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Experimental Design for the Area 8, Phase I Revegetation Research Plots

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Prepared for:

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In support of the Area 8, Phase I tree revegetation research project, Miami University and Ohio University personnel surveyed three plots adjacent to the planned restoration area on July 9, 10, 18, and 19, 1998 (Figure 1). Table 1 provides the sample data for the three plots. Plot No. 3 was mapped to understand the local natural spacing pattern of lowland forest stems. This plot revealed exactly 102 individual stems that were even-aged in origin and low in diversity (14 species were present, 5 were dominant or co-dominant). Based on these findings, the planting plan for the eight research plots was revised as follows.

First, we plan to plant 2 of the study plots with 100 even-aged saplings of 5 species. The stands immediately adjacent to the planting areas are early successional forests containing mostly weedy tree species; however 4 of the 5 species that we are planting were present in the surveyed stands (Table 1). A minor adjustment was also made in the species composition to account for availability in the local nursery stock (green ash substituted for blue ash). The final species composition reflects the distribution found in a mature, relatively undisturbed lowland forest adjacent to Paddy's Run which was surveyed and evaluated by Dr. Brian McCarthy. Three of the five species that we are planting; Ohio buckeye, chinqapin oak, and black walnut, are long lived hardwood species that will eventually become an excellent food source for wildlife. The remaining two species, hackberry and green ash, are hardy species often found in disturbed areas. They were very plentiful in the adjacent wooded area which was mapped.

Next, two mixed plots (saplings and seedlings) will be established to better mimic a multidimensional uneven-aged structure found in mature forests. These forests always contain a relatively low density of mature species and a high density of reproducing recruits. Because of the land use history throughout FEMP, we were unable to secure a site to estimate seedling density, so approximations from the literature for lowland forest sites were used. Thus there is a low density of saplings and a high density of seedlings.

The third approach involves two plots containing only seedlings. These plots are designed to mimic standard restoration efforts and to examine if present practices are sufficient. We are hypothesizing that the planting of seedlings without follow up management would not be sufficient, since they provide only one structural layer, are in heavy competition with herbaceous plants, are under heavy browsing pressure, are susceptible to drought and winter kill, and they suffer high mortality at any time of the year.

Figures 3 and 4 show the planting distribution for the five different sapling species, both for the sapling only and the sapling/seedling plots. Seedlings will be planted in accordance with the randomized design shown on Figure 5. A 10x10 m grid system was generated by programming a randomization routine to assign stems to X,Y coordinates. There will be 10 such sub-grids within each 20x50m plot. The sub-grid will be randomly rotated for all 10 areas

within a plot in order for the plantings to be statistically random. The five different shadings on the Figures represent the five different sapling species that will be planted. The five species have not yet been assigned a shading designation. This will be done once the plots have been flagged in the field and the supplying nursery contacted to color-code the saplings upon delivery. As stated above, the mapped reference site did not determine what specific species to be planted, but rather what densities and distributions to use.

The two control plots will provide areas in which to monitor successional changes in the vegetation and the natural establishment rate of woody species. The control plots will be monitored twice a year (Spring and Fall) and new tree recruits within the control plots will receive tree tubes to protect them from herbivore damage.

Half of the seedlings from each treatment will be placed inside of a tree tube to determine if survival is enhanced. Because of the immediate protection from browsing animals, increased humidity and carbon dioxide levels, we will most likely see reduced mortality and increased growth rates when compared to seedlings without tubes. However, the use of tubes quadruples the cost of planting seedlings because of increased materials and labor. Part of the econometric aspect of this study is to evaluate cost versus performance in order to make recommendations for future restoration efforts at FEMP.

The experimental design of the study will also allow us to compare natural succession (in the control plots), with our restoration efforts. The three experimental treatments (saplings only, seedlings only, and saplings + seedlings), will allow us to determine if there is any benefit to planting a few large trees amongst the seedlings. There is a considerable bank of literature which indicates that large trees may act as "perches" and "safe sites" which encourages birds and other animals to visit the area. Many of the tree species found in early successional stands are bird and animal dispersed. It will be interesting to see if the presence of the large trees accelerates the successional process. The saplings may also tend to modify the climate around the seedlings which may also help to promote their establishment. On the other hand, perches might promote the establishment of non-native invasive species. Again, econometric considerations will be evaluated with respect to the overall benefit of the various approaches.

