3.4 Woody Species Survivorship

3.4.1 Total Population Count

Woody plant species survivorship data was collected during a total count of planted woody species individuals within each woodland zone (Appendix 5, Tables 5-1 – 5-12). This total population count is used to calculate woody species survivorship and test the accuracy of the belted transects survivorship estimates discussed in the next section. The woody species performance standard states that "no less than 80 percent of the initially planted species must survive in a similar proportion to the initial planting and show signs of vigor and health."

This summer (2006) all planted woody species were found alive in the woodland community, and species proportions were similar to the initial planting. Therefore, the woody plant stock survivorship performance standard was achieved (Table 11; Appendix 5, Table 5-12). Total survivorship of all woody species individuals has decreased since last year (2005) (Appendix 5, Table 5-11 and Table 5-12). This decline is most likely due to two straight years (2005 and 2006) of extremely dry conditions in the region.

In addition, survivorship declined substantially over the few years prior to 2004 due to mortality during the winters as a result of a much lower than average snow pack. A normal winter snow pack protects the seedlings from cold winter temperatures. Drought conditions during the summer 2003 likely stressed the trees on site and made them more susceptable to harsh winter conditions. The winter after the summer of 2003 was harsh with early winter rain followed by a hard freeze and extended extreme cold temperatures. These harsh weather conditions impacted trees throughout the region, with the WDNR reporting increased coniferous species mortality in early 2004.

In addition to low snow packs during a few winters and drought conditions during a recent summer, observations indicated that deer browsing also most likely contributed to increased mortality among the planted trees on the site. This is supported by the fact that

woody species survivorship is twice as great in the enclosed woodland (Woodland 10) (24%) as the average woody species survivorship in the other 9 woodland sites (12%), (Appendix 5, Tables 5-10 and 5-11).

It should be noted that high tree mortality was anticipated and that woodlands on site were over-planted with woody species. Therefore, the goal of having trees numerous enough to develop into mature woodlands with appropriate structure was achieved. The tree mortality experienced since reclamation was completed is due to natural causes, such as summer drought, harsh winter conditions, and deer browsing. There is no reason to believe that these declines are due to prior mining or any deficiencies in reclamation activities.

The only notable difference in proportions compared to the restoration plan includes those of oaks (*Quercus* spp.) (-12.9%), pines (*Pinus* spp.) (+8.7%), and gray dogwood (*Cornus racemosa*) (-7.3%) (Table 11; Appendix 5, Table 5-12). All other species and species groups have less than a 5% difference between their planned and current (2006) proportion of the woodland plantings. Oaks now represent a smaller portion of the planted woody species than initially planted (27.5% instead of 40.1%). However, it should be noted that they were planned to be, and remain, the largest group of woody species in the woodlands. The pines now represent a larger portion of the woodland community (12.7%) than initially planned (4.0%). The planted pine species are important members of northern mixed forests and their increased relative numbers will benefit the woodlands of the site. In addition, gray dogwood represents <1% of the woody species instead of 7.6%. However, gray dogwood is a resilient and opportunistic shrub that is expected to persist on site.

It should be noted that for purposes of this analysis, species within the same genus were grouped together because they fill similar ecological and habitat niches (Table 11). Furthermore, many of these species (within the same genus) were easily confused in the field because they look very similar in the seedling and young sapling stage and the identifying

labels on all planting stakes have worn off. In addition, the number of living individuals found (and as a result, survivorship) may be higher than reported for some species (e.g., gray dogwood) because they were not planted in tubes and, consequently, were difficult to find.

