Ecosystem Engineers

Exotic species can affect the environments they invade in many ways. Some have the ability to create, modify, or destroy habitats. Aggressive alien plants can monopolize sunlight or territory. They can alter the temperature or acidity of the soil, and the availability of nutrients. In doing so, they can change wetlands to forests or forests to grasslands. They can reduce diverse ecosystems into single-species fields.

Biologists call this "ecosystem engineering."

Large miconia tree in Hāna rain forest, discovered and controlled by Maui Invasive Species field crew. (Photo courtesy of MISC)

Miconia, a large-leafed tree from Central and South America, is an example of an ecosystem engineer. As it invades Hawaiian rain forests, it unfurls giant, umbrella-like leaves. These huge leaves block out the sun for plants trying to grow below. While miconia seedlings thrive in deep shade, most native Hawaiian rain forest plants need some sunshine. They are adapted to the filtered light that falls through a canopy of *koa* and *ʻōhiʻa* trees.

After miconia pulls the shade down on the forest, it fills the soil with its seeds. Each mature miconia plant produces millions of tiny seeds. These seeds germinate into a carpet of young miconia plants, leaving no room for any other plants to grow. Before long, what was a sunlit rain forest brimming with diverse species of shrubs, vines, ferns, and trees, is now a dark field populated by a single tree species: miconia.

Some plants drop smothering blankets of leaves or needles on the ground. What do you see under a pine tree or an ironwood tree? How might that affect how other plants are able grow?

Chemical Warfare

Some plants alter the chemical composition of the soil where they grow. Conifers increase acidity in the soil. Since many plants don't do well in acidic environments, this limits what can grow alongside a conifer.

Other plants release poisons—chemicals that stifle the growth of neighboring plants. These plant toxins can affect neighboring plants in different ways. They may inhibit other plants' root growth, or prevent other plants from getting nutrients. Toxins can be present in any part of the plant: leaves, flowers, roots, fruits, or stems. They are also found in the surrounding soil after plant parts have decomposed. Examples of plants that produce toxins include sunflowers, sweet potato, alfalfa, black walnut, pine, ironwood, and eucalyptus.

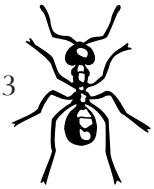
Strawberry guava might also fall onto this list. Originally from Southeastern Brazil's coastal plains, strawberry guava was brought to the Hawaiian Islands in 1825 and has since become seriously invasive.

Though many people enjoy its fruit and wood, strawberry guava is one of the greatest threats facing native Hawaiian forests. It is now found on six of the eight main islands, where it successfully invades native *koa* and *ʻōhiʻa* forests. It grows rapidly and aggressively, efficiently spreads its seeds, and survives in areas with minimal sunlight. If that weren't enough of an advantage, strawberry guava may have a secret weapon: toxic leaf material.

Strawberry guava seedlings emerging from under the leaf litter of parent trees. (Photo courtesy of Forest and Kim Starr)

Strawberry guava seedlings do well under a canopy of strawberry guava trees—but few other species can survive in this environment. Why? It could be because the shade is too dark and doesn't afford seedlings of other species enough light. Or perhaps the leaf litter is too heavy, and other species' seedlings can't push through it. Or maybe the explanation has to do with chemicals in the leaf litter. In 2010, a University of Hawai'i student created a lab experiment to investigate whether strawberry guava leaves might contain toxins that suppress the growth of other plants.

You will be conducting your own lab experiments to see firsthand how invasive plants engineer their environments.



Ecosystem Engineers Lab Report

Group Name: _____ *Date:* _____

1. Hypothesis (State in "If….Then" format): _____

2. Procedure (Control, Variable, Materials, Steps): _____

3. Methods of Data Analysis: _____

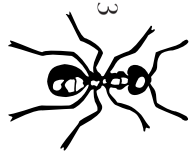
4. Results _____

5. Conclusion _____

Daily Data Sheet - Control

Group Name: _____

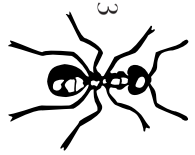
Date	Water Amount	Number of Seedlings	Root Length #1	Root Length #2	Shoot Length #1	Shoot Length #1	Notes



Daily Data Sheet - Lettuce

Group Name: _____

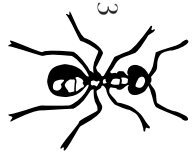
Date	Water Amount	Number of Seedlings	Root Length #1	Root Length #2	Shoot Length #1	Shoot Length #1	Notes

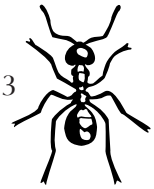


Daily Data Sheet - Strawberry Guava

Group Name: _____

Date	Water Amount	Number of Seedlings	Root Length #1	Root Length #2	Shoot Length #1	Shoot Length #1	Notes





Lab Report Guidelines

Lab reports include the following elements:

Introduction:
Background information justifying why you are testing your specific hypothesis. The introduction should end with a clear statement of your hypothesis and expectations.

Methods:
Detailed description of how your experiment was conducted. It should be detailed enough that someone else could read it and recreate your experiment.

Results and Data Analysis:
Clearly describe your results and what you did to make sense of the data. This includes talking about how and why you made each graph or table.

Conclusions:
Interpret your results and make some conclusions about your research. If no clear conclusions can be made, talk about how you could improve the experiment. Include discussion of future experiments that could be done based on the knowledge that you obtained through your experiment.