TEXAS J. SCI. 52(4) SUPPLEMENT:33-42 NOVEMBER, 2000

EFFECTS OF DATE AND FREQUENCY OF BURNING ON SOUTHERN BAYBERRY (*MYRICA CERIFERA*) IN CENTRAL LOUISIANA

James D. Haywood*, Henry A. Pearson, Harold E. Grelen* and Thomas W. Popham

**USDA Forest Service, Southern Research Station, Pineville, Louisiana 71360*
USDA Agricultural Research Service, Athens, Texas 75751 and
USDA Agricultural Research Service, Stillwater, Oklahoma 74075

Abstract.—*Myrica cerifera* (southern bayberry or waxmyrtle) is one of the most common shrubs in the longleaf pine/bluestem forest type in the West Gulf Coastal Plain. During controlled burns, individual plants can burn intensely because the wax coated foliage and fruits are very flammable. However, *Myrica cerifera* can survive fires on frequently burned sites by resprouting vigorously from the root collar. To determine how burning influences the development of *Myrica cerifera*, this study compared several burning dates (1 March, 1 May and 1 July) and fire frequencies (one, two and three year intervals) on a site in central Louisiana. *Myrica cerifera* plants generally survived all burning treatments, with only two plants dying over eight growing seasons (1.3% mortality). Burning kept average shrub height at or below the initial preburn heights and significantly below the height of the non-burned plants. Final average heights and diameters of *Myrica cerifera* decreased significantly as the burning frequency increased and the date of burning was delayed into the growing season.

Myrica cerifera L., commonly known as waxmyrtle or southern bayberry, is a familiar evergreen shrub of the Atlantic and Gulf Coastal Plain, ranging from southern New Jersey to central Texas (Little 1979). It is also the most common shrub in the longleaf pine (*Pinus palustris*)/bluestem (*Schizachyrium* and *Andropogon* sp.) forest type in the West Gulf Region (Grelen & Duvall 1966).

On longleaf sites, *Myrica cerifera* competes with longleaf seedlings for water, nutrients and sunlight, but its benefits include fixing nitrogen (Grelen & Duvall 1966). Herbaceous plant production, particularly on poorly drained soils, is constantly suppressed by competition from *Myrica cerifera*. Although its abundant seeds are eaten by many songbirds, wild turkey and tree swallows, *Myrica cerifera* is considered an inferior food plant for white-tailed deer and a secondary food plant for bobwhite quail (Grelen & Duvall 1966; Landers & Johnson 1976; Halls 1977). Consequently, the negative qualities of *Myrica cerifera* outweigh its benefits for many, and land managers generally wish to control the spread of this shrub.

Prescribed burning is recommended for controlling *Myrica cerifera*

growth and spread (Lane & Askew 1989). In regularly burned pine stands, *Myrica cerifera* is usually less than 1.5 m tall, but on moist unburned sites it may reach 12 m in height. During prescribed burns, individual plants can burn intensely because the wax coated fruits and foliage are very flammable. However, *Myrica cerifera* is adapted to survival on frequently burned longleaf pine sites by resprouting vigorously from the root collar.

Thus, burning every three to four years during winter top-kills *Myrica cerifera*, but rapidly growing sprouts can restore plants to their preburn heights and enlarge diameter of clumps between burns. However, a more frequent burning schedule may help control *Myrica cerifera* sprout development (Lotti 1956; Lotti et al. 1960).

Summer fires are considered more effective in controlling woody plants than dormant season fires (Lotti 1956; Ferguson 1957; Lotti et al. 1960; Grano 1970; Chen et al. 1975; Boyer 1993), and more specifically, summer fires appear to effectively control *Myrica cerifera* regeneration on the Atlantic and East Gulf Coastal Plain (Lotti 1956; Lotti et al. 1960; Waldrop & Lloyd 1991). In the West Gulf Coastal Plain, summer burning can control understory woody plants (Ferguson 1957; Grano 1970; Haywood et al. 1998), but May burning can be as effective and favors longleaf pine reproduction (Grelen 1975).

The strong findings that fire was very effective at controlling *Myrica cerifera* on the East Gulf Coastal Plain led to this study to further evaluate the effectiveness of fire for controlling *Myrica cerifera* on the West Gulf Coastal Plain. To better evaluate the effects of fire on *Myrica cerifera*, this study compared several burning dates (1 March, 1 May and 1 July) and frequencies of burning (one, two and three year intervals). The objective of this study was to determine the best time to burn for control of *Myrica cerifera* in the West Gulf Region.

