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NESTING BIRDS AND GRAZING CATTLE: ACCOMMODATING BOTH ON MIDWESTERN PASTURES

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Abstract. We measured the diversity, density, nest success, and productivity of grassland birds on three types of sites in southwestern Wisconsin: ungrazed grasslands, continuously grazed pastures, and rotationally grazed pastures. We found that diversity, density, nest success, and productivity were highest on ungrazed grasslands. Continuously grazed pastures had the lowest diversity and density but intermediate nest success and productivity. Rotationally grazed pastures had intermediate diversities and densities but the lowest nest success and productivity. We recommend a grassland management regime in which areas of ungrazed grassland and rotationally grazed pastures are maintained in a 1:2 ratio on farms during the nesting season (15 May–1 July). Our data suggest that such a management regime would result in per-farm avian productivity that is higher than on continuously grazed and rotationally grazed pastures and much higher than that reported for frequently mowed hayfields.

EL ANIDAJE DE AVES Y EL APACENTAMIENTO DE GANADO: COMO ACOMODAR A LOS DOS EN LAS PASTURAS DEL MEDIOOESTE

Sinopsis. Medimos la diversidad, la densidad, el éxito de los nidos y la productividad de aves de pastizal en tres tipos de lugares en el sudoeste de Wisconsin: los pastizales no apacentados, las pasturas continuamente apacentadas y las pasturas apacentadas en rotación. Encontramos que la diversidad, la densidad, el éxito de los nidos y la productividad fueron mayores en los pastizales no apacentados. La diversidad y la densidad fueron menores en las pasturas continuamente apacentadas, pero el éxito de los nidos y la productividad fueron medianos. Encontramos que las diversidades y las densidades fueron medianas en las pasturas apacentadas en rotación, pero asimismo, también tuvieron el menor éxito de los nidos y la menor productividad. Recomendamos un régimen de manejo de los pastizales en el que las áreas de pastizales no apacentados y las pasturas apacentadas en rotación se mantengan en una proporción 1:2 en los terrenos agrícolas durante la estación de anidaje (15 mayo–1 julio). Nuestros datos sugieren que tal régimen de manejo daría por resultado una productividad avícola por granja mayor que en las pasturas continuamente apacentadas y las apacentadas en rotación, y mucho mayor que la registrada en los henares frecuentemente segados.

Key Words: grassland birds; nesting success; pasture management; population densities; rotational grazing; Wisconsin.

As native tallgrass prairies in the midwestern United States have all but disappeared, grassland birds nesting in the region have been forced to adopt a variety of secondary habitats that usually are associated closely with agriculture. Although cultivated row crops do not usually provide suitable nesting habitat for most grassland birds (Basore et al. 1986), other agricultural lands can accommodate many of their needs. The most attractive of the secondary habitats for grassland birds in the Midwest are lands managed intensively to produce forage for animals (Sample 1989). Several types of managed grasslands are found, among them grass/legume hayfields that are mowed regularly to provide food for confined livestock, pastures that are grazed continuously by free-ranging stock, and pastures that are grazed rotationally by animals that are moved regularly within a network of small paddocks.

The attractiveness and suitability of these managed grasslands for nesting birds vary. Hayfields can be attractive to birds selecting habitat in the spring, but birds that nest there may have poor reproductive success when mowing cycles are shorter than nesting cycles and many nests are destroyed (Bollinger et al. 1990, Frawley and Best 1991). Continuously grazed pastures are less attractive to most birds early in the nesting season when there is little vegetative cover, and the continuous presence of livestock causes nest disturbances and failures (Kirsch et al. 1978, Jensen et al. 1990). It has been suggested that rotationally grazed pastures, which are becoming increasingly popular (Undersander et al. 1991), could benefit nesting birds (Barker et al. 1990, Severson 1990). There have been few studies, however, of how birds respond to rotational grazing in the Midwest, and optimism regarding its benefits for birds has been largely speculative.

We studied the diversity, density, nesting success, and productivity of birds nesting in ungrazed pastures, continuously grazed pastures, and rotationally grazed pastures. Our goal was to use this information to design grassland management systems that accommodate the needs both of grazing livestock and nesting birds.

