SUST ʻĀINA BILITY

THE FUTURE IS IN THE PAST - I KA WĀ MA MUA KA WĀ MA HOPE

An indepth look at local and global sustainability issues. Moving into the future with our eyes on the past. Future health of our island and the earth.

BY MICHAEL CAHILL

How do we create a sustainable ecosystem?
How has your community changed since the introduction of man to the islands?
What is the rate of water absorption in different environments around our campus? (Concrete, bare soil, grass)
Why is one environment able to absorb water faster than another environment?

MIDDLE SCHOOL SEVENTH GRADE LIFE SCIENCE

TIMEFRAME ECOSYSTEM EXPERIMENT: AT LEAST 8 WEEKS, MAKIKI HISTORY AND DEFORESTATION LAB: 4 TO 5, FORTY-FIVE MINUTES CLASS PERIODS

STANDARD BENCHMARKS AND VALUES

Next Generation Science Standards

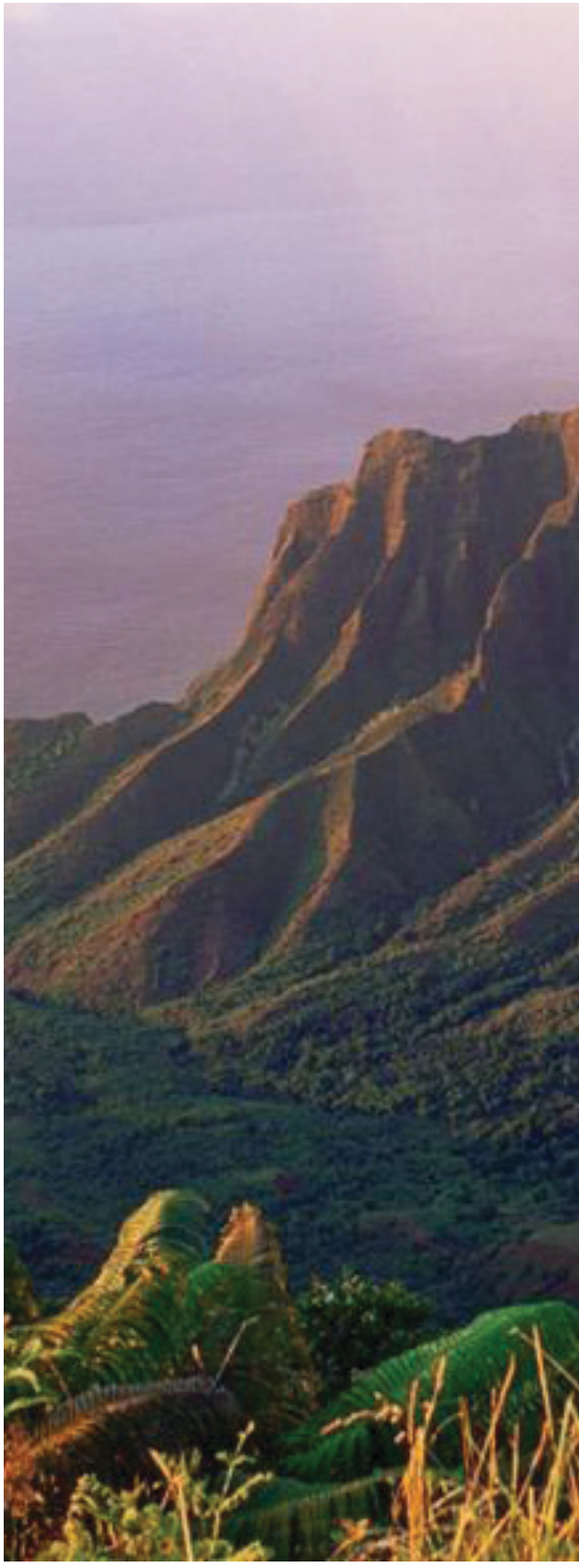
- MS-LS2 Ecosystems: Interactions, Energy and Dynamic (Student introduction)

HCPS III

- Standard 1: The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process (Student practice)
- Standard 3: Life and Environmental Sciences: ORGANISMS AND THE ENVIRONMENT: Understand the unity, diversity, and interrelationships of organisms, including their relationship to cycles of matter and energy in the environment (Student introduction)

Common Core Standards

- RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (Student practice)
- HST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts and information through the selection, organization, and analysis of relevant content. (Student practice)



ENDURING UNDERSTANDING

- All environmental systems are interconnected.
- Humans can create change quickly in an environment
- Native flora and fauna have decreased due to anthropogenic activities

CRITICAL SKILLS AND CONCEPTS

Students will be able to:

- Students will be able to design and sustain an ecosystem for one entire school quarter using 2-liter soda bottles. Students will be able to accurately take data on the ecosystem and report their experiment to the class.
  - ▷ Lessons: Ecosystem Experiment
- Students will be able compare how sustainable our island has been throughout its history of human inhabitants.
  - ▷ Lessons: History of Makiki
- Students will compare the rate of erosion and water absorption into three different environments (grass-forested, bare soil-deforested and concrete- deforested around the campus. Students will be able to understand our aquifers structure and function and how we depend upon roots to bring in more water to our aquifer.

