Forest Clearings Management: Insects and Vegetation for Wild Turkey Broods

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Abstract: Insects and herbaceous vegetation important to young eastern wild turkeys *(Meleagris gallopavo sylvestris)* may be enhanced in forested areas by managing clearings. Natural resource agencies in Virginia and other eastern states have committed significant resources to create and maintain forest clearings to provide habitat for wild turkey broods in predominantly forested areas. However, techniques used to manage clearings often lack definitive ecological justifications. We compared effectiveness of 4 management regimes on forest clearings typical of those used by wildlife managers in the eastern United States to produce insects and vegetation beneficial to turkey broods. Ranging from low to high intensity in development and maintenance, treatments were 1) mowing; 2) disking and liming; 3) planting ladino clover *(Trifolium repens latum)*, mowing, and liming; and 4) planting a perennial grass-forb mixture, mowing and liming. Insect production did not differ between high intensity (3 and 4 above) and low intensity (1 and 2 above) treatments (P=0.19). Mowing may have suppressed insect numbers briefly before increasing them, while disking apparently delayed insect production. We observed several year and period differences in insect dry weights perhaps attributable to timing of vegetation treatments or natural environmental fluctuations. Areas receiving high intensity treatments had higher clover cover estimates (P=0.081) and more plant species per plot (P=0.036). All treated areas had adequate brood vegetation dry weight, plant height, and herbaceous cover estimates. Herbaceous vegetation and insects associated with forest clearings may be important for other wildlife species besides wild turkeys. Managers should consider effects on all species of interest as they weigh potential gains from intensive management practices against the extra cost and labor involved with those treatments. Managers can promote herbaceous ground cover and insects useable by wild turkey broods with simple, low-intensity management techniques.

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Insects are important food items for wild turkey poults (Hamrick and Davis 1971, Blackburn et al. 1975, Hurst and Stringer 1975m Healy 1985) and adults (Dalke et al. 1942, Barwick et al. 1973, Exum et al 1987). Insects are most critical to turkey poults during the first few weeks after hatching (Blackburn et al. 1975; Hurst and Stringer 1975; Healy 1978, 1985). Coleopterans (beetles), homopterans (aphids, leaf hoppers), orthopterans (grasshoppers, crickets), hemipterans (true bugs), and lepidopterans (butterflies, moths) are particularly important to wild turkey poults (Hamrick and Davis 1971, Barwick et al 1973, Hurst and Stringer 1975, Healy 1985).

Availability of insects may be important in turkey brood habitat selection (Healy 1978, 1985). Wild turkey broods use an array of habitats from permanent openings to savannas to forests (Blackburn et al. 1975, Hayden 1979, Pack et al. 1980). Studies in upland, deciduous habitats suggest that fields generally produce more insects available to wild turkey broods than forests (Martin and McGinnes 1975, Healy and Nenno 1983). It appears that abundance of herbaceous vegetation is key in the production of insects and cover for turkey broods (Campo 1983, Healy 1985, Exum et al. 1987).

Structural aspects of vegetation important for eastern wild turkey broods include density, canopy cover, and canopy height (Healy 1978, 1985; Hayden 1979). Although herbaceous vegetation is important for insects, very dense vegetation–such as that associated with mature fescue (*Festuca* sp.) stands–may impede poult travel (Healy 1978, 1985). Canopy cover of trees or herbaceous vegetation must adequately conceal turkey broods from predators (Hayden 1979). Herbaceous vegetation should be tall enough to provide vertical cover for broods without obstructing the view of a hen scanning for predators (Healy 1978, 1985). Schroeder (1985) incorporated these parameters into habitat suitability indices for wild turkeys.

