

## Seasonal Variation in Resprouting Ability of Native and Exotic Hardwoods in South Florida

James R. Snyder

U.S. Geological Survey, Florida Caribbean Science Center, Big Cypress National Preserve Field Station, HCR 61, Box 110, Ochopee, Florida 34141; jim\_snyder@usgs.gov

### *Abstract*

South Florida slash pine forests contain many hardwood species and burn at any time of year. At higher latitudes, it has been widely noted that the season of burning influences the response of hardwoods to fire. It is possible that the seasonal effects are not as pronounced in south Florida because the climate is more equitable and most species are evergreen. The objective of this study was to determine the seasonality in the ability of selected hardwoods to recover following killing of the above-ground stem. Fire is a difficult and expensive treatment to apply consistently over time. Instead of burning, we cut stems of five species (3 native, 2 non-native) at intervals to simulate the killing of stems by fire at different seasons. For most species, 144 individuals were marked at a single location and 12 randomly chosen individuals were cut near ground level each month for a year. Basal diameter, height, and above-ground biomass were measured initially and 2 yr after treatment. One year after cutting, we measured heights and basal diameters. *Schinus terebinthifolius* Raddi (non-native) had up to 33% mortality from cutting in June to October; other species showed little mortality at any time. Recovery of all species except *Melaleuca quinquenervia* (Cav.) S.T. Blake (non-native) was affected by time of cutting and was generally greatest following cutting in November to March. *Guettarda scabra* (L.) Vent (native) biomass recovery after summer cutting was 40% of that after winter cutting. Dry conditions during April, May, and early June typically result in the highest intensity fires in south Florida and presumably the greatest impact on hardwoods. Results have implications for natural area fire management and exotic species control by mechanical means

### **Introduction**

Fire plays an important role in regulating the structure and function of plant communities in south Florida (Wade et al. 1980). The influence of fire is particularly noticeable in the pine forest community, where fire suppresses the development of the hardwood understory by killing shrubs, or, more commonly, just their above-

ground parts. The shrub layer in slash pine (*Pinus elliottii* Engelm. var. *densa* Little & Dorman) forests of southern peninsular Florida is highly diverse and includes a few actively invading exotic species. In the absence of relatively frequent fire, the pine forests succeed to closed hardwood forest.

Southern Florida experiences a subtropical climate with seasonal rainfall. The summer rainy season typically ends in October and conditions get progressively drier until convectional storms begin again usually in May. Wildland fires occur at all times of the year, but they burn the largest area in April, May, and June (Snyder 1991).

In more temperate areas, the season in which fires occur has been shown to greatly influence the response of hardwood understories, with summer burns causing more severe stress than winter burns (Robbins and Myers 1992). It is possible that seasonal variation in factors such as degree of dormancy of hardwoods, ambient temperature, and fuel moisture are different enough in south Florida to moderate or eliminate this seasonal response. Most south Florida pineland hardwoods are evergreen and therefore not as dormant as leafless deciduous trees in the winter. At higher latitudes, air temperatures during the growing season are substantially warmer than during the dormant season so that less heat from the fire is required to raise plant tissues to a lethal temperature. The rainfall pattern in south Florida, with wet summers and dry winters, tends to create drier fuel conditions and, therefore, hotter fire temperatures during the winter than the summer. All these factors may mitigate against the pattern of greater damage from summer fires than winter fires in south Florida.

In a south Florida study comparing hardwood recovery after paired wet and dry season burns, fire temperature rather than season appeared to determine the degree of recovery (Snyder 1986). In one of two pairs of burns, the hardwoods recovered less after the wet season burn than the dry season burn, which was the expected result. In the other case, however, there was less recovery after the dry season burn than the wet season burn. In both instances, it was the hotter fire which had less hardwood regrowth. This suggested that either there is little seasonal variation in the capacity of hardwoods to resprout or, if there are seasonal differences in resprouting ability, the differences can be overridden by the effects of fire temperature.

The objective of this study was to determine if there is seasonality in the ability of selected south Florida hardwoods to recover following killing of the aboveground stem. While shrub response to fire was the main motivation for the study, wildland fire is a difficult and expensive treatment to apply consistently over time, so we studied top removal by cutting as an analog to top-killing by fire. In this way, we were able to keep the treatment constant over an annual cycle, in a sense the treatment being a fire of zero intensity.

