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## THE EFFECT OF FOREST STAND AGE ON OWL DISTRIBUTION IN SOUTHWESTERN VIRGINIA

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Mature forests are essential to certain wildlife species (Meslow et al. 1981, Schoen et al. 1981). Timber harvest, however, has limited the distribution and abundance of mature timber. In the national forests of the southern Appalachians, extensive timber harvesting in the beginning of this century and current silvicultural prescriptions, which call for harvesting many timber types at 80 years of age, have resulted in a forest comprised primarily of young stands (Fig. 1). Intensive timber management on these tracts could further reduce the proportion of forest in the older age-classes.

To effectively manage forest wildlife, we must identify the species dependent upon mature forests and their components and determine the nature of that dependency (Meslow et al. 1981, Schoen et al. 1981). Additionally, we must determine whether the truncated age distribution of forest stands caused by logging is detrimental to these species.

We investigated the influence of stand age on great horned owl (*Bubo virginianus*) and barred owl (*Strix varia*) distri-

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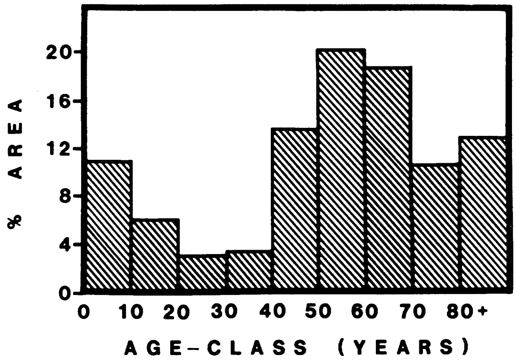


Fig. 1. Age distribution of commercial forest stands on southern national forests (U.S. Forest Service, Southern Region). Total area of classified forest equals 4,220,803 hectares. Compiled from unpublished U.S. Forest Service data.

butions by testing the hypothesis that these species respond to tape recorded vocalizations with equal probability at young (≤80 years old) and old (>80 years old) forest stands. This was roughly equivalent to a comparison of response in below rotation age stands with response in beyond rotation age stands. Tape recorded vocalizations have been used as an aid to detecting owls and other bird species for more than two decades (Fuller and Mosher 1981, Johnson et al. 1981).

We chose to study these two species for several reasons. First, both species have been said to prefer mature stands (e.g., Craighead and Craighead 1956, Hagar 1957) but we were unaware of statistical tests of this hypothesis. Second, although some bird species in the eastern deciduous forest are affected by stand age (Odum 1950, Johnston and Odum 1956) and silvicultural practices (Conner and Adkisson 1975, Webb et al. 1977, Crawford et al. 1981), studies of the effect of stand age and silviculture on large raptorial birds have been limited to western coniferous forests (Forsman et al. 1977, Reynolds et al. 1982). Yet such birds are particularly worthy of study because their populations are more likely to be influenced by environmental perturbations than other species (Terborgh 1976). Finally, the barred owl has been selected as a management indicator species in some southern Appalachian national forests. Land managers are required to determine the impact of management activities on such species (Title 36, U.S. Code of Federal Regulations, Section 219.19).

## STUDY AREA AND METHODS

The study was conducted on the Blacksburg Ranger District of the Jefferson National Forest in southwestern Virginia. The District encompasses approximately 450 $km^2$ of the Ridge and Valley Province (Smith and Linnartz 1981) and ranges from 600 to 1,200 m in elevation. Private inholdings, mostly farmland, occur throughout the valleys; mixed oaks (*Quercus* spp.) predominate on the slopes.

In 1982 and 1983, we randomly selected young and old stands from a list of all stands in the district. We rejected stands within 2 km of previously selected stands and young stands within 1 km of an old stand. We entered stands between 1800 and 2200 and broadcast owl calls from the approximate center of the stand using a tape recorder (Sony VCM-111) and a 35-watt amplifier with an 8-ohm speaker (Perma Power Electronics, Inc.). All owls seen or heard during the sampling period were counted. Because great horned owls appeared to prefer farmland edge, we noted whether the sampling point was >1 km or ≤1 km from the nearest farmland. Observations were not conducted on nights with precipitation, fog, or wind exceeding 15 km/hour. To reduce the variability caused by environmental factors and nesting phenology, young and old-growth stands were sampled in pairs, and the order in which stands in a pair were sampled was randomized.

