

Michigan State University Final Report

Frontier Renewable Resources' COEE Project 2. Increasing Sustainable Biomass Feedstock Availability

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Project 2 - Task 3a. Increasing Plantation Biomass Availability

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Task Summary

Successful wood energy crop production systems will rely on planting stock that is genetically superior with respect to adaptability and growth. The only way to identify superior planting stock is to establish numerous genotypes on a range of sites and observe their performance over time. Five clonal trials of new hybrid poplar (*Populus* spp.) varieties (produced for the Lake States Region at the University of Minnesota's Natural Resources Research Institute) were established and two half-sib progeny tests of Silver maple (*Acer saccharinum*) were established under this task. This task ends with the establishment of these tests but future measurement and analysis of these plantings will help to identify improved stock for future plantings of these two taxa.

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Hybrid Poplar Clonal Trials:

Three poplar clonal trial plantations were established in 2009 using materials newly developed by the University of Minnesota's Natural Resources Research Institute (NRRI) breeding program (Table C1.1). Plantations were composed of 70 clones of hybrid poplars arranged in one-tree plots with 6 blocks per site. The test in Escanaba was established on 6/3/2009, in Skandia on 6/19/2009, and in Brimley on 6/24/2009. Note that Table 1 contains a summary of clones included in a companion planting made in 2008 at the Escanaba site. This planting predates this task but will provide additional information about NRRI clonal performance in Michigan.

All three of the above plantations were maintained in a relatively weed-free condition during the 2009 growing season. Heights and survival were measured, recorded, and summarized at the end of the second growing season in these three plantings. Weed control was difficult due to the climate in summer 2010, which was highly conducive to weed growth. A mid-summer drought also impacted growth of the

plantations, especially poplar at Brimley. An abrupt killing frost in the fall of 2009 also adversely effected the plantations there. Because of these factors it is not clear that any meaningful growth data will be available until after the 2011 growing season.

Two additional 70-clone poplar clonal trial plantations were established as described above in the spring of 2010 to expand the network to a total of five locations (Table C2.1). The test in Lake City was established on 5/23/2010 and near Onaway on 5/22/2010. Maintenance of the plantations continues. Height and survival were measured at the end of the first growing season in these two trials.

Hybrid poplar trials at Escanaba, Skandia, Brimley, Onaway, and Lake City were measured by personnel from the Michigan Forest Biomass Innovation Center for height and survival and monitored for melapsoara rust, Marssonnia leaf spot, septoria leaf spot, and septoria canker. Data files were compiled and distributed to team members for review and analysis. Paul Bloese met with personnel from MFBIC to discuss the data and methods to be used for the analysis and compiled the following summary of results from all five sites. This data is highly preliminary and may only have value as subsequent years' data is collected and compared. All data collected here has been uploaded for inclusion in USDOE's Knowledge Discovery Framework.

Year-2 Results 2009 Plantings

In 2009 a trial of 70 hybrid poplar clones provided by the University of Minnesota was established at three sites in Michigan's Upper Peninsula: Escanaba, Skandia, and Brimley. In fall 2010 height and survival were measured in all three plantings. Measurements collected this early in the rotation have little or no immediate practical application, but may prove useful when re-analyzed with measurements collected throughout the rotation.

Site means for height and survival are given in Table 1. Site effects were significant ($\alpha \leq .01$) for both survival (Kruskal-Wallis test) and height (ANOVA).

Table 2. Site means for survival and height in a poplar clone trial after 2 years of growth at three Michigan sites.

Site	Year-2	
	Survival (%)	Height (cm)
Escanaba	0.97	282
Skandia	0.90	119
Brimley	0.85	45

The percent of the total variation in height accounted for by each of the modeled effects is given in Table C3. After 2 years of field growth site effects dwarfed all other effects in the model for height. Clone effects for height were significant, however clone performance varied widely from site to site. Clone x site effects were more than twice the magnitude of clone effects, and no clones were in the top 10% of the test population at all three sites. After two years of growth clone performance tends to be site specific.