Table 1. Characteristics of five hardwood species included in study.

Scientific name	Common name	Family	Distribution	Origin
<i>Guettarda scabra</i> (L.) Vent	velvetseed	Rubiaceae	Tropical	Native
<i>Melaleuca quinquenervia</i> (Cav.) S.T. Blake	melaleuca	Myrtaceae	Tropical (Australia)	Exotic
<i>Myrica cerifera</i> L.	wax myrtle	Myricaceae	Temperate	Native
<i>Myrsine floridana</i> A. DC.	myrsine	Myrsinaceae	Tropical	Native
<i>Schinus terebinthifolius</i> Raddi	Brazilian pepper	Anacardiaceae	Tropical (S. America)	Exotic

## Methods

Five hardwood species commonly found in pine forests and capable of reaching at least subcanopy stature were included in the study, three native species and two pestiferous exotics (Table 1). The study was carried out in Everglades National Park (ENP) and adjoining Big Cypress National Preserve (BCNP). *Guettarda* is a common native shrub in ENP pinelands. *Myrica* and *Myrsine* are native species common in both ENP and BCNP pinelands, although *Myrica* is found in a broad range of habitats. *Schinus* is an exotic that frequently invades pinelands and other habitats throughout south Florida. *Melaleuca* is a problem exotic in wetland areas of south Florida and commonly invades the wet pinelands of the Big Cypress region.

Study sites were chosen to contain large numbers of stems of a size likely to be top-killed by fire. Each species was studied in either ENP or BCNP, except for *Schinus*, which was tested in both areas. In BCNP, the *Schinus* site was an area of limestone rock fill just south of U.S. route 41 and west of Dona Drive in Ochopee. The *Schinus* in ENP was studied in the eastern end of an area of abandoned farmland known as the Hole-in-the-Donut. The study site was rockland pine forest before it was rockplowed and farmed. *Guettarda* and *Myrsine* were studied at a pineland site in fire management block F west of the Long Pine Key campground, ENP. The *Myrica* site was the edge of a prairie about 5 km north of U.S. route 41 on the west side of Birdon Road, and the *Melaleuca* site was an area of mixed pine and cypress about 6 km north of U.S. route 41 on the west side of Turner River Road in BCNP.

For each species, 144 stems were marked and 12 randomly chosen individuals (120 and 10 for *Myrica*) were clipped 1-2 cm above ground level each month beginning in January (native species) or February (exotic species) 1987. Because most of the species are clonal, we also cut all conspecific stems within a 1 m radius of the marked stems. We also cut back any other understory shrubs that shaded the stump. The intention was to more closely approximate the effects of fire. At the start of the study, the *Guettarda*, *Myrica*, and *Myrsine* stems were 1-2 m tall, the *Melaleuca* stems 0.7-1.2 m tall, and the *Schinus* stems about 1.5 m tall in BCNP and 2 m tall in ENP. *Melaleuca* plants were smaller than the other species because stems of this species much greater than 1 m tall generally are not top-killed by fire, but resprout from the stem. Stems of all the other species were large enough to flower.

Height and basal diameter of stems were measured before cutting and resprouts were measured 1 and 2 yr after cutting. The resprouts were harvested 2 yr after original clipping. Oven-dry (70° C) weights were determined of the initial stems and the 2-yr resprouts. A few months after the second cutting, the pineland site for *Guettarda* and *Myrsine* was burned by a prescribed fire. The other sites were checked for evidence of resprouting after the second cutting.

## Results and Discussion

Most stems survived and resprouted from the base after cutting (Table 2). *Myrsine* suffered the least mortality (only one stem did not resprout) and *Schinus* suffered the most. Nearly all mortality followed cutting in May through October. The relatively high mortality of *Schinus* after top removal in June to October indicates the potential for control by either mechanical treatment or fire during that time period. The results for the other problem exotic, *Melaleuca*, are not encouraging, since only three plants were killed by cutting.

After the second cutting, there was relatively little additional mortality of *Schinus*, except for the June cuttings in BCNP (Table 3). *Melaleuca* and *Myrica* both showed much greater mortality after the second cutting than the first. It is not known whether this was due to repeated cutting or to different environmental conditions after the second cutting. The greatest mortality of *Melaleuca* followed the June through August clippings, but *Myrica* did not show any clear seasonal pattern. The high mortality of *Melaleuca* after the second cutting may have been due in part to flooding of the site during August of that year. Flooding of *Melaleuca* stumps is a known means of mechanical control (Myers and Belles 1995).

