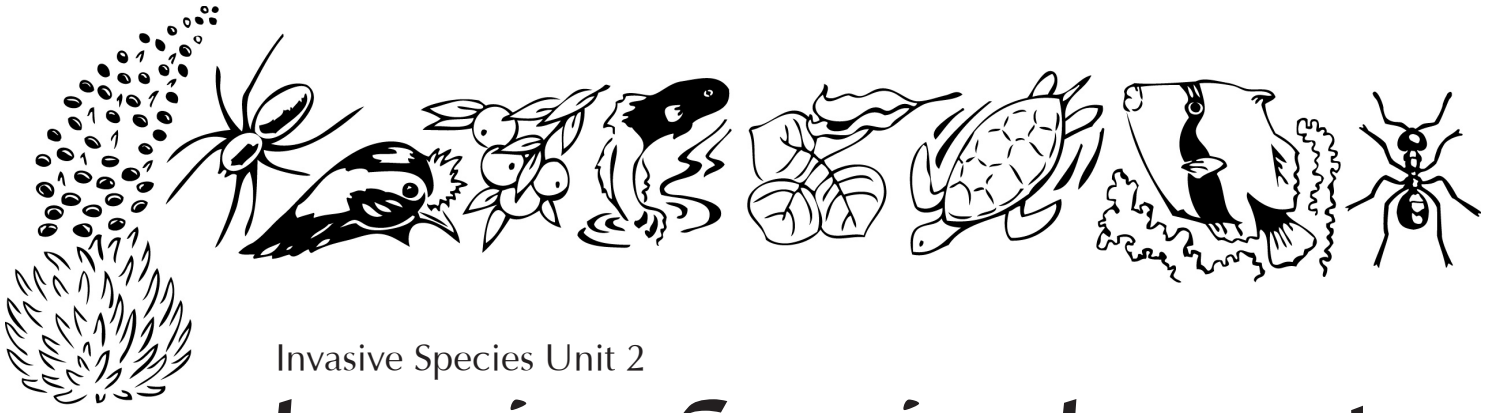


Invasive Species Unit 2

Invasive Species Impacts: Why Care?

Overview

What's the big deal about invasive species? What damage could a few plants possibly cause? Non-native, alien plants and animals may seem harmless at first but their impact can be long lasting and severe. In extreme cases, they may be capable of driving a native species to extinction. When an endemic Hawaiian species goes extinct, it's not just a loss for Hawai'i; it's a loss for the entire planet. Invasive species affect more than just native Hawaiian ecosystems; they can also disrupt cultural practices, damage key industries such as tourism and agriculture, and pose threats to public health and safety. In this unit, students look at invasive species through the lens of each of these concerns.

Length of Entire Unit:

6 class periods

Unit Focus Questions

1) In what ways do invasive species affect the natural environment of Maui? The culture? The economy? Public health?
2) How have invasive species changed Maui over time?

Unit at a Glance

Activity #1

"In Our Lifetime": *Kupuna* Stories

Students collect stories from community members, conduct research, and view historic photos and video clips to see what has shifted in the natural landscape of Maui.

Length:
Two class periods (plus research)

Prerequisite Activity:
None.

Objectives:

- Research and document historic changes in the natural environment of Maui.
- Interview someone who has observed changes in local landscape and biota first hand.
- Create an essay, poster display, brochure, multimedia presentation, song, or chant documenting or reflecting on changes in the natural environment of Maui.
- Present the finished project to the class.
- Gain a "sense of place" and a historic perspective; connect shifts in the community to shifts in natural resources.

Activity #2

Raindrops and Watersheds: Size Matters

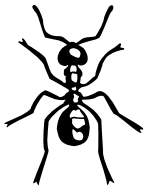
Students recreate rain events and measure the size of water droplets that fall from simulated miconia leaves versus native forest plants.

Length:
One class period

Prerequisite Activity:
None

Objectives:

- Demonstrate how a plant's leaf shape can affect watershed functionality and promote erosion.
- Understand the impact of alien invasion on biodiversity.



Activity #3

Frogs on Floor Four

Students role-play, assuming the responsibilities of Maui resort managers faced with the problem of a coqui frog infestation on the hotel grounds. By calculating the direct and indirect costs of various control strategies, students draft a budget that reveals the financial impact of invasive species on the island's tourist industry.

Length:
One class period

Prerequisite Activity:
None

Objectives:
- Calculate the direct and indirect costs of a coqui frog infestation at an imaginary resort, based on real life scenarios.
- Create a budget that approaches the invasive species issue from a businessperson's perspective.
- Present the budget and articulate reasoning behind decisions made to classmates.

Activity #4

Plagues: Past and Present

Performing a reader's theater, students explore the historic 1899 outbreak of bubonic plague in Honolulu. They document the causes and consequences of the outbreak. During a following class, the teacher infects select students with Glo Germ™ gel to simulate a mystery epidemic. Students use what they learned from the plague outbreak to develop an action plan, identify the pathogen, and stop its spread.

Length:
Two class periods

Prerequisite Activity:
None

Objectives:
- Investigate the impact of alien plants, animals, invertebrates, and pathogens on human health and public safety.
- Explore the historic outbreak of bubonic plague in Hawai'i.
- Create action plan in response to a potential epidemic of rat lungworm disease.

Enrichment Ideas

- Create a poster, flyer, or brochure explaining how invasive species affect a) watersheds, b) cultural resources, c) public health or, d) the economy. Have it reviewed for accuracy by an official at the Hawai‘i Department of Land and Resources http://hawaii.gov/dlnr or Maui Invasive Species Committee: (808) 573-6472 www.misc.org

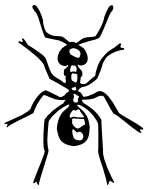
Resources for Further Reading and Research

Lahaina: Waves of Change, film by Eddie Kamae and Myrna Kamae, Hawai‘i Legacy Foundation, 2008. (DVD included in this curriculum or available online at www.hoikecurriculum.org).

Cuddihy and Stone, **Alteration of Native Hawaiian Vegetation**. University of Hawai‘i Press, 1990.

College of Tropical Agriculture and Human Resources (CTAHR) website about coqui frogs: http://www.ctahr.hawaii.edu/coqui/index.asp

For questions about rat lungworm, call the Maui District Health Office at 984-8213 or CTAHR Maui Cooperative Extension Office, at 244-3242, ext. 232.



Activity #1

In Our Lifetime: Kupuna Stories

Length:
Two class periods (depending on length of time allowed for final presentations), plus research project

Prerequisite Activity:
None.

Objectives:
- Research and document historic changes in the natural environment of Maui.
- Interview someone who has observed changes in local landscape and biota first hand.
- Create an essay, poster display, brochure, multimedia presentation, song, or chant documenting or reflecting on changes in the natural environment of Maui.
- Present the finished project to the class.
- Gain a "sense of place" and a historic perspective; connect shifts in the community to shifts in natural resources.

Vocabulary:
Kupuna

● ● ● Class Period One: *Discussion & Research Topics*

Materials & Setup

Lahaina: Waves of Change DVD included in this curriculum

For each student
- Student Pages "Tips for Interviewing" (p. 11)

Instructions

1) Ask students the Hawaiian name of the town, neighborhood, or street that they live on. Do they know what the name means? Consult Teacher Background: "Hawaiian Place Names" for examples of places named for a native Hawaiian species. Ask students if they know if these species are still present at these locations.

2) Encourage them to think about their natural surroundings. Have they noticed changes in their neighborhood, at their favorite beach, surf break, or hiking trail? How?

3) Tell students they will interview a *kupuna* or older local resident about how the natural landscape of Hawai'i has changed in their lifetimes. Afterwards, they will tell their interviewee's story in a documentary, music video, essay, class presentation, painting, slide show, song, or chant.

4) Show the film, *Lāhainā: Waves of Change*. Tell students to critique the film as they watch. What techniques do the filmmakers employ to create a sense of time and place? How are interviews, historic photos, and music incorporated? What kinds of things did interviewees talk about? Have students take notes, recording any new facts they learn about Lāhainā, and anything they notice about the craft of storytelling.

5) Have students select a person to interview. Tell them to choose someone who has lived in Hawai'i for a long time and has spent time outdoors—a fisherman, farmer, forester, rancher, surveyor, or pilot, for example. Hula dancers and cultural practitioners are also good choices. Their interviewee could be an older family member, family friend, or an employee at one of the agencies listed in Teacher Background "Sources." They can also contact Hale Makua or another retirement center for an interviewee.

6) Pass out Student page "Tips for Interviewing." Help students draft interview questions. Topics to cover include: disappearing forest or marine resources, new plant, animal, and insect species that are taking the place of the old ones, medicinal and cultural plants that are now rare. Don't neglect positive changes, such as the re-introduction of nēnē, the Hawaiian goose, which was extinct on Maui.

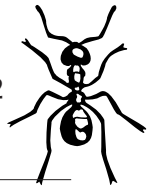
7) You will need to set the parameters for the interviews, such as:
   - How long students will have to conduct their interviews.
   - When they will need to hand in interview notes. These notes will help form the basis for their creative response.
   - How students will tell their interviewee's story. Options include a documentary, music video, essay, class presentation, painting, slide show, song, or chant.
   - How research and presentations will be evaluated.

8) Schedule a day for presentations and allow students to perform or display their work.

Note: Depending upon the needs of your students, you may need to schedule some class time to help students refine their research questions, identify more sources of information, or develop their final presentation.

Journal Ideas

- Describe the experience of interviewing or researching your subject. What made it challenging or fun? What did you learn that you didn't know before?
- How did your view of Maui change after your interview? What do you imagine will change in your lifetime? Have you already noticed changes in your natural environment?
- Who do you think is responsible for these changes? How can you affect future changes? Name five ways.



Assessment Tools

- Class discussion
- Research plans and interview notes
- Final presentations
- Journal entries

Further Enrichment

- Work with the Digitalbus (www.digitalbus.org) to help students produce videos based on their interviews.
- Have students compose a chant, song, or essay celebrating a favorite natural resource that still exists, for example: a place where they catch fish, a surf break or waterfall, a native plant, insect, or bird.
- Encourage students to enter the Environmental Protection Agency's annual "Sense of Wonder" competition by working with an elder person to collaboratively create a photograph, essay, poem, or dance that celebrates the natural world. Entries must be intergenerational projects and are typically due in June; winners are announced in November. For full details, visit www.epa.gov or http://www.epa.gov/aging/resources/thesenseofwonder/index.htm

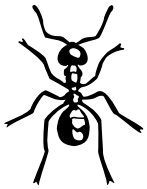
Teacher Background

Hawaiian Place Names

Hawaiian place names often give clues to what once lived in an area. The following locales are named after a Hawaiian plant or animal. Choose a few to discuss. Ask students if they can think of any examples. (It might be helpful to have a detailed map or atlas to reference these sites.)

Examples from Maui:
Hāliʻimaile: strewn *maile* vines
Hanawana: *wana*, or sea urchin, bay
Kanaio: the *naio*, or false sandalwood
Kaimuloli: oven for *loli*, or sea cucumber (an area near Kaupo where people were fond of baked sea cucumber.)
Keʻanae: mullet (also a white taro variety)
Keoneʻōʻio: *ʻōʻio* or bonefish (*Albula glossondonta*) beach
Līpoa: *lipoa* seaweed
Makawao: the beginning of the forest
Mokupipi: pearl oyster island
Nāpili: the *pili* grass
Ōmaʻopio: whistling thrush
Puʻukoliʻi Street: *koliʻi*, a lobelia that grows in the upper forest, hill
Puʻunēnē: *nēnē* hill
Waiheʻe: squid liquid
Waikamoi: water of the *moi*, threadfish
Ukumehame: paid *mehame* wood
ʻUlupalakua: *ʻulu*, breadfruit, ripening on the back of carriers

Examples from other islands:
ʻAiea (Oʻahu): *aiea* tree
Hale Palaoa (Lānaʻi): house of the whale
Haleʻiwa (Oʻahu): house of the *iwa*, or frigate bird
Haleloulu (Molokaʻi): house thatched with *loulu* palm
Hanakoa (Kauaʻi): *koa* tree bay
Hinano Street (Oʻahu): male *hala* flower
Honohononui (Hawaiʻi): much *honohono* grass
Honokoʻi (Molokaʻi): adze bay
Iholena Street (Oʻahu): Hawaiian banana variety
ʻIolani Palace (Oʻahu): royal *io*, or hawk
Kaʻaʻawa (Oʻahu): wrasse fish
Kahala (Oahu): amberjack fish
Kamiloholu (Hawaiʻi): the swaying milo tree
Keahole (Hawaiʻi): *ahole* fish
Koaʻe (Hawaiʻi): tropicbird
Koʻele (Lānai): dark sugar cane
Miloliʻi (Hawaiʻi): fine twist (The village was noted for its excellent cordage.)



