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IMPACT OF PASTURE DEVELOPMENT ON WINTER BIRD COMMUNITIES IN BELIZE, CENTRAL AMERICA[1]

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Abstract. We studied bird use of actively grazed and abandoned (2–4 years) pastures during February 1990 in Belize, where pastures often are maintained by repeated mowing. A total of 46 species was observed in the two pasture types, with 15 species detected in grazed and 39 in abandoned. Species richness for both migrants and residents was lower by >50% in grazed pastures. Overall abundance of birds was lower by nearly 70% in grazed pastures compared with the more structurally diverse abandoned pastures ($P < 0.001$). Based on data from a concurrent study on bird use of forest interior habitat in Belize, 2–4 times more resident species would be expected in nearby broadleaved forests compared to an equal census effort in grazed pastures. In contrast, only about 1.5 times more migrant bird species would be predicted in broadleaved forest interior than in grazed pastures. Foraging guilds were not equally represented between pasture treatments; most notable was an absence of frugivores and nectarivores in grazed pastures maintained by mowing. Our results indicate that retention of some shrubs and overstory trees may reduce the negative effects of pasture development of winter bird populations in Central America.

Key words: *Habitat use; disturbance; neotropical migrants; pastures; Belize; tropical birds.*

INTRODUCTION

The highest rates of deforestation in Latin America are occurring in Central America, the Caribbean islands, and Mexico (Myers 1980, Buschbacher 1986), areas where most neotropical migratory birds overwinter (Terborgh 1980). The major cause of forest clearing in Central America is pasture development for cattle grazing (Myers 1980, Buschbacher 1986). Conversion of tropical forests to grazed pastures drastically alters bird community composition (e.g., Karr 1971, Lynch 1989) and potentially reduces wildlife diversity (cf. Karr 1971 with Lynch 1989), but our knowledge on this topic is remarkably meager (e.g., Askins et al. 1990).

Grazing by livestock can affect plant communities by altering species composition, reducing species diversity, and decreasing vegetative growth (Holechek et al. 1989). Cattle compact soil by hoof action, remove plant materials, and indirectly reduce water infiltration, all of which result in decreased vegetation density (Holechek et al. 1989). In turn, these alterations of the structure and floristics in plant communities are known to negatively affect breeding bird communities in the temperate zone (e.g., Bock et al. 1984, Taylor 1986, Knopf et al. 1988). However, few studies have documented the effect of grazing on birds in the Neotropics (Martin 1984, Lynch 1989). We studied bird use of actively grazed and abandoned pastures in Belize, where pastures often are maintained by repeated mowing. Here we report on avian abundance and composition in these pastures and compare those findings to similar data from nearby tropical forests (Petit 1991).

STUDY AREA AND METHODS

We conducted the study during February 1990 within a 200 km² area in central Belize (17°15'N, 88°45'W). Pastures were located in the flat lowlands (<300 m), the soils of which were derived from limestone bedrock. The climate of central Belize is characterized by relatively high annual rainfall (1,500–2,000 m), <15% of which falls during the January–April dry season (Hartshorn et al. 1984). The area supports semi-evergreen broadleaved forests.

Pastures grazed by cattle were mowed about

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every six months. Common plant species associated with the grazed pastures included pitted bluestem (*Bothriochloa pertusa*), stargrass (*Rhynchospora nervosa*) (a widespread sedge), milkweed (*Asclepias curassavica*), mint (*Hyptis* sp.), and two shrubs, tick trefoil (*Desmodium canum*) and shrubby verbena (*Stachytarpheta cayennensis*). As a result of mowing, shrubs were rarely taller than 20 cm. Grazed pastures ranged in size from 80–200 ha.

Abandoned pastures had not been grazed intensively or mowed for 2–4 years. Emergent woody plants typical of abandoned pastures included palm (*Orbignya cohune*), wild grape (*Coccoloaba belizensis*), bullhorn acacia (*Acacia* sp.) and trumpet tree (*Cecropia peltata*). Canopy height in abandoned pastures was 1–3 m and plot size ranged from 50–180 ha.

