Productivity of Interior Forest and Grassland Birds on Jefferson Proving Ground

1998 Annual Report

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Henslow's Sparrow

INTRODUCTION

Jefferson Proving Ground (JPG) is a closed (since 1995) U. S. Army (Army) ordnance testing facility that is currently proposed for designation as a National Wildlife Refuge. The U. S. Fish and Wildlife Service (FWS) has agreed to assess the productivity of forest-interior birds and to monitor bird species of Management Concern on JPG (Memorandum of Agreement, Army and the FWS, 1997).

Population declines of some species of migrant birds that nest in grasslands or in large tracts of forest (i.e., forest interior) have prompted the FWS to classify these as Species of Management Concern (Table 1). As the name suggests, forest interior birds typically are not found in stands smaller than 200 ha (Robbins et al. 1989, Dawson et al. 1993), and the effect of patch size also appears to be important for some grassland birds (Herkert 1994a, Pruitt 1996). Widespread reports of decreases in nest productivity of grassland and interior forest nesting birds have been blamed on habitat loss and fragmentation. These habitat trends are thought to increase nest losses due to cowbird parasitism and to predators more common in edge habitats (Robinson et al.1993). Typically, management recommendations suggest that to improve productivity of local/regional breeding bird populations, emphasis should be placed on increasing individual habitat patch size, the amount of habitat available in the local landscape, and connectivity among patches (Robinson 1992). For example, landscape fragmentation effects appear to decrease for forest interior birds when the forest within a 5- km radius is greater than 40 % (Robb and Dettmers 1996). Edge effects on nests also appear to decrease with an increased distance to non-forested edge for forest interior birds (Brittingham and Temple 1983) and to woody vegetation for grassland birds (Johnson and Temple 1990, Burger et al. 1994).

Managers face a dilemma when deciding the amount and distribution of vegetation classes (the habitat attribute that managers most often deal with) to emphasize in management plans. “Habitat” is invariably fragmented, especially when species are habitat specialists and require specific requirements (e.g., grassland birds vs. shrubland birds vs. interior forest nesting birds). Management of an area becomes complicated when choices are made within a landscape on what is emphasized in the management plan. The “do-nothing” option will also invariably affect a portion of breeding bird populations (not to mention other flora and fauna species) as the vegetation proceeds through seral stages and eventually reaches climax conditions that local disturbance regimes dictate. Ideally, managers need information on what criteria or optimum set of habitat conditions are for Species of Management Concern to judge the habitat within their jurisdiction and the surrounding landscape. Because the continental population of Henslow’s sparrows (*Ammodramus henslowii*) is decreasing, the FWS has decided to continue to manage the grasslands at JPG to maintain Henslow’s sparrows at their current population level (approximately 900 singing males) (Miller et. al. 1997). JPG was recently classified as a Globally Important Area because of this population of Henslow’s sparrows in the Important Bird Area Program of the American Bird Conservatory.

Grasslands were a small component of the original vegetation at JPG; grasslands prospered at JPG due to prescribed burning to reduce wildfires caused by ordnance testing. Because of this decision and the national concern over grassland and forest interior birds, nest

Table 1. Some forest and grassland birds of Management Concern that occur on Jefferson Proving Ground, Indiana.

Common name	Habitat	Status
Henslow's sparrow	grassland	Fed. special concern, State endangered, PIF [a]
Grasshopper sparrow	grassland	PIF
Dickcissel	grassland	PIF
Sedge wren	grassland	State endangered
Northern harrier	grassland	Fed. special concern, State endangered
N. Bobwhite	grassland, shrub	PIF
Field sparrow	grassland, shrub	PIF
Bell's vireo	grassland, shrub	PIF
Red-headed woodpecker	savannah, forest	PIF
Eastern wood pewee	savannah, forest	PIF
Great crested flycatcher	savannah, forest	PIF
Yellow-billed cuckoo	savannah, forest	PIF
Black-and-white warbler	forest	State special concern
Cerulean warbler	forest	Fed. & State special concern, PIF
Hooded warbler	forest	State special concern
Worm-eating warbler	forest	State special concern, PIF
Broad-winged hawk	forest	State special concern
Red-shouldered hawk	forest	Fed. & State special concern
Sharp-shinned hawk	forest	State special concern

[a] Partners in Flight Priority List

productivity data is needed to justify future management actions. Decisions on grassland management influence areas of reverting forest regeneration and thus influence species using shrub and forest habitats. Evaluation of productivity at both ends of the successional continuum (i.e., grasslands and forest) would give some indication of whether species are self-sustaining or need additional management.

OBJECTIVES

1. To quantify nest success and fledging rates (i.e., productivity) of interior forest and grassland nesting birds.

2. To identify local and landscape parameters that affect productivity of birds that nest in these habitats.

3. To give a preliminary determination of JPG as a population source or sink for bird species nesting in grassland and forest.

4. To document nest sites (or presence during breeding season) of Species of Management Concern on JPG.

5. To document local population trends of Henslow's sparrows and to identify habitat parameters that affect recruitment and breeding density.

STUDY AREA

JPG contains approximately 20,648 ha (51,000 ac) in Jefferson, Ripley, and Jennings counties in southeastern Indiana (38^{N} 60' N, 85^{N} 25' W). Based on preliminary Geographical Information System (GIS) data, the breeding bird habitat at JPG is composed of approximately 37 % mature (closed canopy) forest, 24 % pole-sized (open canopy) forest, 14 % shrub/regenerating forest, 23 % grassland, and 2 % bare areas or open water (Fig. 1). These vegetative classes have a high level of interspersion and juxtaposition within the local landscape. The larger tracts of contiguous forest are found on the northern portion of JPG and the grasslands are interspersed in the remainder of the property. The local landscape around JPG consists of agricultural land with remnant forest tracts found on steeper slopes and in riparian areas.

METHODS

Grassland Road Transects

Because of the potential danger of unexploded ordnance (UXO), we could not safely monitor nests on restricted areas. Because many of these restricted sites contained important habitat for Henslow's sparrow and other grassland birds, we continued to monitor birds in these grasslands with

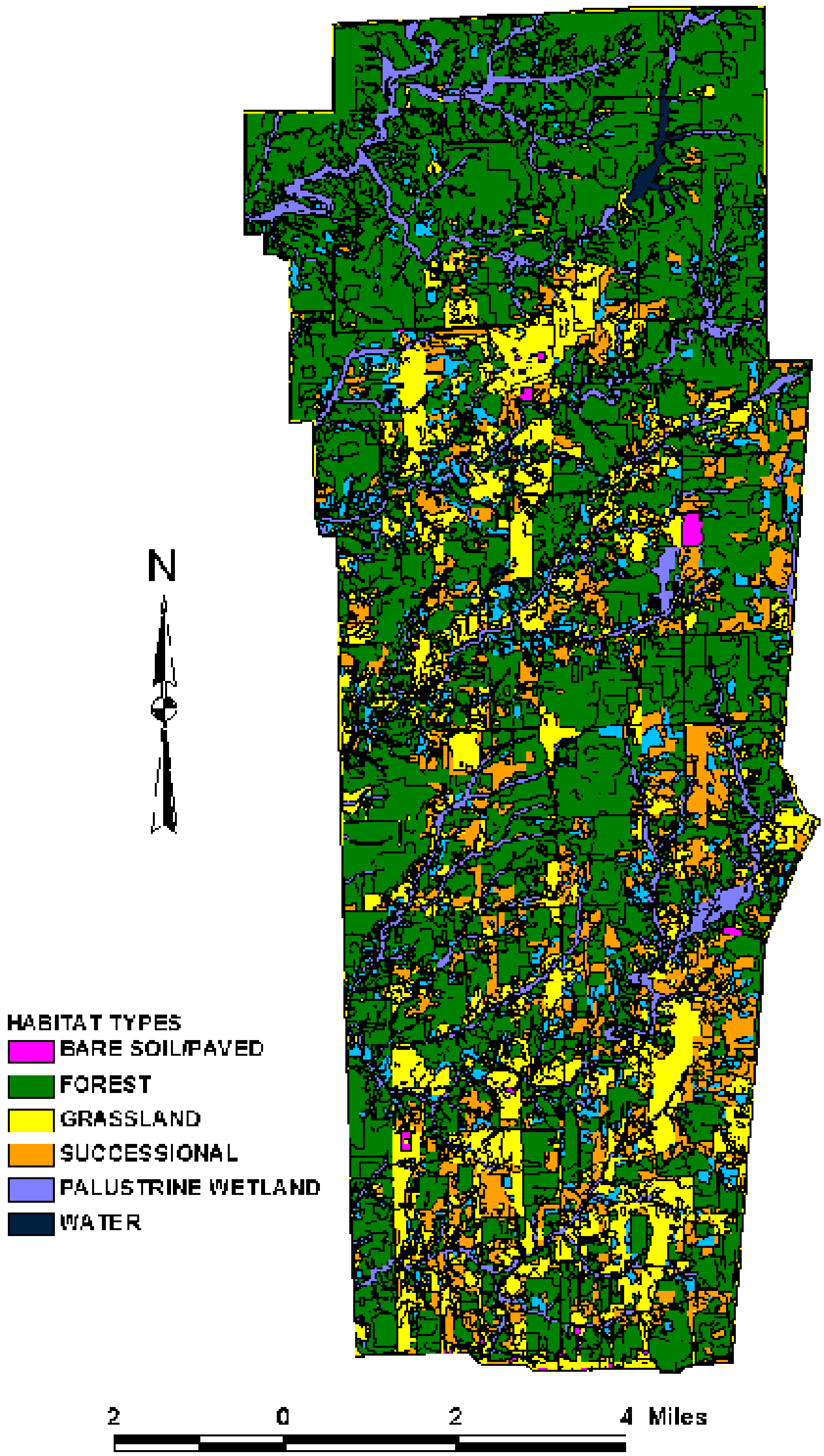


Fig. 1 Simplified aggregation of JPG habitat classifications based upon aerial photograph interpretation.