Management for wild turkey brood habitat has traditionally emphasized creation and maintenance of forest clearings (Stoddard 1936, Mosby and Handley 1943, Wheeler 1948, Healy 1981). Virginia has been one of the most aggressive states in forest clearings management (Larson 1967). The Virginia Department of Game and Inland Fisheries, under a cooperative agreement with the U.S. Forest Service, manages dispersed clearings over a large portion of public land in Virginia for wild turkeys and other wildlife (U.S. Dep. Agric. 1993). However, examinations of clearing management programs in the eastern United States have revealed limited ecological justifications for preferred management practices (Larson 1967, Krusac and Michael 1979).

Available literature contains some specific strategies for managing wild turkey brood habitat. In Mississippi, Hurst (1978) recommended burning brood habitat to promote insects and spiders. Mowing vegetation can increase insect abundance and facilitate poult movement in clearings (Hillstead and Speake 1970, Hurst and Owen 1980). Disking can promote insects and forbs beneficial to gamebirds in managed fields (Manley et al. 1994, Kurzejeski and Greenfield 1997). Studies have shown a positive correlation between presence of clover and both insect production (Hollifield and Dimmick 1995) and feeding rates of turkey poults (Nenno and Lindzey

1979). However, Healy and Nenno (1983) found no relationship between either the feeding rates of young, imprinted poults or amount of insects and intensity of clearing management in West Virginia—from mowing to disking to planting legumes. The simplest technique that will promote herbaceous ground cover may be the most practical tool for managing wild turkey brood habitat (Stoddard 1936, Larson 1967, Healy 1978, Healy and Nenno 1983).

Most studies have attempted to compare effects of manipulating and not manipulating brood habitat. Building on the assumption that mowing, disking, liming, and planting grass or forbs increases insect abundance and improves vegetation structure on turkey brood range, we examined differential effectiveness of these treatments. Our objective was to compare effectiveness of 4 clearing management regimes typical of those used by wildlife managers in the eastern United States in producing insects and vegetation beneficial to wild turkey broods. Ranging from low to high intensity in development and maintenance, treatments included 1) mowing; 2) disking and liming; 2) planting ladino clover, mowing, and liming; and 4) planting a perennial grass-forb mixture, mowing, and liming.

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Methods

Study Area.—We conducted our research on the Glenwood-Pedlar Ranger District of the George Washington and Jefferson National Forests in Botetourt County, Virginia. Selected wildlife clearings (N=10) were located along the western toe slope of the Blue Ridge at 400–460m above mean sea level. Clearings were separated far enough apart to assume independence from the perspective of insect production resulting from our treatments. Sizes of these clearings were 0.03, 0.08, 0.08, 0.10, 0.14, 0.14, 0.16, 0.16, 0.24, and 0.30 ha. Soils throughout the study area were of the Tumbling-Groseclose-Laidig association (R. Williams, U.S. Dep. Agric.–Nat. Resour. Conserv. Serv., Botetourt County, Virginia, pers. commun.). Scarlet oak *(Quercus coccinea)* and chestnut oak *(Q. prinus)* were predominant tree species in adjacent forest stands, where site index estimates ranged from 60–80 (U. S. For. Serv., Continuing Inventory of Stand Conditions, unpubl. data). Orchard grass *(Dactylis glomerata)* and fescue were the predominant herbaceous species in the wildlife clearings before we developed treatments. Before this study, all clearings were maintained by mowing.

Design and Maintenance Regime.—We compared 4 forest clearing treatments used by wildlife managers in forests of the eastern United States. From least to most intensive, treatments included 1) mowing existing vegetation on a 2-year interval; 2) disking existing vegetation and liming on a 2-year interval; 3) planting ladino clover with a rhizobium inoculant, mowing on a 2-year interval, and liming on a 2-year interval; and 4) planting a perennial grass-forb seed mixture, mowing on a 2-year interval, and liming on a 2-year interval. The pre-inoculated grass-forb mixture used in treatment 4 included alfalfa *(Medicago sativa),* annual ryegrass (*Lolium* sp.), red clover *(Trifolium pratense),* white Dutch clover *(Trifolium repens),* and birdsfoot trefoil *(Lotus corniculatus).*

