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2000 ANNUAL REPORT
Area 8, Phase I Revegetation Research Plots
Miami University Task Order 012

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Revision 1

Introduction

This report is the second annual report required under Miami University Task Order No. 12, Area 8, Phase I Revegetation Research Plots. In 1999, eight 1,000 m^2 research plots were established on Fernald site property in the vicinity of the Fernald Ecological Restoration Park. Six of these plots were planted with some combination of seedling and sapling trees, while two plots served as controls. Figure 1 (attached) shows the location of each plot within Area 8, Phase I. Miami University is studying the effects of various seedling and sapling densities with respect to ecological restoration designs, as well as the extent of herbivore damage and volunteer recruits into formerly grazed pasture.

Miami University personnel visited the Fernald site several times in 2000. Data were collected with respect to seedling and sapling survival, volunteer recruitment, and herbivore damage. A summary of the interim findings from 2000 is provided below.

New Plantings

The Chinquapin Oak seedlings, which were unavailable for planting in 1999 were installed in April 2000 as per the original planting design. Tree tubes were installed around one-third of the seedlings. The seedlings appeared to be thriving throughout the summer; however, exact survival figures will not be available until the seedlings are resampled in the Spring of 2001.

Tree Seedling Survival

As indicated by Figure 2, the response of tree seedlings to the tree tubes varied greatly among species and plots; however, an analysis of variance (ANOVA) indicated that the presence of tubes did not significantly effect overall seedling survival (P = 0.89). On first glance, this would indicate that the use of protective tubes on seedlings was not necessary since they did not effect overall survival. However, the data clearly indicate that individual species responded to the presence of tubes in opposite manners, thereby masking the overall effect of tubes on survival (Figure 3). The individual species response to the presence/absence of tubes was highly significant (P<0.01). The *Juglans* and *Aesculus* seedlings had much greater survival when placed in tubes; however, the untubed *Celtis* and *Fraxinus* seedlings exhibited the opposite response (Figure 3). The tubes were primarily installed in order to prevent damage by large herbivores (deer, groundhogs, rabbits). However, there was very little evidence of herbivore browsing on the untubed seedlings. It is likely that the tubes provided some wind protection and increased humidity which may have helped the larger, nut-derived seedlings survive the drought of 1999.

Term	DF	Mean Square	F-Ratio	P Level	Power (Alpha = 0.05)
Plot (A)	3	7.5 E-02	4.19	0.01*	
Species (B)	3	0.31	17.78	0.00*	0.99
Tube (C)	1	4.9 E-04	0.03	0.89	0.05
BC	3	7.5 E-03	0.42	0.74	0.11
S	21	1.7 E-02			
Total	32				

*Term significant at Alpha = 0.05

Figure 2

ANOVA results did indicate significant differences in location of plot and how individual species responded to the protective tubes. The significant differences related to location are most likely a reflection of microsite differences in temperature, humidity, and soil moisture.

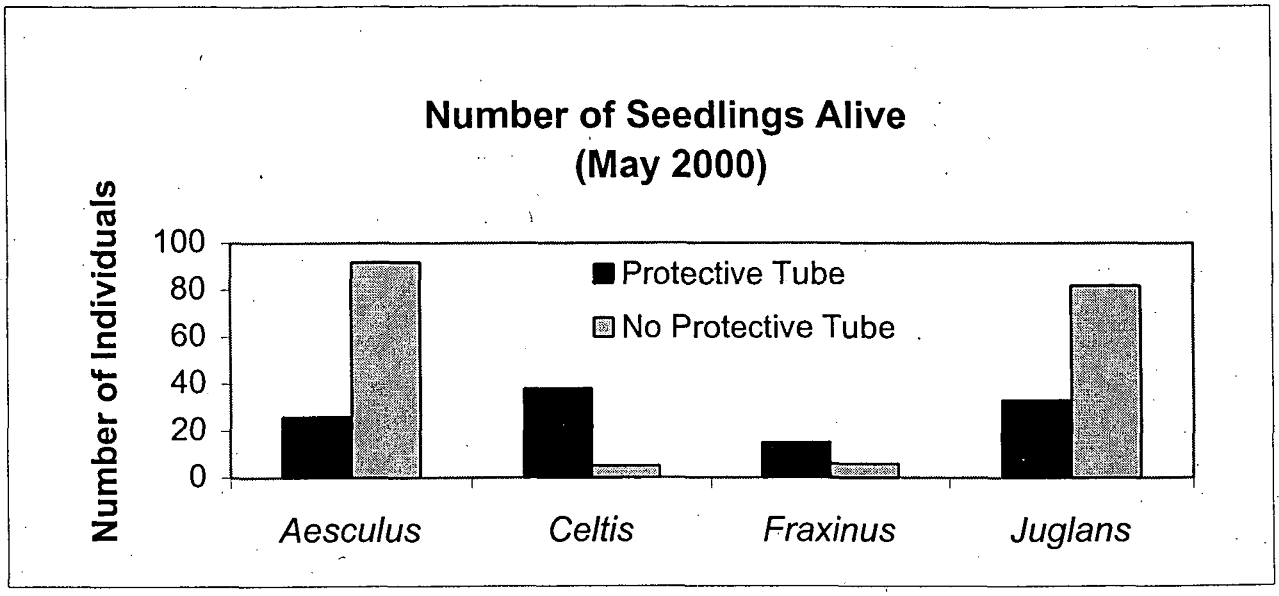

Figure 3.

