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Accelerating Secondary Succession in Cypress Strands

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Successional communities, resulting from logging and burning of cypress strands, are present within the bounds of Corkscrew Swamp Sanctuary. Secondary succession may proceed in these communities until cypress is once again the dominant species, but regrowth of cypress following logging may be slow due to the scarcity of seed sources. Like logging, a severe burn not only destroys seed sources, but also alters edaphic and microclimatic conditions. Invasion of cypress will not occur until the proper conditions for seed germination and seedling survival are present. The question is proposed: Into which stage of succession will a subclimax species (cypress) invade most successfully? If the cypress will survive and grow in an area in an early stage of succession, then the process of secondary succession may be accelerated. Seeds and seedlings of cypress were planted into seral stages following logging, burning, and logging-and-burning, to test the hypothesis.

An inventory of the vegetation in the communities was taken to determine if natural restoration of the cypress forest is occuring. Overstory cypress would have indicated the presence of a seed source, while cypress seedlings around saplings would indicate successful regeneration.

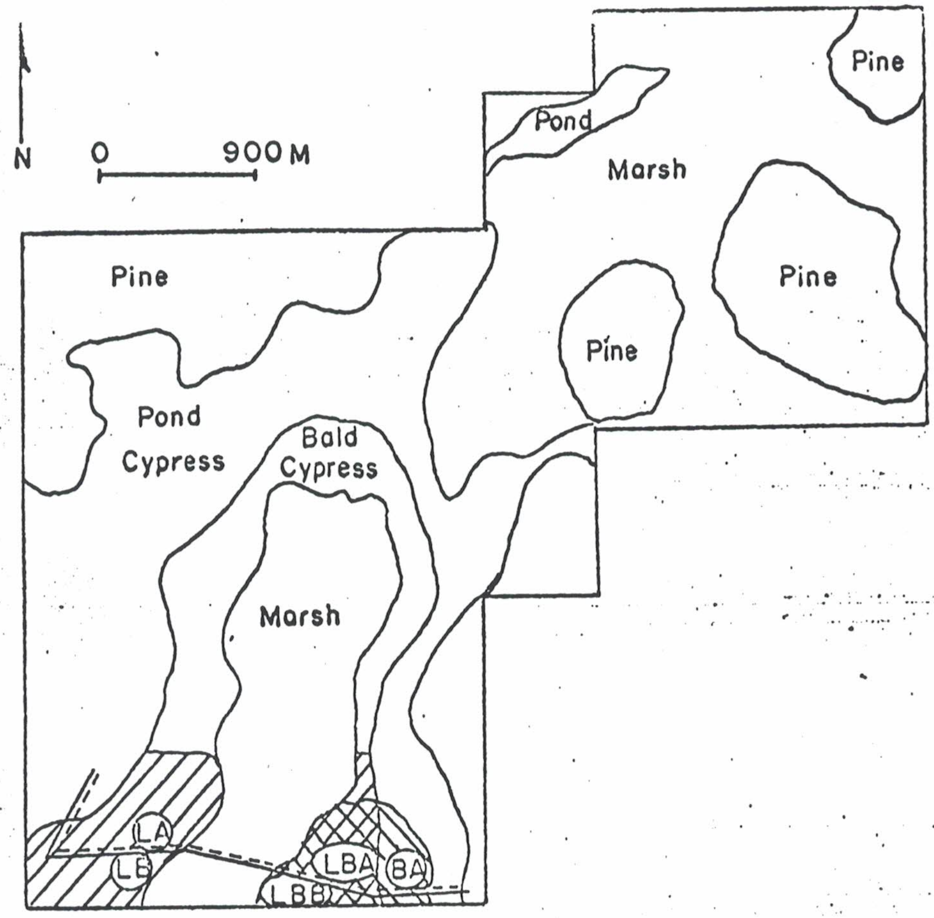
[#]This project was conducted under the supervision of Dr. J. Ewel, Botany Dept.

Methods

The study sites are shown in Fig. 1. The east and west strands of bald cypress were logged in the early 1950's. During the dry season of 1962, the eastern strand of logged bald cypress and unlogged pond cypress was burned. Work on a dike to retain water in the Sanctuary was completed in 1969. To compare the effects of water levels on cypress regrowth, study sites were established above and below the dike in the logged and logged and burned areas. The study site in the burned area was placed above the dike.

