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COMPARISON OF SEVEN FOREST TYPES FOR GAME IN WEST VIRGINIA[1]

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Abstract: Forest type was used as a basis for classifying observations of turkeys (*Meleagris gallopavo*), gray squirrels (*Sciurus carolinensis*), white-tailed deer (*Odocoileus virginianus*), and ruffed grouse (*Bonasa umbellus*) on an 8,100-ha study area. For three years, sightings of game were recorded in each April and November, deer-pellet groups were counted in each April, and leaf nests were counted in each November; then, data for the three years were pooled. The sightings of turkeys, deer, and grouse differed between spring and fall. However, we pooled the spring and fall counts to illustrate use of such data in habitat management. Among seven forest types, all game counts differed from counts that would be expected if locations of game or sign were independent of forest type. Counts for each game species in each forest type were converted to ratios, and comparisons were made directly between all pairs of forest types for any species, and all species/type combinations. Use of the ratios is demonstrated in a hypothetical management analysis. Such comparisons can help define management alternatives and resolve trade-offs among them.

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This paper reports on the relative use of seven forest types by turkeys, gray squirrels, white-tailed deer, and ruffed grouse. We show how measures of game occurrence can be converted to ratings and used to compare forest types for different wildlife species. The methods used may provide guidance for preparing economic analyses or for resolving multiple-use conflicts.

Timber management commonly provides the most practical means for managing habitat of forest wildlife. Shaw (1970:272) asserted that over 90 percent of the vegetative manipulations needed for forest wildlife can be achieved through well-planned timber programs.

Where land managers use timber management for wildlife purposes, they need to evaluate existing habitat conditions as well as the new conditions that timber management will produce. To do this, the manager must choose and consider at least one characteristic of his property that is fundamental to both timber and habitat management. He needs common ground between the two resources. Forest type is such a characteristic. Alone, type is seldom adequate for detailed planning, but it helps answer broad questions such as where to manage for what purpose.

Forest types have differing potentials for producing different kinds of wildlife and different kinds of timber. Foresters routinely assess these potentials for timber, and comparable assessments for wildlife are needed in considering trade-offs among species of wildlife and between wildlife species and kinds of timber. Generally, forest type potentials are better known for timber than for wildlife, particularly where two or more game species with conflicting habitat requirements are involved.

[1] This was a cooperative study between the USDA Forest Service, Northeastern Forest Experiment Station and Monongahela National Forest, and the West Virginia Department of Natural Resources, P-R Project W-39-R.

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STUDY AREA

Field work was done on Middle Mountain in the Rimel-Neola management area of the Monongahela National Forest in Pocahontas and Greenbrier counties, West Virginia. The mountain is a ridge 29 km long and 2.4 to 4.0 km wide. The ridge meanders NNE, and the flanks are dissected by narrow, steep drainages between finger-ridges. Elevations range between 620 m at the southern base of the ridge and 1,085 m at its highest point. Roads encircle the ridge and enclose 9,500 ha, including some non-forested private land along parts of the lower slopes. Our observations were made on national forest land, on about 8,100 ha of almost continuous forest cover.

Cover types varied with elevation and aspect, but stand densities and ages were more nearly uniform than those on most large areas in the region. Nearly all stands included 2 age-classes; some old residual trees were mixed in the same stand with pole timber that was either 20 to 40 or 40 to 60 years old. Site indices (Schnur 1937) for northern red oak (*Quercus rubra*) ranged from 80 or more in coves and stream bottoms to an average of 50 in merchantable stands on upper slopes, to unknown but low indices on the driest ridges and southwest aspects. Stands that were considered marginally merchantable averaged 11.5 m^2/ha (50 ft^2/acre) basal area (trees 12.7+ cm dbh), and the better stands averaged about 23 m^2.

The forest types we used were those described by the Society of American Foresters (1967) and by the USDA Forest Service (Unpublished handbook FSH 4813.1, 1957), but we combined some standard types that were closely related in site and successional characteristics:

1. Yellow pine: includes SAF types pitch pine (*Pinus rigida*) and Virginia pine (*P. virginiana*), and FS (local) types pitch pine, Table Mountain pine (*P. pungens*), and Virginia pine.
2. Oak-pine: similar to SAF type white pine (*P. strobus*)-chestnut oak (*Q. prinus*); same as FS oak-pine.
3. Chestnut oak: SAF and FS (local) types chestnut oak.
4. Red oak-scarlet oak: includes SAF types northern red oak and scarlet oak (*Q. coccinea*); FS (local) type northern red oak.
5. White oak-red oak-hickory: SAF and FS (local) types white oak (*Q. alba*), red oak, and hickories (*Carya* spp.).
6. Mixed hardwoods: similar to SAF type yellow poplar (*Liriodendron tulipifera*) -white oak-northern red oak; FS (local) type mixed hardwoods within the general type oak-hickory. Called cove hardwoods, locally.
7. White pine: includes SAF and FS (local) types white pine, white pine-hemlock (*Tsuga canadensis*), and hemlock.