Table 1

Reference Plot A data

Species	Density	Basal Area
ACNE	173	0.967
ACSA	1	0.096
AEGL	8	0.016
ASTR	1	0.000
CEOC	4	0.085
FRQU	20	0.057
JUNI	8	0.540
LITU	1	0.062
LOJA	10	0.021
MAPO	3	0.079
PLOC	25	0.573
PRSE	12	0.293
ROPS	18	0.292
ULRU	1	0.002
Totals	285	3.084 m2 / 0.1 ha
Totals	2850	30.842 m2 / 1.0 ha

Reference Plot B data

Species	Density	Basal Area
ACNE	30	1.347
ACSA	1	0.041
AEGL	1	0.000
CEOC	29	0.431
GLTR	1	0.105
JUNI	6	0.365
PLOC	1	0.503
QUBI	15	0.694
QUMU	3	0.027
ROPS	4	0.277
ULRU	2	0.097
Totals	93	3.887 m2 / 0.1 ha
Totals	930	38.868 m2 / 1.0 ha

Reference Plot C data *mapped plot

Species	Density	Basal Area
ACNE	68	1.52
ACSA	1	0.01
AEGL	1	0.00
CEOC	2	0.02
CRSP	1	0.00
GLTR	2	0.13
JUNI	2	0.07
PRSE	4	0.11
ULRU	21	0.38
Totals	102	2.24 m2 / 0.1 ha
Totals	1020	22.43 m2 / 1.0 ha

Species List

ID	Scientific Name	Common Name
ACNE	*Acer negundo*	Box Elder
ACSA	*Acer sacharum*	Sugar Maple
AEGL	*Aesculus glabra*	Ohio Buckeye
ASTR	*Asimina triloba*	Pawpaw
CEOC	*Celtis occidentalis*	Hackberry
CRSP	*Crataegus sp.*	Hawthorn
FRQU	*Fraxinus quadrangulata*	Blue Ash
GLTR	*Gleditsia tricanthos*	Honey Locust
JUNI	*Juglans nigra*	Black Walnut
LITU	*Liriodendron tulipifera*	Tulip Poplar
LOJA	*Lonicera japonica*	Amur Honeysuckle
MAPO	*Maclura pomifera*	Osage Orange
PLOC	*Platanus occidentalis*	Sycamore
PRSE	*Prunus serotina*	Black Cherry
QUBI	*Quercus bicolor*	Red Oak
QUMU	*Quercus muhlenbergii*	Chinqapin Oak
ROPS	*Robinia psuedoacacia*	Common Locust
ULRU	*Ulmus rubra*	Slippery Elm

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TABLE 2
AREA 8, PHASE I REVEGETATION RESEARCH PLOTS
PLANTING CHART

Plot	Total # of Trees to be Planted	Breakdown by Species
A	600 Seedlings	120 of each: Buckeye (*Aesculus glabra*), Hackberry (*Celtis occidentalis*), Green Ash (*Fraxinus pennsylvanica*), Chinqapin Oak (*Quercus muehlenbergii*), Black Walnut (*Juglans nigra*)
B	100 Saplings	20 of each: Buckeye (*Aesculus glabra*), Hackberry (*Celtis occidentalis*), Green Ash (*Fraxinus pennsylvanica*), Chinqapin Oak (*Quercus muehlenbergii*), Black Walnut (*Juglans nigra*)
C	Control	0
D	50 Saplings/600 Seedlings	10 Saplings and 120 Seedlings of each species: Buckeye (*Aesculus glabra*), Hackberry (*Celtis occidentalis*), Green Ash (*Fraxinus pennsylvanica*), Chinqapin Oak (*Quercus muehlenbergii*), Black Walnut (*Juglans nigra*)
E	50 Saplings/600 Seedlings	10 Saplings and 120 Seedlings of each species: Buckeye (*Aesculus glabra*), Hackberry (*Celtis occidentalis*), Green Ash (*Fraxinus pennsylvanica*), Chinqapin Oak (*Quercus muehlenbergii*), Black Walnut (*Juglans nigra*)
F	600 Seedlings	120 of each species: Buckeye (*Aesculus glabra*), Hackberry (*Celtis occidentalis*), Green Ash (*Fraxinus pennsylvanica*), Chinqapin Oak (*Quercus muehlenbergii*), Black Walnut (*Juglans nigra*)
G	100 Saplings	20 of each species: Buckeye (*Aesculus glabra*), Hackberry (*Celtis occidentalis*), Green Ash (*Fraxinus pennsylvanica*), Chinqapin Oak (*Quercus muehlenbergii*), Black Walnut (*Juglans nigra*)
H	Control	0