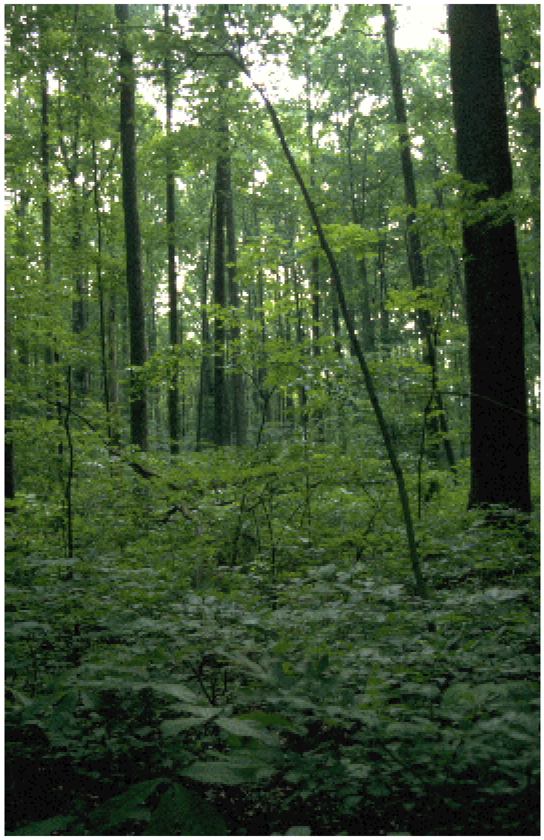
roadside, singing-male surveys; these ca. 37 areas/transects were surveyed annually since 1995; all singing male Henslow's sparrows were counted and located on the transect. The greatest detection distance for Henslow's sparrows was previously estimated as 150 m (Delphi et al. 1995), but the distance for 100 % detection of singing males was probably less (Herkert 1994b). We surveyed each transect twice in 1998; for both visits we recorded singing/sighted birds that were within 75 m and those detected > 75 m; these surveys were considered belt transects of 75-m and 150-m widths. The lengths of the transects were determined by grassland size. Initial surveys were completed during 11 May - 31 May and the second survey was completed during 15 June - 30 July. We surveyed transects between 0500 - 1000 EST using standard Breeding Bird Survey weather guidelines. We determined the amount of elapsed time since each area was burned and measured the area of contiguous grassland habitat adjacent to each transect.

Nest Survey Plots

We found and monitored nests on 10 plots on unrestricted sites on JPG. We placed 4 plots (~ 20-ha) in grassland habitat and 6 plots (~ 40-ha) in closed-canopy mature forest sites. We selected plot locations by placing them in the center of contiguous habitat; plots in forested habitat were selected to have replicates in the interior of large forest blocks, edges of large forest blocks, and isolated forest fragments (Fig. 2). Because there were few unrestricted grasslands, we attempted to select sites that appeared to represent 'typical' JPG grassland habitats (Fig. 2). Plots were marked with a grid (25 m x 100 m) to facilitate monitoring efforts. Territories in plots were spot-mapped (forest plots, 5 coverages over the interior 30 ha of each plot; grassland plots, 6 coverages over the complete plot) with standard procedures (Bibby et al. 1992). Nests found were flagged in a random direction to minimize predation association. Nests were identified to species and usually visited every 3 days (i.e., plots were visited every 3 days) to count eggs/young and to determine stage/status (i.e., building, laying, nestling, failed, egg/nestling mortality) and final outcome for standard Mayfield nest success estimates (Mayfield 1961, 1975). We also recorded cause of mortality and if nests were parasitized (i.e., $\geq$ 1 egg or young cowbird in nest) by brown-headed cowbirds (*Molothrus ater*). Nest initiation dates (i.e., date that first egg was laid) were estimated from fledging dates or when a transition between a nest stage was known. Standard Breeding Biology Research and Monitoring Database (BBIRD) (Martin et. al. 1997) nest variables were sampled for a subsample of the nests. Additional grassland vegetation variables (Robel pole, litter depth, standing dead litter, etc.) were measured at nest sites and random nonuse sites to determine variables important to nest site selection. We measured the percentages of grass, sedges, forb, woody shrubs, green vegetation, leaves, brush, logs, rocks, bare ground, and water present in a 1-m^2 plot centered at the nest and at the random nonuse site. We also estimated the percentage of grass cover that was composed of broomsedge (*Andropogon* sp.).

We marked a sample of Henslow's sparrow nestlings (7-8 days old) with FWS aluminum bands and color bands to facilitate resighting to estimate subsequent site fidelity. Since little information is available on appropriate ages for banding Henslow's sparrow nestlings, we chose to band nestlings 1-3 days before fledging when leg bones were fully developed.

A.



B.

Fig. 2. Examples of habitat on bird study plots at Jefferson Proving Ground; A. Forest Edge plot number 3; B. Grassland plot number 7.

Data Analysis

Grassland Road Transects--For our initial analyses we used the highest singing male count (from the 2 separate counts) for each transect to estimate Henslow's sparrow density. We compared densities of singing male Henslow's sparrows detected $\leq$ 75 m and 75-150 m on road transects with a *t*-test to test whether probability of detecting Henslow's sparrows was related to distance in our road-side survey. We estimated the minimum overall population size and 95 % CI of singing males on JPG by expanding our density estimate with available Henslow's sparrow habitat (i.e., open grassland with scattered shrubs/trees as determined by GIS habitat maps). We used logistic regression to test whether grassland size influenced Henslow's sparrow's use of grasslands. We also compared the density of Henslow's sparrows on grasslands that were small (< 20 ha), medium (20-50 ha), and large (> 50 ha) with *t*-tests. We then graphed each of these estimates (overall density and density vs. grassland size) for all 4-years (1995-98). We also graphed density of singing males against elapsed time since the transect/grassland was burned.

Nest Survey Plots--We used species-specific spot-maps to estimate the density of territories (No. territories/ha) for birds in forest treatments and grassland plots. We used the criteria of at least 2 registrations that were $\geq$ 10 days apart to determine the presence of a "territory"; we also used information such as counter-singing males to denote separate registrations and the presence of an active nest to denote the presence of a territory (Bibby et. al. 1992). We used spot-maps of Henslow's sparrows to estimate their detection probability by assessing the registration per visit of each assumed territory. Thus, if a male Henslow's sparrow was detected on its assumed territory 3 of 6 visits, it would have a detection probability of 0.5. We also compared these detection probabilities among plots with *t*- tests on arcsine transformed proportions (Zar 1996).

We used calculated daily survival/mortality of nests with the Mayfield method (Mayfield 1961, Mayfield 1975) and estimated overall nest success by extrapolating and combining period (i.e., laying, incubating, and nestling) daily survival estimates. We made separate estimates of daily mortality apportioned to cause to contrast influences on nest success. We used CONTRAST (Hines and Sauer 1989) to compare survival/mortality estimates and to test for effects of treatment on nest survival in forested habitat; CONTRAST uses a Chi-square analysis with multiple comparisons (Sauer and Williams 1989). We also compared daily survival of early (< June 15) to late nests (>June 15). We used *t*- tests to compare the influence of cowbird young/eggs on the fledging rate of parasitized nests and nonparasitized nests. We used Mann-Whitney tests to compare vegetation parameters of nests of Henslow's sparrows and random nonuse sites.

We calculated a simple source/sink estimate for closed populations for common species monitored at JPG. We estimated recruitment similarly to Donovan et al. (1995),

$$\text{Mean No. Female Offspring/Female/Year} =$$

$$\text{No. Broods ((Nest Success)(No. Fledged/2) + (1 - Nest Success)(No. Fledged/2)(Nest Success))}$$

where No. Broods was estimated from literature, and Nest Success was estimated from our data. The No. Fledged was estimated from our sample of successful (i.e., $\geq$1 host young fledged) nests; half of this value was assumed to be female. Females that failed their nest attempt were assumed to renest (the second term in the equation). We assumed for this analysis that nest success was similar for each nesting attempt. Since JPG has several Monitoring Avian Productivity and Survival (MAPS) mist-net sites, we used linear regression to compare our estimates of recruitment with MAPS productivity indices, which are based on proportions of juveniles/adults captured (Pyle et al. 1998). Because MAPS current estimates of adult survival had high standard errors (Pyle et al. 1998), we used estimates derived from the literature of adult and juvenile survival in our source/sink calculations (Ricklefs 1973, Donovan et al. 1995). To contrast the sensitivity of our source/sink estimate, we made 2 separate estimates using, 1) 0.60 for adult survival and 0.31 for juvenile survival (i.e., survival from fledging to the following breeding season), 2) 0.40 for adult survival and 0.31 for juvenile survival. These contrasting values of adult survivorship range between high and low values in the literature for the common forest birds sampled at JPG (Donovan et al. 1995). The formula for source/sink estimation (Pulliam 1988, Donovan et al. 1995),

Source(+)/Sink(-) =

Mean No. Female Offspring/Female/Year - ((1 - Adult Survival)/Juvenile Survival)

represents whether recruitment of young into a closed population compensates for adult mortality. Source populations would be positive and sink populations would be negative.

