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Ruffed Grouse Habitat Requirements

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Habitat Defined

Habitat for a particular species represents the physical and biotic resources (food, cover, water, space) needed for populations of that species to perpetuate. Included in this definition is a consideration of the spatial configuration of those resources and the availability and use of those resources over time. Key life history requirements for ruffed grouse must be linked in space and time in such a way that an individual grouse can successfully move throughout the diurnal cycle, for example, from a nighttime roost site, to a foraging area or a loafing area, and back to a roost site, without undue risk of predation. Similarly, grouse must be able to link seasonal habitat requirements successfully. For example, nesting sites must be linked to brooding habitat so the successful hen can move her brood from the nest to appropriate brood cover without undue risk of predation. In general, the suitability of grouse habitat must be assessed at multiple spatial and temporal scales. In many cases, characteristics of individual habitat patches are not the only determinants of grouse habitat suitability. The interspersion and juxtaposition of these habitat patches are of at least equal importance in determining overall habitat quality.

Various, sometimes confusing, terms have been used to describe the habitat of a particular species. We use the term *habitat use* to indicate a descriptive account of the physical and biotic conditions present where a grouse is located. This can be characterized at different scales. The landscape scale includes the cover types and their spatial arrangement found where grouse are located. At the same time, habitat use can be described at a microhabitat scale, such as the number of saplings per acre found where a nest is located. *Habitat selection* refers to the process whereby an individual chooses the conditions that it occurs in. Habitat selection may occur across scales in a hierarchical fashion, including the geographic range (first order, as described by Johnson 1980), landscape or home range (second order), components within the home range (third order), and micro-site. Microhabitat (vegetation characteristics such as stem density, etc.) would be considered part of third order selection. *Habitat availability* refers to the accessibility and procurability of various habitat components at any given temporal or spatial scale (Hall et al. 1997). *Habitat preference* refers to the end result of the habitat selection process, leading to the disproportional use of some resources over others.

In many cases, it is difficult at best to identify which habitat resources are truly available to any given individual over a given time period. Accounting for what is available, however, is an important part of documenting habitat selection and preference, because habitat preference is determined from a comparison of what is used with what is available. Habitat preference can be expressed in absolute terms (i.e., resource use exceeds, equals, or is less than availability), or preference can be expressed in relative terms (i.e., ranking of relative degree of preference when compared with the other available habitats). Also, habitat cannot only be described in terms of its quantity or relative abundance (usually in terms of area), but also in terms of its quality. Habitat quality is a somewhat elusive concept because it can be defined in numerous ways. From a ruffed grouse perspective, we refer to habitat quality as the ability of the habitat to provide the conditions capable of supporting successful reproduction and/or survival.

Life History Requirements

Ruffed grouse life history strategies are centered on the goal of maximizing reproduction and survival for several different life stages. Each stage may have its own specific habitat needs. In most cases, these habitat requirements differ between males and females because female habitat selection is often linked to maximizing foraging opportunities to maximize condition for reproduction. Males, in contrast, may select more for dense cover for security from predation (Whitaker et al. 2006). At times, differences in habitat selection may also exist between juveniles and adults. Starting in the spring (March–April), mate selection is centered on the drumming site. Drumming habitat availability determines largely where males select drumming sites. An adaptive strategy for nesting females is to select nesting sites away from drumming sites to avoid detection by predators. Apparent random use of mature forest may be a function of nesting in areas where there is a lot of habitat, thus making nest searching by predators more difficult.