We censused birds at six sites, three each in actively grazed and abandoned pastures. Point counts were used to estimate relative bird abundances (Hutto et al. 1986). We made one visit to a total of 50 survey points, 25 in each pasture type. Within a given site, 4–10 survey points were spaced 200 m apart along a transect located at least 100 m from habitat edge. Two observers surveyed birds for 6 min at each point and recorded every individual detected within 40 m.

Similarity in bird species composition between pasture types was evaluated with Sorensen's Index (Mueller-Dombois and Ellenberg 1974): $2W \times 100/a + b$, where W was the number of species shared by grazed and abandoned pastures, and a and b were the numbers of species found in grazed and ungrazed pastures, respectively. To control for differences in the number of individuals censused in the two pasture types, rarefaction (Simberloff 1972) was used to examine differences in the number of species between grazed and abandoned pastures. Mann-Whitney *U*-tests were used for statistical comparisons of relative abundance of birds. The significance level for all tests was $P < 0.05$, and all tests were two-tailed. Means are followed by ±one standard deviation.

Vegetation measurements were conducted at 15 randomly selected points along transects in each of the two pasture types. Location of the center of each vegetation plot was determined by a random compass direction and distance (<40 m) from the center of bird point count circles. At each plot, vegetation profiles were measured four times on the perimeter of a 10-m radius subcircle in each of the four cardinal directions.

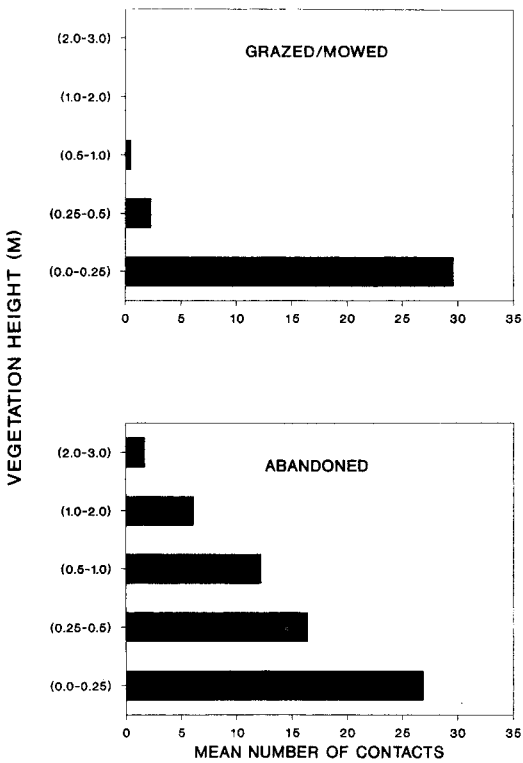

FIGURE 1. Vegetation profiles for grazed/mowed and abandoned pastures in Belize, Central America during winter 1990.

Number of contacts of vegetation along a 1.2-cm-diameter rod was used to estimate relative vegetation density in each of five height intervals (≤0.25, >0.25–0.5, >0.5–1.0, >1.0–2.0, and >2.0–3.0 m). Number of stems of broadleaved or palm trees and shrubs in each of three stem diameter size classes (≤1.0, >1.0–2.5, and >2.5–8.0 cm) was recorded at breast height.

RESULTS

Vegetation height was lower in grazed pastures maintained by mowing compared with abandoned pastures. Vegetation density differed significantly between grazed and abandoned pastures (Mann-Whitney *U*-tests, $P < 0.01$) at all height intervals, except the interval from the ground to 0.25 m ($P > 0.05$) (Fig. 1). Mean stem counts (broadleaved and palm combined) in all diameter size classes were greater (Mann-Whitney *U*-tests, $P < 0.001$) in abandoned than in grazed pastures (≤1.0 cm, $\bar{x} = 46.1$ vs. 1.2; >1.0–2.5 cm, $\bar{x} = 32.3$ vs. 1.1; >2.5–8.0 cm, $\bar{x} = 12.1$ vs. 0). In abandoned pastures, 87% of the total