METHODS

Our study sites were located on privately owned dairy and beef farms in southwestern Wisconsin in a region (Green, Iowa, and Lafayette Counties) featuring an open landscape in which managed grasslands and row crops are the dominant cover types. We selected previously grazed grassland sites that could be managed according to our guidelines. These sites were in open areas away from trees, buildings, or other landscape features that might create ecological edges, and they were in large landscapes that were similar in topography and land use. Over three seasons (1993–1995), 19 sites totaling 98 ha were managed as ungrazed grasslands which cooperating farmers agreed to neither mow nor graze between 15 May and 1 July. Over the same period, 16 sites totaling 91 ha were managed as continuously grazed pasture on which cattle were stocked at densities of 2.5–4 animals per hectare. Finally, 24 sites totaling 124 ha of grassland were managed as rotationally grazed pasture where stocking densities were typically 40–60 animals per hectare in small paddocks that averaged about 5 ha in size. These paddocks were grazed by livestock for 1–2 d and then left undisturbed, typically for 10–15 d, before being grazed again. Stocking densities, durations of grazing, and intervals between grazing varied primarily as a result of the rate at which forage plants grew. Stocking densities were higher, whereas durations of grazing and intervals between grazing were shorter, when vegetation grew quickly.

All of the sites had similar vegetative composition: 50–75% cool-season grasses, 7–27% legumes, and 8–23% forbs. The structure of the vegetation varied with the grazing treatments. Continuously grazed pastures had little vegetative cover and were kept closely cropped by cattle. Ungrazed grasslands had the most complex structure, with residual debris and vegetation that grew throughout the study periods. Rotationally grazed grasslands varied cyclically through the study periods, with much of the vegetation removed during a grazing episode, and the most complex structure redeveloped just prior to the next grazing period after vegetation had recovered. All sites were on level to slightly rolling land, at least 200 m from stands of trees, and without permanent waterways.

On each site we recorded all bird species detected between 1 May and 1 July. Every 3–5 d we visited each site and used a flush-and-follow territory-mapping technique (Wiens 1969) to determine the densities of territorial birds. We mapped the initial spot where a bird was detected, approached it slowly until it flushed, mapped the spot where it next perched, and continued up to 10 cycles of flushing, following, and mapping. When flushed birds flew long distances and left the study site, we did not follow them and assumed they were transients that did not hold a territory on the site. We mapped territories 4–9 times during each season. At the end of the season we combined maps for each site and circumscribed clusters of perch sites for each species. We assumed that each circumscribed cluster of perch sites represented a territory occupied by at least one pair of birds, and we were reassured by the fact that mapped clusters were typically confined to areas similar in size to the reported territories for the various species (Wiens 1969).

We plotted the cumulative number of mapped territories on each site over successive visits. The number of territories on most sites seemed to reach an asymptote after about 6 person-hours of mapping. For all sites, and especially for those that did not reach an asymptote, we fitted curves to the data and extrapolated the curves to 10 person-hours of mapping. We used the projected number of territories after 10 person-hours of mapping as our standardized estimate of the number of territories on a site, thus correcting a potential bias introduced by unequal sampling effort.

We located nests of as many birds as possible on each study site. Nest locations were marked with spray paint on vegetation at a recorded direction and distance from the nest. We revisited each nest every 1–5 d to check on its condition. We noted suspected causes of nest failure but acknowledge that few causes could be assigned definitively. We used a modified Mayfield estimator (Johnson 1979) to determine daily nest survival rates for each species. We report results as estimated proportions of nests that would have survived for the reported duration of a normal nesting cycle from egg-laying through fledging for each species (Ehrlich et al. 1988). We estimated the average number of young presumed to have fledged from nests of each species, based on average clutch size and the average daily survival rates for a treatment site.

We made decisions about how nesting success was calculated that were unique to our study. Nests on ungrazed sites that were destroyed as a result of mowing after the 1 July end of our study period were not recorded as failures; they were recorded as successful through the date on which mowing occurred. Hence, when we report nesting success of birds on ungrazed sites, it is based on exposure days during the study period of 15 May–1 July.