After a successful nesting effort in May, the hen moves the newly hatched brood into adjacent areas that meet the brood's needs in terms of cover from inclement weather and predators, and provides invertebrates for food (see brood habitat descriptions in Chapter 4). The brood breaks up in early fall (September) as juvenile grouse begin to disperse. Dispersing juveniles can be found in a wide range of cover types as they move across the landscape and finally establish their permanent home ranges. Finally, in late fall, grouse move into their fall–winter habitats. In years of good mast crops, this may include use of oak-dominated stands. Later in winter, if acorn crops are depleted, grouse seek out a variety of leafy foods (evergreen leaves and ferns) and soft mast resources to sustain them through winter. In years of abundant hard mast (oak acorns and/or beech nuts), grouse may still use these resources until spring green-up (Long 2007). Unlike regions further north, grouse in the Appalachians did not show a strong affinity for use of evergreen-dominated forests for thermal cover in winter for diurnal or nocturnal use (Whitaker 2003). We speculate that the thermal benefits in general were too limited to influence habitat selection patterns. We did observe daily movement to upper slopes prior to roosting in winter. We suspect such movements were tied to energy conservation accrued in slightly warmer upper-slope microclimates compared to cold-air-accumulating lower slopes (Whitaker and Stauffer 2003).

Methods of Habitat Analysis

Tracking radio-tagged grouse throughout the annual cycle served as the basis for documenting grouse habitat use in the Appalachian Mountains. Although the locations of radio-tagged grouse are invaluable for documenting habitat use at various scales, there are some limitations that need to be recognized. As discussed previously, grouse locations are determined usually by means of triangulation and consequently involve some degree of locational error. That error becomes significant when we attempt to attribute a given habitat type to that location. For example, if the area of error associated with a given location covers 2 hectares (5 acres) in extent, that area may actually be composed of more than one habitat type. This is especially true for a species like ruffed grouse that often use areas where there is a high degree of habitat interspersion. As a result, we may not be able to determine exactly which patch of cover the bird was in.

In some instances, grouse habitat can be described without the need to factor in positional errors associated with triangulated radio-tagged grouse. For example, in the case of nesting habitat, the actual nest itself is located so that nest-site habitat can be described in the vicinity around the actual nest without error. This is also true for habitat associated with drumming sites, and in some cases brood habitat when the telemetry gear is used to actually home in and get a visual sighting of the hen and brood.

Habitat Analyses. Three basic approaches have been used to document ruffed grouse habitat use and habitat selection in the Appalachians. We used basic descriptive statistics to describe grouse habitat use based on habitat parameters that were measured in the field (e.g., sapling stems per hectare around grouse nests). In addition to simple descriptive statistics, however, more advanced analyses entail use of statistical tools that allow for comparing habitats used with those that were available. For example, a method called compositional analysis (Aebischer et al. 1993) compares the composition of cover types associated with a grouse location with the total composition of the study area. If grouse select specific cover types to associate with, then the cover types close to grouse telemetry locations may differ from the overall composition of cover types that are available on a given study area.

Landscape-Level Habitat Selection

Habitat Availability. The study sites included in the ACGRP contained a great latitudinal range of habitat conditions in the Appalachian Mountains (from North Carolina to Pennsylvania) though the range of forest types studied was limited to those that grouse regularly occupied. Generally, this was limited to three major forest types: mixed-mesophytic forests, northern hardwoods forests, and more xeric (drier) oak-hickory forests. Although grouse will occasionally use other forest types (e.g., yellow pine stands), the majority of their use is restricted to the above types. Given the history of logging in the Appalachians, nearly all of the forests available to grouse had been previously logged sometime before or shortly after the turn of the twentieth century. In general, most forests on the study sites were middle-aged (40–80 years since logging), with a limited number of young age classes available (generally ~10% of stands were less than 15 years old) and a limited number of older age classes available (generally less than 10% of available stands were over 100 years old) (Table 9.1). Non-forested openings on the study sites were limited to less than 1% by area in most cases. Gated forest roads represented a significant habitat feature used by grouse across all sites, even though the relative area comprised in logging road habitat was limited to less than 5% of the total study area (Table 9.1). Habitat selection by grouse on the AGCRP study was a reflection of what was available on the study sites.