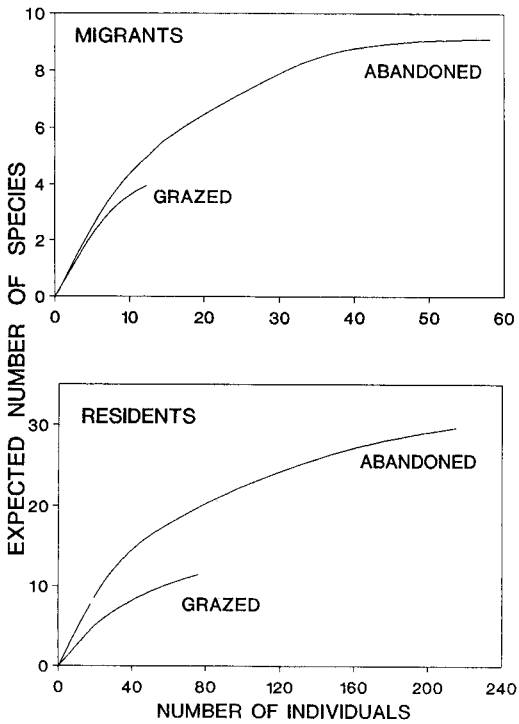

FIGURE 2. Rarefaction curves of migrant and resident bird communities in abandoned and grazed pastures in Belize. Curves represent number of species expected to comprise a sample of n individuals.

stem count (1,356) was derived from broadleaved trees and shrubs, while palm vegetation provided 13% of the total. No palms were counted in grazed pastures.

We observed a total of 46 species, of which 12 (26%) were overwintering neotropical migrants from North America (Appendix). Bird species richness differed markedly between pasture types, with 15 species detected in grazed and 39 in abandoned. Accordingly, species richness for both migrants and residents was diminished by >50% in grazed pastures (Appendix). Rarefaction showed similar differences in species richness between pasture treatments although the number of migratory species did not appear to be substantially affected by grazing (Fig. 2). If the same number of individuals were censused in both habitats, rarefaction predicts that five migratory species would be represented in abandoned pastures (as opposed to four species seen in grazed pastures). In contrast, we observed 74 individuals representing 11 resident species in grazed pastures, but 21 resident species would be expected at that sample size in abandoned pastures.

Sorensen's index indicated that overall bird species composition had a low degree of similarity (30%) between grazed and abandoned pastures. Compared with that for the entire bird community, resident species composition was slightly more similar (34%), whereas migrant species were much less similar (15%).

Overall relative abundance of birds was lower by nearly 70% in grazed pastures (3.4 ± 4.3 [birds/point count]) compared to the more structurally diverse abandoned pastures (11.1 ± 4.4)(Z = 4.75, $P < 0.001$). Likewise, abundance of both migrants (2.3 ± 1.6 [abandoned] vs. 0.4 ± 1.1 [grazed]; $Z = 4.76$, $P < 0.001$) and residents (8.8 ± 4.0 [abandoned] vs. 2.9 ± 4.1 [grazed]; Z = 4.28, $P < 0.001$) was significantly affected by grazing/mowing activities. Foraging guilds were not equally represented between pasture treatments; grazed pastures contained no frugivores or nectarivores, but we recorded four species of each foraging guild in abandoned pastures (Appendix). The difference in percentage of aerial insectivores was also notable, with 27% and 8% of species in grazed and abandoned pastures, respectively.

DISCUSSION

Grazing by cattle, and the concomitant alteration of soil and vegetation, generally causes drastic reductions in animal species diversity across widespread taxa (cf. Holechek et al. 1989). Yet, despite the recently enhanced rate of pasture development in the New World tropics, few data exist on the impact of this practice on animal populations (e.g., Terborgh 1980, Martin 1984, Askins et al. 1990).

In Belize, active pastures represented a habitat severely denuded with respect to avifauna, even when compared with pastures that were once mowed and grazed but left fallow for several years with little or no grazing. This discrepancy in bird species richness becomes even greater, especially for resident birds, when grazed pastures are compared with surrounding tall secondary forest. Based on information from an extensive data set (Petit 1991), 2–4 times more resident species would be expected in moist broadleaved forests in central Belize compared to an equal census effort in grazed pastures. In contrast, only about 1.5 times more migratory bird species would be predicted in broadleaved forest interior than in grazed pastures. Migratory bird diversity in other habitats (e.g., broadleaved forest edge, pine-sa-

vanna), however, is several times greater than that found in grazed pastures (Petit 1991).