Seedling survival, calculated one year after planting, was rather disappointing for most of the species but not altogether unexpected given the severity of the 1999 drought (Figure 4). Surprisingly, 34% of the *Aesculus* seedlings were thriving when censused in May of 2000.

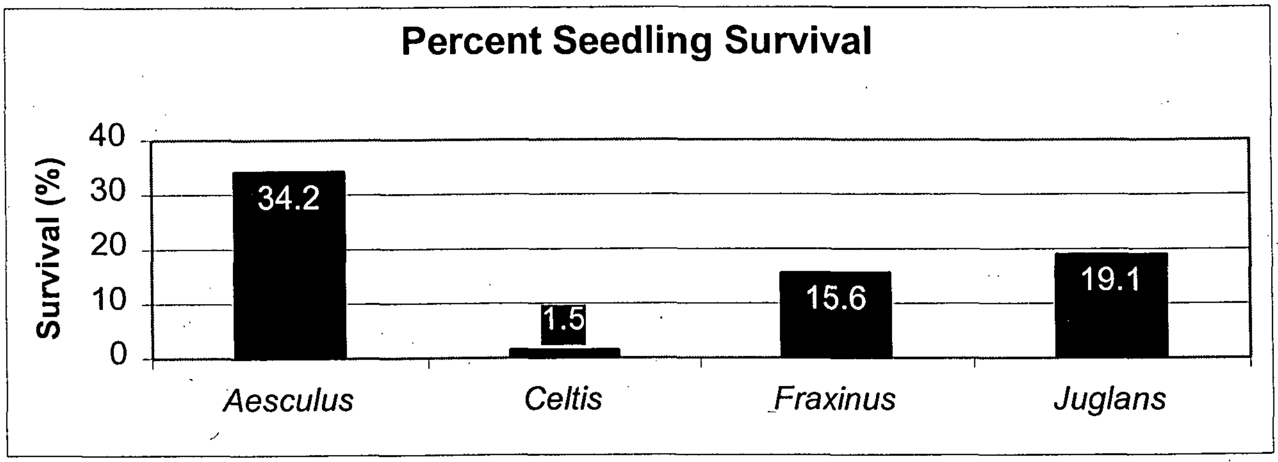

Figure 4.

A large proportion of the seedlings which were alive in the Fall of 1999 died during the winter/early spring of 2000. Approximately 480 seedlings died during this time as a direct result of vole damage. The vole damage included bark stripping on roots and stems as well as complete separation of the stem from the root system. Although there was much concern during the planning stages of this experiment concerning deer herbivory, there were no provisions made in the task order to provide protection from voles. The data suggest that damage to seedlings by voles and other small mammals is much more severe than previously reported in the literature. The site of this study, a former pasture, is prime habitat for small rodents. If similar sites are to be planted in the future, it will be necessary to provide some type of buffer strip between the seedlings and existing grassland vegetation. Other protective devices including mesh screening, or gravel around the base of each seedling may help to provide some protection.

Seedling Recruitment

All woody recruits were identified and marked in May of 2000 (Table 1). Several "desirable" tree seedlings including *Aesculus, Fraxinus, Juglans*, and *Morus* species were well established. Unfortunately there were also several "undesirable" species including *Toxicodendron*, *Vitis*, and *Rosa*. An especially high number of *Toxicodendron* (poison ivy) and *Vitis* (grapevine) recruits were found in Plot B. Both species are found adjacent to the plot. Also, a large branch that was entangled with *Toxicodendron* fell into the plot in Spring 2000. Many of the *Toxicodendron* recruits were probably introduced at that time. Surprisingly there were no *Lonicera maackii* (Amur honeysuckle) individuals, despite the fact that the study site is surrounded on three sides by dense patches of the invasive shrub. It is likely that the dense turf mat is preventing *Lonicera* establishment, but it is curious that *Vitis* seedlings, which have a similar dispersal/establishment mechanism, were found in 5 of the 6 plots. It is possible that the current seed input study being conducted by Ohio University student Curt Hartman will help to explain recruitment at this site.

Woody recruits should continue to be censused and tagged for the next several years in order to monitor the natural succession of this site. The planted *Aesculus* saplings produced nuts in both 1999 and 2000, so it is possible that some of the Buckeye recruits were offspring from the recently planted individuals. However, none of the other planted saplings are of reproductive age, so woody recruits must have come from adjacent seed sources. It may be of interest to map the location of the recruits with the nearest seed source in order to predict optimal "patch size" for future planting projects at FEMP.