The types are listed in increasing order of site moisture. The sequence yellow pine through white pine is characteristic of the changes in type along a path from the dry upper slopes down to the stream bottoms. The oak-pine stands occupied relatively dry sites, and most were adjacent to yellow pine stands. Pitch pine, chestnut oak, and Table Mountain pine dominated the oak-pine stands, and white pine occurred as scattered individuals. Nearly all of the white pine type included some hemlock, was near stream bottoms, and abutted mixed hardwoods.

The 4 types in which oaks or mixtures

Table 1. Number of plots (2,533) and game observations per forest type.

	Type[a]						
	YP	O-P	CO	RSO	WRO-H	MH	WP
No. plots	77	581	375	45	1,181	228	46
Turkey							
Apr		12	8	1	17	1	
Nov		1	8		40		
Gray squirrel							
Apr		13	5		50	13	
Nov		9	6		24	7	
Leaf-nest	9	99	145	7	1,052	237	3
Deer							
Apr	4	12	11	3	38	2	
Nov	2	16	10		69		
Pellet groups	69	631	378	27	1,180	128	37
Grouse							
Apr	6	35	17	1	67	14	4
Nov	1	32	2		51	11	1

[a] The forest types are abbreviated as: yellow pine, YP; oak-pine, O-P; chestnut oak, CO; red, scarlet oak, RSO; white, red oak-hickory, WRO-H; mixed hardwoods, MH; white pine, WP.

of hardwoods predominated occupied about 93 percent of the area. The red oak-scarlet oak, yellow pine, and white pine types were scarce (two, three, and two percent of the area, respectively).

METHODS

Game animals seen, squirrel leaf-nests, and deer pellet groups were counted by experienced biologists and wildlife technicians or by senior or graduate students under our supervision. Each observer worked alone on foot and referenced all observations to a grid of 2,533 permanent plot markers. These were at intervals of 80.5 m along 57 parallel transects that crossed the main ridge at a right angle and were 0.40 km apart.

The leaf-nest plot was 40.2 × 160.9 m, centered on a transect line. The pellet-group plot was a cluster of four 9.29-m^2 circles, each 20.1 m (66 ft) from a plot marker. No fixed plot was specified for game sightings; each sighting was referenced to the nearest plot marker. Cover type was determined from the ground for an approximately 0.50-ha circle centered on a plot marker.

The sampling periods were 16–25 April and 8–23 November in 1968, 1969, and 1970. Observers recorded game sightings in both seasons, pellet groups in April, and leaf-nests in November.

We computed the average number of game observations per plot for each forest type, which is:

$$r_i = n_{ij}/N_j$$

where n_{ij} is the number of observations on the ith kind of game sighting or sign in the jth forest type, and N_j is the number of plots in the jth forest type. We then computed the habitat use ratios for each variable:

$$U_i = r_i/r_j = (n_i/n_j)/(N_i/N_j)$$

These ratios indicate the habitat use by type. For example, there were 99 leaf-nests

Table 2. Chi-square tests of homogeneity in game observations among seven forest types.

	Spring vs. fall count		Spring + fall counts vs. forest type	
Observation	df	χ^2	df	χ^2
Turkeys	7	32.34**	6	19.92**
Gray squirrels	7	4.65	6	23.47**
Leaf-nests			6	504.60**
Deer	7	17.71*	6	27.59**
Deer-pellet groups			6	56.90**
Grouse	7	15.66*	6	13.68*

* $P < 0.05$.
** $P < 0.01$.

on 581 plots in the oak-pine type, and 145 nests on 375 plots in the chestnut oak type:

$$r_{OP} = 99/581 = 0.17, \text{ and}$$
$$r_{CO} = 145/375 = 0.39$$

$$U_{OP/CO} = 0.17/0.39 = 0.44, \text{ and}$$
$$U_{CO/OP} = 0.39/0.17 = 2.3$$

A ratio greater than 1.0 means that more game or sign was counted per plot in the "numerator" forest type than in the "divisor" type.

RESULTS

Our data on game observations by forest type are summarized in Table 1. The turkey, deer, and grouse observations per forest type differed between spring and fall, but those for gray squirrels did not. These spring-vs.-fall differences are pertinent to some forest-habitat-management problems, but we chose to concentrate on the broader implications of combined spring and fall sightings of game, and the leaf-nest and deer-pellet group data. These measures had distributions among types attributable to habitat choices by game, not to chance (Table 2).

