THE CASE OF THE INVADED REEF

Part 1

What is invading ʻAnini Reef and how are human activities contributing to the problem?

HAWAIʻI 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.

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.

ACTIVITY AT A GLANCE

Students work in teams to begin solving "The Case of the Invaded Reef" to determine what is invading the reefs and the factors that caused the invasion to occur. As part of their investigation, students interview fishers and read background information.

MATERIALS

Provided:

- ✓ Crime Scene Report (includes map of ʻAnini)
- ✓ Evidence Data Sheets 1 (2 pages) and 2
- ✓ Observation Sheet
- ✓ PowerPoint presentation, *The Case of the Invaded Reef* (provided on CD)
- ✓ Learning Log - 6

Needed:

For each group of 4 students:

- ✓ meter stick or tape measure
- ✓ box of colored paper clips (to use in a point sampling practice)
- ✓ sheet of paper and pencil

ASSESSMENT

Students complete Learning Log - 6 with:

- hypotheses about what is invading coral reefs at ʻAnini and the factors that contributed to the invasion
- a description of the methods they will use to test their hypotheses

KEY CONCEPTS

- ʻAnini Reef is being invaded by native *limu* species that have become invasive due to human activities.
- The invasion of *limu* on the coral reefs is due to a number of factors including overfishing and pollutants and sediments from surrounding communities.

TIME

3 – 4 class periods

SKILLS

problem-solving, analyzing, researching

ADVANCE PREPARATION

- ☐ Make a copy of the Crime Scene Report and Learning Log – 6 for each student.
- ☐ Make a copy of Evidence Data Sheets 1 and 2 and the Observation Sheet for students review and use in the field.
- ☐ Preview the PowerPoint presentation, *The Case of the Invaded Reef* (provided on CD)

VOCABULARY

abiotic - physical rather than biological; not derived from living organisms

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

biotic - of, relating to, or resulting from living things

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

lōkahi – balance, harmony

phosphates – 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

point sampling – a method of sampling by collecting data at regular intervals along a transect line and recording the presence of species directly beneath the line

sedimentation – deposit of soil and other sediments by water

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

HAWAIʻI DOE RUBRICS

Advanced	Proficient	Partially Proficient	Novice
Science			
Consistently design and safely conduct a logical, systematic scientific investigation to answer a question and test a hypothesis	Usually design and safely conduct a scientific investigation to answer a question or test a hypothesis	Sometimes design and safely conduct a scientific investigation to answer a question or test a hypothesis	Rarely design and safely conduct a scientific investigation to answer a question or test a hypothesis
Language Arts			
Thoroughly connect selected details, examples, reasons, and/or facts to the insight, message, or thesis in a creative and meaningful way	Connect selected details, examples, reasons, and/or facts to the insight, message, or thesis in a meaningful way	Connect some selected details, examples, reasons, and/or facts to the insight, message, or thesis or connect them in a superficial way	Connect few selected details, examples, reasons, and/or facts to the insight, message, or thesis or connect them in an unclear way

TEACHER BACKGROUND INFORMATION

ʻAnini means dwarflike or stunted. However, ʻAnini got its name when the W in Wanini was shot off a street sign. When a new sign was finally made, it too left off the W. Wanini likely came from Wainini (spilled water) referring to seeps of water coming from the rocks in the cliffs.

Today the beautiful and diverse coral reefs of ʻAnini are an incredible resource that is changing. Unfortunately, the reefs are losing

their diversity as native *limu* (algae) species become invasive and overgrow the corals. At ʻAnini we see a major overgrowth of *Cladophora spp.* in the summer months. *Cladophora* is a native species that has become invasive in Hawaiʻi. Another invader at ʻAnini is cyanobacteria. Scientists are not sure whether or not this "blue-green algae" is native or introduced. Cyanobacteria has many forms, the most common looks like wispy brown hair and can cause "swimmers itch." Another form has a red/brown hue and smothers coral heads.

The factors that lead to algae reef invasions can all be traced back to human activities. The student reading provided with this activity includes a chronology of events that contributed to the invasion of coral reefs by *limu* species.

In a balanced, healthy reef ecosystem, corals and coralline algae are the dominant species. The fleshy *limu* are less dominant but they play an important role at the base of the food chain, supporting the diverse species of invertebrates and herbivorous fish that feed on them. When nutrients, such as phosphates from human sewage and lawn or golf course fertilizers wash onto the reef, conditions are favorable for the fleshy *limu* species to grow more rapidly.

