IMPACT OF FOREST PLANTATIONS ON NORTH FLORIDA WILDLIFE AND HABITAT[1]

by

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ABSTRACT

Seasonal measures of the animal community and understory vegetation in nine year old slash pine plantations of three different levels of site preparation intensity are compared to mature natural stands. While there appear to be no significant differences in bird, mammal or arthropod populations between the three site preparation intensities of young plantation, responses were significantly different when mature stands were included in the comparison. Bird and small mammal abundance and diversity was much greater in the mature longleaf pine stand than any other habitat type. Low intensity preparation sites generally supported greater numbers of birds and small mammals than the high intensity plots. Preliminary analyses of arthropod abundance at ground level suggest an inverse relation with site preparation intensity while there are no clear differences in the 0.2 to 1.5 m zone.

Vegetation succession is more advanced in the higher intensity site preparation plantations. While grasses and forbs still dominate the low intensity plots, higher strata woody vegetation dominates the high intensity preparation plots.

INTRODUCTION

The issue of intensive forest management and wildlife is not new to the Southeast. Yet, at the same time that polemical debates between foresters and wildlifers dominate our activity, ecological and land use changes dominate the landscape. This is praticularly true in Florida where total forest acreage is declining at a rate of 81,000 ha (2 X 10^5 acres) per year and where a decline of 22% in south Florida's forest acreage has occurred in the 1960-1970 decade (Bethea 1974). But even though the total pine *(Pinus spp.)* acreage has decreased by 1.62 million hectares (4 X 10^6 acres) since 1950, the volume of pine growing today is judged to be greater than 20 years ago. Florida has led the nation in tree planting in all but three of the last ten years (Bethea 1974). Clearly, the intensity of production per unit land area is the major factor of concern on those lands remaining in timber management.

In addition to improved genetic stock, forest fertilization, and drainage, high intensity site preparation is a dominant management practice. Site preparation is increasingly prevalent in Southeastern pine management and normally ranges from simple cutting and burning of debris to various combinations of stump removal. harrowing and bedding. Yet few studies have addressed this issue of site preparation intensity from a wildlife ecology standpoint. Further, most studies of the effects of intensive forestry to date have dealt with only a few individual species as opposed to the broader animal communities or total ecosystem effects. This study was designed to monitor site preparation effects ranging from abiotic factors such as light penetration and ground water level through plant, arthropod, small mammal, bird, and large mammal abundance. In addition to a taxonomic approach, analysis by vertical strata, structural attributes and functional categories similar to the system of Raunkiaer (1934) was employed. This paper includes preliminary results of site preparation and pine plantations on wildlife while future papers will deal with the vegetation and total systems responses.

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METHODS

Ten 0.4 ha, 9 year old slash pine *(P. elliotii)* plots comprised two replicates each of five levels of site preparation intensity. Site preparation intensities were: I, clear cut and burn; II, cut, burn and chop; III, cut, burn, K-G and harrow; IV, cut, burn, K-G and double harrow; and V, cut, burn, K-G, harrow and bed. Because of time limitations, the study concentrated on intensities I, III, and V. Since we were well aware of the limitations the small 0.4 ha plots would impose upon bird and mammal responses, vertebrates were also monitored on surrounding replicate plantations of the same age and treatment as site preparation levels I and V. In addition, in order to reference the observed plantation responses back to natural stands, two mature pine stands were used as comparative areas. One of these was a 16 ha, closed canopy, natural slash pine stand (fire excluded), while the second was a 70 year old longleaf *(P. palustris)* stand control burned a year before the study. Therefore, measurements such as the species composition and stratification of understory vegetation, the trapping and censusing of arthropods and small mammals and the mist-netting of birds were mainly centered on the site preparation plots. Techniques such as bird, mammal and track count transects were largely centered on the surrounding large scale plantations. All study plots are located near Jasper, Hamilton County, Florida (Fig. 1).

