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Marja, R; Kleijn, D; Tscharntke, T; Klein, AM; Frank, T; Batáry, P 2019 Effectiveness of agri-environmental management on pollinators is moderated more by ecological contrast than by landscape structure or land-use intensity ECOLOGY LETTERS, 22, 1493-1500. 10.1111/ele.13339

Background and objective

Agri-environment management (AEM) started in the 1980s in Europe to mitigate biodiversity decline, but the effectiveness of AEM has been questioned. The objective of this study was to examine the effect of AEM on pollinators species richness and to investigate the influence of local ecological contrast (difference in plant species richness between field margin and crop), landscape structure (proportion of semi-habitats) and regional land-use intensity (extensive or intensive land use) on AEM effectiveness on pollinators.

Search strategy and selection criteria

The authors conducted literature searches using ISI Web of Science Core Collection (WoS) and Elsevier Scopus databases ranging 1945–2016 (last search date: 24 November 2016). The following keywords combinations were used for literature search: TITLE-ABS-KEY (pollinat* OR bee OR bumble* OR hover* OR syrph* OR butterfly) AND TITLEABS-KEY(agri-environment* OR organic* OR integrated OR hedge* OR "field margin" OR fallow OR set-aside OR "set aside") AND TITLE-ABS-KEY (diversity OR richness) AND SUBJAREA(MULT OR AGRI OR ENVI) AND (EXCLUDE(DOCTYPE,"re")). Additionally meta-analysis databases with similar topics and authors' unpublished datasets were used to locate further potential data. 1) study focusing on pollinator' absolute richness (hereafter species richness); 2) including set-aside, but not abandoned grassland studies; 3) studies about agri-environment management (AEM); 4) European AEM studies; 5) more than 3 replicates (at field or farm level) in AEM and in control group; 6) studies at field level (not including the single field experiments); 7) the study did not cover a large area of given countries with different regions, to be able to determine the regional land-use intensity effect.

Data and analysis

The authors used hierarchical models with country, study ID and region or habitat as nesting factors with restricted maximum likelihood to perform the meta-analysis models. First, a model without moderators was fitted to test the general effect of agri-environmental management practices (AEM) compared to control group (usually conventional farming). Second, a model with ecological contrast, landscape structure and land-use intensity as moderators was fitted to test which of them moderate the most the relative effectiveness of AEM for pollinator species richness. Third, a model with ecological contrast, landscape structure and land-use intensity, including their three-way interaction, was fitted to test whether and how they interact with each other. Collinearity between moderators was studied based on the variance inflation factor between moderators. Comparision between fitted models with and without effect sizes defined as influential outliers was performed to identify outliers of effect sizes (no outlier was detected). Publication bias was studied (regression test for funnel plot asymmetry and Rosenthal's method of fail-safe number indicated no significant publication bias).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
62	Croplands and grasslands	Agri-environmental management schemes (hedges, field margins and set aside lands)	No agri-environmental management schemes (usually conventional farming)	Metric: Pollinators species richness; Effect size: Hedge g (standardized difference) comparing the considered metrics between intervention and control	81.25

Results

- Pollinator species richness benefitted from AEM. The summary random-effects model without moderators showed a large positive effect of AEM (effect size 0.83, CIs 0.69–0.96, P < 0.001).
- The model including the moderators indicated that the moderation effect of ecological contrast was larger than that of landscape structure and that land-use intensity was not significant on pollinator species richness.
- Results of the interaction model showed that AEM in case of large contrast, simple (or complex) landscape and intensive land-use had the highest effect size, i.e. benefited pollinator species richness the most compared to the control sites.

Factors influencing effect sizes

- Ecological contrast (difference in richness of plant communities between field margins and crop) : Higher effect of AEM in large vs small landscape structures.
- Landscape structure (proportion of semi-natural habitats) : Higher effect of AEM in simple vs complex landscape structure.

Conclusion

This study shows that pollinator species richness benefitted from agri-environmental management schemes.