Cypress seedlings for transplant studies were obtained from the eastern edge of the undisturbed pond cypress community near the south dike. The seedlings were transplanted during January, 1976, when water levels had receded enough that the seedlings would not be completely inundated. Four seedlings were placed in each of six plots randomly spaced along a 50 m-long north-south transect at each of the five sites. Three plots were set among existing vegetation and three plots were placed in the centers of 5 m x 5 m areas that were cleared of existing biomass. Heights to the nearest 1.3 cm (0.5 in.) were measured at monthly intervals. Percent increase in height was used as a measure of growth.

During November, 1975, seeds were collected from trees exhibiting pond cypress characteristics and from trees exhibiting bald cypress characteristics. (See Appendix A for observations on seedling difference between pond cypress and bald cypress.) In January, 1976, seeds were placed in fiberglass screen bags and placed in the water at each study site. When the water level went below ground at each site, the seeds were planted in furrows approximately 1 cm deep; 250 pond cypress seeds and 100 bald cypress seeds were sown in separate 1 m x 1 m plots adjacent to the seedling plots. During March, seed plots were observed weekly for germination (appearance of cotyledons above



▨ - Logged during early 1950's

▧ - Burned in 1962

== - South dike, construction completed in 1969

LA - Study site, logged, not burned, above the dike

LB - Study site, logged, not burned, below the dike

LBA - Study site, logged and burned, above the dike

LBB - Study site, logged and burned, below the dike

BA - Study site, not logged, but burned, above the dike

Fig. 1. Map of Corkscrew Swamp Sanctuary, showing habitat types and recent history of study sites.

the ground). From March to July, surviving seedlings were tallied monthly at each plot.

Natural vegetation at each of the study sites was placed in one of three categories for the purposes of inventory. Plants greater than 3.8 cm (1.5 in.) were classified as trees; plants taller than 1 m and less than 3.8 cm D.B.H. were considered to be shrubs; and plants less than 1 m tall were considered to part of the understory.

At each site, the diameters of all trees within a 25 m x 25 m plot were measured at a height of 1.37 m (4.5 ft., D.B.H.). The diameters of all shrubs within a 10 m x 10 m plot nested in the tree plot were measured at a height of 30 cm. Basal areas were calculated for each tree and shrub species to yield an expression of dominance. Relative dominance, relative density, and relative frequency were calculated and summed to yield an Importance Value Index (IVI) (Curtis, 1959) for each tree and shrub species.

Every 2 months understory plants from three randomly selected 1 m x 1 m plots along the 50 m sample transect were clipped at each site. Species were separated, oven-dried at 70°C, and weighed to the nearest 0.1 g. Dry weights were used as a measure of dominance. Relative dominance, relative density, and relative frequency were calculated and summed to yield an Importance Value Index for each species, at each site, for each harvest.

Results

Natural Vegetation

Importance Value Indices for overstory species are shown for each site in Tables 1-4. The most important tree and shrub species at the burned-above site (Table 1) was willow (Salix caroliniana). Cypress was present

Table 1. Importance Value Indices for overstory species at burned-not logged study site, above the dike.

	Relative Density +	Relative Dominance +	Relative Frequency =	IVI
Tree Plot #1				
Salix caroliniana	91	87	81	259
Myrica cerifera	06	08	14	28
Persea palustris	01	01	01	03
Taxodium distichum	02	03	04	09
Shrub Plot #1				
Salix caroliniana	83	88	71	242
Myrica cerifera	13	09	12	36
Cephalanthus occidentalis	03	02	04	09
Baccharis halmifolia	<01	<01	04	04
Annona glabra	<01	01	<01	01
Tree Plot #2				
Salix caroliniana	72	38	82	192
Myrica cerifera	15	14	12	41
Taxodium distichum	11	26	06	43
Cephalanthus occidentalis	01	<01	01	01
Sabal palmetto	01	21	01	22
Shrub Plot #2				
Salix caroliniana	93	96	79	268
Myrica cerifera	03	02	08	13
Taxodium distichum	<01	01	08	10
Baccharis halmifolia	01	<01	04	05
Ludwigia peruviana	<01	<01	01	01
Cephalanthus occidentalis	01	<01	01	01

Table 2. Importance Value Indices for overstory species at burned and logged study sites, above and below the dike.

	Relative Density +	Relative Dominance +	Relative Frequency =	IVI
Tree Plot Above Dike				
Salix caroliniana	97	99	99	295
Myrica cerifera	03	01	01	05
Shrub Plot Above Dike				
Salix caroliniana	50	75	71	196
Cephalanthus occidentalis	33	17	13	63
Baccharis halmifolia	09	07	02	18
Myrica cerifera	04	04	07	15
Ludwigia peruviana	03	01	01	05
Annona glabra	01	01	01	03
Tree Plot Below Dike				
Salix caroliniana	96	96	94	286
Myrica cerifera	04	04	06	14
Shrub Plot Below Dike				
Salix caroliniana	62	84	61	207
Baccharis halmifolia	20	05	17	42
Cephalanthus occidentalis	14	09	09	32
Myrica cerifera	03	02	09	14
Ludwigia peruviana	01	01	04	06

Table 3. Importance Value Indices for overstory species at logged not burned study site, above the dike.

