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BREEDING BIRD COMMUNITY CHANGES IN A DEVELOPING PINE PLANTATION[1]

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Abstract. This investigation documents the response of a breeding bird community to a developing pine plantation, age 2 to 11, in eastern Texas. The bird community, censused annually from four 250 x 80 m transects, was at its lowest abundance level and was least diverse when the plantation was in the grass/forb stage at age 2. The plantation grew rapidly into the shrub stage and the vegetation increased in volume and complexity. The bird community also increased in abundance and complexity. Bird abundance increased consistently until the age of the plantation was between 7 and 9 years, but then declined as the pine canopy closed and shaded out lower vegetation. Bird diversity remained high through age 11. In the latter stages (age 9 - 11) there was a low abundance of early successional species, such as the Indigo Bunting and Yellow-breasted Chat, associated with small windrow openings. High numbers of shrub associated species—Northern Cardinals and White-eyed Vireos—inhabited the shrubs and occasional hardwoods. Also, species associated with tall stands, such as Kentucky and Hooded warblers in the understory and Carolina Chickadees, Yellow-billed Cuckoos and Red-eyed Vireos in the canopy, had invaded the stand. In this latter canopy-closure stage, bird diversity was related directly to the presence of hardwood shrubs and trees in the pine dominated stand.
Keywords: Bird community; succession; pine plantation; Texas.

LOS CAMBIOS DE UNA COMUNIDAD DE AVES REPRODUCTORAS AL DESARROLLO DE UNA PLANTACIÓN DE PINOS

Resumen. Esta investigación documenta la respuesta de una comunidad de aves reproductoras al desarrollo de una plantación de pinos con edades de 2 a 11 años en el Este del Estado de Tejas. Esta comunidad de aves, censada anualmente con la aplicación de cuatro transversales de 250 x 80 metros, manifestó el menor nivel y menor diversidad de población cuando la plantación estaba en la etapa de desarrollo de pasto/maleza a los 2 años. La plantación creció rápidamente hasta llegar a tamaño arbusto con un aumento en el volumen y la complejidad de la vegetación. También aumentó la abundancia y la complejidad de las aves. La abundancia de las aves aumentó firmemente hasta que la plantación alcanzó la edad de 7 a 9 años, pero disminuyó a medida que la bóveda de los pinos se cerró y su sombra impidió que creciera la vegetación en las partes bajas. La diversidad de las aves se mantuvo elevada hasta el años 11. En las etapas posteriores (edad 9-11) hubieron pocas de las especies sucesoras, tales como el Gorrión Azul y el Arriero, asociados con pequeñas aberturas de hileras. Los arbustos y, ocasionalmente los árboles de madera dura, estaban habitados por gran número de especies — Cardenal Norteño y Vireo Ojiblanco — asociadas con esta vegetación. Asimismo, especies asociadas con los bosques de árboles altos, tales como dos especies de Verderón Cachetinegro en la vegetación baja y la Mascarita de Carolina, Cuclillo de Pico Amarillo y Vireo Ojirojo en la bóveda, habían invadido el bosque. En esta etapa de cierre de la bóveda, la diversidad de aves estaba relacionada directamente con la presencia de arbustos y árboles de madera dura en el bosque dominado por pinos.
Palabras claves: Comunidad de aves; sucesión; plantación de pinos; Tejas.

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CHANGEMENTS OBSERVÉS DANS UNE COMMUNAUTÉ D'OISEAUX NICHANT DANS UNE PLANTATION DE PINS EN DÉVELOPPEMENT

