Sprouting by Pondcypress (*Taxodium distichum* var. *nutans*) After Logging

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ABSTRACT. *After logging, 17% of the stumps left in pondcypress (*Taxodium distichum *var.* nutans*) swamps produced sprouts that persisted for several years. Significantly more sprouts were present on stumps with diameters < 60 cm (perhaps left from younger trees) and shorter than 70 cm. Stumps in large openings and from trees cut in winter tended to have more sprouts than stumps left in thinned swamps and from trees cut during the summer. Sprout production provides a mechanism for rapid recovery of pondcypress and also ensures seed availability for subsequent regeneration after a swamp is clearcut. South. J. Appl. For. 20(4):209–213*

Pondcypress (*Taxodium distichum* var. *nutans*) is one of the few conifers that sprout after the stem is damaged or destroyed. Epicormic branches often grow from the stem after burning; root sprouting may generate new stems if the entire trunk is destroyed; and dozens (even hundreds) of sprouts may be produced from a stump after the trunk is cut. The ability to produce sprouts after logging has been thoroughly described for other trees and, in many cases, exploited for centuries. For instance, coppice woodlands in the British Isles have been worked since the Middle Ages. In Florida, small swamps dominated by pondcypress are now commonly being clearcut to produce chips for mulch. The ability of pondcypress to sprout increases the possibility that these swamps can regenerate successfully after such intensive logging.

Not all pondcypress stumps produce sprouts after being cut, however. Vigorous sprouting has been described for cypress stumps 25 to 36 cm in diameter at 60 cm above the ground, 40 to 60 yr old, and cut in the fall or winter; at least one 300 yr old tree cut at 2.4 m above the ground is reported to have produced one coppice sprout (Mattoon 1915). However, these descriptions do not discriminate between responses of pond- and baldcypress (*T. distichum* var *distichum*), and more specific information on sprouting that could be used to generate logging guidelines is lacking. This paper examines sprouting by pondcypress in several swamps that were clearcut or partially logged at several different times. Although the logging was not sufficiently controlled to permit a definitive analysis of the factors that control sprouting and subsequent stand restocking, the range of sites and approaches provide an opportunity to examine sprouting in pondcypress in greater detail than has previously been possible.

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Methods

Study Sites

In 1981, several cypress swamps in the Withlacoochee State Forest of central Florida (approximately 29° lat., 82° long.) were selected for thinning from above (diameter limit cut), thinning from below to three levels of basal area, or clearcutting at several patch sizes and shapes (Table 1). All swamps are located in Lake County within approximately 15 km of one another. Six of the swamps ranged from 12–28 pondcypress trees /100 m^2 and 46–66 m^2/ha in basal area of pondcypress (Ewel and Wickenheiser 1988). Logging was carried out by private contractors during the next several years, with some of the swamps cut in the summer and others cut in the winter. The sites are grouped into two treatments: thinned, which includes plots thinned from below to 16 m^2/ha, 25 m^2/ha, and 34 m^2/ha, as well as two plots that were thinned from above (diameter limit cut) to 34 m^2/ha; and open-cut, which includes a series of 12 strip cuts of different widths, a small swamp with two pie-shaped wedges cut from opposite sides, and a clearcut swamp. Although density and basal area measurements were not available for all swamps, they had been selected originally for their similarity to one another. All trees were cut with chainsaws.

Four swamps contained plots that were thinned. Three circular 0.2 ha plots were thinned from above in each of

Table 1 Characteristics of logged sites in the Withlacoochee State Forest

Location	Type of logging	Date logged	Size of logged area	Post-logging basal area (m^2/ha)	Mean width of stumps (cm)	Mean height of stumps (cm)
Thinned swamps						
Billy's Pond 1	Thinned from below	June – Sept. 1984	0.2 ha	16	39	75
				25	34	70
				34	35	67
Billy's Pond 2	Thinned from below	Jan. – Feb. 1984	0.2 ha	16	37	64
				25	34	67
				34	37	66
Dark Stretch Road	Thinned from above	June – Sept. 1984	0.2 ha	34	50	69
North Carter Pond Road	Thinned from above	Jan. – Feb. 1984	0.2 ha	34	39	59
Open-cut swamps						
Revel Road	Strip cut	June 1986	23 m wide	0	42	72
					38	75
Boggey Road					41	76
					31	52
Revel Road			46 m wide	0	34	60
					39	75
Boggey Road					34	54
					33	57
Revel Road			69 m wide	0	37	65
					37	60
Boggey Road					35	54
					37	71
Boggey Road	Wedge cut	June 1986	0.1 ha	0	44	70
Pole Bridge Road	Clearcut	June 1986	1.9 ha	0	44	53

two large swamps (Billy's Pond 1 and Billy's Pond 2). In two other swamps (Dark Stretch Road and North Carter Pond Road), an 0.2 ha diameter limit cut released all codominant crop trees from competition on all sides.