	Relative Density	+ Relative Dominance	+ Relative Frequency	= IVI
Tree Plot				
Ilex cassine	31	19	27	77
Acer rubrum	12	25	11	48
Salix caroliniana	17	13	11	41
Myrica cerifera	15	09	11	35
Taxodium distichum	03	24	04	31
Cephalanthus occidentalis	12	04	11	27
Persea palustris	04	03	15	22
Fraxinus caroliniana	02	01	04	06
Ficus aurea	01	01	03	05
Annona glabra	02	01	01	04
Shrub Plot				
Cephalanthus occidentalis	20	29	45	94
Rapanea guianensis	36	20	11	67
Myrica cerifera	22	20	14	56
Ilex cassine	05	08	14	27
Itea virginica	05	10	04	19
Persea palustris	04	01	11	16
Acer rubrum	03	04	04	11
Salix caroliniana	02	05	01	08
Baccharis halmifolia	03	01	01	05

Table 4. Importance Value Indices for overstory species at logged not burned study site, below the dike.

Tree Plot

	Relative Density +	Relative Dominance +	Relative Frequency =	IVI
Acer rubrum	28	38	15	81
Ilex cassine	19	22	33	74
Myrica cerifera	14	06	22	42
Persea palustris	12	07	07	26
Annona glabra	03	16	04	23
Fraxinus caroliniana	10	04	07	21
Cephalanthus occidentalis	07	02	04	13
Salix caroliniana	03	02	04	09
Ficus aurea	01	02	04	07
Myrsine guianensis	03	01	01	05

Shrub Plot

	Relative Density +	Relative Dominance +	Relative Frequency =	IVI
Cephalanthus occidentalis	53	80	15	148
Baccharis halmifolia	18	04	04	26
Myrsine guianensis	07	03	15	25
Itea virginica	09	02	11	22
Persea palustris	04	03	04	11
Acer rubrum	06	03	01	10
Myrica cerifera	01	01	07	09
Ilex cassine	01	02	04	07

as a minor component of both the tree and shrub plots. At the logged and burned area, both above and below the dike, the major tree and shrub species was also willow. No cypress was found in these study plots. Hardwood species dominate the logged area, both above and below the dike, as shown in Tables 3 and 4. The species are: red maple (Acer rubrum), dahoon holly (Ilex cassine), swamp bay (Persea palustris), wax myrtle (Myrica cerifera). Some of the cypress found in the tree plot had been too small to be cut during logging. Other cypress trees had sprouted from the stumps following logging, and some had grown from seed since the lumbering. No cypress saplings were found in the shrub plots.

Importance values for each species and total dry weights for each harvest for the understory component of the study sites are shown in Tables 5-10 Myrtle and willow were the only tree species found in the understory at the logged and burned, above and below, and the burned-above sites. Cypress was not found in any of the clipped plots. Red maple, myrsine (Rapanea guianensis wax myrtle, swamp bay, and dahoon holly showed signs of regeneration at the logged-below site. Myrsine, red maple, and pond apple (Annona glabra) were present in the logged-above understory

Transplanted Seedlings

Percent increase in height of each transplanted seedling during the study period (175 days) was calculated. These values were summed to yield a total percent increase for each plot. The rates are shown in Fig. 2 for each plot at each site.

Growth of the seedlings in cleared areas was compared (using analysis of variance) to growth of seedlings planted among existing vegetation to evaluate effects of competition. A statistical difference at the 95% confidence level was noted between the growth rates in the cleared areas and

Table 5. Importance value indices of species for each harvest of understory plants at burned above study site.