Mohokea (Hawai‘i): white *moho*, Hawaiian flightless rail bird (extinct)
Mohopilo (Hawai‘i): *moho*, flightless rail bird’s stinky droppings
Mokihana (Kaua‘i): *mokihana* tree
Olokele (Kaua‘i): another name for *i‘iwi* honeycreeper bird
Polihua (Lānai): eggs in bosom (after the sea turtles who nest here)
Puako (Hawai‘i): sugar cane blossoms
Punalu‘u (Hawai‘i): coral dived for
Waialae (Kaua‘i): mudhen water
Waianae (O‘ahu): mullet water
Waikoloa (Hawai‘i): *koloa*, or duck water
Waikīkī (O‘ahu): spouting water, natural springs

Sources

The following gardens and parks likely have staff that would be willing to talk to students about changes in natural landscapes. They are also places students can go to see examples of plants and animals that are now rare. (Contact staff prior to visit for explanatory tours.)

Maui Nui Botanical Garden
Maui Nui Botanical Garden has numerous rare, native plants in addition to a collection of canoe plants. 150 Kanaloa Ave., Kahului, Hawai‘i, (808) 249-2798. www.mnbg.org

Kahanu Garden and Pi‘ilanihale Heiau
Pi‘ilanihale Heiau, the largest prehistoric monument in Hawai‘i, was built in the 14th century. The 122-acre grounds include a canoe garden focusing on the ethnobotany of the Pacific. Self-guided tours, weekdays 10-2, $10. Guided tours Saturdays, $25. Near end of Ula‘ino Rd., Hāna, Hawai‘i, (808) 248-8912.

Haleakalā National Park
Haleakalā National Park offers visitors an abundance of native Hawaiian habitats, ranging from the rain forests of Kīpahulu to the spectacular moonscape of the summit. Hawaiian honeycreepers are easily viewed on a short hike starting at Hosmer’s Grove. Crater Rd., Kula, Hawai‘i, (808) 572-4400. www.nps.gov/hale

‘Īao Valley State Park
‘Īao Valley has a thriving garden of canoe plants, as well as a population of native stream creatures that can be viewed with a mask and snorkel. 5 ‘Īao Valley Rd., Wailuku, Hawai‘i, (808) 587-0300.

Alexander & Baldwin Sugar Museum
Historic photos show what Maui looked like during the initial phases of sugar production. 3957 Hansen Rd., Kahului, Hawai‘i, (808) 871-8058. www.sugarmuseum.com

Bailey House Museum
This small museum contains many historic artifacts, including the skins of extinct Hawaiian birds

and an assortment of native tree snails. Additionally, Edward Bailey's paintings depict the Hawaiian Islands as they were long ago. 2375 Main St., Wailuku, Hawai'i, (808) 244-3326. www.mauimuseum.org

Baldwin House Museum
The restored 1835 home of Reverend Dwight Baldwin has relics from the 19th century, including the doctor's collection of native tree snails and furniture made from rare woods.
120 Dickenson St., Lāhainā, Hawai'i, (808) 661-3262. www.lahainarestoration.org/baldwin.html

Books

Beckwith, Mary Warren, *The Kumulipo: A Hawaiian Creation Chant*. University of Hawai'i Press, 1981

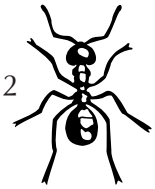
Bird, Isabella, *Six months in the Sandwich Islands*. University of Hawai'i Press, Honolulu, 1966.

Cuddihy, Linda and Stone, Charles. *Alteration of Native Hawaiian Vegetation, Effects of Humans, Their Activities and Introductions*. University of Hawai'i Press, Honolulu, 1990.

Juvik, Sonia P. and Juvik, James O., *Atlas of Hawaii, third edition*. Geography Dept., Univ. Hawai'i. University of Hawai'i Press, Honolulu, 1998.

Rock, Joseph Francis Charles, *The Indigenous Trees of the Hawaiian Islands*. College of Hawai'i, 1913.

Pukui, Mary Kawena, *'Olelo No'eau: Hawaiian Proverbs and Poetical Sayings*. Bishop Museum Press, Honolulu, 1983.



Tips for Interviewing

Prepare:

Set up a time and place for your interview. Choose somewhere quiet and allow at least 1 ½ to 2 hours for your interview. Draft your questions in advance; use the list below to help you get started. Add additional questions as appropriate.

Bring a recording device, or take notes on paper or computer. If you take notes, it's okay to ask the person to slow down while you write down what they've said.

Get started:

Don't be shy! People generally like to talk about themselves, but sometimes they need some encouragement to get started.

Once they've started sharing, be a respectful listener; don't interrupt.

Start with the facts:

What is your first and last name? (Get the correct spelling.)
When were you born?
Where were you born?
How long have you lived on Maui?
Where do you live now?
What kind of work do you do?
Are you married?
Do you have children? How many?

Move on to stories:

Where is your favorite place to go outside on Maui?
What do you like to do there?
Describe how Maui (or their favorite place on Maui) looked when you were young. What has changed over the years?
What is the biggest change you remember witnessing?
Did you or your family members gather food from the forest or ocean? What kinds?

Ask for details:

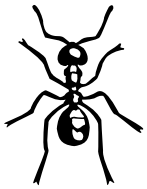
Is there a kind of food or flower or tree that you really miss?
Are there places you used to go to that you don't go to anymore? Why?
Do you remember the bombing of Kahoʻolawe? Describe what it was like.
Do you remember when Lāhainā and Pāʻia sugar mills were still operational?
What did Puʻunēnē (or other town) look like in the old days? (Ask what year they are describing.)
What kind of transportation did you use back then?
How many people lived in your town/area?

Ask for feelings and value statements:

What do you love most about Maui?
How do the changes around the island make you feel?
Do you think people who live here have a responsibility to preserve our resources?
What do you think Maui will be like in the future?

Conclude:

Be sure to thank your interviewee for his/her time.
Explain how you will use the information they shared with you. Consider offering to share your final product with them.



Activity #2

Raindrops and Watersheds: Size Matters!

Length:
One class period

Prerequisite Activity:
None

Objectives:
- Demonstrate how a plant's leaf shape can affect watershed functionality and promote erosion.
- Understand the impact of alien invasion on biodiversity.

Vocabulary:

Aquifer	Kinetic	Watershed
Erosion	Hydrology	Understory
Disdrometer	Throughfall	

● ● ● Class Period One: *Measuring the Drop*

Materials & Setup

For each student
- Student Pages "Water Droplet Lab Worksheet" (p. 16)

For each group of 3-5 students
- A sampling of large and small leaves picked from around the school grounds or brought from home. For large leaves, the bigger the better (example: ginger, *ti,* or banana leaves). For small leaves, leaves averaging three inches long are ideal.
- Flour (2-3 cups)
- Plate
- Spray bottle
- Ruler
- Mesh metal strainer, such as an extra large tea strainer

Note: Use the information in the Teacher Background "Raindrops and Hydrology" (p. 15) to familiarize yourself with the miconia hydrology research. Also, moderating the speed and number of water droplets falling from the leaf can be tricky. Do the experiment once in front of the class to demonstrate how to allow only one droplet to fall into the flour at a time.

Instructions:

1) For context about miconia and its effects on native Hawaiian forests, show the *Miconia Threatens Maui* video included in this curriculum.
(Also available on the web at http://youtu.be/eSwVnIUtGcM.)

2) Tell students that they will be replicating a scientific study that identifies one way that miconia alters the ecosystem.

3) Break the class into groups of 3-5 students. Tell them they will be simulating rain falling from large and small leaves in the forest, and comparing the size of drops.

4) Have each group pour a layer of flour in the plate (roughly 1-2 inches deep) and level it off with the ruler.

5) Spray a leaf with fifteen squirts of water from a spray bottle. Do this away from the flour.

6) Quickly tilt the tip of the leaf over the flour and allow 4-5 raindrops to roll off the tip of the leaf and into the flour. Make sure each droplet has its own clear space on the flour. Droplets will join together on the leaf, but try not to let two droplets fall in the same spot. After five individual droplets fall onto the flour, remove the leaf.

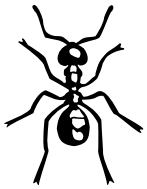
7) Your flour should now be dotted with individual rain droplets. Flour will congeal around each rain droplet. Carefully separate each rain droplet.

8) Sift the droplets from the plate by pouring the flour through a strainer. (You may want to gently roll each droplet into a ball.) Measure the diameter of each droplet in millimeters. If droplets are oblong shapes, measure both sides and record the average size.

9) Have students repeat instructions 2-6 twice, using large leaves and small leaves. They will record the measurements for ten drops from a large leaf and ten drops from a small leaf on the Student Page "Water Droplet Lab Worksheet."

10) Have students compare the sizes of the droplets that resulted from the larger leaves to those from the smaller leaves.

11) Engage students in discussion: were there significant differences in the size of raindrops falling from the different leaves? How might larger or smaller raindrops make a difference in the functions of the rain forest? Did the shape of the leaves make a difference? Use Teacher Background "Raindrops and Hydrology" to explain context of experiment.



● ● ● Class Period Two: *Understory*

Materials & Setup

- A sampling of large and small leaves picked from around the school grounds or brought from home
- Twigs, small rocks, moss and other leaf litter
- Flour, diatomaceous earth, or soil
- Flat tray or baking sheet
- Spray bottle

Instructions

1) Construct a simulated "healthy forest understory," using flour, diatomaceous earth or actual soil, small rocks, sticks, moss, and leaves. Arrange the components on a flat tray. Elevate one side of your forest to represent the gentle rise in elevation typical of the mountain rainforests of Maui. Place a bin on the downhill side of your tray to collect debris.

2) Have each group of students select a nozzle setting on the sprayer, ranging from mist to stream.

3) Spray for two minutes and record the volume of erosional debris that has washed from the tray.

4) Construct a "miconia understory," using only flour or soil and several large sticks. (The sticks represent miconia's shallow roots.) Omit mosses and leaves. Repeat the exercise above, record measurements, and share results in class discussion.

5) Discuss the results as a class. What might this mean for Hawaiian forests that have been invaded by miconia?

Journal Ideas

- What were your expectations prior to conducting the lab? Did you think the leaf size would affect the water droplet size? Why or why not?
- How could soil health in Hawaiian forests affect coral reefs? Agriculture? Public safety?

Assessment Tools

- Lab results
- Participation in class discussion
- Journal entries

Further Enrichment

- Show "Hydrology" powerpoint and discuss. (Included in this curriculum.)
- Read the Robert Hobdy's essay, "The Many Faces of *Koa*." (Included in the appendix.)
- Have students design a lab to test the variance between slender, medium, and thick *koa* phyllodes as described in Hobdy's essay.

Teacher Background

"Raindrops and Hydrology"

Miconia is widely considered the worst weed currently invading Pacific island rain forests. The South American tree has invaded over 60 percent of the island of Tahiti, where sunless, single-species groves have replaced native forest, encouraged erosion, and caused landslides. In Hawai'i, miconia has infested huge swaths of rain forest on Maui and Hawai'i Island. Comprehensive campaigns to control its spread have been underway since the 1990s.

Scientists have known for decades that miconia infestations reduce watershed function in tropical Pacific rain forests. Recently, some hydrologists set out to demonstrate exactly how. They started by measuring the size of raindrops falling in Hawaiian rain forests. Most raindrops average 1-2 mm in size. The world's largest recorded raindrops were 8mm and fell over Hilo, Hawai'i. Bigger drops usually break apart as they fall through the air.

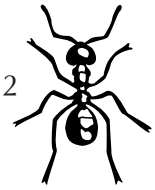
Rainwater that hits trees or other obstructions on its way to the earth is called "throughfall." When the scientists measured the size of throughfall falling from miconia's large leaves, as compared to the size of throughfall falling from the smaller leaves of native plants, they discovered a big difference. The drops falling from miconia leaves were consistently larger.

Large water droplets possess greater kinetic energy than small drops as they fall onto the forest floor. They promote greater erosion, resulting in exposed roots, large ruts in the soil, and diminished water retention. The scientists were able to show that the size of the leaves played a role in reducing watershed function. This lab is a replication of their experiments—only instead of using an expensive laser disdrometer to measure the raindrop size, you'll use flour, water, and a lot of patience.

Miconia's umbrella-like leaves negatively affect watershed function in other ways, too. Small plants cannot grow beneath the shade of giant miconia leaves. In a miconia-dominated forest, the multitude of ferns, small shrubs, lichens and mosses sponge that characterizes native Hawaiian forests disappears. Understory plants wither and die, to be replaced by hundreds of miconia seedlings, exposed roots, and, ultimately, bare soil. Rainwater that would have soaked into the sponge-like understory instead washes off a hard surface, carrying precious topsoil away.

