



THE CASE OF THE INVADED REEF

Part 2

How are human activities affecting coral reefs and what can we do to *hō'ihī* (respect) our reefs and promote sustainability?

HAWAII 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.

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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 'Anini Reef 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 Kaua'i's reefs and what can be done to *hō'ihī* (respect) these magnificent natural resources. They work in teams to creatively express ways to share what they have learned with others in the community.



MATERIALS

Provided in Lesson 5:

- ✓ Crime Scene Report (includes map of 'Anini Beach Park and Reef)
- ✓ Learning Log - 6
- ✓ PowerPoint presentation, *The Case of the Invaded Reef*
- ✓ Evidence Data sheets 1 and 2

Provided in this Lesson:

- ✓ Learning Log - 7
- ✓ Data Display sheets
- ✓ Help Using Excel sheet
- ✓ group- and self-assessment forms

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:

- ✓ 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 - 6 and 7 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 invasion of *limu* at 'Anini Reef is due to run-off of pollutants and sediments from surrounding communities that stimulate the overgrowth of native *Cladophora* and cyanobacteria.
- *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.

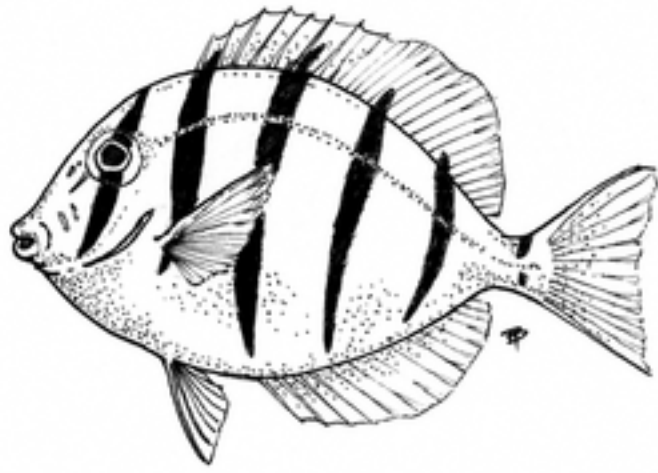
TIME

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 'Anini Beach Park. Let the SOS staff know that your students are gathering data to solve "The Case of the Invaded Reef" so that they can take action to have resource people assist with the activities and have equipment ready for your student teams.
- ❑ Select a day for the field trip when the tide will be low in the morning so that students can conduct their transect study.
- ❑ 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 'Anini.

VOCABULARY

abiotic - nonliving

alien species – species that are not native to an area; species introduced intentionally or accidentally to an area

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

nitrate and phosphate – nutrients released with the decomposition of dead plants and animals and animal waste; also from sewage and fertilizer run-off

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

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

transect - a path along which one records and/or counts occurrences of the phenomenon of study for the process of estimating population entities in a study area



TEACHER BACKGROUND INFORMATION

Ocean Pulse (OP) Monitoring Protocol is not a new invention, rather, the synthesis of many dedicated stewards of the reef. SOS has built on the solid foundation of great conservation organizations to create a standardized; classroom based method that is easily understood and accurately performed by teachers and students of coastal schools. Data collected by trained “OP” teams can be sent to collaborating organizations REEF and Reef Check as well as cataloged in the SOS database for scientists, students, and as a historical “snapshot” for future conservation purposes. The goal of this monitoring method is to introduce students to community based monitoring methods in the hopes that they will want to become “the Eyes of the Reef”.

If you would like more information about getting involved with community based monitoring see the following sites online: www.reefcheck.org and www.reef.org for a detailed description of similar data entry techniques.

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 and what can we do to *hō'ihī* (respect) our reefs and promote sustainability?

Discussion Questions

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

BIOTIC (LIVING)	ABIOTIC (NONLIVING)
Overfishing	Sediments from run-off
Introduction of alien species	Pollutants such as nitrates from sewage and fertilizers
Human contact – stepping on live coral	Marine debris
	Ocean acidification (due to increased carbon dioxide emissions)



- 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 stations 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 on the sandy area inland to the reef. Remember, the reef is a living thing and part of giving *hō'ihi* (respect) to this ecosystem is not to walk on it whenever possible. (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 'Anini

- Upon arrival at the beach park, students will be greeted by the SOS coordinator 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.
- A general schedule for the field trip follows:



- 9:15 Arrive at Anini Beach Park / Protocol and orientation, walk to beach site
 9:45 Teams rotate every 30 minutes and participate in each station.
- Station 1 – Transect study (biotic factors)
 - Station 2 – Water quality testing (abiotic factors)
 - Station 3 – Interviews with scientists (if available) or
Marine debris (abiotic factors)
 - Station 4 – Invertebrate touch tanks
- 11:45 Teams clean up, store data in backpacks, and walk to lunch site
 12:00 Lunch
 1:00 Return to school

AFTER THE FIELD TRIP

4. **Distribute and review Learning Log - 7 and the Data Display sheets and discuss ways to organize and display students' data.**
 - 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.
5. **Distribute the Help Using Excel sheet and review it with students.**
 - Show students how to create different types of charts and graphs using Excel computer software.
6. **Solve the case! Have students each complete Learning Log - 7 and prepare team presentations of their findings to others in the class.**
 - Ask teams to present their findings and conclusions to the class.
 - Show the final few slides in the **PowerPoint presentation** with the data collected by scientists. Note that *Cladophora* is invasive even though it is a native species.
 - Discuss the need to replicate data and adjust ideas based on evidence.

Discussion Questions

 - Were your hypotheses validated by the evidence you collected? If not, what alternative hypotheses might explain your results?
 - Which species (suspects) were most abundant?
 - What was the level of phosphates in the water? Under what conditions might this level change? (*After a heavy rain, especially when fertilizers have been applied to the land.*)
 - Why would it be important to replicate the data collection?
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.

ADAPTATIONS / EXTENSIONS

Take your class to Anahola or 'Aliomanu to explore the reefs. Before visiting the sites, have students read the *mo'olelo Puka a ka Mauna* about Anahola and the story 'Aliomanu provided in the Unit Resources.

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 piece of Anini. 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.)