AUTHENTIC PERFORMANCE TASK:

Students will use their own school grounds to compare water absorption rates in "forested" and "deforested" areas. Students will have a first-hand view of the clear data repeatedly showing faster rate in the forested areas. Students share their evidence of why forests help our aquifers more than deforested areas.

AUTHENTIC AUDIENCE:

Two to three times throughout the implementation of the lessons students will be asked to go home and teach someone in their family or community about the lessons, followed by a discussion and reflection from both parties describing the discussion.

OTHER EVIDENCE:

Scaffolded concepts and hands-on labs to precede this lesson;

- Scientific definition of living vs. non-living (optional-include cultural definitions)
- Structure and function of the Six Kingdoms
- Gas. carbon and water cycles, photosynthesis, cellular respiration
- Definition of sustainability

AUTHENTIC PERFORMANCE RUBRIC

LEARNING TARGETS (Ask yourself the questions and the levels of growth to determine your score)	NOVICE	DEVELOPING PROFICIENCY	PROFICIENT	EXCEEDS
• All environmental systems are interconnected. • Humans can create change quickly in an environment • Native flora and fauna are rare in Hawai'i	Students recognize that some environmental systems are interconnected and humans create change quickly and native flora and fauna are rare	Students describe how environmental systems are interconnected and how humans create change quickly making native flora and fauna rare in Hawai'i	Students explain how most environmental system are interconnected and how humans create change quickly making native flora and fauna rare in Hawai'i	Students evaluate and explain how environmental systems are inerconnected and that humans create change quickly making native flora and fauna rare in Hawai'i

LEARNING PLAN

THE FUTURE IS IN THE PAST, I KA WĀ MA MUA KA WĀ MA HOPE (hawaiian 'olele no'eau or proverb)

ORDER OF LESSONS

1. Intro with a YouTube video of the first organisms to do photosynthesis (see resources)
2. Photosynthesis/Respiration equation Rotation Stations activity
3. Stomata Lab with 'uala leaves. Observe stomata, guard cells (photosynthesis, transpiration and respiration)

CHANGE IN OUR AHUPUA'A SYSTEMS

- Students recognize that some environmental systems are interconnected and humans create change quickly and native flora and fauna are rare
- Students explain how most environmental system are interconnected and how humans create change quickly making native flora and fauna rare in Hawai'i

DEFORESTATION LESSONS/ ACTIVITIES

1. Read History of Makiki-Tantalus by Jennie Peterson
2. Two day fieldtrip to Hawai'i Nature Center (makiki forest and Sandy beach park) for Mauka to Makai Climate Change in our Ahupua'a systems
3. Deforestation Lab Part 1 - testing (outside)
4. Deforestation Re-design of tool and re-testing due to error in data collection with the food can
5. Deforestation Lab Part 2 - Students create data chart to evaluate data and attain class averages to graph and use in post lab discussion questions.
6. Post Deforestation Lesson - present graphs and summary answers to discussion questions from deforestation Lab part 2.

NOTE:

I have attached the worksheets for the activities we did in this lesson as well as copies of teacher models and students work. I must note that while we were testing water absorption we found that our instrument (the food can) was not able to mold to the concrete and all the water seeped out. This made our data inaccurate. I then brought in materials (clay, erasers, paper clips, tape, newspaper, cloth, magazines) and asked the students to redesign the can. We then re-tested the concrete deforested area. You will see the data for concrete from our 2nd test.

Students used their whole class data from all three environments to create graphs and summarize their own group's data and their whole class data. This lead to the students having a deeper understanding of water absorption rates change depending on the environment. Forested areas will tend to have much faster rates of water absorption while bare soil will have slower and concrete has no ability to absorb water.