Table 3. Percent of total variation in 2-year height attributable to modeled effects in a hybrid poplar clone trial (all effects significant at $\alpha \leq .01$).

Effect	DF	% of Total Variation
Site	2	87.4
Rep(site)	15	0.7
Clone	68	0.8
Clone * Site	136	1.8
Error	905	9.2

Year 1 Results 2010 Plantings

In spring 2010 a trial of 69 hybrid poplar clones provided by NRRI was established at two northern Michigan sites: Onaway and Lake City. Of these 69 clones, 30 are common to both the 2009 and 2010 plantations. Survival was tallied in both plantations in fall 2010. First year survival was 67% at Onaway and 60% at Lake City. Height was measured in fall 2010 and will be incorporated in future analyses.

Silver Maple Half-sib Progeny Testing

Acer saccharinum seed was collected in the spring of 2010 from twenty-two seed sources throughout the northeastern US and Ontario. These seed were sown and grown in the tree nursery at Michigan State University's Tree Research Center located on Jolly Road in East Lansing, Michigan. Germination and growth were excellent, with successful establishment of planting stock from trees from Michigan, New York, Pennsylvania, Vermont, New Hampshire, Massachusetts, Connecticut, and Ontario. (Figure C1.2) Seedling growth in the nursery was outstanding. Two planting sites were prepared during the fall of 2010. One at the MSU's Dunbar Forest (approximately 10 miles east of the "Brimley" site) and the other on MSU's main campus in East Lansing). Seedlings were lifted from the nursery, prepared, and placed in cold storage in March of 2011. Seedlings were field planted at both sites in May of 2011 and are presently growing well (Figures 3 and 4). Survival in the plantations is excellent they and should yield useful data for projecting the desirability of silver maple as a biofuel species in Northern Michigan, as well as lead to the identification of superior seed sources

Future Needs:

Due to the project having received initial funding later in the calendar year than was expected during the development of the proposal, it was not possible to collect the silver maple seed until May, 2010. In planning the original budget it was expected that funds would be available prior to seed drop in 2009, thus enabling us to collect seed and grow it in the nursery in 2009, field plant it in 2010, and collect the first growth data during Fall of 2011. The delay in the start of funding shifted the seed collection and growing of the planting stock to 2010 and the field planting to 2011. If residual funds could be retained and expended during 2012, in order to maintain the plantations and collect and analyze data, it would greatly increase the impact of this research effort and better enable us to fulfill expectations we had for providing grower recommendations when the project was formulated.