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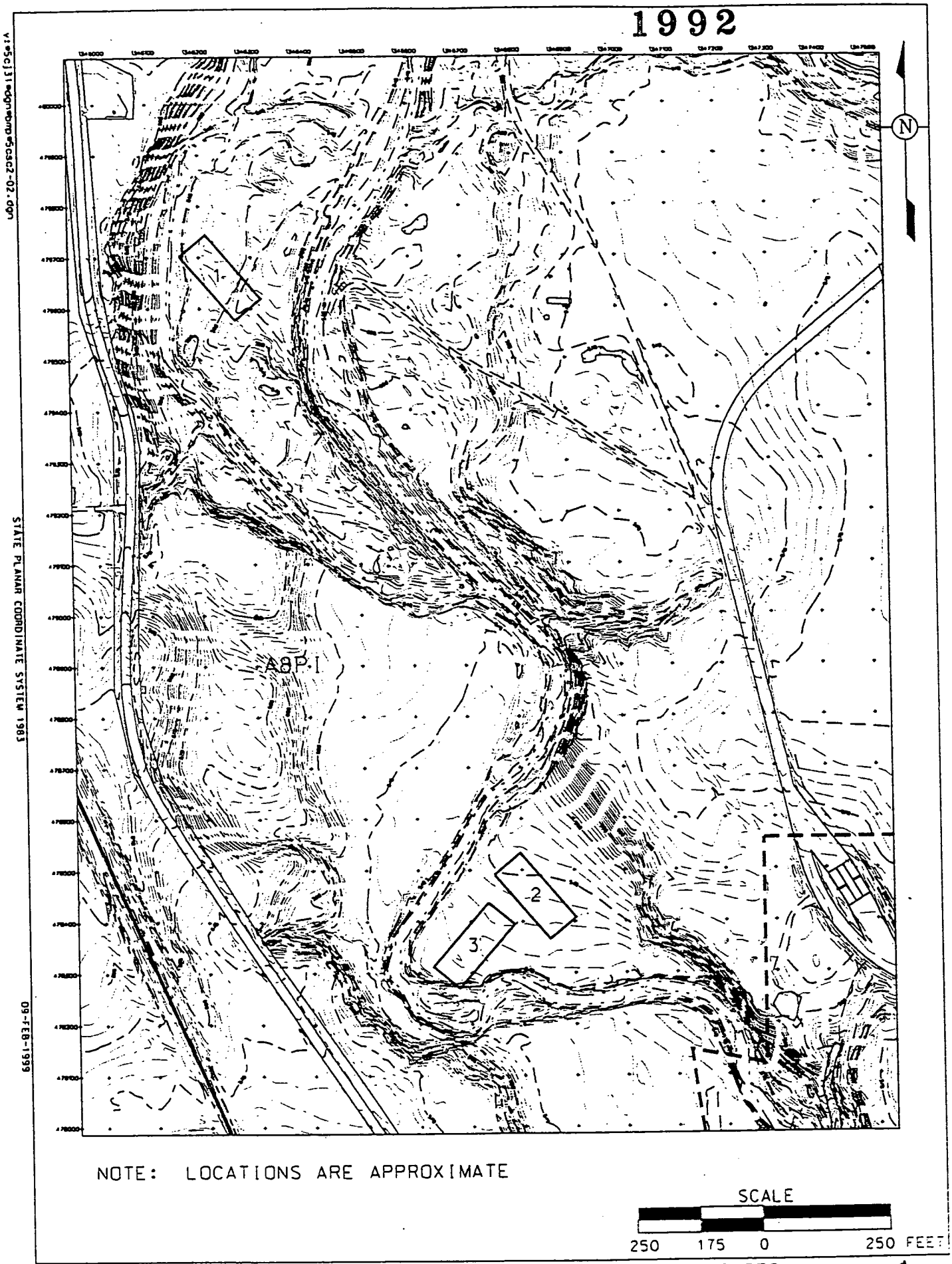