Table 11. Woody Species: Planned composition compared to current (2006) composition; and current (2006) survivorship (similar species combined). Flambeau Mine, August 2006

Scientific Name	Common Name	Plan Composition		2006 Composition		Difference between 2006 & Plan (%)	2006 Survivorship (%)
		No.	%	No.	%		
Abies balsamea	Balsam	69	2.0%	37	6.4%	4.4%	53.6%
Acer spp.	Maples (3 species)	243	7.1%	37	6.4%	-0.7%	15.2%
Amelanchier arborea	Serviceberry	69	2.0%	8	1.4%	-0.6%	11.6%
Betula spp. & Corylus americana	Birches (2 species), Hazelnut	536	15.7%	71	12.4%	-3.3%	13.2%
Carya cordiformis	Bitternut hickory	23	0.7%	10	1.7%	1.1%	43.5%
Cornus racemosa	Gray dogwood	261	7.6%	2	0.3%	-7.3%	0.8%
Fraxinus americana	White ash	109	3.2%	46	8.0%	4.8%	42.2%
Picea glauca	White spruce	70	2.0%	40	7.0%	4.9%	57.1%
Pinus spp.	Pines (2 species)	138	4.0%	73	12.7%	8.7%	52.9%
Populus tremuloides	Quaking aspen	133	3.9%	29	5.1%	1.2%	21.8%
Quercus spp.	Oaks (3 species)	1379	40.4%	158	27.5%	-12.9%	11.5%
Tilia americana	Basswood	316	9.3%	48	8.4%	-0.9%	15.2%
Viburnum lentago	Nannyberry	69	2.0%	15	2.6%	0.6%	21.7%
Total		3415		574			16.8%
Average						+/-3.9%	

3.4.2 Estimates Based on Belted Transect Data

Stem counts along the nine permanent belted transects that pass through woodland zones (two are considered mixed transects) encountered ten of twenty planted woody species (Appendix 5, Table 5-13). All but two of the ten species had 100% survivorship. The belted transect data is primarily being collected as baseline data for tracking the development of the woodlands on the site. Belted transect data alone does not represent woody species survivorship or diversity of the woodland zones. The total population count discussed in the previous section provides a more precise representation of woody species survivorship and diversity.

3.5 Woody Species Performance

Staghorn sumac (*Rhus typhina*), a woody species that was not planted on site,had the highest stem density and canopy intercept (Appendix 5, Table 5-13). Red raspberry (*Rubus* idaeus) and willow (*Salix* spp.) had the second and third highest stem densities, respectively. Quaking aspen and white pine (*Pinus strobus*), native planted tree species, had the greatest canopy intercept after staghorn sumac. White pine and red pine (*Pinus resinosa*) also had the greatest tree density and basal area. Bur oak (*Quercus macrocarpa*) had the next greatest basal area, while bur oak along with white ash (*Fraxinus americana*) had the next greatest tree density.

3.6 Planted Species Survivorship and Establishment

This section evaluates the success of establishing planted species in the intended and appropriate plant communities. Each species needs only to be found once in the intended community to be considered successfully established. Only species on the "Target Species Planting List" (TSPL) are considered when calculating the sites performance according to this diversity standard (Appendix 6). Species included in the TSPL are all those installed on the reclaimed mine site at or above a minimum planting rate (1oz./acre or 100 plants/acre). If planted with seed, the seed must be from a source that is reliable and tests for viability (i.e., not locally collected seed). Species installed below the minimum planting rate or only locally collected, are included in the reclamation program as enhancement species, to provide an increase in species richness.

Twenty-five target species have been planted in the woodlands, 39 in the wetlands, and 17 in the upland grassland (Table 12). Ninety-two percent (92%) of the woodland species (23 species) were found in the woodland this season (2006) (Appendix 6, Table 6-1A-C and 6-2). Eighty-two percent (82%) of the wetland species (32 species) were found in the wetlands, and Ninety-four percent (94%) of upland grassland species (16 species) were found in that

community this season. Overall 68 of 76 (89%) target species planted on the entire mine site were found (Table 12; Appendix 6, Table 6-5). **Greater than 15 target species were found in the woodland and upland grassland communities and greater than 12 target species were found in the wetland community. In addition, greater than 80% of the Target Species was observed in each plant community. Therefore, the diversity performance standard was achieved in the woodland, upland grassland, and in the wetland.**

Table 12. Percent of target planted species that have been established in the intended plant community on the mine site. Flambeau Mine site. 2006.