The recovery of hardwoods after cutting is presented in Figs. 1-6. Height recovery is the height of the tallest resprout divided by the height of the original stem. Basal area recovery is the sum of the basal areas of all resprouts of a stem divided by the initial basal area. Biomass recovery is defined as the dry weight of the re-

Table 2. Mortality (percent) of five hardwood species by month in which individuals were cut. Sample size is n=12, except for *Myrica* (n=10).

Species	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Guettarda</i>	0	0	0	0	17	0	0	0	8	8	0	0
<i>Melaleuca</i>	0	0	0	0	8	0	8	0	0	8	0	0
<i>Myrica</i>	0	0	0	0	0	0	10	0	0	10	0	0
<i>Myrsine</i>	0	0	0	0	0	0	0	0	0	8	0	0
<i>Schinus</i> (ENP)	0	0	8	0	0	25	8	25	33	17	0	0
<i>Schinus</i> (BCNP)	0	0	0	0	0	18 <sup>1</sup>	17	9 <sup>1</sup>	0	33	0	8

<sup>1</sup>n=11.

sprouts at 2 yr divided by the dry weight of the original stem. The data of primary interest are the recovery of biomass 2 yr after cutting. Two years is the shortest practical interval between fires in south Florida pinelands and biomass is the most ecologically meaningful measure of recovery. Height and basal area are non-destructive measures of recovery that are correlated with biomass and allow a check on recovery 1 yr after cutting.

There were significant differences among treatment months in the recovery of dry weights in all cases except for *Melaleuca* and *Myrica* (Kruskal-Wallis test,  $p < .05$ ). In the case of *Melaleuca*, there is no indication of an underlying annual pattern that is masked by the high variability within months (Fig. 1). For *Myrica*, the pattern shows that April to October is probably the period of weakest recovery (Fig. 2) and a larger sample size would probably have resulted in statistical significance.

The recovery of *Guettarda* biomass shows a marked decline after March through September cutting (Fig. 3, the April data were lost in a drying oven fire). The minimum recovery is about 40% of the maximum recovery. Beginning in October, there is an increase in the amount of recovery, but the recovery after December cutting does not approach the recovery that followed the January cutting. The expected pattern was more similar to the recovery of height after one year (Fig. 3). Apparently there is longitudinal trend that is superimposed on the seasonal re-