Other large-leafed plants such as banana and *ti* plants don't cause the damage that miconia does in Hawai'i. Large leaves aren't the only weapon miconia unleashes on the rain forest. It also matures rapidly, dispersing millions of microscopic seeds per year, and growing in tightly packed single-species groves. Its shallow root system increases the likelihood of erosion and landslide. Add these components up and you've got a severely impaired watershed.

Rain forests are critical reservoirs of water for island communities. Rainfall recharges underground aquifers, which are tapped by local communities. Without healthy rain forests, we risk losing our primary source of drinking water. Additionally, when eroded forest soils wash down from the mountain into the ocean, they smother coral reefs. Combating invasive species in our forests is critical to maintaining the integrity of island ecosystems.



Water Droplet Lab Worksheet

Name: _____

Hypothesis: _____
_____
_____

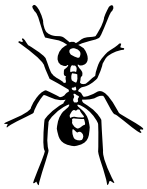
Procedure: _____

Materials: _____

Record water droplet size in millimeters:

Small leaf		Large leaf	
1.	_____	1.	_____
2.	_____	2.	_____
3.	_____	3.	_____
4.	_____	4.	_____
5.	_____	5.	_____
6.	_____	6.	_____
7.	_____	7.	_____
8.	_____	8.	_____
9.	_____	9.	_____
10.	_____	10.	_____
Average size: _____		Average size: _____	

Conclusion: _____
_____
_____
_____



Activity #3

Frogs on Floor Four!

Length:
One class period, with reading assignment

Prerequisite Activity:
None

Objectives:
- Calculate the direct and indirect costs of a coqui frog infestation at an imaginary resort, based on real life scenarios.
- Create a budget that approaches the invasive species issue from a businessperson's perspective.
- Present the budget and articulate reasoning behind decisions made to classmates.

Vocabulary:

Alien	Eradicate	Native
Amphibian	Infestation	Nocturnal
Density	Invasive	

● ● ● Class Period One: *Developing Resort Budgets*

In Advance:
Have students read Student Pages "A Most Unwanted Neighbor - Coqui Frogs," pp. (27-28) aloud in class or assign as homework.

Materials & Setup
"Coqui Calls" audio file on the DVD included in this curriculum or on the www.hear.org.

For each student:
- Student Page "A Most Unwanted Neighbor - Coqui Frogs" (pp. 27-28)

For each group of four to five students:
- Student Pages "Frogs on Floor Four." (p. 24)
- One wild card (from the Teacher Background "Wild Card" page (pp. 20-23)

Instructions
1) Play the "Coqui Calls" recording of coqui frogs for the class. Ask students if they know what the sound is. Tell them it is the mating call of the coqui frog (*Eleutherodactylus coqui*), pronounced: ee-looth-er-o-dact-y-lus co-kee. Ask students if they would be able to sleep while that sound continued through the night.

2) Review the reading assignment.

3) Tell students that they will be acting as the owners and managers of a large resort on Maui that is infested with coqui. They will investigate the financial costs of coqui frog outbreak, based on real numbers from a local resort's budget. Divide the class into groups of four to five students. Explain that each group is in charge of developing a budget for their imaginary resort.

4) Hand out the Student Pages "Control Strategies," and "Resort Budget" to each group. Have each group select a) a general manager who will facilitate the group's discussion and make sure it completes its assignment, b) one or two administrative assistants to do the math c) a secretary who will fill out the "Resort Budget," and d) a public relations spokesperson who will present the group's plan and rationale to the class. (They can also choose a name for their resort.) Tell them to fill out an annual budget, based on their hotel's expenses and revenues. Allow students to work together for 20 minutes.

5) After your students have completed their initial budget, tell them that midway through the year the coqui situation has changed. Pass out one wild card per group. Give groups 5-10 minutes to discuss how this might affect their strategy and revise their budget accordingly for the second half of the year. When they are complete, they will present their budgets and the reasoning behind their choices to the class.

6) When approximately 25 minutes of the class remains, have each group's spokesperson give a 3-5 minute overview of the group's budget.

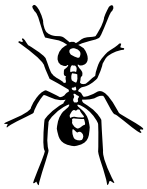
7) At the end of class, ask students to discuss what they learned by doing this activity. Which choices turned out to be the most financially prudent and why?

Journal Ideas

- All business owners need to prioritize expenses and estimate long and short term costs. Which of the coqui scenarios seemed likely to occur? Which seemed less likely? Why?
- Do you think legislation making it illegal to harbor coqui frogs on your property is a good idea? Why or why not?
- Can you think of other strategies for dealing with a coqui frog infestation at a resort? Describe.
- What other ways might invasive species affect people's finances?

Assessment Tools

- Group participation and class presentations
- Student Pages "Resort Budget" and "Resort Budget Explanation"
- Journal entries

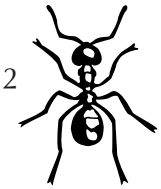


Teacher Version

Resort Budget - Sample Answer Key

(for Control Strategy A "Do Nothing" with "Maui County Council" Wild Card)

	Base - Annual	*Revision due to Coqui*	*Midyear Revision*
Revenue			
200 rooms x $300 x 365 x occupancy	100% occupancy 21,900,000	(80% occupancy) 17,520,000	
Food & Beverage (and other)	5,000,000	4,600,000	
Revenue Subtotal:	26,900,000	22,120,000	
10% tax (based on revenue listed above)	2,690,000	2,212,000	
Add Total Revenue:	29,590,000	24,332,000	
Expenses			
(Expenses in bold are fixed; they stay the same regardless of occupancy.)			
7.25% Occ tax	1,587,750	1,270,000	
4% GE tax	1,183,600	973,280	
Management Staff	**2,700,000**	**2,700,000**	
Housekeeping	2,200,000	2,156,000	
Landscaping/Engineering	**1,000,000**	**1,000,000**	
Reception, Bell Desk, Valet	2,200,000	2,156,000	
Utilities	1,900,000	1,862,000	
Laundry	420,000	411,600	
Pool Cleaner	**50,000**	**50,000**	
Phone and Internet	**125,000**	**125,000**	
Property Insurance	**900,000**	**900,000**	
Property tax ($12 per $1,000 of assessed value)	**1,000,000**	**1,000,000**	
Food & Beverage and Other (Sales, Administration)	3,000,000	2,940,000	
Marketing Expenses	**1,000,000**	**1,000,000**	
County fine			10,000
Outside company to spray citric acid $200 per hour @ 25 hours			5,000
Add Total Expenses	19,266,350	15,388,080	30,388,080
Net Income or Loss (Total revenue minus total expenses)	10,323,650	8,943,920	-6,056,080



Teacher Background
Wild Cards

Cut out the following wild cards. Midway through class, pass out one card to each student group. The letters correspond to the strategies they chose initially. For example, if they chose A) Do Nothing, they should respond to the A) instruction on their wild card. Tell them to revise their budget accordingly for the second half of the year. When they are complete, they will present their budgets and the reasoning behind their choices to the class.

Maui County Council has passed legislation making it illegal to harbor frogs on your property.

A or E: Choose another strategy and pay the County $10,000 in fines.

B or C: No change in budget.

D: Choose another strategy and pay the County $500 in fines.

TripAdvisor reviews condemn hotels with frogs, describing horrors of sleepless nights.

A: Reduce your occupancy revenue by 50 percent.
B or C: Increase occupancy revenue by 25 percent. Guests are booking rooms at your hotel, rather than at those infested with coqui.
D: No change in budget. Since your strategy keeps the frog population down but does not eliminate it entirely, you don't lose revenue, but you don't gain any either.
E: Reduce your occupancy revenue by 30 percent; some of your advertising in favor of frogs was effective.

Landscaping department plants areca palms infested with frog eggs.

A or E: No change in budget.

B: Pay employees $600 to re-treat.

C: Pay outside company $1,000 to re-treat.

D: The children's camp is overwhelmed and can't keep up with the growing frog population. Choose a new strategy and balance budget accordingly. (Include the expenses for both strategies.)

Coqui frogs become accepted.

A, B, C, or D: Reduce revenue by 5 percent. While most guests have come to accept another pest, some still can't sleep with frog noise and stop coming to Hawaii altogether.

E: Increase revenue by 5 percent; now that people accept the frogs, your hotel is well positioned to be a tourist attraction.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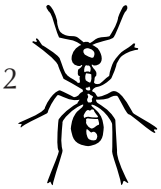

Brown tree snakes invade Maui.

A or E: Now that Maui is crawling with snakes, nobody cares about the frogs, right? Wrong. Snakes feed on coqui and promptly infest your property. People are terrified to bring their children to your resort. Reduce occupancy by 85 percent.

B or C: No change in budget.

D: The camp counselors refuse to catch snakes and quit. Choose a new strategy.

Neighbors sue when frogs infest their property.

A or E: Pay $150,000 in legal fees, plus the cost of professional treatment (Control strategy C).

B or C: You don't have frogs; no change in budget.

D: You have a few frogs, but not enough to warrant a lawsuit. The judge dismisses the case. Pay $500 in legal fees.

Coqui frogs bring property values down; investors back out.

A: Go bankrupt.

B or C: You don't have frogs; no change in budget.

D: You have frogs, but in small enough numbers that they can be still be effectively controlled. Choose a new strategy.

E: Sell your company for a loss to frog researchers from Puerto Rico.


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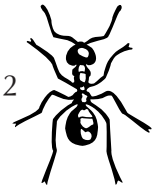


Frogs on Floor Four!

You own a ten million dollar resort on Maui with two hundred rooms that go for $300 per night. Your average occupancy is 100 percent. While you are creating the hotel's annual budget, an employee informs you that the property has a small but growing infestation of coqui frogs. You've heard that coqui frogs are causing problems on the Big Island—driving away customers looking for a quiet nights' sleep and reducing the value of the real estate.

You ask your managers to come up with several strategies in response to this news. It's your job to maintain a profitable resort. Choose the strategy you feel will best protect your financial interests. Revise the base budget on the resort budget worksheet to reflect your choice.

Coqui Frog Response Strategies

A. Do nothing

Direct cost:
Twenty percent lower occupancy rate due to guests who refuse to put up with noise
Potential cost:
Continued drop in occupancy as reputation for sleepless nights builds, diminished property value, legal battles

B. Train employees to spray citric acid

D*irect costs:*
$20 per hour @ 50 hours
$4,000 for training manuals, equipment and safety gear
$1,000 for citric acid
Potential cost:
Medical expenses in case of employee injury, re-treatment

C. Hire outside company to spray citric acid

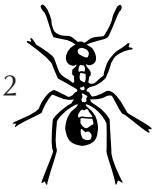
Direct cost:
$200 per hour @ 25 hours
Potential cost:
Re-treatment

D. Use children's camp attendees to catch frogs

Direct cost:
$25 per hour @ 4 hours to train camp counselors how to catch and dispose of frogs
5 percent lower occupancy rate due to guests who refuse to put up with noise
Potential cost:
Ineffective; reduced occupancy; diminished property value

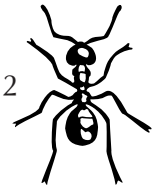
E. Develop PR campaign celebrating frogs

Direct cost:
$3,500 for a marketing campaign: brochures, advertisements and radio spots
$30 per hour @ 40 hours for extra marketing staff
Potential cost:
Legal battles



Resort Budget

	Base - Annual	*Revision due to Coqui*	*Midyear Revision*
Revenue			
200 rooms x $300 x 365 x occupancy	100% occupancy 17,520,000		
Food & Beverage (and other)	5,000,000		
Revenue Subtotal:			
10% tax (based on revenue listed above)			
Add Total Revenue:			
Expenses			
(Expenses in bold are fixed; they stay the same regardless of occupancy.)			
7.25% Occ tax	1,270,200		
4% GE tax	2,700,000		
Management Staff	**2,700,000**	**2,700,000**	
Housekeeping	2,200,000		
Landscaping/Engineering	**1,000,000**	**1,000,000**	
Reception, Bell Desk, Valet	2,200,000		
Utilities	1,900,000		
Laundry	420,000		
Pool Cleaner	**50,000**	**50,000**	
Phone and Internet	**125,000**	**125,000**	
Property Insurance	**900,000**	**900,000**	
Property tax ($12 per $1,000 of assessed value)	1,000,000		
Food & Beverage and Other (Sales, Administration)	3,000,000		
Marketing Expenses	**1,000,000**	**1,000,000**	
Add Total Expenses			
Net Income or Loss (Total revenue minus total expenses)			



Resort Budget Explanation

General Manager: _____
Administrative Assistants: _____
Secretary: _____
Public Relations Spokesperson: _____

Strategy your group chose:

_____

Why:

_____
_____
_____
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_____

Midyear revisions:

_____
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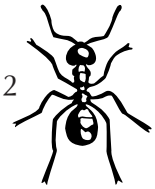
A Most Unwanted Neighbor - Coqui Frogs

From The Maui News
March 14, 2010 - *Kia'i Moku* by Adam Radford

A recent trip to Hilo highlighted the impact coqui frogs can have on our quality of life. It was not just the chorus heard throughout town and in my hotel room, but the fact that they could be heard while having dinner, enjoying a beach park and hiking through native forests. They're everywhere. Recent estimates indicate that coqui have infested more than 60,000 acres of East Hawaii, from the ocean to 4,000 feet in elevation. With Hawai'i County now planning to liquidate its coqui-control equipment, this noisy neighbor seems to have become a permanent resident on the island of Hawai'i.