Figure 1. Network of genetic testing sites in Michigan

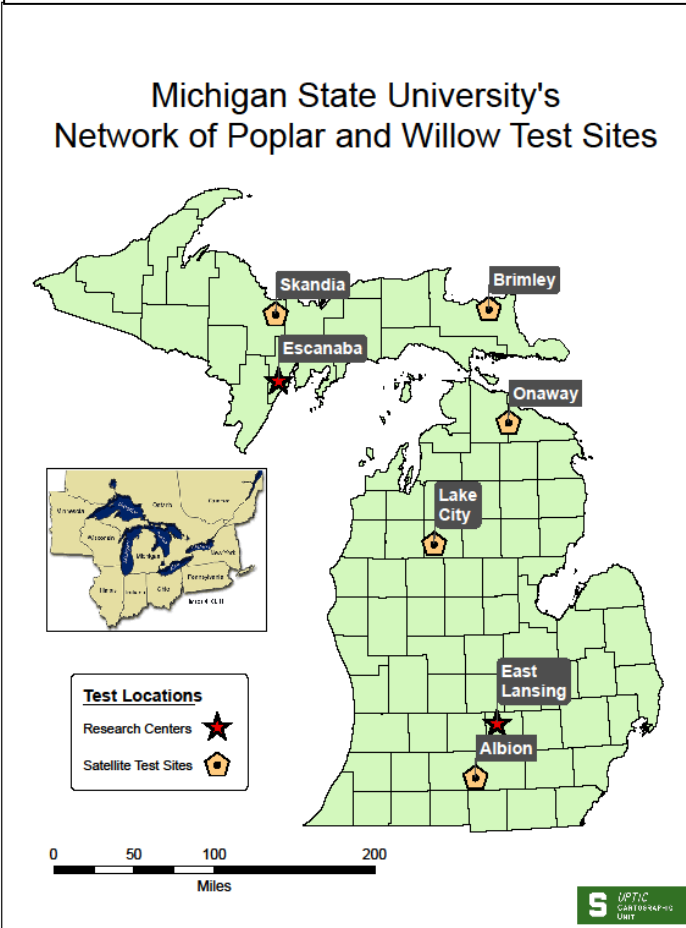


Figure 2. Silver Maple seedlings growing in nursery beds.



Figure 3. Silver maple seedlings at Dunbar Forest in Michigan's Upper Peninsula, 2 months after planting.



Figure 4. Silver Maple Provenance Test. Fall 2011.

Table 1. Poplar clones from NRRI included in Michigan trials.

CloneID	Latin Name	Escanaba08	Escanaba09	Skandia09	Brimley09	Onaway10	Lake City10
22090013	(Populus trichocarpa x deltoides) x deltoides					X	X
22090032	(Populus trichocarpa x deltoides) x deltoides	X					
22091021	(Populus trichocarpa x deltoides) x deltoides	X					
22091022	(Populus trichocarpa x deltoides) x deltoides	X				X	X
23054 30001	NRRI2009		X	X	X		
N944-4	NRRI2009		X	X	X		
21400	NRRI2010					X	X
6300	Populus X euramericana	X					
21700	Populus X euramericana	X	X	X	X	X	X
22700	Populus X euramericana	X	X	X	X		
23300	Populus X euramericana	X	X	X	X	X	X
24400	Populus X euramericana	X					
31500	Populus X euramericana	X					
34400	Populus X euramericana		X	X	X		
41700	Populus X euramericana	X				X	X
22021008	Populus X euramericana	X				X	X
22021009	Populus X euramericana	X				X	X
22021018	Populus X euramericana	X				X	X
22021021	Populus X euramericana					X	X
22021048	Populus X euramericana	X				X	X
22021051	Populus X euramericana	X				X	X
22033013	Populus X euramericana					X	X
22033018	Populus X euramericana		X	X	X	X	X
22057002	Populus X euramericana	X				X	X
22057006	Populus X euramericana	X				X	X
22057011	Populus X euramericana					X	X
22057030	Populus X euramericana	X					
22057032	Populus X euramericana	X					
22057033	Populus X euramericana		X	X	X		
22057059	Populus X euramericana					X	X
22069011	Populus X euramericana	X					
99001111	Populus X euramericana	X	X	X	X	X	X
99007071	Populus X euramericana	X				X	X
99007087	Populus X euramericana		X	X	X		
99007108	Populus X euramericana	X	X	X	X	X	X
99007115	Populus X euramericana	X	X	X	X	X	X
99007116	Populus X euramericana	X				X	X
99008002	Populus X euramericana	X				X	X
99008070	Populus X euramericana	X	X	X	X	X	X
99008080	Populus X euramericana	X	X	X	X		
99008081	Populus X euramericana					X	X
99008098	Populus X euramericana					X	X
99022069	Populus X euramericana		X	X	X		