Zone/Community	Number of Target Species Planted	Number of Target Species Found	Percent Found in 2006
Woodland	25	23	92%
Wetland(s)	39	32	82%
Upland grassland(s)	17	16	94%
Total species list	76	68	89%

3.7 Stem Counts In Wetlands

Stem counts were to be provided in the 8.5-acre wetland restoration zone(s). During the 1999 field study it became apparent that fulfilling the original intent of this requirement was no longer practical. Each planted and seeded individual had multiplied and, for many species, were now represented by many hundreds to thousands of stems. For all species, the original planted stems were no longer identifiable. Impracticality continued through the 2006 samplings season.

Thus, the following method was used in September 1999, each subsequent year, including in August 2006 to estimate stem density. Stem counts were correlated with percent cover in several quadrats and the relationships are graphed in Figures 2, 3 and 4. For key species in these zones, the number of stems in ¼ of a 1-meter square quadrat was enumerated in a representative number of quadrats in the zone. The range of values is plotted against percent cover based on cover values for these wetland species in the study quadrats.

Figure 2. Projected stem count for Eleocharis spp. and Glyceria spp. based on percent cover in quadrats. September 1999, Flambeau Mine.

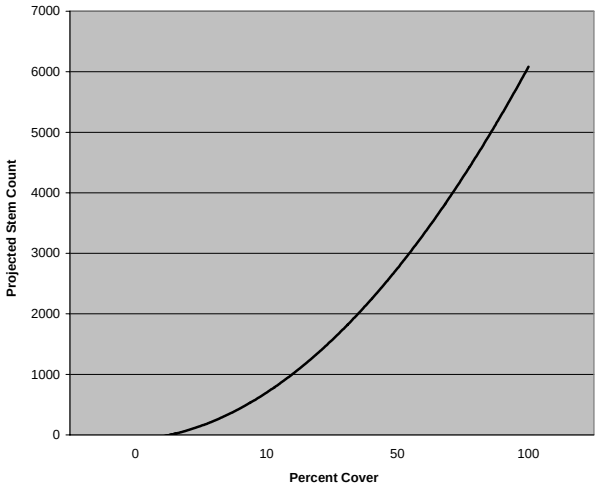


Figure 3. Projected stem count for Sparganium eurycarpum, Acorus calamus, Typha latifolia, and Scirpus validus based on percent cover in quadrats. September 1999, Flambeau Mine.

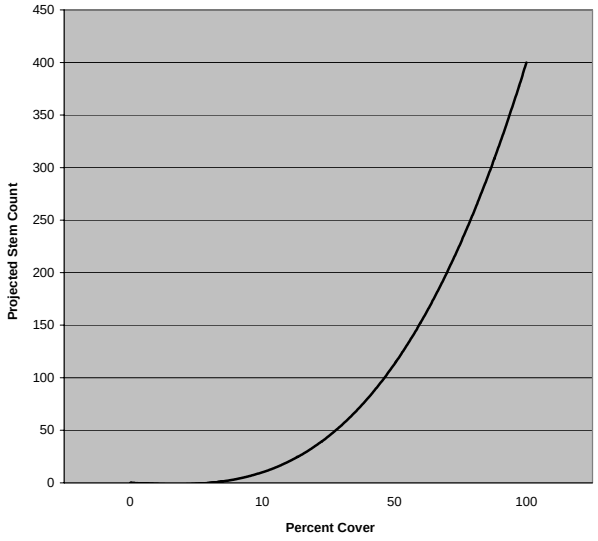
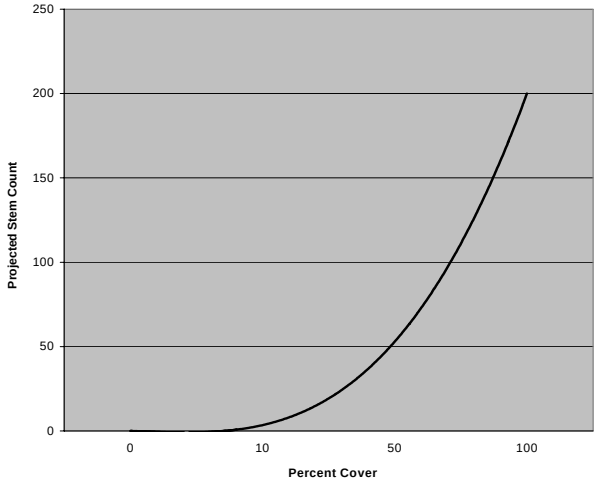