Résumé. Cette recherche documente la réaction d'une communauté d'oiseaux nichants aux différents stades de développement d'une plantation de pins, agés de 2 à 11 ans, dans l'est du Texas. Cette communauté aviaire, recensée annuellement à l'aide de quatre zones transversales de 250 x 80 m. était moins nombreuse et moins diverse lorsque la plantation était encore en herbe/brousaille à l'âge de deux ans. La plantation a poussé rapidement jusqu'au stade de buissons, et la végétation s'est accrue en volume et en complexité. La communauté aviarire s'est également accrue en abundance et complexité. Le nombre des oiseaux a augmenté régulièrement jusqua 'a ce que la plantation atteigne entre 7 et 9 ans, pour diminuer ensuite au fur et à mesure que la voûte se refermait et ombrageait le sous-bois. Une grande diversité d'espèces d'oiseaux a/été constatée jusqu 'a ce que la plantation atteigne llâge de 11 ans. Dans les derniers stades (entre 9 et 11 ans) on a remarqué une diminution des espèces existant à l'origine dans la plantation en herbe tels que *Passerina cyanea* et *Icteria virens*, associées à de petites ouvertures dans les clairières. De grands nombres d'espèces associées aux buissons — *Cardinalis cardinalis* et *Vireo griseus* — vivaient dans les buissons et parfois dans les bois durs. Aussi, les espèces associées avec les bosquets élevés — tels que *Oporornis formosus* et *Wilsonia citrina* dans les sous-bois et *Penthestes carolinensis, Coccyzus americanus* et *Vireo olivaceus* dans la voûte — ont envahi le bosquet. Dans ce dernier stade de fermeture de la voûte, la diversité des oiseaux était en rapport direct avec la présence de buissons et arbres de bois dur dans le bosquet dominé par les pins.

Mots-clés: communauté aviaire; stades de succesion; plantation de pins; Texas.

VERÄNDERUNGEN DER VOGELGEMEINSCHAFT IN EINER SICH ENTWICKELNDEN KIEFERNANPFLANZUNG

Übersicht. Die Untersuchung dokumentiert die Entwicklung einer Brutvogelgemeinschaft in einer Kiefernanpflanzung früher Stadien (2 bis 11 Jahre) in Osttexas. Die in jedem Jahr auf vier 250 x 80 m großen Transekten durchgeführten Bestandsaufnahmen zeigten, daß die Vogelgemeinschaft nach 2 Jahren im Stadium der Gräser/Krautvegetation die niedrigsten Abundanzwerte und die geringste Artendiversität aufwies. Die Kiefernschonung wuchs sehr schnell zum Buschstadium heran und die Vegetation nahm in Menge und Komplexität zu. In gleichem Maße nahm auch die Vogelgemeinschaft an Komplexität und Abundanz zu. Die Abundanz der Vögel wuchs kontinuierlich bis zum Alter der Schonung von 7 bis 9 Jahren, sank danach aber wieder ab, als die Kiefern ein geschlossenes Kronendach bildeten und dadurch die Bodenvegetation beschattet wurde. Die Vogeldiversität blieb jedoch bis ins Stadium von 11 Jahren hoch. In den letzten hier untersuchten Stadien (Jahre 9 - 11) waren Vogelarten früher Sukzessionsstadien wie Indigofink und Gelbbauchwaldsänger nur noch in geringer Häufigkeit an kleinen ausgemähten Lichtungen anzutreffen. Eine große Zahl von Buschbewohnern - Kardinäle und Weißaugenvireos - bewohnte den Buschbereich und die teilweise vorhandenen Harthölzer. Zudem waren typische Arten ausgewachsener Wälder, wie Kentucky- und Kapuzenwaldsänger im Unterwuchs und Carolinameisen, Gelbschnabelkuckucke und Rotaugenvireos im Kronenbereich, in den Jungwald eingezogen. In diesem Stadium des Kronenschlußes war die Artendiversität direkt mit dem Vorhandensein von Hartholzbüschen und -bäumen in dem von Kiefern dominierten Bestand korrreliert.

Schlüsselwörter: Vogelgemeinschaft; Sukzessionsstadien; Kiefernanpflanzung; Texas.

INTRODUCTION

The demand for wood fiber from southern forests is increasing. Small, fast-growing trees are well suited for most wood products. On much forest land, especially industry owned land, older, slower growing pine-hardwood stands are being harvested and replaced by faster growing pine plantations with relatively short harvest rotations (20-30 yr). In 1986, 9% of all midsouth timberland was planted pine and this does not include stands planted to pine but dominated by hardwoods (Birdsey and McWilliams 1986). These land use changes constitute drastic wildlife habitat alterations. There is concern over how wildlife in general, and bird communities in particular, respond to these changes. For example, many of the public comments on recent forest plans focused on wildlife.