Table 1. **RECRUIT DATA (May 2000)**

	Plot ID and Type						
	B Control	G Control	C Seedling	D Mixed	E Mixed	F Seedling	
Genus							**Total**
Acer				1			**1**
Aesculus	16			4		4	**24**
Crataegus	1						**1**
Fraxinus			1				**1**
Gleditisia	8	13	9	1	10	14	**55**
Juglans				2			**2**
Morus						1	**1**
Rosa	1		1	1	1	1	**5**
Toxicodendron		88					**88**
Ulmus	1						**1**
Vitis		31	4	2	4	3	**44**
Total number per plot	**27**	**132**	**15**	**11**	**15**	**23**	**223**

Sapling Status

The saplings were assessed for health, herbivore browsing and damage, and annual growth on October 1, 2000. A total of 78% of the 300 trees were alive, 8% were either root sprouting or producing epicormic sprouts and 14% were completely dead (Figure 5). Several of the trees which were considered to be alive (active sprouting) in May of 2000, had died by the time the trees were censused in October.

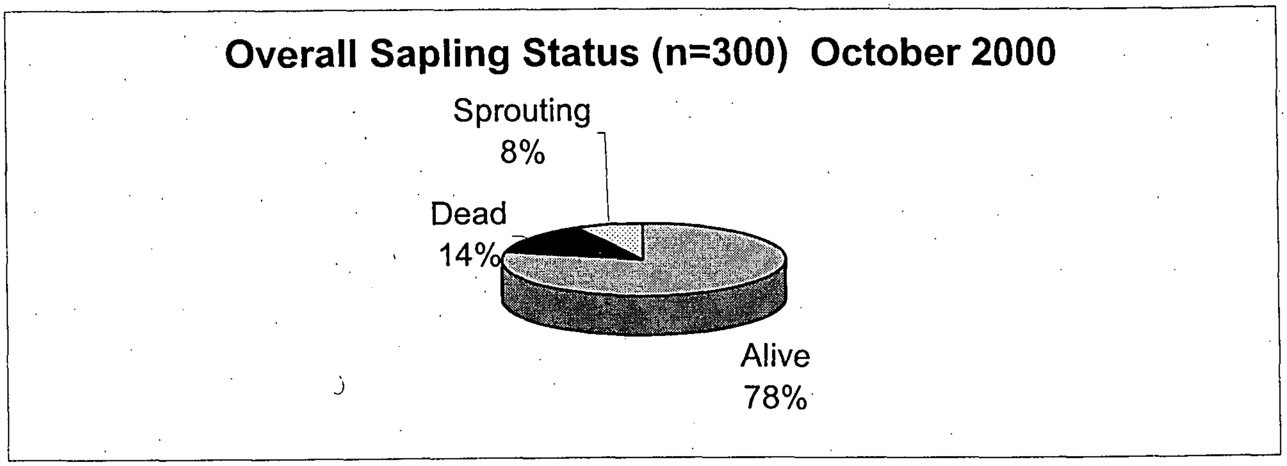

Figure 5.

Survival (not including resprouts) ranged from a high of 93% for *Aesculus* to a low of 65% for *Fraxinus* saplings (Figure 6). Mortality was lowest (1.6%) for *Quercus* saplings and greatest for *Celtis* saplings which had 13% death. The majority of these trees succumbed from drought stress which was previously noted in the 1999 annual report. Resprouting varied greatly among the species. None of the *Aesculus* saplings exhibited any type of sprouting, but 25% of the *Fraxinus* and 28% of *Juglans* had active sprouts in October (Figure 6). If all of the trees that are currently resprouting survive, survival averages will range from 86 to 96%. These averages are very impressive considering the extreme drought stress the young trees faced during their transplant year.

