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A CONTINUED STUDY OF PINE REGROWTH IN PREVIOUSLY LOGGED FORESTS ON ANDROS ISLAND, BAHAMAS

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ABSTRACT

The Bahamian Pines (*Pinus caribaea* var. *bahamensis)* of north and central Andros Island, Bahamas, were "clear cut" from the 1950's to the 1970's by the Owens of Illinois Lumber Company. Their permit required that a pre-selected 5% of the trees in the lumbered areas be left standing to allow natural reseeding on the pine yards. In this study, we compared pine tree density and basal areas between ten logged and two uncut sites. On North Andros, pine density in an "old-growth" uncut area at Big Pond (438 trees/ha) was lower than in a nearby cut forest (846 trees/ha), but was higher than in the "old-growth" forest on little Abaco (169 trees/ha). Basal areas showed a similar pattern. On North Andros, pine tree density was higher in most of the logged sites compared to the uncut "old-growth" site at Big Pond. These results indicate that reseeding and recruitment from seed trees left after logging has been successful and that trees are self-thinning in areas that have not been logged since 1970. This continued study (data collected annually since 1999) may help to evaluate the success of the regrowth strategy with respect to future potential logging operations on Andros.

INTRODUCTION

Forests cover roughly 37 percent of the total land area of the Bahamas, according to the figures provided at the Forest and Agriculture Organization website (FAO, 2001). They are classified into three distinct types: pine yards, coppice, and mangrove areas. The pines are considered the most productive and commercially viable forest resource for Abaco, Andros, Grand Bahama, and New Providence (FAO, 2001). These forests are largely monocultures of self-regenerating Bahamian Pine, *Pinus caribaea var. bahamensis*, an endemic variety of the Caribbean pine. Other species that thrive best in association with the native pine include the ferns, *Anemia adiantifolia, Thelypteris kunthii*, and *Pteridium aquilinum* (Correll & Correll, 1982).

The pinelands of Andros and Abaco islands have been cut numerous times for timber. Although their main harvest was for pulpwood, Bahamian Pine is commercially valuable because it possesses a naturally heavy and dense wood and is resistant to termites. Pine forest logging commenced in 1906 under British rule, when the first license was issued to exploit this resource. During the 1950's through the 1970's, the Owens of Illinois Lumber Company intensively logged the pine forests on Andros Island. Similar harvests took place on Abaco, where all trees over 10 cm diameter at breast height (DBH) were removed for pulpwood by the year 1970 (Lee, 1996).

The pine harvest permit given to Owens of Illinois mandated that a pre-selected (based on vitality) 5% of the pines be left behind to naturally reseed the pine yards. As a result, the forests on Andros are now composed almost entirely of 30-year regrowth pines, approximately 9-12 m in height, with strong regeneration of younger age-classes of pines. Pine trees that were left for reseeding during the time of the logging operations of Owens of Illinois are scattered irregularly throughout the pine yards. These older trees have only a slightly larger DBH than the younger forest and their crowns are only about 3 m above the secondary growth, making them between 12 and 15 m tall (Eckert *et al.*, 2005).

At what rates are the pine forests recovering, and what successional patterns are they undergoing? A comparison between the remaining old-growth pine forests and the harvested pine yards should establish an understanding of the regrowth process in the pine forests on Andros. An understanding of regrowth periods and patterns in the Androsian pine forests would, in turn, provide information for determining the feasibility of future commercial logging on Andros Island.

The objective of this study is to investigate regrowth rates of the Bahamian Pine following timber harvest by the Owens of Illinois Lumber Company and determine any secondary successional patterns. The following hypotheses will be tested: (1) that the pre-selected trees have adequately reseeded the pine yards, and (2) that natural succession patterns have occurred, establishing Bahamian Pines as the dominant species.