Species	11-16-75	1-22-76	3-4-76	5-13-76	7-14-76
Blechnum serrulatum	0	122	35	86	152
Pontedaria cordata	86	31	56	28	0
Panicum hemitomon	61	0	0	65	20
Sarcostemma clausa	0	0	34	51	32
Diodia virginiana	21	28	46	0	15
Woodwardia virginica	13	15	0	31	50
Proserpinaca palustris	21	19	45	8	0
Polygonum punctatum	20	11	45	10	0
Sagittaria graminea	0	30	8	0	0
Andropogon sps.	34	0	0	0	0
Mikania batafolia	0	16	16	0	0
Ludwigia repens	0	20	0	0	0
Baccharis halmifolia	6	0	0	0	7
Typha latifolia	13	0	0	0	0
Sagittaria lancifolia	13	0	0	0	0
Bacopa maritima	0	0	12	0	0
Aster carolinianus	0	0	0	10	0
Osmunda regalia	0	0	0	0	9
Cyperus sps.	0	9	0	0	0
Eupatorium compositifolium	0	0	0	7	0
Juncus polycephalus	6	0	0	0	0
Myrica cerifera	6	0	0	0	0
Salix caroliniana	0	0	0	0	6
Boehmeria cylindrica	0	0	0	0	5

Table 6. Importance value indices of species for each harvest of understory plants at logged and burned study site, above the dike.

Species	11-16-75	1-22-76	3-4-76	5-13-76	7-14-76
Blechnum serrulatum	145	80	179	0	0
Polygonum punctatum	0	127	20	28	93
Mikania batafolia	17	48	23	120	131
Boehmeria cylindrica	34	0	10	27	34
Aster carolinianus	0	24	12	22	0
Sarcostemma clausa	0	0	10	45	0
Myrica cerifera	40	0	15	0	0
Woodwardia virginica	51	0	0	0	0
Cyperus sps.	0	20	0	28	0
Osmunda regalia	0	0	0	0	42
Typha latifolia	0	0	11	30	0
Peltandra virginica	16	0	0	0	0
Azolla caroliniana	0	0	15	0	0

Table 8. Importance Value Indices of species for each harvest of understory plants at logged study site, below the dike.

Species	11-16-75	1-22-76	3-4-76	5-13-76	7-14-76
Blechnum serrulatum	59	72	0	75	30
Nephrolepis exalta	0	31	79	23	102
Acer rubrum	52	26	71	29	27
Osmunda regalia	44	8	10	77	8
Woodwardia virginica	36	16	31	15	23
Sagittaria lancifolia	0	0	53	12	45
Boehmeria cylindrica	24	38	24	11	9
Rapanea guianensis	0	0	14	43	0
Peltandra virginica	22	0	0	0	22
Polygonum punctatum	0	29	0	8	0
Thelyptris normalis	23	8	0	0	0
Itea virginica	0	21	0	0	9
Myrica cerifera	0	0	9	17	0
Diodia virginiana	0	10	0	0	10
Melothria pendula	0	0	0	0	18
Pontedaria cordata	0	17	0	0	0
Baccharis halmifolia	0	15	0	0	0
Mikania batafolia	14	0	0	0	0
Persea palustris	13	0	0	0	0
Smilax laurifolia	12	0	0	0	0
Panicum sps.	0	0	9	0	0
Ilex cassine	0	6	0	0	0

Table 9. Importance Value Indices of species for each harvest of understory plants at logged study site, above the dike.

Species	11-16-75	1-22-76	3-4-76	5-13-76	7-14-76
Blechnum serrulatum	111	186	53	57	52
Woodwardia virginica	46	0	35	54	13
Boehmeria cylindrica	40	22	50	14	18
Sagittaria lancifolia	0	21	50	0	24
Nephrolepis exalta	17	10	0	0	55
Thelyptris normalis	0	0	0	0	75
Crinum americanum	0	0	0	65	0
Osmunda regalia	29	0	15	14	0
Mikania batafolia	0	10	21	19	7
Panicum sps.	32	12	0	0	8
Aster carolinianus	8	13	20	9	0
Acer rubrum	0	0	14	15	15
Melothria pendula	8	0	0	0	24
Annona glabra	0	0	17	17	0
Rapanea guianensis	0	0	0	26	0
Cephalanthus occidentalis	0	0	26	0	0
Polygonum punctatum	0	10	0	0	7
Campyloneuron costatum	0	0	0	10	0
Habenaria sps.	8	0	0	0	0

Table 10. Above ground understory biomass during the study period. Each value is a mean of three 1 m^2 samples. Values are oven dry g/m^2.

