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Effects of Mounding on Planting Conifers in Wetlands

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Abstract

Tree plantings in wetlands can have a high chance of failure due to many reasons. This study attempts see if mounding can improve the success of wetland planting in both first year survival and growth rate for plantings of wetland conifers in fens around the Midwest and northeast United States. Trees were planted in a fen in southwestern Michigan, and their survival after the first year and their growth the following year were recorded to see if mounded trees performed better or worse. Mounding significantly increased the survival of *Picea glauca* and *Abies balsamea*, whereas *Juniperus virginiana* and *Thuja occidentalis* did not show a significant increase in survival. Mounded *Pinus strobus* showed a survival increase that was of questionable significance. (p-value=0.08). While mounding did not increase the survival of *Thuja occidentalis*, mounded *Thuja occidentalis* and *Pinus strobus* grew significantly faster the following year than their unmounded counterparts.

Introduction

Planting trees in wetlands can be a difficult task since factors of drought present in uplands are different and factors of flooding are added. Another complicating factor is the more variable soils—some such as floodplain wetlands are extremely productive whereas others such as northern bogs trees can only attain the size of a shrub. This study attempts to evaluate a planting technique (mounding) and how it may increase (or decrease) the survival of planting *Picea glauca*, *Picea mariana*, *Abies balsamea*, *Juniperus virginiana*, and *Thuja occidentalis* in an organic fen. The results of past experiments in mounding *Picea mariana*, (Sutton, 1991, Reid, 1985 in Londo and Mroz, 2001) *Picea glauca*, (McMinn, 1983, McMinn et. al 1995, Hawkins et. al. 1995 in Londo and Mroz, 2001) and *Thuja occidentalis* (Kangas et. al. 2011) will be compared to the results of this experiment.

Site Description

The study site is located in southwestern Berry County, Michigan, at approximate coordinates 42°33'N, 85°29'W. The soil type is Houghton muck, described as a moderately well-decomposed organic muck originating from partial decomposition of sedges and other herbaceous species. Two soil samples taken from the site had pH values of 5.78 and 5.91. Water pH measurements in holes, ponds, and streams in the local area range from 5.9 to 7.8. Prior to European settlement, Michigan natural features inventory data (downloaded from mnfi.anr.msu.edu/data/veg1800/barry.pdf) predicts the area was a mixed conifer swamp, composed of *Larix laricina, Picea glauca, Picea mariana, Thuja occidentalis*, and *Pinus strobus*, and, some old logs buried in the muck have been identified to have come from a *Picea* species. Approximately circa 1920, a pond draining the area was damned. Currently the site's main vegetation consists of predominantly *Typha latifolia, Typha heterophylla*, and hybrids, with some amount of *Carex* spp. and *Eupatorium* spp. (see Figure 1.) The site also contains patches of *Phalaris arundinacaea* and *Phragmites australis*. Wooded areas near the site contain numerous species, the most common of which in order from most abundant to least abundant being: Trees: *Larix laricina, Fraxinus nigra* (dead from emerald ash borer), *Ulmus americana, Populus tremuloides, Salix spp., Acer rubrum, Betula alleghaniensis*, and *Juniperus virginiana*. Shrubs: *Lindera benzoin, Toxicodendron vernix, Alnus* spp., *Cornus stolonifera, Cornus racemosa, Betula pumila, Carpinus*

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caroliniana, *Viburnum lentago*, and *Ilex verticillata*. The Society of American Foresters cover type would be Tamarack or Black Ash-American Elm-Red Maple in most nearby forested areas (Eyre, 1980).

Figure 1. Photo of the study site; an organic wetland in southwestern Michigan, Approximate coordinates 42°33'N, 85°29'W

Methods

During March of multiple years, trees were planted 6 to 8 feet apart (not all of which are in this particular study) in a fully randomized fashion. Tree locations were marked with wooden stakes and numbered with metal tags prior to planting. Some were planted in spots occupied by earlier plantings that died. Mounds were assigned to random locations prior to planting.

The mound effect analysis was performed for three plantings: (1) a planting of 2-0 *Picea mariana* from alpha nurseries done in spring of 2013, (2) a planting of *Juniperus virginiana* transplanted from nearby private land in the spring of 2013, 2012, and 2011, and (3) a planting of 3-2 *Abies balsamea*, 2-2 *Picea glauca*, 2-2 *Pinus strobus*, and 2-2 *Thuja occidentalis* from Porcupine Hollow Nursery in the spring of 2012. Some locations in which a tree of one planting died were replanted with a tree in the other planting. Yellow cones were put around the *Thuja occidentalis* plantings to protect them from deer herbivory. Mounds were created by taking 5 to 8 gallons of muck from the local soil in 3-gallon buckets, and forming it into a dome shape approximately 14 inches high. All nursery trees were bare root stock.

