INVERTEBRATE AVAILABILITY FOR UPLAND GAME BIRDS IN TALL FESCUE AND NATIVE WARM-SEASON GRASS FIELDS

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ABSTRACT—Native warm-season grasses (NWSG) are commonly recommended over introduced cool-season grasses to enhance the structure of available wildlife habitat. Data concerning food availability (macroinvertebrate abundance) for young gallinaceous birds within these field-cover types are lacking. We collected invertebrate samples from 10 NWSG fields and 10 fields of tall fescue (*Festuca arundinacea*) during the brooding season across Tennessee using a terrestrial vacuum sampler. Fields of tall fescue did not differ in overall invertebrate density or biomass from NWSG fields. Density and biomass of Hemiptera (true bugs) was greater in tall fescue fields ($P = 0.012$), while density of Orthoptera (grasshoppers) was higher in NWSG fields ($P = 0.088$). The lack of difference in overall invertebrate availability between cover types suggests that other parameters (vegetation structure and presence of forbs) have a greater influence on use of fields by young gallinaceous birds.

Conversion of idle cropland to tall fescue pasture has degraded wildlife habitat in the mid-South and has been identified as a primary factor for the precipitous decline in northern bobwhite (*Colinus virginianus*) populations (Washburn et al., 2000). Tall fescue is classified as a perennial long-lived bunchgrass that is extremely competitive (Ball et al., 1996). Although classified as a bunchgrass, tall fescue grows in dense stands, making travel by many small wildlife species (especially ground birds) extremely difficult. In addition, tall fescue leaves droop and fall upon senescence, creating a deep layer of thatch. The dense growth structure and thatch layer preclude weed seeds in the seed bank from germinating; thus, vegetative diversity and weed seed available as food for wildlife are drastically reduced. Further, tall fescue has a variety of toxicosis syndromes caused by a fungal endophyte (*Acremonium coenophialum*), which results in many physiological problems with livestock (Ball et al., 1996). This also makes fescue poor-quality forage for wildlife. When fed a tall fescue seed diet, bobwhites exhibit cloacal swelling that ultimately leads to increased mortality (Barnes, 1999).

Native warm-season grasses (NWSG) have been recommended when converting fields from non-native perennial grasses to provide enhanced wildlife habitat (Warner and Brady, 1996; Washburn et al., 2000; Madison et al., 2001). Warm-season bunchgrasses native to Tennessee include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), broomsedge bluestem (*Andropogon virginicus*), indiangrass (*Sorghastrum nutans*), switchgrass, (*Panicum virgatum*), and eastern gamagrass (*Tripsacum dactyloides*). Various mixtures of these grasses, along with several associated forbs, have been used to restore wildlife habitat. The growth nature of NWSG allows bare ground space between bunches, especially when sowed at relatively low rates (4–6 pounds Pure Live Seed per acre). The resulting open nature at ground level provides travel space for smaller animals (game bird poults, various songbirds, rabbits) while providing a "canopy" of overhead cover. In addition, bare ground space allows various seeds found in the seed bank such as ragweed (*Ambrosia artemisiifolia*), partridge pea (*Cassia fasciculata*), beggar's lice (*Desmodium obtusum*), blackberries (*Rubus* spp.), and pokeweed (*Phytolacca americana*) to germinate, and produce a valuable food source (seeds and soft mast) for many bird species, including northern bobwhites.

Invertebrates are a critical component in the diet of young upland game birds (Handley, 1931; Nestler, 1940; Barwick et al., 1973; Nenno and Lindzey, 1979), providing protein and calcium essential for chick development and survival (Nestler et al., 1945; Robel et al. 1995). Invertebrates often comprise more than 80% of the diet of young northern bobwhites and wild turkeys (*Meleagris gallopavo*; Handley, 1931; Nestler, 1940; Hurst and Stringer, 1975; Hurst, 1992; Burger, 2001; Dickson, 2001). The availability and quality of brood habitat influences survival of gallinaceous chicks (Hurst, 1972; Everett et al., 1980; Metzler and Speake, 1985). Invertebrate abundance and availability are two primary factors determining brood habitat quality (Rosene, 1969; Hurst, 1992; Peoples et al., 1996) and have been linked to variations in breeding success (Southwood and Cross, 1969). A change in invertebrate availability arising from changes in vegetation (conversion from fescue to NWSG) would impact populations of gallinaceous birds that use those areas.