FIGURE 1. A8PI REVEGETATION RESEARCH PLOTS
REFERENCE PLOT LOCATIONS

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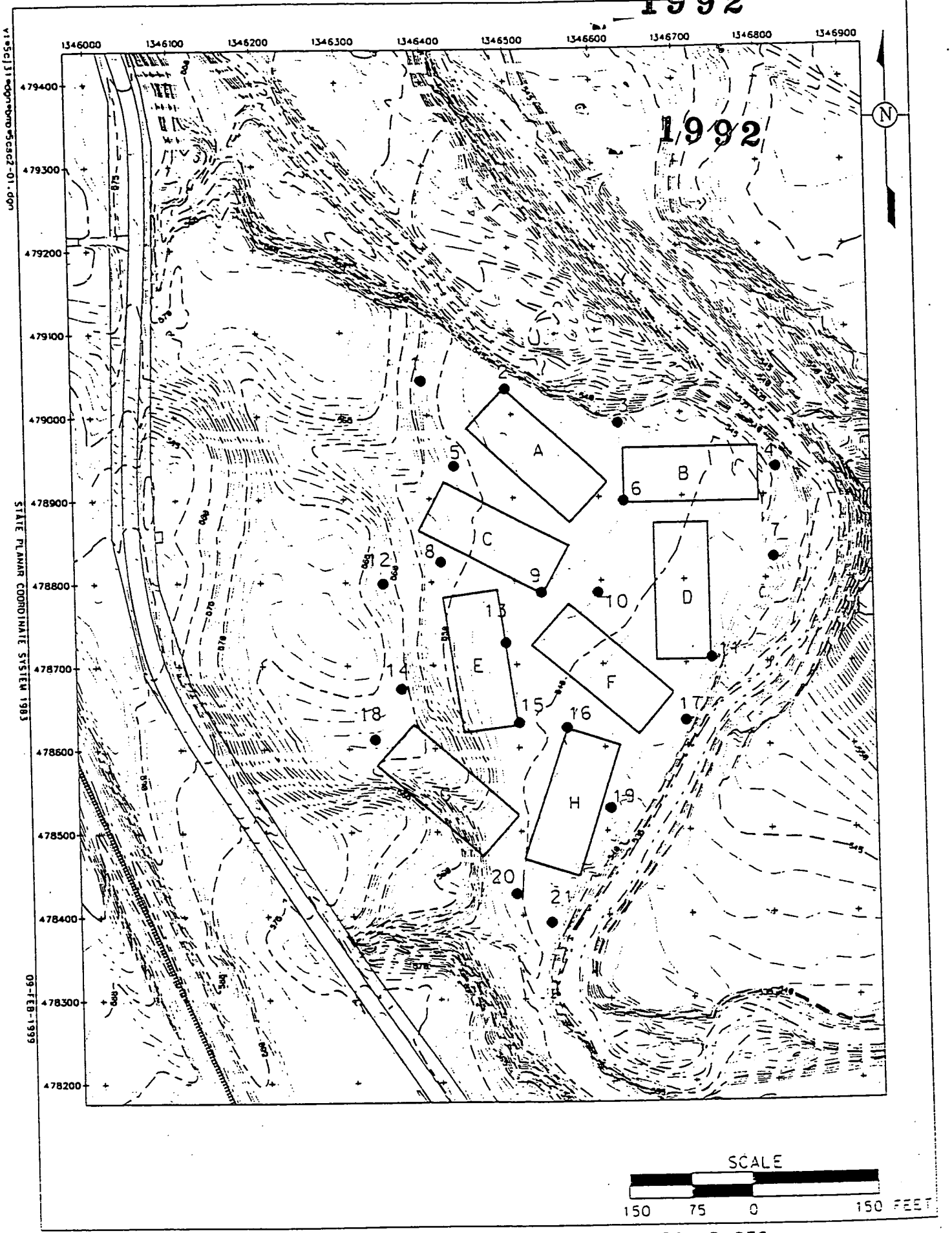