Site	Date				
	11-16-75	1-22-76	3-4-76	5-13-76	7-14-76
Logged-above the dike	51	61	46	44	126
Logged-below the dike	24	27	38	80	132
Logged-and-burned-above the dike	61	24	329	80	6
Logged-and-burned-below the dike	111	39	35	51	97
Burned-above the dike	57	35	24	104	320

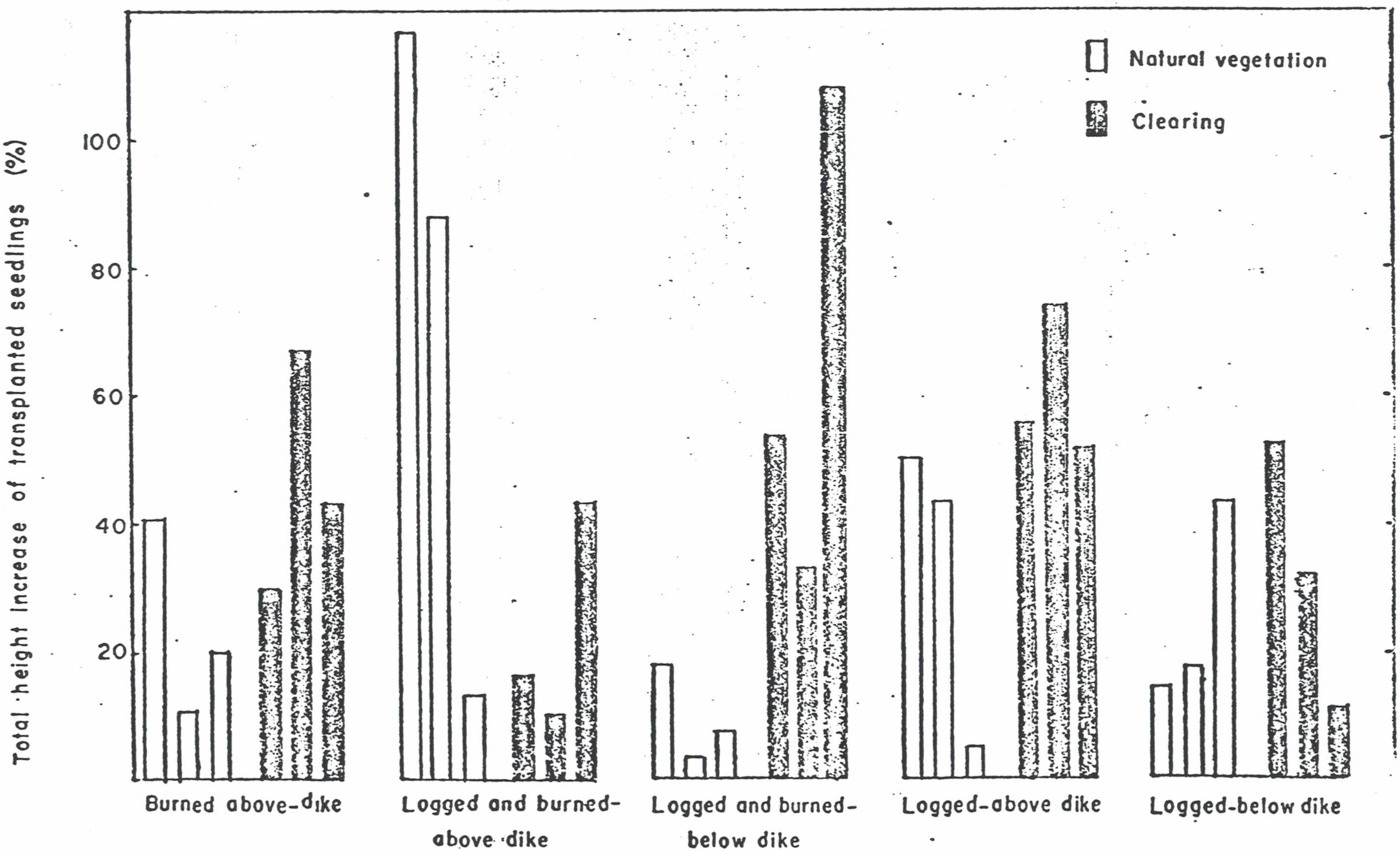


Fig. 2. Height increases of transplanted seedlings in cleared and natural areas of the study sites.

uncleared areas of the logged and burned site below the dike. At no other site was there a significant difference in growth of transplated seedlings between plots in cleared areas and plots among the existing vegetation.

Mean increases in heights of the transplanted seedlings were analyzed among sites, again using an analysis of variance to see if cypress was more successful at becoming established in certain sites than others. However, within-site variation in growth rates was greater than differences among sites, so no difference could be statistically demonstrated among growth rates at the five sites.

Likewise, no significant difference in height increase was noted between seedlings growing above and below the dike.

Of the seedlings transplanted, 78% survived for the full 175 days of the study period. No difference in mortality of seedlings among sites was noticed. Survival of seedlings in cleared areas was not different from that of seedlings growing among the existing vegetation. The different water levels above and below the dike had no effect on seedling mortality.