There have been several studies of breeding bird communities in southern forest stands of different ages and vegetative composition (e.g., Johnston and Odum 1956, Shugart and James 1973, Conner and Adkisson 1975, Dickson and Segelquist 1979). In general, during the growth and development of a forest stand, breeding bird diversity and density are both relatively low in the grass-forb stage and then become higher in the shrub-sapling stage as vegetation structure becomes more complex. Bird diversity and density decrease as trees reach pole size, become dense and shade out lower vegetation; then increase once again as the stand matures, opens up and allows several levels of vegetation to coexist (Johnston and Odum 1956, Shugart and James 1973, Conner and Adkisson 1975, Dickson and Segelquist 1979).

Investigators in these previous studies selected different stands to represent general successional development of a stand type. In our study, we documented the breeding bird community in a developing pine plantation annually to trace changes in the rapidly developing stand. By studying a single, large, relatively homogeneous stand, possible site or stand variation bias was reduced and short term vegetative and bird community changes were followed.

Results from the study for plantation ages 2-6 were reported in Dickson et al. (1984). Bird community and habitat changes in the pine plantation 7-11 years after establishment are emphasized in the present report.

STUDY AREA AND METHODS

The study was conducted on a pine plantation of about 500 ha located approximately 8 km south of Nacogdoches, Texas, in Nacogdoches County. The area is near the western edge of the Southern Coastal Plain. Dominant vegetation consists of loblolly *(Pinus taeda)* and shortleaf *(P. echinata)* pines, and associated oaks *(Quercus spp.)*, sweetgum *(Liquidambar styricaflua)* and other hardwood species. Soils are classified as Tenaha loamy fine sand and Cuthbert fine sandy loam. The area is generally rolling upland with a few intermittent streams. Merchantable trees on the area had been clearcut and the remaining woody vegetation cleared, pushed into windrows and burned in 1975. The site was planted in the winter of 1975-76 with loblolly pine seedlings at an approximate spacing of about 1.8 by 3.7 m. Remnant snags were felled before the study was initiated.

Four 80- by 250-m transects (2 ha each) were established on the pine plantation at least 100 m away from the adjoining woods and other transects in 1977. Plots were similar in topography and representative of the total plantation. Birds on each of the 4 transects were censused 9 times, an equal number of times by each of 3 census takers. Annual censuses by the same people were conducted during May each year from plantation age 2 (1977) through plantation age 11 (1986). All birds detected by sight or sound within a 40-m lateral distance from the transect mid-line were plotted on each transect map while each census taker slowly traversed the midline of each transect (Conner and Dickson 1980). Censusing of each transect took from 12 to 20 minutes, the extra time on some plots being used for identifying and recording birds. All censusing was completed by 3 hours after sunrise. Censusing was avoided during high winds (>19 kph) or substantial rain. Bird abundance, species richness, and bird species diversity (MacArthur and MacArthur 1961) were calculated for all transects each year. Bird species diversity was calculated from the information theory formula $H' = -\sum p_i \ln p_i$, where p_i = the proportion of all birds of the $_i$th species.

Low vegetation on each of the four transects was sampled each growing season from six 4.05-m^2 circular plots randomly located each year at least 1 m away from each transect midline. Percentage of horizontal surface area to the nearest 5% was estimated for each plant species ≤ 2 m

high. Species were combined into broad taxonomic groups for presentation (Table 1). Woody vegetation was sampled from six 200-m^2 circular plots on each transect (Table 2). Stem density and basal area were determined from measurement of individual stems and height of dominant trees measured with a vertical pole. Foliage density (Figure 1) was measured horizontally at 1-m height intervals to 6 m with a 0.5- by 0.5-m checkered board (MacArthur and MacArthur 1961, Conner and O'Holloran 1986).