Large openings were cut in some swamps to determine response to more intensive logging. These open-cut plots included 12 strips that were clearcut in widths of 23 m, 46 m, and 69 m (representing one, two, and three times the average height of a mature pondcypress tree) in three contiguous swamps. In a nearby swamp, two pie-shaped wedges (each approximately 0.05 ha and 42 m wide at the outside edge) were clearcut to create large gaps in a small swamp without damaging remaining trees or removing all potential seed sources. One small (1.9 ha) cypress swamp on Pole Bridge Road that was clearcut was also included in this group.

Logs were left after harvesting on most of these sites, so a meaningful analysis of restocking after harvesting could not be performed.

Measurements

Four annual censuses were conducted in the thinned swamps. In the first year, presence of live sprouts was noted for 41–52 stumps in the center of each plot; 50 stumps/plot were examined in subsequent years. In 1988, maximum height and diameter of each stump were also recorded.

High water, dense brush and slash, and felled trees limited mobility in the open-cut swamps. At these sites, maximum height and diameter of 50 stumps (100 stumps in the clearcut swamp) along randomly located transects were recorded in 1988.

Statistical Analysis

Because stump heights and diameters each spanned an order of magnitude, tests of significance on these parameters were conducted on log-transformed data; the data are presented in untransformed mode for clarity. One-way analyses of variance were used to determine if the various swamps differed in size of stumps after logging and to detect significant difference in height and diameter among stumps bearing live, dead, or no sprouts. If main effects proved significant ($P < 0.05$) in the analysis of variance, significance of individual treatment effects was evaluated with Scheffe's test.

Spearman's coefficients of rank correlation were calculated to determine if relationships existed between the percentage of stumps in a swamp with living sprouts and the mean height and mean diameter of the stumps. To determine whether a tendency to cut young (and therefore narrower) stumps might be confounding the issue, the heights of stumps with and without live sprouts within each of three diameter classes representing 82% of the stumps (20–29 cm, 30–39 cm, and 40–49 cm) were compared using a t-test.

A chi-square analysis of the number of stumps with live sprouts and no surviving sprouts in the thinned plots was used to test the impact of season of harvest on sprouting.

Results

Incidence of Sprouting

Many of the stumps in the logged plots sprouted prolifically during the first year after cutting. It was not unusual to find at least 10 sprouts on a stump; one had 350. No record was kept of number of sprouts per stump in later years, but few stumps had more than two live sprouts after the second year. In 1988, 17% of the 1150 stumps that were censused in all the swamps still bore at least one live sprout.

Among the stumps surveyed in the eight plots that were thinned in 1984, 40% had live sprouts in 1985, which was the first growing season after logging for the summer-cut swamps and the second for the winter-cut swamps (Figure 1a, 1b). By 1988, however, live sprouts were present on only 24% of the stumps cut in winter 1984 (Figure 1a) and 7% of the stumps of trees cut in summer 1984 (Figure 1b) Among the 14 swamps and plots cut in summer 1986, survivorship by 1988 averaged 18%, ranging from 0% in the wedge cut and in a 23 m strip to nearly 50% in a 46 m wide strip cut (Figure 1c).