STUDY SITE

This study was initiated in 1978 on a cutover longleaf pine/bluestem range in the temperate, outer coastal plain mixed forest ecoregion of the southern United States (McNab & Avers 1994). It is located within the USDA Forest Service, Kisatchie National Forest in central Louisiana about 39 km south of Alexandria, at an average elevation of 52 m (31°00' north latitude by 92°30' west longitude). Soils are a complex of moderately well drained (Beauregard soil series) to poorly drained (Caddo soil series) fine-silty, siliceous, thermics with associated

moderately well drained coarse-silty, siliceous, thermic "pimple" mounds (Messer soil series), typical of Louisiana flatwoods (Kerr et al. 1980). Beauregard soils are Plinthaquic Paleudults, Caddo soils are Typic Glossaqualfs and Messer soils are Haplic Glossudalfs (Soil Conservation Service 1975; Kerr et al. 1980).

Climate in the areas is humid and subtropical with mean January and July temperatures of 9 and 27°C, respectively (Louisiana Office of State Climatology 1985). Annual precipitation averages 1,400 mm, and all monthly averages exceed 90 mm. The 250 day growing season is from 10 March to 15 November (the spring and fall dates with a 50% probability of a frost).

Harms (1996) defines this site as a wet pine site because the soils are seasonally wet during winter and often droughty during the late growing season. Kerr et al. (1980) consider these soils to be best suited for forest management.

The study site had been burned every third year in late winter or early spring for more than 20 years prior to the initiation of this study. Scattered longleaf pines, blackjack oaks (*Quercus marilandica* Muenchh.) and southern red oaks (*Q. falcata* Michx.) were the most abundant trees. Oaks that survived the frequent burning were now too large to control by fire. Bluestem grasses dominated the abundant herbaceous ground vegetation.

METHODS AND MATERIALS

Thirty 20 by 20 m plots (0.04 ha) were established, then, ten treatments were assigned to the individual plots as a completely randomized design (Cochran & Cox 1957). There were three replicates for each treatment.

On each plot, five individual plants or clumps of *Myrica cerifera* were selected of uniform size and were permanently marked with numbered metal tags for remeasurement purposes. These plants had been repeatedly top-killed by previous prescribed burns. They averaged about 1.4 m tall when treatments were first applied. All pines and other hardwood trees and shrubs more than 1 m tall were severed near ground level and removed from plots.

The ten treatments included a control plot (no burning once the plots were established) and fires on three dates (1 March, 1 May or 1 July) and at three frequencies of burning (one, two or three years apart). Burns were applied within two days before or after the target dates. The

annual burns were applied beginning in 1978 through 1984. The biennial burns were applied in 1978, 1980, 1982 and 1984. The triennial burns were applied in 1978, 1981 and 1984. Thus all treated plots were burned in 1978 and 1984 but only subsets of plots were burned in other years. Burning treatments were head fires unless high winds made backfires necessary.

In March 1978, maximum diameter and maximum height of each clump were measured with a calibrated stick or pole and recorded to the nearest 3 cm before initial burns were applied. Plants were remeasured at the end of each growing season through 1985.

Different dates of burning mean the period of time plants have to recover before the end of the growing season also differs. This can be a problem when comparing end-of-growing-season measurements. However, fixing a period of time after each burn when measurements are taken (such as remeasurement on the anniversary date of the last burn) still presents problems because growing conditions over different fixed periods of time differ as well.

In this study, survival and growth was measured one year after all burning ceased to allow all the *Myrica cerifera* plants time to recover. The final measurements in August 1985 were taken more than 18 months after the last March burn, 16 months after the last May burn, and 14 months after the last July burn in 1984. This is considered to be an acceptable method because all *Myrica cerifera* plants had over a year to recover.

