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CHANGES IN UNDERSTORY WOODY VEGETATION IN RED-COCKADED WOODPECKER (*PICOIDES BOREALIS*) NESTING CLUSTERS

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Abstract.—Understory woody vegetation in red-cockaded woodpecker nesting clusters located in *Pinus taeda* (L.) and *P. echinata* (Mill.) dominated stands were inventoried from December 1986 through January 1987 and later in January 1995 to determine what effects court-ordered management schemes had on the composition, abundance, and diversity of these stands. There was a significant difference ($P<0.001$) in the composition between the first sampling period and the second with species diversity increasing and a change from a *P. taeda/P. echinata* dominated community to a *P. taeda/Rubus* spp. understory.

Resumen.—La vegetación leñosa, bajo el docel de bosque, localizada en áreas dominadas por *Pinus taeda* (L.) y *P. echinata* (Mill.), y en donde se pueden encontrar grupos de nidos del pájaro carpintero rojo, fue cuantificada desde diciembre del 1986 hasta enero del 1987 y posteriormente en enero del 1995. El objectivo fue detectar los efectos que tienen los esquemas ordenados de manejo sobre la composición, abundancia y diversidad de estos grupos de vegetación. Hubo una significante diferencia ($P<0.001$) en la composición de especies entre el primer período de muestra y el segundo, con un incremento en la diversidad de especies. Este cambio de una comunidad dominada por *P. taeda/P. echinata* a una comunidad dominada por *P. taeda/Rubus spp.* bajo el docel del bosque.

The red-cockaded woodpecker (*Picoides borealis*) was federally listed as an endangered species in 1970 (USF&WS 1970). Originally, the species exhibited a wide distribution in the mature pine forest of the Southeast, ranging from New Jersey to Texas, and along the Atlantic and Gulf Coastal Plain and inland as far as Missouri and Kentucky (Hooper et al. 1980). The species' endangered status is a result of loss and fragmentation of habitat (Hooper et al. 1980; Lennartz et al. 1983; Conner & Rudolph 1991). Though populations are widespread, most (about 90%) are too isolated and small to be genetically viable (Lennartz et al. 1983), and are therefore highly susceptible to extirpation over time.

Forest management to aid in the recovery of the red-cockaded woodpecker is the subject of great controversy in Texas and throughout the South. Biological and popular environmental advocacy groups alike have criticized industrial-style clearcutting and short rotation forestry as

contributing to the decline of the red-cockaded woodpecker (USF&WS 1985; Conner & Rudolph 1989). Lawsuits filed against the U. S. Forest Service in 1985 by the Sierra Club, Texas Committee On Natural Resources and The Wilderness Society, alleged Forest Service culpability in declining red-cockaded woodpecker numbers in Texas. On 17 June 1988, the U.S. District Court for Eastern Texas found for the plaintiffs and issued a permanent injunction against the Forest Service which required, among other things, thinning timber stands, road closure, and midstory control.

Court-ordered intensive manipulations of red-cockaded woodpecker habitat have been rigorously applied since 1988. Data are now available to evaluate the environmental effects of the court orders. The purposes of this study were to compare 1987 base-line data for understory woody vegetation to 1995 vegetation data and to determine the effects of mandated intensive management on understory woody vegetation.

METHODS

Understory woody vegetation in seven *Pinus taeda*/*P. echinata* stands (Mann 1980: SAF cover type 80) with red-cockaded woodpecker nesting clusters in the northern Angelina National Forest were inventoried from December 1986 through January 1987 using the line intercept method (Smith 1966). Transects one chain (66 ft = 20.12 m) in length were randomly located with a cavity tree that approximated the center of the nesting cluster. After the transects had been inventoried, locations were recorded. Accurate documentation of the original line intercept transect locations in 1986 and 1987 (hereafter, 1987 data) allowed the lines to be relocated and inventoried again in January 1995. Line intercepts data were used to calculate the importance value of each species, which were the sums of relative frequency, relative density, and relative dominance. Nomenclature follows Vines (1960).

Diversity was measured by using Fisher's *alpha* diversity index (Fisher et al. 1943). The index is calculated by solution of the equation:

$$S_T = a\log_e(1+N/\alpha)$$

where:

S_T = total number of species
N = number of individuals.