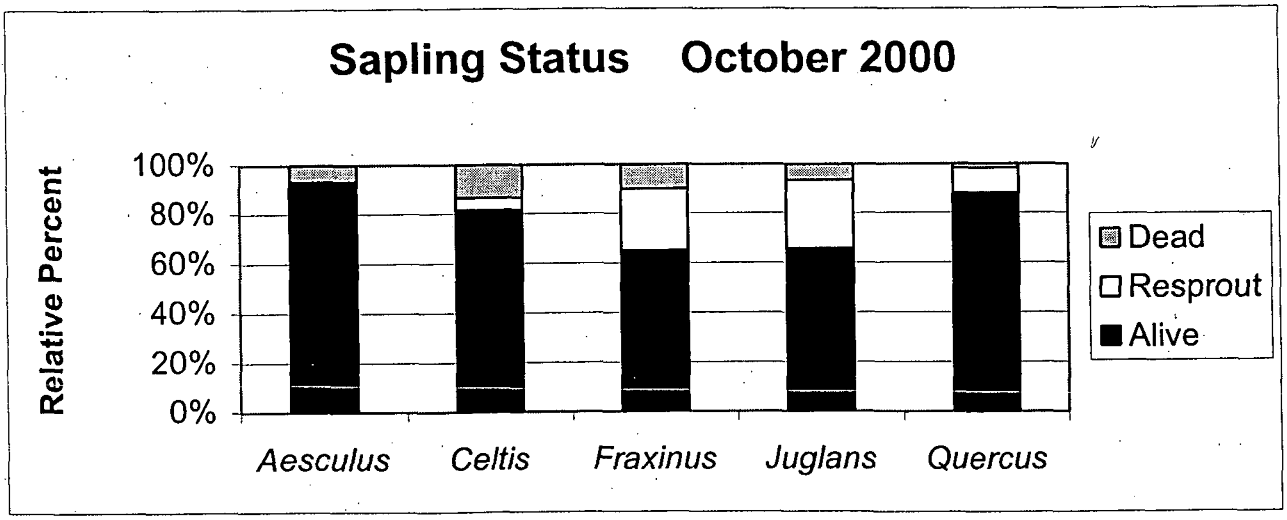

Figure 6.

All saplings were assessed for herbivore damage in the Fall of 1999 and in the Fall of 2000 (Figure 7). The majority of the deer browsing observed occurred early in the growing season of 1999 with 28% of the trees being browsed to some degree. The majority of the browsing was confined to the removal of a few of the lower terminal buds. Browsing dramatically decreased in 2000 with only 5% of the trees being damaged by herbivores. Deer rubbing was much higher in 1999 (22%) compared to 14% in 2000 (Figure 7). Vole damage does not appear to be a major factor (6% in 1999 and 1% in 2000); however, it should be noted that when the trees were affected, the damage was usually severe.

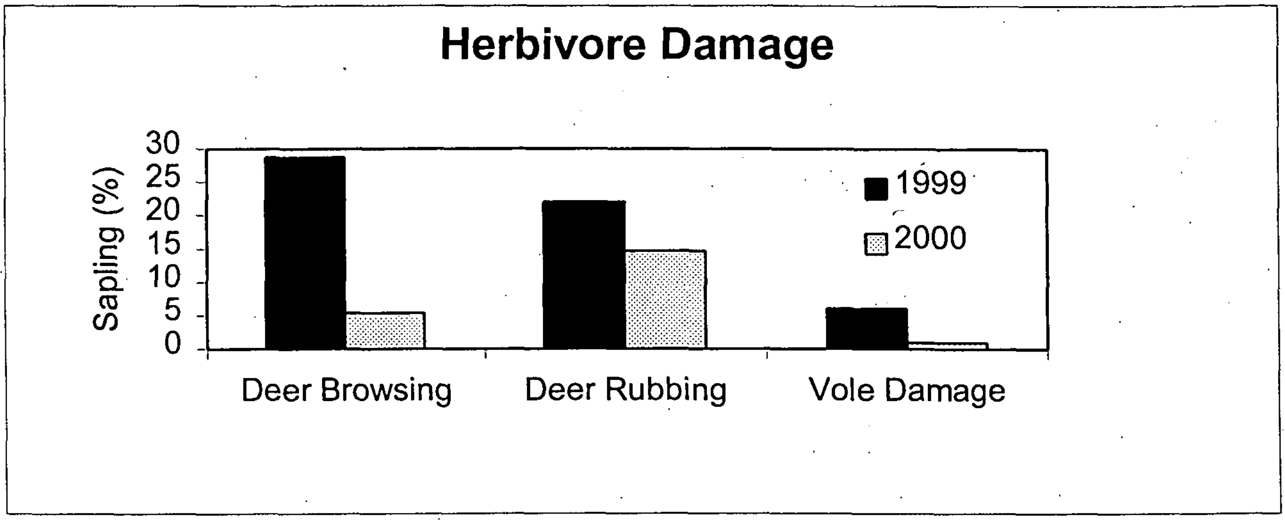

Figure 7.

As previously stated, deer browsing was much more severe in 1999 than in 2000 (Figure 8). The deer obviously had feeding preferences; 93% of the *Quercus* and 35% of the *Aesculus* were browsed in 1999. None of the *Celtis* saplings have ever been browsed; although this may be more related to sapling height than taste preference. All of the *Celtis* saplings were well over 10 feet tall, with no branches available at "browse" height.