Data on height and survival was gathered the fall of 2013 for all species, the *Juniperus virginiana* also includes data gathered from falls of 2011 and 2012, and no in-planting locations were unaccounted for. Fisher's exact test of independence and the Wilcoxon rank-sum test were performed in R, for which code is presented in the appendix. The Wilcoxon rank-sum test was used because the height growths did not appear to follow a normal distribution, which could make the t distribution a poor approximation for the sampling distribution of the median or mean. Height growth analysis was done for the growing season of 2013 on the 2012 plantings, not on the *Picea mariana* and *Juniperus virginiana* since some of them were planted in 2013. Height analysis will be performed on them after measurements in the fall of 2014.

Results

Table 1. Percent mortality the first growing season in the ground for the plantings in a Berry County wetland, MI, with a p-value from Fisher's exact test.

Species	Mound	No mound	p-value	N (total)	N (mound)	N (no mound)
Thuja occidentalis	11.5%	18.2%	0.30010	157	113	44
Abies balsamea	14.5%	42.9%	0.01332	76	55	21
Picea glauca	11.3%	42.1%	0.00669	91	72	19
Pinus strobus	19.2%	38.2%	0.08004	86	52	34
Picea mariana	0.0%	9.5%	0.11750	123	28	95
Juniperus virginiana	10.2%	16.1%	0.40680	105	49	56

Discussion

In Figure 3, mounding does seem independent of location for all species. Spacing between tree plantings seems relatively constant, whether a study tree is surrounded by other trees planted either in or not in this study. Within the *Picea glauca-Thuja occidentalis-Pinus strobus-Abies balsamea* planting, species seems reasonably independent of location, with a possible exception in the north and central areas; the north most patch does not have as much *Pinus strobus* and the center does not have as much *Thuja occidentalis* as one would expect. Given that these four species were planted the same time, from the same nursery, with similar stocks, they are much more suitable for between species comparison than *Juniperus virginiana* or *Picea mariana*. As evidenced by Figure 3, the *Picea mariana* and *Juniperus virginiana* are not centered in the same area as each other nor the other species. This, combined with their different planting conditions, makes them less suitable for between species comparison. However, comparing the mounded plantings to unmounded within these species, should still yield valid results. Sample sizes for mounded vs. unmounded were generally not equal, regardless of species (Table 2), and, combined with a low death rate for *Picea mariana*, made Fisher's exact test the optimal statistical procedure for testing independence.

Table 2. Estimated effect of mounding on median height growth one year after planting, in centimeters. For a tree of height H in year n, RGR is defined as H_n/H_{n-1}, and G is defined as H_n-H_{n-1} in this study.

Species/metric	Estimated effect	p-value	est. 5%	est. 95%	N
Thuja occidentalis/RGR	0.1722	0.00003	0.093	0.243	125
Thuja occidentalis/G	12.3825	0.00003	7.303	17.145	125
Abies balsamea/RGR	0.0691	0.14576	-0.030	0.166	55
Abies balsamea/G	2.5400	0.15985	-1.270	6.985	55
Picea glauca/RGR	0.0519	0.14778	-0.022	0.145	68
Picea glauca/G	5.0800	0.15744	-2.540	13.335	68
Pinus strobus/RGR	0.0648	0.01256	0.016	0.128	53
Pinus strobus/G	7.3025	0.00532	2.223	12.700	53

Mounding generally had either a positive effect on survival or a positive effect on growth for most species. This survival effect was most profound in *Picea glauca* and *Abies balsamea*. *Pinus strobus* had the lowest overall survival. The very low death rate of *Picea mariana* causes this study to be inconclusive as whether mounding affects its first year survival. This data does not indicate that mounding affects the first-year survival of *Thuja occidentalis* or *Juniperus virginiana*, which, whether due to a different site, planting conditions or climate, is different from the results concerning *Thuja occidentalis* survival in (Kangas, 2011), where a positive effect on survival was found. The results in this experiment for *Picea mariana* are similar to the findings in (Sutton, 1991), despite differences in site, planting stock, location, and mounding techniques used. (Reid, 1985) had lower survival. For *Picea glauca,* (McMinn, 1983, McMinn et. al. 1995, Hawkins et. al. 1995 in Londo and Mroz, 2001) had higher survival overall, with the exception of unmounded trees in (Hawkins et. al, 1995 in Londo and Mroz, 2001), with large differences in survival between mounded and unmounded trees. While difference in overall survival could easily be due to a better planting stock or the climate in British Columbia being more favorable for *Picea glauca*, the large difference in survival being attributed to mounds is consistent with the results of this study.

