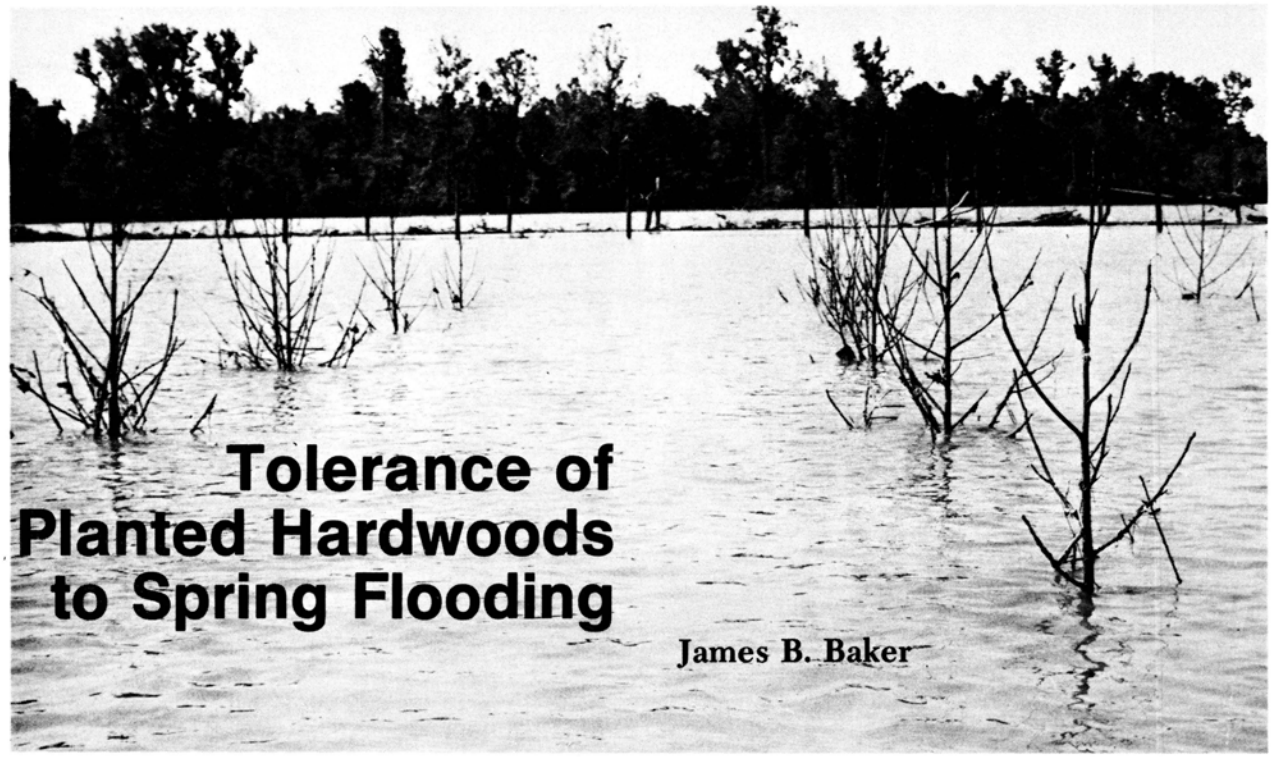
Reprinted from: Southern Journal of
Applied Forestry 1(3): 23-25, 1977.



Tolerance of Planted Hardwoods to Spring Flooding

James B. Baker

Figure 1. Defoliated cottonwood after floodwater begins to recede.

*ABSTRACT. Cuttings of eastern cottonwood (*Populus deltoides*) and seedlings of sweetgum (*Liquidambar styraciflua*), water tupelo (*Nyssa aquatica*), American sycamore (*Platanus occidentalis*), and green ash (*Fraxinus pennsylvanica*) were planted on a slackwater clay (Vertic Haplaquept) in western Mississippi in two consecutive years and inundated soon after foliation. During each of the two years, survival following flooding was consistently high for water tupelo, green ash, and sycamore, low for cottonwood, and intermediate for sweetgum. With the exception of green ash, however, all species lost their leaves and died back to the root collar during flooding. Thus trees, other than ash, that were living at the end of the growing season had originated from root collar sprouts.*

Many of the areas available for planting southern hardwoods are sometimes flooded for short periods in the spring and early summer. Although most hardwood seedlings can survive extended flooding during the dormant season and even tolerate water-saturated soil conditions in the summer, few can withstand complete inundation after foliation (Broadfoot and Williston 1973).

Studies indicate that some hardwoods are apparently more tolerant than others to flooding during the growing season (Hosner 1958, 1960; Kennedy and Krinard 1974; McAlpine 1961). However, these reports are from simulated flooding tests in metal tanks or drums or from surveys of tree damage caused by natural flooding. There are no data from field experiments designed to test the tolerance of hardwood seedlings to flooding. This study evaluates first-year survival and growth of five hardwood species subjected to spring flooding under controlled field conditions.

