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Promoting the Reestablishment of *Cladium jamaicense* and *Muhlenbergia capillaris* in the Hole-in-the-Donut Restoration Area of Everglades National Park

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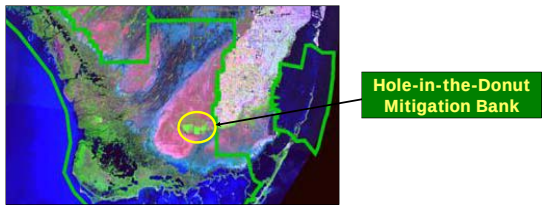
Introduction:

The Hole-in-the-Donut (HID) is an area of previously farmed land within Everglades National Park that is currently being restored to wetland. By 1975 all agriculture ceased, leading to the invasion and dominance of Brazilian pepper *(Schinus terebinthifolius)* on 6,600 acres of fallow fields. In order to effectively restore the HID, heavy equipment is used to remove *Schinus* and scrape the nutrient-rich soil down to limestone bedrock. This land-clearing creates conditions that are favorable for colonization by native wetland vegetation. Given that the HID is a mitigation bank, permit criteria define that successful restoration is accomplished by restoring the area to a short-hydroperiod marl prairie plant community dominated by sawgrass *(Cladium jamaicense)* and muhly *(Muhlenbergia capillaris).*



The Hole-in-the-Donut wetland restoration area and mitigation bank.

Sawgrass is a sedge with sharp-toothed blades located along the edges of the leaves with a height that can reach over three meters. Muhly is a perennial bunch grass with long narrow leaves usually 45 to 90 cm in length. In 2009, an adaptive management study was conducted to determine if *Cladium jamaicense* and *Muhlenbergia capillaris* could be reestablished by seeding a newly scraped restoration area. The objectives and hypotheses of this study were as follows:

Objectives:

1) To determine the best time period to collect potentially viable *Cladium* fruit for seeding restored areas of HID.
2) To evaluate the feasibility of seeding newly restored areas of HID with *Cladium* and *Muhlenbergia.*

Hypotheses:

1) *Cladium* does not produce viable seeds uniformly throughout the reproductive season.
2) Newly restored sites can be successfully seeded with *Cladium* and *Muhlenbergia* seeds. That is, *Muhlenbergia capillaris* and *Cladium jamaicense* germinate and survive if seeded within a newly restored site.

Muhlenbergia capillaris (hairawn muhly)

Cladium jamaicense (Jamaica sawgrass)

Cladium and *Muhlenbergia* study site in the Hole-in-the-Donut 2009 restored area.

Methods:

Cladium jamaicense seeds were collected at 2-week intervals from July 14 through August 25, 2009. In the lab, 50 sawgrass seeds from each of the four collection dates were debracted and inspected for intact endosperm; seeds without endosperm were classified as inviable, whereas seeds with endosperm were considered potentially viable. *Muhlenbergia capillaris* seeds were collected on October 29, 2009, as based on the highest phenological germination rate from a previous greenhouse experiment. The sawgrass and muhly field experiment was initiated in mid-November, when 30 plots were randomly installed across a 100 acre test site that was restored in May 2009. Plots were 0.5 m X 2 m and consisted of seven sawgrass plots, 13 muhly plots, and ten control plots that were not seeded.

Research plots – looking for seedlings.

Cladium and *Muhlenbergia* plot locations.

Prior to seed scatter, plots were inspected for natural recruitment of *Cladium* and *Muhlenbergia* plants, and none were found. One gram of *Cladium* seed (approximately 500 seeds) from the collection date with the highest percentage of intact endosperm was scattered into each sawgrass plot, while 0.15 g of *Muhlenbergia* seed (app. 1000 seeds) was scattered into the muhly plots. All plots were observed for seedlings every two weeks for the first three months and monthly up to one year.

Results:

Cladium jamaicense seeds collected on July 28, 2009 had the highest percentage of intact endosperm at 40% (Figure 1). As of March 2010, there was no observed germination of *Cladium* or *Muhlenbergia* in any of the seeded or control plots.

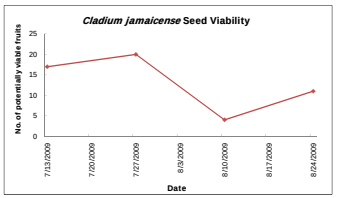


Figure 1. *Cladium jamaicense* potential seed viability by date, as based on intact endosperm.

Discussion:

During the development of this seeding project, it was suggested that *Cladium jamaicense* does not produce viable seed uniformly throughout the reproduction season. Our study supported this hypothesis. An underlying assumption of this study was that an intact endosperm meant that there was a potentially viable seed. Given this data, late July is an optimum time for seed collection and harvesting the one-seeded fruits during this time will increase the likelihood of successfully seeding a newly restored site.

The second hypothesis was that scattering seeds collected during the time of highest potential seed viability would guide a successful *Cladium* and *Muhlenbergia* seeding program. We cannot yet test this hypothesis with this field experiment because no sawgrass or muhly germination has been observed in any of the test or control plots. It is possible that none of the seeds germinated, suggesting that none of the seeds were viable, despite laboratory results. A more likely explanation is that a heavy rain event that occurred immediately after the seeds were scattered in the field redistributed the seeds outside the plots or even drowned them (Figure 2). A final possibility is that field germination rates are much lower or germination takes longer than anticipated.

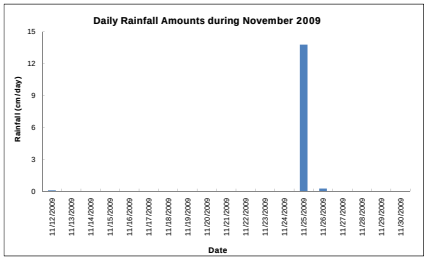


Figure 2. Daily rainfall amounts during Nov. 2009. Data courtesy of U.S. EPA (2010).

We plan to repeat the field project in order to retest the seeding establishment hypothesis and eliminate the possibility that flooding influenced the results. This study of directly seeding sawgrass and muhly into a newly restored area is only one of a number of permutations we are going to be evaluating. Future tests include 1) seeding of *Cladium* and *Muhlenbergia* into older, established restored areas and 2) planting of *Cladium* and *Muhlenbergia* plugs in both newly restored and established areas. The results of this research will tell the Hole-in-the-Donut project which methodologies will be best for sawgrass and muhly reestablishment.

References and Acknowledgements:

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