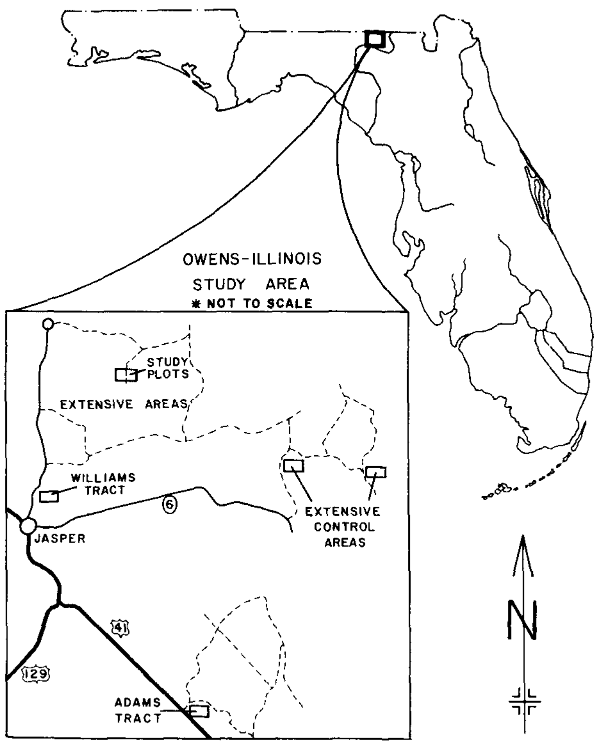

Figure 1. Location of replicate intensive site preparation plots, extensive slash pine plantations, and the mature longleaf and slash pine stands on Owens-Illinois lands in Hamilton County, north central Florida.

Four intensive sampling periods of three or more weeks each fell in July and October of 1973 and January and April of 1974. Less structured observations began in late 1972 and continue until present. The variables measured were categorized into climate, soil, decomposition, understory and overstory vegetation, arthropods, mammals and birds. This paper will deal mainly with animal responses although a cursory description of structural changes in understory vegetation is given to illustrate habitat differences.

Six 1 m^2 quadrats were clipped on each plot during each of the four seasons to assess vegetation biomass dynamics. All clippings from these plots were sorted by vertical stratum (0-¼ m, ¼-½ m, ½-1 m and 1-2 m) while three were additionally sorted by species and three by life form and morphological classes. In addition, 20 vertically stratified point frame frequency counts were conducted on each plot to assess species composition. Tree height and dbh was measured on two 1/200 ha plots in the plantations and two 1/50 ha plots in the mature pine areas. Canopy closure was compared by vertically stratified light intensity readings and fish-eye lens photographs.

Arthropods were sampled twice per season with a gasoline powered DeVac suction insect sampler by walking along established 200 m transect lines traversing each plot. In addition, ground dwelling arthropods were sampled with four 15 cm diameter pitfalls on each plot during two separate 7-day periods each season. Additional arthropod data were obtained using litter bags (of the decomposition study), mist nets, and total counts on pine shoots.

Bird usage of the areas was sampled by erecting three mist nets on each of the site preparation plots and 2 nets in each of the mature stands. Since both 5.5- and 9.2-meter nets were used, all net data have been converted to meter days (i.e. a 5.5 m net for 1 day = 5.5 m days while a 9.2 m net for 1 day = 9.2 m days). In addition to the 3,730 m days of mist netting, 122 hours were spent counting birds along transects.

Small mammals were censused by grid trapping with Sherman live traps spaced at 7 m intervals and the mark-and-recapture technique. A total of 15,123 adjusted trap nights of sampling resulted (adjusted trap nights = trap nights - ½ for each sprung trap, Nelson and Clark 1973). Large mammal and game bird sampling included track and pellet counts from 20 replicate 1 m^2 quadrats from each plot (= 480 quadrats) as well as 29 km of roadside track counts.

RESULTS AND DISCUSSION

Vegetation. The young plantations are dominated by slash pine with varying amounts of wax myrtle *(Myrica cerifera)*, gallberry *(Ilex glabra)*, palmetto *(Serenoa repens)* and blackberry *(Rubus betulifolius)* depending on the level of site preparation. Grassy leafed aster *(Heterotheca graminifolia)* was the dominant forb on all plots while deer tongue *(Trilisia odoratissima)* occurred frequently on low intensity plots but seemed to be replaced by yellow eye grass *(Xyris caroliniana)* on the high intensity plots. Grasses are generally more abundant on the low intensity site preparation areas, but while wiregrass *(Aristida stricta)* declines with increasing intensities of site prepartion, dropseed *(Sporobolus junceus)*, broomsedge *(Andropogon virginicus)*, chalky bluestem *(Andropogon capillipes)* and low panicums *(Panicum spp.)* all seemed to increase with increasing site preparation (Fig. 2).