RESULTS

Grassland Road Transects

The mean density of Henslow's sparrows on the 75-m wide transects (0.58 ± 0.11 [SE] singing males/ha) was similar to those detected between 75-150-m (0.39 ± 0.08 , 66 df, t = 1.36, p = 0.18). Thus, we estimated densities from Henslow's sparrows detected on 150-m wide transects in further analyses. The average density detected in 1998 was 0.55 ± 0.10 singing male/ha; this extrapolates to 803 ± 156 singing male Henslow's sparrows (95 % CI, uncorrected for the detection probability of territorial male Henslow's sparrows) on 1463 ha of grassland habitat estimated on JPG (Figs. 3, 4).

Counts made during previous years were converted to densities on these assumed 150-m wide transects to facilitate standardized estimates for statistical comparisons. Densities of Henslow's sparrows have increased (i.e., slope, b = 0.07, p < 0.05) during the 4 years of survey data, but the estimated number of singing males has remained stable (Figs. 3, 4). Approximately 471 ha of grassland habitat have been lost during 1995-98 due to the conversion of grassland in the southern portion of JPG (i.e., south of the firing line) into agricultural fields. The area of grassland habitat north of the firing line was assumed to remain the same during 1995-98 for this analysis, but long-term trends have indicated

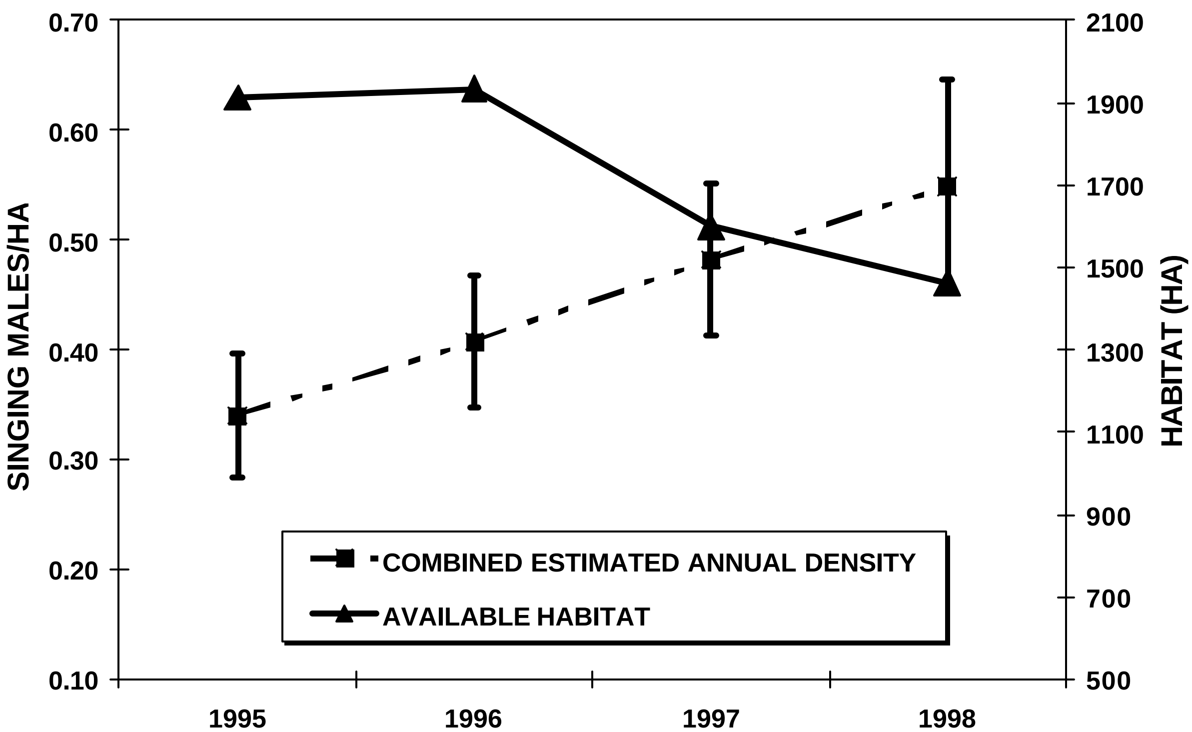


Fig. 3. Change in overall density of singing male Henslow's sparrows detected on roadside transects and available grassland habitat on Jefferson Proving Ground, IN, 1995-98. Available habitat was estimated with GIS data and field checked.

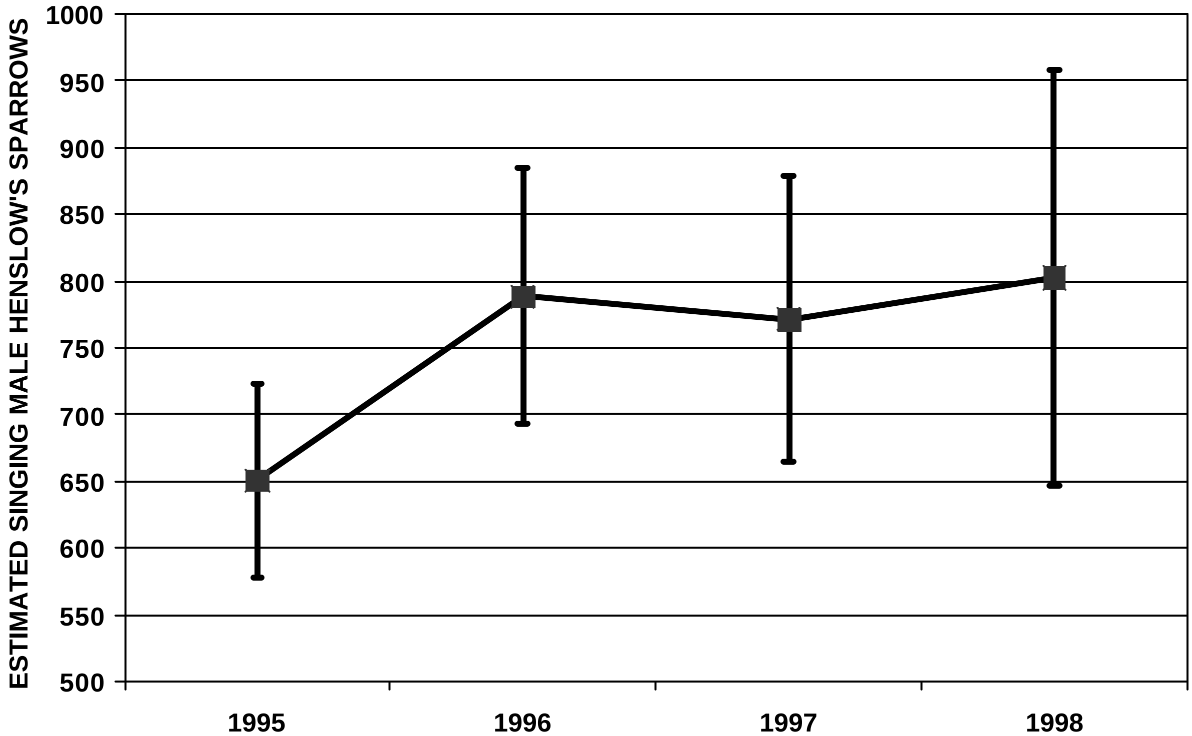


Fig. 4. Number of singing male Henslow's sparrows and 95 % CI's estimated from roadside transects and extrapolated by the amount of available habitat estimated by GIS on Jefferson Proving Ground, IN, 1995-98. Estimated number was not corrected for detectability of Henslow's sparrows.

that woody vegetation is encroaching on most of these grassland areas.

Logistic regression indicated from 1998 data that as field size increased, the probability of occurrence of breeding Henslow's sparrows increased (Wald ÷^{2} = 5.71, 1 df, p = 0.02). The odds of a field being used by breeding Henslow's sparrows were estimated to increase by 5.9 % with each 1-ha increase in field size (b = 0.057 ± 0.024 [SE]; odds ratio = 1.059). The smallest grassland field that singing male Henslow's sparrows were detected in was 6-ha during 1995-98. Density of singing male Henslow's sparrows was related to grassland size, and grasslands larger than 20 ha had higher densities (0.67 ± 0.12 singing males/ha) than those in grasslands < 20 ha (0.22 ± 0.11 singing males/ha; t = 2.73, 25 df, p = 0.01; Fig. 5) in 1998. Densities in grasslands > 50 ha (0.63 ± 0.17 singing males/ha) were similar to those in grasslands 20 - 50 ha in size (0.71 ± 0.17 singing males/ha; t = -0.32, 23 df, p = 0.75; Fig. 5). Differences in Henslow's sparrow densities for grasslands of different sizes were not as apparent during 1995-97 (Fig. 5). Densities of singing male Henslow's sparrows were also affected by the length of time since the area was burned (Fig. 6). Highest densities of singing males occurred the year following the fire (i.e., 2 growing seasons following the fire); most fires took place during late winter and early spring at JPG. Henslow's sparrows were detected singing in some areas the same growing season (year 0, Fig. 6) that the area was burned but at comparably lower densities. Analysis of changes in individual fields was more complex; most fields did not have complete monitoring histories for 5 subsequent years following a fire.