Differences between the treatments at the end of the study were tested by analyses of variance at the 0.05 probability level. If significant treatment mean differences for *Myrica cerifera* diameter and height were found in the analyses of variance, the treatment means were separated by using Duncan's Multiple Range Tests at the 0.05 probability level (Cochran & Cox 1957). Analyses of covariance tests were also used, with the initial height and diameter values as covariates, but these tests provided no additional information compared to the analysis of variance tests because of the uniformity in original plant sizes and the burning treatments repeatedly reduced the stature of *Myrica cerifera.*

RESULTS

Two of a total 150 *Myrica cerifera* clumps were completely killed by fire during the study, and both were on the annual May burned plots. Plant heights on unburned controls were significantly taller than the

other treatments at the end of the study (Table 1). On the control plots, average height of *Myrica cerifera* increased from 1.3 to 2.1 m, a gain in height of 62% over eight growing seasons.

Burning in July resulted in the greatest reduction in height growth (Table 1). Average height of *Myrica cerifera* decreased from 1.3 m in March 1978 to 0.5 m in November 1984. The plants still only averaged 0.8 m tall 14 months after the last burn.

Burning in March and May had less influence on *Myrica cerifera* height growth than burning in July (Table 1). On the March burned plots, *Myrica cerifera* height was suppressed initially from 1.4 m in March 1978 to 1.0 m in February 1979. However, *Myrica cerifera* averaged 1.1 m tall in November 1984 and was 1.3 m tall 18 months after the last burn. On the May burned plots, *Myrica cerifera* averaged 1.4 m in height at the beginning of the study and was 0.7 m tall in October 1981. However, plants averaged 1.0 m tall in November 1984 and were 1.1 m tall 16 months after the last burn.

Over eight growing seasons, annual burning had a greater effect on *Myrica cerifera* height growth than either biennial or triennial burning (Table 1). Because *Myrica cerifera* had only one year to recover between burns, the successive fires caused a gradual decrease in average height from 1.4 m at the beginning of the study to 0.6 m in October 1981, and this height was maintained through 1984. Heights averaged 0.8 m on the annually burned plots at the end of the study.

Myrica cerifera on biennially burned plots averaged 1.3 m tall at the beginning of the study (Table 1). Biennial burning was effective in the years applied, reducing heights to 0.8 m on average, and the two year period between burns was insufficient for *Myrica cerifera* to fully recover in stature. Heights averaged 1.1 m at the end of the study.

Triennial burning was also effective in the years applied reducing heights to 0.8 m on average, but the three year period between burns allowed the shrubs to recover. At the beginning of the study *Myrica cerifera* was 1.4 m tall on the triennially burned plots, and by the end of the study *Myrica cerifera* was 1.3 m tall.

The interaction between how burning date and frequency of burning influenced plant height was also tested. At the end of the study, *Myrica cerifera* on the annual May and July burned plots averaged 0.7 m tall, which was significantly shorter than the *Myrica cerifera* on the annual March burned plots (1.2 m tall). On biennially burned plots, *Myrica*

Table 1. Average height in meters on measurement dates (month/year) of *Myrica cerifera* clumps in response to varying burning treatments from March 1978 through August 1985.

Measurement dates	03/78	02/79	09/79	10/80	10/81	10/82	09/83	11/84	08/85
Burning dates									
No burning[1]	1.3	1.6	1.6	1.8	1.8	1.9	2.0	2.1	2.1a[2]
March 1	1.4	1.0	1.2	1.3	1.1	1.1	1.3	1.1	1.3b
May 1	1.4	.8	1.1	.9	.7	.8	1.0	1.0	1.1b
July 1	1.3	.6	.9	.9	.6	.7	.8	.5	.8c
Frequency of burning									
No burning[1]	1.3	1.6	1.6	1.8	1.8	1.9	2.0	2.1	2.1a[2]
Annual[3]	1.4	.8	.8	.8	.6	.7	.6	.6	.8d
Biennial[3]	1.3	.9	1.2	.8	1.2	.8	1.1	.8	1.1c
Triennial[3]	1.4	.8	1.2	1.4	.6	1.1	1.3	1.1	1.3b

[1] The last general burn of the study area was in 1975. Thereafter, control plots were not burned.

[2] By dates and frequency, means for the final measurement with the same lower case letter are not significantly different at a 0.05 probability level, based on Duncan's Multiple Range Tests.

[3] The annual burns were applied beginning in 1978 through 1984. The biennial burns were applied in 1978, 1980, 1982, and 1984. The triennial burns were applied in 1978, 1981 and 1984.

cerifera on the July burned plots were 0.8 m tall and were significantly shorter than were those on the March burned plots (1.3 m tall). On triennially burned plots, *Myrica cerifera* on the July burned plots were 1.0 m tall and were significantly shorter than those on either the March or May burned plots (an average of 1.5 m tall) at the end of the study.