In 1982, we sampled 24 young and 25 old stands from 4 February to 2 April. Each sampling period consisted of three segments: (1) a 5-minute prebroadcast period during which we listened for spontaneous vocalizations; (2) a 7-minute broadcast period during which we played eight sets of great horned owl calls; and (3) a 10-minute postbroadcast period during which we listened for responses. Each set of calls consisted of 21 hoots in 10 seconds and was followed by a 40-second silent period.

In 1983, we sampled 20 young and 20 old stands from 13 March to 22 April, including 5 of the stands sampled in 1982. Each sampling period consisted of four segments: (1) a 7-minute barred owl broadcast; (2) a 10-minute postbroadcast period; (3) a 5-minute great horned owl broadcast; and (4) a 10-minute postbroadcast period. The broadcast periods followed the 1982 procedure, except that the great horned owl broadcast consisted of only six sets of calls.

Tests for homogeneity of proportions were conducted using Pearson's chi-square statistic (two-dimensional models) and the maximum likelihood ratio statistic (three-dimensional models; Fienberg 1982).

## RESULTS

Ages of stands sampled in 1982 ranged from 12 to 72 years for young stands ($\bar{x}$ = 52, SD = 17) and from 81 to 212 years for old stands ($\bar{x}$ = 101, SD = 29). The sizes of young and old stands were similar ($\bar{x}$ young = 64 ha, range 5–507 ha, SD = 110; $\bar{x}$ old = 37 ha, range 7–216 ha, SD = 48; Wilcoxon Rank Sum Test, $P = 0.35$). We heard great horned owls at 5 of 25 old stands and 1 of 24 young stands ($\chi^2 = 2.86$, 1 df, $P = 0.09$). Owls responded at 5 of 17 stands that were ≤1 km from farmland but at only 1 of the other 32 stands ($\chi^2 = 7.14$, 1 df, $P = 0.008$).

Table 1. Great horned and barred owl responses to tape recorded owl vocalizations in relation to farmland (≤1 km from farmland, >1 km from farmland) and stand age (≤80 years old, >80 years old) on the Blacksburg Ranger District, Jefferson National Forest, 1982–83.

| | Response | | No response | | |
|---|---|---|---|---|---|
| | Stand age | | Stand age | | |
| | Old | Young | Old | Young | Total |
| Great horned owl, 1982 | | | | | |
| Farmland | 5 | 0 | 3 | 9 | 17 |
| No farmland | 0 | 1 | 17 | 14 | 32 |
| Total | 5 | 1 | 20 | 23 | 49 |
| Barred owl, 1983 | | | | | |
| Farmland | 4 | 3 | 3 | 3 | 13 |
| No farmland | 12 | 6 | 1 | 8 | 27 |
| Total | 16 | 9 | 4 | 11 | 40 |

Great horned owls responded at 5 of 8 stands that were both >80 years old and ≤1 km from farmland, but at only 1 of the other 41 stands (Table 1). The hypothesis that owl responses can be explained by three independent two-way interactions (response–farmland, response–stand age, and stand age–farmland) was not supported by the data ($G^2 = 7.25$, 1 df, $P = 0.008$), suggesting the existence of a strong three-way relationship among farmland, old stands, and owl response.

Ages of stands sampled in 1983 ranged from 0 to 72 years for young stands ($\bar{x}$ = 39, SD = 26) and from 82 to 131 years for old stands ($\bar{x}$ = 98, SD = 15). Young stands were similar in size to old stands ($\bar{x}$ young = 21 ha, range 2–67 ha, SD = 17; $\bar{x}$ old = 27 ha, range 4–78 ha, SD = 18; Wilcoxon Rank Sum Test, $P = 0.12$). We heard barred owls at 16 of 20 old stands and 9 of 20 young stands ($\chi^2 = 5.23$, 1 df, $P = 0.022$) (Table 1). Barred owls responded at 7 of 13 stands ≤1 km from farmland and at 18 of the other 27 stands ($\chi^2 = 0.615$, 1 df, $P = 0.430$). Similarly, three-dimensional models including response, stand age, and proximity to farmland provided no evidence that barred owls either favored or avoided old stands near open farmland. We obtained only one great horned owl response in 1983, at an 87-year-old stand <1 km from farmland.

## DISCUSSION

Both owl species responded more frequently at old stands than at young stands. Similarly, Forsman et al. (1977) obtained significantly greater spotted owl (*Strix occidentalis*) response in Oregon old-growth (≥200 years old) forests than in young forests. All spotted owl nests discovered in Oregon in 1970–80 ($N = 47$) were in forests >70 years old (Forsman et al. 1982).

