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Scheper, J; Holzschuh, A; Kuussaari, M; Potts, SG; Rundlf, M; Smith, HG; Kleijn, D 2013 Environmental factors driving the effectiveness of European agri-environmental measures in mitigating pollinator loss – a meta-analysis *ECOLOGY LETTERS*, 16(7), 912-20. 10.1111/ele.12128

### Background and objective

As biodiversity continues to decline, it is pivotal to know what ecological factors explain success or failure of agri-environmental measures. Effectiveness, i.e. enhancement of biodiversity in sites under agri-environmental management compared to control sites, has been hypothesised to be influenced by a number of factors. Using a meta-analytic approach, this study examines the factors affecting the effectiveness of agri-environmental measures by addressing the following questions: 1) Are agri-environmental measures more effective in simple than in complex or cleared landscapes? 2) Does the effectiveness of agri-environmental measures decline with increasing land-use intensity? 3) Is measure-induced contrast in resource availability positively related to effectiveness of agri-environmental measures? Here the results concerning flower strips, extensive grasslands and grass-sown or naturally regenerated uncropped farmland habitats are reported.

### Search strategy and selection criteria

The authors searched the ISI Web of Science, SCOPUS, CAB abstracts, Biological abstracts, AGRICOLA and AGRIS bibliographical databases for studies that addressed the effects of agri-environmental measures on pollinators. Records were included that were published up until October 2011. To minimise potential publication bias associated with the 'file drawer problem', the authors also searched for grey literature using the Google web search engine and by approaching contacts (nature conservation organisations, scientists) in 26 European countries with a request for relevant reports and unpublished studies available in languages accessible to the authors. 1) Studies that compared the species richness and/or abundance of the focal taxa (Apiformes, Lepidoptera, Syrphidae) between sites with agri-environmental measures (not necessarily need to be part of a formal agri-environmental scheme as long as they included environmentally friendly practices that could potentially benefit pollinators) and conventionally managed control sites; 2) reported means, SD, SEM or CI and sample sizes for both treatment and control (in the text, tables, graphs or after requesting the authors) to allow calculation of effect sizes; 3) included at least four spatial replicates; 4) were geographically restricted to Europe.

### Data and analysis

Random effect models were used to estimate the effect of agri-environmental measures on species richness and abundance of pollinators. Effectiveness of agri-environmental measures was examined across farmland type (croplands vs. grasslands) and type of measures (flower strips, extensive grasslands or grass-sown or naturally regenerated field margin or set-aside). When sample size allowed it, the factors affecting agri-environmental measures' effectiveness were investigated separately for croplands and grasslands. Results heterogeneity was tested. 95%CI around mean effect sizes were computed. Publication bias in all data sets (except the data sets used in the meta-regressions) was assessed.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
71	Croplands and grasslands	Sites with agri-environmental measures including 1) sown flower strip; 2) grass-sown or naturally regenerated field margin or set-aside)	Conventionally managed control sites	Metric: Abundance and richness of pollinators; Effect size: Hedge g (standardized difference) comparing the considered metrics between intervention and control	68.75

### Results

- Overall, agri-environmental measures had significant positive effects on species richness and abundance of pollinators in agroecosystems.
- In croplands, all types of agri-environmental measures effectively enhanced species richness and abundance of pollinators. The magnitude of the effectiveness for species richness did not differ among the measure-types. However, measure types differed in their effects on abundance, with the largest mean effect size observed for sown flower strips.
- In grasslands, different types of measures varied in their effectiveness for both species richness and abundance. For both species richness and abundance, effect sizes were largest for sown flower strips, smaller for extensive grasslands.
- Regarding the flower strips, meta-regressions showed that the number of flower species that were sown was positively related with effect size for pollinator abundance but not species richness. However, when only the obligate pollen feeding bees were considered, the number of sown flower species in strips was significantly related with the effectiveness of flower strips in increasing both species richness and abundance.

### Factors influencing effect sizes

- Number of flower species in strip : The effect of flower strips on pollinator abundance increases when the number of flowers species increases in flower strips.

### Conclusion

This study shows that agri-environmental measures generally enhance local pollinator species richness and abundance in agroecosystems.