Activity #2

Bogs and Pigs Don't Mix

● ● ● In Advance *Student Reading*

- As homework reading, assign the Student Page "Bogs and Pigs Don't Mix" (pp. 19-21).

● ● ● Class Period One *Impact of Pigs in the Rain Forest*

Materials & Setup

For each group of three to four students

- One set of "Pig Impact Clue Cards" (master, pp. 16-18)

For each student

- Student Page "Bogs and Pigs Don't Mix" (pp. 19-21)
- Student Page "Monitoring Revegetation in Greensword Bog" (pp. 22-24)
- Student Page "Analyzing the Data" (pp. 25-28)

Instructions

1) Begin the class by asking students for their ideas about the main problems linked with feral pigs feeding in rain forests and bogs. Make a list on the board or overhead.

2) Divide students into groups of three to four and hand out one set of "Pig Impact Clue Cards" to each group. Tell students that scientists and resource managers have identified five main problems linked with feral pigs feeding in the rain forest. Their task is to use the clue cards to identify those five problems. (If students need help figuring out how to use the cards, suggest that they read each card first and then try to group together cards that relate to each other. There are between two and five clue cards that describe each of the five problems.)

3) Groups should write a description of each of the five problems and the clue cards they used to arrive at each.

4) Once groups have completed their work, have groups report their results by having each group describe one problem and the clue cards they used to arrive at it. Continue until all the problems have been reported. There may be more than five, depending upon how groups interpreted the clues. Use the teacher background "Five Problems With Pigs" (pp. 11-12) as a guide, but also be prepared to accept other well-reasoned conclusions.

5) Open a class discussion about the impact of pigs in the rain forest.

6) Assign the Student Pages "Monitoring Revegetation in Greensword Bog" and "Analyzing the Data" as homework.

Journal Ideas

- Do you think that pigs should be fenced out of intact rain forest on Haleakalā and special areas such as bogs? Why or why not?
- How are pigs important in traditional Hawaiian culture? Do they have the same significance today?
- Researchers monitoring the regrowth of vegetation in Greensword Bog saw only eight nonnative plant seedlings in the plots during the course of their study. Researchers recorded these plants and then pulled them out. How might that approach have influenced the regrowth of vegetation in the bog? Do you think this approach is acceptable for scientific researchers in this situation? Why or why not?

Assessment Tools

- Group descriptions of problems associated with feral pigs in the rain forest
- Participation in group work and class discussion
- Student Page "Analyzing the Data" (teacher version, pp. 13-15)

Teacher Background

Five Problems with Pigs

Problem #1: Pigs spread nonnative plants and create conditions conducive to their growth in the rain forest.

- The fruit of strawberry guava, a nonnative plant that has become established across thousands of acres of rain forest on Haleakalā, are a preferred food source of pigs.
- Strawberry guava seeds pass through pigs' digestive tracts and are still able to germinate when excreted. Other plants, such as clidemia, produce seeds that stick to pigs' coats.
- Strawberry guava and many other nonnative plants thrive in areas where the native plant cover has been disturbed and the soil exposed. They germinate, grow, and reproduce rapidly.

Problem #2: Pigs feed on native plants, reducing their populations and sending ripple effects through the natural systems that depend on them.

- Pigs selectively seek out certain native plant species for food. Plants with particularly fragile stems and leaves, such as many of the lobeliad species, have drastically declined because of predation by pigs.
- Of all the layers of rain forest vegetation, the ground layer of mosses and small ferns has probably been altered most by pigs, but they have not been totally eliminated because they survive as epiphytes, using other plants for support, especially the trunks of native tree ferns.
- Starch from native tree fern trunks (such as the *hāpu'u*) is a favored food source of pigs. Pigs knock over mature tree ferns and eat them.
- In bogs, pigs eat the central growth stem of the rosette-shaped *Plantago pachyphylla* as well as other native plants, such as those in the lobeliad group.
- Some native bird species have specialized beaks for extracting nectar from lobeliad flowers, their preferred source of food.

Problem #3: Pig wallows become breeding grounds for the mosquitoes that carry avian malaria, which threatens native rain forest birds and reduces their potential range.