FIGURE 2. A8P1 REVEGETATION RESEARCH PLOTS

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Figure 3
Area 8, Phase I Revegetation Research Plots
Sapling Treatment
Planting Template (Shaded to Species)

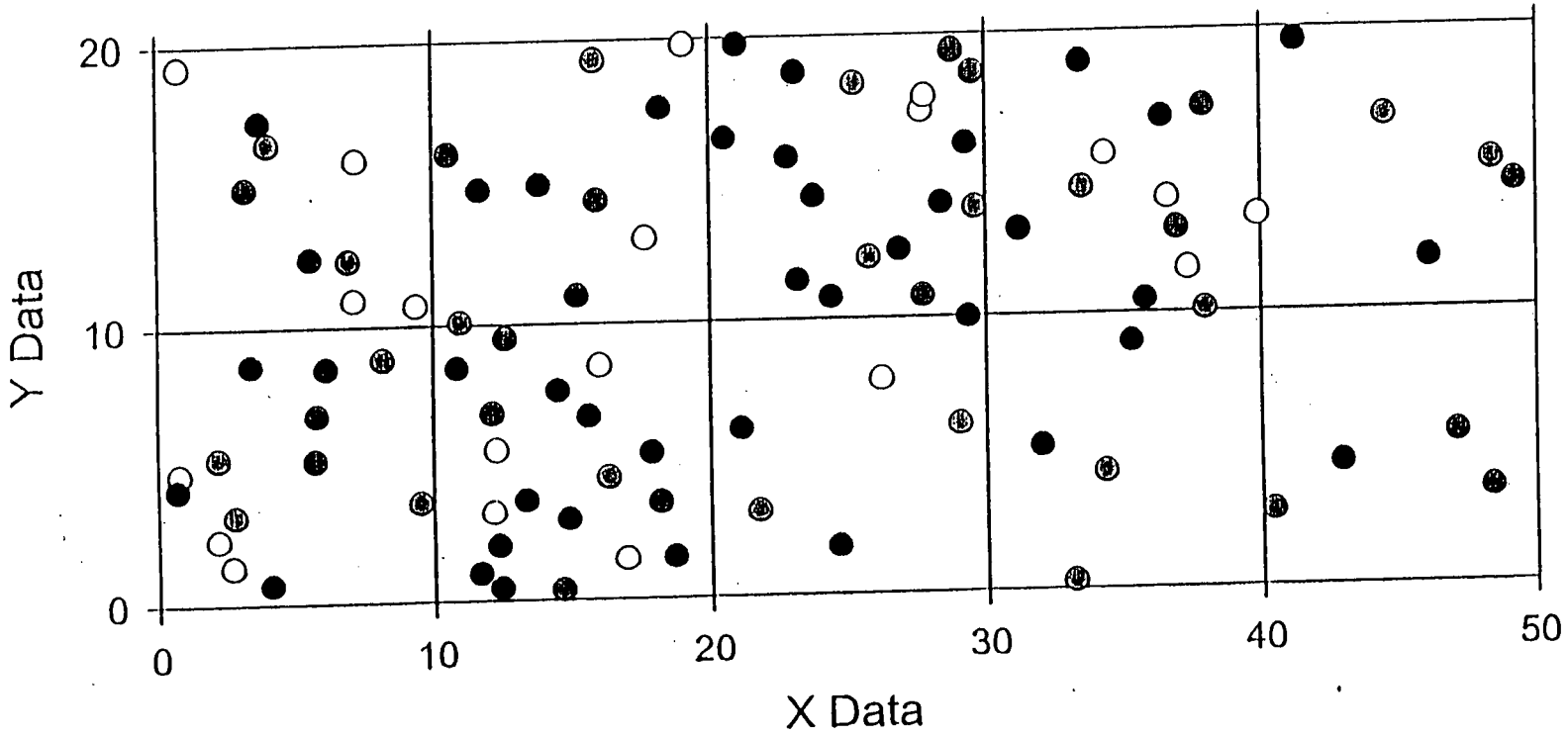

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Figure 4
Area 8, Phase I Revegetation Research Plots
Saplings for Sapling-Seedling Treatment
Planting Template (Shaded to Species)

