



THE MYSTERY OF THE MOSTLY MISSING REEFS

Part 2

How are human activities affecting coral reefs in Hilo Bay and what can we do to *hō'ihī* (respect) the bay and promote sustainability?

HAWAI'I DOE STANDARD BENCHMARKS

Science 1: The Scientific Process: SCIENTIFIC INVESTIGATION

Scientific Inquiry

- SC.7.1.1 Design and safely conduct a scientific investigation to answer a question or test a hypothesis.
- SC.7.1.2 Explain the importance of replicable trials.

Science 3: Life and Environmental Sciences: ORGANISMS AND THE ENVIRONMENT

Interdependence

- SC.7.3.3 Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem.

Math 11: Data Analysis, Statistics, and Probability: FLUENCY WITH DATA

Data Collection and Representation

- MA.7.11.1 Design a study, collect data, and select the appropriate representation (line graph, bar graph, circle graph, histogram, stem and leaf plot, box and whisker plot) to display the data.

Language Arts 4: Writing: CONVENTIONS AND SKILLS

Citing Sources

- LA 7.4.5 Cite various grade-appropriate sources using a consistent format when reporting information.

Language Arts 5: Writing: RHETORIC Meaning

- LA.7.5.1 Connect selected details, examples, reasons, and/or facts to the insight, message, or thesis in a meaningful way.

Language Arts 6: Oral Communication: CONVENTIONS AND SKILLS

Discussion and Presentation

- LA.7.6.2 Give short prepared oral presentations incorporating information from research to inform and persuade.

NĀ HONUA MAULI OLA 14 – 1, 6, 10

Plan for meaningful learner outcomes that foster the relationship and interaction among people, time, space, places, and natural elements around them to enhance one's ability to maintain a "local" disposition with global understandings.

- Be keen observers of their natural environment.
- Honor and respect personal and community resources.
- Preserve, protect, and sustain a healthy environment.

ACTIVITY AT A GLANCE

Students collect evidence in a field study at Mokuola (Coconut Island) to complete the investigations they began in Lesson 5. As a culminating activity, students write a persuasive paper applying what they've learned in the unit to take a stance on what



is affecting the future health of Hilo Bay and what can be done to *hō'ihī* (respect) this magnificent natural resource. They work in teams to creatively express ways to share what they have learned with others in the community.

MATERIALS

Provided in Lesson 5:

- ✓ Situation Report (includes map of Hilo Bay and Mokuola)
- ✓ Learning Log - 6
- ✓ PowerPoint presentation, *The Mystery of the Mostly Missing Reefs*
- ✓ Data Search Notes
- ✓ Evidence Data sheets 1 and 2

Provided in this Lesson:

- ✓ Learning Logs - 7 and - 8
- ✓ Data Display sheets
- ✓ Help Using Excel sheet
- ✓ Self-assessment Teamwork form

Provided with this Unit:

- ✓ Additional student readings (Provided in Unit Resources)
- ✓ Culminating Project Rubrics and Student Assessment Overview (in Unit Introduction)
- ✓ *oli* (chants) (Provided in Appendix and on CD)

Needed:

- ✓ 3 clipboards with rubber bands
- ✓ 9 clear sheet protectors (3 for each clipboard)
- ✓ 3 grease pencils
- ✓ craft materials, musical instruments, camera (depending on students' projects)

ASSESSMENT

Students:

- Display the data that they collected in tables and appropriate graphs.
- Complete Learning Logs with written conclusions from their investigation,

including adjustments based on evidence, and the importance of replicable trials.

- Complete a culminating paper that answers the unit essential question.
- Work with their teammates to present their unit project to others in the school or community.
- Complete a self-assessment of their work with their team.

GENERAL LEARNER OUTCOMES

GLO 2: Community Contributor

The understanding that it is essential for human beings to work together

- Cooperate with and help and encourage others in group situations.

GLO 5: Effective Communicator

The ability to communicate effectively

- Communicate effectively and clearly through speaking, using appropriate forms, conventions, and styles to convey ideas and information.

KEY CONCEPTS

- The primary reasons for the scarcity of coral reefs in Hilo Bay are the high volume of fresh water entering the bay through surface and groundwater sources and the breakwall, which limits the circulation of salt water entering the bay.
- Other factors that affect coral reef development in Hilo Bay include sediments and pollutants, such as nitrates and phosphates, that stimulate growth of invasive *limu*. Overfishing also impacts healthy reef development.
- *Ma ka hana ka 'ike*. By doing one learns.
- There are different ways to display our data so that we can interpret our findings, draw conclusions, and show how the conclusions are linked to the data.
- We can promote sustainability by sharing what we have learned with others, and by





actions such as fishing responsibly, preventing the spread of alien *limu*, and preventing pollution.