There was some between-year variation in measured parameters, but it did not affect the relative values associated with treatments. The only significant between-year difference was in nest success, which was higher overall in 1995 than in 1994. We combined data for all sites and all years of the study when calculating mean values for each of the three treatments. We made comparisons between treatments for four groups of birds: all species combined, Red-winged Blackbirds (*Agelaius phoeniceus*), Savannah Sparrows (*Passerculus sandwichensis*), and other less abundant species combined. We compared treatments using analysis of variance and the Tukey test. Significant differences had a probability of 0.05 or less.

RESULTS

We found differences in the numbers and types of species recorded on different treatment sites. The species associated with each type of grassland site are shown in Table 1. Mean number of species per site varied ($F_{2,56} = 3.6$, $P < 0.05$): ungrazed grasslands ("refuges") averaged 8.2, continuously grazed pastures averaged 5.2, and rotationally grazed pastures averaged 7.7. Ungrazed grasslands and rotationally grazed

TABLE 1. OCCURRENCE AND ABUNDANCE (TERRITORIES PER 40 HA) OF BIRDS ON UNGRAZED GRASSLANDS, CONTINUOUSLY GRAZED PASTURES, AND ROTATIONALLY GRAZED PASTURES IN WISCONSIN

Species	Treatment		
	Ungrazed (N = 19)	Continuously grazed (N = 16)	Rotationally grazed (N = 24)
Killdeer *Charadrius vociferus*	A[a]	4.1	A
Upland Sandpiper *Bartramia longicauda*	A	A	–
Eastern Kingbird *Tyrannus tyrannus*	A	–	A
Horned Lark *Eremophila alpestris*	–	A	A
Sedge Wren *Cistothorus platensis*	4.3	1.3	9.4
Eastern Bluebird *Sialia sialis*	A	–	–
Brown Thrasher *Toxostoma rufum*	A	1.9	6.5
Field Sparrow *Spizella pusilla*	A	–	A
Vesper Sparrow *Pooecetes gramineus*	1.9	3.2	1.4
Savannah Sparrow *Passerculus sandwichensis*	153.7	107.6	122.5
Grasshopper Sparrow *Ammodramus savannarum*	5.2	8.7	6.5
Henslow's Saprrow *A. henslowii*	2.9	3.0	3.9
Dickcissel *Spiza americana*	31.8	6.7	8.9
Bobolink *Dolichonyx oryzivorus*	20.2	21.2	22.3
Red-winged Blackbird *Agelaius phoeniceus*	103.6	16.2	103.8
Eastern Meadowlark *Sturnella magna*	7.6	–	A
Western Meadowlark *S. neglecta*	4.0	2.3	3.2
Brown-headed Cowbird *Molothrus ater*	A	A	A

[a] A = individuals observed but not territorial.

grasslands supported significantly more species than continuously grazed sites (Tukey's test, $P < 0.05$, respectively). Some species were associated primarily with certain treatments. Killdeer (*Charadrius vociferus*) and Horned Larks (*Eremophila alpestris*), for example, were most common on continuously grazed pastures.

We also found differences in densities of territorial birds (Table 1, Fig. 1) which were significant for all species ($F_{2,56} = 4.6$, $P < 0.05$), for Red-winged Blackbirds ($F_{2,56} = 5.4$, $P < 0.05$), and for other less abundant species ($F_{2,56} = 4.9$, $P < 0.05$). There were significantly more territorial individuals of all species and of Red-winged Blackbirds in ungrazed grasslands ("refuges") and rotationally grazed pastures than in continuously grazed pastures, and more Savannah Sparrows in ungrazed grasslands than in rotationally or continuously grazed pastures (Tukey's test, $P < 0.05$, respectively).

Nesting success varied significantly between the three grassland types for all species combined ($F_{2,56} = 5.5$, $P < 0.05$), for Red-winged Blackbirds ($F_{2,56} = 6.1$, $P < 0.05$), for Savannah Sparrows ($F_{2,56} = 4.8$, $P < 0.05$), and for other less abundant species ($F_{2,56} = 5.1$, $P < 0.05$; Table 2, Fig. 2). In each case, nesting success was significantly higher on ungrazed grasslands ("refuges") than on continuously grazed pastures (Tukey's test, $P < 0.05$), and it was significantly higher on continuously grazed pastures than on rotationally grazed pastures (Tukey's test, $P < 0.05$). Many of the losses on grazed grasslands were apparently caused by

