# ENHANCING OAK REGENERATION IN A MIXED BOTTOMLAND HARDWOOD STAND AFTER A MAJOR DISTRUBANCE[1]

W.B. Steele, D.D. Hook, M.A. Buford, and J.G. Williams [2]

**Abstract.** In 1989, Hurricane Hugo destroyed an 85-acre mixed bottomland hardwood stand on the Santee Experimental Forest near Huger, SC. Detailed basal area and species composition data on this stand, as well as the parent stand provided the opportunity to evaluate several silvicultural treatments for increasing the cherrybark oak (*Quercus falcata var. pagodifolia*) and shumard oak (*Quercus shumardii*) component of a bottomland hardwood stand. A study was installed on the site in 1990 which consisted of four treatments with increasing degrees of silvicultural manipulation and investment. Treatments range from no enhancement to cutting of all stems greater than 1 inch DBH, herbicide control of undesirable hardwoods, and planting of cherrybark oak seedlings. Comparison of treatments after two years suggest that control of undesirable hardwood sprouts with herbicide application and planting oak seedlings had a positive effect on the oak component. This ongoing project will monitor stand growth to observe the long-term effects of these treatments on stand composition and value.

## Introduction

Bottomland hardwood ecosystems provide a wide variety of natural resource benefits including timber production, water quality enhancement, flood storage, nutrient recharge, and waterfowl habitat (Hall and Lambou 1989). Many mixed bottomland hardwood stands are dominated by oak species (Clatterbuck and Hodges 1988) and provide mast for wildlife. Cherrybark and shumard oaks are among the most valuable components of bottomland hardwood stands (Hodges and Janzen 1986, Johnson 1979) and are capable of producing quality saw logs in 60 years (Hook and Stubbs 1965).

Cherrybark and shumard oaks reproduce from seed and sprouts, (Putnam 1951) with the best sprouts stemming from the buds of younger stumps at or below ground line and from stumps less than 10 inches in diameter (Johnson 1977, Wendel 1975). Sprouts from low stumps are more acceptable because they tend to have less disease and rot (Aust et al. 1984). Dense thickets of hardwood sprouts naturally thin themselves during the early stages of stand growth. Through competition, the total number of stems is often reduced from several thousand per acre at regeneration to 1,600 - 1,800 by age 20. Of these, about 400 may develop to be commercially useful (Zahner and Myers 1984).

Herbicides are a potentially useful site preparation alternative to mechanical methods (Neary 1983) and the most effective and selective method of controlling hardwood competition is individual tree treatments (Cantrell et al. 1986). Also, underplanting cherrybark oak seedlings prior to final harvest may be beneficial where advanced regeneration is not sufficient. Seedlings may be spot planted at relatively low densities (200-500 per acre) to supplement natural regeneration and to reduce the cost of intensive treatments (Lorimer 1989). The survival of 15 to 20 carefully placed oak seedlings per acre at maturity may provide an adequate quality sawtimber component to a mixed hardwood stand (Johnson 1980).

There is a need in the South to develop effective techniques for restoring mixed bottomland hardwood wetland forests (McKevlin 1992). In addition to natural resource benefits such as wildlife habitat, flood control, and water quality enhancement, timber value can be improved by silvicultural methods that increase the composition of high value species such as cherrybark and shumard oak.

## Materials and Methods

### *Study Site*

The study site is located off Yellowjacket Road between Turkey Creek and Negro Field Creek

[1] Paper presented at the Seventh Biennial Southern Silvicultural Research Conference, Mobile, AL, November 17-19, 1992.

[2] Graduate Student and Professor, Clemson University, Clemson, SC; Project Leader, Southeastern Forest Experiment Station, Charleston, SC; Statistician, Clemson University, Clemson, SC.

on the Santee Experimental Forest near Huger, South Carolina. More than 80% of the stems of the 29-year old stand were uprooted or broken off by Hurricane Hugo in September, 1989. Soils of the first terrace are a humiaquepts that were farmed for rice prior to abandonment in the 1890's. The second terrace is a fluviaquents that was row cropped during the same period. About 80% of the soils are hydric and consequently about 80% of the site is considered a wetland (USACE, 1987).

The Southeastern Experiment Station has performed numerous research studies on this site since the late 1950's. It was the location for a study initiated in 1958 to assess the suitability of the seed tree method for regenerating a bottomland hardwood stand (DeBell et al. 1967). Other research studies performed on the site include: 1) development of sweetgum root sprouts (Hook et al. 1970), 2) observation of understory growth retardation under three species of oak (Hook and Stubbs 1967), and 3) early stand development (Buford, Hook, and Bunton, 1990).

