Land-clearing Treatments Indicate Differences in Total Phosphorus in Soils Following Soil Removal in the Hole-in-the-Donut; Implications for Improving the Restoration Process through Adaptive Management

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Introduction:

The Hole-in-the-Donut (HID) restoration is successful following complete soil removal to limestone bedrock. The restoration process itself consists of chipping the monoculture of invasive *Schinus terebinthifolius*, piling the Brazilian pepper and soil into windrows, and hauling the material away to a soil disposal mound. An initial scrape of the remaining soil is done along the limestone rock, followed by a more thorough final scrape where as much soil as possible is removed. Upon final scrape, shallow pockets of soil and exposed limestone rock remain, such that native plant colonization occurs naturally over the first three years (Figure 1).

Figure 1. Native plant colonization in the Hole-in-the-Donut restoration 20 years following land-clearing to limestone rock.

In 2007, land-clearing efforts were cut short with the onset of the rainy season. Though the 100 acre site was cleared and the initial bulk scrape was completed, the final scrape did not occur. It was known that heavy rates of phosphorus were applied to the oligotrophic marl prairie soils and that failing to remove all soil to limestone bedrock could result in the reinvasion of Brazilian pepper. Two years post-scrape vegetation data indicated a higher percentage of less desirable species like *Typha* and *Baccharis* when compared to other restored areas (O'Hare 2009). We hypothesized that the vegetation that colonizes a bulk-scraped site is mining phosphorus from the soil and a delayed final scrape would lower soil total phosphorus levels. If so, would laboratory results for phosphorus change the HID restoration process for final scrape?

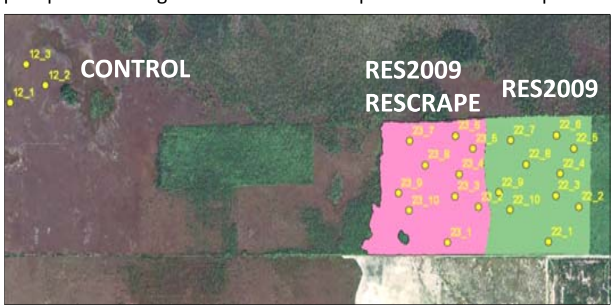

Figure 2. Soils were sampled at two restoration sites in the HID and a control.

Figure 3. Soils were collected in May 2009 following restoration of Res2009 and Res2009 Rescrape areas.

Methods:

In 2009, a delayed final scrape was completed for the Res2009 Rescrape area of interest, along with the Res2009 same-year final scrape, an adjacent newly cleared site (Figure 2). Ten soil samples were taken from each land-clearing treatment in May 2009 and compared to the upper five cm of an undisturbed marl prairie control soil in proximity to the HID (Figure 3). Soils were analyzed at the Tropical Research and Education Center according to EPA 365.1 protocol, with a focus on total phosphorus (TP).

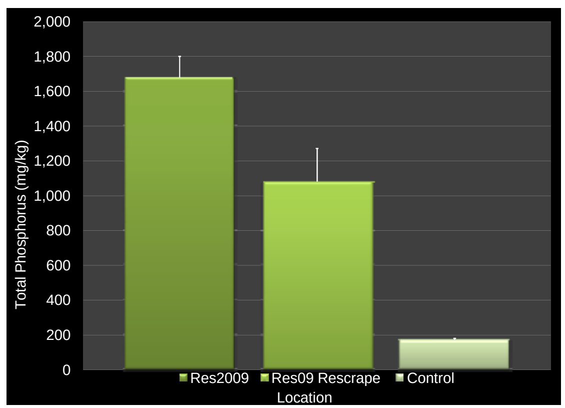

Figure 4. Soil total phosphorus was significantly lower for the delayed final scrape, yet higher than the control. Error bars are shown at two standard errors above the mean.

Results:

Soils data indicated that total phosphorus in the delayed final Res2009 Rescrape was significantly lower at 1081 mg/kg TP when compared to 1679 mg/kg TP in soils from the Res2009 same-year final scrape (Figure 4). Soils in restored areas were higher than the experimental control of 173 mg/kg TP, as well as background levels for soil TP in Everglades marl prairie wetlands (Chen et al. 2000).

Discussion:

Since this was a pilot study, further evaluation of these preliminary observations is needed. Additional, more detailed data will be necessary to rule out our assumption that there was no difference in land use history and investigate whether a delayed final scrape will lower phosphorus levels in restored soils. Future work entails a larger sample size and replicate plots distributed within a block design across the landscape for same-year and delayed final scrape analyses. Testing of soils in the lab will be important in determining the availability of phosphorus for plant uptake and may support post-restoration vegetation cover data. Given that the target species composition of the HID mitigation permit is a marl prairie plant community, a reduction in the colonization of less desirable plant species is important in relation to soil TP (Figure 5).

Figure 5. Less desirable marl prairie species like *Baccharis halimifolia* and *Schinus terebinthifolius* (left) have the ability to uptake higher levels of TP when compared to *Cladium jamaicense* and *Muhlenbergia capillaris* (right).

Ongoing research within the HID demonstrated that *Baccharis* and *Schinus* plant tissue samples contained higher TP levels than dominant marl prairie species like *Cladium* and *Muhlenbergia* (Inglett et al. 2010). Therefore, if higher available phosphorus remains in soils post-restoration, the likelihood that less desirable plant species may dominate newly restored sites may be increased. Since soils were collected from actual vegetation plot locations, a follow-up vegetation survey is warranted in the future. The implications of this research are potentially significant for the HID restoration process. Adaptively managing the Hole-in-the-Donut via delayed final scrape could reduce soil phosphorus, and improve species composition and the overall success of the restoration.

References:

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