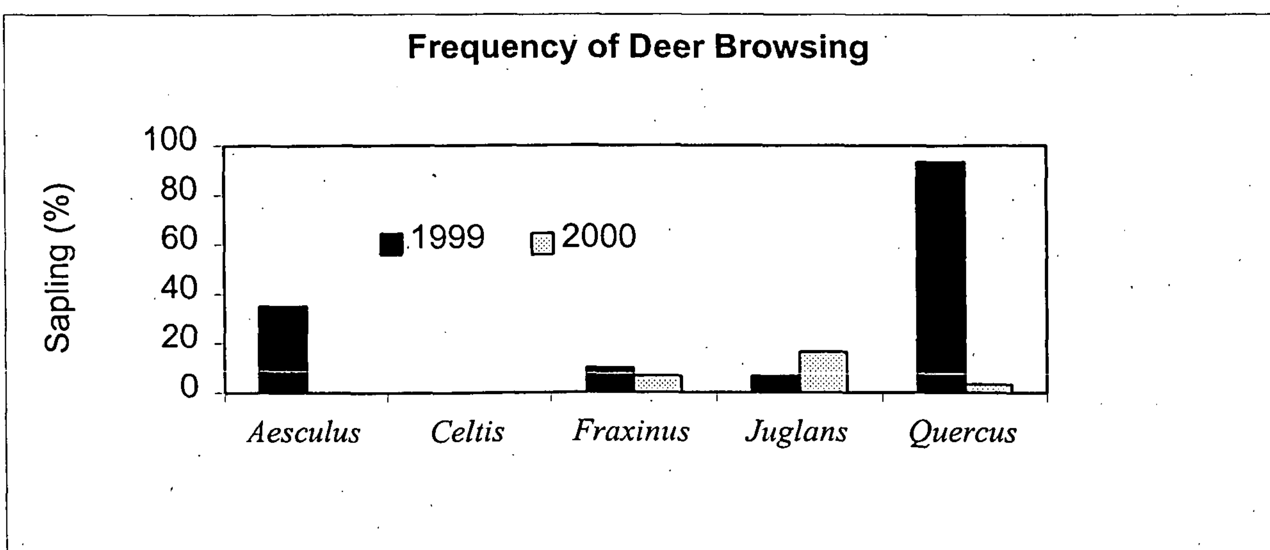

Figure 8.

Deer rubbing was also much more intense in 1999 than in 2000 (Figure 9). This may be an artifact of sampling dates. The 1999 survey was conducted on October 18 while the 2000 survey was conducted on October 1. Also, protective tubes were installed on the saplings in late September 2000. The deer exhibited preferences when it came to rubbing: *Fraxinus* and *Quercus* trees were most "desirable"; while *Celtis* and *Juglans* were seldom rubbed (Figure 9). This information would indicate that there is little need to install protective tubing on some species, while protective tubes could potentially benefit "at risk" species.

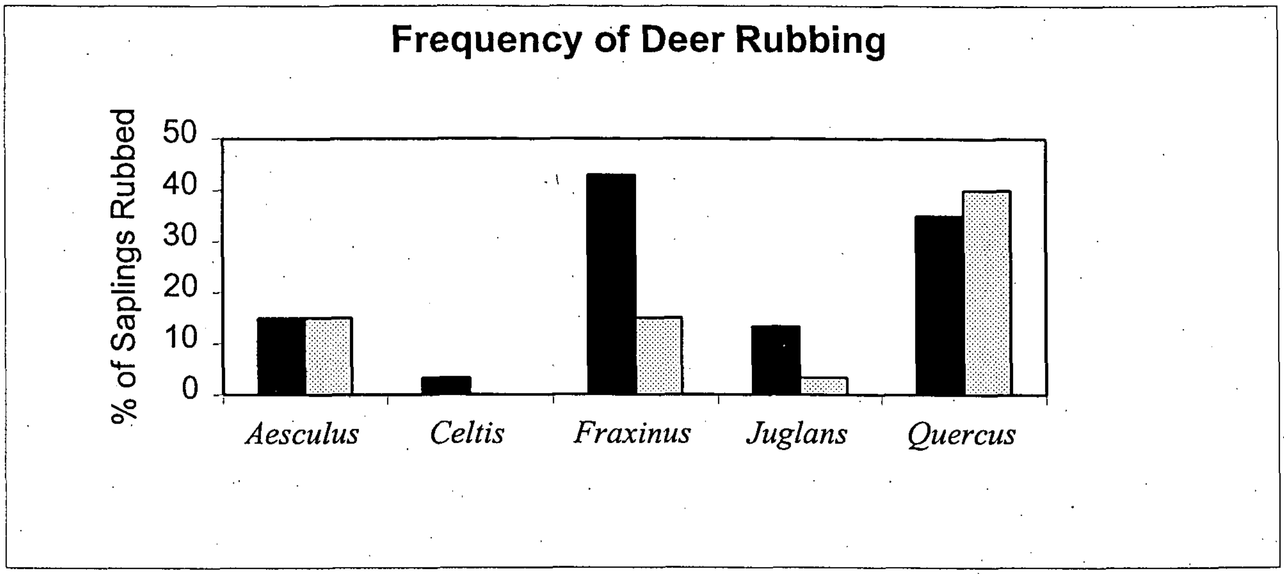

Figure 9.

In order to establish some type of quantifiable method of assessing damage related to deer rubs, a severity index was established during the census of 1999. Each stem was divided into quadrants, and a score of 0 (no rub) to 4 (rub completely girdling the stem) was obtained for each sapling (Figure 10). It should be of interest that the majority of the trees were never rubbed [78%, (n=234) in 1999 and 86% (n=256) in 2000]. When rubbing did occur, damage was more severe in 1999 than in 2000 (Figure 10). Approximately 9% of the trees received a score of 3 or 4 in 1999 compared with only 4% in 2000. None of the trees in 2000 received a score of 4, which may have to do with the timing of the census, the fact that tubes were installed on the trees, or less interest by the deer.

