Restoration Impacts on Fuels & Fire Potential

Pacific Fire Exchange

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JOINT FIRE SCIENCE PROGRAM

Ecological Restoration & Fire Disturbance

A primary goal of many ecological restoration projects is to reestablish aspects of natural ecosystems in degraded areas. This is often accomplished by promoting native plant species and controlling undesirable species. In addition to returning native species to the site, ecological restoration must also anticipate and manage for disturbances like fire. This can be accomplished either by returning natural patterns of disturbance to a landscape or by reducing types of disturbance that were not common historically. Contemporary restoration efforts must consider not only how actions improve ecosystem functions but also how changes can modify response to and recovery from disturbance events like fires.

Fuels and fire management can be complementary with ecological restoration goals. Changes in plant communities affect the quantity, arrangement, chemical content, and moisture content of potential fuels, which can make an ecosystem more or less prone to burning. Depending on the characteristics of the ecosystem, restoration activities can intentionally alter fuels to change expected fire behavior.

Fire Behavior & Invasive Grasses

In Hawai‘i, the threat of fire is increasing due to the spread of fire-prone, nonnative grasses and frequent, human-caused ignitions. One problematic species is guinea grass (*Megathyrsus maximus*).

*Figure 1. Experimental fire in guinea grass (*Megathyrsus maximus*). Note the continuous, monotypic spread of the grass, high fuel loads and high fire intensity. Photo by C. Trauernicht.*

guinea grass is an African pasture grass that was introduced to Hawai‘i in the 1800s as livestock forage and has since overtaken large areas of low elevation landscapes, especially on old agricultural lands. This aggressive grass can burn at a very high intensity, creating dangerous conditions for firefighters. Following a fire it resprouts rapidly and complicates restoration efforts by crowding out native plant species.

Management Implications

- Restoring native vegetation in Hawai‘i can suppress fire-promoting non-native grasses, but may not change fuel properties enough to reduce potential for fire while plants are still establishing.
- Repeated herbicide application to suppress invasive grass may be necessary until a native tree canopy is fully restored.
- Careful consideration should be used when selecting species to use in ecological restoration in a fire context:
  - **‘A‘ali‘i**, a hardy shrub used widely in restoration, has much lower moisture content than other species, and its use should be balanced with fire mitigation.
  - ***Naio***, a small native tree, has high moisture content, and should be considered in restoration where fire is a threat.
- Restoring grass-invaded landscapes requires complementary fire risk mitigation such as fuels reduction while native plants are establishing.

A restoration experiment

To investigate how ecological restoration can modify potential fire behavior, University of Hawaii researchers established experimental restoration plots in a guinea grass-invaded area of the Waianae Kai Forest Reserve on Oahu. Their study compared fuel characteristics including moisture content, grass cover, and grass biomass (fuel loads) across five treatments:

1) No restoration (control plots),
2) Herbicide application only (herbicide control), and
3 to 5) Herbicide application with outplanting three different suites of native species (restoration plots).

Control plots had continuous guinea grass cover. Experimental herbicide and outplant restoration plots were treated with the herbicide glyphosate four months before outplanting.

Restoration plots included ‘ilie‘e (*Plumbago zeylenica)* as groundcover, ‘a‘ali‘i (*Dodonea viscosa*) as midstory shrub, and one of three canopy trees: 1) milo

(*Thespesia populnea*), 2) kou (*Cordia subcordata*), or 3) naio (*Myoporum sandwicense*).

Species were selected based on local knowledge of prior outplanting success, rapid growth rates, and commercial availability. The study area was fenced to exclude ungulates that might trample and eat the vegetation. The experimental plots were treated with herbicide at three, ten, and 16 months after outplanting. Researchers assessed plant survival and fuel characteristics 27 months after outplanting.

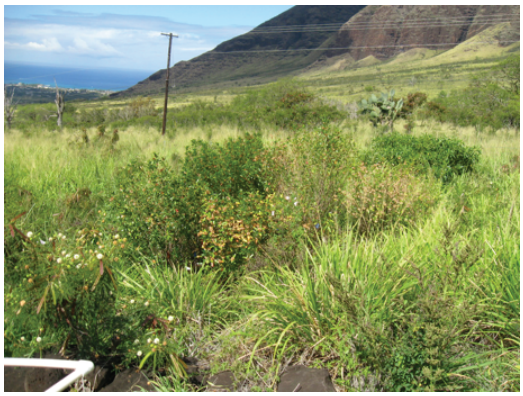

Figure 2. Restoration outplanting site at Waianae Kai Forest Reserve, Oahu, Hawaii 27 months following outplanting.