Nest Survey Plots

Red-eyed vireos (*Vireo olivaceus*) were the most common species of bird detected in forest plots while Henslow's sparrows and field sparrows (*Spizella pusilla*) were the most common birds detected in grasslands (Tables 2, 3). Generally, detected densities of common forest birds were less variable than common grassland birds as indicated by smaller coefficients of variation. For example, Henslow's sparrows and field sparrows were not sympatric on 2 grassland plots, but both species cooccurred on 2 of the 4 plots. The 10 most common species of forest birds were found on all of the forest plots. The detectability of Henslow's sparrows on their assumed territories averaged 0.716 ± 0.176 (SD)(n = 82) and did not differ among plots (p > 0.05); thus, a territory of a Henslow's sparrow had an estimated 72 % probability of being detected with 1 visit during spot-mapping. Point estimates of brown-headed cowbirds were higher on forested plots (8.15 ± 0.77 [SE] detected birds/visit/30 ha) than grassland plots (2.67 ± 2.44 detected birds/visit/30 ha) but were not statistically different (t = -2.14, 4 df, p = 0.099).

We monitored a total of 290 nests in which fates could be assigned and Mayfield estimates calculated (Table 4). Extrapolated nest success estimates ranged from 0 to 0.648 for forest birds and 0.134 to 0.287 for grassland birds (species with $n \geq 10$; Table 4). Depredation of nests appeared to be the main cause of nest failure (Table 5). Grassland birds were rare cowbird hosts at JPG; only 3 of 36 field sparrow nests and 0 of 14 Henslow's sparrows nests were parasitized. Forest birds were common cowbird hosts at JPG (Fig. 7). Although cowbird parasitism did not appear to be a primary cause of nest failure (Table 5), parasitized wood thrush nests that fledged host young had somewhat lower numbers (2.50 ± 0.34) of fledged young than nests that were not parasitized (3.14 ± 0.17,

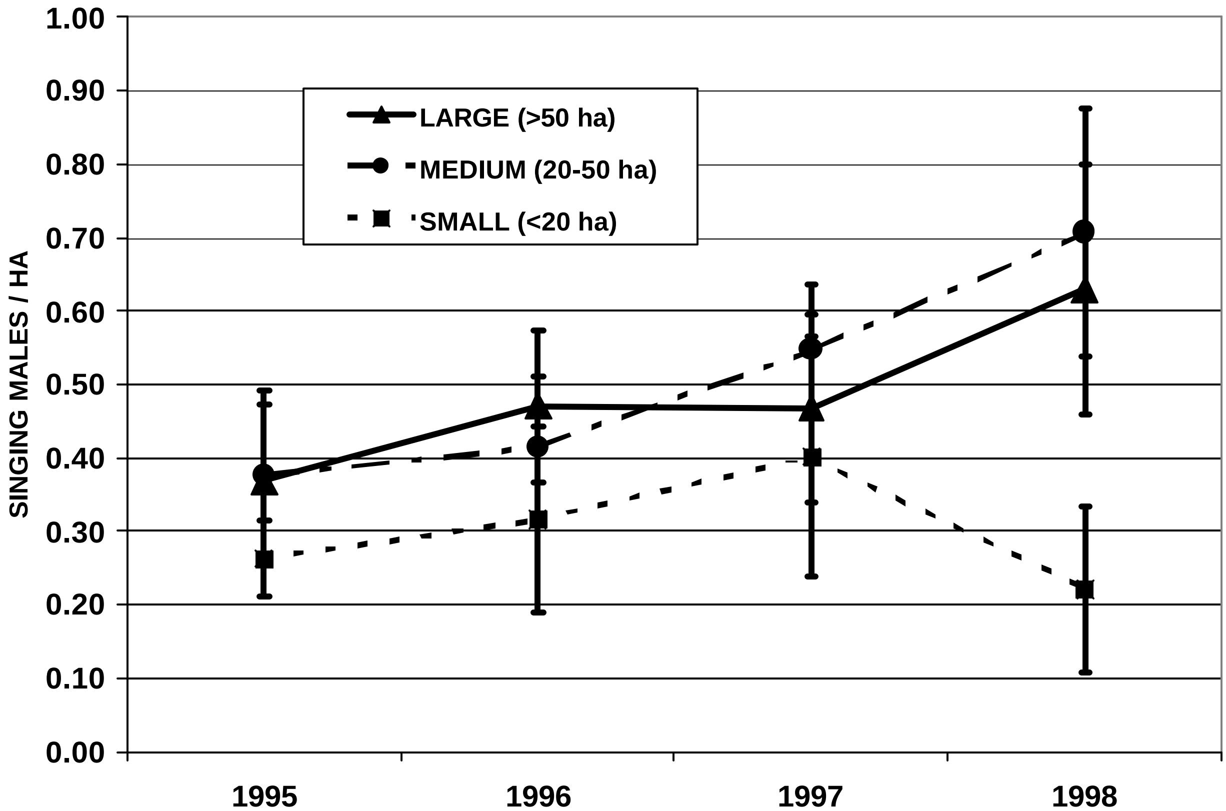


Fig. 5. Effect of grassland size on density of singing male Henslow's sparrows on roadside transects on Jefferson Proving Ground, IN, 1995-98.

Fig. 6. Effect of fire on density of singing male Henslow's sparrows detected on roadside transects on Jefferson Proving Ground, IN, 1995-98. Some grassland units are represented for several points (i.e., Years Since Fire), others are not.

Table 2. Estimated densities (territories/ha) of selected birds detected during spot-mapping on grassland plots (n = 4) at Jefferson Proving Ground, IN, 1998.

Species	Range		SD
Henslow's sparrow	0.00 - 2.61	1.10	1.15
Field sparrow	0.00 - 1.41	0.65	0.58
Common yellowthroat	0.06 - 0.45	0.28	0.17
Prairie warbler	0.00 - 0.44	0.25	0.18
Indigo bunting	0.00 - 0.25	0.16	0.11
Eastern meadowlark	0.07 - 0.25	0.15	0.08
Yellow-breasted chat	0.00 - 0.37	0.13	0.17
Northern bobwhite	0.00 - 0.22	0.11	0.09
Orchard oriole	0.00 - 0.15	0.10	0.07
Eastern kingbird	0.06 - 0.10	0.08	0.02
Eastern bluebird	0.00 - 0.15	0.07	0.06
Red-winged blackbird	0.00 - 0.15	0.07	0.08
Song sparrow	0.00 - 0.15	0.06	0.06
Eastern wood peewee	0.00 - 0.15	0.06	0.07
Blue-gray gnatcatcher	0.00 - 0.22	0.06	0.11
Blue-winged warbler	0.00 - 0.15	0.04	0.07
Eastern towhee	0.00 - 0.15	0.04	0.07
Grasshopper sparrow	0.00 - 0.10	0.03	0.05
Baltimore oriole	0.00 - 0.07	0.02	0.04
Brown thrasher	0.00 - 0.05	0.01	0.03
Blue jay [a]	0.00 - 7.33	2.53	3.46
Brown-headed cowbird [a]	0.00 - 9.99	2.67	4.88
American crow [a]	0.00 - 5.93	1.53	2.93
Common grackle [a]	0.00 - 1.50	0.38	0.75

[a] Detected birds/complete visit/30 ha, not territories/ha.

Table 3. Estimated densities (territories/ha) of selected birds detected during spot-mapping on forest plots (*n* = 6) at Jefferson Proving Ground, IN, 1998.

Species	Range		SD
Red-eyed vireo	0.75 - 1.34	1.18	0.32
Acadian flycatcher	0.44 - 0.72	0.62	0.11
Ovenbird	0.26 - 0.81	0.58	0.23
Wood thrush	0.33 - 0.66	0.48	0.13
Eastern wood peewee	0.13 - 0.56	0.30	0.15
Kentucky warbler	0.06 - 0.61	0.26	0.19
Scarlet tanager	0.11 - 0.38	0.25	0.11
Eastern titmouse	0.06 - 0.28	0.15	0.08
Northern cardinal	0.03 - 0.33	0.13	0.12
Red-bellied woodpecker	0.03 - 0.16	0.09	0.05
Hooded warbler	0 .00 - 0.33	0.07	0.13
Yellow-throated vireo	0.00 - 0.11	0.06	0.04
White-breasted nuthatch	0.00 - 0.11	0.06	0.04
Pileated woodpecker	0.00 - 0.07	0.05	0.03
Yellow-billed cuckoo	0.00 - 0.11	0.05	0.04
Worm-eating warbler	0.00 - 0.13	0.05	0.06
Indigo bunting	0.00 - 0.15	0.05	0.06
Carolina wren	0.00 - 0.17	0.05	0.07
Cerulean warbler	0.00 - 0.09	0.04	0.04
Louisiana waterthrush	0.00 - 0.06	0.01	0.02
Blue jay [a]	3.79 - 7.31	5.63	1.21
Brown-headed cowbird [a]	6.05 - 10.91	8.15	1.89
American crow [a]	0.32 - 4.84	1.62	1.65
Common grackle [a]	0.00 - 0.32	0.08	0.14

[a] Detected birds/complete visit/30 ha, not territories/ha.

Table 4. Daily nest survival, overall Mayfield nesting success, and estimates of recruitment for selected species (i.e., where $n \geq 10$) of birds on Jefferson Proving Ground, IN, 1998. Mayfield nest success used extrapolated probabilities from each nest stage (i.e., laying, incubation, nestling) to give final combined estimate.

