Post-wildfire Plant Regeneration in Arid Ecosystems: Overcoming Biotic and Abiotic Soil Limitations Legacy

Project # 16-831

Background:

Even in natural habitat, regeneration of dominant tree species can be limited. The lack of seedlings are a problem for the Hawaiian supalpine dryland forest dominated by māmane (*Sophora chrysophylla)* (Fig. 1). Palila (*Loxioides bailleui*), an endemic and federally endangered Hawaiian bird, is dependent on māmane; its diet is restricted to the seeds, flowers, and caterpillars of this tree. The current range of the remaining Palila population is the subalpine woodland on Mauna Kea on the island of Hawai'i. In the face of increasing wildfire frequency and severity, climate change, invasive species, and land-use change, it is important identify natural regeneration limitations of this important host tree. In order to decrease cost and improve restoration efficiency, we conducted a germination, growth, and survival experiment at Pōhakuloa Training Area (PTA) in Hawai'i.

Figure 1. Flowers of the māmane tree

Objective:

The experiment tested potential limitations of māmane seed germination and seedling growth, in a recently burned area in comparison to an unburned control site. We focused on fertilization and *Rhizobium* inoculum to help reveal the constraints for māmane regeneration and test potential restoration techniques that will help overcome these constraints and increase the success of current habitat management and restoration efforts for Department of Defense (DoD) managed lands.

Summary of Approach:

The experiment utilized 4 treatments: control, fertilization, *Rhizobium* inoculum, and fertilization and *Rhizobium* in combination—for both a field and a greenhouse experiment. The control treatment had no additions. The fertilization treatment was a surface application of Nutricote 13-11-11 Type 180 applied at a "sensitive crop rate" of 78g/ft^2 or 20g/pot. The *Rhizobium* treatment was applied at the rate of 2.0 x 10^5 g CFU/seedling by mixing 0.2 grams of Guard N with 600mL non-chlorinated water. The Fertilization x *Rhizobium* treatment had both treatments applied.

Benefit:

Approximately 3% of PTA is designated as Palila critical habitat. Post-fire vegetation management fulfills two important DoD missions: 1) maintaining quality training lands, and 2) environmental stewardship of land resources, particularly in regard to protected species. Developing and testing effective procedures to improve regeneration of subalpine forests in Hawai'i provides critical tools to adapt to increasing aridity from climate change and to augment māmane habitat, which is a limiting factor for the critically endangered Palila bird.

Accomplishments:

The experiments showed that survival was not affected by the site or treatment. The Burned site had increases in growth over the Unburned site. Treatment results were unexpected: *Rhizobium* addition usually did not enhance growth, while fertilizer addition did, and in combination a synergistic effect was not noticeable. Germination results suggest that fertilization and soil properties may have an inhibitory effect. Healthy māmane populations are necessary for Palila recovery. Tis tree species, if protected from ungulates, can regenerate well across other sites, but at PTA, germination is the primary bottleneck. Māmane forest cover has a number of benefits for military readiness and operations: stabilizing soil, reducing dust and erosion, and potentially dampening the grass-fire cycle. While this study worked on a species endemic to Hawai'i, the process of systematically testing potential limiting resources with amendments is one that can be done for species at other military sites facing recruitment limitations. Many military installations deal with wildfire, and as our study shows, it is important to consider that fire may not always have negative effects on growth and regeneration of dominant tree species.

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