Vegetation Characteristics in Seasonal-disked Fields and at Bobwhite Brood Locations

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Abstract: Disking fallow fields is a management practice commonly used to promote early successional habitats for northern bobwhite *(Colinus virginianus)* broods. However, effects on habitat value for bobwhite broods from different seasonal timing of disking is poorly understood. We compared vegetation composition and structure among fall-disked fields (*N*=24), spring-disked fields (*N*=26) and bobwhite brood locations determined by telemetry (*N*=22 broods). Both disking treatments produced more bare ground and visual obstruction than brood locations. In a joining cluster analysis based on vegetation structure, neither spring-disked nor fall-disked fields were grouped with broods. Ground coverage in disked fields tended to be dominated by a few species, but plant community composition differed between fall-and spring-disked fields. Spring disking promoted agronomic weed species such as *Senna obtusifolia* and *Crotalaria spectibilis* which have little food value to quail. Fall disking promoted important food plants for bobwhite, including *Ambrosia artemisiifolia* and *Rubus* spp. Fall-disked fields and broods were grouped serparately from most spring-disked fields in a joining cluster analysis based on vegetation composition. On our study site, use of annually disked fields by broods (*N*=22) was low (<5% of locations) relative to use of open-canopy pine (*Pinus* spp.) forests (88% of locations). We recommend fall-disking over spring-disking to promote important food plants for bobwhite. However, neither of the disking treatment provided habitat used by broods on our study area.

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In the southeastern United States, early successional plant communities provide northern bobwhite (hereafter bobwhite) broods with essential resources including invertebrates, seeds, and protective cover. Quail managers implement disturbance regimes to create and maintain these essential early successional habitats. Disturbance not only influences plant community composition and invertebrate resources, but also plant community structure, which may influence accessibility of food resources to bobwhite and efficacy of protective cover.

Disking is a common management practice used to create early successional plant communities for bobwhite chicks (Stoddard 1931, Rosene 1969, Burger et al. 1990, Manley et al. 1994). Disking is thought to create a plant community composition and structure suitable for bobwhite chicks because it inhibits woody growth, promotes favored seed producing plants, reduces plant residue, increases bare ground, and increases insect abundance (Stoddard 1931, Scott and Klimstra 1954, Rosene 1969, Manley et al. 1994). However, the season when soil disturbance occurs may affect both structure and composition of the resulting plant community (Rosene 1969, Landers and Mueller 1986, Lee 1994). Plant composition and structure influence type and abundance of seeds and invertebrates available to bobwhite (Southwood et al. 1979, Schowalter 1985). Therefore, seasonality of soil disturbance could be important to habitat suitability of disked areas for bobwhite.

Recent changes in land management philosophies on public lands have resulted in less soil disturbance in upland forests. On public lands, fields are often the only areas where soil disturbance is practical. On private lands managed for bobwhite, disking fields to promote annual weeds is a common management practice to create brood habitat. Therefore, on both public and private lands, information is needed on suitability of plant communities to bobwhite broods from various disking treatments. Therefore, our objectives were to compare the vegetative characteristics of fields disked during October–November or March–April to vegetation at bobwhite brood locations.

The study was conducted on Tall Timbers Research Station (TTRS) located in Leon County, Florida. TTRS consists of 1,300 ha of rolling pine forest (62%) with hardwood drains (21%) and fallow fields (13%). Loblolly *(Pinus taeda)*, shortleaf *(P. echinata)*, and to a lesser extent longleaf *(P. palustris)* pines and live oak *(Quercus virginiana)* compose the dominant tree overstory on upland sites, whereas sweetgum *(Liquidambar styraciflua),* oak (*Q.* spp.), hickory (*Carya* spp.), American beech *(Fagus grandifolia),* and southern magnolia *(Magnolia grandiflora)* compose the dominant tree overstory in drains and hammocks. Basal area of pine stands was 5–15 m^2/ha, which is characteristic of open, park-like forests in the Red Hills region. Prescribed fire was used to manage upland pine forests on a 2- to 3-year rotation.

Methods

We randomly assigned 50 fields ranging in size from 0.8–10.1 ha to spring (N=26) or fall (N=24) disking treatments. Fields were disked during October–November 1995 or March–April 1996. We disked fields until most of the vegetation was incorporated into the soil, leaving a homogeneous surface of bare soil.