Seed Germination

The percentages of pond cypress seed and bald cypress seed germinated on a given date are shown in Fig. 3 for all study sites. The highest germination observed was 11% for bald cypress at the burned-above site, but by the end of the study, only 1% still survived. Average germination was less than 3% at all sites. Of the seeds which germinated, less than 10% survived into the wet season. At most sites germination increased early in the study, then declined. During this time water levels slowly receded, then rapidly rose. The burned-above site was dry from February 14 through July 17, but the logged and burned-above sites did not dry out until March 22 and were wet on June 11.

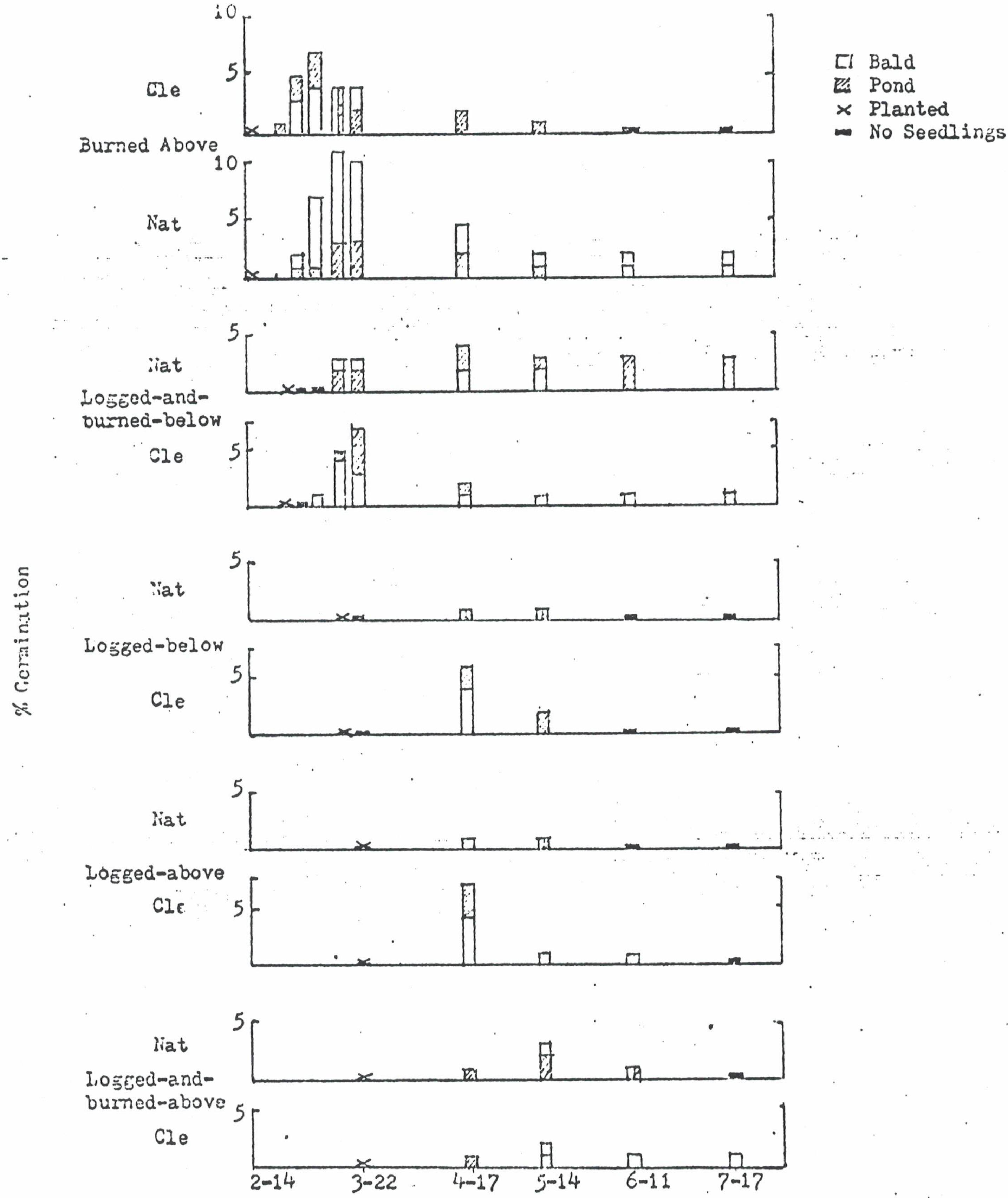


Fig. 3. Percent germination of baldcypress and pondcypress seeds planted in cleared and natural areas of the study sites at Corkscrew Swamp Sanctuary.