Fisher's *alpha* was used because it exhibits low sensitivity to sample size (Kempton & Taylor 1974; Magurran 1988), good discriminate ability (Kempton Wedderburn 1978; Taylor 1978), great robustness (Magurran 1988) and demonstrated suitability in a variety of ecological applications (Southwood 1978).

Table 1. Relative frequency, relative density, relative dominance and importance values for woody understory vegetation in 1987 in red-cockaded woodpecker nesting clusters from northern Angelina National Forest.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value (IV)
Pinus taeda	14.00	35.90	33.79	83.69
Pinus echinata	10.67	16.59	15.61	42.87
Cornus florida	4.00	3.86	11.05	18.91
Liquidambar styraciflua	6.67	4.31	6.52	17.50
Quercus falcata	8.00	3.86	5.44	17.30
Crataegus crus-galli	7.33	4.32	1.25	12.90
Gelsemium sempervirens	5.33	6.82	0.02	12.17
Quercus nigra	2.66	1.14	7.71	11.51
Rubus spp.	4.66	4.31	2.47	11.44
Myrica cerifera	5.33	3.18	0.07	8.58
Ilex vomitoria	4.00	2.05	1.75	7.80
Quercus alba	1.33	0.45	5.84	7.62
Crataegus marshallii	4.00	2.50	0.78	7.28
Carya texana	3.33	1.59	1.40	6.32
Quercus stellata	2.66	1.59	1.48	5.73
Smilax rotundifolia	2.66	1.13	<0.01	3.79
Others	13.29	6.32	4.85	24.46
Totals	99.92	99.92	100.03	299.87

Other species in descending order of importance value (IV): *Viburnum dentatum* (3.20), Rhus copallina (2.89), *Rhus glabra* (2.59), Acer rubrum (2.59), *Callicarpa americana* (2.54), *Lonicera japonica* (2.47), *Baccharis halimifolia* (2.08), *Vitis rontundifolia* (2.01), *Smilax lanceolata* (1.78), *Carpinus caroliniana* (1.24) and *Carya cordiformis* (1.07).

Similarity in understory woody vegetation composition between the two sampling periods was calculated by using Sorensen's index of similarity [IS] (Sorensen 1948):

$$IS = 100(2C/(A+B))$$

where:

C = Number of species common to the two sample periods
A = Total number of species in sample period one
B = Total number of species in sample period two.

Differences in species composition between sample periods was determined by a χ^2 test (Sokal & Rohlf 1981).

Results and Discussion

In the 1987 samples, the understory woody vegetation was dominated by *P. taeda* with *P. echinata* as the sub-dominant species; together they made up 42.2% of the combined importance values (Table 1). In the 1995 inventory, *P. taeda* remained the most important species but its

Table 2. Relative frequency, relative density, relative dominance and importance values for woody understory vegetation in 1995 in red-cockaded woodpecker nesting clusters from northern Angelina National Forest.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value (IV)
Pinus taeda	8.62	18.81	20.96	48.39
Rubus spp.	9.09	14.57	11.15	34.81
Pinus echinata	7.27	10.18	11.49	28.94
Liquidambar styraciflua	6.32	5.09	8.37	19.78
Quercus falcata	5.91	6.08	7.27	19.26
Gelsemium sempervirens	5.91	8.20	3.22	17.33
Myrica cerifera	4.09	5.80	6.00	15.89
Cornus florida	1.82	2.26	7.76	11.84
Callicarpa americana	6.36	2.40	1.97	10.73
Quercus stellata	3.64	2.82	3.32	9.78
Smilax rotundifolia	4.55	2.82	1.77	9.14
Quercus nigra	4.09	1.98	2.33	8.40
Quercus phellos	3.18	2.26	2.76	8.20
Vaccinium stamineum	3.64	1.84	1.58	7.06
Rhus copallina	1.82	1.69	1.83	5.34
Acer rubrum	2.27	1.41	1.57	5.25
Others	21.32	11.70	6.35	39.37
Totals	99.90	99.91	99.70	299.51