We captured bobwhites in February–March 1995 and 1996 using baited funnel traps. Each quail was leg banded and radio-tagged using 6-g necklace transmitters. We located broods 4 times daily on 2-hour intervals, alternating first location time between morning (0700 hours) and afternoon (1300 hours). We randomly picked and flagged a daily brood location to measure vegetation characteristics. Individual brood locations were sampled, regardless of habitat type, and pooled from hatch to 43 days.

We measured vegetation structure, composition, density, and ground cover once in each field during July. A 40-m transect was located within each field starting 15 m in from a corner and running diagonally toward the opposite corner. We sampled vegetation at 10-m intervals from the beginning of the transect, with 2 sub-sample points perpendicular to the transect (sub-samples per field=10). At each sub-sample point, we estimated canopy cover, plant composition, and average vegetation height. At 5 sub-sample points, we also measured vegetation density and ground cover.

We measured canopy cover using a 0.25 m^2 grid (0.5 m × 0.5 m) composed of 200 cells. The grid was placed at the predominant canopy height and the number of cells that were obstructed by living vegetation recorded. Vegetation composition was determined by counting the number of cells obstructed by individual plant species regardless of canopy strata. Vegetation density (visual obstruction reading [V.O.R. 1 and V.O.R. 2]) was estimated using a Robel pole (Robel et al. 1970) from 4 cardinal directions. We recorded 2 readings from each direction (4 m away from the pole at a height of 1 m and 0.5 m). Ground cover (% bare and % debris) was determined using a line intercept on 1-m transects centered on the subplot.

To estimate vegetation characteristics at brood locations, 1 daily telemetry location was randomly selected until the brood was 6 weeks of age. Birds were flushed at 21 and 42 days of age and after any inconsistent large movements to verify if the adult was still with chicks. Vegetation characteristics at brood points were sampled within 1 week of the date the brood used the location. We sampled vegetations at 5 sub-sample points, including the estimated brood location and then 4 m away in each cardinal direction. At each sub-sample point, we characterized vegetation structure and composition using the same methods described for fields.

Plots within fields and locations within broods were treated as subsamples. Vegetation data was averaged for each field or brood and mean values were used in analyses. Plant genera with mean coverage <2% of treatments (brood, spring, or fall) were combined to form a miscellaneous category. We used MANOVA to determine treatment effects on structural variables (V.O.R. 1, V.O.R. 2, mean plant height, canopy cover, % bare ground, and % debris ground cover). Percentage bare ground and debris were not normally distributed (various transformations were unsuccessful at normalizing distributions). Newman-Kuels post-hoc comparisons were used to compare individual treatment differences. We used distribution-free statistics in comparisons among field treatments and brood locations for plant composition variables which did not meet distributional assumptions of ANOVA. A Kruskal-Wallis ANOVA by ranks and median test was used to detect differences among the 3 treatments for each genus. If significant differences were detected, Mann-Whitney *U* tests were used to examine differences among treatments.

We used joining cluster analysis (StatSoft 1996) to join cases (individual broods and fields) into similar groups using structural and compositional variables. Groupings demonstrate the level of differences/likenesses between treatments in multidimentisonal space and gives a visual representation of the treatment's similarities. A separate analysis was conducted using both vegetation structure and vegetation composition data. Chebychev distance measure and Ward's method amalgamation rule were used in all cluster analyses. This distance measure helps define 2 objects as

Table 1. Comparison of vegetation structure characteristics among bobwhite broods (N=22), spring-disked fields (N=26), and fall-disked fields (N=24) at Tall Timbers Research Station, Florida, 1995–1996.

Treat/Response variable	Brood	Spring	Fall
V. O. R. 1	45.34A[a]	69.51B	90.6C
V. O. R. 2	66.41A	117.86B	127.49B
% bare[b]	16.72A	57.93B	44.38C
% debris[b]	71.50A	41.27B	54.47C
Avg. hgt.	47.10A	52.41A	52.57A
Canopy	92.71A	97.06B	91.92A

a. Means followed by different letters are significantly different, Newman-Keuls test, $P < 0.05$.

b. The response variables were not normally distributed.