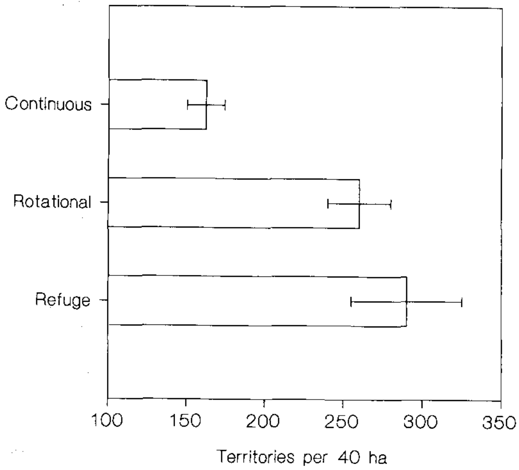

FIGURE 1. Mean (± SE) densities of territories on three types of Wisconsin grasslands: ungrazed grasslands ("refuges"; N = 36 site-years), continuously grazed pastures (N = 32 site-years), and rotationally grazed pastures (N = 48 site-years).

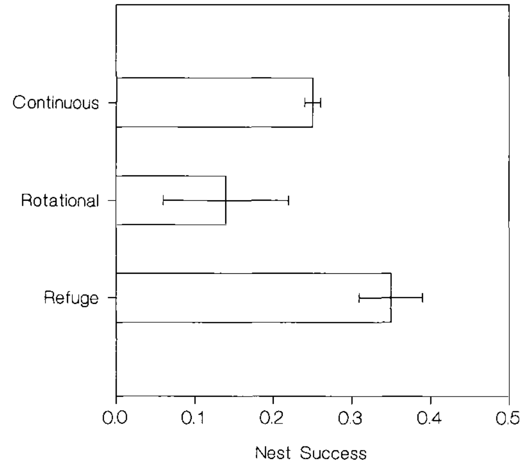

FIGURE 2. Mean (± SE) nesting success for nests on three types of Wisconsin grasslands: ungrazed grasslands ("refuges"; N = 74 nests), continuously grazed pastures (N = 31 nests), and rotationally grazed pastures (N = 87 nests). Nesting success is calculated using a modified Mayfield estimator.

cattle trampling nests and by desertion after cattle grazed the cover around the nest.

We estimated avian productivity of different grasslands by multiplying the density of territories of each group of species on sites by the predicted number of young fledged per nest (Fig. 3). There were significant differences between grasslands for all species combined ($F_{2,56} = 6.4$, $P < 0.05$), for Red-winged Blackbirds ($F_{2,56} = 5.1$, $P < 0.05$), for Savannah Sparrows ($F_{2,56} = 5.5$, $P < 0.05$), and for other less abundant species ($F_{2,56} = 4.7$, $P < 0.05$). For all species combined, for Red-winged Blackbirds, and for other less abundant species combined, ungrazed grasslands ("refuges") produced the most young per unit area; continuously and rotationally grazed pastures produced significantly fewer young (Tukey's test, $P < 0.05$). For Savannah Sparrows, ungrazed grasslands and rotationally grazed pastures produced more young than continuously grazed pastures (Tukey's test, P <

TABLE 2. NUMBERS OF NESTS OBSERVED ON UNGRAZED GRASSLANDS, CONTINUOUSLY GRAZED PASTURES, AND ROTATIONALLY GRAZED PASTURES IN WISCONSIN

	Treatment		
Species	Ungrazed (N = 19)	Continuously grazed (N = 16)	Rotationally grazed (N = 24)
Killdeer	0	2	0
Upland Sandpiper	1	1	0
Brown Thrasher	2	0	3
Field Sparrow	0	0	1
Vesper Sparrow	0	0	2
Savannah Sparrow	11	12	13
Grasshopper Sparrow	1	3	0
Bobolink	1	2	6
Red-winged Blackbird	54	5	56
Eastern Meadowlark	2	2	5
Western Meadowlark	2	4	1
All species	74	31	87