Figure 4. Projected stem count for Pontederia cordata and Sagittaria latifolia based on percent cover in quadrats. September 1999, Flambeau Mine.



Substantially more stems of the planted species were present in 1999-2006 in the wetland than were originally seeded and plugged in 1998. The abundance (% cover) of these species has increased since 1999. Therefore, the density of these graphed species has also increased. When abundance and density of species change, the relationship between percent cover and stem density do not change, but rather the position of the species on the graphed line changes (i.e. moves up or down the line). Observed changes on abundances of graphed species since 1999 are as follows. The abundance of spike rush (*Eleocharis* sp.) has decreased since 2001. The abundance of manna grass (Glyceria spp) (called *Glyceria striata* in past reports) had increased slightly in 2002. The abundance (percent cover) of all measured species increased in 2003 and the density (stem count) changed correspondingly as projected in the graphed projections. No change in abundance was noted for any of the measured species in 2004 or 2005. However, the abundance of vegetation, including all of the graphed species, decrease in 2006 due to extremely dry conditions.

3.8 Biomass Sampling

Fifty one-meter square biomass samples (25 from “burned” areas and 25 from “unburned areas) were collected during the summer monitoring. These samples were collected two meters west of each survey sample point as specified in the biomass sampling protocol (Appendix 7). These samples were sorted by native and non-native vegetation, weighed (wet weight) at the FMC office in the field, and then air-dried and reweighed (dry weight) at the AES office.

The mean total weight and mean native weight of the burned area samples is 559g and 346g, respectively (Appendix 7, Figure 7-1 and Table 7-1). The mean total weight and mean native weight of the unburned area samples is 658g and 436g, respectively (Appendix 7, Figure

7-2 and Table 7-2). The mean total weight and mean native weight of all samples is 609g and 391g, respectively (Appendix 7, Figure 7-3 and Table 7-3).

The total and native running means are beginning to stabilize in both the burned area and unburned area samples, indicating that the sample size in each group of samples was sufficient (Appendix 7, Figures 7-1 and 7-2). When all samples are pooled, the mean appears to stabilize well before the 50th sample (Appendix 7, Figure 7-3).

The mean total weight and mean native weight of the burned area samples are 84g and 174g greater than in 2001, respectively. The mean total weight and mean native weight of the unburned area samples are 117g and 274g greater than in 2001, respectively. The mean total weight and mean native weight of all samples are 101g and 219g greater than in 2001, respectively.

All analyses document that biomass, both native and total, is greater in all areas of the Upland Grassland in 2006 than in the year of NOC (2001). **The performance standard of having no less than 80% of the biomass at NOC present at COC has been met.**

4. DISCUSSION

The major portion of the Flambeau Mine site was seeded with a partial complement of the reclamation seed mixes in spring 1998, and the remainder of the site was seeded with the same seed mixes in the fall 1998. Some seeds that could not be otained in 1998 were added in early summer 1999, and some supplemental planting occurred in spring 2000. All originally planned plantings were completed in 2001 in addition to supplemental plantings in the woodlands.

In fall 1998, the majority of the site was dominated primarily by cover crop species and agronomic leguminous species typically associated with roadside stabilization projects. This initial flush of agronomic species was anticipated because these species typically dominate the