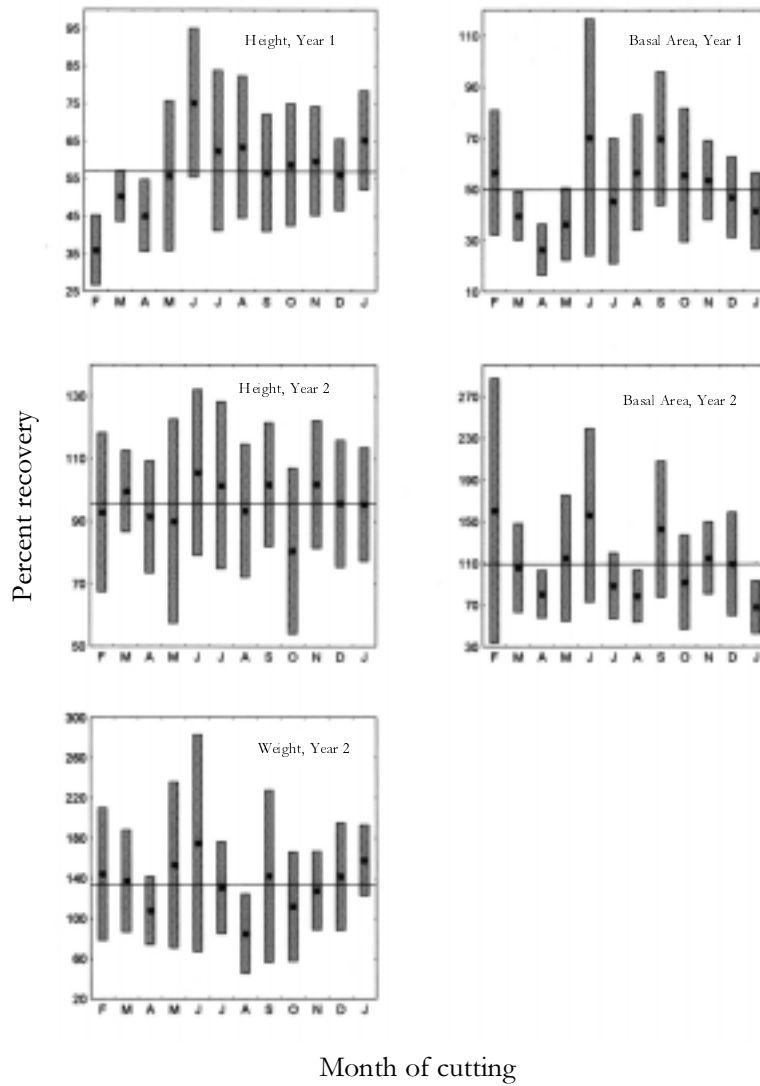


Figure 1. Percent recovery of *Melaleuca quinquenervia* 1 and 2 yr after cutting (filled squares are means of treatments; shaded boxes are  $\pm 2$  SE; horizontal lines are overall means).

sponse. This could be due to the increasing age or size of the *Guettarda* stems, but the size of the stems did not change significantly over the 11 months between the first and last cuttings. It seems highly unlikely that the 11-month difference in age was important either, since all the stems were probably resprouts themselves dating from a prescribed fire about five years before the start of the study. Most

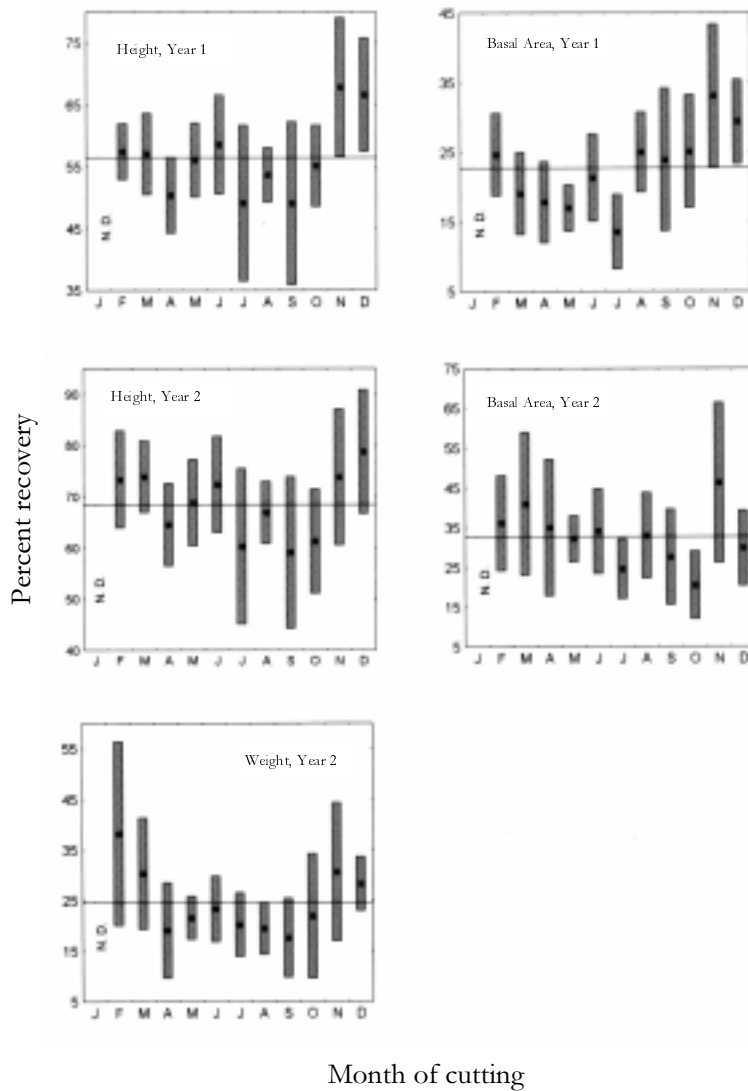


Figure 2. Percent recovery of *Myrica cerifera* 1 and 2 yr after cutting (filled squares are means of treatments; shaded boxes are  $\pm 2$  SE; horizontal lines are overall means; N.D. = missing data).

likely, the lower recovery after November and December clippings compared to the January and February clippings is due to less favorable growing conditions during the second growing season than the first. This probably was related to the amount and timing of rainfall.