"different" if they are different on any 1 dimension. Ward's method amalgamation rule uses an analysis of variance approach to evaluate the distances between cases.

Results

Bobwhites with broods (N=22) were most often located in pine stands burned either during the dormant season (39% of locations) or during the growing season (49% of locations). About 10% of locations were in disked fields, 4.8% in spring-disked fields, and 4.5% in fall-disked fields.

Structural variables differed among brood locations, spring-disked fields, and fall-disked fields (Wilk's Lambda = 0.246, df =12, P<0.001). Brood locations had less bare ground and lower vegetative density at 1 and 0.5 m than either disking treatment (Table 1). Spring-disked fields had more bare ground and more herbacious canopy closure than either fall-disked fields or brood locations. There was no difference in average vegetation height between brood locations and either disking treatment.

Plant composition of disked fields was dominated by a few genera, whereas plant composition at brood locations was more evenly distributed among genera (Table 2). Spring-disked fields were dominated (>10% coverage) by *Senna obtusifolia, Cyperus* spp., *Diodia teres,* and *Richardia scabra.* Fall-disked fields were dominated (>10% coverage) by *Senna obtusifolia, Cyperus* spp., *Diodia teres,* and *Richardia scabra.* Fall-disked fields were dominated by *Ambrosia artemisiifolia, Rubus* spp., and *Solidago* spp. Only 2 genera (*Campsis radicans* and *D. teres*) did not differ among brood locations, spring-disked fields, and fall-disked fields. There was no difference in coverage of *Chamaecrista fasciculata* and *Desmodium* spp., between disking treatment. Plant species with mean coverage >20% that were more prevalent in fall-disked fields included *Acalypha gracilens, Conyza canadensis, Oxalis stricta, Panicum* spp., and *Trichostema dichotomum.* Plant species with mean coverage >20% that were more prevalent in spring-disked fields included *Crotalaria spectibilis, Digitaria* spp., *Ipomea* spp., and *Jacquemontia tamnifolia.*

Cluster analysis performed on structural data did not consistently group spring-

Table 2. Comparison of vegetation composition among bobwhite brood locations (N=22), spring-disked (*N*=26), and fall disked fields (*N*=22), on Tall Timbers Research Station, Florida, 1995-1996.

	Kruskal-Wallis		Mann-Whitney *U*							
Genus	Chi-square	*P*-level	Brood mean	*P*-level[a]	Spring mean	P-*level*[b]	*Fall mean*	*P*-level[c]
Acalypha gracilens	9.213	0.010	0.649	0.572	0.323	0.000	4.042	0.001
Ambrosia artemisiifolia	25.673	0.000	4.639	0.271	8.185	0.000	38.988	0.000
Andropogon spp.	23.376	0.000	5.920	0.015	0.000		0.000	0.017
Campsis radicans[d]	0.839	0.657	8.491	n/a	11.358	n/a	13.267	n/a
Senna obtusifolia	30.810	0.000	0.463	0.000	36.161	0.000	5.775	0.000
Centrosema virginianum	29.495	0.000	6.423	0.000	19.462	0.330	2.242	0.000
Chamaecrista fasciculata	9.430	0.009	13.339	0.028	8.480	0.531	7.754	0.012
Conyza canadensis	18.478	0.000	1.318	0.025	4.211	0.000	11.191	0.001
Crotalaria spectibilis	30.278	0.000	1.032	0.000	15.085	0.000	3.138	0.001
Cyperus spp.	22.037	0.000	6.073	0.000	110.946	0.000	18.225	0.009
Desmodium spp.	11.898	0.003	5.586	0.001	1.889	0.110	3.888	0.102
Digitaria spp.	8.902	0.012	0.541	0.096	12.627	0.014	0.367	0.299
Dioda teres[d]	5.370	0.068	3.775	n/a	26.373	n/a	12.975	n/a
Helianthus spp.	23.827	0.000	4.845	0.000	0.085	0.544	1.238	0.003
Ipomea spp.	19.341	0.000	0.401	0.000	8.550	0.048	4.225	0.000
Jacquemontia tamnifolia	13.128	0.001	0.299	0.000	19.481	0.027	2.833	0.037
Oxalis stricta	36.930	0.000	0.395	0.573	1.142	0.000	8.404	0.000
Panicum spp.	15.421	0.000	6.384	0.000	1.342	0.001	6.809	0.957
Paspalum spp.	6.597	0.037	3.294	0.055	16.869	0.931	7.988	0.046
Piriquet aublet	6.593	0.037	0.000	0.505	0.331	0.424	5.229	0.151
Pityopsis graminifolia	50.579	0.000	6.000	0.000	0.000		0.000	0.000
Quercus spp.	54.546	0.000	6.724	0.000	0.000		0.000	0.000
Rhus copallinum	48.727	0.000	12.148	0.000	0.000	0.133	1.392	0.000
Richardia scabra	15.422	0.000	0.740	0.000	24.073	0.000	1.525	0.389
Rubus spp.	25.842	0.000	16.109	0.659	18.450	0.000	55.921	0.000
Smilax spp.	41.014	0.000	6.400	0.000	0.308	0.470	0.546	0.000
Sorghastrum spp.[e]	46.758		6.471	0.000	0.000		0.000	0.000
Solidago spp.	32.843		11.662	0.000	2.689	0.000	40.854	0.000
Trichostema dichotomum	14.129	0.001	0.445	0.035	0.223	0.004	6.096	0.145
Miscellaneous	11.911	0.003	3.720	0.253	13.739	0.284	1.867	0.004