TIME

3 – 4 class periods plus field trip and community presentation



SKILLS

observing, measuring, analyzing, interpreting data, chart and graph creation, writing, collaboration, oral communication, creativity

ADVANCE PREPARATION

- ❑ See the Field Site Appendix at the back of this guide for information on setting up a field trip to Mokupāpapa Discovery Center and Mokuola (Coconut Island).
- ❑ Select a day for the field trip when the tide will be low in the morning so that students can conduct their transect study.
- ❑ Place the Evidence Data Sheets 1 and 2, Data Search Notes, and Map of Mokuola (6 pages from Lesson 5) into clear sheet protectors and onto clipboards (one set for each of the 3 groups). Secure the sheets at the bottom of the clipboards with rubber bands. Note: students can use grease pencils and write on the sheet protectors if weather is rainy.
- ❑ Review the DOE's water safety protocols and, if required, arrange for a lifeguard to accompany the students.
- ❑ Make a copy of Learning Log - 7, the Data Display sheets, and the self-assessment form for each student.
- ❑ Make a copy of the culminating activity rubrics (in Unit Introduction) for each student or copy them onto a transparency and project them to review with the class.



- ❑ If your students will be conducting protocol at the site, select an *oli* from the CD and *Oli* Appendix (or other source) for students to learn and present when they arrive at Mokuola.

VOCABULARY

abiotic - nonliving

biotic – living; having to do with living organisms

carrying capacity – the number of individuals that an environment can support without diminishing that environment's future ability to sustain life

hō'ihi – respect

invasive species – species whose introduction does or is likely to cause economic or environmental harm or harm to human health

lōkahi – balance, harmony

overfishing – the practice of harvesting marine life faster than it can be replenished naturally

quadrat – a sampling plot used for studying plant or animal life

sedimentation – deposit of soil and other sediments by water

sustainability – meeting present needs for resources without compromising the ability of future generations to meet their needs





TEACHING SUGGESTIONS

Before the Field Trip

1. **Revisit the essential question for this unit and discuss it with students as you write their ideas on the board:** How are human activities affecting coral reefs in Hilo Bay and what can we do to *hō'ihi* (respect) the bay and promote sustainability?

Discussion Questions

- What does it mean to *hō'ihi* (respect) the bay and why should we do this?
- What is sustainability and how does it relate to the bay? Why should we be concerned about future generations?
- What have we learned about how human activities are affecting the bay?
- If we broke down the possible effects into biotic (living) and abiotic (nonliving) what might those effects on the bay be?

BIOTIC (LIVING)	ABIOTIC (NONLIVING)
Overfishing	Sediments from run-off
Alien species	Pollutants such as nitrates and phosphates from sewage and fertilizers
Human contact – stepping on live coral	Marine debris
	Fresh water
	Breakwall

- How will our field trip help us to answer the unit essential question? (Transects will address biotic effects, and water quality testing and marine debris observations will address abiotic effects.)
2. **Review the culminating paper and project described in the Student Assessment Overview in the Unit Introduction. (If this was not assigned in the first lesson, ask teams to select topics listed on the overview.)**
 - Check to see how students are doing with their projects to answer the essential question for this unit.
 - If you have not already done so, distribute the additional student readings from the Unit Resources to the appropriate student groups.



- Ask student teams to make plans for gathering information and photographs during the field trip to be used in culminating projects.
- Review the rubrics for student papers and team presentations and discuss criteria for evaluation.
- Remind students of deadlines for completing papers and projects.

3. Review logistics, safety precautions, protocol, and what students will need to wear and bring for their field investigations.

- Explain the process that will be followed in the field with teams rotating to different stations to collect data.
- If students plan to offer an *oli* (chant) when they arrive, practice what they will do before the trip. Listen to the *oli* on the CD provided and follow along with written copies in the Appendix.



Ask students to:

- Return signed permission forms for the field trip.
- Wear covered shoes or *tabis*, old clothes, and a hat.
- Bring sunscreen, drinking water, snacks and lunch.
- At the site, stay with their teams and leader and move slowly and carefully to avoid holes in the reef flat. (Reminders will be given at the site along with boundaries to observe and precautions about reef animals that can sting or bite.)