On the control plots, the diameter of *Myrica cerifera* clumps increased from 1.8 m in March 1978 to 3.4 m in August 1985 (Table 2). This was a gain in diameter of 89% over eight growing seasons. On the July burned plots, the diameter of clumps changed little, averaging 1.7 m in March 1978, 1.4 m in November 1984, and 1.8 m 14 months after the last burn. March burning did not significantly control *Myrica cerifera* diameter growth compared to burning in July. Diameter of clumps on the March and May burned plots averaged 1.8 m in March 1978 and 2.5 and 2.1 m 16 and 18 months after the last burn, respectively.

Annual burning had a greater effect on *Myrica cerifera* diameter growth than either biennial or triennial burning (Table 2). Since *Myrica cerifera* had only one year to recover between burns, the successive fires caused a gradual decrease in average diameter of clumps from 1.7 m in March 1978 to 1.2 m in October 1982. Thereafter, some recovery in average diameter was measured, and by the end of the study, average clump diameter had recovered to its pretreatment size.

Table 2. Average diameter in meters on measurement dates (month/year) of *Myrica cerifera* clumps in response to varying burning treatments from March 1978 through August 1985.

Measurement dates	03/78	02/79	09/79	10/80	10/81	10/82	09/83	11/84	08/85
Burning dates									
No burning[1]	1.8	2.2	2.3	2.8	2.9	3.0	3.0	3.4	3.4a[2]
March 1	1.8	1.8	1.8	1.9	1.8	1.9	2.2	2.3	2.5b
May 1	1.8	1.5	1.6	1.6	1.4	1.6	1.8	1.9	2.1bc
July 1	1.7	1.3	1.5	1.5	1.4	1.4	1.6	1.4	1.8c
Frequency of burning									
No burning[1]	1.8	2.2	2.3	2.8	2.9	3.0	3.0	3.4	3.4a[2]
Annual[3]	1.7	1.4	1.4	1.3	1.2	1.2	1.3	1.4	1.7d
Biennial[3]	1.7	1.8	1.8	1.5	1.9	1.6	1.9	1.9	2.1c
Triennial[3]	1.9	1.5	1.8	2.2	1.6	2.1	2.4	2.3	2.6b

[1] The last general burn of the study area was in 1975. Thereafter, control plots were not burned.

[2] By dates and frequency, means for the final measurement with the same lower case letter are not significantly different at a 0.05 probability level, based on Duncan's Multiple Range Tests.

[3] The annual burns were applied beginning in 1978 through 1984. The biennial burns were applied in 1978, 1980, 1982, and 1984. The triennial burns were applied in 1978, 1981 and 1984.

Biennial burning reduced clump diameters in 1980 and 1982 but was less effective in 1978 and 1984 (Table 2). At the beginning of the study, clumps averaged 1.7 m in diameter, and by the end of the study, clumps averaged 2.1 m in diameter, a gain of 24% in maximum width. Triennial burning reduced clump diameter in 1978 and 1981 but did not effectively reduce clump diameter in 1984. At the beginning of the study, clumps averaged 1.9 m in diameter, and by the end of the study, clumps averaged 2.6 m in diameter, a gain of 37% in maximum width.

The interaction between how burning date and frequency of burning influenced clump diameter was also tested. At the end of the study, *Myrica cerifera* on the plots annually burned in May and July averaged 1.4 m wide and were significantly smaller in diameter than the *Myrica cerifera* annually burned in March (2.3 m wide). Date of burning did not significantly affect clump diameter on the biennially or triennially burned plots.

Discussion and Conclusions

Overall, burning in July significantly reduced *Myrica cerifera* clump diameter when compared to March burning and significantly reduced *Myrica cerifera* height when compared to both March and May burning

(Tables 1 and 2). The seven annual burns significantly reduced clump height and diameter when compared to four biennial or three triennial burns. Biennial burning significantly reduced *Myrica cerifera* height and diameter when compared to triennial burning.