a. *P*-level for H_o: brood=spring.

b. *P*-level for H_o: spring=fall.

c. *P*-level for H_o: fall=brood.

d. Kruskal-Wallis results of Ho: brood=fall=spring were not significant.

e. Johnson grass *(Sorghastrum halepense)* was not found.

or fall-disked fields with brood locations (Fig. 1). However, the same analysis performed on plant composition data linked primarily fall-disked fields with broods (Fig. 2).

Discussion

Plant composition in disked fields was generally dominated by a few species. Fall-disked fields were dominated by *A. artemisiifolia* and *Rubus* spp., 2 genera considered important as food and cover plants for bobwhite (Stoddard 1931, Rosene 1969). Spring-disked fields were dominated by less desirable species such as *C.*

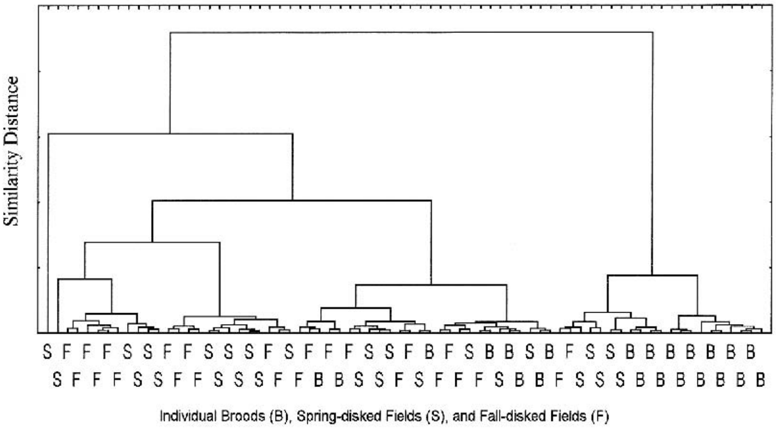

Figure 1. Tree plot resulting from joining cluster analysis of structural variables (V.O.R. 1, V.O.R. 2, avg. hgt., canopy cover, % bare ground, %debris on ground) from broods (B) (*N*=22), spring disked fields (S) (*N*=26), and fall disked fields (F) (*N*=24) on Tall Timbers Research Station, Florida, during 1995 and 1996. Individuals grouped at lower linkage distances are more similar.