My work creates many opportunities to talk about coqui, and I am often asked why they are perceived as a nuisance in Hawai'i when they are beloved in their native home of Puerto Rico.
One consideration is that they have no natural enemies here and can reach population densities more than twice that of their native range. This may cause significant problems for native insects (which they eat), change soil composition to the benefit of non-native plant species and compete with Hawaii's native birds for food. Possible economic impacts in infested areas include diminished property values and sales, a change in the quality of visitor experiences due to their persistent nocturnal calls and decreased sales in the floriculture and nursery industry.

During my short visit to Hilo, I learned that a colleague with deep ties to Hawai'i agriculture was facing the prospect of moving and foregoing personal professional opportunities, primarily because



of the coqui. These experiences strengthened my motivation to keep coqui from becoming widely established on Maui.

Coqui are believed to have been introduced to Hawai'i by hitchhiking on plants or associated products in the late 1980s. Since then, coqui have shown up on most of the main Hawaiian Islands, in California, and Guam on plant shipments. This is still the primary avenue for dispersal, particularly from heavily infested areas. To help minimize the risk of introducing coqui to your neighborhood, the Maui Invasive Species Committee started a coqui-free certification program. The voluntary program encourages plant industry participants to adopt specific practices to reduce movement via the nursery trade. If you see a business designated as "coqui-free," you can feel confident that you will not be purchasing coqui along with your plants or plant products.

Like the Big Island, Maui has coqui. Unlike the Big Island, Maui has only six infested areas, which cover an estimated 227 acres. Eleven population centers (areas with five or more calling males) have been removed since 2004. Five others have very low numbers of coqui. Really, only one substantial population remains. Maui has kept populations from becoming established by quickly responding to reports of new coqui locations. Although new introductions from infested areas are a constant concern for Maui residents, quickly identifying and capturing a few rogue males typically prevents a couple of coqui from becoming thousands. Left unchecked or unreported, coqui populations on Maui would be sure to rival East Hawai'i at some point.

In Hā'iku, for example, an area that once had low numbers of coqui has now spilled over into a steep-sided gulch. Efforts have begun to remove coqui from the 225-acre area by applying a 12 to 16 percent solution of citric acid (a food additive). But challenging terrain and trying to work at night (when coqui are most active) have demanded the development of creative citric application tools. These include fixed-line sprinklers, high-volume sprayers and even limited use of a helicopter in inaccessible areas. Although daunting, successful control efforts over the last four years have shown that the key to preventing coqui from permanently establishing is early detection of new locations, repeated systematic treatment of known populations and removal of frog-friendly habitat.

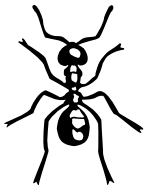
Unfortunately, even the combined resources of state and county agencies on Hawaii, as well as regular outings by community-based coqui control groups, have been no match for the coqui.

On Maui, we only have one large population left. We still have a strong chance to become and remain coqui-free. Please help by calling the Maui Invasive Species Committee at 573-MISC (6472) if you happen to hear a coqui frog.

More information about the coqui-free program can be found at www.coquifreemaui.org.

** Adam Radford is the vertebrate operations supervisor for the Maui Invasive Species Committee. He manages MISC's efforts to control invasive animals and banana bunchy top virus.*

http://www.mauinews.com/page/content.detail/id/529537/A-most-unwanted-neighbor---coqui-frogs.html



Activity #4

Plagues: Past and Present

Length:
Two class periods

Prerequisite Activity:
None

In Advance:
Order Glo Germ™ powder and ultraviolet light for Class Period Two. (Glo Germ™ powder and light can be purchased from: www.hdd.net/cgi-bin/glogerm/hazel.cgi, www.amazon.com and www.glogerm.com. A two-ounce bottle will last several years.)

Optional:
Assign parts for the reader's theater a day or two before class to allow students to practice. Have students read Student Pages "Plague On Our Shores" and highlight their parts.

Objectives:
- Investigate the impact of alien plants, animals, invertebrates, and pathogens on human health and public safety.
- Explore the historic outbreak of bubonic plague in Hawai'i.
- Create an action plan in response to a potential epidemic of rat lungworm disease.

Vocabulary:

Bubonic plague	Larvae	Pathogens
Contaminated	Lymph node	Quarantine
Epidemic	Meningitis	
Epidemiology	Parasitic	

● ● ● Class Period One: *Bubonic Plague in Hawai'i*

Materials & Setup

For each student:
- Student Pages "Plague on Our Shores" script and worksheet (pp. 45-53)

Note: If you have extra time, you can assign the script as homework and allow students practice their roles before performing in class. They can bring props and costume elements from home, such as police or firemen's hats, doctor's coats, brooms (which can double as rifles), plastic or plush rats, and fire hose.

The slideshow "Bubonic Plague in Honolulu 1899" is included with this curriculum and available for download at www.hoikecurriculum.org. It duplicates much of the information in the "Plague on Our Shores" script but includes historic photos of the events. If you think your students will have a hard

time following the script, or want to present the information in a visual format, you can show this slideshow as a precursor to their reader's theater.

Instructions

1) Use information provided in the Teacher Background "How Invasive Species Can Endanger Public Health and Safety," to lead a brief discussion on the topic.

2) Direct students in a reader's theater performance of "Plague on Our Shores." Use the Teacher Background "Readers' Theater Tips" as a guide. Break students into groups of five. Each group will perform one act of the play.

3) Pass out the Student Page "Plague on Our Shores Worksheet" and have the students in the audience to assume a role while listening. They can choose from: ship captain, ship passenger, doctor, epidemiologist, Chinese merchant, Hawaiian landlord, lawyer, fireman, church pastor, schoolteacher, pregnant mother, plague victim, crematorium operator, or other relevant characters. They will discuss their various characters' reactions to the play at the end of class.

4) In addition to noting their characters' reactions, instruct students to listen for a) steps the Department of Health took to prevent the spread of the disease, b) what kind of resistance those steps were met with, and c) long-term effects of the bubonic plague outbreak in Hawaii. They will record their answers on the Student Page "Plague on Our Shores Worksheet."

5) Discuss worksheet answers as a class.

● ● ● Class Period One: *Responding to a Public Health Emergency*

Materials & Setup

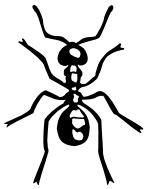
Glo Germ™ powder
Ultraviolet light
Teacher Copy Master "Symptom Cards" (pp. 43-44)

For each student:
- Student Pages "Disease Diagnosis Chart" (pp. 54-55)
- "Rat Lungworm Disease Fact Sheet" (pp. 57-59)

For each group of students:
- Student Pages "Rat Lungworm Disease Response Strategy" (pp. 56-67)

Instructions

1) Before class, smear a light coating of Glo Germ ™ powder onto five students' desks or chairs. (Alternately, apply it to your own hand and choose students to shake hands with.) Do not tell the students. This invisible powder is meant to simulate the slime trail of a slug infected with rat lungworm parasites.



2) Review the material covered in class period one regarding how invasive species can endanger public health.

3) Tell students that members of their class have been infected with imaginary cases of a disease spread by invasive species. They will spend the rest of class working as a team to respond to this public health crisis.

4) Turn the overhead lights off and have students pass their hands under the ultraviolet light. The students with glowing hands are ill. Give the "sick" students symptom cards (Copy Master "Symptom Cards"), which they keep private from the other students. Tell the class that the students became ill after sharing a picnic lunch. At first they thought it was the flu or food poisoning. But when the symptoms didn't disappear after a day, they suspected something more serious and went to the emergency room. Now it's up to the class to diagnose their sick classmates and protect the public from an epidemic.

5) Pass out the Student Page "Disease Diagnosis Chart." Students will take turns asking their "sick" classmates questions from the chart to determine what illness they are all suffering from. By process of elimination, the class will agree on a diagnosis.

6) After the correct diagnosis is made (rat lungworm disease), show the short video on rat lungworm disease. http://animal.discovery.com/tv-shows/monsters-inside-me/videos/the-rat-lungworm.htm

7) Pass out the Student Pages "Rat Lungworm Disease Fact Sheet," to each student and read aloud together.

8) Break students into 4-5 groups to devise response strategies. Tell them to record their groups' answers on Student Page "Rat Lungworm Disease Response Strategy."

9) Go over worksheet answers in class.

Journal Ideas

- Speculate how cultural differences affected the spread of the plague. Might things have been different if the outbreak had started in the missionary or native Hawaiian communities?
- What would be different if an outbreak of plague occurred today?
- Rabies is another example of a disease spread by invasive species. Write a few paragraphs about how life in Hawai'i would be different if rabies were present here. If you don't know what rabies infections are like, ask your classmates, teacher, and friends if they have lived an area with rabid animals.

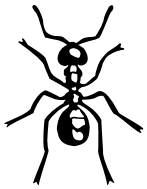
Assessment Tools

- Participation in readers' theater and class discussion
- Participation in class activity: disease diagnosis
- "Plague on Our Shores" and "Rat Lungworm Response Strategy" worksheets
- Journal entries

Further Enrichment

- Show the students the video, Secrets of the Black Death by Nature Video available on YouTube: www.youtube.com/watch?v=pRZYb2Jl22g

- Have students research current public health and safety plans currently for Hawai‘i. They can contact the Hawai‘i Department of Health Maui Bioterrorism Preparedness Branch at 808-243-8640 or visit www.hawaii.gov/health



Teacher Background

How Invasive Species Can Endanger Public Health and Safety

What is an invasive species?

- A nonnative species that directly preys upon or outcompetes native species for resources

- An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health

What types of organisms can be invasive?

- Plants
- Animals, including: birds, fish, reptiles, amphibians, mammals
- Insects
- Plant diseases
- Animal diseases

What are some ways that invasive species might affect public health and safety?

- Plants have toxins and can poison people or animals. Examples in Hawai'i: Fireweed (*Senecio madagascariensis*) is toxic to livestock and is widespread on several islands. Rubber vine (*Cryptostegia grandiflora*) has sap that burns skin and causes respiratory problems. It is contained on Maui, but is problematic on Molokai.

- Plants can create safety hazards, such as unpassable thickets. Examples in Hawai'i: Gorse (*Ulex europaeus*) is a thorny shrub that infests Maui ranchlands, restricting the ability of humans and livestock to move through areas. Tumbleweed (*Salsola tragus*) is a noxious pest that disrupts traffic when it rolls across rural roads.

- Plants can spread wildfires. Examples in Hawai'i: Fountain grass (*Cenchrus setaceus*) is fire-adapted, meaning it provides fuel for fires and readily re-sprouts after a fire. It is contained on Maui, but covers many acres on the island of Hawai'i.

- Animals can bite humans. Examples in Hawai'i: Venomous snakes, big cats, monitor lizards, piranhas have all been reported on Maui, though none of these alien species are known to be established here.

- Insects bite or sting humans. Examples in Hawai'i: Mosquitoes, centipedes, scorpions, brown recluse spiders, little fire ants, and stinging nettle caterpillars attack humans, causing varying degrees of pain or allergic response. All of these species are alien, introduced pests.

- Animals and insects can damage agriculture. Examples in Hawai'i: Because of the Mediterranean fruit fly (*Ceratitis capitata*) infestation, Hawai'i cannot export many valuable fruit crops and must bear the expense of costly inspections. Nurseries and farms

infested with little fire ant (*Wasmannia auropunctata)* and coqui frog (*Eleutherodactylus coqui*), have to decontaminate their products before selling. Employees at orchards on the island of Hawai'i have quit due to little fire ant infestations. Axis deer (*Cervus axis*) devastate corn and pineapple fields and eat valuable pasture meant for cattle, costing farmers and ranchers hundreds of thousands of dollars each year.

- Plant diseases can damage agriculture. Examples in Hawai'i: Banana bunchy top virus and papaya ringspot virus can devastate entire crops.

- Insects carry diseases that affect humans. Examples in Hawai'i: In 1899, fleas infested with bubonic plague bit rats and humans in Hawai'i, resulting in the quarantine and eventual burning of Chinatowns in Honolulu and Kahului and numerous deaths. Recently, several outbreaks of dengue fever, which is spread by mosquitoes, infected many people on Maui. Malaria, a potentially fatal mosquito-borne disease, has not been reported in Hawai'i, primarily because the mosquito species (*Anopheles* spp.) that carries the disease is not found here—yet.