Habitat	Species	No. nests (No. failed)	Observation days	Daily overall survival	Daily survival variance	Mayfield nest success	Young/ successful nest (SE)	fledged/ adult female/year
Forest	Acadian flycatcher	70 (39)	1213.5	0.968	0.0051	0.325	2.35 (0.15)	1.28
	Wood thrush	67 (40)	828.5	0.952	0.0074	0.252	3.00 (0.16)	1.32
	Red-eyed vireo	28 (28)	252	0.889	0.0198	0.000	0.00 (0.00)	0.00
	Ovenbird	15 (8)	135.5	0.941	0.0202	0.280	4.00 (0.49)	1.45
	Kentucky warbler	10 (2)	88	0.977	0.0159	0.648	4.14 (0.26)	1.81
Grassland	Field sparrow	36 (24)	295.5	0.919	0.0159	0.134	3.42 (0.23)	1.07
	Henslow’s sparrow	14 (4)	75	0.947	0.0259	0.287	4.00 (0.26)	1.97

Table 5. Overall daily mortality and daily mortality apportioned to cause of failure for selected species (i.e., where $n \geq 10$) of birds on Jefferson Proving Ground, IN, 1998. Stochastic failures were due to abandonment, weather, and other similar causes.

Species	No. nests (No. failed)	Total daily mortality	Cause		
			Predation	Parasitism	Stochastic
Acadian flycatcher	70 (39)	0.0321	0.0305	0.0000	0.0016
Wood thrush	67 (40)	0.0483	0.0459	0.0012	0.0012
Red-eyed vireo	28 (28)	0.1111	0.1032	0.0040	0.0040
Ground nesters [a]	31 (11)	0.0345	0.0345	0.0000	0.0000
Field sparrow	36 (24)	0.0812	0.0812	0.0000	0.0000
Henslow's sparrow	14 (4)	0.0533	0.0533	0.0000	0.0000

[a] Ground nesting species include ovenbird, Kentucky warbler, worm-eating warbler, and Louisiana waterthrush.

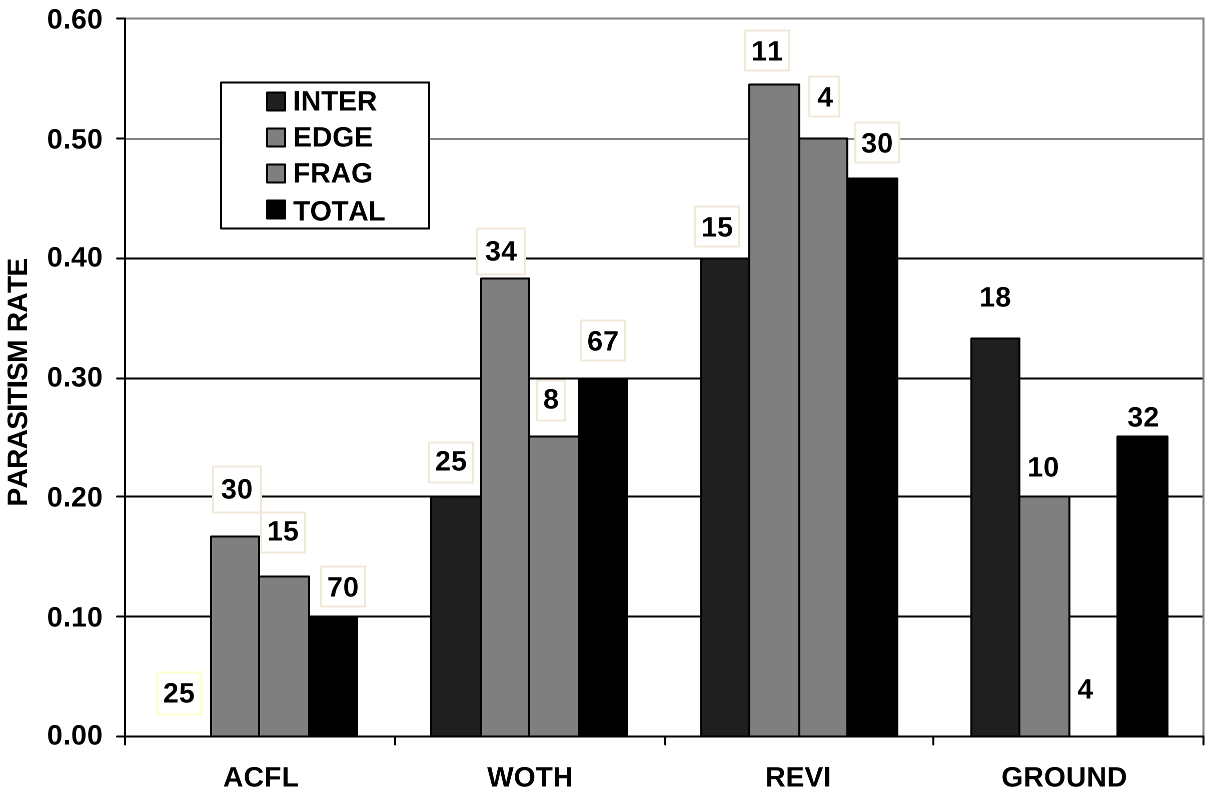


Fig. 7. Brown-headed cowbird parasitism rates (% nests parasitized) on forest interior (INTER), forest interior edge (EDGE), forest fragment (FRAG), and combined (TOTAL) plots for Acadian flycatcher (ACFL), wood thrush (WOTH), red-eyed vireo (REVI), and ground nesting species (GROUND; ovenbird, Kentucky warbler, worm-eating warbler, and Louisiana waterthrush) on Jefferson Proving Ground, IN, 1998. Numbers represent sample size of nests.

t = -1.73, 25 df, 2-tailed p = 0.096, 1-tailed p = 0.048). Late nests (those initiated after 15 June) had higher point estimates of daily survivorship than early nests, but this difference was only significant for wood thrush (*Hylocichla mustelina*) (Fig. 8). An overall treatment effect of forest plot type was also observed for wood thrush (p = 0.048) (Fig. 9).

Our simple source/sink analysis indicated that with the recruitment estimated at JPG, wood thrush and Acadian flycatchers were just able to replace losses under a scenario of good adult survival (0.60) but not with poor survival (0.40) (Figs. 10, 11). Henslow's sparrows were able to replace losses even under relatively poor survival conditions, but red-eyed vireos at JPG were not able to replace any losses due to lack of recruitment (Figs. 10, 11). Our estimates of recruitment appeared correlated with those of MAPS productivity indices for species that MAPS mist-net sites commonly captured (Fig. 12).

Monitored Henslow's sparrow nests were initiated as early as 1 May and as late as 27 July. Average clutch size was 4.50 ± 0.29 (SE) eggs (n = 4), and successful nests fledged an average of 4.00 ± 0.26 young (n = 10). We color banded 15 nestlings prior to fledging (Table 6, Fig. 13). An additional 3 nests were found after the nest fledged or failed, but the fates of these nests could not be determined. Broomsedge sp. dominated (13 of 17; 77 %) nest substrates; 3 additional nests were in cool season grass sp. and 1 nest was found in a species of panicum. Nest substrate height averaged 67.12 ± 6.11 cm high. Nests were typically at the base or top of a clump of grass (nest height, 7.81 ± 1.67 cm, n = 16) and were very well concealed (97 ± 0.74 % concealment, n = 17). Grass and sometimes surrounding herbaceous vegetation formed an overhanging canopy that concealed the nest cup, but as the nestling stage progressed the cup became slightly more visible, probably from nestling/fledgling or adult feeding activity. Litter depth and height of standing dead vegetation were both greater at nest sites than nonuse sites, but other vegetation variables were similar (Table 7). Some vegetation measurements (e.g., % vegetation that was green; live vegetation height) were probably biased due to the timing of data collection (August), especially for early nests (nests initiated in May-June).

DISCUSSION

Grassland Road Transects

Information gathered from road transects from 1995-98 indicate that the population of Henslow's sparrows on JPG appears stable. The observed density increases during this time period could be from a region-wide increase in the population or a shifting of the local breeding population caused by local losses of habitat on JPG. Henslow's sparrows show a strong area effect at JPG with an increasing probability of occurrence with increasing field size. The density of territories also appeared to be affected by grassland size, although this effect was not consistent among the years of the survey. Grassland area was shown to influence occurrence, breeding density and nest success for grassland birds in Missouri (Maiken Winter, Pers. Comm.).

If we incorporate our estimate of Henslow's sparrow detectability (0.716), the average breeding density in 1998 would be 0.77 ± 0.14 (SE) singing male/ha; this extrapolates to 1,121 ± 218 (95 % CI) singing male Henslow's sparrows on 1463 ha of grassland habitat on JPG. This is a conservative estimate, since the detection probability is most likely biased high because our spot-mapping protocol did not recognize territories of Henslow's sparrows that had fewer than 2