Homes built at ʻAnini, like many places across the state, have cesspools (a hole dug in the ground with a cement top) that overflow during heavy rainstorms carrying sewage to the ocean. They may also "leak" as the tides go in and out. In 2000, the Environmental Protection Agency required all cesspools to be replaced by plastic septic tanks.

Another factor that contributes to the invasion of *limu* species is overfishing. The Department of Land and Natural Resources, Division of Aquatic Resources (DLNR/DAR) requires commercial fishers to file fish catch reports, which helps the agency to monitor the resources. DAR reports that there has been a significant decrease in the abundance of inshore marine resources over the past three decades (DLNR/DAR 2005). When herbivorous fish (like surgeonfish) that help to control the growth of *limu* are overfished, this affects the balance on the coral reef. When overfishing is combined with excessive nutrients from human activities on land, the stage is set for invasion.

Since 1950, there have been 18 different species of *limu* introduced to Oʻahu, some intentionally for aquaculture research and others accidentally on ship hulls (Russell, 1992). Five of those species have become highly invasive:

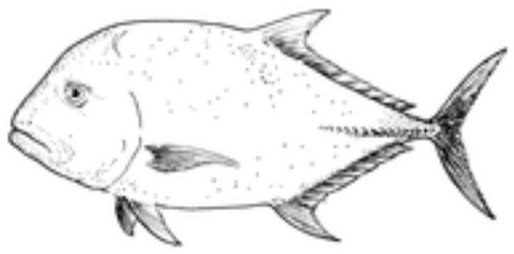
- gorilla seaweed (*Gracilaria salicornia)*
- leather mudweed (*Avrainvillea amadelpha*)
- prickly seaweed (*Acanthophora spicifera)*
- smothering seaweed (*Kappaphycus spp.*)
- hookweed (*Hypnea musciformis*)

Of these five, leather mudweed, prickly seaweed, and hookweed have spread to Kauaʻi (HiMAG 2003).

Scientists studying invasive *limu* use many different monitoring techniques to collect statistical data. The method chosen in this activity for sampling of substrates and species is SOS Ocean Pulse "point sampling."

Point sampling was chosen because it is the least ambiguous and fastest method of survey and is easily learned by non-scientists. This method is also used by Reef Check (www.reefcheckhawaii.org) internationally. Students simply look at a series of points where the transect line lies above the reef and note down what lies exactly under those points. Substrate type is recorded at 0.5 m intervals along the line, i.e. at: 0.0 m, 0.5 m, 1.0 m, 1.5 m etc., up to 19.5 m (40 data points per 20 m transect segment). 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 "OP" teams (after further training) can be sent to collaborating organizations REEF (www.reef.org) and Reef Check (www.reefcheckhawaii.org) as well as cataloged in the SOS database for scientists, students, and as a historical "snapshot" for future conservation purposes.

Teaching Suggestions



ulua (giant trevally)

1. **Introduce the "Case of the Invaded Reef" to students.**
   - Present the focus question for this investigation and the standards students will be addressing.
   - Explain that there are invaders taking over some of the reefs at ʻAnini and that students will be working in teams to solve the mystery of the invaders' identity and piece together clues to explain **why** the invasion has taken place.

2. **Show the PowerPoint presentation provided to introduce the suspects in the case.**
   - Divide the class into investigative teams and ask students in each team to prepare to take notes during the presentation. Explain that these notes will help the team to discuss the suspects after the presentation.
   - Pose questions during the PowerPoint presentation to help students focus.

     <u>PowerPoint Presentation Questions</u>

     The Case:
     - How did the reef look before the invasion?
     - How is it different after the invasion?
     - How is *lōkahi* (balance, harmony) evident or not evident in the images of the two reefs?

     The Suspects:
     - Which of the suspects are most likely to be the invaders? Why?
     - Which are the least likely to be invaders? Why?
     - How could we find out?
     - What factors allowed the invasion to occur?

3. **Review the assessments that will be required for each student to solve the case and distribute the Crime Scene Report.**
   - Review the Crime Scene Report and explain that it holds clues to the mystery.
   - Challenge teams to read the report, take notes, and discuss.
   - Summarize their ideas about clues contained in the report, particularly the possible impact of nitrates and phosphates from sewage and stream run-off onto the reef.