REFERENCES

"Discovery of Photosynthesis: Unleashes Superweapon: 02" youtube video

Stomata/ Photosynthesis lab (by Michael Cahill)

www.nsta.org/middleschool/connections.aspx

http://tantalusoahu.com/about/history/ history of Makiki by Jennie Peterson, Hawai'i Nature Center Historian

Field trip: Hawai'i Nature Center- Mauka to Makai impacts of climate change to our Ahupua'a systems & for the deforestation lab idea

ADDITIONAL RESOURCES

(used as Extension activities and research)

Ecosphere Project (nsta.org/middleschool//connections.aspx)

http://www.canoeplants.com/uala.html (history of 'uala and how to grow)

"Strangers in Paradise" video (Hawai'i and the impacts of invasive species on native flora, fauna

"Huliau" video (How we as locals in Hawai'i can care for the land)

Bishop Museum Science Education Department borrow box of resources for "How will a skatepark impact the environment near a stream?" lesson

NAME _____ PERIOD _____ DATE _____

A BRIEF HISTORY OF MAKIKI-TANTALUS

BY JENNIE PETERSON, JENNIEPETERSON (AT) WEBTV.NET, HAWAII NATURE CENTER

HTTPS://TANTALUSOAHU.COM/ABOUT/HISTORY/

Instructions: We will learn about the anthropogenic (human-caused) changes to the land by doing a jig saw reading and drawing activity in groups.

Students are grouped (2-5 students) with a section of the reading. Students read the section with their group then illustrate the section with drawings you will then use to share your reading with the rest of the class.

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 1 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

The human history of Makiki-Tantalus is long, extensive and diverse and the subsequent impact on the environment has been immense. Although there has never been a complete archaeological study of the area, a state archaeological survey of Makiki Valley in 1980 revealed numerous prehistoric agricultural sites. The early Hawaiians grew taro in the swampy land near the valley mouth, where runoff from Tantalus collected, and on the small alluvial flats along the streams. The lowland taro lo'i reached into the neighboring valleys of Manoa and Pauoa. Legend tells of sweet potato gardens grown on Round Top, whose Hawaiian name, Pu'u 'Ualaka'a means "hill of the rolling sweet potato".

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 2 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

Undoubtedly the ahupua'a of Makiki provided the ancient people with a wealth of resources. Water was plentiful in Moleka and Kanealole Streams which join to form Makiki Stream. Although few native food plants existed in Hawai'i, the pioneering settlers brought with them food crops which grew readily in this new fertile land. Hawaiian introductions included taro, sugarcane, sweet potato, breadfruit, mountain apple, banana, ti and kukui. Plants that provided fuel, building material, medicine, fiber and dye grew in the upper valley and mountain areas. Also, forest birds and land snails were plentiful. From 1100-1600 A.D. there was a period of expansion when the native population grew and their impact on the land intensified.

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 3 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

By the 1600s, the lowland forests had been so extensively utilized that archaeologists calculate that about 80 percent of the land below 2,000 feet had been altered. Change accelerated with the arrival of Westerners, beginning with Captain James Cook in 1778. The increasing numbers of explorers and traders in the 1800s had a significant impact on the Makiki-Tantalus area, which was located close to the shipping and trading port of Honolulu. Introduced livestock such as horses, cattle, goats and pigs began to destroy the forest understory and compact the soil. From 1815-1826 the sandalwood trade with China virtually eliminated this native tree from the area. A single ship's hold could carry more than 6,000 trees at one time!

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 4 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

Whaling ships by the dozens plied Hawaiian waters in the 1830s-1860s. The readily accessible Makiki-Tantalus area provided trees for fuel to render the whale blubber into oil. Numerous other trees were harvested for building materials, to fuel foundries, and for firewood. By the late 1800s most of Makiki was bare, denuded of trees. The native forest was gone.

A rare glimpse of the Makiki area in the midst of these irreversible alterations is given in a fascinating account written in 1831 by an Austrian botanist, Dr. F. J. F. Meyens. He presents us with a sense of what the native forest was like and a preview of what was to come, as he hiked from Honolulu up Punchbowl, on the top of Pu'u Kakea and down through Makiki Valley.

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 5 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

Meyens describes the entire slope of Puowaina (Punchbowl) and the ridge behind it as completely barren except for low herbage and grasses scattered at elevations below 700 feet. (The nature Center is at 350 feet; Round Top is at 1,000 feet.) The valley below was covered with cultivated gardens of taro, bananas and sugar cane. A mixture of native and introduced plants existed in the higher areas. Common native plants included koa (up to 8 feet in diameter!), ilima, 'awa, mamaki, naupaka, olona, maile, 'ohelo, lama, kopiko, ferns and more lobelias than he had found anywhere else on the island. There were also many tree ferns from which the Hawaiians collected to pulu (fine "wool") to sell for stuffing mattresses. The introduced plants, while not yet widespread, were ones that would prove to be very invasive-kukui, morning glory vine and ginger. The top of Pu'u Kakea supported no trees, just a dense growth of ti and morning glory. Grazing horses and long-horned cattle were common.