While it is clear NWSG provide better vegetative structure for wildlife, the relative abundance of invertebrates associated with NWSG as compared to tall fescue is not known. The objective of this study was to determine and compare mean invertebrate density and biomass in fields of tall fescue and NWSG.

MATERIALS AND METHODS

Ten fields of tall fescue and 10 fields of NWSG located across Tennessee were chosen for invertebrate collection. To min-

TABLE 1. Overall mean ± SE[1] invertebrate density (per m^2) and biomass (mg/m^2) in tall fescue (n = 10) and native warm season grass fields (n = 10) sampled across Tennessee, June, 1999.

Cover type	Density	Biomass
Tall fescue	7.2 ± 1.88[a]	38.6 ± 12.2[a]
Native warm season grasses	5.2 ± 1.20[a]	38.8 ± 13.0[a]

[1] Means with the same letter in the same column are not different ($P > 0.30$).

imize both potential bias and influence on invertebrate populations (Owen, 1976; Morris, 1981; Healy and Nenno, 1983), fields chosen for study had not been mowed and all contained < 10% forbaceous vegetation (each field sampled contained > 90% tall fescue or NWSG). Sampling was conducted between 23 May and 11 June 1999 on sunny days between 10 AM and 5 PM. This sampling period was chosen as it coincides with the peak brood-rearing period for wild turkeys in Tennessee and is just before most tall fescue fields are cut for hay. Twelve invertebrate samples were collected from each field within a 0.25-m^2 bottomless box with lid using a modified hand-held blower-vac (Harper and Guynn, 1998). Invertebrate samples were dried at 60° C for 48 h (Murkin et al., 1994) and debris removed. Invertebrates were identified to order, counted, and weighed.

Data were analyzed using SAS statistical software (SAS Institute Inc., 1990). The UNIVARIATE procedure was used to evaluate normality of invertebrate data and similar variance was checked using the check of equality of standard deviation. Overall invertebrate density and biomass data were compared between tall fescue and NWSG fields using a complete randomized design. Density and biomass of invertebrate orders were compared using Fisher's Exact Test. Data were split into two classifications, Hexapoda and Other, and compared between treatments using Fisher's exact test

RESULTS

Two hundred and forty 0.25-m^2 invertebrate samples were collected from 20 fields across Tennessee. Five classes of invertebrates were collected: Arachnida (including orders Acari and Araneae); Diplopoda; Gastropoda (order Pulmonata); Hexapoda (including orders Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Lepidoptera, Orthoptera, and Trichoptera); and Malacostraca (order Isopoda).

Invertebrate data were non-normal, skewed toward zero because all orders were not present in all samples. Data were log transformed to meet the assumptions for ANOVA and to perform mean-separation of invertebrate order density and biomass.

There was no difference in mean invertebrate density (F = 1.05, $d.f.$ = 19, P = 0.318) or biomass (F = 0.69, $d.f.$ = 19, P = 0.418) between cover types (Table 1). Density (F = 7.75, $d.f.$ = 19, P = 0.012) and biomass (F = 7.52, $d.f.$ = 19, P = 0.013) of Hemiptera were greater in tall fescue fields. Density of Orthoptera (F = 3.24, $d.f.$ = 19, P = 0.088) was higher in NWSG fields. Other orders did not differ ($P \geq 0.10$) in density or biomass (Table 2) between cover types. More of the tall fescue fields sampled contained Hemiptera (P = 0.070) than NWSG fields.

TABLE 2. *Mean ± SE[1] density (per m^2) and biomass* (mg/m^2) of invertebrate orders in tall fescue (n = 10) and native warm season grass fields (n = 10) sampled across Tennessee, June, 1999.