Other species in decending order of importance value (IV): *Crataegus crus-galli* (5.21), Rhus glabra (4.73), *Vaccinium arboreum* (4.66), *Lonicera japonica* (4.23), *Smilax lanceolata* (3.84), *Carya texana* (2.54), *Baccharis halimifolia* (2.40), *Vitis rotundifolia* (1.93), *Carpinus caroliniana* (1.75), *Nyssa sylvatica* (1.41), *Ilex vomitoria* (1.41), *Crataegus marshallii* (1.40), *Carya cordiformis* (0.97), *Quercus alba* (0.79), *Ulmus alata* (0.76), *Prunus serotina* (0.67) and *Ulmus americana* (0.67).

importance value decreased from 83.7 to 48.4. *Rubus* spp. replaced *P. echinata* as the second most important species (Table 2).

The total number of individuals in the understory woody vegetation in *P. taeda/P. echinata* stands with red-cockaded woodpecker nesting clusters increased from 440 to 707 (31.3%) from 1987 to 1995. Seventeen species increased numerically from 1987 to 1995 and eight species decreased, including *P. taeda* and *P. echinata* which are the species used by red-cockaded woodpeckers for nesting in these stands. One species recorded in the first sampling period, *Viburnum dentatum* (L.), was not observed in the second. Seven new species were observed in 1995, including *Nyssa sylvatica* (Marsh.), *Prunus serotina* (Ehrh.), *Quercus phellos* (L.), *Ulmus alata* (Michx.), *U. americana* (L.), *Vaccinium stamineum* (L.) and *Vaccinium arboreum* (L.). *Smilax rotundifolia* (Michx.) did not change from 1987 to 1995. Total number of species increased from 27 in 1987 to 33 in 1995. Twenty-six species appeared common in both samplings. Species that increased or

Table 3. Species composition change from 1987 to 1995 in red-cockaded woodpecker nesting clusters from northern Angelina National Forest. Increase or decrease in number of individuals on line transects is shown in parenthesis.

Increaser Species	Decreaser Species
Acer rubrum (+7)	*Carya texana* (-3)
Baccharis halimifolia (+5)	*Cornus florida* (-1)
Callicarpa americana (+14)	*Crataegus crus-galli* (-6)
Carpinus caroliniana (+1)	*Crataegus marshallii* (-9)
Carya cordiformis (+1)	*Ilex vomitoria* (-7)
Gelsemium sempervirens (+28)	*Pinus echinata* (-1)
Liquidambar styraciflua) (+17)	*Pinus taeda* (-25)
Loncera japonica (+5)	*Quercus alba* (-1)
Myrica cerifera (+27)	
Quercus falcata (+26)	
Quercus nigra (+9)	
Quercus stellata (+13)	
Rhus copallina (+9)	
Rhus glabra (+6)	
Rubus spp. (+84)	
Smilax lanceolata (+6)	
Vitis rotundifolia (+15)	

decreased in number are shown in Table 3. Woody plant diversity increased from a Fisher's *alpha* value of 6.348 in 1987 to 7.177 in 1995.

Sorensen's index of similarity indicated a high degree of similarity (86.7) in floral content between the two sampling periods. However, analysis of the total data set indicated there was a significant change in the composition of the understory woody vegetation in the northern Angelina National Forest with red-cockaded woodpecker nesting clusters from 1987 to 1995 ($\chi^2 = 185.24, df = 33, P < 0.001$).

Court-ordered attempts to superimpose a savanna on a habitat of an ecosystem naturally composed of pine-hardwood canopies which may have dense understories, seem incongruous. Red-cockaded woodpeckers have existed in areas dominated by mixed stands for many years (Kalisz & Boettcher 1991). This is especially true in Texas (Conner & Rudolph 1989). Mixed stands are within the historical range of variability on these sites and should be managed as such. Another concern addressed in the existing court order was the loss of potential nesting tree recruitment. The species increasing in number under the court order are mast producers and browse species (Table 3), which may ultimately create a habitat more suitable for species such as white-tailed deer (*Odocoileus virginianus*).

Based on these data, the goals of the red-cockaded woodpecker

recovery plan will probably not be met unless the substantial hardwood component, most notably the increased *Quercus* spp. of the understory, is controlled in a manner more consistent with the native forest type. These data also underscore the point that courts are not the place to make natural resource management decisions.

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