In addition to the changes in species composition noted above, a distinct difference in structural composure resulted from site preparation. Canopy height of the young pines ranges from an average of only about 4 m on the burn-only plots to over 8 m on the high intensity plots (Fig. 3). At nine years of age the burn-only plots have essentially no midstory development and are distinguished by a predominatly grass-forb and saw palmetto understory. On the other hand, the high intensity site preparation plots are dominated by a wax myrtle and gallberry midstory with only a modest palmetto and dwarf oak *(Quercus spp.)* understory. In addition to the nearly complete canopy closure and the more sparse grasses and forbs, the high intensity plots contain greater amounts of litter which consist predominantly of pine straw. Not only is there less litter on the lower intensity plots but it is predominantly of angiosperm origin.

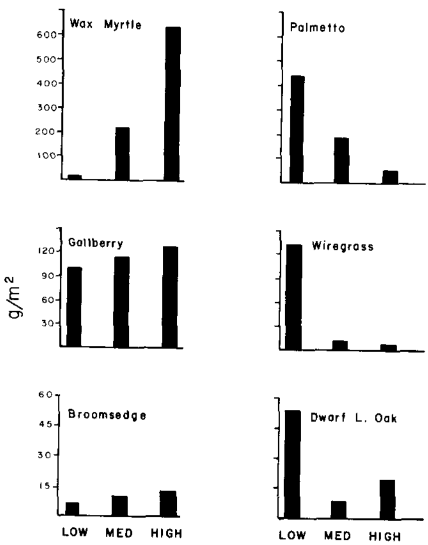

Figure 2. Individual species responses for typical increaser and decreaser species in grams per m^2 as a function of site preparation intensity.

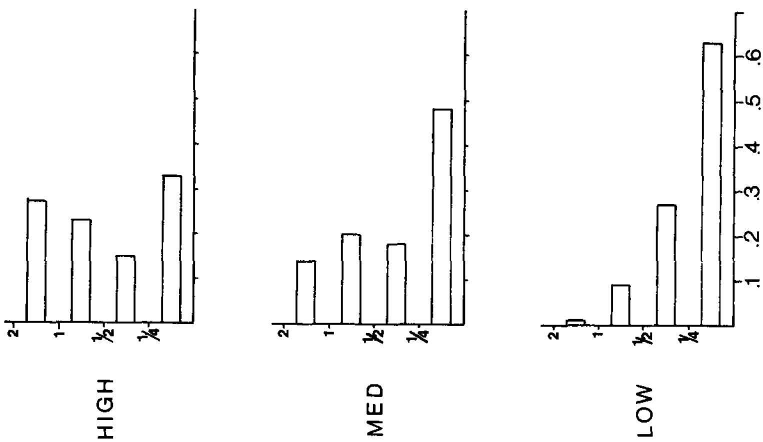

Figure 3. Vertical and life from habitat structures on equal aged slash pine site preparation plots B-I, B-III and B-V in Hamilton County, north central Florida. Ground level grasses, forbs and palmetto show an inverse relation with intensity of site preparation while midstory woody plants show a direct relation with preparation intensity.

When the total amount of plant biomass (excluding roots and litter) occurring below 2 m is plotted as a function of height, the progressively higher placement with greater site preparation is clear (Fig. 4). On the burn-only plots 63% of the total biomass occurred lower than ¼ m from the ground while only 1% occurred between 1 and 2 m above ground. The comparable percentages for the medium intensity plots are 48 and 14 while the high intensity plots have only about 33% of the understory biomass in the lower stratum and 27% in the 1 to 2 m zone.

