Agricultural intensification and ecosystem function in a brigalow (Acacia harpophylla) landscape: implications for ecosystem services

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ABSTRACT

Agricultural intensification, involving habitat fragmentation and modification, typically leads to a decline in biodiversity and ecosystem function. While most studies concentrate on remnant patches, the less intensively managed components of agricultural landscapes may also provide biodiversity values and ecosystem services. This study examines the contribution of different categories of land management to biodiversity and ecosystem function along a gradient of agricultural intensification. Differences within these land management categories are also examined. Research results are interpreted in the broad context of ecosystem services and their resilience in agro-ecosystems.

This research was conducted in the Brigalow Belt bioregion of southern Queensland near Dalby, Australia. Twenty-two small remnant brigalow (*Acacia harpophylla*) patches were selected and sampling sites established at the core and edge within the remnant and at the core and edge of an adjacent area of the agricultural matrix. Spatial information about remnant brigalow patch characteristics and attributes of the surrounding landscape were determined using aerial photographs and geographic information systems. Soil carbon concentration and the composition and diversity of plant and bird communities were used as ecological indicators. A combination of univariate and multivariate analysis methods was employed to compare indicators between core and edge across four distinct land management categories along a gradient of intensification. Spatial information was used to aggregate soil carbon data and to model the effects of landscape context on biotic communities.

Small, fragmented brigalow remnants contained higher levels of biodiversity and soil carbon and were compositionally distinct compared with the surrounding agricultural matrix of grassland and cropland. Soil carbon levels declined with increasing land use modification, with even the most sensitive (labile) carbon fractions showing little sign of recovery in naturally regenerating grasslands. Plant diversity also decreased with increasing land use intensity; however, cultivated areas reverted to semi-natural grassland assemblages following the cessation of regular tillage. Bird communities were predictably higher in the more structurally and floristically complex remnant brigalow but, unlike soil and plant indicators, showed little variation among matrix land management categories. Relationships
for indicators measured across the vegetation-matrix boundary resembled a step function, with no detectable difference between core and edge in the same land management category. Plant and bird communities were influenced largely by landscape context variables, rather than measured local structural attributes of the vegetation.

Measured indicators in different land management categories along the intensification gradient showed distinct trends, with the nature of these relationships somewhat indicator-specific, particularly within the matrix. Different land management categories contained unique species assemblages, with all indicators higher in remnant brigalow. However, the significant contribution of secondary and regenerating grassland components of the agricultural matrix to biodiversity and ecosystem function are also highlighted. In particular, natural regeneration of plant communities in former arable lands, resulting in novel grassland ecosystems, suggests some degree of resilience in these systems and provides potential opportunities for enhancing biodiversity and ecosystem function. The observed similarity between core and edge for plants and soil carbon in both Brigalow and matrix suggests that land use boundaries are abrupt, with no detectable ecotone.

Results are discussed in the context of a state and transition model, enabling the conceptualization of changes between different land management categories caused by agricultural intensification and regeneration. The usefulness of the measured variables as potential indicators of ecosystem function in highly fragmented and modified agricultural landscapes is discussed. Inferences are made about the role that different landscape components play in maintaining overall ecosystem function and ecosystem services. A broader ecological approach to assessing biodiversity and ecosystem function in agro-ecosystems, that incorporates different land management categories and a range of ecological indicators, is recommended. In particular, the research suggests that the intrinsic value of the grassland components of the agricultural matrix for maintaining biodiversity and ecosystem function should be recognised and that natural remnant and semi-natural grassland components of the landscape should be maintained. This research is of particular value for balancing biodiversity conservation with production in brigalow landscapes and agro-ecosystems more generally.
CERTIFICATION OF DISSERTATION

I certify that the ideas, experimental work, results, analysis and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

__________________________________________  ________________
Signature of candidate                      Date

ENDORSEMENT

__________________________________________  ________________
Signature of supervisor/s                  Date

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              Date
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