We paired treatments 1 with 2 and 3 with 4 because of similarities in development and maintenance requirements. Paired treatments were randomly assigned to fields and individual treatments were randomly assigned to halves of clearings. We divided each clearing with the slope to prevent chemical leaching between adjacent treatments. All clearings were mowed in July 1994 to establish identical conditions initially across all areas. We then developed treatments during 1994 and 1995. Pelletized, dolomitic lime was applied to designated areas in December 1994, disking was conducted during April 1995, and clover and grass-forb mixtures were seeded in May1995. We prepared seedbeds by disking only and then broadcast seed using a hand-held cyclone spreader. We repeated all treatment activities besides planting again in 1996 during the same months the treatments were originally established. We treated no clearings in 1997.

Our costs and application rates were presumably typical for managers working in Appalachian forests. Lime used in treatments 2, 3, and 4 cost \$593.35/ha (\$88.56/metric ton × 6.7 metric tons/ha) due to a lack of prior soil amendments and limited access for bulk application. Ladino clover seed used in treatments 3 cost \$32.43/ha (\$8.27/kg × 3.92 kg/ha). The National Wild Turkey Federation provided the grass-forb seed mixture used in treatment 4 at \$70.42/ha. (\$4.19/kg × 16.81 kg/ha). For every \$1.00 we spent on labor and equipment (\$7/hour labor, \$25/hour tractor) associated with implementing treatment 1, we spent \$3.50 on treatment 2, \$4.00 on treatment 3, and \$4.00 on treatment 4.

Insect Sampling.—We sampled insects twice annually (Jun and Jul) in 1995, 1996, and 1997. Within each half of each field, 100 non-overlapping sweeps were taken using a standard insect net with a hoop diameter of 40 cm while walking slowly through the field. One sweep consisted of 1 forehand or backhand stroke. Samples were collected on days with no rain or wind and after vegetation dried in the mornings. Insects were killed using ethyl acetate and frozen for later analysis. Specimens were thawed and sorted into 1 of 4 groups: Homoptera, Coleoptera, Orthoptera, and a combined group of other orders. The 4 insect categories were selected on the basis of their importance as a food source to turkey poults (Wheeler 1948, Hamrick and

Davis 1971, Barwick et al. 1973, Hurst and Stringer 1975, Healy 1985). After sorting, we weighed samples to the nearest 0.01 g and placed them in a drying oven at 50 C for 24–48 hours. We repeated this process until 2 consecutive sample weights were identical.

Vegetation Sampling.—Between 17 June and 8 July 1997, 10 0.1-m^2 quadrats were established within the treated area of each half of each field. We established quadrat positions using coordinates obtained form random numbers tables. A wooden frame with inside measurements of 20 cm x50 cm was placed on the ground to delineate each quadrat (Daubenmire 1959). The long axis of the frame was kept perpendicular to the field edge.

We estimated percentage cover for grass, forbs, woody plants <50 cm tall, total herbaceous vegetation, bare ground, clover, and birdsfoot trefoil within each quadrat according to protocols established by Daubenmire (1959). Our cover classes were 0, 1–5%, 6–25%, 26–50%, 51–75%, 76–95%, and 96–100%. Within each quadrat, we measured height of the tallest herbaceous plant, recorded total number of woody and herbaceous plant species, and clipped woody vegetation <50 cm tall and all herbaceous vegetation as close to the ground as possible (Healy 1985). Clipped vegetation was placed in paper bags, labeled by quadrat, and dried at 38 C for 24 hours before weighing.

Data Analysis.—We compared effects of treatment 1 versus treatment 2, treatment 3 versus treatment 4, and low intensity treatments (1 and 2 combined) versus high intensity treatments (3 and 4 combined) on insect dry weight and vegetation within the selected fields. All analyses were conducted using PROC GLM (SAS 1987), with the level of significance set at $\alpha = 0.10$ for all tests of differences among means.