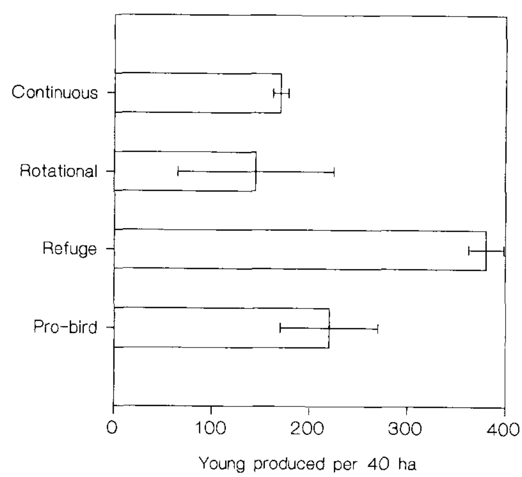

FIGURE 3. Mean productivity (± SE) of four types of Wisconsin grassland: ungrazed grasslands ("refuges"; N = 36 sites), continuously grazed pastures (N = 32 sites), rotationally grazed pastures (N = 48 sites), and a hypothetical system of ungrazed and rotationally grazed grasslands ("pro-bird"; N = 6 sites).

0.05). The "pro-bird" treatment (see Discussion, below) produced more young of all species combined, of Red-winged Blackbirds, and of Savannah Sparrows than did continuously grazed pastures (Tukey's test, $P < 0.05$).

DISCUSSION

Our main findings can be summarized as follows. Of the three grassland types, ungrazed grasslands ("refuges") tended to have the highest diversity, densities, nesting success, and productivity. Continuously grazed pastures tended to have the lowest diversity and densities and intermediate nest success and productivity. Rotationally grazed pastures had intermediate diversity and densities and the lowest nest success and productivity. Overall, ungrazed grasslands were the most productive and rotationally grazed pastures the least productive of the treatments (Fig. 3).

We used these findings and the results of previous studies to explore the possibilities of managing agricultural grasslands to benefit nesting birds. On the basis of previous studies (e.g., Bollinger et al. 1990, Frawley and Best 1991), we concluded that mowing hayfields was the least desirable management practice because birds are often attracted to these grasslands but rarely succeed in rearing young. Early and frequent mowing makes it almost impossible for birds to complete a nesting cycle. Across much of the Midwest, most agricultural grasslands are mowed to provide forage for confined livestock, a situation that some people have blamed for declining grassland bird populations in the region (Sample 1989). Trends in hayfield management are moving toward even earlier and more frequent mowing as new forage crop varieties are developed (Ryan 1986, Ratti and Scott 1991).

Continuous grazing provides mixed opportunities for grassland birds. As our study confirmed, continuously grazed pastures are not very attractive to most grassland birds because they are kept closely cropped by livestock and provide poor nesting cover when migrants arrive and select breeding habitat. They also tend to be near buildings and crop fields. Birds that do settle in continuously grazed pastures experience moderate levels of nesting success, but overall productivity remains low because of the sparse densities of nesting birds. The most obvious management change that might improve avian productivity would be to reduce stocking densities, which would probably increase attractiveness and nesting success. This change, however, would be inconsistent with the ideal agronomic goal of balancing the rates at which forage plants are produced and consumed by livestock.

Rotational grazing also offers advantages and disadvantages for nesting birds. In some cases, rotationally grazed pastures cover much of a farm's area, creating relatively large patches of grassland that are attractive to birds. Because a farm's pasture land is divided into small paddocks, most of which do not have cattle in them at any particular time, much of the total pasture area remains highly attractive to birds. Our results reveal that densities of territorial birds are relatively high in rotationally grazed pastures, reflecting this attractiveness. Eventually, however, each paddock must temporarily support a high density of cattle. When high densities of livestock graze a paddock, there is a high probability of nests being trampled or abandoned (Koerth et al. 1983, Paine et al. 1996). Our results demonstrate that nests in rotational pastures have low overall survival rates because of the brief, but devastating, disturbances caused by concentrated livestock. Many (64%) of the nest losses on our rotationally grazed pastures occurred while cattle were present. Furthermore, nests that survived an initial grazing episode often lost their protective cover and were more vulnerable to predation. Some were also exposed to cattle at least one more time because grazing cycles were much shorter than nesting cycles.

We used these results to design a grassland management system that could accommodate the needs of grazing animals and also produce the largest possible number of fledgling birds. In this paper we discuss the avian aspects of this system; we will discuss the agronomic aspects elsewhere. We based our grassland management system on the premise that it should neither require farmers to sacrifice the livestock carrying capacity of their farms nor reduce the rate of forage consumption by their livestock. Within these constraints, we sought ways to maximize a farm's avian productivity.