Results of this study of the West Gulf Coastal Plain differ from those of research in South Carolina, where fires were more effective in controlling *Myrica cerifera*. In South Carolina for example, four annual burns accomplished 90% mortality (Lotti 1956) of *Myrica cerifera* (cf. Lotti 1956), and mortality was nearly 100% after seven annual burns (Lotti et al. 1960). Lewis & Harshbarger (1976) found no *Myrica cerifera* on annual summer burns after 20 years. Waldrop & Lloyd (1991) also reported rapid mortality with annual summer burns, nearing 100% within eight years. Why burning treatments during this current study caused only minor mortality is unknown. Fuel condition, fire intensity, soil type and nutrient differences may help explain differences in *Myrica cerifera* mortality between the eastern and western portions of the Southeastern Coastal Plain. Rainfall quantities and patterns, however, do not appear dissimilar enough across the Southeast to explain these differences (Byrd et al. 1984).

In the Gulf Coastal Plain of Alabama, 18 years of biennial spring or summer burns failed to significantly reduce number of hardwood root-stocks over biennial winter burns or no burns at all, although spring or summer burning reduced hardwood stature (Boyer 1993). These findings are more similar to results obtained during this study.

Since only two of the 150 *Myrica cerifera* plants were completely killed by any of the burning regimes during this study, these results suggest that fire may not completely remove *Myrica cerifera* from a site. Consequently, burning should not be considered a completely effective control technique for *Myrica cerifera* growing in the longleaf pine/bluestem forest type of the West Gulf Coastal Plain. If elimination of this shrub is necessary, herbicide treatments may have to be used where burning is unable to arrest *Myrica cerifera* development. However, even though the shrubs may not be killed, prescribed burning on all dates reduced the stature of *Myrica cerifera*. A decrease in plant stature resulting from prescribed burning should still benefit herbaceous plant production because more growing space and sunlight are available compared to areas with unburned plants (Glitzenstein et al. 1995; Brockway & Lewis 1997). Unfortunately, periodic prescribed burning has to continue because the plants begin to recover between burns, that is, the effects of fire on *Myrica cerifera* is transitory in nature.

July was generally the best time-of-year to burn. Annual burning reduced *Myrica cerifera* size more than other burning frequencies. However, burning too frequently can be counterproductive if fuels cannot sufficiently accumulate between burns (Grelen 1975), and Glitzenstein et al. (1995) found that burning annually was less effective than biennial burning, presumably for this reason.

Clearly, the more common practice of prescribed burning in winter or spring every three or more years will not control the spread of *Myrica cerifera* as well as the more intensive alternatives tested in this study. Despite this, less frequent burning early in the growing season may be the only practical burning method for attempting to keep *Myrica cerifera* competition at a minimum that is compatible with other forest management and wildlife activities.

LITERATURE CITED

Boyer, W. D. 1993. Season of burn and hardwood development in young longleaf pine stands. Pp. 511-515, *in* Proceedings of the seventh biennial southern silvicultural research conference (J. C. Brissette, ed.), USDA For. Serv. Gen. Tech. Rep. SO-93, Southern For. Exp. Stn., New Orleans, Louisiana, 665 pp.

Brockway, D. G. & C. E. Lewis. 1997. Long-term effects of dormant-season prescribed fire on plant community diversity, structure and productivity in a longleaf pine wiregrass ecosystem. For. Eco. Manage., 96:167-183.

Byrd, N. A., C. E. Lewis & H. A. Pearson. 1984. Management of southern pine forests for cattle production. USDA For. Serv. Gen. Tech. Rep. R8-GR4. Southern Region, Atlanta, Georgia, 22 pp.

Chen, M. Y., E. J. Hodgkings & W. J. Watson. 1975. Prescribed burning for improving pine production and wildlife habitat in the hilly coastal plain of Alabama. Auburn Univ., Alabama Agricultural Exp. Stn., Bull. 473, Auburn, Alabama, 19 pp.

Cochran, W. G. & G. M. Cox. 1957. Experimental designs. 2nd ed. John Wiley & Sons, New York, 611 pp.

Ferguson, E. R. 1957. Stem-kill and sprouting following prescribed fires in a pine-hardwood stand in Texas. J. Forestry, 55(6):426-429.

Glitzenstein, J. S., W. J. Platt & D. R. Streng. 1995. Effects of fire regime and habitat on tree dynamics in North Florida longleaf pine savannas. Ecological Monographs, 65:441-476.

Grano, C. X. 1970. Eradicating understory hardwoods by repeated prescribed burning. USDA For. Serv. Res. Pap. SO-56, Southern For. Exp. Stn., New Orleans, Louisiana, 11 pp.