- Animal diseases can affect the human population. Feral animals such as deer carry giardia, which can infect humans and other animals that drink contaminated water or eat feces. Cats and birds carry toxoplasmosis, which can infect humans who come in contact with the animals' feces. Typhus and bubonic plague are carried by mice and other animals, and are spread to humans through fleabites. Rat lungworm multiplies in rats and is spread to humans via snails and snail slime. Swine flu, bird flu, and rabies are potential threats.

  Infectious human diseases fall under the purview of the federal Center for Disease Control and the state Department of Health. When the diseases involve livestock, birds, or wild animals, natural resource managers have a role to play in halting the spread.

What is Rat Lungworm Disease?

The rat lungworm can cause a disease called angiostrongyliasis (rat lungworm disease) which can affect the brain and spinal cord. Symptoms may include severe headache, stiffness of the neck and back, skin tingling and sensitivity, sensitivity to light, hallucinations, nausea and vomiting.

Cuban Slug

Semi Slug

Foods such as raw produce, raw or undercooked snails, freshwater prawns, crabs and frogs can be contaminated by an unseen parasite *Angiostrongylus cantonensis (rat lungworm).* Fish do not spread this parasite. The rat lungworm is found most often in snails and slugs and has also been found in the flatworm. The worm infects rats, which pass the parasite to snails, slugs, freshwater prawns, crabs and frogs, not humans.

Baby Semi Slug on nickel

Giant African Snail

Prevention

DO NOT eat raw foods contaminated with the slime* from snails or slugs or visible snail or slugs. *WASH PRODUCE* completely and boil snails, freshwater prawns, crabs, and frogs for *AT LEAST 3-5 MINUTES*. Do not handle snails and slugs with bare hands. Apply slug bait to eliminate slugs from your garden. Cover your catchment tanks to prevent slugs and snails from having access. Controlling rodents can also help control the rat lungworm. *If you think you may have angiostrongyliasis, see your health care provider and let him/her know of your exposures.*

**Scientists are not sure whether exposure to slime can make you sick*

For more information call the Hawai'i District Health Office Disease Investigations office: 808-933-0912 or see CDC website: http://www.dpd.cdc.gov/DPDx/HTML/Angiostrongyliasis.htm

Hawai'i State Department of Health
Disease Investigation Branch
Chiyome L. Fukino, Director of Health
Linda Lingle, Governor of Hawai'i

January 29, 2009

Teacher Background

Readers' Theater Tips

Tell students that they will be performing a dramatic re-enactment of real-life events that happened in Honolulu in 1899. Encourage them to act with flourish. Their classmates will depend on their actions to know what is happening.

Tell students that an effective reader….

- Reads with expression
- Enunciates, using his/her voice effectively to convey meaning
- Faces the audience and projects his/her voice
- Shows emotion
- Uses props, when appropriate (the script can be a prop)

Almost everyone will get a chance to die. They should maximize their turn to shine in the spotlight. Show emotion! Die in agony! After dying, they should stand up to read their next lines.

Divide class into groups of five students. Each group will perform an act. After each act, use the talking points below to go over what happened. Students should listen carefully so they can fill in their worksheets as the play unfolds.

Talking points:

Act I: The Infection

What happened in this act?

A freighter unloaded cargo at Honolulu wharf. Large numbers of rats died. You Chong contracted plague.

How did You Chong contract the plague?

From a fleabite.

Have you ever heard of bubonic plague before? Did you know that it came to Hawai'i?

The next act explains the history of this dreaded disease.

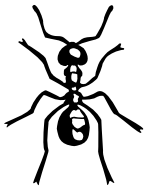
Act II: History of the Black Death

What happened in this act?

Three waves of bubonic plague struck: first in Constantinople (now called Istanbul, the largest city in Turkey), then Europe, and finally in Asia. The European epidemic killed a third of the population—40 million people. Scientists investigated the cause of the disease. Four more people died in Chinatown. Health inspectors visited Chinatown and found filthy conditions, perfect breeding grounds for the plague.

Who lived and worked in Chinatown?

Chinese and Japanese rented from Hawaiian and *haole* landowners.



Did scientists know how the plague is spread at this time?

No. They knew rats caught the disease, but they did not know how it spread from rats to humans.

What is the plague and how is it spread?

Plague is a bacterial disease caused by *Yersinia pestis*. Rats, wild rodents, cats, and dogs can become infected with plague, which is then spread by fleas. Humans can contract plague if bitten by infected animals or fleas.

Listen to the next act for examples of how the Hawai'i Board of Health responded to this crisis.

Act III: Rapid Response

What happened in this act?

The Board of Health quarantined Chinatown, built a hospital, camp, and crematorium. They deputized citizens to search for plague victims. They raided private homes and sanitized them with lime. They burnt peoples' belongings and built new toilets. They closed schools and halted marine traffic. They charged taxes on imported goods to pay for all of the quarantine measures. Under pressure, they lifted the quarantine.

What is lime?

Quicklime is calcium oxide, a powerful disinfectant made by burning limestone. It is strongly alkaline and destroys pathogenic microorganisms. It is rarely used today because of its hazardous side effects. It is extremely caustic and causes skin burns and respiratory inflammation.

Closing the port of Honolulu in that era would be like closing the airports today. Can you imagine what would happen if all airline flights to the Islands were canceled? Who would be inconvenienced? If quarantine lasted for more than a few days, how would people get food and supplies? What would the general atmosphere be like in a quarantine zone, where no on could leave and no new supplies could be delivered?

How long was quarantine in effect?

Seven days, from Dec 12 to Dec 19, 1899.

Why did the Board lift the quarantine?

Chinatown residents wanted freedom and fresh supplies. Business owners wanted to do business. Ship captains wanted to move on.

Do you think they should have lifted the quarantine?

The next act will reveal whether the choice was a good one.

Act IV: The Great Chinatown Fire

What happened in this act?

The Board of Health reinstated the quarantine and burned contaminated houses and shops down. The Chinese community bore the brunt of the property damage and felt unfairly targeted. Dozens more people died of plague. A controlled burning spread to a nearby church. All of Chinatown caught on fire. Police prevented people from leaving the quarantine zone, even though it was burning down around them.

Imagine what it would feel like to be trapped in a quarantine zone where your neighbors were dying of a horrific disease. Consider how it would feel if all of your privacy was stripped and your belongings thrown into the street and burnt. Then imagine your home catching on fire. You aren't allowed to leave. How would you feel? Now consider it from another perspective: how would you feel if you were on the outside looking in?

Did the Board of Health need to burn peoples' belongings and houses? Why?

No. The plague is spread by fleas and infected rodents. If they controlled the fleas, they wouldn't have had to place people in quarantine or destroy their possessions.

The Board of Health did the best they could with the information they had at the time. Still, their actions had major consequences for the people living in Honolulu.

Act V: An End to the Plague—We Hope

What happened in this act?

Four thousand people were trapped in a stone church while Chinatown was burned to the ground. No one died, but many were homeless. The fire burned the plague-infested fleas and rats as well. Because the quarantine was lifted too early, ships carried the plague to other islands. The Chinese population in Hawai'i dropped from 20 to 5 percent.

Why did the Chinese population drop?

Their homes and businesses were destroyed. They probably felt angry at how they were treated and scared that they might be treated that way again. Most likely they moved to other cities with large Chinese communities.

Does plague still exist?

Yes.

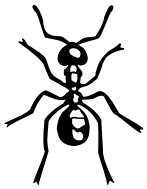
Does it kill people?

Very few. It can now be treated with antibiotics.

Could it be deadly again in the future?

Yes, the disease could mutate into an antibiotic resistant strain.

What did you learn about epidemics and invasive species from this lesson? What did the Board of Health do well? What could they have done better? Remember this, because tomorrow you will be reacting to an imaginary epidemic in your classroom!



Teacher Version

"Plague on Our Shores" Worksheet - Answer Key

As an audience member, what character were you?

Describe your reactions to:

Act I: [Accept any reasonable response; students will be missing answers for the act they perform in.]

Act II:

Act III:

Act IV:

Act V:

List at least five steps the Department of Health took to prevent the spread of the bubonic plague in Honolulu.

Answers include:

- Quarantined Chinatown;
- Built temporary hospital, camp, and crematorium outside of town at Sand Island;
- Sent anyone with signs of plague to the temporary hospital;
- Sent anyone who had been in contact with plague victims to the temporary camp;
- Closed schools;
- Deputized a volunteer brigade of private citizens to locate plague cases and infected premises;
- Disinfected houses with lime; destroyed toilets and dug new cesspools; burnt belongings and rubbish;

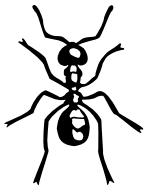
- Closed the port of Honolulu to both incoming and outgoing vessels;
- Forbade any vessel to leave Honolulu Harbor without the prior clearance from the Board of Health;
- Cancelled shore leave for mariners and passengers aboard vessels anchored offshore;
- Ordered all offshore ships to stay offshore, declared them plague-free as long as no contact was made with the shore and no human case of plague developed onboard ship within seven days;
- Ordered all foreign ships already docked at the wharf to move a minimum of six feet away from the dock, grease mooring lines, and attach rat-guards on lines anchored to the shore;
- Exchanged cargo via shuttlecrafts to minimize contact with land;
- Loaded export cargo under the strict supervision of a Board of Health inspector, to insure that it was plague-free;
- Taxed imports to defray quarantine costs. Used tax monies to combat rats;
- Burned infected homes and stores.

What kind of resistance did the Department of Health encounter?

- People resisted quarantine;
- Chinese people accused the Department of Health of racism;
- Shop owners demanded compensation for destroyed goods;
- Business interests demanded the re-opening of the harbor.

What long-term effects did the bubonic plague outbreak have on Hawai‘i?

- 337 people died;
- Chinatowns on O‘ahu and Maui were destroyed;
- Local businesses lost revenue or closed permanently;
- Chinese population dramatically declined, from 20 percent of the total population to less than 5 percent.



Teacher Version

Rat Lungworm Response Strategy - Answer Key

Are quarantine measures for sick patients required? Why or why not?

No, the disease is not contagious nor spread by human-to-human contact.

Do any invasive species need to be controlled? If so, which ones? What methods will be used to control them?

Rodents and slugs should be controlled, particularly the semi-slug *Parmarion martensi*. Rat traps and slug bait could be dispersed to areas where those animals occur. Biological controls for the semi-slug could be explored.

What kind of expertise do you need to respond to this emergency? Which agencies need to be involved?

Expertise could include: knowledge of how diseases spread (epidemiology), knowledge about slugs and rats.
Agencies could include: Hawai'i Department of Health; Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife; Invasive Species Committees on each island; pest control companies; media outlets: radio, T.V., and newspapers.

What kinds of decontamination procedures are necessary?

Regularly disinfect cooking surfaces, utensils, toothbrushes, and any areas that might be infested with slugs.

Inspect and wash fruits and vegetables before eating.

Examine produce before washing. Remove any dirt, debris, insects, snails or slugs, and discard leaves that might have been damaged by snails or slugs. Clean raw vegetables and fruits well before peeling, cutting, eating, or cooking. Wash produce under a cold-water spray and then soak it in distilled water for 1-2 minutes. Use a vegetable brush for produce with thick skin (melons, cucumbers, winter squash, citrus, potatoes). Waxy-skinned citrus fruits and cucumbers also may have pathogens sticking to the outside peel. With bunched fruit (blueberries, grapes, raspberries, strawberries, and similar fruits) spray or rinse in a colander with cold water. Remove all visible dirt and blot dry with a paper towel.

Use protective gear (gloves and/or tongs) when handling infected rats, slugs, or other animals.

Dispose of infected rats, slugs, and other animals. (Seal slugs in a plastic bag so that their slime will not be spread.)

List equipment that will be needed:

rat traps
slug bait
gloves
plastic bags

What is your general plan? Describe steps to be taken.

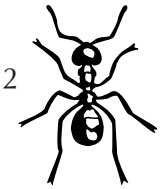
Control rats and slugs
Wash produce and cooking surfaces/implements
Inform public about threat, recommend prevention methods

When and for how long will the plan be implemented?

Indefinitely

What information will be shared with the public? How and when will the public be alerted?

Basic information about the disease, how it spreads, and prevention methods should be shared with the public. Public should be notified immediately. Press releases should be sent to local newspapers and T.V. and radio stations.



Symptom Cards

Student 1:

After sharing a picnic lunch of fried chicken, organic green salad, and fruit salad, you and your friends all reported feeling sick. At first you thought it was food poisoning. But when the symptoms didn't disappear after a day, you suspected something more serious.