4. **Encourage teams to interview fishers and elders familiar with ʻAnini to gather additional evidence about how the reefs are changing over time.**
   - Ask teams to develop a set of questions and review them with one another before requesting interview time with family members or others in the community.
   - Discuss proper ways to approach people for interviews and the importance of thanking them for their information and time.
   - A polite gesture is to offer a *makana* (gift) to the interviewee. It could be something the student made or gathered from his/her *wahi* (place). This simple act honors the person who is providing the student with valuable information and opens the door to a successful interview.
   - Discuss the importance of taking notes during an interview and checking to see that the information recorded was heard correctly. Students may want to ask permission to tape record the interviewee for later reference.
   - Ask students to report their findings from the interviews.

5. **Ask students in each team to develop hypotheses about the case and present them to the class for discussion.**
   - Ask teams to develop a hypothesis that addresses: a) which suspects are responsible for the invaded reef, and b) why they are responsible.
   - Have each team present its hypothesis and discuss students' ideas.

Mermaid hair (*Cladophora*) (native to ʻAnini Reef)

6. **Discuss ways that students could test their hypotheses and practice the point sampling method.**
   - Explain that marine monitoring surveyors (especially community-based groups like SOS and Reef Check) often use a point sampling method with a transect line to study the composition of reefs. Since it isn't possible to count everything, this is one method to estimate the percent of different species on the reef from a small area.
   - To practice this method before going on the field trip, explain that students will use a meter stick or tape measure to be a transect on the desktop. The desktop surface will represent sand, and colored paper clips will be used to represent living organisms on the reef.

Procedure for Point-Sampling method

- Divide the class into groups of four students and give each group a meter stick or tape, and a box of colored paper clips. Ask each group to have a sheet of paper and pencil as a tally sheet.

Demonstrate for the class:

- Place the different colored paper clips randomly on a cleared desktop. Lay a transect line (meter tape measure or meter stick) on top.
- Ask students to record what they see touching the transect every 10 cm, e.g., desktop, green paper clip, blue paper clip etc.
- Have all groups set up their sample transects and paper clips and tally what they see.
- Continue this process every 10 cm on the transect lines until students reach the edge of the desk.
- Let students know that in the field, they will use meter tapes and record data of what they see on the reef every .5 m from 0 to 19.5m. They will then move to the 25m mark and continue at .5m intervals until 44.5m mark.

7. **Practice the math procedure to calculate the percentage cover of different substrate types and different "species" (colored paper clips) found.**

$$\text{Percent cover of the transect line} = \frac{\text{\# of "hits" for an item*}}{\text{total \# of points}}$$

*"Hits" refers to the presence of an item found ever .5m under the line

8. **Determine how effective this method was for sampling the "reef."**
   - Count the total number of colored items that were actually distributed in this practice session and have students compare this to their results.
   - Discuss the effectiveness of this method for sampling a reef and why scientists need to use sampling methods.

9. **Distribute Evidence Data Sheets 1 and 2 and the Observation Sheet.**
   - Review the sheets with students and discuss how they will work together to collect data in the field.
   - For Evidence Data Sheet 2, discuss where phosphates come from and ways that people increase phosphate levels in the water.

10. **Have students complete Learning Log – 6 with their hypotheses, method, and summary of evidence from interviews and/or reading.**

ADAPTATIONS/EXTENSIONS

Language Arts: Writing: Range – Have students interview *kūpuna* about the different ways that Hawaiians use *limu* for food, medicine, adornment, and protocol. Ask them to reflect in their Learning

WRITING PROMPTS

- Hawaiians use different kinds of *limu* (seaweed) to…
- Today we use *limu* for many things, including…

