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Topic 1 - Ecological approaches to systems' health

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DOES ORGANIC MANAGEMENT HELP PRESERVE LOCAL FUNCTIONAL DIVERSITY? A CASE STUDY IN THE PAMPA OF SOUTH AMERICA

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Abstract: Organic agriculture is a production management system that promotes and improves the health of agroecosystems. We studied the association between changes in taxonomic diversity and changes in ecosystem functions in highly modified landscapes. We sampled birds across the land use intensification gradient from relict and organically farmed land to conventionally farmed land in the Pampa ecoregion of Argentina. Using bird traits as indicators of species' response to environmental change or the effect of ecosystem functions, we calculate functional diversity (FD) metrics. We show a consistent change in the taxonomic and functional diversity from undisturbed habitats to agroecosystems with organic and conventional production systems. Organic farm management retains a significant amount –but not all - of birds' functional diversity. Organic management linked with the maintenance of natural habitats could be a key to conserving ecosystem functioning.

Introduction: Organic agriculture is a production management system that attempts to promote and improve the health of agroecosystems, given the negative effects that natural habitat transformation has on biodiversity. Birds are one of the most sensitive groups to these land-use changes (Schwab et al. 2006). The South American Inland Pampa has a very high disturbance rate showing a striking gradient of land transformation under agroecosystems, with bird diversity higher in natural grassland than in modified areas under organic and conventional agriculture (Brandolin et al. 2016). Although organic farming systems aim to reproduce natural cycles, the anthropogenic disturbances they bring may affect species diversity and community functioning. We studied the association between changes in taxonomic diversity and changes in ecosystem functions, considering the effect of organic farm management in conserving functional diversity in highly modified landscapes.

Material and methods: We conducted our study in the vicinity of Arias (33°40' S / 62°31' O), southeastern Córdoba province, Argentina (Fig. 1). The area is the flat Inland Pampa in the Pampa ecoregion (Soriano et al. 1991). The study was conducted at two very differently managed farms only 5 km apart: (1) “Estancia Las Dos Hermanas” (DH) is a non-intensive mixed farming system (100% organically farmed since 1992), with grass-fed cattle and organic cropping conducted without use of artificial fertilizers/biocides, following a strict integrated plan for soil and biodiversity conservation; (2) “Estancia La Taba” (LT) is conventionally farmed, alternating genetically modified soya and maize crops. DH includes 1,005 ha devoted to the strict conservation of relicts of saline wetlands and native grasslands.

We sampled birds across the land use intensification gradient represented by (1) Relict (Rel): seasonally-grazed natural grasslands and shrublands; (2) Organically farmed (OF): this includes grazed semi-natural grasslands with different livestock loads, and more intensively used agroecosystems with organic crops and cultivated pastures; (3) Conventionally farmed (CF): intensively used agroecosystems with conventional crops with the use of fertilizer and biocides periodically. Bird counts were conducted during three years (2013-2015) and a total of 527 fixed-radius count points was established. We used 100 m as the radius within which birds were identified by vision or sound. The count points were randomly distributed within each habitat using a digital map (ArcMap 10.1) that includes the types of vegetation and land uses within the farm.

A total of six bird species traits, including body mass, sensibility to anthropic disturbance, nest location, nest type, foraging strategy and migratory behavior, were used to explain responses of birds to land-use changes. These traits may dictate a species’ response to environmental change or the effect of ecosystem functions such as pollination effectiveness, handling of fruit and seeds, type and location of food consumed, transport nutrients, resource use (e.g. regulation of invertebrate pest outbreaks or seed dispersal), among others. Trait data were compiled from a wide range of field guides, family monographs and other ornithological literature. For each habitat within the gradient, the functional and taxonomic diversity of species was estimated. We used various functional diversity (FD) metrics: species richness (SpRic), singular richness (SRic), functional richness (FRic), and functional dispersion (FDis). To compute the indices, we used the “FD-package” in R statistical language (Laliberté et al. 2014).

Results: We recorded 50 species of birds belonging to 22 families in three land use types. Of the total, 46 (92%) were medium or large size species. Twenty-nine species (58%) were categorized as had low or medium sensitivity to environmental changes and only one species (Bearded Tachurí) has high sensitivity to them. Most species (74%) made open cup nests, either on the ground (18 species) or on vegetation (24 species). Thirty-five species (70%) were insectivorous: foraging on the ground (20 species), amid foliage (11 species), or in the air (4 species); six species (12%) were omnivores, six feed on other vertebrates and six feed on seeds or fruit. 33 of the species were resident, 16 short-distance migrants and 1 long-distance migrant.

The indices of functional diversity highlighted a general loss of diversity as land-use intensified (Fig. 2). Relict vegetation showed the maximum values for all the indices: species richness, functional richness, functional dispersion and singular richness. The relict of native habitat preserves an assemblage of birds with higher taxonomic and functional diversity than the other land uses. Some species that inhabit the relict habitat are habitat specialist, making them very sensitive to changes and disturbances (e.g. the near threatened Bearded Tachurí).

As intensity of use increased, taxonomic richness decreased by 11.91% for OF and 52.39% for OF and CF, respectively. Similarly, singular richness decreased by only 9.1% in OF but by 51.52% in CF. Functional richness was at a maximum in the Relict, medium in OF, conserving 64.6% of the functional richness of natural environments, and minimum in CF, losing almost 98% of functional richness. Functional dispersion is maintained at 87.12% in OF but only 59.4% in CF.