Given the results of our study and previous studies, we knew it would be challenging to improve the avian productivity of continuously and rotationally grazed pastures because the most obvious modifications would not satisfy our basic agronomic constraints. Reducing the stocking density of continuously grazed pastures would improve avian productivity but reduce livestock carrying capacity. Making the intervals between grazing events on rotationally grazed pastures long enough to allow nesting cycles to be completed (approximately 25–30 d) would increase avian productivity. But it could also reduce the quality and quantity of forage available to livestock held on paddocks beyond the point at which most new plant growth had been consumed, and it could make grazing cycles so long that cattle would encounter older forage when they were eventually moved to a new paddock.

Instead of modifying the way pastures are grazed, we focused on finding how both grazed and ungrazed grasslands could be included on a farm during the nesting season. By providing an ungrazed "refuge" to complement grazed pastures, we predicted that the overall avian productivity of a farm could be enhanced because of the higher densities and nest success associated with the refuge. Although it proved difficult to incorporate the refuge concept into a continuous grazing system, it was feasible to combine a refuge with a rotational grazing system.

During the peak of the midwestern nesting season (mid-May through June), cool-season forage plants normally grow so vigorously in Wisconsin that it can be difficult for farmers to rotate their livestock rapidly enough through paddocks to keep up with the new growth. In contrast, when plant growth slows later in the summer, farmers need to use all of their rotational pasture area to satisfy their animals' demands. We capitalized on the fact that many rotational grazers seem to maintain more pasture area than they need during the nesting season in order to cope with the bottleneck in forage availability that occurs later in the season. We estimated that during the late spring and early summer up to about a third of rotational pasture area may not be needed, providing an opportunity to set aside a temporary refuge without compromising livestock productivity.

We used our data to predict the avian productivity that might be achieved on a farm that set aside a third of its grassland area as an ungrazed and unmowed refuge from 15 May until 1 July and grazed the remaining grassland area using a rotational system. After 1 July, the refuge area can be mowed and incorporated into the rotational grazing schedule. An example of such a system is shown in Fig. 4. As can be seen in Fig. 3, this "pro-bird" system improves avian productivity over a completely rotational or completely continuous grazing system. At the same time, we can show that carrying capacity and forage availability are adequate to accommodate the needs of livestock (Paine et al. 1996). There may even be additional agronomic benefits associated with our pro-bird system.

Although the pro-bird system has advantages over other grazing systems, it does not allow nesting grassland birds to be productive enough to replace expected annual losses. Because of this deficit, even the birds nesting on a farm managed under a pro-bird grazing system seem to be a population sink, but not to the extent of the other grazing systems.

We conclude that it is feasible to accommodate the needs of livestock while modifying grassland management to improve avian productivity. Nonetheless, we are concerned that even the improvements achieved under our pro-bird management system may not be adequate to allow some grassland birds to maintain stable populations. And, of course, some grassland birds have habitat needs that simply cannot be met on the types of agricultural grasslands we studied.

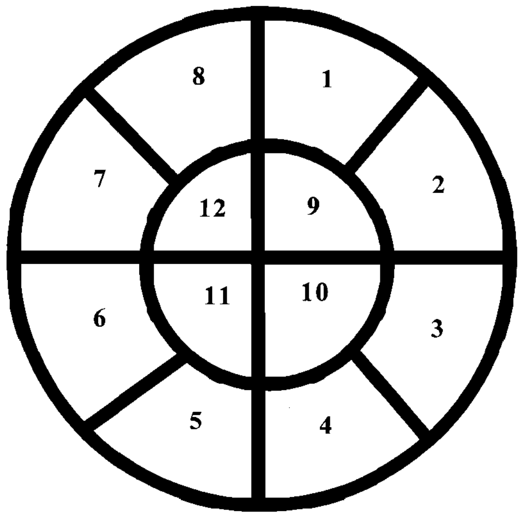

FIGURE 4. An example of a "pro-bird" grassland management system with 12 paddocks, in which a third of a farm's grassland area (paddocks 9–12) has been set aside as a refuge during the peak of the nesting season (15 May–1 July) while the remaining grassland area is managed as rotationally grazed pasture.

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