Effects of the above treatments on oven dry weights of homopterans, coleopterans, orthopterans, miscellaneous insects, and all insect groups combined were tested using a completely randomized design with a split-plot (for comparing high and low intensity treatments) or split-split plot (for comparing a single treatment with another) arrangement of treatments. Each field ($N = 10$) was split by 2 time periods (Jun and Jul), 3 years (1995, 1996, and 1997), and 2 vegetation treatments. We examined treatment effects on the following vegetative parameters in a randomized block design (blocking on field): percentage cover of grass, forbs, total herbaceous vegetation, woody vegetation, bare ground, clover, and trefoil; plant canopy height; number of plant species; and plant oven dry weight.

Results

Insects

Proportions of insect orders by treatment and overall are presented in Table 1. Although the importance of homopterans, coleopterans, orthopterans, and other insects to wild turkeys is well established (Wheeler 1948, Hamrick and Davis 1971, Barwick et al. 1973, Hurst and Stringer 1975, Healy 1985), preference among these

Table 1. Mean proportions (%) of total insects by order collected during 1995–1997 from different vegetation treatments on forest clearings in Botetourt County, Virginia.

	Treatments						
	1—Mow	2—Disk/lime	3—Clover +mow/lime	4—Grass-forb +mow/lime	Low intensity [a]	High intensity [a]	All
Order	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
Homoptera	31	22	28	24	26	25	26
Coleoptera	19	22	26	21	21	24	21
Orthoptera	22	14	17	14	19	16	18
Miscellaneous	28	42	29	41	34	35	35
N	30	30	30	30	60	60	120

a. Low intensity treatments included mowing and disking/liming; high intensity treatments included planting clover and grass-forb mixtures.

orders is not. Healy (1985) found that insect composition in the diets of wild turkey poults were similar to the insect orders that were available. We found no treatment effects on oven dry weights of homopterans, coleopterans, orthopterans, or miscellaneous insects when analyzed separately by group (P>0.10). Therefore, we combined the 4 groups into a single category that we assume reflects the available insect biomass commonly used by wild turkey poults (Table 2).

We did not detect any statistically significant treatment, year, or period effects on combined insect dry weights (P>0.10). We failed to detect a difference in insect dry weights between areas receiving high intensity treatments and areas receiving low intensity treatments across all years (F=1.81; 1,24 df; P=0.19; Table 2). We found no differences in insect dry weights between treatment 1 and treatment 2, nor between treatment 3 and treatment 4 (Table 2).

We found an interaction between period and year effects (F=9.15; 2,24 df; P=0.001). Across all treated areas, mean dry weight of all insects combined was greater in June than July during 1995, but was lower in June than July during both 1996 and 1997 (Table 2). We found this relationship in both low intensity (F=17.67; 2,24 df; P=0.001) and high intensity treatments (F=4.60; 2,24 df; P=0.020).

We also detected an interaction between treatment and year effects (F = 6.86; 2,12 df; P = 0.010). Dry weights of combined insect samples collected in areas under treatment 1 decreased from 1995 to 1997, whereas those collected in areas under treatment 2 increased (Table 2). We did not find a similar interaction for treatments 3 and 4.

Vegetation

Areas receiving high intensity treatments had higher clover cover estimates (F=4.00; 1,8 df; P=0.081) and more plant species/plot (F=6.37; 1,8 df; P=0.036) than low intensity treatments (Tables 3, 4). Treatments did not differ significantly in plant dry weight or grass, forb, total herbaceous, woody plant, or bare ground cover estimates (P>0.10; Tables 3, 4). We found a significant difference (F=5.94; 1,4 df;

Table 2. Mean oven dry weights (g) and associated standard errors (SE) of all insects collected during 1995–1997 from different vegetation treatments on forest clearings in Botetourt County, Virginia.

