Appendix S3. Effects of landscape variables on arthropod abundance and services using a) mean-centered landscape variables within studies, b) standardized response variables.

Supporting Information to Martin, E. A. et al. The interplay of landscape composition and configuration: new pathways to manage functional biodiversity and agro-ecosystem services across Europe.

a) Effects of landscape variables on arthropod abundance and services using mean-centered landscape variables within studies

Effects of landscape variables on biodiversity and services may vary according to the range taken by these variables in a given region. In order to examine effects of landscape variables across the full range of their values in European landscapes, we chose not to standardize landscape variables within studies. Hereby, we focus interpretation in the main text on effects across full gradients (hereafter 'full gradient analyses'), i.e. capturing the fact that responses to landscape change within studies may differ across European gradients (Van de Pol & Wright 2009). In particular, non-linear trends reflecting differences in effects across European landscape ranges may not be reflected in individual studies covering only a subset of these ranges.

Here, we provide results of analyses using mean-centered landscape variables, representing trends within studies independently of occupied ranges (Appendix S3 Figs. 1-3). Effects using mean-centered variables differed in several cases from effects across full gradients. With mean-centered variables, interactions between edge density and composition variables were comparatively rare. Positive effects of % SNH and negative effects of % arable were found on all arthropods, pollinators and pest control. For all arthropods and pollinators, effects of %SNH were non-linear (concave). With notable exceptions (pollinators that change diet between the larval and adult stage and are strongly associated with crops or pests as larvae, ground-dispersing enemies that overwinter outside crops, pollination services), edge density had less impact on response variables than when considering full gradients.

Differences in effects associated with different regions of the landscape gradients are likely to cancel each other out when centering variables. In addition, the gradients covered by individual studies represent highly variable portions of overall European gradients and could be insufficient to detect regional-scale trends. These reasons can explain differences in results between mean-centered and full gradient analyses. The results shown here point to the fact that effects of edge density essentially took place across full gradients and represent the effects of variation in the ranges of landscape variables across European study regions.

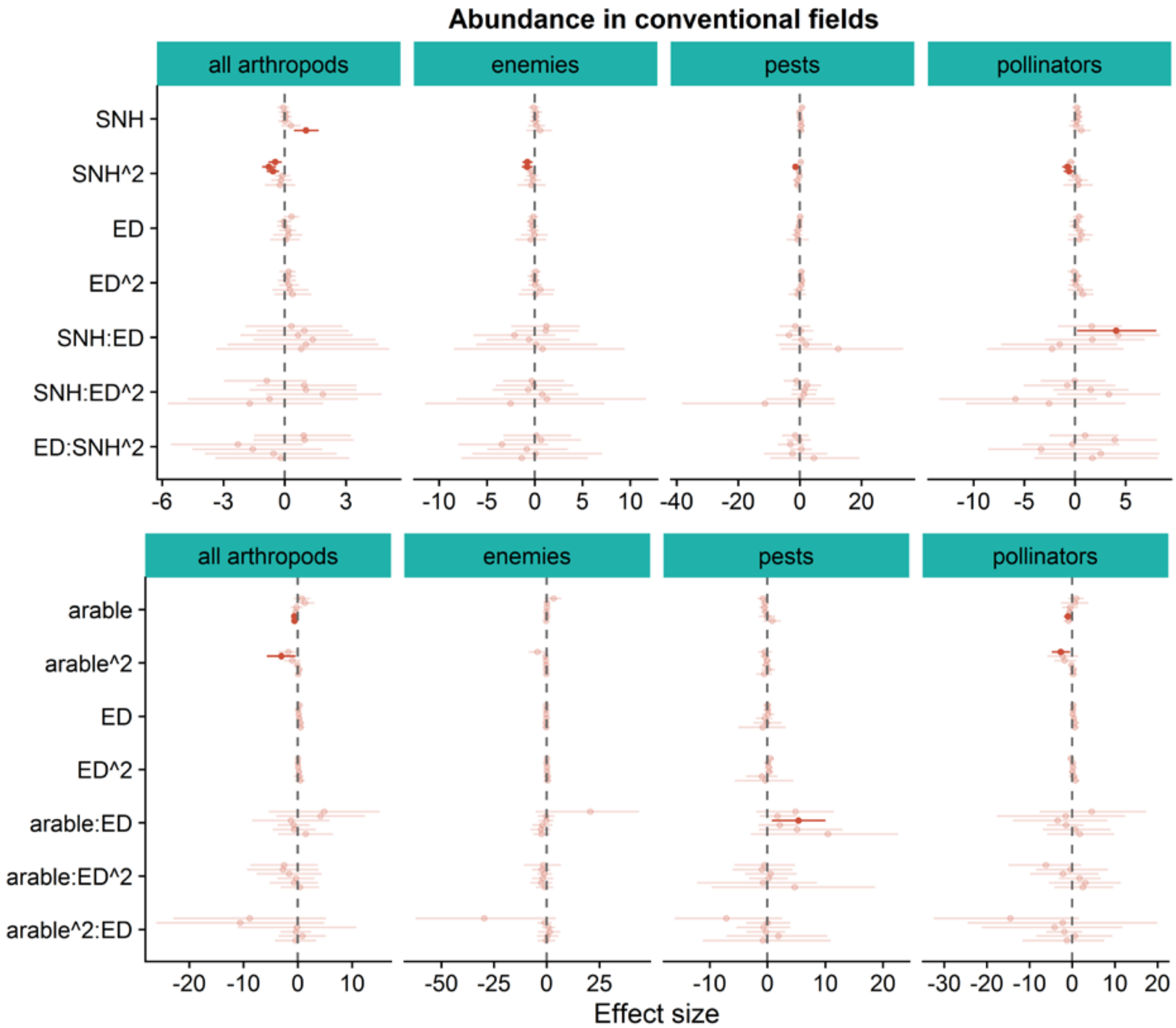
b) Effects of landscape variables on arthropod abundance and services using standardized response variables