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 6 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

Within the valley itself Meyens noted many Hawaiian huts, and on a low ridge transecting the valley (behind the Nature Center) sat a quarry where the basalt outcrop was being chipped into pieces of rock used to make octopus lures. This observation confirms the relevance and meaning of the valley's name, as one interpretation of the word "makiki" is a type of stone used for weights in octopus lures.

Glimpses of the valley 100 years ago are also available from informal records. Climbing Pu'u 'Ohi'a (Tantalus Peak) was a frequent outing for Punahou students. In the 1840s, they named it "Tantalus" after a Greek god. Collecting land snail shells and duck hunting in the ponds behind Tantalus and Pu'u Kakea were also favorite activities. One account states that over 2,000 kahuli snails (which are now extinct in the valley) were collected on a single hike!

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 7 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

During the Great Mahele of 1848 several land awards were made in upper Makiki Valley. Many parcels along Moleka and Kanealole streams were purchased between 1864 and 1876 by Mr. J.M. Herring. He built a carriage road to his property and made an unsuccessful attempt to grow coffee.

The barren hillsides became heavily eroded, and both the quantity and quality of fresh water in the streams below declined. In 1893 the Kingdom of Hawai'i formed a Commission of Agriculture and Forestry. In 1903 this became the Territorial Board of Agriculture and Forestry. The Board acquired upper Makiki Valley in 1904, and began a much-needed reforestation effort in 1910. Ralph Hosmer, the first territorial forester, began to select and grow thousands of trees, mostly species introduced from Australia, Asia, and other parts of the world at the nursery located right behind the present Nature Center buildings. In 1913 Makiki-Tantalus was declared a Forest Reserve by the Territorial government.

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 8 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

Reforestation and reclassification of land were not the only changes taking place during this time. Tantalus has long been a favorite locale for summer houses for those wishing to escape the summer's heat. In 1891, the H.W. Schmidts, having received a deed for property at the top of Tantalus from Queen Lili'uokalani, built a house called Maluhia. In the following years more and more families built mountain retreats as roads began to replace the old horse trails. The Tantalus road was built in 1902 and connected to the Round Top section in 1914 but it was not fully paved until several years later. A house midway up the Tantalus side called the halfway house provided ice, soda and a few groceries for the summer occupants.

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 9 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

In 1927 the Van Tassel family leased land from the Territory on Round top and established the first macadamia nut orchard in Hawai'i at Nutridge Farm. Other trees were planted in the late 1930s by the Civilian Conservation Corps in another reforestation project. The road to the top of 'Ualaka'a was put in in the late 1940s in order to create a park and look-out. After statehood, the division of Forestry was transferred to the newly established Department of Land and Natural Resources and Makiki-Tantalus was zoned as a conservation district.

A BRIEF HISTORY OF MAKIKI-TANTALUS

Section 10 https://tantalusoahu.com/about/history/

by Jennie Peterson, Hawai'i Nature Center

Today, a 2,000 acre parcel designated as the Makiki-Tantalus State Recreation Area provides a much-loved retreat from the bustling city. New trails and look-outs have opened up the area for hikers, joggers, mountain bikers, picnickers, people out to enjoy the view and Hawai'i Nature Center students learning to love and care for the forest.

Makiki-Tantalus is a place of extraordinary change. Nearly all the plants in the area are introduced. There is only a scattering of native koa, mamaki, and moa. There are no more kahuli snails. Mongoose, rats and feral cats are common. Only one native bird is regularly hear in the forest – the 'amakihi. Introduced cardinals, mynas, sparrows, mejiros and doves are common. The introduced shama thrush does enhance the woods with an enchanting song and the visiting kolea (Pacific golden plover) chooses the grassy slope of Round Top as a winter retreat. What will tomorrow's students find here? What kind of change will we bring?