The results show that functional richness decreases with species richness loss (principally singular richness loss), since lower species richness decreases the probability of observing species with extreme trait values (decrease in functional dispersion), tending to the functional homogenization of the assemblages. This indicates that land-use intensification leads to the loss of species and therefore to the functional simplification of species communities.

Discussion: We analyze the relationship between bird functional diversity and the disturbance levels of different systems. Bird taxonomic and functional diversity changes with transformations from original habitats to agroecosystems of both types studied. Organic farm management retains a significant amount –but not all- of birds' functional diversity. Land-use change may lead to alterations in ecosystem functions (Wellstein et al. 2011). Functional diversity decreases with species richness loss, tending to the functional homogenization of bird assemblages and affecting the ecosystem's resilience to disturbances (Laliberté et al. 2010). This suggests that heterogeneous landscapes with remnants of original habitats in mosaics of land use types best preserve taxonomic and functional diversity. Dos Hermanas Farm is a good example of the balance between conservation and non-intensive farming. Organic management linked with the maintenance of natural habitats could be key to conserving ecosystem functioning.

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Image:

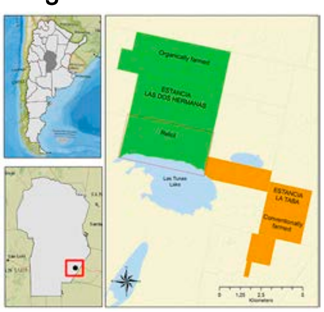
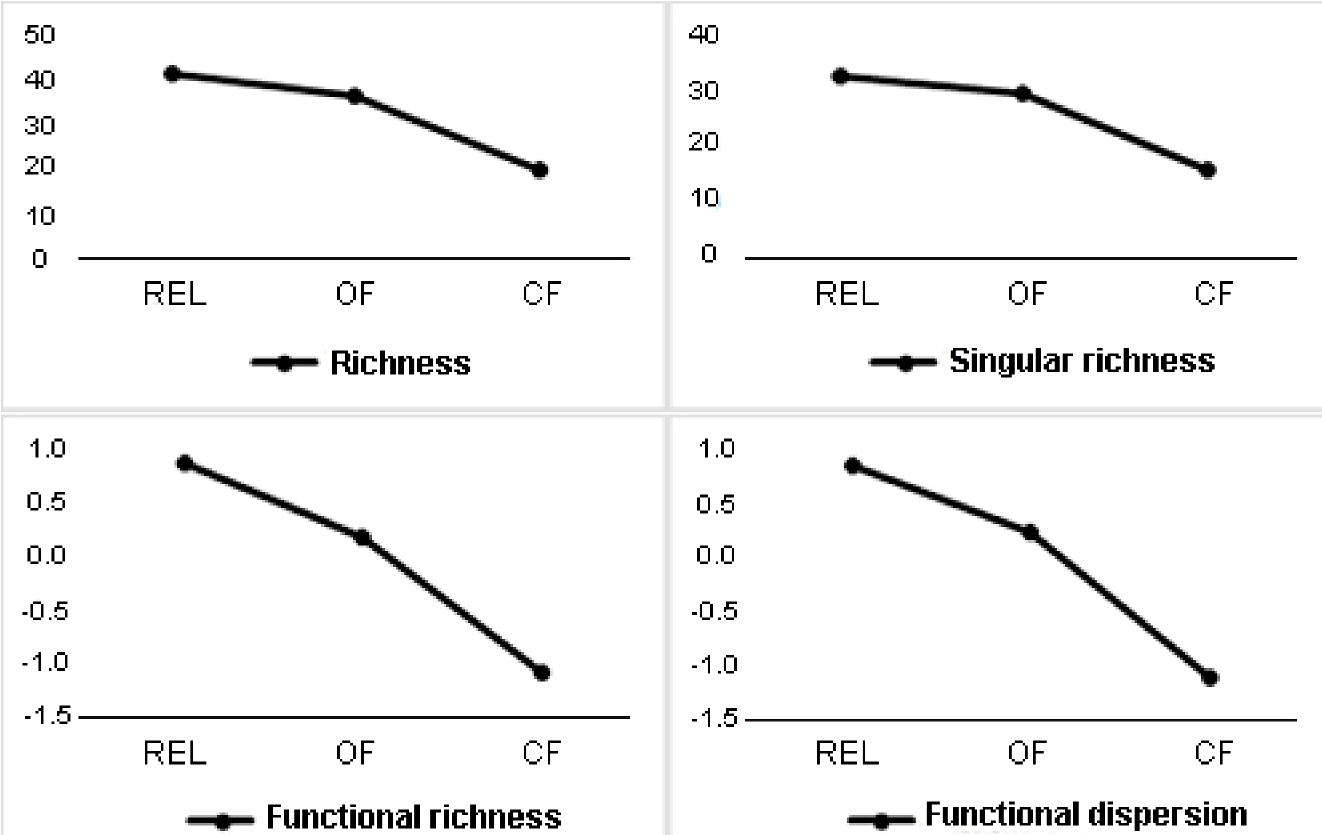


Image 2:



Disclosure of Interest: None Declared

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