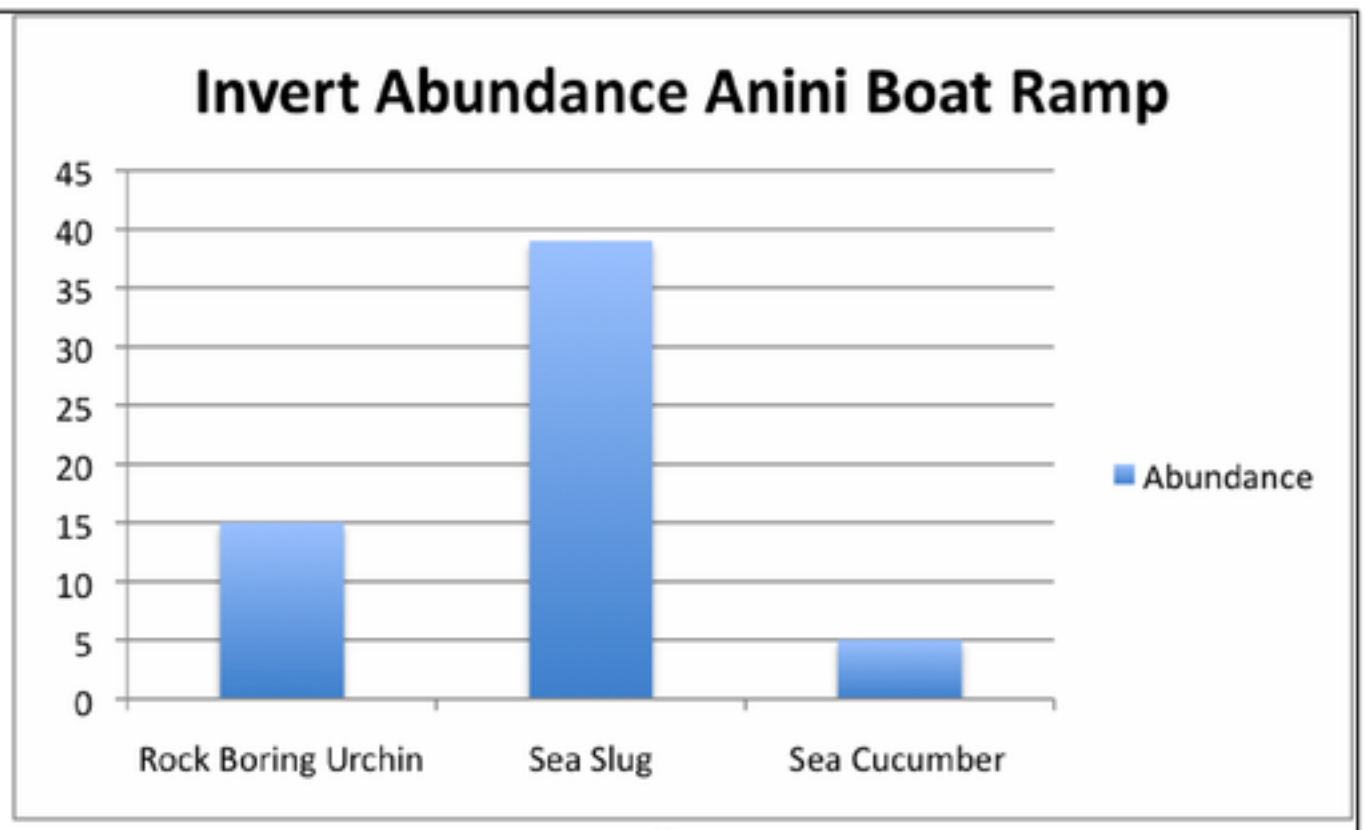
Logs about what they learn.

Science 1: Scientific Investigation - Have students conduct experiments growing *limu*. Place an invasive *limu* species such as *Cladophora* from the reef in a tank with a non-invasive native species. Add fertilizer to the tank over a two-week period and see which species grows more rapidly. For more information on this experiment, and other activities related to invasive *limu*, see the *Investigating Limu* module produced by the U.H. Hawai'i Marine Algae Group (HIMAG).

Science 1: Scientific Investigation - **Mobile Invertebrate Survey:** Ocean Pulse Belt transect recording all species along the transect line.

1. Transect lines are deployed and mobile invertebrate data is collected in 20m intervals. Same as above mentioned transect practice.
2. Each person records all mobile invertebrates seen within 2.5m of each side of the line (or area available to survey) (focusing on basic RC "indicator" species for new team members).

3. Record all species found in Excel and create basic graphs that show abundance (actual number) of each species found on the transect line.



	A	B
1	Species	Abundance
2	Rock Boring Urchin	15
3	Sea Slug	39
4	Sea Cucumber	5

REFERENCES

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Hawai'i Marine Algae Group (HiMAG). 2003. Hawaiian Marine Life Alien Seaweeds Card Set.

Russell, Dennis J. 1992. *The Ecological Invasion of Hawaiian Reefs by Two Marine Red Algae, Acanthophora spicifera (Vahl) Boerg and Hypnea musciformis (Wulfen) J. Ag., and their association with two native Laurencia nidifica J. Ag. and Hypnea cervicornis*. J. Ag. ICES Marine Science Symposium 194: 110-125.

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RESOURCES

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Eldredge, Lucias G. and C.M. Smith. (eds). 2001. *A Guidebook of Introduced Marine Species in Hawai'i*. Bishop Museum Technical Report 21, Bishop Museum Press. Honolulu, HI.