In order to verify that results of full gradient analyses are not caused by differences in mean response values (or intercepts) between studies, we compare these results with analyses using standardized response variables within studies. This comparison allows to verify that results depend on differences in landscape ranges across Europe and not on differences in study means (intercepts), which could occur if study means were correlated with specific ranges of the landscape gradients. In Appendix S3 Fig. 4-6, we present results of analyses using abundance and ecosystem service response variables standardized within studies by subtracting the study mean and dividing by 2 standard deviations (function rescale in R package arm v.1.9-3, Gelman & Su 2016). These analyses show high robustness of full gradient analyses to standardization of response variables, confirming that differences in mean predictor values between studies did not affect the results of full gradient analyses.

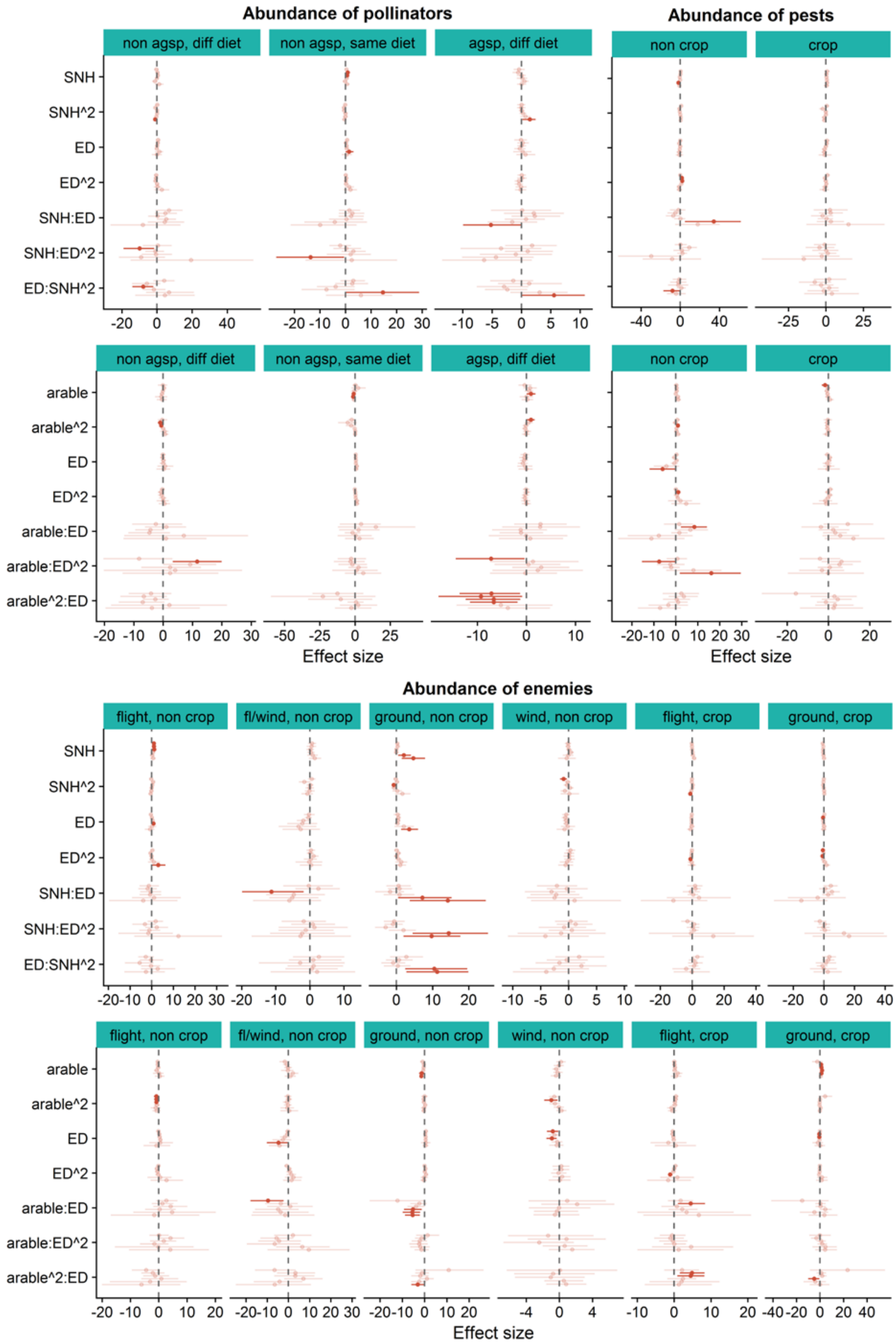
Supplementary references

Gelman, A. & Su, Y.-S. (2016). arm: Data Analysis Using Regression and Multilevel/Hierarchical Models. R package version 1.9-3. https://CRAN.R-project.org/package=arm.

Van de Pol, M. & Wright, J. (2009). A simple method for distinguishing within-versus between-subject effects using mixed models. *Anim. Behav.*, 77, 753.