RESULTS AND DISCUSSION

Birds were least abundant and diverse when the plantation was in the grass/forb stage just after the time the pines were planted. The study was not established until after the first growing season. The low vegetation present during the second season after planting supported the lowest number of birds (234/km^2) and the least diverse bird community (15 species, bird species diversity = 1.98, Table 3). The Indigo Bunting, Yellow-breasted Chat, Northern Cardinal, Blue Grosbeak, Northern Bobwhite, Prairie Warbler and Mourning Dove were the most abundant species. These birds typically occupy early successional stands throughout the South (Johnston and Odum 1956, Shugart and James 1973, Conner and Adkisson 1975, Dickson and Segelquist 1979, Dickson et al. 1984).

After plantation age 2 the vegetative community became more shrubby and increased consistently in height and complexity (Figure 1). The bird community increased in abundance and complexity consistently for several years in response to this vegetational change (Figure 2). Number of birds per square kilometer increased from 234 the second year after establishment until plantation age 7 to 9 years when abundance peaked at almost 500 birds/km^2. Bird diversity, as refleted by total species detected and by bird species diversity for all transects, increased from age 2 until age 10 (total species = 30, bird species diversity = 2.41). Other investigators of bird habitat relationships in forest stand successional stages have also found increases in bird density and diversity as stands grow from the grass/forb to the shrub stage and increase in complexity (Johnston and Odum 1956, Conner and Adkisson 1975, Dickson and Segelquist 1979).

As the pine stand grew in the latter stages of this phase of the study, changes were apparent. Between the ages of 7 and 9, the canopy of the pine plantation was beginning to close and shade out forbs and hardwood shrubs. From years 8 to 11, pine basal area increased from 10 to 18 m^2/ha (Table 2). From ages 7 to 11, the percentage of area covered by hardwood foliage less than 2 m tall declined from 50 to 32, and the area covered by forb foliage declined from 65 to 25% coverage (Table 1). This changing habitat was apparently declining in its capability to support the total bird community. Total bird abundance declined the 10th and 11th year after establishment. In other studies, it has been demonstrated that bird density and diversity often decline in dense pole stage stands where vegetation heterogeneity is not high (Johnston and Odum 1956, Meyers and Johnson 1978, Conner and Adkisson 1975, Dickson and Seqelquist 1979). But in this stand, occasional hardwoods grew from sprouts, and shrubs and hardwoods that grew in small openings along windrows and in other spots where pines had died created some vegetative heterogeneity. In the latter stages of this phase of the study, bird diversity remained relatively high because of the few patches of different vegetation. The small openings allowed a few of the early successional species to persist. For example, there were a few Indigo Buntings, Yellow-breasted Chats and Northern Bobwhites in the plantation, mostly in small windrow openings. Sufficient hardwood shrub patches also remained to support species associated with the shrub successional stage, such as Northern Cardinal, White-eyed Vireo and Carolina Wren. The few volunteer hardwood trees in the stand also were sufficiently developed (Table 2) to permit colonization by species, such as Kentucky and Hooded warblers, normally associated with the understory of mature stands, and a few canopy dwelling species, such as Carolina Chickadees, Yellow-billed Cuckoos, Red-eyed Vireos and Black-and-white Warblers.

As the pines continue to grow, further dominate the stand, and shade out shrub, forb, and grass vegetation, we expect further changes in the bird community. Most bird species depend on non-pine vegetation in pine stands. We anticipate bird density to drop considerably in the next few years and bird diversity to decline slowly as the few openings are overtopped and early successional bird species are eliminated.

TABLE 1. Percent of area covered by plant groups in a pine plantation in eastern Texas as estimated from 24 4.05 m^2 circular plots.