NAME _____ PERIOD _____ DATE _____

PLANT DEFORESTATION EXPERIMENT LAB

PROCEDURE:

1. Measure the diameter of food can (2 cans per group) (groups of 2-5 students)
2. Find 3 areas (away from other groups) that are forested (plants growing), deforested (bare soil), deforested (concrete).
3. Use these areas to perform your experiments.
4. Place can steady and firmly on the ground and have one person hold the can down tightly to the earth during the test.
5. One person measure out 200 milliliters of water in to your glass beaker. This person will pour the water into the can when it is time.
6. One or two people will be the timers and time how long it takes for the water to completely absorb into the ground (only leaving a wet mark). One teammate will use the timer while the other teammate says when to start and stop the timer.
7. Do this process for all three sites
8. Record all your data on the chart provided.

DATA TABLE:

AREA TESTED	TIME IT TOOK FOR WATER TO SOAK INTO GROUND
FORESTED (WITH PLANTS)	
DEFORESTED (SOIL ONLY)	
DEFORESTED (SIDEWALK OR CONCRETE)	

OBSERVATIONS/ DISCUSSION QUESTIONS:

1. Which area had the fastest rate of time for water to soak into the ground?
2. Why do you think this was?
3. Which area had the slowest rate of time for water to soak into the ground?
4. Why do you think this was?
5. List 3 ways forests and plants are important to our ecosystem. Use back if needed.
6. How would you feel if we keep tearing up the forest to make more sidewalks and buildings?
7. What would happen to our atmosphere?
8. How would this impact the living organisms on our planet?

NAME _____ **PERIOD** _____ **DATE** _____

DEFORESTATION LAB PART 2

STANDARD 3: ORGANISMS IN THE ENVIRONMENT

Learning Target: I will be able to complete a scientific experiment to observe how changes to the land can impact our aquifers (water resources) and habitats for living organisms.

Check list (make sure you wrote this on the back of your Deforestation Worksheet)

_____ Choose your variables (independent and dependent)

_____ Choose your constants (the things you kept constant)

STANDARD 3: ORGANISMS IN THE ENVIRONMENT

1. Develop the question you tested for example: "When I change _____ what happens to _____ ?
2. What were you predicting about these different environments? Write or create a graph explaining what you thought would happen to the different environments and the rate of water absorption into the ground.
3. Graph what the actual results were from your group and the averages of the whole class. Graph paper is provided.
4. How did the actual results compare to what you expected would happen?
5. How might you explain any unexpected results? (Think about the concrete test as well as the other environments)
6. Why did you re-test the concrete environment?
7. What did you observe about the concrete's ability to absorb water?
8. Based on your results of all the environments tested, what question(s) might you want to ask or investigate next?
9. What is happening to our water resources when we take away forests?
10. What is happening to our atmosphere when we take away forests?
11. How does this impact the living organisms on our planet? (archaea, bacteria, protists, fungi, plants, animals)

NAME _____ PERIOD _____ DATE _____

ECOSYSTEM PROJECT

METHODS: Students will be in groups of 3-4 students. They will design a plan using the questions below to build a sustainable ecosystem. They will use two 2-liter soda bottles, one inverted on the other with a string to connect the top (the terrestrial portion) the the bottom aquarium habitat. Students will build unique ecosystems based on their designs and the parameters mentioned in the materials section.

To create osmosis, nail a hole in the terrarium cap and push cotton string through. Pour soil in top portion making sure string is equally divided in both habitats and not touching the side of the bottle.

Students with observe and record data on their ecosystems daily.

MATERIALS:

Fresh water plants (elodea, java moss, etc.)

Land plants (start from seed, corn, grass, green onio, beets)

Marine and terrestrial invertebrates (snails, pill bugs, water fleas, ants, worms, cockroaches, spiders, etc.)

String (to create osmosis between the two bottles through a hole in the terrarium cap.

Two 2-liter soda bottles (clear is best)

Tape

Nail

Soil

Sand

Rocks

Water

Hammer

TESTABLE QUESTION:

CAN YOU CREATE A SUSTAINABLE ECOSYSTEM?

1. Identify your variables.
2. Write your hypothesis.
3. Graph your hypothesis
4. Create data tables to collect your qualitative and quantitative observations.
5. Record data (first making a hypothesis every time) at the beginning of class every week for 8 weeks.
6. Do Post Lab Questions
7. Graph what the actual results were from your group and the averages of the whole class.
8. Present your data and conclusion

ECOSYSTEM EXPERIMENT POST LAB QUESTIONS

1. How did the actual results compare to what you expected would happen?

2. How might you explain any unexpected results?

3. Did you meet your goal to create a sustainable ecosystem? Explain.

4. Did any other group create a sustainable ecosystem? Explain how.

5. Based on your results what question(s) might you want to ask or investigate next?

6. What would you do differently next time? Explain why.

7. How was your bottle ecosystem similar and different to a real ecosystem?