The reasons for the apparent preference for mature stands are not clear and merit further study, but several hypotheses seem plausible. Owls may require large trees found in mature stands for nest cavities or to hold stick nests. Owls must also be able to move through a timber stand unimpeded by branches and other obstructions. Old stands on our study area appear to have lower stem densities and more subcanopy flying space than young stands. Many of the youngest stands (≤20 years old) are nearly impenetrable. Nicholls and Warner (1972) found that habitats preferred by barred owls on their central Minnesota study area had unimpeded travelways and an abundance of cavities. Southern and Lowe (1968) and Fuller (1979) also commented on the importance of unimpeded travelways in habitat selection by raptorial birds.

The great horned owl's preference for stands near farmland is consistent with the observations of Fuller (1979) who found that great horned owls in Minnesota preferred fields and field–forest edges for hunting and upland oak for all other activities. This association is likely related to food habits because field and edge species, especially lagomorphs and voles (*Microtus* spp.), compose a substantial part of great horned owl diets (e.g., Craighead and Craighead 1956, Petersen 1979). Thus, the three-way interaction among old-growth, farmland, and owl response may reflect the species' nesting and hunting habits and the importance of resource juxtaposition.

Several factors may have contributed to the lower great horned owl response in 1983. Great horned owls in Virginia lay eggs as early as January (Larner et al. 1979). It is possible that the later sampling period in 1983 was responsible for the low response rate. Petersen (1979) reported that great horned owl clutch initiation in Wisconsin ranged from 29 January to 21 March, but that territorial hooting ended by mid-February. Response to recordings may or may not follow this pattern. It is also possible that the taped barred owl call, which preceded the great horned owl broadcast in 1983 but not in 1982, inhibited great horned owl response. In Minnesota, the two species' home ranges overlap, yet they rarely remain close to one another (Fuller 1979). It is not clear, however, why the larger owl should be inhibited by barred owl calling. Perhaps the barred owl hooting elicited hunting behavior from the great horned owl, which occasionally preys on the smaller species (Bent 1938). The difference in response rate between years also may have been the result of annual variability in the great horned owl population. Although northern great horned owl populations appear to cycle (Stewart 1969, Adamcik et al. 1978), we are unaware of evidence for this phenomenon in the south.

## MANAGEMENT IMPLICATIONS

Because both owl species responded less frequently at young than at old stands, intensive timber management in which most stands are cut at 80 years of age may cause declines in owl populations. Many nominally young stands contained at least a few mature trees. The responses we obtained at young stands suggest that this older component may satisfy the owl's requirements in some cases. Current clearcut logging seldom spares such trees, however. Thus, in the future, young stands will likely be less suitable for owls than at present.

Regulations resulting from the National Forest Management Act of 1976 require the Forest Service to maintain and improve the habitat of management indicator species such as the barred owl. In the next several decades, if timber harvest continues at the current rate, an increasing proportion of southern national forests will be >80 years old (Fig. 1). Our results suggest that this will benefit both great horned owls and barred owls; the former will benefit most if old stands are adjacent to farmland. Provisions for the maintenance and improvement of mature stands should be included in forest plans. Further studies in the eastern forest will be required to determine the optimal size, distribution, and abundance of such stands. The interaction between farmland and old stands observed in this study underscores the need to determine how old stands interact with other habitat characteristics to affect the distribution of owls and other wildlife species.

Most of the recent research on old-growth wildlife relationships has been conducted in the Pacific Northwest. This is perhaps appropriate given the amount of old growth that remains there and the economic incentives for removing it (Meslow et al. 1981). The importance of mature timber to wildlife should be determined in all forested ecosystems, however. Further studies in the eastern forest will determine the importance of preserving the few remaining old stands there and the optimal distribution and abundance of such stands.

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## MAMMAL POPULATIONS ON PHOSPHATE-MINED AND NATURAL AREAS OF NORTH FLORIDA[1]

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Phosphate mining is Florida's third largest industry, and more than 74,000 ha of the state have been altered by mining (Hendry 1978, Stowasser 1979). The United States is the world's leading phosphate producer, and five Florida counties contribute 80% of the country's supply. Worldwide demands for phosphate products (e.g., fertilizer, industrial chemicals, and livestock feed supplements) are expected to increase well into the 21st century (Stowasser 1979).

Florida's mining regulations are being revised, and the draft of the revised regulations places more emphasis on wildlife habitat restoration. However, resistance to stricter reclamation regulations is substantial; the nature and rigor of future mining regulations are uncertain. Baseline information on the impact of phosphate mining on wildlife is needed if regulations and future policies are to adequately address

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