- Pigs create wallows in the rain forest, which form pools of standing water.
- Mosquitos breed in open water.
- Nonnative mosquitos transmit avian malaria, a disease introduced in the early 1900s along with nonnative birds.
- Many Hawaiian honeycreepers, including the rare *'ākohekohe*, are highly susceptible to avian malaria.
- Mosquitos rarely occur above 1200 meters (3936 feet) in elevation.

Problem #4: Pigs rooting and wallowing expose soils to compaction and erosion, lessening the ability of these areas to support vegetation.

- Pigs can uproot entire areas of vegetation in bogs and other parts of the rain forest. The exposed areas they leave range from a square meter to several hundred square meters.
- Pigs rooting and wallowing clear the forest floor of leaf litter and mix up the fertile, organic humus with the lower layers. The soil in these areas often becomes compacted and difficult for plants to grow on or susceptible to erosion without the protection of plant cover.

Problem #5: Over time, repeated pig disturbances disrupt the cycles and fertility of the native forest, down to the fundamental level of decomposition and soil formation.

- Pigs often revisit the same areas time after time.
- Soil-dwelling larvae and earthworms are a preferred food source of pigs, which they find by rooting in the soil.
- The fertility of rain forest soils depends upon a cycle of decomposition and soil formation in which leaf litter and other organic matter is recycled from the forest into the soil by microorganisms.

Teacher Version

Analyzing the Data

At the end of these questions, there is a table that summarizes data collected by researchers studying Greensword Bog. [Data table included in student version only.] Use this table to answer the following questions.

1) What are the two dominant plant species in Greensword Bog? Explain your reasoning.

   Carex echinata and *Oreobolus furcatus* are the dominant plant species. Each has 100 percent frequency and coverage of over 33 percent. The other plant species do not have nearly as high frequency and coverage.

2) Identify two native species that by 1987 *had not* regained or surpassed their 1973 cover *and* frequency levels.

   These species could include:
   - *Dichanthelium cynodon*
   - *Vaccinium reticulatum*
   - *Plantago pachyphylla*
   - *Argyroxiphium grayanum*
   - *Viola maviensis*
   - *Sadleria pallida*

3) Identify two native species that by 1987 *had* regained or surpassed their 1973 cover *and* frequency levels.

   These species could include:
   - *Carex echinata*
   - *Deschampsia nubigena*
   - *Metrosideros polymorpha*

4) There are two native species (*Dichanthelium cynodon* and *Metrosideros polymorpha*) that by 1987 had *surpassed* their 1973 frequency levels but had only *matched or not regained* their 1973 cover levels. Offer an explanation for this phenomenon.

The most likely explanation is that the plants of these species are smaller and probably younger plants than had occurred in 1973. Seedlings may have established themselves in more plots but together would not cover as much ground as fewer, more developed individuals.

5) In February 1987, cold weather came to Greensword Bog. As happens occasionally, frost covered the ground and the plants. Researchers suspect that the frost caused a setback in the recovery of some plant species in Greensword Bog. When researchers sampled the site in the summer of 1987, they found that certain species seemed to have suffered seedling mortality during that frost. Using the table of results, identify two species for which this *might* be true. Explain your reasoning.

These species could include:

- *Oreobolus furcatus* (53 percent coverage in 1986 dropped to 34 percent in 1987)
- *Dichanthelium cynodon* (84 percent frequency in 1986 dropped to 79 percent in 1987)
- *Vaccinium reticulatum* (46 percent frequency in 1986 dropped to 42 percent in 1987)
- *Plantago pachyphylla* (eight percent frequency in 1986 dropped to six percent in 1987)
- *Argyroxiphium grayanum* (19 percent frequency and 1.6 percent coverage in 1986 dropped to 18 percent and negligible in 1987)
- *Metrosideros polymorpha* (32 percent frequency in 1986 dropped to 15 percent in 1987)
- *Sadleria pallida* (12 percent frequency in 1986 dropped to one percent in 1987 — again, an example of a decline that began earlier than 1987)

Use your brains (not the data table) to answer the following questions:

6) Name and explain two variables (besides frost) that could affect the reproduction, growth, and re-establishment of native plants in Greensword Bog. Tell whether you think each factor would have a positive or negative effect, and explain why.

