Response of Restoration Chestnut Seedlings to Forest Management Strategies

Cindy Ingram, Zoe Bergman, Dr. Heather Griscom
James Madison University

Abstract

The American Chestnut tree (*Castanea dentata*) was a keystone species in the Appalachian Forest once numbering as many as one and every third tree. Since the accidental introduction of the Chestnut Blight (*Cryphonectria parasitica*), this iconic tree has become functionally extinct as all efforts to stop the spread of the fungus failed. Efforts to create a Chinese/American hybrid tree that can replace the lost American Chestnut have been ongoing, the goal being to have a tree with American form but Chinese resistance to the blight. Our research seeks to identify the most effective forest management strategies for these hybrids to help ensure their success in a forest setting.

Hybrid Chestnut trees were planted in two different sized canopy gaps, 40% vs 60%. Within these gaps we further manipulated by planting some with landscape fabric and some with 12" tree shelters. All plantings had a 2 meter deer fence erected around them.

Seedlings planted in the smaller gaps had significantly greater diameter and survival rates than those planted in larger ones. Within the gaps, the use of landscape fabric and tree shelters had no significant effect in small gaps; however, in large gaps, there was a positive effect in seedling height when landscape fabric was used.

The general trend for better survival, height, and diameter in small gaps suggests that restorative plantings should be done there.

Question

How do management techniques (creating gaps, installing landscape fabric, and using short tree shelters) effect the growth and survival of planted Restoration Chestnuts 1.0 in an Appalachian Cove Forest?

Predictions:

- Seedlings will have greatest survival and growth in large gaps (~60% canopy openness) compared to smaller gaps (~40% canopy openness).
- Seedlings partially protected from competition (landscape fabric) and rodent herbivory (tree shelters) will have greater survival and growth.

RESULTS

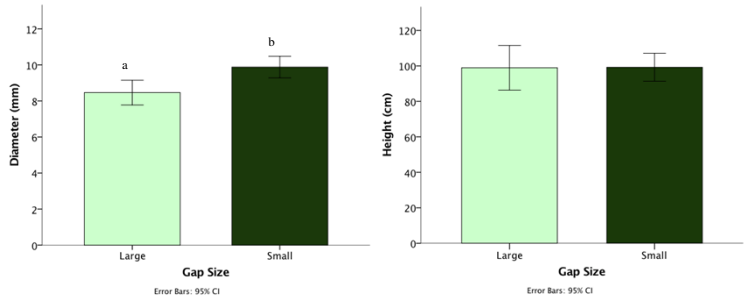

Figure 2 and 3. Average diameter (mm) of chestnut seedlings in large versus small gap (left), the average height (cm)of chestnut seedlings in large versus small gap (right) at the end of the 4th year. Lower case letters symbolize significant differences, p<0.002 & p>0.3 respectively.

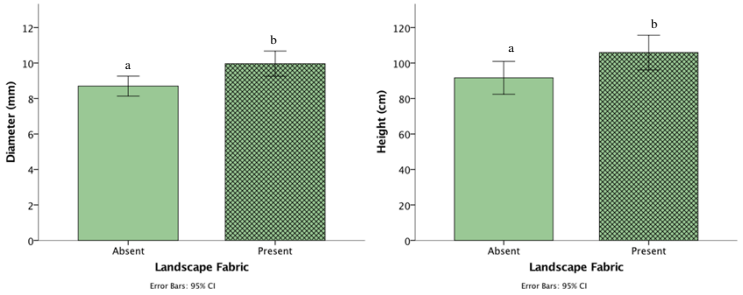

Figure 4 and 5. The average diameter (mm) and height (cm) of chestnut seedlings with presence or absence of landscape fabric at the end of the 4th year. Lower case letters symbolize significant differences, p <0.02.

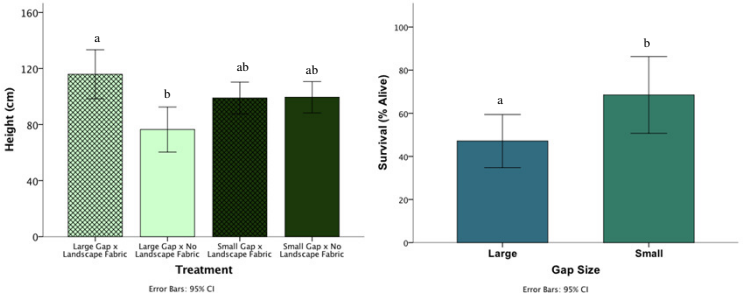

Figure 6. The average height (cm) of chestnut seedlings with the interaction between gap size and landscape fabric (left), and the average survival of chestnut seedlings in large versus small gaps (right) at the end of the 4th year. Lower case letters symbolize significant differences, p <0.003 & p<0.0001 respectively.