		Treatments													
		1—Mow[a]		2—Disk/lime[a]		3—Clover +mow/lime[a]		4—Grass-forb +mow/lime[a]		Low intensity[b,c]		High intensity[b,c]		All[d]	
Period		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
1995	Jun	1.12	0.23	0.57	0.20	0.94	0.28	0.90	0.33	0.84B	0.17	0.92C	0.21	0.88D	0.13
	Jul	0.41	0.10	0.31	0.16	0.47	0.08	0.50	0.10	0.36B	0.06	0.49C	0.06	0.42D	0.04
	Total	0.76A[e]	0.17	0.44A	0.11	0.70	0.16	0.70	0.18	0.60	0.10	0.70	0.12	0.65	0.08
1996	Jun	0.22	0.04	0.32	0.10	0.36	0.13	0.49	0.14	0.27B	0.05	0.42C	0.09	0.35D	0.06
	Jul	1.00	0.26	0.60	0.12	0.73	0.25	0.80	0.22	0.80B	0.15	0.77C	0.16	0.78D	0.11
	Total	0.61A	0.18	0.46A	0.09	0.54	0.15	0.64	0.14	0.54	0.10	0.59	0.10	0.56	0.07
1997	Jun	0.15	0.03	0.56	0.11	0.58	0.15	0.35	0.13	0.36B	0.09	0.46C	0.10	0.41D	0.07
	Jul	0.57	0.12	0.68	0.10	1.04	0.35	0.91	0.27	0.63B	0.08	0.98C	0.21	0.80D	0.12
	Total	0.36A	0.09	0.62A	0.07	0.81	0.19	0.63	0.17	0.49	0.06	0.72	0.13	0.61	0.07
1995–97	Jun	0.50	0.14	0.48	0.08	0.62	0.12	0.58	0.13	0.49	0.08	0.60	0.09	0.55	0.06
	Jul	0.66	0.12	0.53	0.07	0.75	0.15	0.74	0.12	0.59	0.07	0.74	0.09	0.67	0.06
	Total	0.58	0.09	0.51	0.05	0.69	0.10	0.66	0.09	0.54	0.05	0.67	0.07	0.61	0.04

a. Sample size (*N*) for month (year) = 5, year total = 10, month (all years) = 15, and all years total = 30.

b. Low intensity treatments included mowing and disking/liming; high intensity treatments included planting clover and grass-forb mixtures.

c. Sample size (*N*) for month (year) = 10, year total = 20, month (all years) = 30, and all years total = 60.

d. Sample size (*N*) for month (year) = 20, year total = 40, month (all years) = 60, and all years total = 120.

e. Statistically significant interactions or differences among means with same letters.

Table 3. Mean cover estimates and associated standard errors (SE) from quadrate plots taken 1995–1997 within different vegetation treatments on forest clearings in Botetourt County, Virginia.

		Cover (%)											
		Grass		Forb		Total herbaceous		Woody		Bare ground		Clover	
Treatments	Plots *(N)*	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
1—Mow	50	27.6	4.9	20.5	4.4	52.9A[b]	9.7	6.6	2.7	5.0	1.3	0	0
2—Disk/lime	50	21.8	3.9	23.0	6.5	48.3A	10.3	7.4	3.6	5.4	1.1	0.42	0.29
3—Clover + —mow/lime	50	21.8	4.7	27.5	7.2	54.1	9.7	2.9	1.4	8.5	0.8	12.8	8.3
4—Grass-forb mix — + mow/lime	50	26.9	4.2	28.4	8.3	62.1	5.3	2.5	0.7	6.3	1.8	12.2	4.8
Low intensity	100	24.7	4.1	21.8	5.1	50.6	10.0	7.0	3.2	5.2	1.0	0.21B	0.15
High intensity	100	24.3	3.7	28.0	7.2	58.1	7.0	2.7	0.8	7.4	1.0	12.5B	6.1
All	200	24.5	2.6	24.9	4.3	54.3	5.9	4.8	1.7	6.3	0.8	6.3	3.5

a. Low intensity treatments included mowing and disking/liming; high intensity treatments included planting clover and grass-forb mixtures.

b. Statistically significant differences between means with same letters.