FIELD EXPERIMENT

The study was initiated in 1972 and repeated in 1973. The experimental design was a 4-replicate randomized complete block. In January of each year, unrooted cuttings of cottonwood and seedlings of green ash, sweetgum, American sycamore, and water tupelo were planted in 25-tree plots at a spacing of 10 × 10 feet. All seedlings were nursery grown (1-0) stock and were graded uniformly each year. The site was a Sharkey clay soil (Vertic Haplaquept) in a minor depression on the Delta Experimental Forest near Stoneville, Mississippi, that had recently been cleared of a mixed hardwood forest.

A levee was constructed around the study area, and, after the trees had leafed in May, three feet of water was pumped onto the plots from a well adjacent to the study area. The water level was maintained by periodic additions of water from the well. All trees were completely covered for four weeks; then the water was drained. The plantings were cultivated with a disk harrow three times each summer.

Survival counts were taken before flooding, one week after water drawdown, and at the end of the growing season. Counts taken one week after water drawdown were only tentative estimates of survival based on whether the top of the seedling was living. Survival values were adjusted for mortality occurring before flooding. In addition,

Figure 2. Even though most hardwood seedlings can survive extended flooding during the dormant season, few can withstand complete inundation after foliation.

the condition of the seedlings was categorized as (1) dead, (2) died back but resprouted, or (3) living. Tree height was recorded at the end of each growing season.

Analysis of variance and Duncan's New Multiple Range Test were used to evaluate the effects of flooding on survival and growth for each of the two years. All statistical tests were performed at the 0.05 level. Survival data were transformed to arcsin $\sqrt{\%}$ before analysis.

TABLE 1. Survival of five hardwood species observed one week and one season after spring flooding.

Species	Survival after one month of spring flooding											
	One week after water drawdown						One season after water drawdown					
	1972		1973		Mean		1972		1973		Mean	
	Percent											
Cottonwood	47	c[1]	0	d	24	c	38	c	0	c	19	c
Green ash	100	a	82	b	91	a	97	a	88	a	92	a
Sweetgum	62	c	74	b	68	b	82	b	80	b	81	b
Sycamore	52	c	18	c	35	c	93	a	88	a	90	a
Water tupelo	93	b	97	a	95	a	67	b	76	b	72	b

[1] *Within columns, means followed by the same letter are not significantly different (0.05 level), according to Duncan's New Multiple Range Test.*

TABLE 2. Tree heights of five hardwood species one season after spring flooding.

Species	Tree height at end of one season following spring flooding			
	1972		1973	
	Feet			
Cottonwood	3.7	a[1]	—[2]	
Green ash	2.8	b	2.9	a
Sweetgum	1.1	d	1.4	d
Sycamore	2.2	c	2.6	b
Water tupelo	1.6	cd	2.1	c

[1] *Within columns, means followed by the same letter are not significantly different according to Duncan's New Multiple Range Test (0.05 level).*

[2] *There were no living trees of this species for this year.*

SURVIVAL AND GROWTH AFTER FLOODING

All species except green ash lost their leaves each year during the flooding period. Thus when survival counts were made, live seedlings (other than ash) included those that had either resprouted from the root collar or had leafed out from the original stem. Seedlings that showed no sign of sprouting or leafing were recorded as dead.

Estimates made one week after water drawdown (and averaged over the two years) indicated 95-percent survival for water tupelo and 91-percent for green ash but only 24-percent for cottonwood (Table 1). All of the water tupelo and cottonwood that were living had resprouted from the root collar, whereas the ash continued growing from the original stem. Kennedy (1970) has also observed that flooding of water tupelo seedlings results in dieback, although most plants resprout within a week after water recedes. Hosner (1958), working with potted seedlings of cottonwood and green ash flooded in metal tanks, also found that green ash recovers rapidly after removal from water while cottonwood recovers slowly.

Some of the cottonwood and water tupelo that were living one week after drainage died by the end of the growing season. However, this additional mortality cannot be attributed solely to flood damage, since some plants probably died during the summer from other causes.

Only 35 percent of the sycamore and 68 percent of the sweetgum appeared to be living one week after the water was removed, but when seedling survival was evaluated at the end of the growing season, 90 percent of the sycamore and 81 percent of the sweetgum were living. Thus most of these surviving plants originated from sprouts that developed sometime later than one week after the water receded.

First-year height growth varied among species (Table 2). In 1972, when some of the cottonwoods survived flooding, their growth was significantly better than that of most other species. Except for cottonwood in 1972, green ash generally grew better during each of the two years than the other species.

CONCLUSIONS

On sites where recently planted hardwoods are subject to lengthy inundation after foliation in the spring or early summer, proper selection of flood-tolerant species is important. The following conclusions can be drawn about the suitability of the five species tested for spring-flooded planting sites.

- Water tupelo, green ash, and sycamore were consistently tolerant of spring flooding; only about 10 percent were killed by the water. Cottonwood was intolerant; sweetgum tolerance was intermediate.
- Except for green ash, the majority of all species tested died back to the root collar during flooding. Trees, other than ash, that were living at the end of the growing season had originated from root collar sprouts.
- Cottonwood and water tupelo resprouted within a week after floodwater was removed, but sycamore and sweetgum did not begin sprouting until several weeks after drainage. This delayed sprouting should be considered when evaluating sycamore and sweetgum survival following a flood.
- Green ash attained the best height growth in the first year after flooding, except for cottonwood during the year that it survived.

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