In terms of height growth in the year after transplant; there were some *Picea glauca* and *Pinus strobus* that had dieback on their top, which caused them to have a negative growth rate, and an RGR below 1. Secondly, the species that mounding seemed to help in height growth were the opposite of the species the mounding seemed to affect the survival of. *Thuja occidentalis* showed a marked improvement in growth between mounded and unmounded plantings, whereas for *Abies balsamea* and *Picea glauca* the effect was not statistically significant. *Pinus strobus* and *Picea glauca* had very variable growth rates, which suggests that another site factor has a strong influence on height growth. Kangas (2011) found a positive effect of mounding on height growth on the wetter of the sites studied in Michigan, which would be consistent with this study's results if this study site were as wet. However, pools located throughout the study area range from showing water tables similar to the drier of the sites to slightly drier than the wet site in (Kangas, 2011). P-values were similar between RGR and growth rate for all species except *Pinus strobus*. This is because *Pinus strobus* was the species where the median height of trees was most different (not statistically significantly different) between mounded and unmounded trees. Also, the planter on the site has noted that, of the many plantings on the site, those that were mounded seemed more successful. This study does not have multiple sites, which limits its usability.

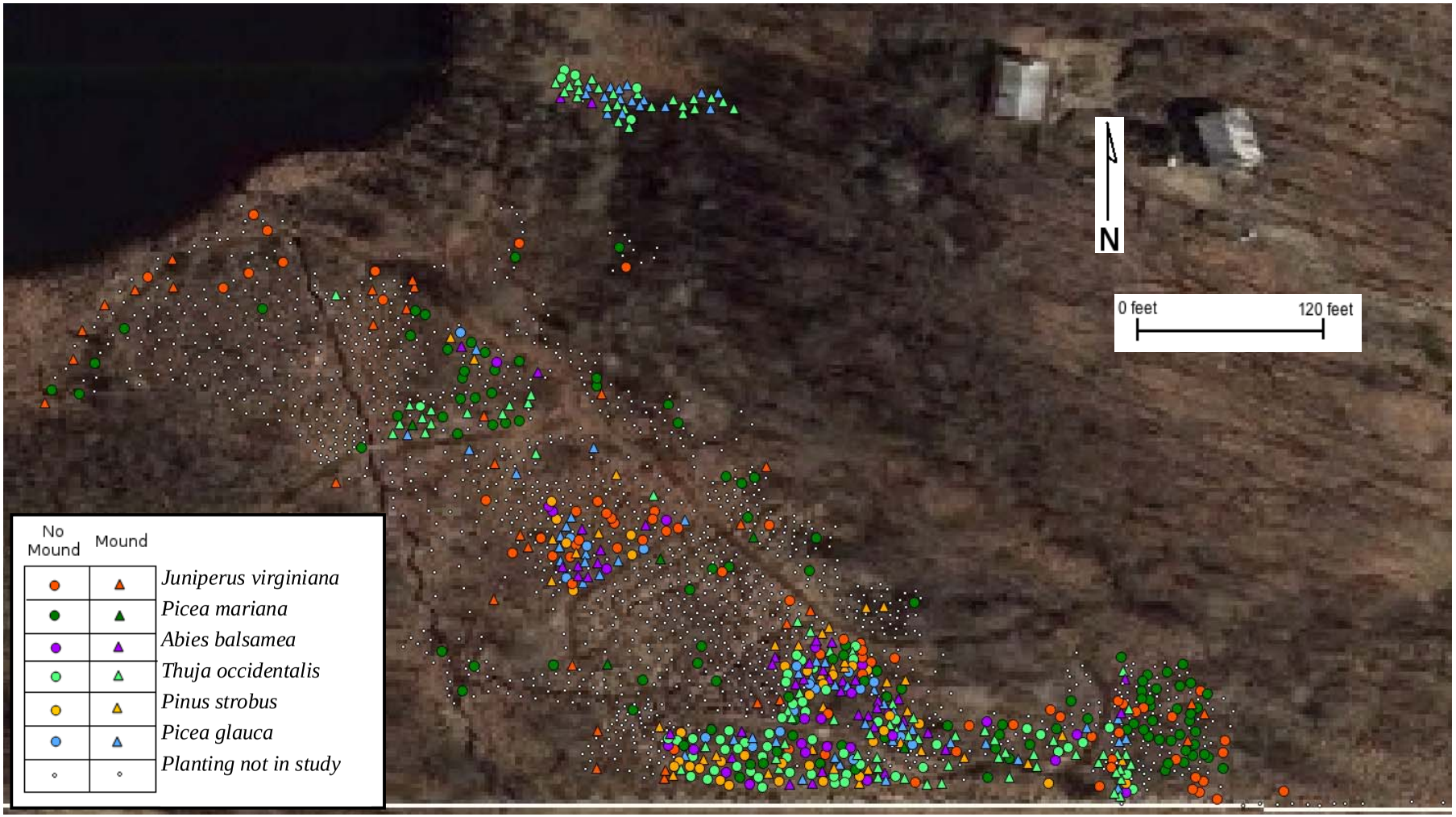

Figure 3: Orthophoto with points indicating locations of study trees. For locations formerly occupied by a dead study tree that were replanted with a another study tree, the symbol indicates the later planting.

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