Naturally, overall differences in vegetation are greater between the mature stands and the young plantations than between either of the two natural stands or between the various sites preparation treatments. The longleaf stand overstory consists of about 80% longleaf and 20% slash with an average canopy height of 21 m. The basal area is about 28 m^2/ha with about 632 stems per hectare. A thinning 15 years ago and a control burn less than a year before the study have kept the stand open and thus light penetration to ground level is 30% of open field conditions.

The natural slash pine stand is different in that it has not been burned in 25 years, competing midstory species are well developed, litter is deep and light penetration is only 8% of open conditions. It has about 560 stems per hectare with an average dbh of 25 cm and a crown height of 30 m.

Arthropods. Results of the arthropod sampling fit well with the observed microclimate and vegetation conditions. Because of the large number of groups, the several different collection techniques, and the seasonal interaction with both the above, we cannot go into great detail here. However, if only the July and October sampling periods and only the DeVac sampler and the pitfall trap data are considered and all the different taxa are combined, certain trends do emerge. The DeVac sampler preferentially selects from the vertical zone 20 to 150 cm above ground where a greater amount of vegetation occurs on the higher intensity site preparation plots. Therefore, it is reasonable that arthropods sampled by this technique increase as a function of site preparation intensity (Table 1). By contrast, the pitfalls selectively trap arthropods from the ground level, and the maximum number occurs on the medium intensity preparation plots. We suspect that this intensity is optimal for ground arthropods because it has the median amount of live ground vegetation and the median amount of litter. The combination of these two factors apparently provides favorable microclimatic and environmental conditions.

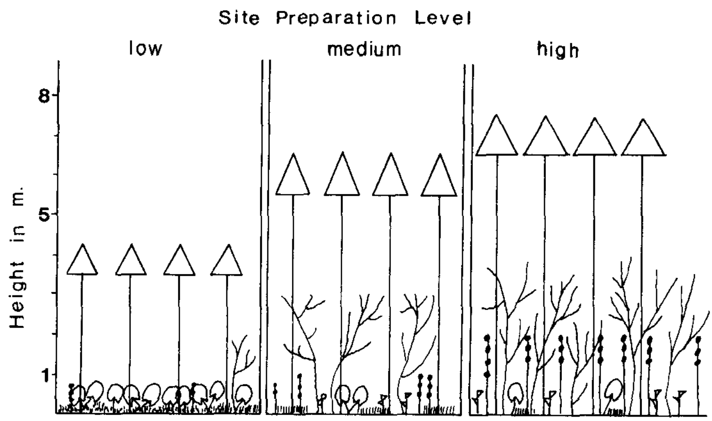

Figure 4. Proportions of understory vegetation biomass distributed in the four vertical strata 0-¼ m, ¼-½ m, ½-1 m, 1-2 m as a function of site preparation intensity levels.

Table 1. Preliminary analysis of average arthropod numbers sampled during the summer and fall periods. Each entry represents the overall mean +1 std. error from samples collected during each of two sampling periods on each of two replicate plots.

	Prep Level I		Prep Level III		Prep Level V	
	Pitfall	DeVae	Pitfall	DeVac	Pitfall	DeVac
Summer X	152+35	100+24	177+57	105+10	97+21	139+24
Fall X	561+47	76+ 5	563+54	103+12	476+65	112+ 7
Overall X	362	88	370	104	286	125

But yet another result is still unexplained. Pitfall samples were very much higher in October than in July while DeVac samples were lower in October than July (Table 1). This apparently reflects some sort of downward movement of arthropods in the fall. Since both fall samples reflected the same response, it is unlikely that it is a sampling or short term climatic artifact.

The implications of the above phenomenon for ground feeding game birds will be better known when we complete the analyses. At this time it appears that the lower intensities of site preparation definitely favor more vegetation and arthropods at ground level. Browsers and insect eating vertebrates should respond accordingly. An entirely different analysis needs to be done for canopy arthropods and we have only begun this. Preliminary analysis indicates that the mature longleaf stand supports about 12 times more arthropods per branch than the mature slash pine stand (i.e. 1.56 per branch vs 0.13 per branch). We believe this has direct bearing on the bird populations which we discuss shortly.

