Habitat Preferences of American Chestnut in an Appalachian Cove Forest

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Narrative:

The impetus for this study comes from an experiment I began six years ago. I would like to expand our findings from a prior site-specific case study located in a Virginia oak-hickory forest with a regional comparison, by replicating the study design in a more productive, diverse Appalachian cove forest ecosystem in West Virginia. The hypothesis is that chestnut seedlings will have greater growth, and equal or greater competitive performance, in cove forests and that optimal gap size for chestnut growth will differ. In the Virginia oak-hickory forest study, we found that chestnut seedlings performed better in small forest gaps (30-45% light) than in large gaps (50-80% light) (Griscom et al., 2012). This was due to a combination of factors found in small gaps: chestnut seedlings experienced lower competition with tulip poplar, there was sufficient moisture during the driest months of the year, and light levels were adequate. However, this recommendation may not be applicable to other forested ecosystems in American chestnut's native range. For instance, higher annual precipitation, such as within cove forests, may change results. Larger gaps in cove forests may yield greater growth rates and survival.

Experimenting with gap size within different forest ecosystems is important for chestnut re-introduction efforts because we cannot necessarily plant hybrid chestnut seedlings where pre-existing sapling sprouts occur. We have observed very few chestnut stump sprouts at several cove forest inventory sites in north-central WV, in contrast to frequent chestnut stump sprouts at in oak-hickory forests within the Ridge and Valley province of VA. This could be interpreted as evidence for better chestnut habitat in the drier oak-hickory forests. Alternatively, lack of chestnut stump sprouts in cove forests of WV may be due to forest understory conditions that do not support persistence of stump sprouts: higher leaf area index and higher annual precipitation (e.g. 1450mm in north-central WV vs. 920mm in mid-western VA). I predict that optimal growth sites for seedlings are not correlated with abundance of chestnut sprouts, because stump sprouts occur in a small subset of chestnut habitat - - in optimal places for the persistence of stump sprouts, rather than optimal places for the recruitment of seedlings within gaps.

We tested the performance of chestnut seedlings in two different ecosystems in WV that have no stump-sprouting individuals. In a boreal, high elevation forest ecosystem (943m), chestnut survival was poor (Griscom et al., 2011). However, in a cove system (elevation ranges from 500-600m), average seedling growth rate was 27.1cm/year with a maximum potential of 78.5cm/year and a survival rate of 73% with > 50% light (unpublished data from a pilot study). Seedlings were not watered, weeded, or protected from deer browse. In comparison, seedling growth rates in the oak-hickory forests of VA (elevation ranges from 300-550m) averaged 21.8cm/year with a maximum potential of 58cm/year and 65% survival in the optimal treatment (Griscom et. al., 2012). Seedlings were not given supplemental water or weeded but they were protected from deer herbivory. However, this comparison is not robust, because we did not control for light levels and deer herbivory, or measure the performance of competing trees (e.g. tulip poplar), in the WV pilot study. Thus, I propose a study in a WV cove forest replicating the methods used in the prior VA study. This will test my prediction that chestnut performs better in Appalachian cove forest habitat than in the oak-hickory forest habitat of the Ridge and Valley province and within larger gaps rather than within smaller gaps as found in the previous VA study. Competition with tulip poplar, however, may be more extreme in WV.

Methods

Site description: For this field experiment, I propose planting seeds of chestnut hybrids (BC3-F3) within small and large gaps in a cove ecosystem in West Virginia. Common cove canopy species indicators are found within this forest: basswood, tulip tree, yellow buckeye, sugar maple, yellow birch, beech, and eastern hemlock as well as a diversity of wildflowers: wood anemone, may apple, red trillium, white trillium, wild ginger, hepatica, wild leek, foamflower, Soloman's seal, cut-leaves toothwort, and squirrel-corn. The loam soils are acidic (pH 3.7) with a CEC of 17 meq/100 g. This forest is considered high-graded because all trees greater than 12 inches in diameter were cut in 2005.

Site preparation: The south/southwest slope of the study site will be divided into two blocks (upper slope, mid slope). Four gaps will be randomly located within each block for a total of 8 gaps. Gaps will represent two light levels: 30-45% light and 65-80%. All tree trunks within an 8 meter radius will be cut to achieve light levels of 30-45% light (this was successful in the prior study in Virginia). To achieve light levels of 70-85% light, all trees within a 16 meter radius will be removed. Understory vegetation will be cleared as well. Light will be remeasured with hemispherical photography after the clearing and additional trees will be removed from the canopy if needed.

Planting: Fifty hybrid seeds will be planted 2m apart in each gap. A total of 400 BC3-F3 seeds will be required. Seedlings will be protected from deer browse with a two meter tall nylon mesh fence. In addition, seeds will protected from rodents with 3 inch diameter aluminum flashing as recommended by TACF (Hebard 1991).

Environment: Microclimate conditions will be measured with SMA soil moisture smart sensors and photosynthetically active radiation (PAR) smart sensors within the center of each gap attached to a HOBO® Micro Station Data Logger. Naturally regenerating tulip poplar (first year growth) within the gaps will be tagged and monitored for comparison with chestnut seedlings.

Timeline: The project will begin this fall with plot set-up. Seeds will be planted in the spring of 2014 and seedlings will be measured at the end of every growing season for at least 3 years (through 2016).

	Create gaps / build fences	Measure light levels	Plant seeds	Measure seedlings/germination
Summer 2013				
Fall2013	X			
Spring2014			X	
Summer 2014		X		X
Fall2014				X
Fall2015				X
Fall2016				X

Measuring and Reporting On Results:

Height, diameter at root collar and mortality of seedlings will be measured at the end of every growing season for three years (and beyond). ANOVA analysis will determine the effect of gap size on seedlings. The goal is to publish a paper in a peer-reviewed journal comparing the results from this experiment to the previous experiment in the oak-hardwood forest in Virginia. Results will also be disseminated to the public and TACF. I have written a paper and presented results from the prior experiment many times in the past four years and plan to do the same with results from this experiment.

Budget: I am requesting BC3F3 seeds (N=400) and funds ($2000) to pay students to help plant seeds, construct/repair fences and measure seedlings. Additional funding has been granted by the Jeffress Memorial Trust but all funds must be used by June 2014 which will not allow me to pay students to help with fieldwork.

Item	**TACF request**
General expenses	
Fringe:	
1. FICA @ 7.65% on PI salary only	0.00
Equipment and Supplies	
2. Technical support (planting seeds, constructing/repairing fences, measuring seedlings). 5 students * $10/hr * 40 hrs	2000.00
3. Supplies: hybrid seeds (provided by TACF)	0.00
Total	**$2,000**

References

Griscom, H., B. Griscom. 2012. Evaluating the ecological niche of American chestnut for optimal hybrid seedling reintroduction sites in the Appalachian Ridge and Valley Province. New Forests. 43. 441-455.

Griscom, B.G., H.P. Griscom. 2011. Species-Specific Barriers to Tree Regeneration in High Elevation Habitats of West Virginia. Restoration Ecology. 19. 660-670.