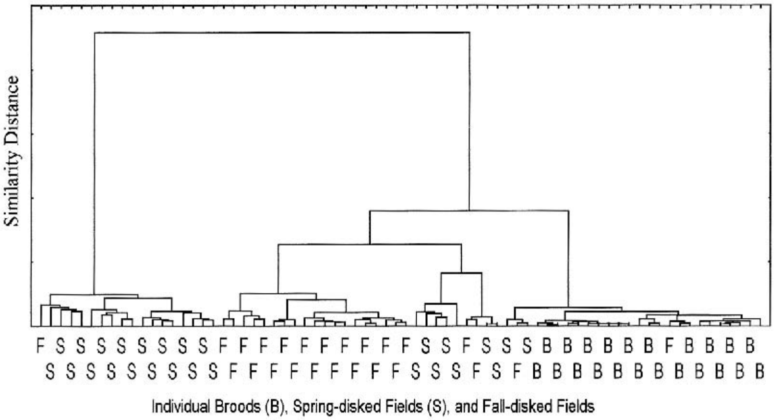

Figure 2. Tree plot resulting from a joining cluster analysis of plant compositional variables from broods (B) (*N*=22), spring-disked fields (S) (*N*=26), and fall-disked fields (F) (*N*=24) on Tall Timbers Research Station, Florida, during 1995 and 1996. Individuals grouped at lower linkage distances are more similar.

spectibilis, S. obtusifolia, and *Cyperus* spp. These species have little food value and may be toxic for bobwhite (Graham 1941). These results are consistent with replicated plots on TTRS that have been disked in the same months for over 20 years, suggesting that these plant community responses are sustainable for decades. Similarly, Olinde (2000) reported that disking during November or February increased food plants for bobwhite relative to disking in May. Similar to our results, Olinde (2000) reported lower abundance of native grasses and no change in native legume abundance for disked areas relative to pine forests. These results are not surprising because the regular use of fire may have promoted legume growth in both of these upland forest systems.

Unlike disked fields, areas used by broods were not dominated by a few species of plants but rather a diverse group of species. Cluster analysis indicated that composition of fall-disked fields more closely resembled composition of plants at brood locations than did spring-disked fields. However, disked fields lacked bunch grasses, such as *Andropogon* spp. And *Sorghastrum* spp., and woody vegetation found at brood locations. Taylor and Burger (2000) reported that woody vegetation was an important habitat component for broods on their study area.

Neither disking treatment produced a vegetation structure entirely similar to that at brood locations. While vegetation heights and canopy coverage were similar, brood locations had less bare ground and greater visibility than vegetation produced by either disking treatment. Bare ground is considered an important component of brood habitat for bobwhite quail (DeVos and Mueller 1993, Taylor and Burger 2000). Percentage bare ground (16.7%) was within the range reported in other studies (Speake and Sermon 1986, Devos and Mueller 1993, Puckett et al. 2000, Taylor and Burger 2000).

Low use of disked fields by broods on TTRS is contrary to results reported from telemetry studies of bobwhite broods in upland pine forests in south Georgia (Yates et al. 1995). In that multi-year study, 39%–55% of bobwhite brood locations were in fall-disked fields dominated by *A. artemisiifolia* (Yates et al. 1995). On the south Georgia sites studied by Yates et al. (1995), insect abundance in fallow disked fields was higher than that in burned or unburned pine forest. As a result, bobwhites may have been more attracted to fallow fields on the Georgia sites than in our study. Differences in ground cover composition and structure in upland pine forests between the south Georgia sties and TTRS may also explain differences in selection for fields by broods. Clay-dominated soils associated with TTRS quickly produce a diverse and lush groundcover that apparently provides suitable brood habitat throughout the upland pines. Soils on the Yates et al. (1995) study have a greater sand and lower clay content compared to TTRS. Groundcover vegetation in upland pine forests on their study areas were dominated by sparse grasses and hardwood shrubs that provide less overhead cover. Therefore, *A. artemisiifolia* dominated fields provided overhead cover on their study areas which may be missing in the upland pine areas.

In conclusion, fall-disking promoted important food plants for bobwhite, whereas spring-disking promoted less desirable species. Other than the toxic weeds, *S. obtusifolia* and *C. spectibilis,* there was no difference in other legume species between spring and fall-disked fields. Key habitat components of brood habitat, namely bunch grasses and woody vegetation, were lacking in disked fields. The low use of disked fields by broods on our study area suggests that although early successional habitats are essential brood habitats, disked fields should not be universally considered an important brood habitat in the Red Hills region of south Georgia and north Florida. However, this vegetation type may be locally important if alternative habitats with adequate overhead cover and invertebrate resources are limited.

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