99037017	Populus X euramericana		X	X	X	X	X
99037039	Populus X euramericana	X					
99037044	Populus X euramericana	X					
99037046	Populus X euramericana		X	X	X	X	X
99037049	Populus X euramericana	X	X	X	X	X	X
99037051	Populus X euramericana		X	X	X	X	X
99037053	Populus X euramericana	X					
99038002	Populus X euramericana		X	X	X	X	X
99038003	Populus X euramericana	X				X	X
99038005	Populus X euramericana	X					
99038007	Populus X euramericana					X	X
99038012	Populus X euramericana	X					
99038013	Populus X euramericana	X	X	X	X	X	X
99038022	Populus X euramericana	X	X	X	X	X	X
99038036	Populus X euramericana	X	X	X	X	X	X
99059016	Populus X euramericana	X	X	X	X	X	X
99059019	Populus X euramericana	X				X	X
99059043	Populus X euramericana	X	X	X	X	X	X
99059066	Populus X euramericana		X	X	X		
99098008	Populus X euramericana	X					
99105008	Populus X euramericana	X				X	X
99105088	Populus X euramericana	X				X	X
23057 32006	Populus X euramericana		X	X	X	X	X
23059 32018	Populus X euramericana		X	X	X	X	X
23071 33040	Populus X euramericana		X	X	X		
23071 33042	Populus X euramericana		X	X	X	X	X
23071 33057	Populus X euramericana		X	X	X		
23074 01609	Populus X euramericana		X	X	X		
23074 16002	Populus X euramericana		X	X	X		
23074 16008	Populus X euramericana		X	X	X		
23074 16037	Populus X euramericana		X	X	X		
23074 37038	Populus X euramericana		X	X	X		
23079 17041	Populus X euramericana		X	X	X	X	X
23079 17047	Populus X euramericana		X	X	X	X	X
23079 17069	Populus X euramericana		X	X	X	X	X
9732-07	Populus X euramericana					X	X
9732-11	Populus X euramericana	X				X	X
9732-18	Populus X euramericana					X	X
9732-19	Populus X euramericana	X				X	X
9732-24	Populus X euramericana	X				X	X
9732-31	Populus X euramericana	X				X	X
9732-32	Populus X euramericana					X	X
9732-36	Populus X euramericana					X	X
9732-40	Populus X euramericana					X	X
9732-48	Populus X euramericana					X	X
DN164	Populus X euramericana	X					
DN2	Populus X euramericana	X					
DN5	Populus X euramericana					X	X

252-4	Populus deltoides					X	X
D113	Populus deltoides					X	X
D124	Populus deltoides					X	X
22066086	Populus deltoides x (Populus trichocarpa x deltoides)	X					
22066094	Populus deltoides x (Populus trichocarpa x deltoides)	X					
23060 26041	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23060 26063	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23070 02099	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X	X	X
23070 27001	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X	X	X
23070 27023	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23070 27061	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23070 33014	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X	X	X
23070 33024	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23076 01391	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23076 01395	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23076 18011	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23076 18019	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23076 20012	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23076 20056	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X		
23076 21006	Populus deltoides x (Populus trichocarpa x deltoides)		X	X	X	X	X
5912917	Populus deltoides x deltoides					X	X
502.37	Populus deltoides X maximowiczii	X					
22007002	Populus deltoides X maximowiczii		X	X	X		
99002003	Populus deltoides X maximowiczii		X	X	X		
99002017	Populus deltoides X maximowiczii		X	X	X		
99002026	Populus deltoides X maximowiczii		X	X	X		
99002030	Populus deltoides X maximowiczii		X	X	X		
152x11861	Populus deltoides X maximowiczii	X					
NC14106	Populus deltoides X maximowiczii	X					
NM6	Populus nigra X maximowiczii	X					
22090013	Populus trichocarpa x deltoides		X	X	X		
52124074	Populus trichocarpa x deltoides		X	X	X		
52124105	Populus trichocarpa x deltoides		X	X	X		
52124144	Populus trichocarpa x deltoides		X	X	X		
52124230	Populus trichocarpa x deltoides		X	X	X		
23001 03057	Populus trichocarpa x deltoides		X	X	X	X	X
23001 03071	Populus trichocarpa x deltoides		X	X	X	X	X
23001 04014	Populus trichocarpa x deltoides		X	X	X		
23010 11022	Populus trichocarpa x deltoides		X	X	X		
23010 11024	Populus trichocarpa x deltoides		X	X	X		
23014 11066	Populus trichocarpa x deltoides		X	X	X		
TOTAL NUMBER OF CLONES per SITE		56	70	70	70	69	69