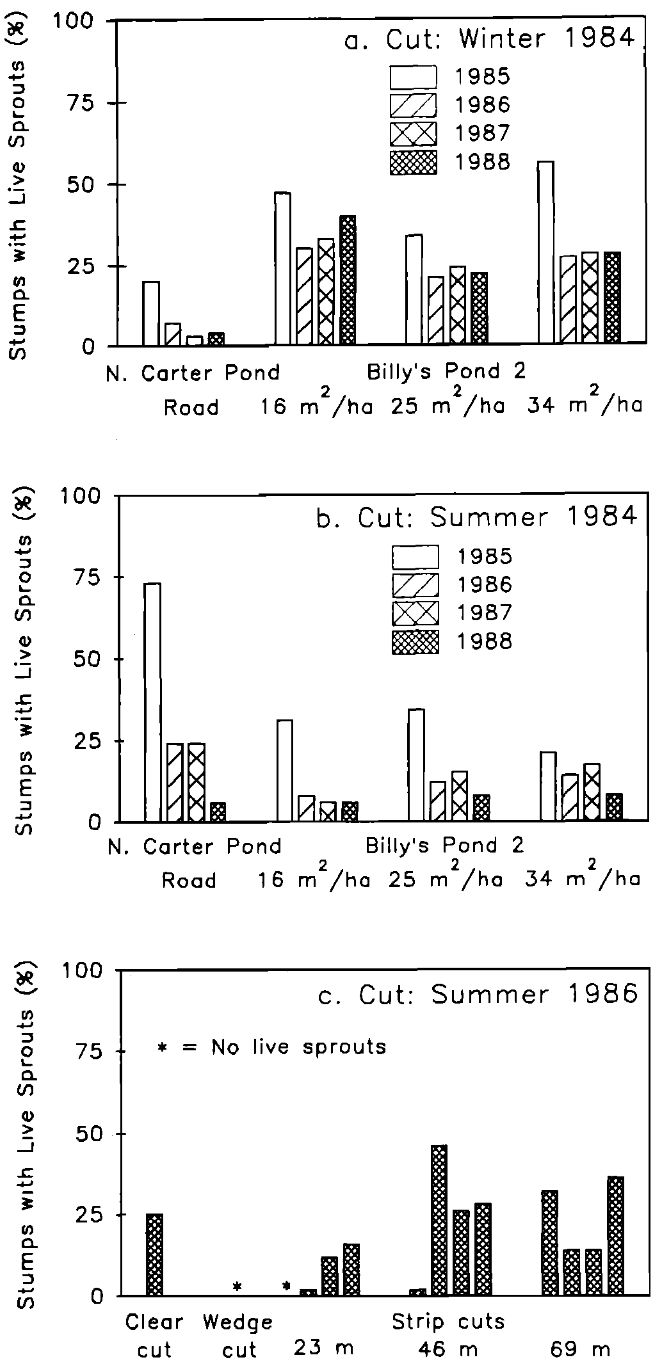

Figure 1. Annual changes in percentage of stumps bearing live sprouts in plots logged in (a) winter 1984, (b) summer 1984, and (c) summer 1986. Each bar in Figures 1a and 1b represents the percentage recorded in a plot in a specific year. The stumps shown in Figure 1c were measured only in 1988, and each bar represents the percentage recorded in a different swamp.

Effect of Size of Stump on Sprouting

The heights and diameters of the stumps that bore live sprouts in 1988 were significantly smaller ($P < 0.05$) than those of stumps bearing dead sprouts and no sprouts (Figure 2). Some of the logged plots had significantly larger or smaller stumps than others, but no pattern was evident in these relationships. Among the 22 plots, tall stumps were larger in diameter ($P < 0.05$). Swamp-by-swamp correlations between percentage of stumps with living sprouts and mean height and mean diameter were not significant ($P > 0.05$). For each of the three diameter classes, the stumps with no surviving sprouts were significantly taller ($P < 0.05$) than the stumps with at least one live sprout. Therefore, there was a consistent tendency for smaller trees to be cut closer to the ground, and there was also a consistent response of successful sprouting from shorter stumps within each diameter class.

The frequency distributions of heights of all stumps bearing live sprouts differed from the frequency distribution of diameters. Stumps shorter than 70 cm were much more likely to sprout than taller stumps; none of the 40 stumps taller than 110 cm produced live sprouts (Figure 3). Presence of live sprouts decreased rapidly with increasing diameter; only two of the 136 stumps with diameters greater than 57 cm bore live sprouts (Figure 4).