Your symptoms:

- **Severe headaches**
- **Skin tingling and sensitivity**

Student 2:

After sharing a picnic lunch of fried chicken, organic green salad, and fruit salad, you and your friends all reported feeling sick. At first you thought it was food poisoning. But when the symptoms didn't disappear after a day, you suspected something more serious.

Your symptoms:

- **Severe headaches**
- **Vomiting**

Student 3:

After sharing a picnic lunch of fried chicken, organic green salad, and fruit salad, you and your friends all reported feeling sick. At first you thought it was food poisoning. But when the symptoms didn't disappear after a day, you suspected something more serious.

Your symptoms:

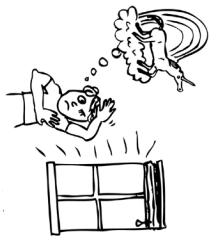
- **Stomach cramps**
- **Muscle spasms**

Student 4:

After sharing a picnic lunch of fried chicken, organic green salad, and fruit salad, you and your friends all reported feeling sick. At first you thought it was food poisoning. But when the symptoms didn't disappear after a day, you suspected something more serious.

Your symptoms:

- **Sensitivity to light**
- **Hallucinatins**

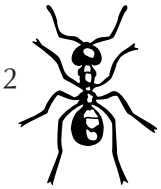


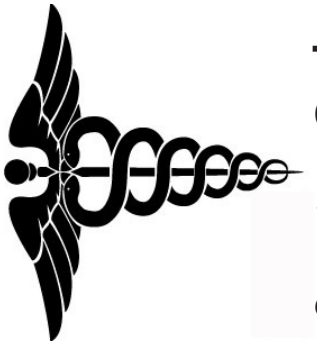
Student 5:

After sharing a picnic lunch of fried chicken, organic green salad, and fruit salad, you and your friends all reported feeling sick. At first you thought it was food poisoning. But when the symptoms didn't disappear after a day, you suspected something more serious.

Your symptoms:

- **Severe headaches**
- **Inability to urinate**

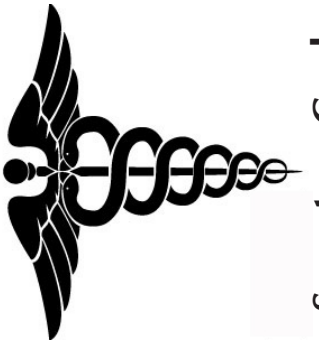




Symptom Card

Symptom Card

Symptom Card



Symptom Card

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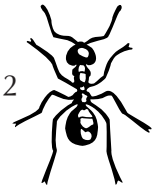


PLAGUE ON OUR SHORES

The outbreak of plague in 1899 was one of the most dramatic public-safety disasters in Hawaiian history. Two invasive species were responsible for the spread of this terrifying disease: rats and fleas.

(Stage directions indicated in CAPITALS.)

Act I: Infection

ACTOR A: On Oct. 20, 1899, the freighter America Maru unloaded rice and other foodstuffs at the wharf in downtown Honolulu. The cargo sat on the pier for a few weeks.

ACTOR B: As December rolled around, dockworkers began noticing wharf rats behaving strangely.

ACTOR C: The rodents were venturing out in the daylight, and dying in agony. Not just a few. Hundreds of rats littered the pier.

ACTORS A, B, C, & E: IMITATE RATS; STUMBLE AND DIE IN AGONY.

ACTOR D: Workers shrugged and swept the dead animals off into the harbor. Good riddance.

ACTOR D: SHRUG AND SWEEP RATS AWAY.

ACTOR C: SCRATCH FLEA BITE.

ACTOR E: A few blocks away at the Wing Wo Tai grocery, You Chong scratched at a flea bite.

ACTOR A: That bite carried the bubonic plague, otherwise known as Black Death.

ACTOR B: A week after the fleabite, Chong's temperature skyrocketed to 105 degrees. Plague bacteria multiplied in his bloodstream. They settled into his liver, spleen, kidneys, lungs, and brain.

ACTOR C: SHIVER, SHAKE, CONVULSE, AND BREATHE IN GASPS.

ACTOR B: Chong began to shiver.

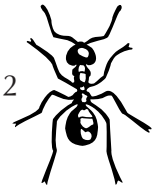
ACTOR D: His pulse raced liked a runaway locomotive. His breath came in gasps.

ACTOR E: The lymph nodes in Chong's thighs, neck, and armpits began to swell.

ACTOR C: GRAB THIGHS, NECK AND ARMPITS IN PAIN.

ACTOR A: The swellings, called buboes give bubonic plague its name. Within hours, they grow to the size of tangerines. They turn black as blood pools beneath the skin.

ACTOR B: Black Death is aptly named.



ACTOR D: Within three days, Chong died.

ACTOR C: DIE IN AGONY.

ACTOR B, D, & E: EXAMINE DEAD BODY WITH CONCERN AND HORROR.

ACTOR A: Horrified doctors examined his body. They knew that the most feared disease in human history had come to Honolulu.

Act II: History of the Black Death

ACTOR A: Black Death swept across the globe in three waves. The first pandemic, known as the Justinian Plague started in the year 541. It began in Egypt and spread throughout the Middle East and Mediterranean, killing 70,000 people—one thousand victims a week.

ACTORS A, C, D, & E: COLLAPSE AND DIE.

ACTOR B: Later, in the 1340s, a second wave of horror devastated Europe. Entire cities fell ill and died. Pyres burned without ceasing. Wagons piled with swollen bodies creaked through narrow streets.

ACTOR C: PUSH WAGON AND CRY: "Bring out your dead! Bring out your dead! Bring out your dead!"

ACTOR D: In just five years, 25 million Europeans—a third of the population—fell to Black Death. By the year 1400, 40 million were dead.

ACTOR E: The horror rattled Western culture to its core.

ACTOR A: Hawai'i was hit during the third wave of bubonic plague, which began in 1890. Over ten years, the disease infected China, Japan, India, and Southeast Asia. Twenty million people died. Eventually Black Death crossed the Pacific and flared up in San Francisco, stopping in Honolulu on its way.

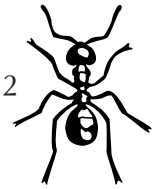
ACTOR B: By 1899, humankind had the tools of science to combat the disease. If scientists could identify what caused the Black Death and how it spread, they could stop its terrible fate.

ACTORS A, B, D, & E: FOCUS MAGNIFYING GLASS, SCRIBBLE NOTES, AND SCRUNCH EYEBROWS IN CONCENTRATION.

ACTOR C: Scientists identified the bacteria that caused plague: *Yersinia pestis*.

ACTOR D: Under a microscope, the bacteria looks like rice musubi.

ACTOR E: Scientists learned that rats contracted the disease. Large numbers of dead rats often preceded a plague epidemic in humans.



ACTOR A: But the no one knew yet that fleas spread the disease from rats to humans.

ACTOR E: Meanwhile, within hours of You Chong's death in Honolulu, four more victims were diagnosed with bubonic plague. They too died. All were residents of Honolulu's Chinatown.

ACTORS B, C, D, & E: CONVULSE, GASP, AND DIE.

ACTOR A: The Hawaii Board of Health sent inspectors to investigate Chinatown. What they found shocked them.

ACTOR B: The neighborhood was a bustling business district, but it was also overcrowded and unsanitary.

ACTOR C: More than 7,000 residents were crammed into Chinatown's fifty acres at the turn of the century, in an era when no building rose above two stories.

ALL ACTORS: SQUISH TOGETHER LIKE SARDINES.

ACTOR D: Many were Japanese immigrants renting from Chinese landlords, who in turn paid Hawaiian and haole landowners.

ACTOR E: The neighborhood was bursting with shanty buildings, chicken coops and livestock corrals.

ACTOR A: Sewage and garbage overflowed into the streets. The outdoor toilets reeked. The alleys swarmed with rats, maggots, flies, lice, and cockroaches.

ACTOR B: It was the perfect environment for the plague.

Act III: Rapid Response

ACTOR A: Board of Health officials swung into action. That same day, on Dec 12th, 1899, they quarantined Chinatown and posted guards around its edges.

ACTORS B, C, D, & E: STAND GUARD WITH IMAGINARY RIFLES.

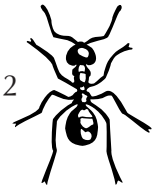
ACTOR B: They built a temporary hospital, camp, and crematorium outside of town on Sand Island.

ACTOR C: Anyone showing signs of plague was immediately moved to the hospital.

ACTOR D: Anyone who had been in contact with a plague victim was sent to live in the temporary camp.

ACTOR E: Those who died were quickly cremated.

ACTOR A: The Board deputized private citizens to locate plague victims. Deputies raided private



homes, and sprayed the insides with lime to disinfect them.

ACTOR B: They destroyed outdoor toilets, and dug new cesspools. They ordered residents to dump their rubbish and belongings into the street to be burnt.

ACTOR A: KNOCK DOWN DOOR & SEARCH FOR PLAGUE VICTIMS. ACTOR C: SPRAY LIME ON WALLS. ACTOR D: TORCH BELONGINGS. ACTOR E: DIG CESSPOOLS.

ACTOR C: Schools were closed. Marine traffic, the main artery of business in the Islands, came to a halt.

ACTOR D: The Board of Health closed the port of Honolulu to incoming and outgoing ships. No vessel could leave Honolulu Harbor without clearance from the Board.

ACTOR E: Foreign ships were ordered to stay offshore. Shore leave for sailors and passengers was cancelled.

ACTOR A: After one week, if no cases of plague developed onboard and no contact had been made with land, a vessel was declared plague-free and allowed to sail away.

ALL ACTORS: BLOW KISSES AND WAVE BON VOYAGE.

ACTOR B: Ships already docked at the wharf weren't that lucky. They were ordered to move six feet away from the dock, grease their mooring lines, and attach rat-guards on lines anchored to the shore.

ALL ACTORS: PULL ON IMAGINARY ROPES, GREASE LINES.

ACTOR C: Cargo was exchanged via shuttlecrafts, to minimize contact with land. Exports were inspected to insure that they were plague-free. Imports were taxed to pay for quarantine costs and rat extermination.

ACTOR D: A week passed without any new cases of plague in the city. Many were hopeful that the disease had been caught early enough to prevent a general outbreak.

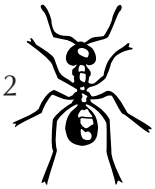
ACTOR E: Meanwhile, Chinatown residents trapped by the quarantine grew impatient. They wanted access to fresh food and supplies, and the ability to move freely.

ACTOR A: Business owners were losing money; they wanted their shops re-opened.

ACTOR B: Ship captains were anxious to get back to their home ports.

ALL ACTORS: ACT IMPATIENT, DEMAND END TO QUARANTINE.

ACTOR C: Under pressure from the business sector, the Board of Health lifted the quarantine at noon on Dec. 19th. Everyone was relieved.



ACTOR D: But…over the days leading up to Christmas, several more people died. Their terrifying symptoms could not be ignored.

ACTOR E: The Black Death was still alive in Honolulu.

Act IV: The Great Chinatown Fire

ACTOR A: The Board of Health reinstated the quarantine. This time they decided to burn down contaminated households and stores.

ACTOR B: Personal belongings and commercial goods that could be easily moved were sprayed with lime and moved to a warehouse. Everything else was burned.

ACTOR C: A government photographer took pictures of each building and its contents. Then it was set alight.

ACTOR A: TAKE PHOTOS OF BUILDINGS, ACTOR B: SET HOUSE ON FIRE.

ACTOR D: Inhabitants were forcibly moved to the hospital or detention camp.

ACTORS A & D: DRAG B & C OUT OF HOUSE. SPRAY THEM WITH LIME. IF THEY RESIST, THREATEN TO ARREST OR SHOOT THEM. TORCH HOUSE.

ACTORS B & C: RESIST QUARANTINE. SOB OVER BURNING HOUSE.

ACTOR E: Honolulu firemen sprayed nearby buildings with streams of water.

ACTOR A: Soldiers and police kept crowds in line and watched for looters.

ACTORS A & D: ACT AS SOLDIERS.

ACTOR B: Chinese residents felt unfairly targeted. They accused the Board of Health of racism and demanded compensation for their burned homes and belongings.

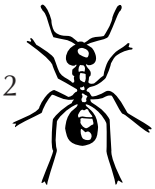
ACTOR C: Although thousands of Hawaiian and Japanese were affected by the quarantine and burnings, Chinese-owned businesses absorbed the brunt of property damage.

ACTOR D: The newspapers kept track of the burnings with maps. Lists of the dead were updated daily.

ALL ACTORS: CHECK NEWPAPERS FOR DEATHS.

ACTOR E: By late January, dozens of people had passed away.

ACTOR A: The new crematorium on Quarantine Island blazed day and night.



ACTOR B: On the morning of Jan. 20th, firemen were conducting a controlled burning when the wind scattered embers across neighboring rooftops.