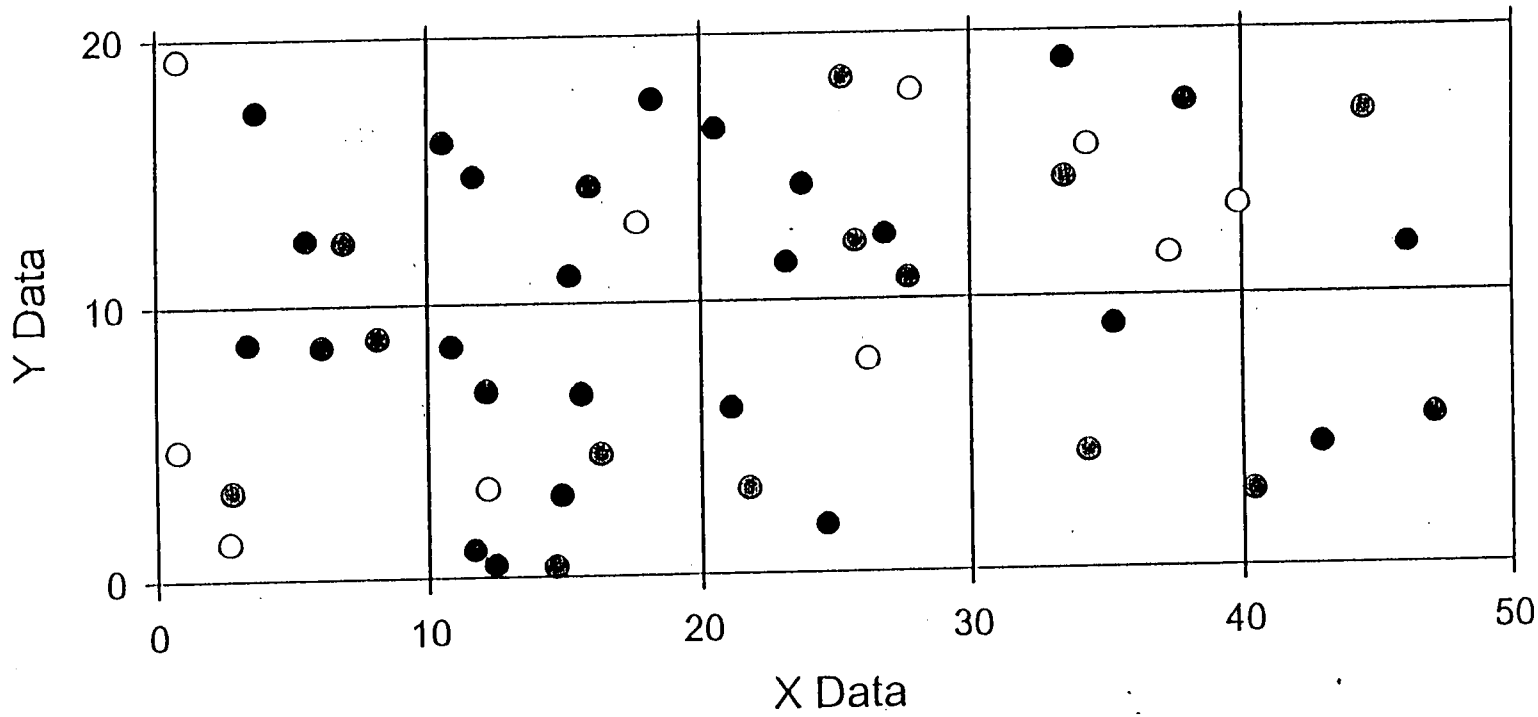
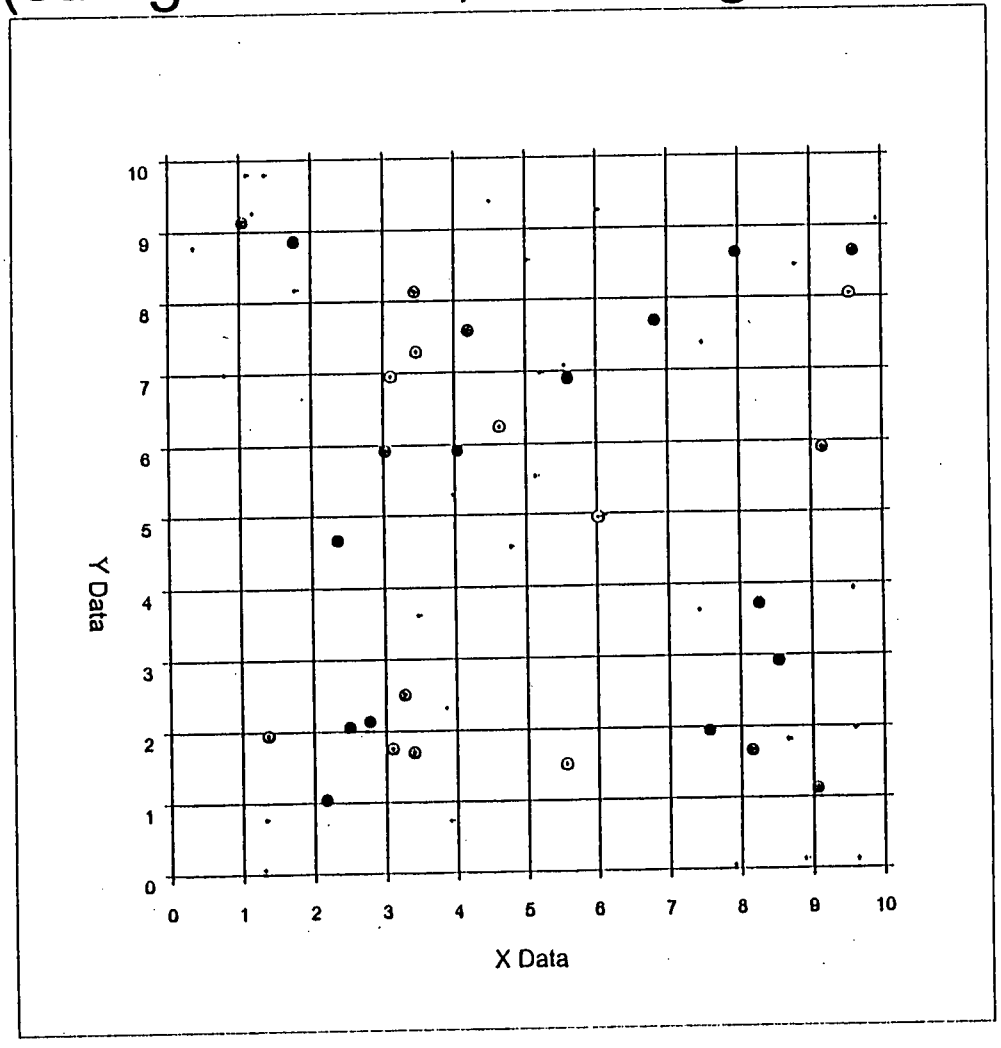
Figure 5
Seedling Treatment
Planting Template (Shaded to Species)
(sub-grid 1×1 m; circle = grow-tube)