Order	Cover type	Density	Biomass
Acari	Fescue	0.0 ± 0.00[a]	0.0 ± 0.00[a]
	Native	0.02 ± 0.01[a]	0.05 ± 0.03[a]
Araneae	Fescue	1.14 ± 0.14[a]	12.40 ± 8.17[a]
	Native	1.23 ± 0.41[a]	3.10 ± 0.99[a]
Coleoptera	Fescue	0.77 ± 0.17[a]	3.86 ± 1.91[a]
	Native	0.87 ± 0.33[a]	3.92 ± 1.35[a]
Diplopoda	Fescue	0.01 ± 0.01[a]	0.02 ± 0.02[a]
	Native	0.00 ± 0.00[a]	0.00 ± 0.00[a]
Diptera	Fescue	0.05 ± 0.03[a]	0.01 ± 0.01[a]
	Native	0.03 ± 0.01[a]	0.26 ± 0.18[a]
Pulmonata	Fescue	0.11 ± 0.07[a]	2.17 ± 1.66[a]
	Native	0.09 ± 0.07[a]	8.88 ± 8.84[a]
Hemiptera	Fescue	0.56 ± 0.23[a]	1.55 ± 0.55[a]
	Native	0.08 ± 0.06[b]	0.40 ± 0.38[b]
Homoptera	Fescue	3.78 ± 1.53[a]	5.73 ± 2.94[a]
	Native	1.28 ± 0.31[a]	5.05 ± 1.58[a]
Hymenoptera	Fescue	0.43 ± 0.16[a]	0.45 ± 0.17[a]
	Native	0.96 ± 0.31[a]	0.73 ± 0.24[a]
Isopoda	Fescue	0.02 ± 0.01[a]	0.20 ± 0.10[a]
	Native	0.00 ± 0.00[a]	0.00 ± 0.00[a]
Lepidoptera	Fescue	0.08 ± 0.04[a]	0.62 ± 0.45[a]
	Native	0.03 ± 0.01[a]	0.56 ± 0.39[a]
Orthoptera	Fescue	0.28 ± 0.05[b]	11.73 ± 8.28[a]
	Native	0.61 ± 0.16[a]	6.99 ± 3.86[a]
Trichoptera	Fescue	0.00 ± 0.00[a]	0.00 ± 0.00[a]
	Native	0.02 ± 0.02[a]	0.02 ± 0.02[a]

[1] Means with the same letter within each order are not different ($P > 0.10$).

There was no difference in prevalence of other invertebrate orders among fields (Table 3).

DISCUSSION

Invertebrate abundance and availability has been shown to vary between vegetation types. (Stoddard, 1963; Webb, 1965; Southwood and Cross, 1969; Blackburn et al., 1975; Dunaway, 1976; Nenno and Lindzey, 1979; Shelton and Edwards, 1983; Healy, 1985; Jackson et al., 1987; Knox, 1994; Hollifield and Dimmick, 1995; Harper et al., 2001) but comparisons between tall fescue and NWSG have not been made. Because invertebrate abundance is influenced by the forb component (Webb, 1965; Healy and Nenno, 1983; Hollifield and Dimmick, 1995; Harper et al., 2001), we thought it was important to sample grass communities that were relatively "forb free," giving a better representation of what the actual grasses harbored. The presence of naturally occurring forbs, particularly legumes, would likely increase invertebrate abundance.

Although we found statistical differences in the number of Hemiptera and Orthoptera between cover types, relatively few of either were present (< 1 per m^2). When compared to openings containing a variety of forbs, the density of invertebrates in these pure grass stands (5–7 per m²) was considerably lower. Unmanaged wildlife openings in the southern Appalachians contained a variety of naturally occurring forbs, and harbored 46 invertebrates per m² (Harper et al. 2001). Sixty-eight percent of these invertebrates (31 per m²) derived from seven orders of Hexapoda (Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Lepidoptera, and Orthoptera) that are considered primary prey of wild turkey poults (Hamrick and Davis, 1971; Hurst and Stringer, 1975; Nenno and Lindzey, 1979; Healy, 1985). Future research might focus on invertebrate availability and vegetative structure when the desired forb component is present within NWSG stands.