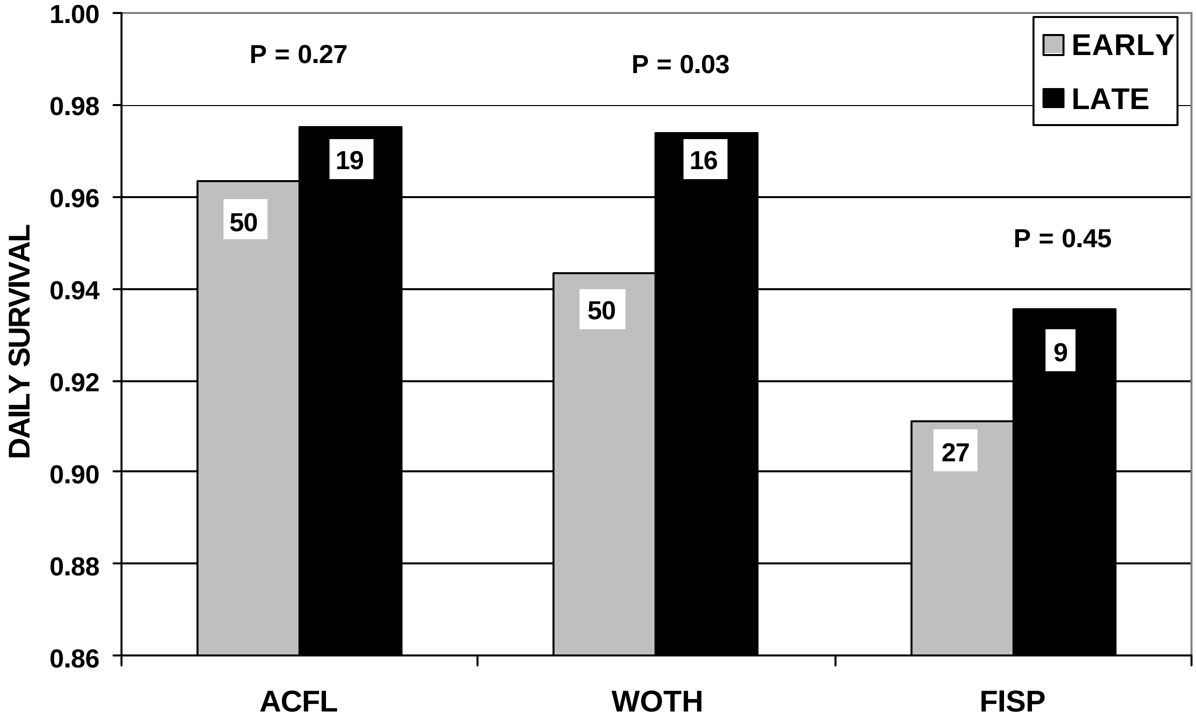


Fig. 8. Comparison (*p*-values from CONTRAST Chi-square test) of early(< June 15) and late (>June 15) daily nest survival for Acadian flycatchers (ACFL), wood thrushes (WOTH), and field sparrows (FISP) on Jefferson Proving Ground, IN, 1998. Numbers represent sample sizes of nests.

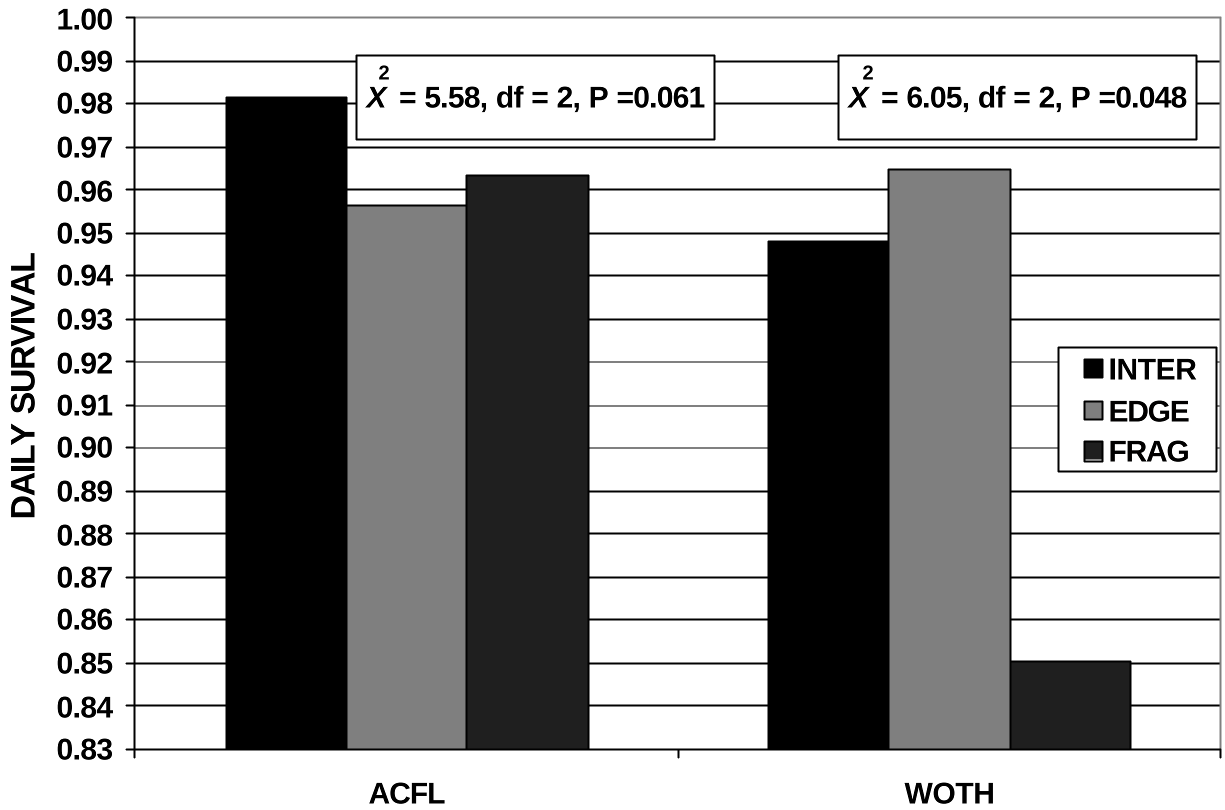


Fig. 9. Comparison (*p*-value from overall CONTRAST Chi-square test) of daily nest survival for forest interior (INTER), forest interior edge (EDGE), and forest fragment (FRAG) for Acadian flycatchers (ACFL) and wood thrushes (WOTH) on Jefferson Proving Ground, IN, 1998.

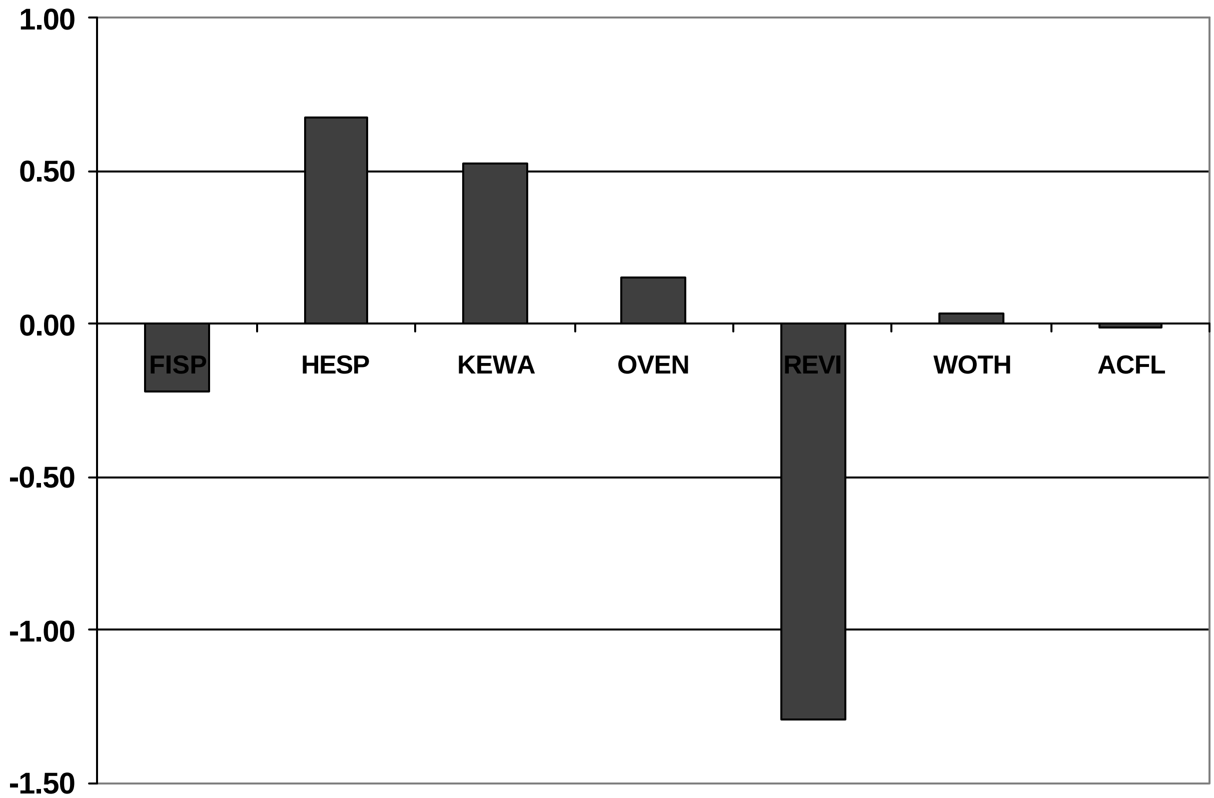


Fig. 10. Initial source/sink analysis for selected birds on Jefferson Proving Ground, IN, 1998. Analysis used estimates of 0.60 for adult survival and 0.31 for juvenile survival. Positive values represented recruitment that exceeded adult mortality and negative values represented recruitment that did not replace adult mortality.