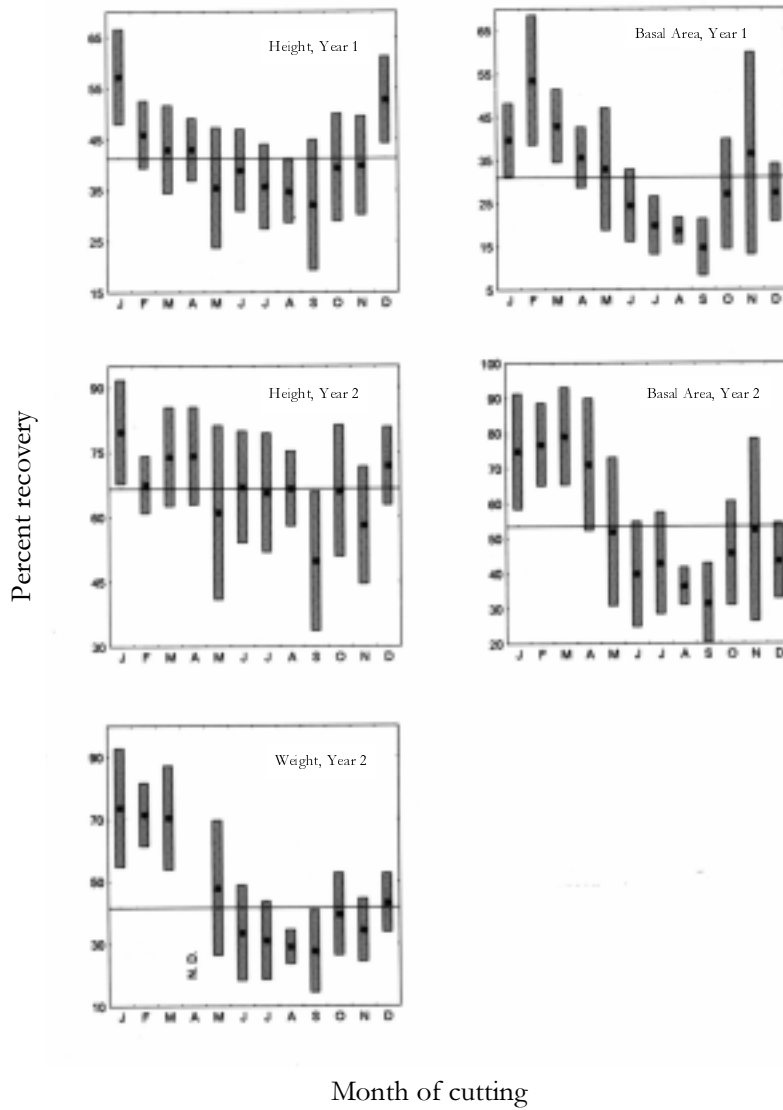


Figure 3. Percent recovery of *Guettarda scabra* 1 and 2 yr after cutting (filled squares are means of treatments; shaded boxes are  $\pm 2$  SE; horizontal lines are overall means; N.D. = missing data).

The seasonal pattern for *Myrsine* shows minimal recovery of biomass after cutting in May (Fig. 4), several months earlier than for *Guettarda*. The minimum recovery is slightly more than 50% of the maximum recovery. A decline in recovery after September seems to be a more dramatic manifestation of the same phenomenon seen late in the year with *Guettarda*. The February treatment appears to be anoma-