ACTOR C: The wooden roof of Kaumakapili Church, the tallest building in the area, erupted into flame.
ACTOR B: Like blazing dominos, one after another, buildings began to ignite.

ACTOR C: Wetting the buildings made no difference; water evaporated instantly in the heat of the firestorm.

ACTOR D: Merchants frantically tried to drag their goods out of storefronts.

ACTORS A & B: FRANTICALLY DRAG GOODS OUT OF STORE. ACTORS C & D: STOP

ACTORS A & B WITH RIFLES.

ACTOR E: Chinatown was ablaze, and yet it was still a quarantine zone. As buildings exploded around them, police prevented citizens from fleeing.

ACTOR A: The inhabitants were trapped.

Act V: An End to the Plague-We Hope

ACTOR A: By mid-afternoon, more than 4,000 Chinatown residents were locked up on the grounds of Kawaiahao church, a stone building that survived the fire.

ALL ACTORS: HUDDLE TOGETHER LOOKING SAD AND SCARED.

ACTOR B: Luckily the flames burnt themselves out before the entire population was seized by panic.

ACTOR C: No one died in the fire, but Chinatown was reduced to ashes.

ACTOR D: As night fell, the city struggled to cope with the huge number of homeless refugees.

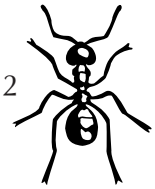
ACTOR E: There was a silver lining: the breeding grounds for rats and fleas vanished in the flames.

ACTOR B: Unfortunately, Honolulu's quarantine had been lifted prematurely. Infected ships carried the plague to the neighbor islands.

ACTOR C: Starting in January of 1900, several people on Maui, Kauai, and the Big Island contracted the plague.

ACTORS A, B, C, & E: CONVULSE & DIE.

ACTOR D: On Maui, like on Oahu, the deaths were concentrated in the Chinatown district. Officials



decided to burn the Kahului Chinatown to the ground.

ACTOR E: That kept the plague from erupting as an epidemic, but did not eliminate the disease entirely.

ACTOR A: Over the next five decades, random cases of bubonic plague would show up around the Islands.

ACTOR B: The Chinese population in Hawaii never recovered. The numbers of Chinese continued to slip over the years, from 20 percent of the population to less than 5 percent in the 1990 census.

ACTORS A, C, D, & E: PACK UP YOUR BAGS, PUT ON YOUR HAT, AND BOARD BOAT BACK TO CHINA. WAVE GOODBYE.

ACTOR B: WAVE GOODBYE TO YOUR FRIENDS & FAMILY WHO ARE LEAVING.

ACTOR C: According to a report published in the early 1930s, 337 people in Hawaii were known to have contracted bubonic plague. Only 34 survived. This 95 percent death rate is high, even for Black Death.

ACTOR D: The last human case of plague in Hawaii was documented in 1947 in Kamuela.

ACTOR E: Authorities routinely test Honolulu's wharf rats for plague, because a new outbreak could occur at any time.

ACTORS A, B, C, & D: COLLECT RATS AND TEST THEM FOR DISEASE

ACTOR A: The Black Plague still roams the earth. It is rampant in the wild rodent population of the Western United States. Infected fleas can live for weeks after their host dies.

ACTOR B: According to the National Science Foundation, bubonic plague is on the rise, as well as other rodent-borne pathogens such as hantavirus.

ACTOR C: Campers and hikers should avoid sites where animals have suddenly died en masse.

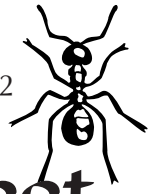
ACTOR D: In 2012, a young girl contracted bubonic plague while camping in Colorado.

ACTOR E: Luckily, no one has to die from the plague today. It can now be treated with antibiotics.

ACTOR A: But Black Death has not gone away. The plague bacterium is still part of our global environment.

ACTOR B: Out in the wild, the disease is biding its time, quietly mutating with infinite patience.

ACTOR C: An antibiotic resistant strain may one day appear on our city streets.



Plague on Our Shores Worksheet

As an audience member, what character were you? (circle)

ship captain, ship passenger, doctor, epidemiologist, Chinese merchant, Hawaiian landlord, lawyer, fireman, church pastor, schoolteacher, pregnant mother, plague victim, crematorium operator, other _____

Describe what happened in each act and your reactions:

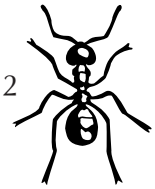
Act I:

Act II:

Act III:

Act IV:

Act V:



List at least five steps the Department of Health took to prevent the spread of the bubonic plague in Honolulu.

What kind of resistance did the Department of Health encounter?

What long-term effects did the bubonic plague outbreak have on Hawai‘i?

Rat Lungworm Disease Fact Sheet

Rat lungworm (*Angiostrongylus cantonensis*) is a parasitic worm transmitted between rats and mollusks, including slugs or snails. When humans ingest an infected snail or slug — or even the slime left by these creatures — they can contract angiostrongyliasis, or rat lungworm disease.

*Rat lungworm (*Angiostrongylus cantonensis*) larvae burrow into nervous system tissue after they are consumed by humans. Photo courtesy of: Center for Disease Control*

People react differently to rat lungworm infection. Some do not have any symptoms, and others have only mild symptoms for a brief period of time. Severe cases can result in coma, brain damage, and death.

The parasite's lifecycle: Adult worms lay eggs inside the lungs of a rat. These eggs hatch into larvae, which are then coughed up from the rat's lungs and swallowed back into its stomach. The larvae are expelled in the rat's feces, which slugs or snails (and sometimes freshwater prawns, crabs, and frogs) feed on. A second rat eats one of these parasite-infected mollusks. The parasites travel through the rat's bloodstream to mature in its lungs and the lifecycle repeats itself.

When humans accidentally consume rat lungworm larvae, the parasites cannot finish their lifecycle. They burrow into the tissue of the nervous system, including the brain. The body's immune system mounts a defense against the invasion. This response causes inflammation and swelling around the brain and the spinal cord, a condition known as meningitis. Common symptoms of meningitis include: severe headaches, skin tingling and sensitivity, stiffness in the back and neck, sensitivity to light, hallucinations, nausea, and vomiting.

Rat lungworm disease is extremely rare worldwide. It has been documented in Asia, the Caribbean, and the Pacific Islands, including Hawai'i. Cases in the continental United States have been linked to travel to those parts of the world. The parasite has likely been spread by rats on ships and by the introduction of mollusks.

Rat lungworm disease was first found on Oahu in 1958. But between 2004 and 2011, at least ten cases were reported on the island of Hawai'i. The spike in the disease corresponds to the introduction of the semi-slug *Parmarion martensi* to Hawai'i in 2004. (Semi-slugs are in between slugs and snails; they are mollusks with thin, insubstantial shells.) *Parmarion martensi* is particularly susceptible to rat lungworm infection; as it begins to dominate the slug habitat in Hawai'i, the prevalence of the disease increases.

Parmarion martensi is not yet known to be established on Maui. It is a high-priority for prevention through inter-island quarantine, along with other invasive pests such as coqui frogs and little fire ants. Like the little fire ant, the semi-slug is occasionally intercepted amidst the large quantities of cut *ti* leaves sent to Maui from the Big Island for *luau* decorations at Maui hotels.

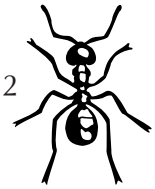
The semi-slug Parmarion martensi *is a prime carrier of rat lungworm parasites. Photo courtesy of Digital Taiwan*

Slugs can be clear and less than an inch long, making them hard to spot. Each one can carry thousands of worms. Slugs may leave parasites in their slime trails, contaminating countertops, cooking utensils, and even toothbrushes.

To prevent rat lungworm infection: Regularly disinfect cooking surfaces, utensils, and any areas that might be infested with slugs. Use protective gear (gloves and/or tongs) when handling infected rats, slugs, or other animals. Seal slugs in a plastic bag so that their slime will not be spread.

Most importantly, take time to decontaminate fruits and vegetables before eating. Examine produce before washing. Remove any dirt, debris, insects, snails, or slugs. Discard leaves that might have been damaged by snails or slugs. Clean raw vegetables and fruits well before peeling, cutting, eating, or cooking. Wash produce under a cold-water spray and then soak for 1-2 minutes. Use a vegetable brush for produce with thick skin (melons, cucumbers, winter squash, citrus, potatoes). Waxy-skinned citrus fruits and cucumbers also may have pathogens sticking to the outside peel. With bunched fruit (blueberries, grapes, raspberries, strawberries, and similar fruits) spray or rinse in a colander with cold water. Remove all visible dirt and blot dry with a paper towel.

Snails and slugs can hide in the folds of lettuce. Wash your vegetables thoroughly!
Photo courtesy of:
University of Massachusetts



Rat Lungworm Disease Response Strategy

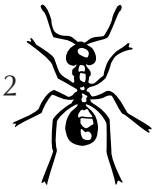
Whenever public health is threatened, government officials are expected to respond quickly and efficiently. Hopefully a response strategy has been agreed upon in advance, so that emergency staff can get to work without delay. Sometimes, as was the case with the plague, officials have to act without knowing critical details—such as how the disease was transmitted. Use what you learned about the 1899 plague epidemic to create a response strategy for a modern outbreak of rat lungworm disease.

Are quarantine measures for sick patients required? Why or why not?

Do any invasive species need to be controlled? If so, which ones? What methods will be used to control them?

What kind of expertise is needed to respond to this emergency? Which agencies need to be involved?

What kinds of decontamination procedures are necessary?

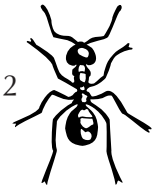


List equipment that will be needed:

What is your general plan? Describe steps to be taken.

When and for how long will the plan be implemented?

What information will be shared with the public? How and when will the public be alerted?



Disease Diagnosis Chart

A group of friends arrived in the emergency room complaining of various symptoms—some quite serious. It's too much of a coincidence that they all became sick simultaneously. You suspect that they are victims of a mysterious epidemic. Use this chart to diagnose them as a group. If any member of the group has the symptom described, assume they all could have it and proceed to the next symptom.

Question #1:
Do patients have severe headache?

YES: Could be caused by many ailments. Continue to question #2 to narrow it down.

NO: No diagnosis.

Question #2:
Are patients suffering from nausea? V omiting?

YES: Continue to question #3.

NO: Diagnosis: dehydration.

Question #3:
Are patients experiencing sensitivity to light? Hallucinations?

YES: Continue to question #4.

NO: Diagnosis: Influenza.

Question #4:
Are patients experiencing skin tingling or numbness?

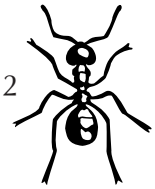
YES: Continue to question #5.

NO: Diagnosis: Possible drug overdose.

Question #5:
Do patients have severe stomach cramps and muscle spasms?

YES: Continue to question #6.

NO: Diagnosis: Migraine.



Question #6:
Do patients have diarrhea?

YES: Diagnosis: Food Poisoning.

NO: Continue to question #7.

Question #7:
Do patients have inability to urinate?

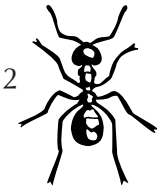
YES: Diagnosis: Meningitis, continue to question #8 to determine type and cause.

NO: Diagnosis: Viral meningitison.

Question #8:
Were patients exposed to raw vegetables?

YES: Diagnosis: Parasitic meningitis, caused by rat lungworm infection.

NO: Diagnosis: Bacterial meningitis, caused by pneumococcus.



The Silence of the Frogs

From The Maui News
April 10, 2005 - story by staff writer, Valerie Monson

MAKAWAO – In fighting the swarms of coqui frogs that can drive reasonable adults mad, one is the most frustrating number.

"It's all about people power," said Adam Radford of the Maui Invasive Species Committee (MISC), talking about the key to eradicating the thumb-sized frogs with sirens in their throats.

"It's a waste of resources when you work up to a border and you can't go any farther. We'll never get on top of this without neighborhoods and personal responsibility."

In other words, no matter how vigilant the effort of an individual who daily sprays, blasts and vaporizes the frogs on his or her property, peace and quiet can't be guaranteed until an entire neighborhood joins one way or the other.

That's what has brought together the residents of a rural enclave outside of Makawao. Because property values can wither if word gets out that frogs come with the house and lot, some of those interviewed don't want the name of their streets revealed even as the numbers of invading vertebrates have been dwindling through their coordinated attacks.

"This is probably the most organized group on Maui," said Radford, sitting in the living room of marine biologist Ann Fielding, who is happy to announce that her yard is officially frog-free thanks to her friends and neighbors. "A lot of times, you'll get one or two people who are really proactive, two or three who will be supportive but not active, and one that's not necessarily supportive and takes some convincing."