Oak-hickory sites in general were dominated by chestnut, white, red, scarlet, and black oaks, shagbark, pignut, mockernut, and bitternut hickories, white, pitch, Virginia, and table mountain pine, eastern hemlock, red and sugar maple, and beech. Many of these forests were probably also dominated by American chestnut prior to introduction of the chestnut blight during the early 1900s. Mixed-mesophytic sites were co-dominated by red and sugar maple, basswood, sweet and yellow birch, black cherry, white ash, white pine, American beech, northern red oak, eastern hemlock, yellow buckeye, and yellow poplar, depending upon individual site conditions. Northern hardwood forests, generally restricted to higher elevations in the southern Appalachians, were

Table 9.1. Distribution and age classes of forest types available on three Appalachian study sites in Virginia and West Virginia (Endrulat 2003).

		Study Sites					
		VA2		WV1		WV2	
Age Class	Forest Type	Area (ha)	%	Area (ha)	%	Area (ha)	%
0-4	Hardwood	129	4	251	7	7	<1
	Softwood	41	1	0	0	0	0
	Other	1	<1	13	<1	2	<1
5-15	Hardwood	344	10	135	4	255	13
	Softwood	105	3	0	0	0	0
	Other	56	2	0	0	0	0
16-26	Hardwood	539	15	0	0	454	22
	Softwood	0	0	0	0	0	0
	Other	0	0	39	1	0	0
27-90	Upland Hardwood	1984	56	228	4	1181	58
	Cove Hardwood	0	0	215	4	15	1
	Mountain Hardwood	87	3	2489	57	0	0
	Softwood	6	<1	0	0	3	<1
	Mixed	105	3	0	0	2	<1
	Other	0	0	13	<1	6	<1
Roads		123	4	149	4	101	5
Total		3520	100	3532	100	2026	100

dominated by sugar maple, American beech, yellow birch, and black cherry.

In addition to forest type and age class, the spatial configuration of habitat patches is of primary importance to patterns of habitat use exhibited by ruffed grouse. A cover type patch can be defined as a distinct, recognizable area of vegetation that has similar structure and plant species composition throughout. Patches typically are characterized in a given area by different age classes of forest stands or different forest types, and can often be delineated by linear features on a landscape, including roads, streams, and other corridors. Several spatial characteristics of patches define grouse habitat suitability at a landscape scale. *Juxtaposition* refers to spatial arrangement of various cover types. That is, which cover types are adjacent to each other. *Interspersion* refers to the degree to which cover types are intermingled across the management area or landscape. Landscape linkages (corridors) are also important in defining ruffed grouse habitat suitability because linkages facilitate movement between habitat patches on either a diurnal or seasonal basis. Corridors important for ruffed grouse most often include riparian zones, sequential patches of successional forest, and woods roads.

Habitat Use. Ruffed grouse in the Appalachian Mountains can be found in virtually any forest type available, but their greatest densities occur in northern hardwood, mixed-mesophytic, and oak-hickory forests. A difference in how grouse used sites was seen between mesic and xeric (oak) forest types. Grouse, especially females, in oak-hickory forests made greater use of roads and bottomlands than grouse in mixed-mesophytic and northern hardwood forests. Grouse in mixed-mesophytic forests made greater use of clearcuts than in oak-hickory forests (Whitaker et al. 2006). We suspect grouse in oak-hickory forests are more nutritionally stressed than grouse in mesic forest types and, as a result, seek out higher-quality foraging opportunities along roadsides and in riparian zones to supplement the food resources found

What's up with oaks?

It is clear that the ecology of ruffed grouse in the Appalachians is influenced by oaks, and we thus need to understand something of this group of trees. As a group, oaks are arguably one of the most ecologically important trees in the continental United States. At least 58 different species of oaks occur within the United States, and their range includes most of the country, with the exception of the central and northern Rockies. In the eastern United States, and especially in the central and southern Appalachian regions, oaks are the most common trees found in many forest stands. Portions of the central and southern Appalachian region contain a tremendous diversity of oak species (15 or more), some of the greatest concentrations of different species found throughout the oaks' range.