Grelen, H. E. 1975. Vegetative response to twelve years of seasonal burning on a Louisiana longleaf pine site. USDA For. Serv. Res. Note SO-192, Southern For. Exp. Stn., New Orleans, Louisiana, 4 pp.

Grelen, H. E. & V. L. Duvall. 1966. Common plants of longleaf pine-bluestem range. USDA For. Serv. Res. Pap. SO-23, Southern For. Exp. Stn., New Orleans, Louisiana, 96 pp.

Halls, L. K. 1977. Southern bayberry/*Myrica cerifera* L. Pp. 57-58, *in* Southern fruit-producing woody plants used by wildlife (L. K. Halls, ed.), USDA For. Serv. Gen.

Tech. Rep. SO-16, Southern For. Exp. Stn., New Orleans, Louisiana, 235 pp.

Harms, W. R. 1996. An old-growth definition for wet pine forests, woodlands, and savannas. USDA For. Serv. Gen. Tech. Rep. SRS-2, Southern Res. Stn., Asheville, North Carolina, 7 pp.

Haywood, J. D., A. Martin, Jr., H. A. Pearson & H. E. Grelen. 1998. Seasonal biennial burning and woody plant control influence native vegetation in loblolly pine stands. USDA For. Serv. Res. Pap. SRS-14, Southern Res. Stn., Asheville, North Carolina, 8 pp.

Kerr, A., Jr., B. J. Griffis, J. W. Powell, J. P. Edwards, R. L. Venson, J. K. Long & W. W. Kilpatrick. 1980. Soil survey of Rapides Parish, Louisiana. USDA Soil Conservation Serv. and For. Serv. and Louisiana State University Agricultural Exp. Stn., Baton Rouge, Louisiana, 87 pp. and 114 maps.

Landers, J. L. & A. S. Johnson. 1976. Bobwhite quail food habitat in the Southeastern United States with a seed key to important foods. Tall Timbers Research Station, Misc. Publication No. 4, Tallahassee, Florida, 90 pp.

Lane, C. L. & J. L. Askew. 1989. Wax myrtle in a coastal plain loblolly pine stand. Pp. 483-486, *in* Proceedings of the fifth biennial southern silvicultural research conference (J. H. Miller, ed.), USDA For. Serv. Gen. Tech. Rep. SO-74, Southern For. Exp. Stn., New Orleans, Louisiana, 618 pp.

Lewis, C. E. & T. J. Harshbarger. 1976. Shrub and herbaceous vegetation after 20 years of prescribed burning in the South Carolina coastal plain. J. Range Manage., 29(1):13-18.

Little, E. L., Jr. 1979. Checklist of United States trees (native and naturalized). USDA For. Serv. Agriculture Handbook No. 541, Washington, DC, 375 pp.

Lotti, T. 1956. Eliminating understory hardwoods with summer prescribed fires in Coastal Plain loblolly pine stands. J. Forestry, 54(3):191-192.

Lotti, T., R. A. Klawitter & W. P. LeGrande. 1960. Prescribed burning for understory control in loblolly pine stands of the coastal plain. USDA For. Serv. Station Pap. No. 116, Southeastern For. Exp. Stn., Asheville, North Carolina, 19 pp.

Louisiana Office of State Climatology. 1985. Louisiana monthly climate review. Louisiana State University, Southern Regional Climate Center, Baton Rouge, Louisiana, Vol. 5, 61 pp.

McNab, W. H. & P. E. Avers, compilers. 1994. Ecological subregions of the United States: Section descriptions. USDA For. Serv. Administrative Publication WO-WSA-5, Washington, DC, 267 pp.

Soil Conservation Service. 1975. Soil Taxonomy. USDA Soil Conservation Serv. Agriculture Handbook No. 436, Washington, DC, 754 pp.

Waldrop, T. A. & F. T. Lloyd. 1991. Forty years of prescribed burning on the Santee fire plots: Effects on overstory and midstory vegetation. Pp. 45-50, *in* Fire and the environment: Ecological and cultural perspectives: Proceedings of and international symposium (Nodvin, S. C. & T. A. Waldrop, eds.) USDA For. Serv. Gen. Tech. Rep. SE-69, Southeastern For. Exp. Stn., Asheville, North Carolina, 429 pp.

JDH at: dhaywood@fs.fed.us