Photo by L. Ellsworth.

Balancing Restoration & Fire Mitigation

The study showed that both the herbicide-only and restoration treatments reduced guinea grass biomass, which would decrease potential fire intensity. In addition, the restoration treatments - unlike the herbicide-only plots - also reduced guinea grass cover, which diminishes the potential for fire to spread. This encouraging result demonstrates that proactive native plant restoration can help reduce guinea grass and fire potential in a landscape.

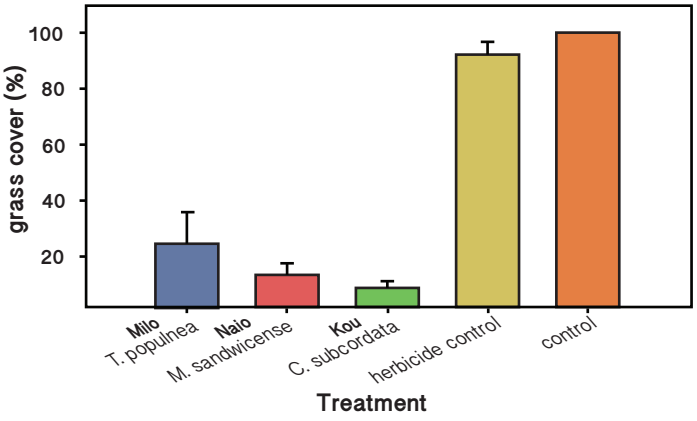

*Figure 3. Guinea grass (*Megathyrsus maximus*) cover in experimental native plant outplant treatment and control plots.*

The researchers also looked at how the native plants used for restoration affected potential fire behavior. They compared the fuel moisture of guinea grass and the native plants used in restoration. ʻAʻaliʻi, a shrub widely used in restoration, had much lower moisture content in its wood and leaves than the other native species, which indicates it would ignite and burn more easily. Naio, in contrast, had much higher fuel moisture than the other species, indicating fire resistance.

Including the native plants in models of fire behavior (Behave 5.0) demonstrated no differences between the control and experimental treatments in predicted fire intensity or forward rate of spread of fire. This seems to contradict the observed reduction in guinea grass, but can be explained by the potential for the native trees and shrubs to burn in the early stages of restoration. These findings suggest that ecological restoration must be complimented by other fire mitigation measures - at least in early restoration - such as reducing invasive grass fuels surrounding restoration sites.

The full research article by Ellsworth, Litton, and Leary is available online:
http://doi.wiley.com/10.1111/rec.12263

Moving Forward

While this work provides insight into the potential for restoration to disrupt the positive feedback between nonnative grasses and wildfire, these results are only a snapshot in time and may not be indicative of longer-term treatment effectiveness. Determining whether a restoration project is successful at suppressing nonnative grasses and reducing fire potential requires a much longer time perspective. Future work must address this knowledge gap by re-measuring the Waianae Kai and other restoration projects at longer term intervals in invasive grass-dominated dryland ecosystems in Hawaiʻi.

In addition, managers will likely want to consider the trade-offs in cost and fire mitigation when deciding to use restoration versus herbicide-only treatments. The study results show that outplanting native species can suppress grasses better than herbicide alone. This may help reduce long-term costs and effort associated with maintaining fuel breaks. However, when native ecosystem recovery is the main objective, managers must also consider fire risk in the surrounding landscape, especially during early stages of native plant establishment.

Further Reading & Resources:

Powell, KB, LM Ellsworth, CM Litton, KLL Oleson, and SA Ammondt. 2017. Balancing ecological restoration of native species with economic reality: Lessons from a Hawaiian dry lowland ecosystem dominated by the invasive grass *Megathyrsus maximus*. In press: Pacific Science.

Ellsworth, LM, CM Litton, and JK Leary. 2015. Restoration impacts on fuels and fire potential in a dryland tropical ecosystem dominated by the invasive grass *Megathyrsus maximus*. Restoration Ecology 23(6): 955-963.

Ammondt, S AE, CM Litton, LM Ellsworth, and JK Leary. 2012. Restoration of native plant communities in a Hawaiian dry lowland ecosystem dominated by the invasive grass *Megathyrsus maximus*. Journal of Applied Vegetation Science 16(1): 29-39.

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