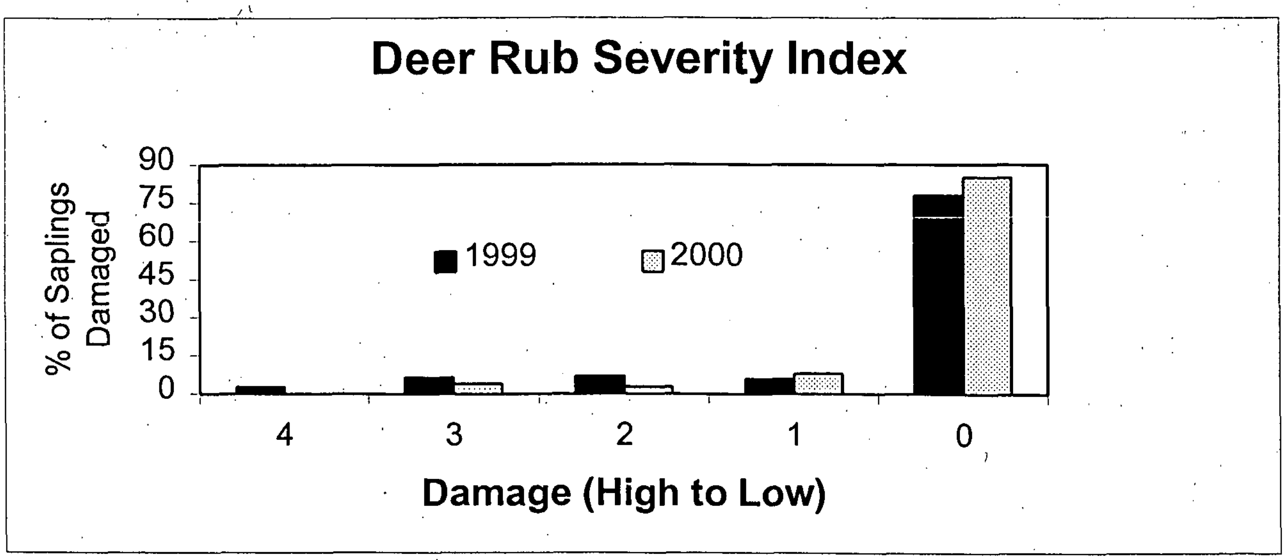

Figure 10.

Of the 300 saplings planted, 27 individual trees (9%) received a rub severity score of 3 or 4 in 1999 (Figure 10). In order to determine the fate of the trees after being severely rubbed, the individual trees were assessed in October of 2000. Fifty-two percent of the trees were alive and the trunks had produced callus tissue over the rubbed area. Forty-one percent of the severely rubbed trees had resprouted either by producing epicormic sprouts above the rubbed area, or by producing root sprouts. Two of the 27 trees (7%) which were severely rubbed in 1999 were dead in October 2000 (Figure 11). These preliminary data suggest that it may be unnecessary to protect trees from rubbing given that 0.6% of the 300 planted trees actually died as a result of rubbing. These data however are preliminary and continued monitoring of the trees on this site could provide valuable information for future management decisions. It is possible that all of the severely rubbed trees may eventually die as a result of secondary infections or water transpiration issues.

DOE experienced severe deer rub damage across the site in 1999. Because of this, it was decided to install protective tubes on all planted saplings at the site. Labor and material to install 300 tree tubes within the revegetation research plots cost approximately $2,000. DOE justified this action, since deer rubs within the research plots will potentially result in over $3,000 damage (if all 27 severely rubbed trees die). Because the tubes were installed in September 2000, further rub data will not be collected.

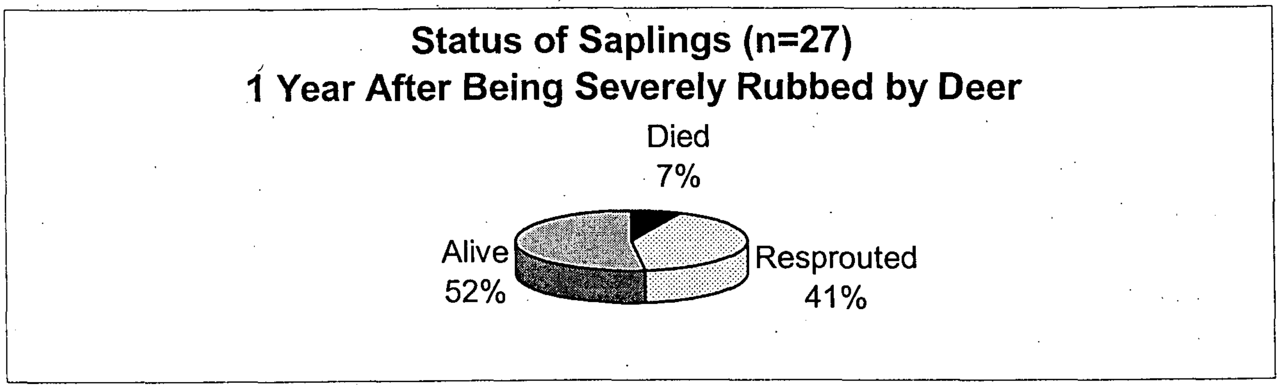

Figure 11.