Other research (e.g., Rappole and Warner 1980, Waide 1980, Lynch 1989, Robbins et al. 1989, Hutto 1989) has shown that development of agricultural lands and pastures in the Neotropics creates preferred habitats for numerous migratory bird species, such as Least Flycatcher (*Empidonax minimus*), Yellow Warbler (*Dendroica petechia*), Common Yellowthroat (*Geothlypis trichas*), and Yellow-breasted Chat (*Icteria virens*). Our censuses in Belize also indicate that those species benefit from forest clearing. However, Least Flycatchers, Yellow Warblers, Common Yellowthroats, and Yellow-breasted Chats exhibited clear avoidance of heavily managed pastures, which suggests that only after pastures are abandoned or grazing intensity lessens, do those lands become suitable winter habitat for migrants (and residents) (cf. Lynch 1989; Petit et al., in press).

Retention of some shrubs or overstory trees in pastures provides habitat for numerous species (Martin 1984, Lynch 1989). For example, in the Yucatan, active pastures with scattered overstory trees and shrubs supported numbers of species similar to those found in nearly a dozen other vegetation types (Lynch 1989). Other studies have shown that bird species richness increases rapidly with addition of vertical layers of vegetation (MacArthur and MacArthur 1961, Roth 1976). In Belize, turnover of bird species apparently proceeds fairly rapidly after grazing and mowing activities lessen, because similarity of bird communities in grazed and recently abandoned pastures was low.

Pasture development had a differential impact on avian feeding guilds. Aerial insectivores and, possibly, carnivores were probably not greatly affected by elimination of woody vegetation (Appendix). Aerial insectivores do not rely upon vegetation for feeding substrates and open-country raptors may have enhanced hunting success at sites with relatively sparse vegetation (e.g., Bechard 1982). In contrast, species dependent upon food resources produced directly (frugivores, nectarivores, and granivores) or indirectly (foliage insectivores) by tall plants were less well represented in grazed compared to abandoned pastures. Local absence of frugivores and nectarivores could have widespread ramifications, because those species are important seed dispersers and pollinators, respectively (Feinsinger 1983, Herrera 1984).

Efforts aimed at lessening the inevitable impact of human encroachment on tropical ecosystems must develop plans that offer a compromise between economic and social expansion and sound ecological fundamentals (National Research Council 1982). Our results, along with those of others (Karr 1971, Lynch 1989), indicate that retention of some shrubs and overstory trees may reduce the negative effects of pasture development on winter bird populations in Central America. Although species assemblages in active pastures are markedly different in composition than those found in nearby broadleaved forests (this study; Petit 1991; also see Lynch 1989), scattered shrubs and trees in pastures do attract substantial numbers of resident and migrant species, some of which are usually considered forest-dwellers (Lynch 1989, Robbins et al. 1989). Furthermore, woody vegetation contributes directly (by providing seeds) and indirectly (by attracting fruit-eating seed dispersers) to the seed banks of active pastures and may allow succession to proceed more rapidly once intensive grazing or management ceases. This, in turn, allows rapid turnover and accumulation of bird species that use more complex vegetation types and that are most susceptible to human-caused extirpation.

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APPENDIX. Composition and total number of birds detected in grazed/mowed and abandoned pastures in Belize, Central America, February 1990. Numbers represent total number of individuals detected in each pasture type.

	Species	Status[a]	Guild[b]	Grazed/ mowed	Abandoned
1	Cattle Egret (*Bubulcus ibis*)	R	FI	2	0
2	Black-shouldered Kite (*Elanus caeruleus*)	R	CA	0	1
3	Roadside Hawk (*Buteo magnirostris*)	R	CA	0	1
4	American Kestrel (*Falco sparverius*)	M	CA	1	0
5	Ruddy Crake (*Laterallus ruber*)	R	FI	0	4
6	Common Snipe (*Gallinago gallinago*)	R	FI	2	0
7	Blue Ground-Dove (*Claravis pretiosa*)	R	OM	0	1
8	Plain-breasted Ground-Dove (*Columbiana minuta*)	R	OM	1	3
9	Olive-throated Parakeet (*Aratinga nana*)	R	FR	0	7
10	Red-lored Parrot (*Amazona autumnalis*)	R	FR	0	4
11	White-fronted Parrot (*A. albifrons*)	R	FR	0	2
12	Grove-billed Ani (*Crotophaga sulcirostris*)	R	FI	0	1
13	Little Hermit (*Phaethornis longuemareus*)	R	NE	0	2

APPENDIX. Continued.