Discussion

Reliability of the Sprouting Response

The propensity for stumps with small diameters to sprout successfully (Figure 4) supports the observation that younger trees are more likely to produce sprouts when cut, although the ages of these trees are not known. The consistent response of shorter stumps (Figure 3) suggests

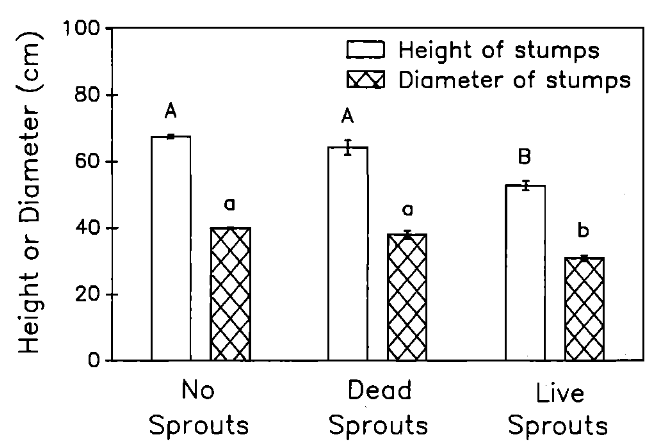

Figure 2. Mean heights and diameters (+ 1 standard error) of stumps bearing no sprouts ($n = 843$), dead sprouts ($n = 107$), and live sprouts ($n = 200$) among all swamps measured in 1988. There were no significant differences in height among categories with the same capital letter or in diameter among categories with the same lower case letter. Analyses were performed on log-transformed data; the figure is drawn from untransformed data.

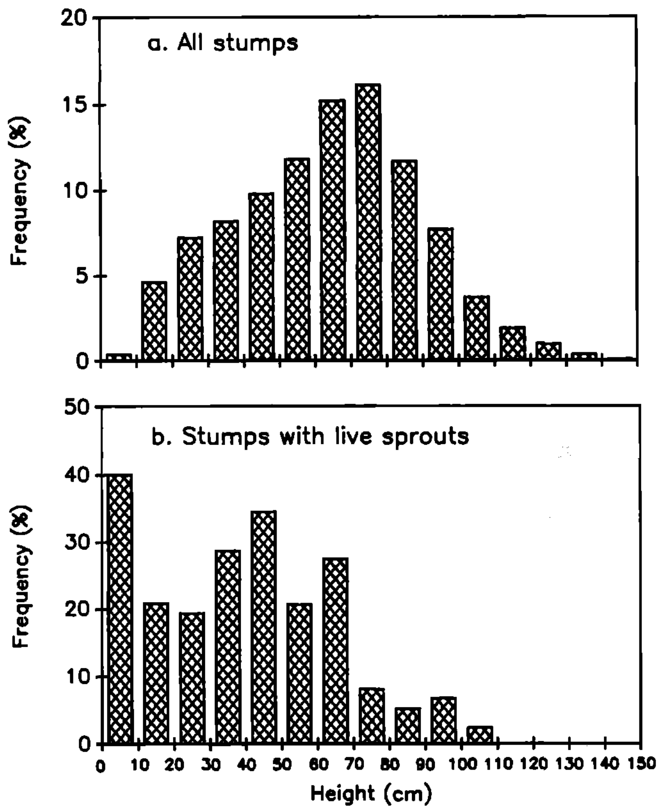

Figure 3. Frequency distributions of heights of (a) all stumps censused in all the logged plots in 1988, and (b) all the stumps that bore live sprouts in 1988.