The oaks can be divided into two broad groups: the red oak group and white oak group. These divisions are based on differences in the flowering and acorn production characteristics between these two groups. The white oak group produces mature acorns in the fall from flowers that were present on the tree during the spring of that same year. Species belonging to the red oak group produce acorns from flowers that bloomed during the spring of the previous year. Common species within the red oak group include northern red oak, black oak, and scarlet oak. Other less common species include southern red oak, pin oak, and blackjack oak. The species in the white oak group most common to the central and southern Appalachians include white oak and chestnut oak. Others in the white oak group include the swamp white oak, chinkapin oak, post oak, and burr oak. In the eastern United States, red oak species tend to be slightly more abundant than those within the white oak group.

In the Appalachian region, oaks within both species groups tend to be most prevalent on drier, upland sites, such as hillsides and mountaintops having a southern, western, or southwestern exposure. Oaks tend to dominate these sites, comprising most or all of the trees present within the stand. However, they also can be a component of forest stands having a northern or eastern exposure, as well as stands found in the valleys and deep stream ravines common throughout the Ridge and Valley regions of the central and southern Appalachians. In these areas, oak species generally are evenly mixed with other tree species or are minor components of the overall forest stand.

One of the most ecologically interesting and valuable aspects of oaks is acorn production. Acorns serve as a critical food source for over 100 different species of wildlife, from white-tailed deer and black bear to chipmunks and deer mice. Even some songbird species such as blue jays eat acorns. Acorns within both species groups have a high-energy content and are easily digested. Those within the white oak group have a greater palatability than those of the red oak group, presumably because of the higher tannin levels present in red oak acorns. Tannins, which belong to a group of chemical compounds called phenols, give red oak acorns a bitter taste and they can interfere with various digestive and physiological functions in animals. Because most upland game birds lack a sense of smell, they typically select acorns based on their size rather than their taste or tannin content.

Acorn production varies considerably from tree to tree within the same species (for example, two white oaks or two red oaks). Some trees periodically produce very large crops in some years and have few or no acorns in other years. Other trees are consistently poor producers and have few if any acorns every year, even when other trees of the same species in the same stand have a large crop. Some trees appear to be genetically predisposed to having good acorn crops in years having favorable conditions for production while others are predisposed to producing few if any acorns regardless of other factors.

Acorn production across a forest stand for both the red and white oak species groups also varies considerably from year to year. Some years are "boom" years with large acorn crops within one or both species groups. Other years are "bust" years with little or no acorn production in one or both groups, and some years fall in between. The boom and bust crop years can occur in a somewhat cyclic pattern that is referred to as masting. Within the white oak group, good acorn crop years occur roughly every two to three years, and in the red oak group they occur about every five to six years. However, because some acorn production occurs almost every year and many factors influence acorn production within a forest stand, these boom and bust cycles are often difficult to detect. Several climatic factors, including spring temperatures when flowers are present, summer rainfall during the growing season, and frost events influence annual acorn production across forest stands and contribute to the annual variability in production patterns.

The pattern of acorn production within individual species groups in a given year is very similar across a large geographic area. Studies have shown that acorn production patterns from year to year are similar in forest stands separated by 300 miles or more. This broad geographic similarity in acorn production is referred to as ***synchrony*** and has been documented within both the red oak and white oak species groups. However, because of the differences in the flowering and acorn production characteristics that exist between these two groups, they rarely follow the same synchronous patterns.

The gypsy moth can be considered the most damaging agent to oaks in the Appalachian region. Gypsy moths are native to Europe and Asia, and were introduced into the United States in Massachusetts in 1868. Their range has continued to expand, with their southern extent reaching West Virginia, Virginia, and North Carolina. Gypsy moth caterpillars repeatedly defoliate trees and have killed oaks, especially northern red oak, in a wide area in the northeastern United States. Oak trees can recover from a single defoliation, but may be weakened enough to make them more susceptible to damage and death from other diseases or insects. Acorn production also will fail during years of moderate to heavy defoliation.