Look for clear reasoning and plausibility. Possible answers include:

- The number of surviving plants to produce seed, send out vegetative sprouts, or expand (in the case of species that grow in clumps such as *Carex echinata* and *Oreobolus furcatus*)—More survivors should have a positive effect on reestablishment

- Distribution of surviving plants—If surviving plants are distributed throughout the bog, rather than in just one place, reestablishment should be enhanced.

  *TEACHING EXAMPLE: In Greensword Bog, pig damage had eliminated greenswords (*Argyroxiphium grayanum*) from the central bog. Greenswords survived only at the bog margins. Reestablishment of greensword frequency and cover in the central bog has been slow.*

- Whether the species is well-adapted to disturbed areas—Species that are better adapted to disturbed areas should have an advantage.

  TEACHING EXAMPLE: In Greensword Bog, the native grass Deschampsia nubigena *continually increased, surpassing its 1973 occurrence.* Deschampsia *occurs in nearby bogs under a regime of chronic pig disturbance as well as in the natural disturbance of windward stream sources.*

- Competition from other species—A slow-growing species might have difficulty re-establishing itself in the face of competition from other, faster-growing species. Or a species could reestablish quickly but then decline due to competition from other species.

  *TEACHING EXAMPLE: In Greensword Bog,*Oreobolus furcatus *expanded quickly. In the sixth year, it declined sharply (from 53 percent cover to 34 percent) with* Carex echinata *and* Deschampsia nubigena *overtopping it and reducing the amount of sunlight available to it.*

- Other sources of seedling mortality such as excessive sunlight or unusually dry conditions—These would have a negative effect on reestablishment.

- Alteration or compaction of the soil—These would probably have a negative effect on reestablishment.

7) If you were designing a vegetation study, how might the kind of vegetation you are going to look at affect the size of your plots?

The basic answer is that larger vegetation generally requires larger plots and smaller vegetation requires smaller plots.

Pig Impact Clue Cards

Cut on dashed lines

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Strawberry guava and many other nonnative plants thrive in areas where the native plant cover has been disturbed and the soil exposed. They germinate, grow, and reproduce rapidly.	Pigs selectively seek out certain native plant species for food. Plants with particularly fragile stems and leaves, such as many of the lobeliad species, have drastically declined because of predation by pigs.
In bogs, pigs eat the central growth stem of the rosette-shaped *Plantago pachyphylla* as well as other native plants, such as those in the lobeliad group.	Pigs can uproot entire areas of vegetation in bogs and other parts of the rain forest. The exposed areas they leave range from a square meter to several hundred square meters.

Cut on dashed lines

Of all the layers of rain forest vegetation, the ground layer of mosses and small ferns has probably been altered most by pigs, but they have not been totally eliminated because they survive as epiphytes, using other plants for support, especially the trunks of native tree ferns.	Starch from native tree fern trunks (such as the *hāpu'u*) is a favored food source of pigs. Pigs knock over mature tree ferns and eat them.
Some native bird species have specialized beaks for extracting nectar from lobeliad flowers, their preferred source of food.	Pigs create wallows in the rain forest, which form pools of standing water.
Mosquitos breed in open water.	Nonnative mosquitos transmit avian malaria, a disease introduced in the early 1900s along with nonnative birds.

Cut on dashed lines

Many Hawaiian honeycreepers, including the rare *ʻākohekohe*, are highly susceptible to avian malaria.	Mosquitos rarely occur above 1200 meters (3936 feet) in elevation.
Pigs often revisit the same areas time after time.	Pigs rooting and wallowing clear the forest floor of leaf litter and mix up the fertile, organic humus with the lower layers. The soil in these areas often becomes compacted and difficult for plants to grow on or susceptible to erosion without the protection of plant cover.
Soil-dwelling larvae and earthworms are a preferred food source of pigs, which they find by rooting in the soil.	The fertility of rain forest soils depends upon a cycle of decomposition and soil formation in which leaf litter and other organic matter is recycled from the forest into the soil by microorganisms.