Species	Status[a]	Guild[b]	Grazed/ mowed	Abandoned
14 White-necked Jacobin (*Florisuga mellivora*)	R	NE	0	1
15 Fork-tailed Emerald (*Chlorostilbon canivetii*)	R	NE	0	1
16 Rufous-tailed Hummingbird (*Amazilia tzacatl*)	R	NE	0	2
17 Yellow-bellied Elaenia (*Elaenia flavogaster*)	R	OM	0	2
18 Least Flycatcher (*Empidonax minimus*)	M	FI	0	7
19 Vermilion Flycatcher (*Pyrocephalus rubinus*)	R	AI	0	5
20 Great Kiskadee (*Pitangus sulphuratus*)	R	OM	0	5
21 Social Flycatcher (*Myiozetetes similis*)	R	OM	0	8
22 Tropical Kingbird (*Tyrannus melancholicus*)	R	OM	1	8
23 Fork-tailed Flycatcher (*T. savanna*)	R	AI	3	2
24 Gray-breasted Martin (*Progne chalybea*)	R	AI	3	5
25 Tree Swallow (*Tachycineta bicolor*)	M	AI	2	0
26 Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	R	AI	46	0
27 Brown Jay (*Cyanocorax morio*)	R	OM	0	7
28 Spot-breasted Wren (*Thryothorus maculipectus*)	R	FI	0	3
29 Gray Catbird (*Dumetella carolinensis*)	M	FR	0	3
30 Mangrove Vireo (*Vireo pallens*)	R	FI	0	5
31 Yellow Warbler (*Dendroica petechia*)	M	FI	1	6
32 Magnolia Warber (*D. magnolia*)	M	FI	0	3
33 Yellow-rumped Warbler (*D. coronata*)	M	OM	7	0
34 American Redstart (*Setophaga ruticilla*)	M	FI	0	2
35 Waterthrush sp. (*Seiurus* sp.)	M	FI	0	1
36 Common Yellowthroat (*Geothlypis trichas*)	M	FI	0	24
37 Gray-crowned Yellowthroat (*G. poliocephala*)	R	FI	0	4
38 Yellow-breasted Chat (*Icteria virens*)	M	OM	0	10
39 Indigo Bunting (*Passerina cyanea*)	M	GR	0	2
40 Green-backed Sparrow (*Arremonops chloronotus*)	R	OM	0	4
41 Blue-black Grassquit (*Volatinia jacarina*)	R	GR	1	61
42 Variable Seedeater (*Sporophila aurita*)	R	GR	1	1
43 White-collared Seedeater (*S. torqueola*)	R	GR	2	61
44 Thick-billed Seedfinch (*Oryzoborus funereus*)	R	GR	0	5
45 Eastern Meadowlark (*Sturnella magna*)	R	OM	12	0
46 Melodius Blackbird (*Dives dives*)	R	OM	0	3
Summary:				
Total individuals			85	277
Total number of species detected			15	39
Total number of species in common			8	—
Total number of unique species			7	31
Total number of long distance migrants (%)			4 (27)	9 (23)
Total number of aerial insectivores (%)			4 (27)	3 (8)
Total number of foliage insectivores (%)			3 (20)	11 (28)
Total number of omnivores (%)			4 (27)	10 (26)
Total number of granivores (%)			3 (20)	5 (13)
Total number of frugivores (%)			0	4 (10)
Total number of nectarivores (%)			0	4 (10)
Total number of carnivores (%)			1 (6)	2 (5)

[a] R = resident; M = migrant.
[b] Foraging guild. AI = aerial insectivore; CA = carnivore; FI = foliage insectivore; FR = frugivore; GR = granivore; NE = nectarivore; OM = omnivore.