During the Investigation at Mokuola (Coconut Island)

- Upon arrival at the island, students will be greeted by an instructor with an introduction to the site.
- They will be oriented to the stations that are set up for each team and introduced to volunteers and assistants. See map of Mokuola provided in Lesson 5.
- A general schedule for the field trip follows:
 - 8:45 Arrive at island / Protocol and orientation, walk to sites
 - 9:00 Teams rotate every 30 minutes and participate in each station (10-minute transition and reorientation between stations).
 - Station 1 – Water quality testing
 - Station 2 – Quadrat study
 - Station 3 – Water quality testing
 - 11:00 Teams organize data sheets and have picnic lunch (change to dry clothes if needed)
 - 12:00 Visit Mōkupāpapa (20-minute stations)
 - Station 1 – Safe Haven
 - Station 2 – Scavenger Hunt
 - Station 3 – Wet Lab
 - 1:30 Return to school



After the Field Trip

4. Distribute and review Learning Logs – 7 and – 8.

- Ask students to complete **Learning Log - 7** and then discuss their responses to the questions.

5. Distribute the Data Display sheets and the Help Using Excel sheet and review them with students.

- Discuss the appropriateness of different types of data display for the data they collected.
- Ask students to describe the benefits of each type of graph for analyzing and drawing conclusions and displaying data.
- Explain that the selection of type of graph is generally determined by what is to be emphasized or demonstrated in the data set.
- Discuss the factors to consider when selecting a type of graph: clarity of presentation, contrast / comparison of the data, changes / trends / growth and the rate of change / growth, and a measure of the closeness or spread of the data.
- Show students how to create different types of charts and graphs using Excel computer software.

6. Solve the mystery! Have students each complete Learning Log - 8 and show the final slide in the PowerPoint presentation.

- Ask teams to present their findings and conclusions to the class.
- Generate a discussion of students' responses to the questions on Learning Log – 8 and compare the teams' conclusions.
- Show the final slide in the PowerPoint presentation and discuss the answer to the mystery. Let students know that scientists continue to study Hilo Bay to shed more light on this question.

7. Plan a *hō'ike* (exhibit) for students' culminating projects.

- Set a date for students to share their unit culminating projects with others in the school or community.
- Provide time for student teams to discuss ideas about ways to share what they have learned with others.

8. Wrap up the unit.

- Ask students to complete a self-assessment of their work with others on their teams.
- Discuss their feedback and what individuals can do to promote successful teamwork.
- Congratulate teams for their hard work to solve the case and complete their projects.



ADAPTATION / EXTENSION

Science 3: Organisms and the Environment:

Conduct a demonstration to reinforce the concepts of carrying capacity and sustainability and the impact of biotic and biotic factors.

Sustainability and Carrying Capacity Demonstration

- Place a large clear bowl in a central area of the classroom and identify it as a fine fishing spot in Hilo Bay. Fill the bowl with 32 “fish” (peanuts or fish-shaped crackers). Explain that this represents the carrying capacity of the reef—the number of fish that the reef can support without the environment deteriorating. If there were more fish, the reef would be out of balance.
- Divide the class into four boats of fishers who will be fishing from this reef. (Don’t emphasize conservation with the fishers, let them work on maximizing their harvest if they want. The need for conservation will soon become clear.)
 - Explain that there will be four harvesting periods, each lasting 30 seconds.
 - During the harvest, all boats fish at once and they may catch all of the fish, some of the fish, or none.
 - For every fish that a boat harvests, the fishers receive 1 point.
 - For every three fish remaining on the reef after each fishing round, one fish will be added up to the carrying capacity of 32 fish.
- After each harvesting period, add up team points and restock the reef, if adequate numbers of fish remain.
- Conduct another round of fishing and bring in biotic and abiotic factors to affect the population of fish on the reef. After the first harvest, remove an additional 8 fish that die due to destruction of habitat from an abiotic factor.
- Ask fishers to identify abiotic factors and provide an extra point for each correct answer (e.g., siltation, pollution, physical damage to coral heads from boat anchors).
- After the second harvest, remove another 8 fish that die due to a biotic factor. Ask fishers to identify biotic factors and provide an extra point for each correct answer (e.g., introduced *limu* smothers coral, overfishing)



After the final harvest, discuss what happened in the demonstration.

Discussion Questions

- What is carrying capacity?
- Why are fish only replaced if some fish remain on the reef?
- How do abiotic and biotic factors affect the fish population?
- Did the reef become overfished?
- What would be the best strategy for harvesting from the reef sustainably? (If each boat harvests 2 fish during each round, this would allow the same number of fish to be restored.)