	Plantation age in years since planting									
Plant groups[a]	2	3	4	5	6	7	8	9	10	11
Grass and grasslikes	10.2	13.1	17.1	22.3	19.8	13.1	11.0	9.8	10.0	11.5
Forbs	53.2	53.1	82.2	60.8	66.2	65.1	44.3	34.5	38.6	25.3
Ferns	3.5	3.1	11.7	7.7	2.7	4.0	3.8	5.6	2.9	4.8
Hardwoods	55.7	50.5	64.4	64.3	60.7	50.3	40.3	40.7	48.6	32.3
Pines	2.3	3.5	5.0	10.8	10.2	6.5	2.1	0.4	0.2	0.4
Total	124.9	123.3	180.4	165.9	159.6	139.0	101.5	91.0	100.3	74.3

[a]Height ≤ 2 m

TABLE 2. Mean vegetative characteristics of a pine plantation in eastern Texas as determined from 24 200 m^2 circular plots.

	Plantation age in years			
Charactistic	8	9	10	11
Height (m)				
Pine	7.3	8.9	10.2	11.3
Hardwood	5.3	6.9	7.9	8.6
Basal area (m^2/ha)				
Pine	10.4	11.8	16.0	18.0
Hardwood	0.6	0.6	0.8	1.0
No. stems/ha ($\geq$ 5cm)				
Pine	1096	1085	1156	1102
Hardwood	179	206	208	294

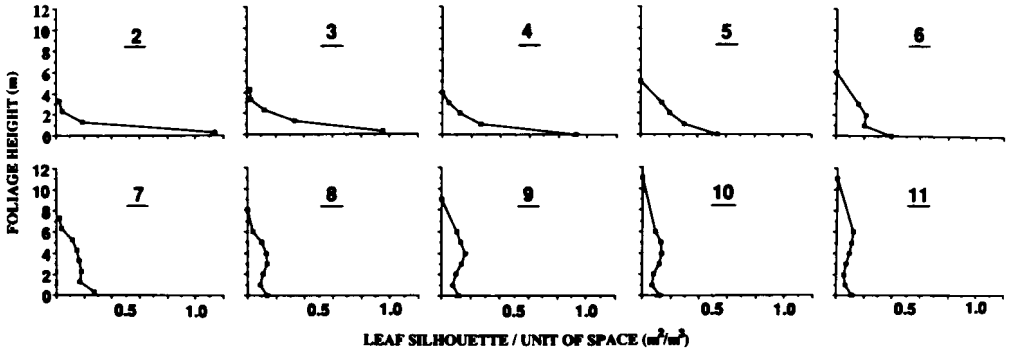

FIGURE 1. Foliage profiles (MacArthur and MacArthur 1961) of a developing pine plantation. Numbers represent years since planting.

TABLE 3. Number of birds per km² detected from transect counts in a pine plantation.

	Plantation age									
Species	2	3	4	5	6	7	8	9	10	11
Indigo bunting *Passerina cyanea*	89	93	108	68	69	64	69	51	29	22
Yellow-breasted chat *Icteria virens*	39	78	86	104	124	124	97	94	39	17
Blue grosbeak *Guiraca caerulea*	17	14	15	1	3	6				
Northern Bobwhite *Colinus virginianus*	11	8	8	19	6	10		1	3	4
Painted bunting *Passerina ciris*	3	17	18	18	15	14	6		2	
Prairie warbler *Dendroica discolor*	7	33	47	54	46	57	46	25	14	
Blue jay *Cyanocitta cristata*						6	10	14	14	4
Northern cardinal *Cardinalis cardinalis*	33	20	38	54	58	96	115	157	171	175
White-eyed vireo *Vireo griseus*	1	3	14	38	43	49	36	42		
Carolina wren *Thryothorus ludovicianus*	1		4	13	11	8	11	15	14	11
Brown-headed cowbird *Molothrus ater*	4		4	2	13	10	11	6	7	14
Carolina chickadee *Parus carolinensis*	1	2		2	3	3	2		2	17
Yellow-billed cuckoo *Coccyzus americanus*		3	8		2		21	25	10	13
Red-eyed vireo *Vireo olivaceus*		3	2	3				4	8	13
Black and white warbler *Mniotilta varia*						3	3	8	18	18
Kentucky warbler *Oporornis formosus*						6	13	22	10	17
Hooded warbler *Wilsonia citrina*									6	13
Others[a]	28	21	11	29	51	21	24	13	51	40
Total birds	234	295	363	405	444	477	464	477	426	407
Total species	15	19	18	18	20	22	22	20	30	25
Bird species diversity[b]	1.98	2.04	2.06	2.19	2.25	2.19	2.24	2.13	2.41	2.31

[a] Uncommon birds detected <9 times each year.
[b] From MacArthur and MacArthur (1961).