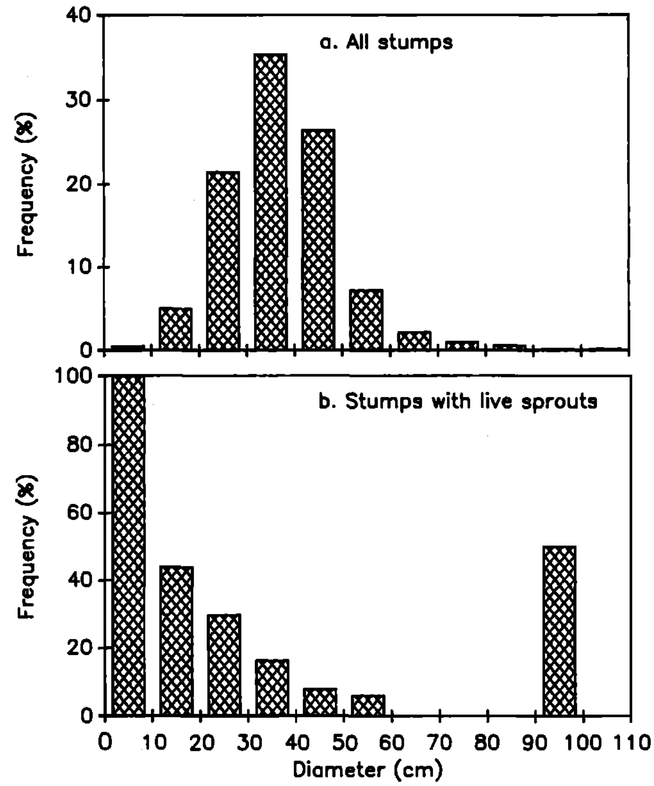

Figure 4. Frequency distributions of diameters of (a) all stumps censused in all the logged plots in 1988, and (b) all the stumps that bore live sprouts in 1988.

that trees cut closer to the ground are more likely to bear sprouts that will survive to grow into the canopy.

Another study (Rockwood and Geary 1991) demonstrates that sprout production in *Taxodium* may decrease rapidly with age. Sprouts were produced by 81% of 3 yr old baldcypress saplings but by only 37% of 6 yr old trees (from the same cohort, harvested 3 yr later). The wide range of heights and diameters of stumps that produced no sprouts and live sprouts in this study (Figures 3, 4) and the lack of a strong correlation between size and sprouting within a swamp indicate that it is not easy to predict for any one swamp which stumps are likely to sprout. The depth of water in a swamp, for instance, might confound this relationship if stumps were cut short enough to be submerged for long periods.

The unusually high percentage of stumps that sprouted initially in the Dark Stretch Road diameter limit cut (Figure 1b) is anomalous, given that stumps in this swamp had the largest mean diameters among all the swamps, but more than half of these sprouts had died by the first year. The small percentage of stumps that sprouted in the North Carter Pond Road diameter limit cut (Figure 1a) also seems anomalous, particularly since these stumps were cut shorter than the stumps on the other plots that were cut in winter 1984. However, these stumps were wider than most, perhaps because they were cut closer to the ground but perhaps also because they were older. Differences in water levels are not likely to be the cause; data collected at these two sites previously indicate that hydrologic patterns are similar (Ewel and Wickenheiser 1988).

The effect of season on sprouting does not appear to be strong. The swamps cut in summer 1986 spanned a wide range of responses by 1988, and the average percentage of stumps bearing live sprouts was equivalent to the average for all the swamps cut in 1984 after 2 yr. There are no significant relationships with height or diameter to explain the variation, but it is notable that the lowest incidence of stumps with live sprouts tended to be in the swamps with the smallest openings: the 23 m wide strips and the wedge cut. This is consistent with observations of prolific sprouting of tropical tree species in strip cuts relative to small natural gaps (Hartshorn 1989). In the latter study, however, sprouting was prolific on both 20 m wide and 50 m wide strips. The response of pondcypress to the size of the opening may be stronger when the trees are harvested in the summer rather than the winter.

Management Implications of Regeneration Patterns

Sprouting not only hastens the recovery of basal area on a site but also ensures a seed source on clearcut sites. Because no more than 50% of the stumps surveyed in the clearcut sites sprouted, seedlings are necessary for a fully stocked stand The natural recovery of cypress swamps from clearcutting without subsequent planting is generally attributed to the production of sprouts and their subsequent production of seeds (Terwilliger and Ewel 1986, Ewel et al. 1989). For this reason, cutting stumps of desirable trees as low as possible to encourage sprouting may enable foresters to ensure seed production.

Although this study does not demonstrate that logging in the winter will significantly increase the likelihood of sprouting (as suggested by Williston et al. 1980), this may be a conservative practice to follow until a more definitive analysis can be performed. If summer cutting is necessary, larger openings may encourage sprouting. On the other hand, where regeneration is not desired, such as when thinning, stumps may be cut higher, and swamps may be logged in the summer. Assessment of sprouting success after logging must wait until the second growing season after harvesting, however, because of the high rate of mortality of individual sprouts in the first year.

Several other uncertainties about harvesting pondcypress remain to be addressed, especially concerning the ability of a given tree to sprout after repeated logging and the sprouting response of stands of differing stocking densities; the difference in sprouting response of pondcypress and baldcypress is unclear as well. Further research in these areas will provide not only useful information for managers who wish to ensure successful regeneration, but it may be useful for formulation of guidelines for other species that coppice as well.

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