*Treatments*

The site was divided into eight treatment blocks of 6.4 acres each. Four treatments were randomly applied to the eight blocks resulting in two replications of each treatment which are: 1) control, no treatment; 2) cut all stems greater than one inch DBH; 3) cut all stems greater than one inch DBH and spray all stumps except red oak with a chemical to inhibit sprouting; and 4) cut all stems greater than one inch DBH, spray all stumps except red oak, and plant 1,0 cherrybark seedlings at 1210 seedlings per acre on a 6 by 6 foot spacing. All trees were felled by chainsaw. A glyphosate spray mixed to a 50% solution with diesel fuel and a colorant to insure stump coverage was used on all stumps other than red oak to discourage stump sprouting. The spray was applied with a backpack sprayer with a flat nozzle immediately after the trees were felled.

*Seedling Measurement*

A minimum of five 4/100 acre plots per 6.4 acre block were established on the permanent plot centers used in earlier studies. All tree species taller than 4.5 feet were identified and flagged. Height and DBH of these trees were recorded as well as the stump diameter and number of sprouts per stump within these plots. In the cut-spray-plant blocks, the height of all planted seedlings were also recorded. A 1/1000 acre plot was established at 16 feet due north of each sample plot center, where sprout height, stump diameter, and number of stems were recorded for all woody stems less than 4.5 feet in height. Also, an ocular estimate of the percent cover by woody vegetation, herbaceous vegetation, and woody debris by quadrant, clockwise from north, was made on the 1/1000 acre plot. All measurements were made in the summer of 1991 and again in the summer of 1992 in order to determine one year's growth.

## Results

Thirty-two tree species were found on the study site in 1992. Figure 1 shows the number of stems per acre by treatment for all tree species. The increase in number of stems from control to the cut treatment was due to stump sprouting. Treatments involving herbicide control showed a reduction in number of stems per acre by about 50%.

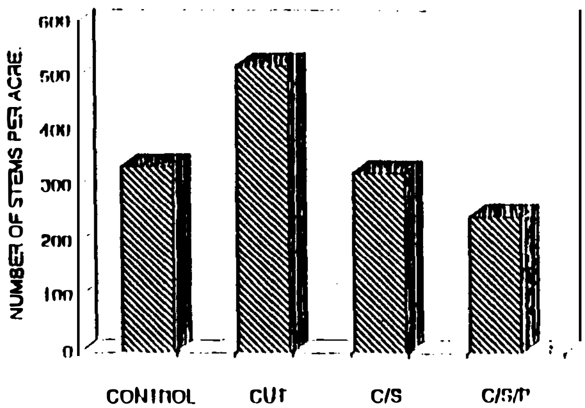


Figure 1. *Woody competition by treatment for 1992 growing season.*

The number of stems per acre and percent basal area for the six most frequently occurring species are shown in Table 1. Number of stems per acre of sweetgum (*Liquidambar styraciflua*) and ironwood (*Carpinus caroliniana*) were not statistically different by treatment. Sweetgum roots sprout prolifically and thus cannot be effectively controlled by stump application of herbicides. Ironwood stumps were of a much smaller diameter than other species and may have been overlooked by spray applicators or the spray may not have been effective on this species.

The species that comprise the majority of the basal area and stems per acre shifted from sweetgum and ironwood in treatment 1 to a more even distribution in treatment 2 and then to favoring red maple (*Acer rubra*), oak, and ash (*Fraxinus sp.*) in

Table 1. *Characteristics of Six Selected Species in a Bottomland Hardwood Stand Three Years After Hurricane Hugo.*

| Species | Control | | Cut | | Cut/Spray | | Cut/Spray/Plant | |
|---|---|---|---|---|---|---|---|---|
| | % BA* | # Stems /Acre | % BA | # Stems /Acre | % BA | # Stems /Acre | % BA | # Stems /Acre |
| Red maple | 3 | 18 | 14 | 224 | 18 | 134 | 10 | 92 |
| Ash | 2 | 53 | 15 | 216 | 14 | 73 | 26 | 38 |
| Red oaks | 2 | 13 | 11 | 67 | 16 | 77 | 22 | 356** |
| Sweetgum | 33 | 105 | 28 | 91 | 25 | 39 | 6 | 36 |
| Ironwood | 13 | 195 | 10 | 62 | 2 | 25 | 4 | 19 |
| Elm | 4 | 95 | 9 | 57 | 6 | 39 | 11 | 40 |

*BA = Basal Area

** For this treatment, planted seedlings are included in # Stems /acre, but are not included in % BA.

treatments 3 and 4 which involved herbicide application.

Duncan's Multiple Range Test showed significant ($\alpha = 0.05$) differences in stems per acre by treatment. Red maple was more abundant in treatment 2 than in the other treatments. Elm (*Ulmus sp.*) was more abundant in treatment 1 than in treatments 3 and 4. Ash was more abundant in treatment 3 than in treatment 1. Red oaks were found to be more abundant in treatments 3 and 4 than in treatment 1.