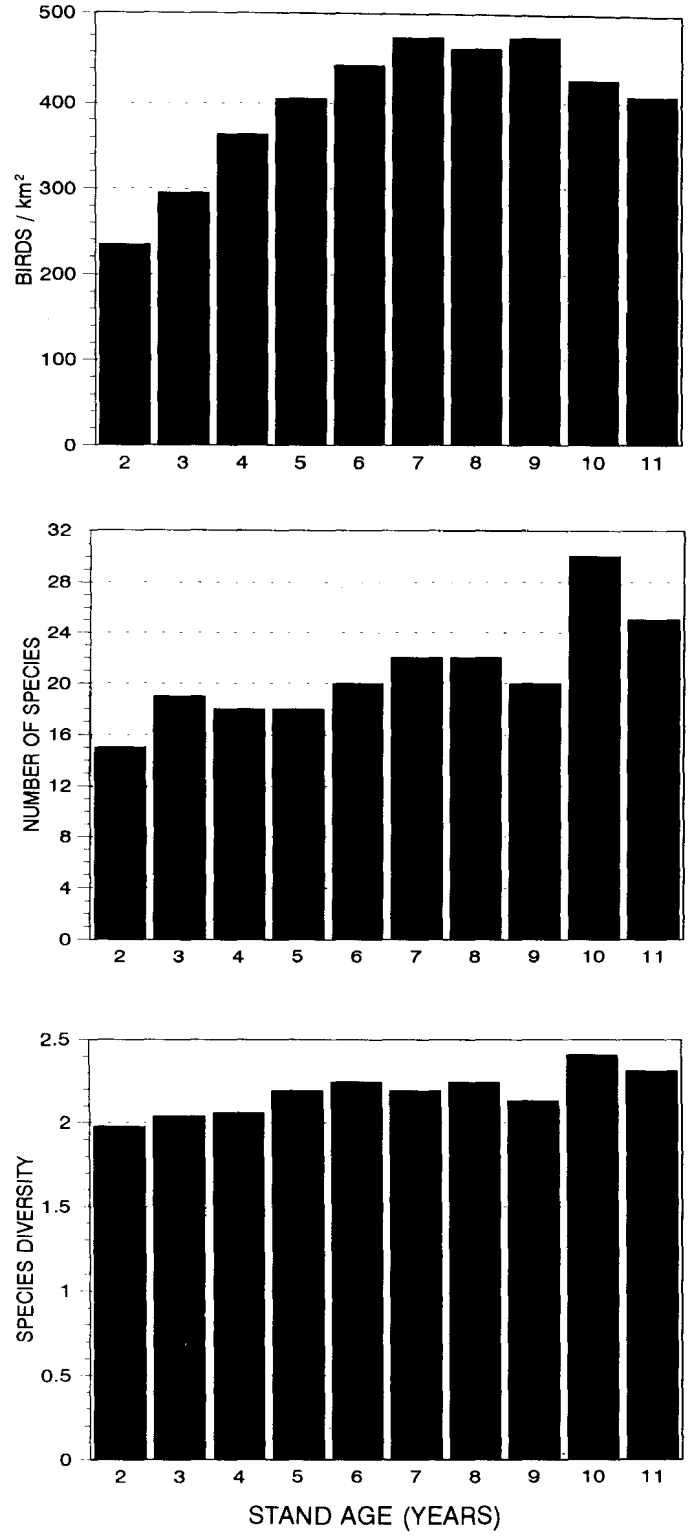

FIGURE 2. Breeding bird abundance and diversity in a developing pine plantation.

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