Table 4. Mean plant canopy height, species richness, and plant oven dry weight estimates and associated standard errors (SE) from plots taken 1995–1997 within different vegetation treatments on forest clearings in Botetourt County, Virginia.

		Height of tallest plant (cm)		Plant species per plot *(N)*		Oven dry weight (g/m^2)	
Treatments	Plots *(N)*	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
1—Mow	50	97.0	8.6	4.2	0.5	189.4	33.6
2—Disk/lime	50	91.1	8.8	4.2	0.4	205.1	40.8
3—Clover + —mow/lime	50	87.7	7.3	7.4	1.3	153.6	31.0
4—Grass-forb mix — + mow/lime	50	98.0	5.6	7.4	1.2	160.9	34.2
Low intensity[a]	100	94.1	8.2	4.2A[b]	0.3	196.9	24.0
High intensity[a]	100	92.8	5.6	7.4A	1.2	156.9	32.0
All	200	93.4	4.7	5.8	0.8	176.9	20.0

a. Low intensity treatments included mowing and disking/liming; high intensity treatments included planting clover and grass-forb mixtures.

b. Statistically significant differences between means with same letters.

P=0.071) in total herbaceous cover estimates between treatments 1 and 2. Mowed areas (treatment 1) had slightly greater total herbaceous cover estimates than disked/limed areas (treatment 2) (Table 3).

All treated areas had plant dry weight estimates within the adequate range (60–300 g/m^2) defined by Healy (1978, 1985; Table 4). Our canopy height estimates in all fields sampled exceeded the optimal range (20–60 cm.) But were within the adequate range (20–100 cm) defined by Schroeder's (1985) habitat suitability indices (Table 4). Although all treated areas had "useable" herbaceous cover (20%–100%), only those areas seeded with the grass-forb mixture (treatment 4) had cover classed by Schroeder (1985) as optimal (60%–80%; Table 3). Although birdsfoot trefoil was planted in the grass-forb mixture in May 1995, we found none in any treated area in July 1997.

Discussion

Insects

We expected to enhance insect habitat most by planting clover (Hollifield and Dimmick 1995) and other forbs, i.e., by establishing treatments 3 and 4. We were unable to detect differences between treatments, but this may have resulted from low statistical power. Although we did not formally examine power, it is plausible to assume that the limited scope of the study and low replication reduced our ability to detect differences. Insect production was slightly higher in areas under high intensity treatments, but the measurable effects to turkeys are unknown and should be investigated further.

The period-by-year and year-by-treatment interactions we observed resulted from within- and between-year fluctuations in insect dry weights. These fluctuations may have represented natural oscillations in insect abundance and/or may have related to timing of treatments and longevity of treatment effects.

The interaction of period and year was probably influenced by several phenomena: relatively large samples of homopterans collected during June 1995, large samples of coleopterans collected in July 1996, and the trend for samples of all types of insects to be larger in July than June during 1997. Found at no other time during the study, periodic cicadas *(Magicicada septemdecula)* collected in 11 of the 20 insect samples during June 1995 likely accounted for the peak in homopteran dry weight, and should be considered an anomaly in the data.

The interaction of year with effects of treatments 1 and 2 may have been linked to timing and persistence of these 2 treatments. Since vegetation in disked areas (treatment 2) was greatly disturbed during spring 1995 and 1996, we expected insect dry weights to be less than in areas only mowed (treatment 1). No areas were treated in 1997, allowing restoration of vegetation and insect habitat.