The annual growth rate was determined for each of the trees by comparing the incremental change in diameter from 1999 to 2000. Diameters were obtained in the same manner as the previous year by using electronic calipers around the trunk of the tree 1 meter above the soil surface. Growth rates ranged from an average of 2.4 mm in *Quercus* to 1.4 mm in *Celtis* (Figure 12). It is interesting to note that *Quercus* saplings experienced the greatest deer damage (browsing and rubbing), yet still had the highest growth rate of the five species being investigated.

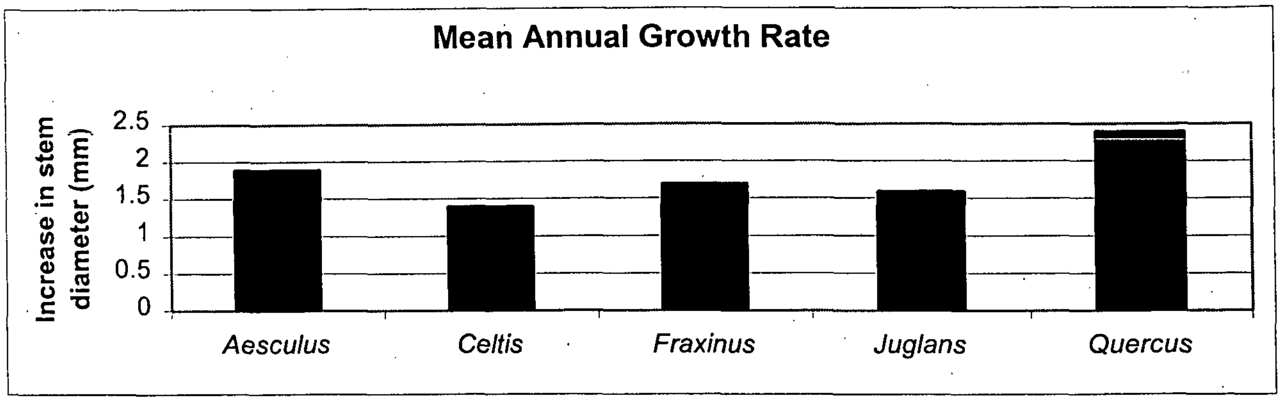

Figure 12.

Fungal sporocarps were observed on several of the trees during the October 2000 census (Figure 13). Fungal infections are often present on trees that have been previously weakened or damaged by other stresses. It is likely that the drought of 1999 followed by the wet summer of 2000 is responsible for the presence of the fungal infections. Approximately 43% of the *Celtis* saplings, 21% of the *Quercus*, 15% of the *Juglans*, 11% of the *Aesculus*, and 2.5% of the *Fraxinus* are currently infected (Figure 13). Careful monitoring of the trees early in 2001 is vital since it may be necessary to apply a fungicide in order to prevent further sapling injury and possible death. Although there is quite a bit of evidence that tree tubes promote the growth of fungal diseases, the current infections are not related to the installation of the tree tubes since they were only installed one week prior to the census.

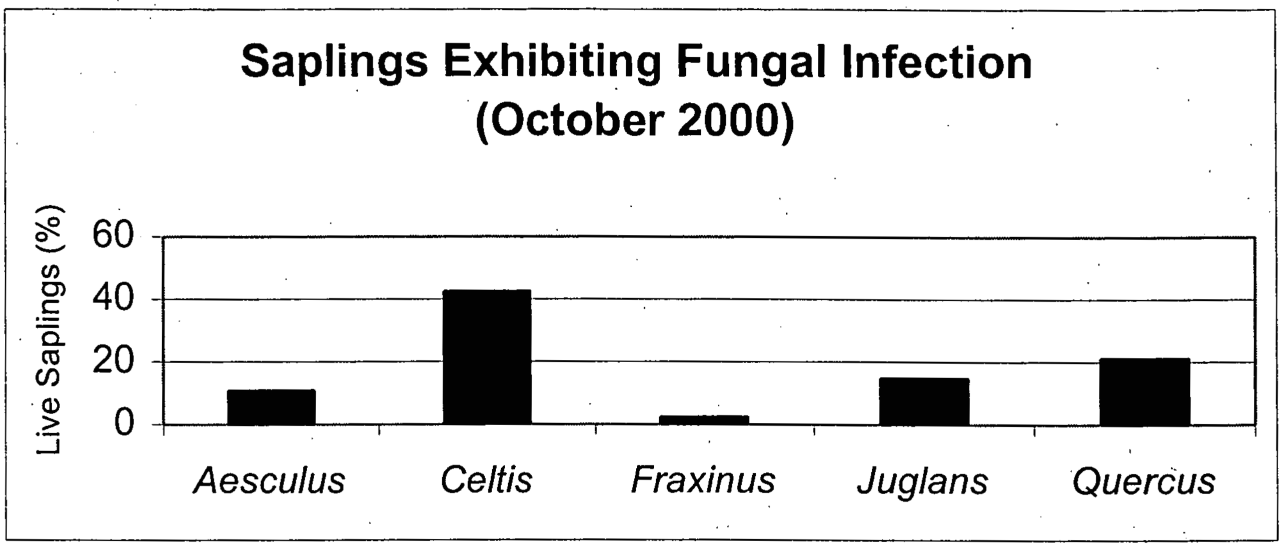

Figure 13.