Discussion

Cypress seedlings can apparently survive equally well in various kinds of successional vegetation. Well-developed cypress can survive and grow in any of the disturbed communities. Differences in response of the seedlings to the different sites may be masked by the slow response of the growth rate following transplanting. Murphy and Deghi (1975) found an increase in growth rate during the second year following transplanting of seedlings into cypress domes near Gainesville, Fla.

The differences in growth measured at the logged and burned-below site between plots in cleared areas and plots in uncleared areas was probably due to competition. The increase in height of the transplanted seedlings in cleared areas was not much higher than increases at other sites, but the increases in the uncleared areas were much lower than those observed at other sites. Density of stems and basal areas at the logged and burned-below site were not much different than basal areas and densities at other sites, but the spatial pattern of the understory was highly variable. The seedlings transplanted among existing vegetation at this site were subjected to more intense competition than were those planted at the other sites.

The critical factors in cypress regeneration seem to be available seed source and proper water requirements for germination and survival. Once seed sources are removed, regrowth can be slow (Oosting, 1948). Cypress regrowth may be slower than other logged forests due to limited mobility of the seed. A few seed sources are present at the logged sites and the burned site. Regeneration is occuring at these sites and is probably retarded by the moisture requirements necessary for survival.

The cypress seed must spend one to three months soaking (Mattoon, 1916) so that imbibition of the hard seed coat is accomplished (Murphy and Stanley, 5). Seeds that remain under water for 12 months are no longer viable (Applequist, 1959). The seed must germinate in or on dry ground (Demaree, 1932). After germination the seedling must maintain root contact with water to survive. It must also grow tall enough to escape inundation by rising water levels.

The logged and logged and burned sites above the dike were dry for only 2 months, not enough time for the seedlings to grow tall enough to escape inundation. Seedlings in cleared areas at other sites died from water stress, perhaps brought about by high evapotranspiration and low availability of water. Seedlings in the uncleared areas of the other sites did not grow tall enough to escape inundation. Low germination percentages of the seeds planted also contributed to poor survival.

Conclusions

1. Transplanted cypress seedlings can survive in logged, logged and burned, and burned cypress strands. Low seed germination, followed by water stress and slow growth, limits reporduction.

2. Natural regeneration of cypress is occurring at the burned and logged sites where seed sources are present. No cypress regeneration was noticed at the logged and burned site.

