots, and clean benches. Environments that are slug and snail free are highly recommended. Be sure that there is no moss or algal growth on the bench or in the surrounding area. Adequate light is also needed. Clean the area that will be used for the ohia cuttings. Again keep slugs and insects out. **Transplanting:** Cuttings are frequently rooted in 3 to 4 months. Remove the entire pot of cuttings, by laying the pot in its side, holding the cuttings and move the entire mass outwards. Pull all cuttings out, side-wards. Do not pull upwards or roots will be lost. Proceed slowly and avoid breaking or injuring any of the roots. Healthy roots are white. If any are brown, discard all the cuttings in that pot. Add about ¼ pot of moist medium to bottom of each pot and hold the cutting in the center while filling the edges of the pot. Fill each pot to ¾ filled with one cutting per pot. Add a small amount of fertilizer to a corner surface of the pot. Water and return to an environment with at least 65% shade. As cuttings are established in 2-3 weeks, move them to an environment with more light. Once the root system expands, growth will be rapid. After a month or two, plants can be grown in higher

	levels of light. After a few months if they are getting too large for the 4” pot, transplant to 6” pots, and eventually into 10” pots. For more in-depth information and images on planting from cuttings, click here

Open Source Contributor Feedback Form

We invite you to contribute to the development of this Hawai‘i-based science curriculum!

Please use the following form to:

- Provide editing suggestions
- Give insight into classroom experiences
- Share supporting learning materials you've created (i.e., worksheets, assessments, videos of teaching technique, additional resources)
- Share artifacts of learning (i.e., photos, learning materials, completed student work examples)

Take the survey here to join us as a contributor!

Contact Us!

Do you have additional questions? Are you looking to contribute to the RDC in a way not listed in the Open Source Contributor Feedback form?

Email us at sarah@akakaforests.org