Small mammals. From the total adjusted trap nights of effort and a total catch of 200 small mammals, both catch per unit effort and the frequencies of different species results. When all seasons and species are combined there is no significant difference between the number of catches on the high intensity site preparation plots (two small plot reps plus two large plantation reps) and the low intensity preparation plots. A total of 29 individuals were caught on the plantation plots and only 12 of these were caught on the high intensity plots. In addition, it is worth pointing out that nine of the total of 12 were caught during one sampling period and for three other seasonal periods and four plots a total of only three individuals were trapped (Table 2). This contrasts with the low intensity plots wherein the 17 individuals were caught with greater seasonal and plot consistency. Although three species were caught in each of the site preparation intensities, 83% of the high intensity preparation plot catches were of one species *(Peromyscus gossypinus)* while the dominant species of the low intensity plantations contributed only 47% of the total.

Comparison of the plantation data with those of the mature stands reveals more striking differences. Even though only 16% of the trapping effort was directed at these two sites, 86% of the small mammal catches resulted from this effort. Further, although only 8% of the trapping effort was located in the longleaf stand, 82% of the catches derived from it. In addition, the longleaf stand was the only plot on which all four species resident to the area were caught (viz. cotton rat *(Sigmodon hispidus),* cotton mouse *(P. gossypinus),* golden mouse *(P. nuttalli)* and least shrew *(Cryptotus parva)).* With the exception of one individual caught on the high intensity plots, the longleaf stand was the only area in which the golden mouse was caught. The mature slash pine stand supported the fewest number of species with the cotton mouse being the only species caught there. Cotton mice also dominated the high intensity preparation plots while the cotton rat and least shrew dominated the burn-only plantations. This latter result is quite probably because of the higher density of ground level vegetation and arthropods on these sites.

Table 2. Small mammal captures in low (I) and high (V) intensity site preparation areas and two mature stands. All seasons are combined and each of the plantation values represents the total from four replicate plots.

SPECIES	High Intensity	Low Intensity	Mature, Unburned Slash Pine Stand	Mature, Burned Longleaf Pine Stand
	Habitat Type			
Cotton rat	1	7	0	93
Cotton mouse	10	2	7	57
Golden mouse	1	0	0	8
Least shrew	0	8	0	6
No. individuals	12	17	7	164
No. species	3	3	1	4
Adjusted trap nights of effort	5,852	5,852	1,040	1,106
Animals caught per adj. trap night	.0020	.0029	.0067	.1483

Table 3. Comparative bird abundance in 9 year old low (I), medium (III) and high intensity (V) site preparation slash pine plantations and two mature stands. Numbers represent the mean number observed or caught plus or minus the standard error of the mean. Numbers in parentheses are birds caught per meter day of mist net effort.

	Habitat Type				
	I	III	V	Mature slash	Mature longleaf
Mist nets	1.9+.6 (.004+.001)	5.4+.3 (.014+.006)	4.0+1.3 (.010+.003)		
Transects (no./hr)	9.6+6.4		1.4+1.0	6.6+6.0	81.2+34.1
Total no. of species	15		2	8	45
No. spp. per transect hr.	1.3+.7		.14+.1	2.0+1.4	8.6+ 3.5

Birds. Neither mist net catches nor the number of birds observed on the transects revealed significant differences between the site preparation intensities (Table 3). On the other hand, there is an interaction effect of technique with preparation intensity. The mist net data suggest that medium intensity preparation in best for birds while high intensity is next best and the low intensity plots support fewest. Transect data support nearly the opposite conclusion with approximately seven times as many birds being observed in the low intensity site preparation plantations as in the high intensity plantations. Bird species diversity is much greater in the low intensity plantations.

Unlike the nonsignificant site preparation effects, when the mature stands are included in the comparison there are very highly significant differences ($P<.005$ in both the number of species and the total number of individuals seen per transect hour (Table 3). Approximately nine times as many birds were seen in the mature longleaf as in the low intensity plantations and roughly 60 times as many birds occur in the mature longleaf as in the high intensity preparation plots (Fig. 5). Shannon-Weaver indices of species diversity followed essentially the same pattern as the number of species (i.e. from $H' = 1.20$ in mature longleaf to 0.72 in mature slash to 0.06 in the high intensity plantations).