The planted cherrybark oak seedlings increased the oak component in treatment 4 by three fold. Survival of the seedlings after three years was 46%. Undoubtedly, mortality of planted oaks will continue in coming years. However, if even 20% survive, the long term impact on the oak component will still be substantial.

## Conclusions

Significant differences in the number of stems per acre of red oak species between treatments indicate that, at least in the short term, the red oak component of a mixed hardwood stand can be increased by the application of herbicides to non-oak tree species and by planting red oak seedlings. Whether the initial promising effects result in an increase in mast producing trees and higher quality forest products will await future evaluations.

## Acknowledgment

This project was partially supported by the USDA, Forest Service, Southeastern Forest Experiment Station.

## Literature Cited

Aust, W.M., J.D.Hodges, and R.L. Johnson. 1984. The origin, growth, and development of natural, pure, even-aged stands of bottomland oak. Proc. 3rd. bien. south. silv. res. conf. USDA For. Serv. Gen. Tech. Rep. SO-54:163-170.

Buford, M., D. D. Hook, and C. Bunton. 1990. Growth and compositional changes in a mixed bottomland hardwood stand through age 28 years. In Proc. International Symp. on Wetlands and River Corridor Management. July, 1989. Charleston, SC. Sponsored by American Assoc. of Wetland Managers.

Cantrell, R.L., D.M. Flinchum, and D.G. Neary. 1986. Individual tree treatments using herbicides for control of turkey oak. Sou. J. Appl. For. 10(3):131-133.

Clatterbuck, W.K. and J.D. Hodges. 1988. Development of cherrybark oak and sweet gum in mixed, even-aged bottomland stands in central Mississippi. Can. J. For. Res. 18: 12-18.

DeBell. D.S., J. Stubbs, and D.D. Hook. 1967. An introductory study in seed-tree cutting of the bottomland hardwood type of the Carolina coastal plain. USDA For. Ser., Southeastern Forest Experiment Station, Charleston, SC. Unpublished report.

Hall, D.H. and V.W. Lambou. 1989. Determining the value of bottomland hardwood Riverine wetlands to fisheries. In: Wetlands and river corridor management. Proc. of the international wetlands symposium. July 6-9, Charleston, S.C.

Hodges, J.D. and G.C. Janzen. 1986. Studies on the biology of cherrybark oak: recommendations for regeneration. In: Proc. 4th Bien. Sou. Silv. Res. Conf. USDA For. Ser. Gen. Tech. Rep. SE-42.

Hook, D.D., P.P. Kormanik, and C.L. Brown. 1970. Early development of sweetgum root sprouts in Coastal South Carolina. USDA For. Ser. Res. Pap. SE-62. 6pp.

Hook, D.D., and J. Stubbs. 1967. An observation of understory growth retardation under three species of oaks. USDA For. Ser. Note SE-70. 7pp.

Hook, D.D., and J. Stubbs. 1965. Selective cutting and reproduction of cherrybark and Shumard oaks. Journal of Forestry. 63(12):927-929.

Johnson, R.L. 1980. New ideas about regeneration of hardwoods. In: Proc. Hardwood Regeneration Symposium: SE Lumber Manufacturers' Assoc. p.17-19. As stated by: L.E. Nix and S.K. Cox. 1984. Proc. 4th Bien. Sou. Silv. Res. Conf. USDA For. Ser. Gen. Tech. Rep. SE-42:129-132.

Johnson, P.S. 1979. Shoot elongation of black oak and white oak sprouts. Can. J.of For. Res. 9:489-494.

Johnson, P.S. 1977. Predicting oak stump sprouting and sprout development in the Missouri Ozarks. USDA For. Ser. Res. Pap. NC-149. 11pp.

Lorimer, C.G. 1989. The oak regeneration problem: new evidence on causes and possible solutions. In: Proc., 17th annual symposium of the hardwood research council. Merimac, Wisconsin.

McKevlin, M.R. 1992. Guide to regeneration of bottomland hardwoods. Gen. Tech. Rep. SE-76. Asheville, NC: USDA, Forest Service, Southeastern Forest Experiment Station. 35pp.

Neary, D.G. 1983. Monitoring herbicide residues in springflow after an operational application of hexazinone. Sou. J. Appl. For. 7(4):217-223.

Putnam, J.A. 1951. Management of bottomland hardwoods. USDA For. Ser. Sou. For. Exper. Sta. Occas. Pap. 116. 60pp.

U.S. Army Corp. of Engineers. 1987. Wetland Delineation Manual. Technical Report Y-87-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Wendel, G.W. 1975. Stump sprout growth and quality of several Appalachian hardwood species after clearcutting. USDA For. Serv. Res. Pap. NE-329. 9pp.

Zahner, Robert and R.K. Myers. 1984. Productivity of young piedmont oak stands of sprout origin. Sou. J. Appl. For. 8:102-108.