Given that all areas except those under treatment 2 were mowed just 2 weeks prior to insect sampling in July 1996, we expected to collect larger samples of insects (especially homopterans) attracted to the new growth in vegetation. However, there may have been only a small cohort of homopterans present in the study area during July 1996 (e.g., cicadas may have disappeared), or 2 weeks growth of vegetation may have been inadequate for optimal insect activity. Hurst and Owen (1980) reported that fields in Mississippi produced fewer insects for the first 2–3 weeks following mowing; after the lapse, there was greater insect production than before mowing. Beetles (coleopterans) were captured in relatively large numbers during July 1996, except in areas under treatment 2, which were not freshly mowed. It is possible that beetles were selecting the low, dense vegetation just mowed or that ground beetles were more readily sampled when vegetation was low. Coleopterans available to turkey poults, especially ground beetles (such as Carabidae), were probably underestimated using our sweep-netting technique (Hollifield and Dimmick 1995). Future studies could combine pit-fall traps, vacuum technology, and sweep netting to obtain more complete insect samples. We should emphasize that our objective in the current study was to assess relative differences in insect abundance between treatments rather than quantify total insect dry weights.

Vegetation

We examined vegetation only once at each site during 1997, when no areas were treated and differences in treatment effects may have been less extreme than during 1995 and 1996. Therefore, our results reflect temporary fallow conditions characteristic of clearing management regimes, but should not be inferred to represent all years in a management cycle.

Although high intensity treatments produced more clover and more plant species than low intensity treatments, we conclude that vegetative differences between treatments were marginal and any of the clearing management prescriptions resulted in acceptable herbaceous ground cover levels based on the recommendations provided by Healy (1985). Since clover and other forbs were seeded in high intensity treatment areas, we expected to find higher estimates of clover, forb, and total herbaceous cover and more plant species/plot in these areas. Since disked areas (treatment 2) experienced soil and vegetation disturbance without subsequent planting, these stands may have lagged behind others in producing herbaceous cover. The absence of birdsfoot trefoil in any field suggests that we may have used bad seed or the legume was out-competed by grasses. Krusac and Michael (1979) cautioned against planting birdsfoot trefoil in situations where there will be competition from grasses, citing studies by Lesser and Smith (1960) and Webb and Patric (1961).

Management Implications

Our results and Healey and Nenno's findings (1983) suggest that natural variations in environmental productivity and quality may eclipse management effects on insects and vegetation available for wild turkeys. The apparent profusion of insects at distinct times regardless of our habitat treatments suggests that fluctuations in insect populations may have larger impacts on insect availability to wild turkeys than do vegetation treatments. Healy and Nenno (1983) found that differences in forest site index for clearings in West Virginia had a much greater influence on both amount of insects and feeding rates of young poults than did disking, liming, and planting legumes. However, for given insect populations and site conditions, we may expect relative differences between treated areas, such as fewer insects in areas recently disked or more insects in areas recently mowed.

Fields left fallow for 1 year retained some differences attributable to treatments. Although birdsfoot trefoil was not present 2 years after planting, ladino clover was very abundant where seeded. Given their apparent vigor and capacity to support insects (Grace 1942, in Hollifield and Dimmick 1995), clovers may benefit forest game birds as much as any planting. Our results also suggest that unseeded fields left without treatment for several years may experience a more rapid incursion of woody vegetation than those seeded with forbs. However, mowing or disking on a 2-year interval should prevent invasion of many woody species and maintain an adequate level of herbaceous cover. Hurst (1978) suggested that fields be burned every 3 years to maintain conditions preferred by wild turkey broods.

Managers should consider if improvements in insect production or vegetative structure warrant high intensity management of wildlife clearings. Forest clearings generally are not managed only for wild turkeys. Other game and nongame species associated with early successional habitats may be more sensitive to insect and vegetation enhancements achieved through high intensity treatments than wild turkeys. However, treatments such as planting and liming may be difficult to justify under restricted budgets given that some comparable effects may be achieved by mowing or disking only. Other research in the Appalachian Mountains has documented that invertebrate populations and poult feeding rates in unmanaged and managed openings were similar (Healy 1978, Harper et al. 2000). Our conclusions support others' recommendation to use the simplest, least expensive technique that will promote herbaceous ground cover in managing forest clearings for wild turkey broods (Stoddard 1936, Healy 1978, Healy and Nenno 1983, Harper et al. 2000).

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