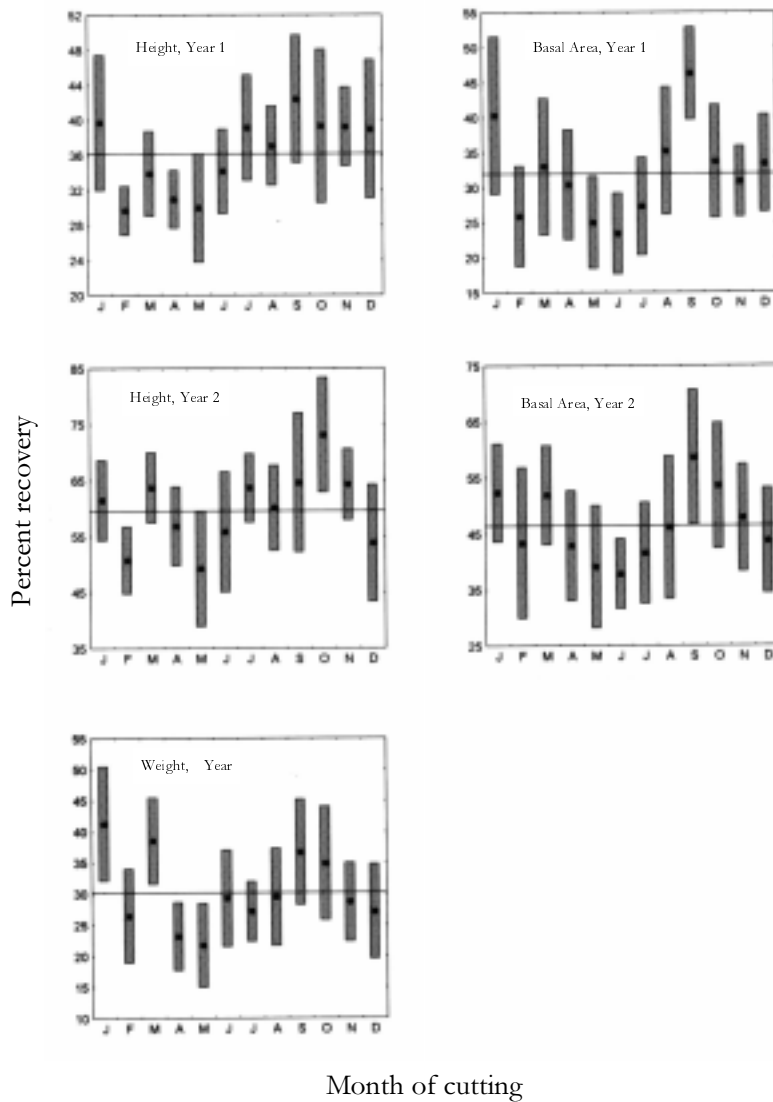


Figure 4. Percent recovery of *Myrsine floridana* 1 and 2 yr after cutting (filled squares are means of treatments; shaded boxes are  $\pm 2$  SE; horizontal lines are overall means).

lous. Overall rates of recovery of *Myrsine* are substantially lower than those of *Guet-tarda*. The direct comparison can be made because the species were studied at the same site and the stems were presumably the same age, since they all probably dated from the last fire. The maximum recovery of biomass of *Guet-tarda* was about 72% of original weight while *Myrsine* reached slightly over 40% of its pre-