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APPENDIX A

Differences between Bald Cypress and Pond Cypress

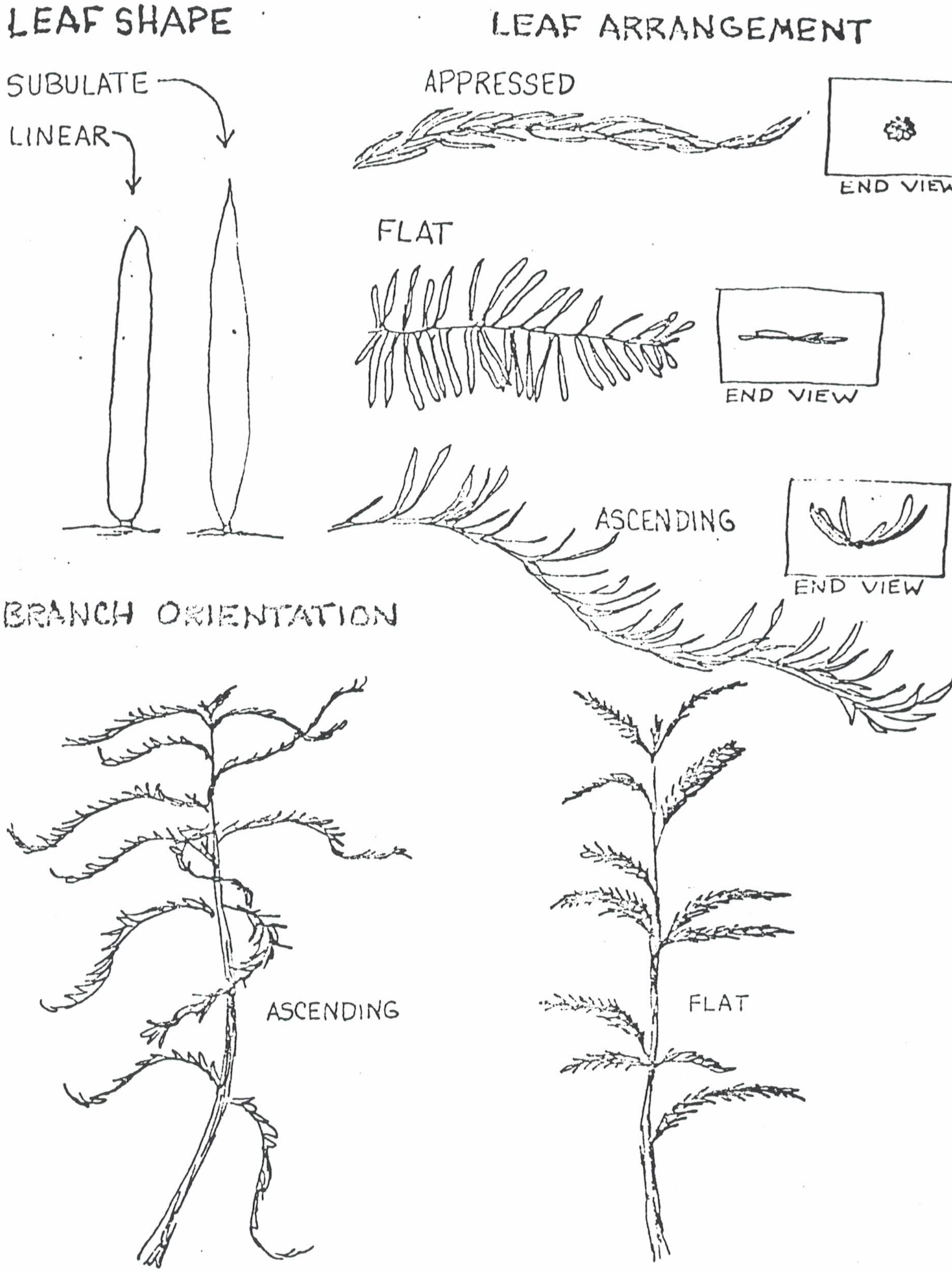
Most taxonomists (Small, 1933; Lang and Lakela, 1971) feel that there are two species of cypress in Florida: bald cypress, Taxodium distichum, and pond cypress, Taxodium ascendens. Bald cypress has leaves which are linear (parallel margins) and spread out flat on branches which, in turn, are attached at a wide angle from a main branch. The pond cypress leaves are subulate (awl-shaped) and appressed (lie flat against the branch); the branches tend to be ascending. Both trees grow up to 40 m in height. Long and Lakela (1971) question the distinction between the "species". They believe that there may be only one species of cypress, and morphological differences are due to habitat variation. The two kinds of cypress may also be ecotypes, or genetically differentiated subpopulations. The two types of cypress were raised under similar conditions to see if leaf characteristics were genetically determined. Pond cypress seedlings were planted in disturbed pond cypress and bald cypress habitats and the leaf arrangement, shape, and branch orientation were observed (Table A-1), (Fig. A-1).

The two types of seed planted in greenhouse flats grew into two different types of seedlings. Seedlings grown from bald cypress seed had flat, linear leaves on flat branches. The pond cypress seedlings had slightly ascending, subulate leaves on ascending branches.

Table A-1. Leaf and branch characteristics of bald cypress and pond cypress seedlings grown in different habitats.

		Leaf Shape		Leaf Arrangement			Branch Orientation	
Origin	Habitat	subulate	linear	appressed	ascending	flat	ascending	flat
Baldcypress Seed	burned pondcypress		x			x		x
Baldcypress Seed	greenhouse flats		x			x		x
Pondcypress Seed	greenhouse flats	x			x		x	
Pondcypress Seedling	burned pondcypress natural	x				x		x
Pondcypress Seedling	burned pondcypress cleared	x		x			x	
Pondcypress Seedling	logged-burned baldcypress natural	x				x		x
Pondcypress Seedling	logged-burned baldcypress cleared	x		x			x	
Pondcypress Seedling	logged baldcypress natural	x				x		x
Pondcypress Seedling	logged baldcypress cleared	x		x			x	

FIGURE A1. POND AND BALD CYPRESS - DIFFERENTIATING CHARACTERS



The pond cypress seedlings, transplanted into the field, retained their leaf shape, but varied in leaf arrangement and branch orientation. The seedlings growing in cleared areas displayed tightly appressed leaves on ascending branches. The seedlings growing among existing vegetation had flat leaves growing out of branches that were slightly ascending or flat.

The leaf shapes of each type of cypress seemed to remain constant throughout a variety of habitats. The leaf arrangement and branch orientation of the pond cypress seedlings varied with habitat. Flat leaves and branches were found in areas of low transpiration and limited light. Seedlings with appressed leaves on ascending branches grew in areas of higher sunlight intensities, and higher transpiration.

Pond cypress and bald cypress seem to have inherent genetic differences. Each type is highly variable in its expression of leaf and branch characteristics. This variability masks any clear distinction between the two types.

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