If left unmanaged, mature oak stands will gradually transition to stands dominated by other tree species, including maples, American beech, and black gum. Seedlings and saplings of these species tolerate the shaded understory beneath a stand of mature oak trees and can persist in the forest understory for long periods. Most oak species are considered either shade intolerant or intermediately shade tolerant, thus they do not survive as well in the shade as shade tolerant species. Maintaining oaks in a forest system requires active management, and some means to manage for oaks are described in Chapter 13.

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on the drier ridges and slopes. Grouse in mixed-mesophytic forests, in contrast, can afford to seek out habitats offering more cover (i.e., clearcuts) because of the lower levels of nutritional stress.

The age of forest stands and their juxtaposition, interspersion, and linkages are important predictors of relative use. Young forests (6–20 years old) provided the cornerstone of grouse habitat use on AGCRP study sites. Such early successional forests were selected in almost all cases, with stronger selection being shown by males and occurring when availability of young forests was rare on the landscape (Whitaker et al. 2006). In North Carolina, male and female grouse selected forest stands that were young (6–20 years old) and generally located on transitional sites close to upper-slope dry sites and lower-slope moist sites. The spatial configuration and size of cover-type patches appears to be important in defining habitat suitability for Appalachian ruffed grouse. Grouse in Virginia selected home ranges that had forest patch sizes smaller than the average for the study areas and in areas with greater than average amounts of edge between different patches of cover (Fearer and Stauffer 2004). Grouse in Virginia also selected for areas with greater than average cover type diversity. Grouse in North Carolina had smaller home ranges (i.e., they found all of their habitat requirements over a smaller area) in watersheds that had greater juxtaposition of selected cover types (midslope transition stands that were 6–20 years old). North Carolina grouse also had smaller home ranges when gated forest roads intersected these preferred habitats. These results have obvious implications for how managers and landowners might approach managing their forests for ruffed grouse.

Microhabitat Selection

Drumming logs. Male grouse select drumming sites usually adjacent to and above logging roads that traversed the study sites. In North Carolina, the logs actually selected for drumming were not unique in size and location when compared to other logs available on the study area (Schumacher et al. 2001; Table 9.2). Drumming sites were characterized by a display platform 30–45 centimeters (14–16 in) in height. These conditions were most often met on downed trees; however, other platforms such as rocks may be used on occasion. Drumming sites were located in areas with greater midstory densities and vertical cover than logs that were available randomly in the area. We found 85% of the drumming logs to be on or near a ridge top in mature (more than 40 years old) forest stands and significantly closer to gated forest roads than logs located at random in the forest. In spite of the fact that most drumming logs were in mature stands, male grouse made significant use of clearcuts during the breeding season (Whitaker et al. 2006). Thus juxtaposition of mature stands with clearcuts is important for male breeding season habitat selection. The drumming site is the focal point in a male's home range, and is used in both spring and fall. In most cases, however, the availability of potential drumming logs themselves did not limit grouse distributions on ACGRP study sites. Drumming sites, however, were selected in specific locations on the landscape, presumably because they were positioned to maximize potential contact with females during the breeding season while minimizing potential for predation.

Table 9.2. Average habitat characteristics for drumming logs and random logs located on Wine Spring Creek Ecosystem Management Area, North Carolina, 1999–2001 (Schumacher et al. 2001). Vertical vegetation density and mid-story density were significantly different between drumming logs and random logs. From these data it is clear that males are selecting logs that have greater density of vertical vegetation and mid-story stems.