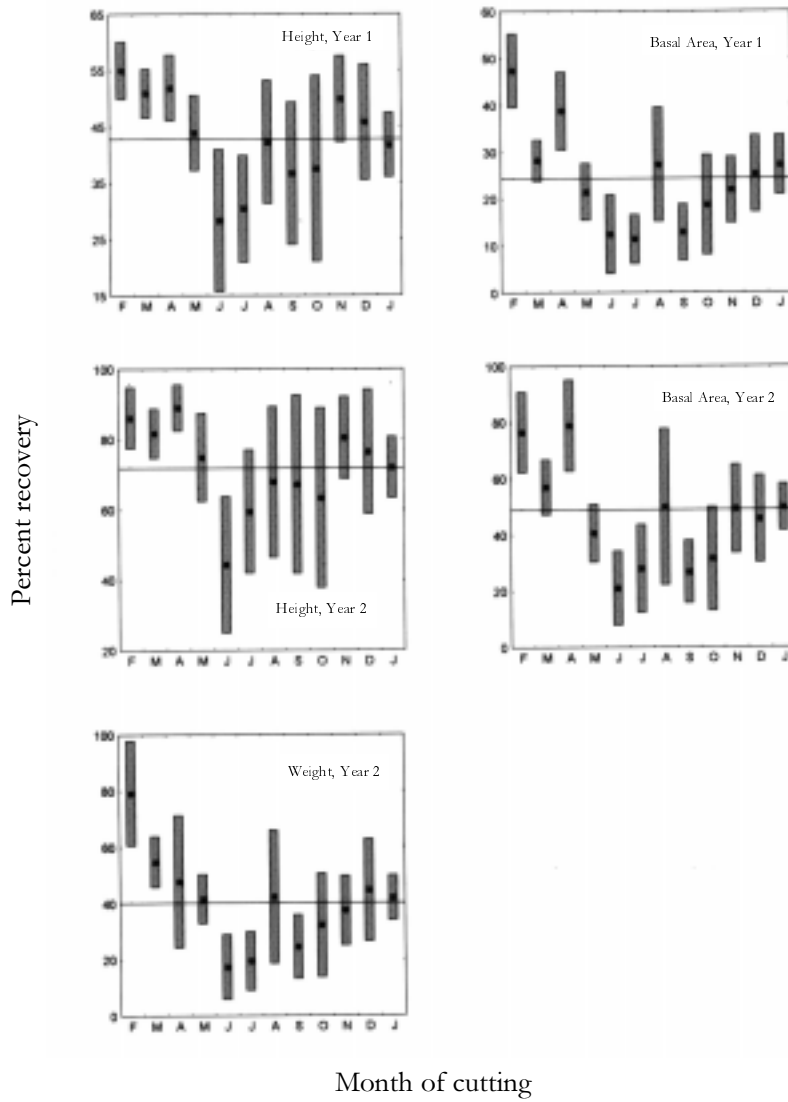


Figure 5. Percent recovery of *Schinus terebinthifolius* in Big Cypress National Preserve 1 and 2 yr after cutting (filled squares are means of treatments; shaded boxes are  $\pm 2$  SE; horizontal lines are overall means).

treatment weight.

*Schinus* was tested at two sites. At BCNP, *Schinus* exhibited a highly seasonal pattern of biomass recovery (Fig. 5). Minimum recovery of biomass occurred after

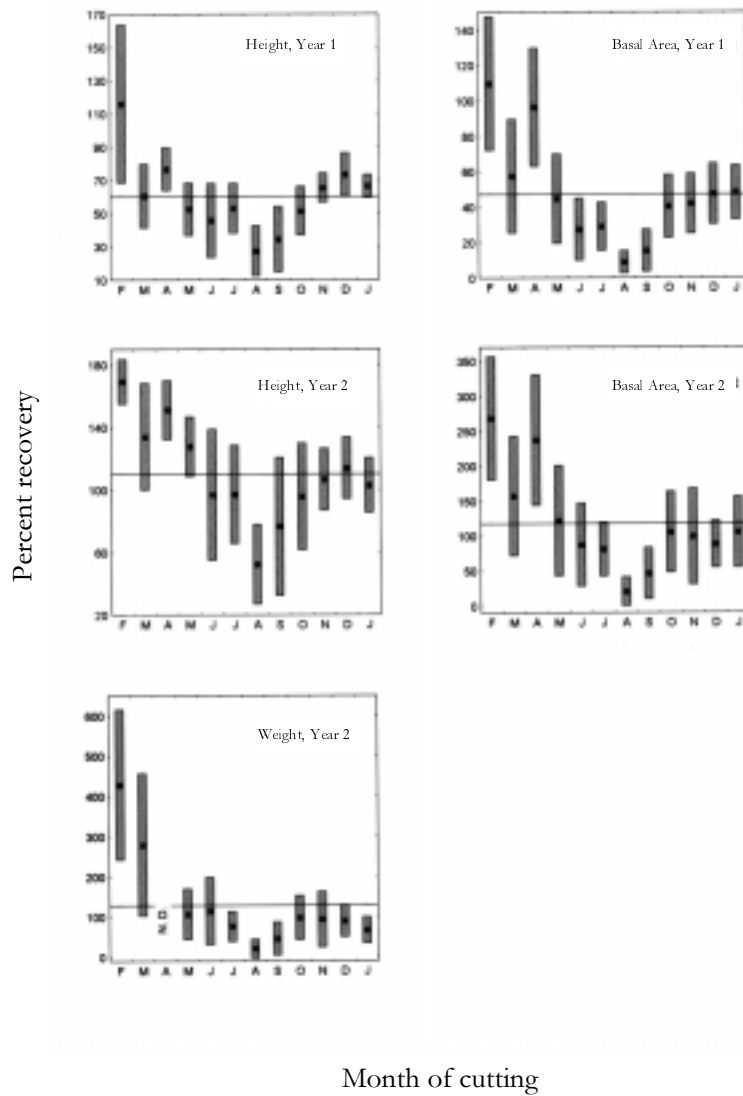


Figure 6. Percent recovery of *Schinus terebinthifolius* in Everglades National Park 1 and 2 yr after cutting (filled squares are means of treatments; shaded boxes are  $\pm 2$  SE; horizontal lines are overall means; N.D. = missing data).

