RESEARCH BRIEF

Spatial heterogeneity increases diversity and stability in grassland bird communities

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MANAGEMENT IMPLICATIONS

- Fire and grazing disturbance in grasslands can increase habitat heterogeneity and improve grassland bird diversity, abundance, and population stability.
- Habitat heterogeneity can result in high bird community variability at fine scales and greater bird community diversity and stability at landscape scales.
- Managing a shifting grassland mosaic of large patches burned in different years can increase landscape heterogeneity and reduce bird community variability that may result from repeated annual burning and grazing.

In this study, the authors examined grassland birds at The Nature Conservancy's Tallgrass Prairie Preserve in Oklahoma to understand the impacts of pyric herbivory-induced habitat heterogeneity on avian diversity, stability, and individual species abundances. They examined vegetation heterogeneity across a gradient of fire frequency and grazing and developed indices to measure changes in the bird community at fine- and landscape-scales across time.

Grasslands evolved as spatially and temporally dynamic ecosystems with frequent disturbance from fire and herbivores. Human actions that disrupt these disturbances have reduced ecosystem function, biodiversity, and ecological services in many remaining grasslands. Contemporary rangeland management uses a combination of fire and grazing—an ecological process known as pyric herbivory—to create a shifting mosaic in vegetation structure, composition, density, and biomass. In this process, grazing animals are attracted to forage in recently burned areas and reduce their use of unburned areas.

Grasshopper Sparrow perched atop vegetation in an intermediate burn patch (12-24 months post fire) at The Nature Conservancy's Tallgrass Prairie Preserve, OK. (Photo: Torre J. Hovick)

Grassland birds are known to have very specific nesting habitat requirements, necessitating structurally diverse habitats to support multiple species. Previous research had demonstrated that restoring habitat heterogeneity can increase grassland bird diversity, but the relationships between patch size, fire frequency, scale, and grassland bird community dynamics had not been investigated.

The study included seven landscape units (1063–242 ac) subdivided into one to eight patches (195-934 ac) in which spring (March to April) or spring and summer (late July to August) burns were conducted. The resulting design included landscape units that ranged in fire frequency from one annually burned patch to an eight-patch unit with spring and late-summer fires at a four-year return interval (Fig. 1). Burns were conducted from 2008 through 2013; only one patch was burned per experimental landscape, season, and year. All landscape units were grazed at a moderate level by domestic cattle (*Bos taurus*) at 1 animal unit month per acre. Twelve 200-meter line transect surveys in each landscape were used to record bird species (four times annually from 15 May through10 July) and vegetation characteristics (once each year in mid-June). In this study, analyses focused on five species that accounted for nearly 94% of all bird detections: dickcissel (*Spiza americana*), grasshopper sparrow (*Ammodramus savannarum*), eastern meadowlark (*Sturnella magna*), Henslow's sparrow (*A. henslowii*), and upland sandpiper (*Bartramia longicauda*).

For bird communities at the landscape unit scale, authors found a significant, negative relationship between the community change index and the number of patches, with bird communities in the most homogenous units (fewest patches) exhibiting nearly four times greater change than those in the most heterogeneous (most patches) unit.

Diversity and stability in grassland bird communities

However, at transect scales, greater heterogeneity was associated with greater variability in the bird community; landscape units with more patches had greater bird community variation among transects over time. This is because transects in landscape units with fewer patches are more similar to each other in vegetation metrics, while those in landscapes with more patches have more variable vegetation in different successional recovery stages.

At the species level, density of three of the five focal bird species had a significant, positive relationship with landscape-level heterogeneity. Henslow's sparrow abundance was most associated with fire return interval, and the generalist species dickcissel was the only one that did not show a response to fire return interval or the landscape heterogeneity (Fig. 2). At the transect scale, densities of dickcissel, Henslow's sparrow, and eastern meadowlark showed positive relationships with litter depth or cover, while grasshopper sparrow had a negative relationship with litter depth, and upland sandpiper abundance was negatively associated with vegetation height. Densities for all focal species except dickcissel were greatest at a three- to four-year fire return interval (Fig. 2), which corresponds to regional tree ring fire history data showing a mean fire return interval of 3.8 years.

In summary, transect-scale heterogeneity increased temporal variability in the grassland bird community, but landscape-scale heterogeneity was associated with greater temporal stability. The authors suggest that fine-scale heterogeneity demonstrates the dependence of grassland birds on disturbance and explains temporal variation in species composition as succession proceeds over time. Although each species had preferences for certain vegetation characteristics, none reached maximum abundance where landscape heterogeneity was low. This suggests that heterogeneous landscapes either provide optimal nesting conditions, or that species select for diverse landscapes with stabilized resources and refugia from disturbance or predation. The study results support the role of spatial and temporal heterogeneity in the conservation of biodiversity, community stability, and ecosystem function in grasslands, where managing heterogeneity may have many conservation benefits.