Habitat Variable	Drumming logs	Random logs
Height (cm)	50.0	51.9
Diameter (cm)	50.5	52.8
Length (m)	8.3	7.6
Slope (%)	26.9	28.3
Moss Cover (%)	34.8	44.6
Vertical Vegetation Density (%)	41.4	25.7
Basal Area (m^2/ha)	15.4	18.1
Understory Density (stems/ha)	12,433	10,302
Mid-story Density (stems/ha)	6,805	3,438

Nest Sites. Hens selected nest sites generally from whatever forest types were available on the area. Nest-site selection appears to be more related to structural habitat characteristics than forest species composition. Appalachian grouse nested in forest stands with greater basal areas and also in stands with significantly more coarse woody debris (logs and tree limbs on the ground) than average conditions on the study area (Tirpak et al. 2006, Table 9.3). Selection for these characteristics makes biological sense because hens place nests under or against logs, stumps, or living trees. In addition, nests tended to be closer to roads than other locations within the hen's home range; 55% of nests were located within 10 meters of a road compared to only 17% of systematic points within the hen home range were within 10 meters of a road (Table 9.3). Selection for roadside nesting sites may reflect the desire to use roads as corridors for foraging while the hen is incubating, and for moving the brood from the nest site to high quality brood habitat.

Table 9.3. Habitat characteristics at nest and systematically located sites, 1995–2002 (Tirpak et al. 2006). The data are based on 73 nest sites and paired samples located on 5 study areas.

Habitat Variable	Mean Values	
	Nest Site	Systematic Site
Basal area (m^2/ha)	24.7	19.7
Deciduous canopy cover (%) of trees (≥8 cm dbh)	80.8	83.5
Coniferous canopy cover (%) of trees (≥8 cm dbh)	5.1	6.5
Ground cover (% herbaceous or woody vegetation ≤1m tall)	47.2	49.8
Coarse woody debris cover (% dead woody vegetation ≥15 cm diameter)	17.3	9.2
Stems (<8 cm dbh and ≥1.5 m high)/ha	13,382	10,701
Distance to road or opening class (%)		
Close (<10 m)	54.8[a]	17.2
Moderate (11–100 m)	20.5	74.5
Far (>100 m)	24.7	8.3
Timber size class (%)		
Sapling (<12.5 cm dbh)	34.2	38.2
Pole (12.5–27.8 cm dbh)	37.0	35.6
Sawtimber (>27.8 cm dbh)	28.8	26.3
Midstory (>1 m high to bottom of canopy) volume class (%)		
Open (<20%)	28.8	3.5
Moderate (20–50%),	67.1	90.0
Closed (>50%)	4.1	6.5
Understory (≤1 m high) volume class (%)		
Open (<20% woody and <30% herbaceous)	49.3	43.5
Herb (>30% herbaceous vegetation)	31.5	37.5
Wood (>20% woody vegetation)	19.2	19.0
Slope class (%)		
Gentle (0–10%)	43.8	49.1
Moderate (11–30%)	47.9	44.8
Steep (>30%)	8.2	6.1

[a] represents the percent of total within each class of variable.

Brood Habitat. The brood period is critical for grouse population recruitment and brood survival is a key factor limiting population growth, therefore habitat use during this period is very important. Brood habitat is influenced by the needs of the grouse chicks during late May–August to locate invertebrates and succulent, green vegetation for food while avoiding potential predators. To meet these needs, hens in the Appalachians move broods into areas with well developed herbaceous understories that support relatively high invertebrate densities under well-developed overstory canopies and modest understory woody stem densities (Table 9.4). This pattern is different from studies conducted within the range of aspen in the Lake States, where brood habitat is often characterized as areas with high sapling stem densities (Gullion 1977, Kubisiak 1978). In the Appalachians, there are areas in the forest with greater stem densities than those selected by hens as brood habitat. However, it is the balance between cover (moderate stem densities and herbaceous cover) and food (invertebrates) that hens appear to seek. These conditions, as a result, are somewhat unique in typical Appalachian forests. Broods frequently move great distances from nest sites to reach these preferred conditions for the brooding period. Often these movements are tied to the presence of forest roads and other natural corridors traversing the forest. These movements often have survival consequences, as broods that don't travel as far tend to experience greater survival rates (Tirpak et al. 2005). Thus, good interspersion and juxtaposition of nesting habitat with brood habitat has positive survival benefits for grouse.

Table 9.4. Brood habitat characteristics in North Carolina (Fettinger 2002) and Virginia–West Virginia (Haulton et al. 2003) compared with random points located within 100 m of brood locations.