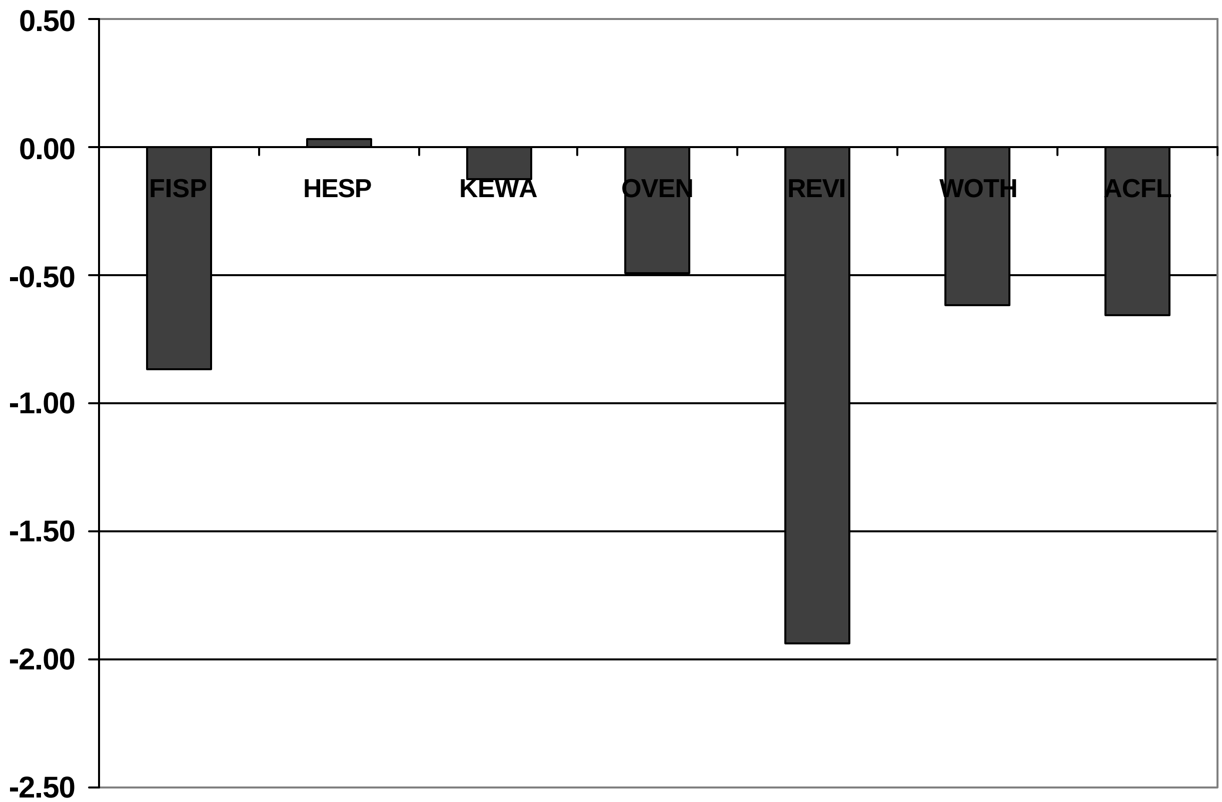


Fig. 11. Initial source/sink analysis for selected birds on Jefferson Proving Ground, IN, 1998. Analysis used estimates of 0.40 for adult survival and 0.31 for juvenile survival. Positive values represented recruitment that exceeded adult mortality and negative values represented recruitment that did not replace adult mortality.

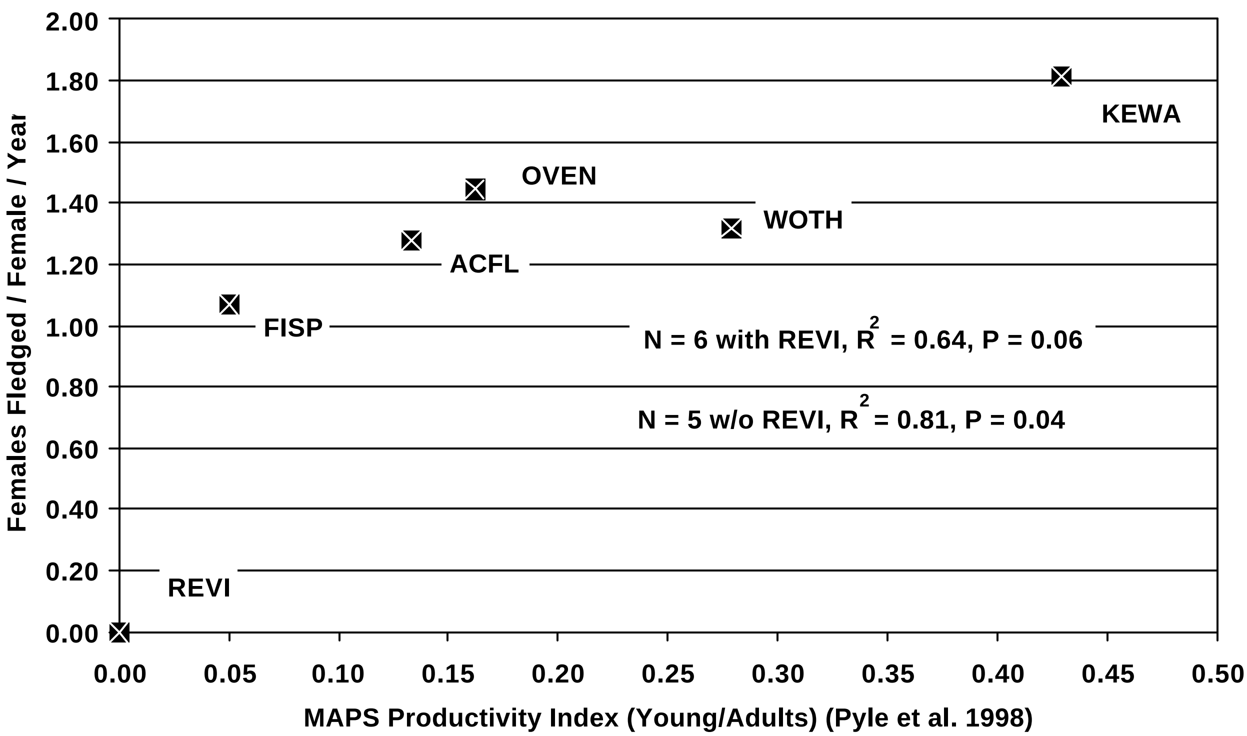


Fig. 12. Linear regression results of regressing recruitment estimated from nest plots with productivity indices (young/adult captured) estimated from MAPS mist net sites (indices from 1997 data) on Jefferson Proving Ground, IN, 1998.

Table 6. Information on Henslow's sparrows nestlings banded on Jefferson Proving Ground, IN, 1998.

FWS Band No.	Date	Plot	Nest ID	Age	Weight(g)	Color band
2070-24031	6/15/98	8	98JRR66	6-7	10.00	L Green R FWS [a]
2070-24032	6/18/98	8	98TVL67	7-8	12.00	L Yellow R FWS
2070-24033	6/18/98	8	98TVL67	7-8	10.50	L Orange R FWS
2070-24034	6/18/98	8	98TVL67	7-8	11.50	L White R FWS
2070-24035	6/18/98	8	98TVL67	7-8	10.25	L Blue R FWS
2070-24036	8/12/98	9	98JPL89	7-8	9.75	L Yellow/White R FWS
2070-24037	8/12/98	9	98JPL89	7-8	9.75	L Green/White R FWS
2070-24038	8/15/98	9	98TVL72	7-8	9.75	R White/FWS
2070-24039	8/15/98	9	98TVL72	7-8	10.25	R Pink/FWS
2070-24040	8/15/98	9	98TVL72	7-8	9.75	R Yellow/FWS
2070-24041	8/18/98	7	98TVL66	7-8	9.00	R Blue/FWS
2070-24042	8/19/98	8	98JPL86	7-8	9.50	L FWS R Yellow
2070-24043	8/19/98	8	98JPL86	7-8	9.00	L FWS R Blue
2070-24044	8/19/98	8	98JPL86	7-8	9.50	L FWS R Green
2070-24045	8/19/98	8	98JPL86	7-8	10.00	L FWS R Orange

[a] Bands on left leg (L) or right leg (R); color bands and U. S. Fish and Wildlife Service aluminum leg bands (FWS).

Fig.13. Henslow's sparrow nestling (7-8 days old) with color band and U. S. Fish and Service aluminum leg band, Jefferson Proving Ground, August, 1998.

Table 7. Comparison (*p*-values from Mann-Whitney tests) of vegetation parameters taken at Henslow's sparrow nest sites and nonuse sites on Jefferson Proving Ground, IN, August, 1998.

	Nest	(*n* = 17)	Nonuse	(*n* = 17)	
Variable		SE		SE	*p*
Litter depth (cm)	15.94	1.87	5.25[a]	1.03	0.00
Standing dead veg. (cm)	89.06[a]	3.43	60.06[a]	8.80	0.01
Live vegetation height (m)	74.35	7.19	74.65	6.74	0.77
Distance to perch (m)	5.06	1.12	6.86[a]	1.74	0.73
Avg. Robel Pole	4.38	0.29	3.89	0.40	0.20
% Grass	67.06	5.61	58.82	5.35	0.22
% Grass that was broomsedge	55.88	7.02	36.76	7.96	0.11
% Forbs	30.00	5.88	28.76	5.14	0.99
% Sedge	2.94	0.86	11.82	4.51	0.50
% Shrubs	4.71	2.48	5.59	2.90	0.93
% Vegetation that was green	75.59	5.11	73.82	6.06	1.00

[a] $n = 16$

registrations. We also assume that these detection probabilities estimated from our spot-mapping protocol would be appropriate for roadside transects. Ideally, we should use double sampling techniques (color marking for mark-recapture, etc.) on our roadside transects to estimate unbiased detection probabilities (Lancia et al. 1994).

