Measuring Recovery 25 Years After Fire

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Grass-Fueled Fires in Volcano, Hawai'i

In Hawai'i, many different exotic grass species were brought in as ornamental plants and as forage for cattle. These grasses have moved into woodland and forest areas dominated by native trees and shrubs including 'ōhi'a, a'ali'i, pukiawe, 'akia. Because grasses quickly dry out when rains stop, they act as "fine fuels", increasing the odds of ignition (from campfires, machinery, fireworks) and helping fires spread quickly across a landscape.

After several fires in the 1970s and 1980s in Hawai'i Volcanoes National Park, researchers showed that fires kill native trees and shrubs, while the grasses quickly resprout. Competition from grasses for light and water limits the ability of native species to re-establish, which may cause areas to become 'stuck' in a grassland state that is far more likely to burn again in the future. This phenomenon of grass and fire positively reinforcing each other is referred to as the grass-fire cycle.The grass-fire cycle explains why the same areas tend to burn repeatedly over time and how fire and grasses prevent new growth of native trees and shrubs in those areas.

Since 1987, the National Park Service has prevented fires in burned areas by limiting access to people (and thus accidental ignitions) during intense droughts when grasses are most likely to carry fires. The research sites in the Park established in 1988 were revisited 25 years after the fires to answer questions about recovery for landscapes that do not experience repeated burns.

Key Questions

If we could exclude fire, how "stuck" are these grass-invaded woodlands?

If a landscape goes decades without burning, do ecosystems and plant communities return to what they were before?

Fire Exclusion

Study Sites

Researchers established plots within unburned and burned areas in previously continuous ōhi'a woodland. The unburned areas were dominated by an open canopy of ōhi'a trees and a dense understory of native shrubs, with abundant beardgrass *(Andropogon virginicus)* and molasses grass *(Melinis minutiflora).* The burned sites were dominated by a carpet of molasses grass, some native a'alii *(Dodonaea viscosa)* and scattered *Morella faya* (faya or fire tree) trees (Figure 1).

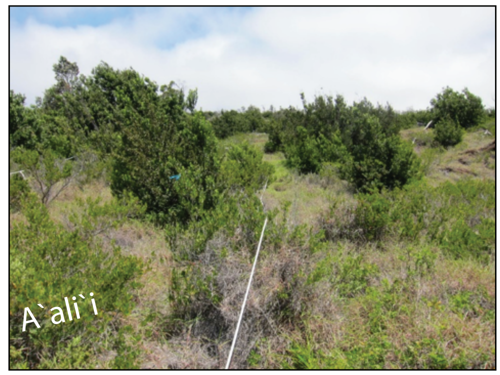

Figure 1. Surveyed plot with native shrubs at a burned site, Hawai'i Island, 2011 (photo by Carla D'Antonio)

Methods

The researchers looked at recovery using both ecological measures and plant community indicators. Ecological measures included primary productivity (i.e., plant growth), and nitrogen and carbon pools through the collection and analysis of plant, soil, and leaf litter samples. Plant type and composition were also measured.

Ecological Terms

ANPP - Above-ground Net Primary Productivity, or how much plant material is being generated through photosynthesis.

Nitrogen & Carbon Pools - the quantity of nitrogen (N) and carbon (C) within soil, plants, the air, or a body of water. C & N pool in soils can indicate fertility and affect the type and quantity of plants that can grow in a particular area.

Nitrogen-fixing - Certain plants (for example in the pea family) can "fix" or convert N from the atmosphere into forms that plants can use for growth.

Ecosystem vs. Community Recovery

Researchers discovered that the dominant woody plants returning to the burned grasslands are the exotic tree *Morella faya* instead of native species (Figure 2) with overall plant growth comparable to unburned woodlands (Figure 3).

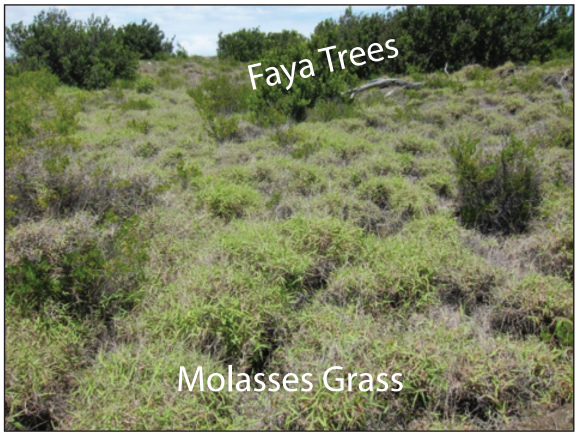

Figure 2. Burned site with a carpet of Molasses grass with dense stand of faya trees, Hawai'i Island, 2011. (photo by Carla D'Antonio)

Figure 3. Unburned site with native species, Hawai'i Island. (photo by Carla D'Antonio)

However, there is less carbon storage in the burned versus unburned woodlands due to differences between ōhi'a and faya tree structure. Unlike 'ōhi'a, faya trees are nitrogen-fixing, which promotes molasses grass growth (thereby limiting subsequent faya re-generation). Soil nitrogen, while increasing the fertility of the burned sites immediately after fires, is now no different from unburned woodlands. Finally, even though productivity and soil fertility are similar between the two sites, plant species in burned sites have drastically changed. Burned areas have essentially become novel ecosystems with few native species compared to abundant exotic trees and grasses, indicating that fire risk is still high.

Management Implications

Restoring native vegetation may be achieved by:

- physically cutting and herbiciding non-native species
- actively planting native trees and shrubs
- incorporating "nurse plants" e.g., native species planted under existing trees and shrubs to protect against sun and wind in fire-impacted sites

Restoration is difficult due to alien trees out-growing native species. Faya trees, for example, appear to grow larger in burned versus unburned areas.

Fuel breaks can reduce the risk of fire ignition and lessen the intensity and speed of fires, while livestock grazing is an effective tool for maintaining fuel breaks over large areas.

Moving Forward

This research is one of the few examples looking at long-term effects of fire on Pacific Islands. The 'ōhi'a woodland sites surveyed in the National Park represent a small piece of the climate types and plant species found across the region. However, the findings are important because they indicate that impacts of the grass-fire cycle on Pacific Island forests can last for decades, even in the absence of recurrent fires.

The full research article by D'antonio, Yelenik and Mack is available at:
Journal of Ecology, 2017, 105, 1462-1474

Further Reading & Resources:

Hughes, F., Vitousek, P.M. and Tunison, T., 1991. Alien grass invasion and fire in the seasonal submontane zone of Hawai'i. *Ecology*, 72(2), pp.743-747.
Pacific Fire Exchange, 2018. The Grass Fire Cycle [Factsheet].

Acknowledgements

Carla M. D'antonio, UC Santa Barbara, Environmental Studies Progra and Dept. of Ecology, Evolution and Marine Biology

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Clay Trauernicht, University of Hawai'i, Dept. Natural & Environmental Resource Management

Melissa Chimera, Hawai'i Wildfire Management Organization