Fielding said her neighborhood "frog squad" has grown to include about a dozen regulars who show up at the group's monthly meetings and participate in hunts that take place after dark when the males of this nocturnal species let loose with their torturous calls of "ko-KEE, ko-KEE."

Not just an outlet to whine about their common problem, the frog fraternity has provided hope to those who feared they would spend the rest of their nights with earplugs and Tylenol.

"Once you hear the frogs and you know you've got them, you just think you have to learn to live with them until you realize there's a whole group that cares," said Fielding. "You realize there's support and energy."

And, already, there have been results.

"We can go out and in just a few nights we can make a big difference," said Bob Hobdy, who lives next door to Fielding – and no longer has frogs, either. "This really has become a SWAT team."

The story of the coqui frogs illustrates in horror-movie fashion how an alien species that looks as harmless as a fly can have entire communities in an uproar in less than 10 years. It wasn't until 1997 that the first ear-splitting screech was heard in Pulehu, such a strange sound that it was thought to be an exotic bird.

Nowadays, the invasion has reached the point that, in January, Big Island Mayor Harry Kim told the state Legislature his county should be declared in a "state of emergency" because of the frogs. Although Maui hasn't reached that crisis level, Maui County Mayor Alan Arakawa has asked the Legislature for $2 million to help get rid of the frogs here while it's still possible. That's in addition to $450,000 that the county grants to MISC to attack alien species in general.

A bill to help with the eradication of the frogs remains alive at the Legislature, but no dollar amount will be designated for the item until the final budget is hammered out between the two legislative houses.

However, government, like one individual, can't stop the shrieking of the frogs on its own.

"The big challenge is for people to care enough to get active themselves and not just say 'Oh, let the government do it all,'" said Hobdy.

Members of the Realtors Association of Maui have become so alarmed that they've appointed a coqui frog subcommittee.

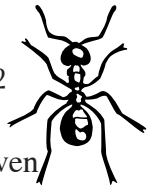
"There's already been an effect on some property values," said Terry Tolman, executive vice president of the association's board of directors. "If you were buying a piece of property and you didn't go there at night when you were in the process of buying and the first night you went to bed and heard the frogs, how would you feel? It's a big issue. There could be a major hit on property values and tourism."

Realtor Bob Hansen, who has firsthand experience with the frogs, heads up the coqui subcommittee. Hansen became acquainted with the cries because he owns a condo unit across the street from a Kihei nursery infested with frogs. Later, he heard a single coqui in the Wailea neighborhood where he lives and quickly called the president of the homeowners association. The frog was captured – and none has been heard since.

"This is something that's got to be attacked right away or we'll be just like the Big Island," said Hansen.

Tolman said Realtors must make sellers aware that they have a responsibility to let future buyers know if coqui frogs are infesting a property, just as they're required to disclose other problems.

The effects of the coqui and other invasive species on land values has become such a hot topic that Radford and state wildlife biologist Fern Duvall have been asked to address the Realtors association's general membership meeting at the end of the month to increase awareness and emphasize the serious crossroads where Maui stands.



Radford, who came to MISC last June, said neighborhood groups are essential at this juncture. Even though the number of frogs has risen slightly in the last few years, he believes that, with enough people power and funding, Maui can avoid the fate of the Big Island.

"Most sites on Maui are accessible," said Radford. "My goal is to make substantial progress by the end of this summer."

That's a pretty ambitious schedule, but Radford said the MISC staff is "really ramping up our efforts this summer" when a crew of four workers will be brought on temporarily to concentrate largely on the frogs.

While neighborhoods-in-action work the best, Radford knows that such enthusiasm for civic duty won't happen everywhere. He simply wants to get permission from property owners to give him and his colleagues access to the land to capture the frogs by hand or to spray citric acid that kills the coqui on contact.

"Sometimes it takes more than one visit (to convince the homeowner to let him work on the property)," said Radford. "The economic arguments make sense to some people when the environmental ones don't. When you talk about (declining) property values, a lot of times they say 'OK, come anytime you want.' "

If you hear frogs in your neighborhood, call Radford at 573-MISC (6472).

Fritz Bathelt, who has been trying diligently to rid his 10-acre Huelo lot of frogs for years, said he hopes homeowners will do more than just allow Radford access.

"I agree that we have a chance to eradicate them if we stay on top of things and get the frogs," said Bathelt. "But we cannot leave the responsibility to Adam alone. He can't be everywhere. People need to get the frogs when they first hear them. They need to get involved."

There might be no homeowner on Maui more dedicated to frog annihilation than Bob Flint, whose storybook house in a gulch that was once used as a stone quarry has gone from nighttime idyllic hideaway to nails-on-a-chalkboard. The amphitheater walls cause the already-shrill cries of the male frogs to echo in stereo, and the steep hillsides blanketed with vegetation forced Flint to learn to rappel up and down cliff faces to help him in his mission to stamp out the frogs.

"This is just a part of my life now," said Flint as he matter-of-factly filled a plastic backpack fogging machine with a citric acid mixture that's lethal to frogs. "Almost every night, I'm out here. The good side is the physical exercise. I guess you could say frogs are good for the heart."

But not for the peace of mind. In his zeal to weed out the frogs, Flint has tried everything known to experts and then some. He's used fungicides, sprays, a pellet gun and even once considered building a flamethrower. The recent cool, wet winter – which seems to keep the frogs quiet – gave Flint some much-needed time off.

However, with the return of spring and the upcoming dry heat of summer, Flint and the rest of the neighborhood squad know that their evenings will become a lot busier.

"I've been enjoying the cold weather," said Flint. "But the season is upon us, and I've got to get back in the mode of doing this every night."

Flint worries, though, that all his efforts might be for naught if nurseries and independent plant sellers continue to import frog-infested stock and pass them on to unsuspecting customers.

Fielding said she'd like to see nurseries given financial support to get them frog-free. Hobdy suggested that only nurseries that have been inspected and certified as frog-free be allowed to sell plants.

"If they can't sell plants because they're not certified, that will get their attention," he said.

Nancy Snow, nursery manager at Kula True Value Hardware, said she's careful to do business only with wholesale growers she's familiar with. One of the nurseries she orders from on the Big Island comes with a bill of sale that states, "all plants guaranteed to be coqui-free."

"People who order should demand that the wholesaler is frog-free or don't order from them," advised Snow.

Bob Hansen urges fellow Realtors to boycott all nurseries on the island that carry plants with frogs or frog eggs.

Fighting coqui not only affects property values, it hits the wallet in other ways. Flint said his fogging machine cost him $700 and his monthly tab for citric acid runs about $300.

Wearing a gas mask and headlamp while holding the long spray gun attached to his backpack, Flint looks more like he's ready to sign up for duty in Iraq than spend an evening flushing out frogs. "Let's nuke 'em!" he cries as he cranks up the machine.

With Flint's heavy artillery available, his neighborhood group has more weapons on hand than just spray bottles of citric acid, but Radford says those little bottles might be all that many residents need if they take action when that first screech is heard.

That's what Hobdy did.

"We suddenly had two right outside our bedroom window, but we went out and nailed them right away," said Hobdy. "I haven't had any action on my property for a few months, but you just can't let them get going. You have to keep them at bay."

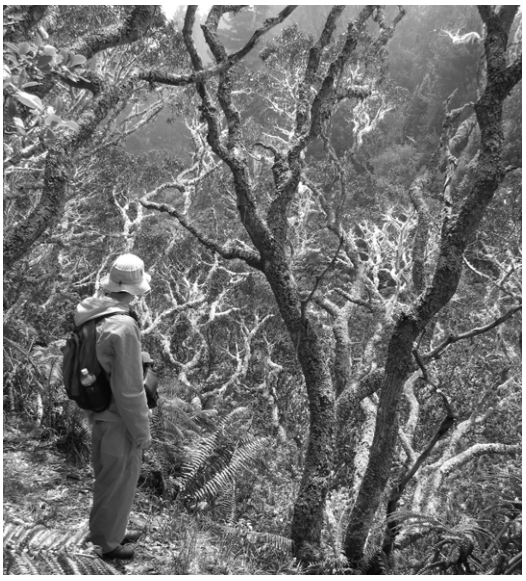
And you have to get a little help from the neighborhood.

http://www.mauinews.com/page/content.detail/id/7756/The-Silence-of-the-Frogs.html

The Many Faces of Koa

By Bob Hobdy, Photos by Forest and Kim Starr

Koa (*Acacia koa*) is the monarch of the Hawaiian forests. Its name also means warrior and brave one. With a name like this, it is no coincidence that it is the largest and most dominant tree in the forest. Its wood is one of the most beautiful in color and grain and it has great workability and stability. The Hawaiians prized it as the premier wood for canoes, and the harder dryland woods were used for tools, weapons and paddles.



Koa is also a benevolent parent tree to its smaller neighbors in the mesic forests. Its great spreading crowns are relatively open, allowing ample light to filter through for the smaller trees, shrubs and ferns in the understory, while its roots, in partnership with symbiotic rhizobial bacteria, produce nitrogen that also nourish the understory plants. Where the finest *koa* forests grow, the most luxuriant *maile* vines proliferate.

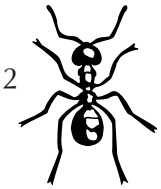
Koa is also extremely variable in stature and appearance throughout its statewide range. So much so that at one time three segregate species were recognized. High elevation trees look different than low elevation trees, and wet forest trees look different than dry forest trees. *Koa* has adapted to a wide range of habitats and changed to better survive in these habitats. As an example, the *koa* forests at high elevations (4,000-6,000 ft.) on the leeward slopes of Hawai'i and Maui have developed extremely wide leaves. These "leaves" in *koa* are actually enlarged leaf petioles called phyllodes that are thick and leathery.

These have evolved to replace the delicate bipinnate true leaves, apparently as a means for minimizing desiccation in dry climates. Typical *koa* has long sickle-shaped phyllodes 15-30 mm wide. The high elevation *koa*, however, have phyllodes 40-55 mm wide that are blunt tipped and only slightly curved. One theory is that wide phyllodes provide more surface area for condensing water out of fog. In upper Kula and Kahikinui where these trees grow, the annual rainfall averages about 40 inches.

This is peripherally low for *koa*, which prefers 60-150 inches per year. On these leeward slopes, however, there is usually a thick cloud bank that forms from the gentle orographic lifting of warm air during the day. This dense *naulu* cloud is full of moisture, but little of it falls as rain.

These broad phyllode koa condense great amounts of water from these clouds to the point that it "rains" under these trees, nearly doubling the actual precipitation and creating a more ideal climate for these trees and their understory beneficiaries. *Koa* trees in both wetter and drier forests away from this *naulu* cloud have phyllodes of normal width. Of special note are the *koa* trees that grow in lower Kīpahulu Valley. These trees have long, extremely narrow (6-8 mm wide) phyllodes that give these trees a lacy appearance.

The range of *koa* forest on East Maui is of interest. On the leeward Kula and Kahikinui slopes it lies in an elevation band between 3,500 and 6,000 feet, consistent with the occurrence of the *naulu* cloud. But *koa* does not naturally occur on the windward slope where rainfall is too high for its liking due to the trade wind effect. So *koa* wraps around the edges of Haleakalā only to Kailua on the northwest corner and only to Kīpahulu on the southeast corner, and then abruptly stops where rainfall exceeds about 200 inches per year. The great Kīpahulu Valley is literally filled with *koa* forests while the adjacent Waiho'i Valley to its north has but a handful.



Likewise on the northwest corner a dense *koa* forest occurs at Honopou then suddenly gives way to a lowstatured *ʻōhiʻa* and fern forest at Kailua. Another interesting characteristic of these two endpoints is also tied to rainfall. Where the tradewinds wrap around Haleakalā the isohyets (lines of equal rainfall) lie vertically on the shoulders of the mountain rather than horizontally as they do on both the windward and leeward slopes. Thus the zone of ideal rainfall for *koa* (60-150 inches per year) stretches from near sea level to 7,000 feet. On the northwest it runs from lower Peahi up to upper Waikamoi and Hosmer Grove, and on the southeast it runs up Kīpahulu Valley from just above the highway to the upper reaches of the valley below Kuiki and Pohaku Palaha. On the map the range of *koa* looks like a boomerang with parentheses on each end.

Also of botanical and cultural interest is the low-statured, gnarly, dry forest species known as *koaiʻa* or *koaiʻe* (*Acacia koaia*). This allied species grows in the hot lowlands between 1,200 and 2,000 feet on the leeward side of the island.

It has an interesting range as there is a considerable space between where it grows and the *koa* which is higher on the slope. The name *koaiʻe* connotes *koa* with connection to fishing. Indeed great shark hooks were crafted from curved roots or branches of this strong wood. The name *koaiʻe* connotes *koa* with a connection to *kapa* (barkcloth) mallets, which in fact was another major use.

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