June cutting and was about 25% of the maximum recovery which followed February cutting. As with *Guetarda* and *Myrsine*, the recovery after the last treatment did not come close to the recovery after the first treatment.

Table 3. Cumulative mortality (percent) of three hardwood species after two cuttings. Sample sizes vary because not all plants were relocated.

Species	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Melaleuca</i>	17	8	17	27	25	72	55	42	0	17	0	9
<i>Myrica</i>	0	10	11	33	22	0	22	0	33	20	11	0
<i>Schinus</i> (ENP)	0	0	9	8	0	33	25	33	33	25	8	0
<i>Schinus</i> (BCNP)	0	0	0	0	0	60	27	10	22	33	0	14

In ENP, the minimum recovery of *Schinus* occurred two months later, in August, and was less than 5% of the maximum recovery (Fig. 6), easily the most dramatic effect of season out of the six cases. However, there were some unusual aspects to the case of *Schinus* in ENP. The above-ground biomass 2 yr after cutting in February was more than four times greater than the initial biomass. In contrast, the recovery of *Schinus* in BCNP and the three native species was less than 100% after 2 yr. Growing conditions in the former farmland were apparently much more favorable during the first growing season than the subsequent seasons. In addition, the vigorous regrowth of *Schinus* and other hardwoods resulted in shading of the smaller resprouts, suppressing growth of the resprouts from later months.

Basal area and height serve as fairly good surrogates for biomass, based on their correspondence at 2 yr (Figs. 1-6). In general, interpretations based on 1-yr recovery of height and basal area would agree with those based on 2-yr biomass. Exceptions include both height and basal area recovery of *Melaleuca* at 1 yr, where there are obvious minima early in the year that are not seen in the recovery of dry weight at 2 yr (Fig. 1). The 1-yr recovery of *Myrica* basal area also appears to have a minimum earlier in the year that is no longer seen at 2 yr (Fig. 2).

In summary, the data show that there is seasonal variation in the resprouting ability of south Florida pine forest hardwoods. The seasonal variability is stronger for the exotic *Schinus* than the native species tested. Above-ground biomass recovery of the hardwoods is generally lower after cutting in April to October. The minimum recovery ranged from May to September depending on the species and site. Mortality also shows seasonality, with almost all occurring after May to October

cutting. Very few stems of native species died, but as many as one third of the *Schinus* stems did not resprout after the September and October cutting.

Presumably, top-killing by fires of equal intensity at different seasons would show the same patterns, but with less vigorous resprouting and more mortality. It is reasonable to expect that the more intense the fire, the less vigorous the resprouting and the greater the mortality. Therefore, high intensity fires during the summer should result in the least hardwood recovery. Given the annual pattern of rainfall and the influence that has on fuel conditions, it is likely that hot fires during May and June, during years with prolonged dry seasons, will result in the least recovery of hardwoods. Summer fires under wet fuel conditions, however, will not necessarily be as stressful to hardwoods as winter fires with dry fuels.

### Acknowledgements

Alan Herndon, Gordon Ward, Lisa Spier, John Delapp, Tony Pernas, and Renee Beymer assisted with the study. Jim Burch produced the graphics.

### Literature Cited

- Myers, R. L., and H. A. Belles. 1995. *Studies to Develop Melaleuca Control Tactics Using Fire and Herbicides*. Nongame Wildlife Program Project Report. Tallahassee: Florida Game and Fresh Water Fish Commission.
- Robbins, L. E., and R. L. Myers. 1992. *Seasonal Effects of Prescribed Burning in Florida: A Review*. Miscellaneous Publication No. 8. Tallahassee, Fla.: Tall Timbers Research, Inc.
- Snyder, J. R. 1986. *The Impact of Wet Season and Dry Season Prescribed Fires on Miami Rock Ridge Pineland*. South Florida Research Center Report SFRC-86/06. Homestead, Fla.: National Park Service, Everglades National Park.
- \_\_\_\_\_. 1991. Fire regimes in subtropical south Florida. *Tall Timbers Fire Ecology Conference Proceedings* 17:303-319.
- Wade, D., J. Ewel, and R. Hofstetter. 1980. *Fire in South Florida Ecosystems*. General Technical Report SE-17. Asheville, N.C.: U.S. Forest Service, Southeastern Forest Experiment Station.