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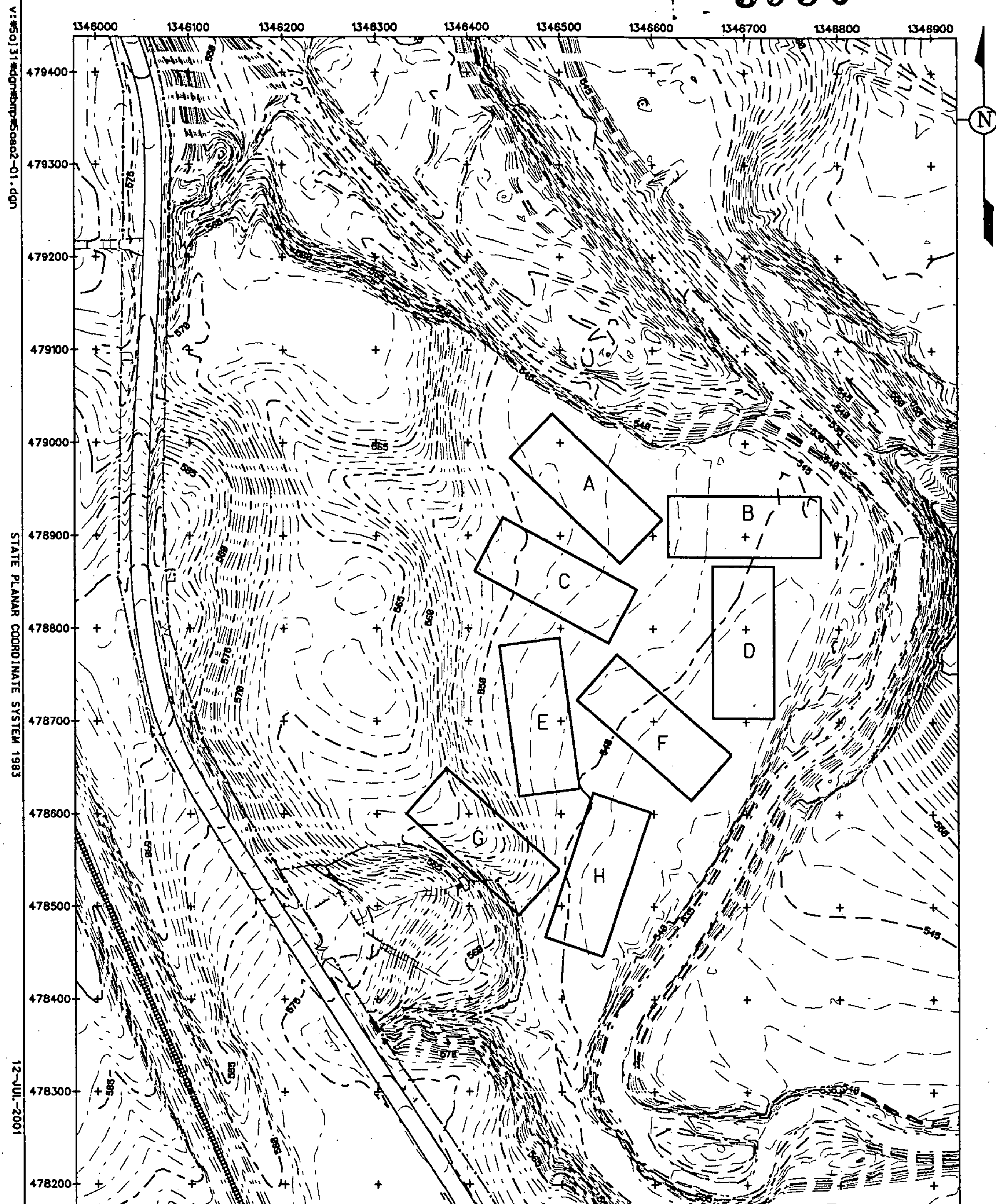

PLOT ID:	TYPE:	PLOT ID:	TYPE:
A	SAPLINGS	G	CONTROL
B	CONTROL	H	SEEDLINGS
C	SEEDLINGS		
D	SAPLING/SEEDLING MIX		
E	SAPLING/SEEDLING MIX		
F	SEEDLINGS		

SCALE

150 75 0 150 FEET

FIGURE 1. A8PI REVEGETATION RESEARCH PLOTS