Methods

- One-year-old container seedlings of Restoration 1.0 chestnuts were planted within 8 plots. Seedlings were spaced 1 meter apart.
- Four plots were within large gaps (~60% canopy openness) and four plots within small gaps (~40% canopy openness) on the southwestern slope at an elevation of ~ 800m.
- Each plot was located in the center of the canopy gap and surrounded by 7" deer fencing.
- Within each plot, landscape fabric was applied to every other row, and half of the seedlings were randomly selected to receive 12" tree shelters.
- Height (cm), diameter (mm), and survival were recorded at the end of every growing season (2015-2018).
- ANOVA tests were performed to determine significant differences in seedling growth between treatments.
- Binomial regression was performed to determine if treatments affected survival.

CONCLUSIONS

- Four year old chestnut saplings had the greatest growth (diameter) and survival in small gaps (Figure 2 and 3). The increased survival (70% compared to 40%) and diameter size could be due to less competition with *Rubus* spp and other herbaceous and woody shrub and tree species that compete well in higher light conditions.
- Smaller gaps may also harbor less small mammal predators due to less dense vegetative cover. The combination of landscape fabric and high vegetation cover in large gaps may have negatively affected seedling survival in large gaps after four years. Tree shelters did not prevent this predation because some rodents were tunneling under the shelters.
- Tallest height (~ 140 cm) was achieved in large gaps but height was not significantly different between gap size. Seedlings that grew more quickly in large gaps surpassed the vegetative cover. Average growth rate increased between year 3 and 4 in large gaps (Figure 6 and 7).
- Within large gaps, chestnuts grew significantly taller with landscape fabric present (Figure 6). This could be due to a decrease in below ground resource competition. We do not think this is due to above ground competition for light. In the 4th year there was no significant difference in canopy openness at chestnut sapling height (~ canopy openness = 25%? In small and large gaps?). We should mention however that physically crushing of chestnuts was more commonly observed in large gaps.

Acknowledgements: Many thanks to the American Chestnut Foundation for the seedlings and their tireless work to bring back the American Chestnut. Thank you WV TACF members for helping us plant in 2015. Thank you to all the student volunteers we have had in the field over four years!

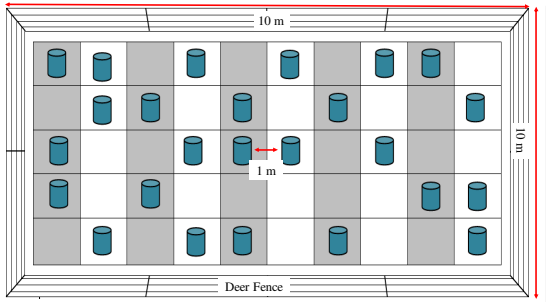

Figure 1. Experimental design of a single plot. Not to scale. Each square represents the location of a single chestnut, the shaded squares represent landscape fabric, and the blue tubes indicate a tree shelter.

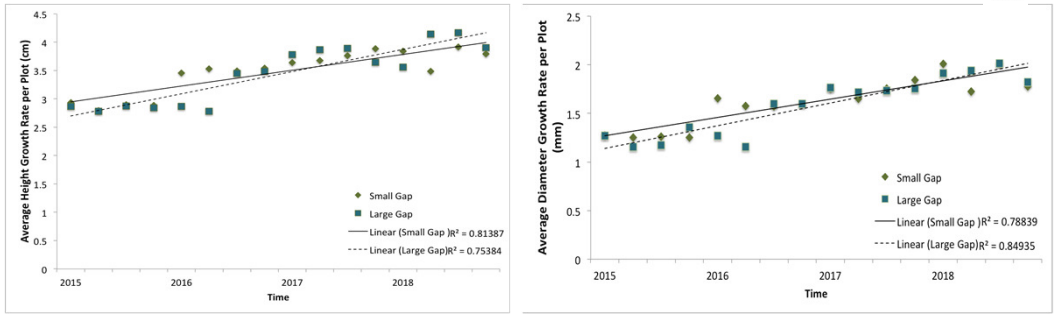

Figure 7 and 8. A linear regression of the average growth rate for height (left) and diameter (right) over the four years chestnut seedlings were sampled. The R^2 value is also shown next to the legend.