METHODS

Tree sampling began in 2001 and continued in 2002 at six localities: San Andros Airport, London Ridge, Rainbow Blue Hole, Charlie's Blue Hole, Morgan's Bluff, and in the Big Pond area. GPS locations ensured that earlier data collected were not duplicated when areas were resampled. In 2003-2004, new sites were added: Church's Blue Hole, Atala Coppice, near Mastic Point, and the Red Bays area. The Big Pond area was divided into a "cut" area and a possibly "old-growth" area. This dichotomy was assumed due to the greater DBH of the trees and greater distances between the trees in the "old-growth" area. Tree density was almost double in the cut area compared to the uncut. The "old-growth" area was the area most likely to represent an Andros old-growth site. In addition, an old-growth stand on Little Abaco was also measured for comparison.

In the sampling procedure, trees and saplings were recorded separately. In order to be a "tree," the plant must have a DBH >8 cm. In order to be a "sapling," the plant must have a DBH < 8 cm and a minimum height of 3 m (Eckert *et al.*, 2005).

To determine the density of pines within the yards, we used a plotless method known as the point-quarter method (Smith, 1996). Point-quarter sampling consists of locating random points within the stand to be sampled or along a line transect passing through the stand. These random points become focus points for sampling. At each focus point, the sample area is divided into four quarters or quadrants by visualizing a grid line, predetermined by compass bearing, and a line crossing it at right angles, with both transects passing through the point. The closest tree or sapling in each quarter to the focus point is selected. Distance from the point to the tree or sapling is recorded, along with the DBH and species.

Sampling was conducted using DBH metric tapes, a laser range finder, and GPS units to record location of points. Estimations of density and basal area were calculated using methods described in Eckert *et al.* (2005). Distances from the center position to each tree at each focus point were added together. The summation of these numbers was then divided by the total number of points per stand, squared, and divided by 10,000 m to estimate the density of each stand in trees per hectare. The DBH measurements, taken in centimeters, were converted into basal area measurements using a series of mathematical calculations. To calculate the basal area (BA) per stand in m^2/ha, area measurements were added together, divided by the number of points per stand, and multiplied by the locality's previously determined density.

RESULTS

Using the old-growth site on Little Abaco as a model old-growth site, the general result was that tree density decreased and tree size (BA) increased in older stands (Table 1). Comparison of the Big Pond old-growth site on Andros with the old-growth sites on Little Abaco shows that pine density was much lower on Little Abaco (169 vs. 438 trees/ha) (Table 1).

Comparison of cut and uncut areas at the Big Pond sites on Andros also support this pattern. The Big Pond uncut area had a lower tree density (438 trees / ha) than the nearby cut stand

Table 1. Study sites, basal area (BA), and density per hectare of pine trees at one old-growth site on Little Abaco, an old-growth (un-cut) site on North Andros, and other cut sites on North Andros.

Stand	BA/ha (m^2)	Trees/ha
Little Abaco old-growth	11	169
Big Pond "old-growth"	13	438
Big Pond "cut"	17	846
Near Atala Coppice	12	554
Morgan's Bluff	33	598
Red Bay	16	621
London Ridge	15	692
San Andros AirPort	14	737
Road to Mastic	6	439
Rainbow Blue Hole	14	904
Church's Blue Hole	11	926
Charlie's Blue Hole	21	1431

(846 trees/ha) (Table 1). On Andros, the average pine density in new growth areas was 775 trees/ha, which was much higher than the average density of the old-growth area of Big Pond (438 trees/ha) (Table 1).

DISCUSSION

These results indicate that reseeding and recruitment from seed trees left after logging has been successful on Andros. Pine tree density was high in all ten sites sampled that were previously logged. On North Andros, pine density in an "old-growth" uncut area at Big Pond (438 trees/ha) was lower than in a nearby cut forest (846 trees/ha), suggesting that natural thinning is occurring. Pine density in the uncut "old-growth" of the Big Pond stand (438 trees/ha) was higher than that of an "old-growth" forest on Little Abaco (169 trees/ha.). Perhaps Andros is a more favorable environment for pine growth and can support higher tree densities than the northern Abaco Islands.

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