The number of observations per 100 plots (Table 3) shows the relationships among all the game observations within 1 type (in a row), and among all the types for 1 kind of game observation (in a column). There was no apparent ranking of the observations of deer, deer-pellet groups, and grouse along the site-moisture gradient from yellow pine through white pine, nor was there a clear association between these observations and predominance of either pines or hardwoods. The highest values for deer-pellet groups and grouse were in the oak-pine type, but there was little relation between deer seen and pellet groups counted per forest type.

Turkeys, squirrels, and squirrel leaf-nests definitely were associated with the hardwood types. Squirrels seen and leaf-nests counted showed close agreement, and both distributions decreased along a site-moisture gradient from mixed hardwoods (moist) to oak-pine (dry). Turkeys were associated with the oak types. No turkeys were seen in the pine types, and only one was seen in mixed hardwoods. Turkeys

Table 3. Number of observations per 100 plots for each forest type.

Type[a]	Turkeys	Squirrels	Leaf-nests	Deer	Pellet groups	Grouse
YP			11.7	7.8	89.6	9.1
O-P	2.2	3.8	17.0	4.8	108.6	11.5
CO	4.3	2.9	38.7	5.6	100.8	5.1
RSO	2.2		15.6	6.7	60.0	2.2
WRO-H	4.8	6.3	89.1	9.1	99.9	10.0
MH	0.4	8.8	103.9	0.9	56.1	11.0
WP			6.5		80.4	10.9

[a] The forest types are abbreviated as: yellow pine, YP; oak pine, O-P; chestnut oak, CO; red, scarlet oak, RSO; white, red oak-hickory, WRO-H; mixed hardwoods, MH; white pine, WP.

Table 4. Comparisons of ratios of observations per 100 plots, by forest type. Observations per 100 plots are from Table 3.

Divisor forest type[a]	Numerator forest type[a]						
	YP	O-P	CO	RSO	WRO-H	MH	WP
			Turkeys, April and November[b]				
O-P	0.0	1.0	1.9	1.0	2.2	0.2	0.0
CO	0.0	0.5	1.0	0.5	1.1	0.1	0.0
RSO	0.0	1.0	1.9	1.0	2.2	0.2	0.0
WRO-H	0.0	0.5	0.9	0.5	1.0	0.1	0.0
MH	0.0	5.5	10.7	5.5	12.0	1.0	0.0
			Gray squirrel leaf-nests, November				
YP	1.0	1.4	3.3	1.3	7.6	8.9	0.6
O-P	0.7	1.0	2.3	0.9	5.2	6.1	0.4
CO	0.3	0.4	1.0	0.4	2.3	2.7	0.2
RSO	0.7	1.1	2.5	1.0	5.7	6.7	0.4
WRO-H	0.1	0.2	0.4	0.2	1.0	1.2	0.1
MH	0.1	0.2	0.4	0.2	0.8	1.0	0.1
WP	1.8	2.6	6.0	2.4	13.7	16.0	1.0
			Deer-pellet groups, April				
YP	1.0	1.2	1.1	0.7	1.1	0.6	0.9
O-P	0.8	1.0	0.9	0.5	0.9	0.5	0.7
CO	0.9	1.1	1.0	0.6	1.0	0.5	0.8
RSO	1.5	1.8	1.7	1.0	1.7	0.9	1.3
WRO-H	0.9	1.1	1.0	0.6	1.0	0.6	0.8
MH	1.6	1.9	1.8	1.1	1.8	1.0	1.4
WP	1.1	1.3	1.3	0.7	1.2	0.7	1.0
			Grouse, April and November				
YP	1.0	1.3	0.6	0.2	1.1	1.2	1.2
O-P	0.8	1.0	0.4	0.2	0.9	0.9	0.9
CO	1.8	2.3	1.0	0.4	2.0	2.1	2.1
RSO	4.1	5.2	2.3	1.0	4.5	5.0	4.9
WRO-H	0.9	1.1	0.5	0.2	1.0	1.1	1.1
MH	0.8	1.0	0.5	0.2	0.9	1.0	1.0
WP	0.8	1.1	0.5	0.2	0.9	1.0	1.0

[a] The forest types are abbreviated as: yellow pine, YP; oak pine, O-P; chestnut oak, CO; red, scarlet oak, RSO; white, red oak-hickory, WRO-H; mixed hardwoods, MH; white pine, WP.
[b] Comparisons for yellow pine and white pine as divisor types are omitted because no turkeys were seen in either pine type.

seen per 100 plots decreased from moist to dry sites among the oak types, with the exception of the scarce red oak-scarlet oak type.