Larger mammals. The relative abundance of the larger vertebrates derived more from sign than actual sightings. When all track observations are combined, the low intensity plantations reflected the greatest large mammal usage (17 tracks/count) with the high intensity plantations and mature longleaf stand reflecting about equal usage (i.e. 10.6 and 10.2 tracks/count respectively). When these data are separated by species, deer *(Odocoileus virginianus)* seemed to prefer low intensity plantations, then the longleaf stand and lastly the high intensity plantations.

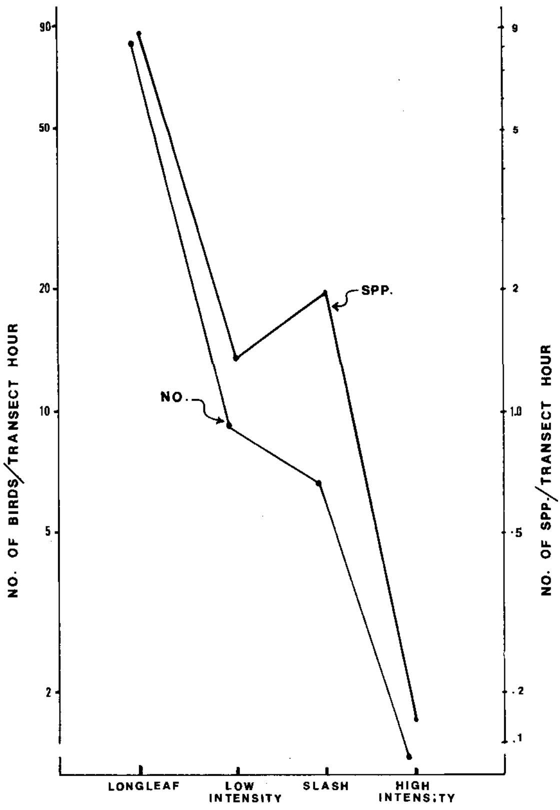

Figure 5. Average number of birds and the average number of bird species seen per hour of walking transect through the extensive site preparation plantations and mature longleaf and slash pine stands.

Armadillos *(Dasypus novemcinctus)* and opossums *(Didelphis marsupialis)* favored the low intensity plantations (probably because of the greater arthropod abundance) while cottontail rabbits *(Sylvilagus floridanus)* seemed to prefer the medium intensity plots followed by the high intensity and finally the low intensity plots. Lumping all pellet types together revealed a greater number on the medium intensity plots, followed by the high intensity and lastly the low site preparation plots.

Taken in total, the effects of intensive site preparation on wildlife seem quite clear. Even though nutrition and subtle ecological relations are surely involved, an analysis of habitat structure appears sufficient to explain most of the effects. For example, simultaneously with the enhanced responses of midstory woody species such as wax myrtle and gallberry most grasses and forbs are reduced. This reduces forage for many ground browsing and grazing species such as cotton rats, rabbits, quail *(Colinus virginianus)* and others (Hebb 1971). In addition to increased shading and the inverse relation between overstory density and understory productivity (Blair 1969, Jameson 1967, Anderson *et al.* 1969), the rapid accumulation of pine straw on the intensive sites acts to further impede ground level vegetation. The loss of litter diversity and the increased litter C/N ratio most likely slows decomposition *(Gosz et al.* 1973). These and possibly other factors greatly reduce the number of ground level arthropods which in turn reduces animals such as shrews, opossums and armadillos. All of these are ground level effects. As shown in Figs. 3 and 4, there is a more rapid development of midstory woody plants under intensive site preparation. But there are generally not as many individual plants on these faster growing sites and this along with the more clumped distributional pattern affects yet other wildlife. We believe these aspects of structure largely explain the ordering of bird abundance. Finally, the canopy structure itself is important for certain foraging, nesting and flying species. It is here that species differences are particularly important as are the natural controls such as self pruning and fire. In addition to gross morphological differences, the leaf density, length of branch relative to the leaf whorl and other factors appear important in governing arthropod mico-habitat. This in turn affects the number of birds in the canopy itself.

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