Restoration of maritime forests:

evaluating limiting factors of *Quercus virginiana* regeneration

Introduction: Maritime forests along the southern Atlantic Coast are dominated by *Quercus virginiana,* live oak. These forests have been heavily impacted from human development, agriculture, and conversion to pine plantations resulting in the native maritime forest and ecosystem services at risk. Pine beetle outbreaks have led to salvage cuts of abandoned pine plantations, providing the opportunity to restore maritime forest.

Pinus taeda plantation — Maritime forest

Question: How do key limiting factors of understory light and competing vegetation determine regeneration success of *Q. virginiana*?

Emily C. Thyroff[1], Owen T. Burney[2], Douglass F. Jacobs[1]

[1]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN

[2]John T. Harrington Forestry Research Center, New Mexico State University, Mora, NM

Methods: 1-year-old bareroot live oak seedlings were planted in February 2017 at 16 **fenced** plots on St. Simon's Island, Georgia using a split-plot experimental design; there are 4 blocks, each with 4 plots 66 m x 44 m areas were clearcut or thinned to provide an overstory buffer for the 26 m x 14 m experimental plots (Figure 1)

Figure 1. Experimental plots from left to right: clearcut, heavy thin, light thin, no thin. Within the clearcut plot the different vegetation control levels are visible with 0 years of weeding on the left and 2 years of weeding on the right. Whole plot factor is the overstory (understory light) treatment and subplot factor is mechanical hand weeding

Response variables: Seedling survival, growth (height, diameter), foliar nitrogen, light response curves (light saturation and light compensation points)

Results:

78% avg. survival across treatments after first year
- Clearcut (83%) is significantly greater than no thin (72%)

Growth and foliar nitrogen (Figure 2)
- Growth significantly greatest in the weeded, clearcut plots
- Weeding significantly increases percent foliar nitrogen than not weeded

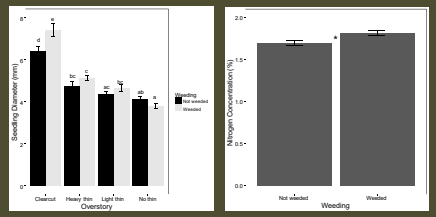

Figure 2. (Left) diameter (mm), (right) percent nitrogen concentration of *Q. virginiana* seedlings planted in varying overstories and weeding treatments. Letters and star indicate significant differences among treatments using a two-way ANOVA, ($p \leq 0.05$)

Light response curves (Figure 3)
- Light compensation and light saturation points were calculated from the light response curves
- The greater the photosynthetically active radiation (PAR), the greater the photosynthetic rate, light compensation, and light saturation points

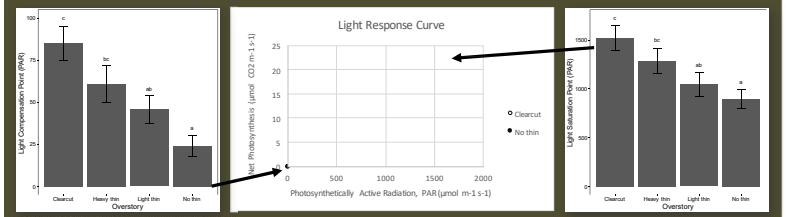

Figure 3. (Left) light compensation point is the PAR when photosynthesis equals respiration therefore net photosynthesis is zero. (Center) light response curves created by capturing net photosynthesis at varying PAR levels. (Right) light saturation point is the PAR when maximum net photosynthesis is achieved

Discussion:

Our results indicate the importance of reducing overstory canopy density to allow sufficient light in the understory and weeding

- **Weeding to reduce competing vegetation** is important following clearcutting and heavy thinning
  - Weeding increases percent **foliar nitrogen** which is an essential macronutrient for plant growth and development
- *Q. virginiana* shows **plasticity** via differing photosynthetic rates in response to varying light (PAR) environments
  - No thin reaches positive photosynthesis quicker (lower light compensation point), but also reaches maximum photosynthesis quicker (light saturation point)

Figure 4. *Q. virginiana* seedling growing in front of old growth maritime forest

Figure 5. Mature *Q. virginiana* within old growth maritime forest

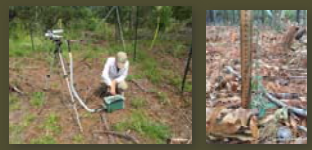

Figure 6. (Left) using a LiCOR 6400XT to create light response curves. (Right) recording seedling height

Despite that *Quercus spp.* are generally intermediate in shade tolerance and therefore shelterwood cuttings are recommended, best regeneration occurred in full light of clearcuts

Results from this experiment will be used toward developing **management prescriptions** that are likely to promote *Q. virginiana* regeneration as a key species in maritime forest restoration

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