Invertebrate abundance and biomass changes (usually increases) through the growing season and stage of vegetative growth may influence invertebrate populations. This should not, however, govern when invertebrate populations are sampled. Game bird poults need invertebrates for food soon after hatching, regardless of vegetation stage. We determined our sampling period based on the life cycle of game bird poults in Tennessee. Late May/early June represents the peak hatching period for wild turkeys as well as initial northern bobwhite nests (Dimmick, 1968; Rosene, 1969; Everett et al., 1980; Davis, 1992; Dimmick, 1992; Martin, 1993; Harper, 1998). Because tall fescue is a cool-season grass, it has matured and produced seed by late May/early June. However, vegetative biomass is not necessarily greater in tall fescue fields at this time. Switchgrass and eastern gamagrass begin to flower in late May/early June and the vegetative biomass in these fields (as well as big bluestem and indiangrass) is often greater than that produced by tall fescue, even though it has past maturity (Balasko et al., 1984; Staley et al., 1991; Wolf and Fisk, 1995).

While invertebrates play an important role in determining brood habitat quality (Handley, 1931; Nestler, 1940; Barwick et al., 1973; Hurst, 1978; Nenno and Lindzey, 1979; Anderson and Samuel, 1980; Healy and Nenno, 1983; Healy, 1985; Rogers, 1985), invertebrate order, availability, and vegetative structure are just as important (Healy, 1985; Davis, 1992; Porter, 1992; Peoples et al., 1996; Harper et al., 2001). In Pennsylvania and West Virginia, young turkeys could not travel effectively in perennial cool-season grasses, yet old fields with a forb component allowed free movement for finding and gathering seeds and invertebrates (Nenno and Lindzey, 1979; Healy, 1985). Difficulty in traveling adversely affects the poults' feeding rate, causes increased energy expenditure, and may ultimately increase mortality via physiological stress and/or predation.

Many factors influence invertebrate abundance and composition within a given habitat. The influence of weather and time of year has been documented (Hughes, 1955; Williams, 1961). Other factors include mechanical manipulation, prescribed fire, and the composition and amount of accumulated litter. Morris (1981) found leafhopper abundance declined after grassland cutting and populations were most affected by cutting in July. Hurst (1970) found areas recently prescribed burned produced more invertebrates and Harper et al. (2001) reported invertebrate density and biomass were influenced by vegetative litter biomass. The fields sampled in this study had not been mowed or burned during the current growing season and did not reflect invertebrate populations affected by those treatments.

Although we found no difference in invertebrate density and biomass between fields of tall fescue and NWSG, this should not suggest these two cover types offered similar wildlife habitat. Differences in the amount of use tall fescue and NWSG receive by gallinaceous broods is more likely determined by vegetative parameters rather than invertebrate abundance. As more lands are placed in federal programs provided through Farm Bill provisions designed to enhance wildlife habitat and prevent soil erosion, the value of cover type becomes increasingly important. This is especially true when managing for northern bobwhites, rabbits, various songbirds, and other wildlife species dependent upon early successional habitats.

TABLE 3. Invertebrate order presence in tall fescue field samples (n = 10) and native warm season grass field samples (n = 10) sampled across Tennessee, June, 1999.

Order	Fescue	Native	P value
Acari	0	1	1.000
Araneae	10	10	1.000
Coleoptera	10	9	1.000
Diplopoda	1	0	1.000
Diptera	3	3	1.000
Pulmonata	4	2	0.629
Hemiptera	8	3	0.070
Homoptera	10	10	1.00
Hymenoptera	10	10	1.00
Isopoda	1	0	1.000
Lepidoptera	7	4	0.370
Orthoptera	10	10	1.000
Trichoptera	0	1	1.000

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