We used an estimated detection distance of 150 m in our density estimates, but depending on observers and conditions, Henslow's sparrows can sometimes be detected to 200 m (Koford 1999). Although our comparison of densities estimated with 75-m belt transects were similar with those estimated with 75-150-m transects, variability in detection at greater distances could confound estimates (Wolf et. al 1995). We stopped our roadside surveys by 10:00 EST, but noticed decreases in detectability (i.e., singing) by 7-8:00 EST. Koford (1999) quantitatively showed decreases in singing frequency during late morning, but Heller and Hughes (1997) showed detectability of Henslow's sparrows remained fairly constant.

The mechanism of how fire influences breeding densities of Henslow's sparrows at JPG is unknown. Prescribed fire could positively influence the growth and vigor of broomsedge sp. and other plants that occur in the acidic soils found on JPG (Mike Homoya, Pers. Comm.). Fire could also decrease local predator densities, especially if the fire occurred in early spring when some predators (e.g., snakes) would be vulnerable. From observed changes in densities on individual fields, it appears that the fire effect differs with other associated disturbance factors (i.e., previous soil removal, herbicide application, etc.). Complete histories of disturbance for the monitored fields are not presently available, but some fields appear to becoming more productive (i.e., less unvegetated areas) with time. Henslow's sparrow densities are increasing in these fields at later time intervals than other fields. Many fields showed an initial strong response 2 growing seasons after the fire as illustrated by the overall trend (Fig. 6). This initial strong response by Henslow's sparrows could allow a more aggressive prescribed fire rotation that would be helpful in fighting woody encroachment. There are apparently differences in recolonization by breeders in response to fire between northern and southern areas within the range of Henslow's sparrows (see Pruitt 1996).

Nest Survey Plots

Results from our pilot field season should be interpreted cautiously. Variation in annual nest success can be great, and larger sample sizes could alter nest success estimates and associated estimates of recruitment. We analyzed our data to better prepare for the upcoming field season and to incorporate our initial findings to strengthen important data sets in 1999. For example, estimates of recruitment probably could be improved with separate estimates of nest success for early and late nests. The number of nesting attempts per female also could improve estimates of recruitment. Survival estimates derived by MAPS stations on JPG are also needed to better understand local source/sink dynamics.

The suite of species found on plots were dependent on the habitats found within these plots. We selected relatively, large open grasslands to increase our probability of including nesting Henslow's sparrows. Because we selected such sites, Henslow's sparrows were the most common nesting bird in our grassland plots. Our forest fragment plots were more heterogeneous than plots in forest interior and forest interior edge; one fragment plot had a large stand of pole timber within the plot boundaries and the other plot, because of a recent fire history, had a reduced mid-story. These factors contributed to density and species occurrence differences observed among plots.

The total lack of recruitment by red-eyed vireos is perplexing. Low recruitment for red-eyed vireos could be due to a combined vulnerability to avian predators (e.g., blue jays) and to parasitism by brown-headed cowbirds. Nest losses due to egg removal or puncturing of eggs by cowbirds would also be classified as predation, so losses due directly to cowbirds would be difficult to ascertain. Causes of nest mortality are generally difficult to estimate from nest sign and such estimates are usually biased (Diane Granfors, Pers. Comm). Besides corvids, we commonly observed snakes on forest and on grassland plots; a black racer (*Coluber constrictor*) was observed depredating a field sparrow nest. Corvids and snakes are both common in edge habitats, and the habitat heterogeneity on JPG would favor high densities of these predators.

Plans For Next Year

We plan to basically repeat our study during 1999 with additional field personnel to increase our sample of nests. We will evaluate our choices of forest fragment plots to ensure that the plots meet our study objectives. An additional grassland plot could be marked and searched if the site becomes available. We will remark plot boundaries and use a Global Positioning System (GPS) receiver to locate plot boundaries for plot area estimates and for GIS analyses. We will begin nest searching in April-May in grasslands to find early nesting species (e.g., eastern meadowlark). Vegetation sampling of nests will be done as quickly as possible after termination of nesting to reduce seasonal biases. Additional landscape analyses via GIS will take place following the 1999 field season.

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LITERATURE CITED

Bibby, C. J., N. D. Burgess, and D. A. Hill. 1992. Bird census techniques. Academic Press

Britingham M. C., and S. A. Temple. 1983. Have cowbirds caused forest songbirds to decline? Bioscience 33:31-35.

Burger, L. D., L. W. Burger, J. A. Faaborg. 1994. Effects of prairie fragmentation on predation on artificial nests. J. Wildl. Manage. 52:249-254.

Dawson, D. K., L. J. Darr, and C. S. Robbins. 1993. Predicting the distribution of breeding birds forest birds in a fragmented landscape. Trans. N. Am. Wildl. And Nat. Res. Conf. 58:38-43.

Delphi, P. J., J. Hengeveld, and S. Pruitt. 1995. Results of Henslow's sparrow surveys at Jefferson Proving Ground, Indiana in 1995. U. S. Fish and Wildlife Service, Bloomington, IN. 9 pp.

Donovan, T. M., F. R. Thompson, III, J. Faaborg, and J. R. Probst. 1995. Reproductive success of migratory birds in habitat sources and sinks. Conserv. Biol. 9:1380-1395.

Heller, S., and K. Hughes. 1997. Song activity of Henslow's sparrow and grasshopper sparrow over a 24-hour period. Indiana Audubon Quarterly 75:61-67.

Herkert, J. R. 1994a. The effects of habitat fragmentation on midwestern grassland bird communities. Ecol. Appl. 4:461-471.

______. 1994b. Status and habitat selection of the Henslow's sparrow in Illinois. Wilson Bull. 106:35-45

Hines, J. E. and J. R. Sauer. 1989. Program CONTRAST: a general program for the analysis of several survival or recovery estimates. U. S. Fish and Wildlife Service, Gen. Tech. Report-24, Washington, D. C.

Johnson, R. G., and S. A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. J. Wildl. Manage. 54:106-111.

Koford, R. 1999. Status of Henslow's sparrow in the former tall-grass prairie ecosystem. Final Report, RWO No. 43. Iowa Coop. Fish and Wildl. Res. Unit, Ames. 58 pp.

Lancia, R. A., J. D. Nichols, and K. H. Pollock. 1994. Estimating the number of animals in wildlife populations. Pages 215-253 *in* T. A. Bookhout, ed. Research and management techniques for wildlife and habitats. Fifth ed. The Wildlife Society, Bethesda, MD.

Martin, T. E., C. E. Paine, C. J. Conway, W. H. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD field protocol. Montana Cooperative Wildlife Research Unit, Missoula, MT. 65 pp.

Mayfield , H. 1961. Nesting success calculated from exposure. Wilson Bull. 73:255-261.

______. 1975. Suggestions for calculating nest success. Wilson Bull. 87:456-466.

Miller, S., L. Pruitt, and S. Pruitt. 1997. Henslow's sparrow surveys at Jefferson Proving Ground from 1995-97. U. S. Fish and Wildlife Service, Jefferson Proving Ground, IN. 9 pp.

Pulliam, H. R. 1988. Sources, sinks, and population regulation. Am. Nat. 132:652-661

Pruitt, L. 1996. Henslow's sparrow status assessment. U. S. Fish and Wildlife Service, Bloomington, IN. 113 pp.

Pyle, P., D. R. Froehlich, and D. F. DeSante. 1998. The 1997 annual report of the monitoring avian productivity and survivorship (MAPS) program on military installations in the midwest: Fort Riley, Fort Leavenworth and Sunflower Army Ammunition Plant, Fort Leonard Wood, Crane Naval Surface Warfare Center, Jefferson Proving Ground, and Fort Knox. Inst. Bird Populations, Point Reyes Station, CA. 70 pp.

Ricklefs, R. L. 1973. Fecundity, mortality, and avian demography. Pages 336-435 *in* D. S. Farner, ed. Breeding Biology of Birds, National Academy Science, Philadelphia, PA.

Robb, J. R., and R. P. Dettmers. 1996. Implications of stand characteristics and landscape-level effects on forested wetland wildlife. Pages 63-74 *in* S. D. Roberts and R. A. Rathfon, eds. Management of forested wetland ecosystems in the central hardwood region: a regional ecosystem management workshop. Purdue Univ., W. Lafayette, IN.

Robbins, C. S., D. K. Dawson, and B. A. Dowell. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic States. Wildl. Monogr. 103:1-34.

Robinson, S. K. 1992. Population dynamics of breeding neotropical migrants in a fragmented Illinois landscape. Pages 400-418 *in* J. M. Hagan and D. W. Johnston, eds. Ecology and conservation of neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C.

_____, J. A. Gryzbowski, S. I. Rothstein, M. C. Brittingham, L. J. Petit, and F. R. Thompson. 1993. Management implications of cowbird parasitism on neotropical migrant songbirds. Pages 93-102 *in* D. Finch and P. Stangel, eds. Status and management of neotropical migratory birds. U.S.D.A. For. Serv., Gen. Tech. Rep. RM-229.

Sauer, J. R. and B. K. Williams. 1989. Generalized procedures for testing hypotheses about survival or recovery rates. J. Wildl. Manage. 53:137-142.

Wolf, A. T., R. W. Howe, and G. J. Davis. 1995. Detectability of forest birds from stationary points in northern Wisconsin. Pages 19-23 *in* C. J. Ralph, J. R. Sauer, and S. Droege, eds. Monitoring bird populations by point counts. U.S.D.A. For. Serv., Gen. Tech. Rep. PSW-

GTR-149.

Zar, J. H. 1996. Biostatistical analysis. Third ed. Prentice Hall, Upper Saddle River, NJ. 662 pp. + appendices.