



Using historical photos and current elevation data to identify suitable locations for pine rockland restoration within the Hole-in-the-Donut, Everglades National Park



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The Hole-in-the-Donut (HID) is a 6,600 acre wetland restoration project where Everglades National Park is restoring previously farmed land by removing invasive woody vegetation and disturbed soils. Much of the HID was rock-plowed and fertilized, which converted low-nutrient, poorly aerated soils to richer aerated soils that were readily invaded by Brazilian pepper (*Schinus terebinthifolius*). Mechanically clearing Brazilian pepper and scraping away disturbed soils to limestone bedrock restores conditions conducive to colonization and dominance by native wetland vegetation. Following restoration, communities of short to medium hydroperiod prairie develop within the first year.



Monoculture of exotic Brazilian pepper.



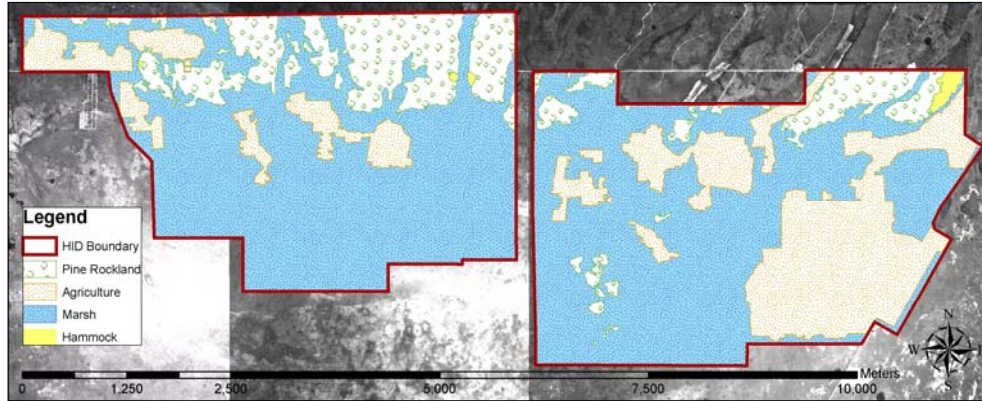
Wetland prairie 18 years post-restoration.

Restoration of pine rockland dominated by South Florida slash pine (*Pinus elliotii* var. *densa*) is much slower. Pine recruitment has occurred in restored areas adjacent to pineland seed source, but is limited by distance from seed source, and elevation as a result of hydroperiod. The objectives of this research were to (1) identify suitable areas for pine rockland restoration based upon interpretation of 1940's aerial photos, and (2) test the effects of hydroperiod on slash pine by scattering seeds across five consecutive elevation ranges in areas removed from a pine seed source.



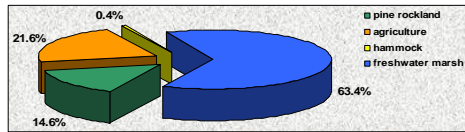
Reclamation of South Florida slash pine is limited by distance from seed source and elevation.

1940's aerial photos were downloaded from the USGS SOFIA database and the digital images were georeferenced. ArcMap was used to interpret and delineate land cover in the HID based on a scale of 50 map units, such that a given land cover was defined by a minimum of 50 meters.



Aerial interpretation of the Hole-in-the-Donut circa 1940. Note the ridges of pine rockland and fingers of freshwater marsh to the north. Agriculture was initially limited to areas of marl prairie wetland.

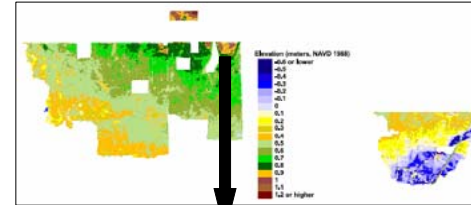
As a result of aerial interpretation, the historical extents of pine rockland, marsh, hardwood hammock, and agriculture were delineated. During the 1940's tomato farming was limited to the marl prairie wetlands, an indication that prior to farming about 85% of the HID was freshwater marsh. Ridges of pine rockland were found at slightly higher elevations, with shorter hydroperiods, minimal soil, and exposed limestone rock. Historical interpretation shows that 14.6% of the HID pine rockland was dominated by a mix of dense and sparse *Pinus elliotii* var. *densa*. Over time, the entire HID footprint was farmed, as the invention of the rock-plow allowed farmers to break-up the underlying rock and intermix it with the soil above. In 1975, farming ceased. The lands were left fallow and became invaded by Brazilian pepper.



1940's land cover distribution for the Hole-in-the-Donut.

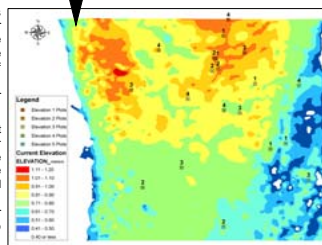
To date 3,800 acres have been restored. Current high accuracy elevation data (+/-0.1 m) exists for restored sites. These elevations are permanently lower than pre-farming elevations; however, in some areas elevation is high enough to promote a shorter hydroperiod and survival of slash pine.

An experimental area of suitable elevation that was removed from seed source was selected to jumpstart restoration where pine rockland historically occurred in the HID. *Pinus* seeds were collected during October 2006 and a greenhouse viability study in January 2007 resulted in 36% germination. In February, the study area was pre-treated with fire. Then a laser level was used to select four random points per elevation across five elevation ranges, for a total of 20 research plots.

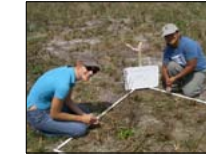


The figure above shows current elevation data for restored sites. The highest elevations have natural recruitment of *Pinus elliotii* var. *densa*, or elevations favorable for pine restoration.

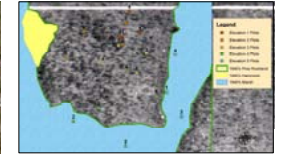
The figure to the right shows an area of higher elevation which has the potential to support pine rockland, yet is removed from pine seed source. Plots were placed over five elevation ranges to test slash pine survival.



During March the seeds were cold stratified for one week, and 100 seeds were scattered by direct seeding into each two-meter squared plot on each of five elevation areas. Germination and survival of *Pinus elliotii* var. *densa* was monitored during the 2007 rainy season.

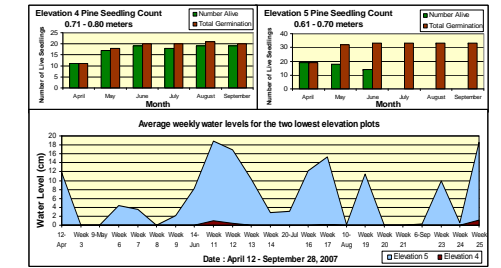


Direct seeding of slash pine.



Seeds were scattered in historic pine rockland.

Preliminary data support the hypothesis that slash pine is more likely to survive at high elevations, given that the presence of South Florida slash pine has been attributable to surface elevation, hydroperiod, burn history, and microsite soil differences, with hydroperiod being the primary controlling site characteristic.



Germination and survival data for pine six months post-scatter. Note the weekly water level data.

Future research will include planting of slash pine seedlings at the same range of elevations and a microcosm study. Both will investigate the effects of hydroperiod on *Pinus elliotii* var. *densa* and the species adaptive mechanisms to changing hydroperiod. These studies will guide restoration of South Florida slash pine in the Hole-in-the-Donut and throughout South Florida.

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