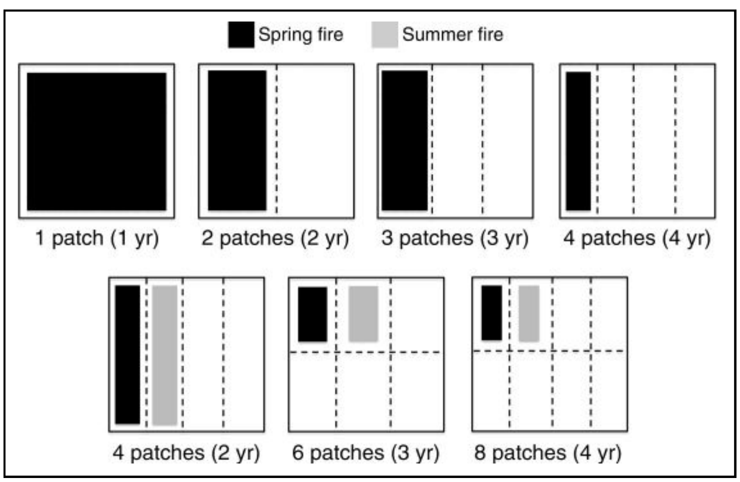

Fig 1. Experimental design used in the study. Each box represents an exterior fence of an experimental landscape with the number of patches and fire return interval indicated below. Dashed lines are hypothetical patch divisions created by discrete fire and focal grazing; no experimental landscape had interior fencing. Dark boxes represent spring fires (March–April) and gray boxes represent summer fires (late July–August).

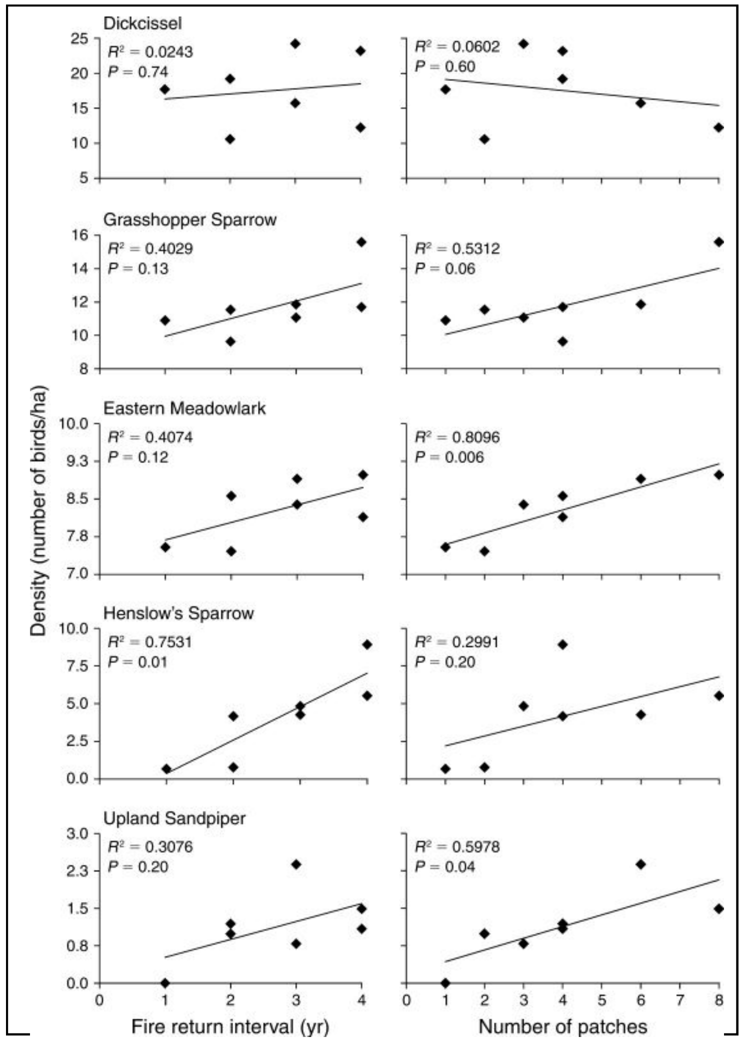

Fig. 2. The responses of individual species to fire return intervals and the number of patches within an experimental landscape at the Tallgrass Prairie Preserve, Oklahoma, USA.

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