Many other comparisons can be made from Table 3, but converting observations per 100 plots to ratios simplifies comparing the forest types (Table 4). The ratios we chose to calculate were for turkeys and grouse seen, squirrel leaf-nests, and deer-pellet groups because these were the most reliable measures of game presence. Each ratio is one number representing a pair of forest types, and each ratio can be considered as an index of the use of one forest type relative to another by one species of game. For example, reading across the first row of Table 4, we compare the number of turkeys seen in oak-pine to those seen in all other types: none was seen in yellow pine, 1.9 times as many were seen in chestnut oak, 2.2 times as many were seen in white oak-red oak-hickory, and so on.

These ratios have practical uses. Given

a forest tract with several types, we can use the ratios to help judge where to invest habitat funds. Or, given a forest type and the option to convert it to some other type, we can use the existing type as the divisor and estimate the potential outcome of the type change on each species of game. The ratios also illustrate the ecological differences that can be observed in simple comparisons of the observations per 100 plots. For example, the range in ratio values for deer and grouse is less (0.5 to 1.9 and 0.2 to 5.2, respectively) than for turkeys and squirrels (0.0 to 12.0 and 0.1 to 16.0, respectively). This indicates that turkeys and squirrels have definite forest type preferences, whereas deer and grouse are less exacting. In general, converting one type to another would have more effect on turkeys and squirrels than on deer and grouse.

DISCUSSION

Ideally, coordinated management of timber and wildlife habitat requires knowing animal/habitat relationships (production functions) that can be used to estimate wildlife costs and returns continuously throughout the lives of forest stands. A separate function would be needed for each wildlife species or group of species having similar habitat preferences. This ideal probably is not attainable (Muhlenberg 1964).

However, most experienced observers can estimate some wildlife production capabilities for certain kinds of forest stands. For example, the relationships between deer habitat quality and timber production are fairly well known for some stands.

Unfortunately, few habitat-management studies have concerned more than one wildlife species at a time, and most people tend to be biased toward certain wildlife species. Many managers find it difficult to objectively judge the trade-offs among wildlife species and other forest resources. The availability of numerically rated timber/wildlife relationships would allow a systematic consideration of management alternatives.

We believe that the forest type/game relationships reported here can be useful in evaluating trade-offs. We emphasize that the type ratios are no substitute for judgment. They can be applied strictly to only one area and certain stages of stand development. However, methods and ratios such as those we computed can be used in many ways for comparing management alternatives.

To demonstrate one of these ways, we refer to Table 4 and concentrate attention on gray squirrels and deer because their habitat preferences tend to conflict. The ratios for gray squirrels and deer show many useful relationships. For example, suppose Middle Mountain is to be managed for deer, squirrels, and timber, in that order of priority. The best type for deer is oak-pine (ratios in the oak-pine column all exceed 1.0). But oak-pine is not a particularly stable type; it can be maintained as oak-pine or changed to chestnut oak or yellow pine—three alternatives. Either of the conversions might increase timber production (by varying degrees), but what is each likely to do to deer habitat? The row ratios for oak-pine indicate that among the conversion options the deer objective favors chestnut oak over yellow pine.

At this point, estimated effects on deer of the ecologically feasible alternatives can be compared with economic effects on timber production. If the timber-production effects can be adequately estimated in dollars, the effects on deer can be estimated as opportunity costs in dollars.

But what about squirrels? In this example, they are more important than timber. The row ratios for leaf-nests in the oak-pine type (Table 4) emphasize the obvious; changing the oak-pine type to chestnut oak may strongly improve habitat quality for squirrels, but converting to yellow pine is detrimental to squirrels.

Now, one of the three alternatives—suppressing the pine to change the type to chestnut oak—clearly looks best for deer and squirrels, although not best, by a narrow margin, for deer alone. The next step would be to estimate the timber returns from the chestnut oak option and decide whether it is financially acceptable. If not, other options could be similarly analyzed.

This example is one that an experienced biologist could solve quickly without laboring through the computations. Even so, the computations might be worthwhile for showing the step-by-step logic of his solution to his colleagues, including foresters and the landowner. Most experienced forest game biologists have had recommendations rejected because they were armed only with general opinions, whereas contending experts had facts and figures about forest resources other than wildlife.

Wildlife managers need comparisons of this sort—two or more resources relative to some mutual characteristic such as forest type. Such comparisons can help resolve conflicts among objectives or at least serve as starting points for focusing on more specific management alternatives.

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