Habitat Variable	North Carolina		Virginia–West Virginia	
	Brood Mean	Random Mean	Brood Mean	Random Mean
Basal Area (m^2/ha)	20.7	20.9	15.9	17.7
Canopy Cover (%)			82.0	81.0
Saplings (stems/ha)[a]	5975	4598	3822	3581
Ground Cover (%)[b]	54.0	37.0	62.0	49.0
Vertical Cover (%)	55.0	44.0		
Distance to Road (m)	130.0	111.0		
Distance to Opening (m)	444.0	446.0		
Distance to Cut (m)	56.0	58.0		

[a] Saplings defined as < 11.4 cm dbh in NC and <8 cm dbh in VA-WV.
[b] Ground cover included only herbaceous plants in NC, and included herbaceous and woody in VA-WV.

Fall dispersal. Fall represents a critical time period during which broods break up and juvenile grouse disperse. Habitat use at this time can be described based on what juveniles are selecting as opposed to what adult grouse with established home ranges have previously selected. In North Carolina, juvenile and adult females selected similar habitat types during the fall (Jones 2005). Although juvenile females were dispersing, they still showed similar habitat selection patterns as their adult counterparts. In contrast, juvenile males showed substantial differences in habitat selection from adult males. Adult male habitat selection during fall in North Carolina was similar to what was observed throughout the annual cycle, selecting for young (6–20 year old) stands, usually associated with roads (Jones 2005). Juvenile males, in contrast, showed little tendency to select for particular habitats at all; juvenile male habitat use did not differ from what was available on the study area in general. Based on these results, a picture emerges of adult males staying in their home ranges associated with their drumming sites, perhaps to maintain their territorial dominance of that area, as juvenile males are seeking potential sites of their own (Whitaker 2003). Juvenile males, excluded from already occupied adult male territories, disperse across the landscape, seeking out areas with vacant territories to settle. All grouse during this period show preference for use of gated forest roads. Even in the case of juvenile males, roads may serve an important function as dispersal corridors. By December, the fall shuffle is complete and most juvenile males have settled into their permanent home ranges.

The availability of hard-mast crops influences fall habitat selection by ruffed grouse. Selection of forest roads, particularly by female grouse, was stronger during fall–winter if mast crops were poor (Whitaker et al. 2006). Roads may provide important alternate foraging habitat for grouse during fall, especially when hard mast is limited.

Winter. Grouse habitat requirements during winter are associated with meeting nutritional needs while avoiding predation. In North Carolina, habitat use did not differ by age class; juvenile grouse settled into home ranges that were very similar to those of adults. Males consistently continued to select young xeric stands (6–20 years old) associated with roads (Jones 2005). Selection in winter for high stem densities undoubtedly is related to the need for cover for predator avoidance. Elsewhere in the Appalachians, male grouse selected mesic bottomlands during the non-breeding season, including winter. This pattern of habitat selection may have been influenced by increased foraging opportunities in this cover type in winter, especially in poor hard mast years (Whitaker et al. 2006). In contrast, females used a broader cross range of age classes of stands, but still were generally associated with xeric stands and roads. Because females are not tied to a particular site or territory during this time of year, they have the ability to use a larger home range that encompasses a greater range of habitats, in association with pursuing optimal foraging strategies. Female habitat selection in winter must balance the need for maximizing nutritional gains in preparation for the upcoming breeding season with the need to avoid predators.

In summary, throughout the year, ruffed grouse reflect their classification as a "forest grouse." They require a diversity of forest stand ages to meet their needs on an annual basis; but, it is clear that the highest quality grouse habitat will have a relatively large proportion of young (6–20 years) forest present, along with some high-quality herbaceous cover to support broods and more mature stands for breeding. When we consider particular locations within the stands, our detailed microhabitat measurements confirm that denser is better. Reducing all the arcane habitat measurements and statistical analysis to something practical, we get: The more difficult it is to walk through, the better the habitat is.