Appendix S3 Figure 1. Results of models explaining the abundance of all arthropods and subsets of enemies, pollinators and pests as a function of landscape composition (% SNH, top panel; % arable land, bottom panel) and configuration variables (ED, edge density of crop/crop and crop/non-crop boundaries) in conventional fields. Effect sizes are estimates and bootstrapped 95% CI of full model terms, calculated at six successive spatial scales (0.1, 0.25, 0.5, 1, 2 and 3 km radii around sites) shown from top to bottom for each term. Radii at which CI do not overlap with zero are highlighted. Separate models were run with either % SNH or % arable as composition variable. Intercept estimates are not shown. Only effects for which CI do not overlap with zero at more than one radius are considered for interpretation. In contrast to Fig. S5, results presented here were obtained using standardized (mean-centered) landscape variables within studies and refer to the within-study effects of these variables on abundances.


Abundance of pollinators
Abundance of pests
non agsp, diff diet
non agsp, same diet
agsp, diff diet
non crop
crop
SNH
SNH^2
ED
ED^2
SNH:ED
SNH:ED^2
ED:SNH^2
arable
arable^2
arable:ED
arable:ED^2
arable^2:ED
Effect size
Abundance of enemies
flight, non crop
fl/wind, non crop
ground, non crop
wind, non crop
flight, crop
ground, crop

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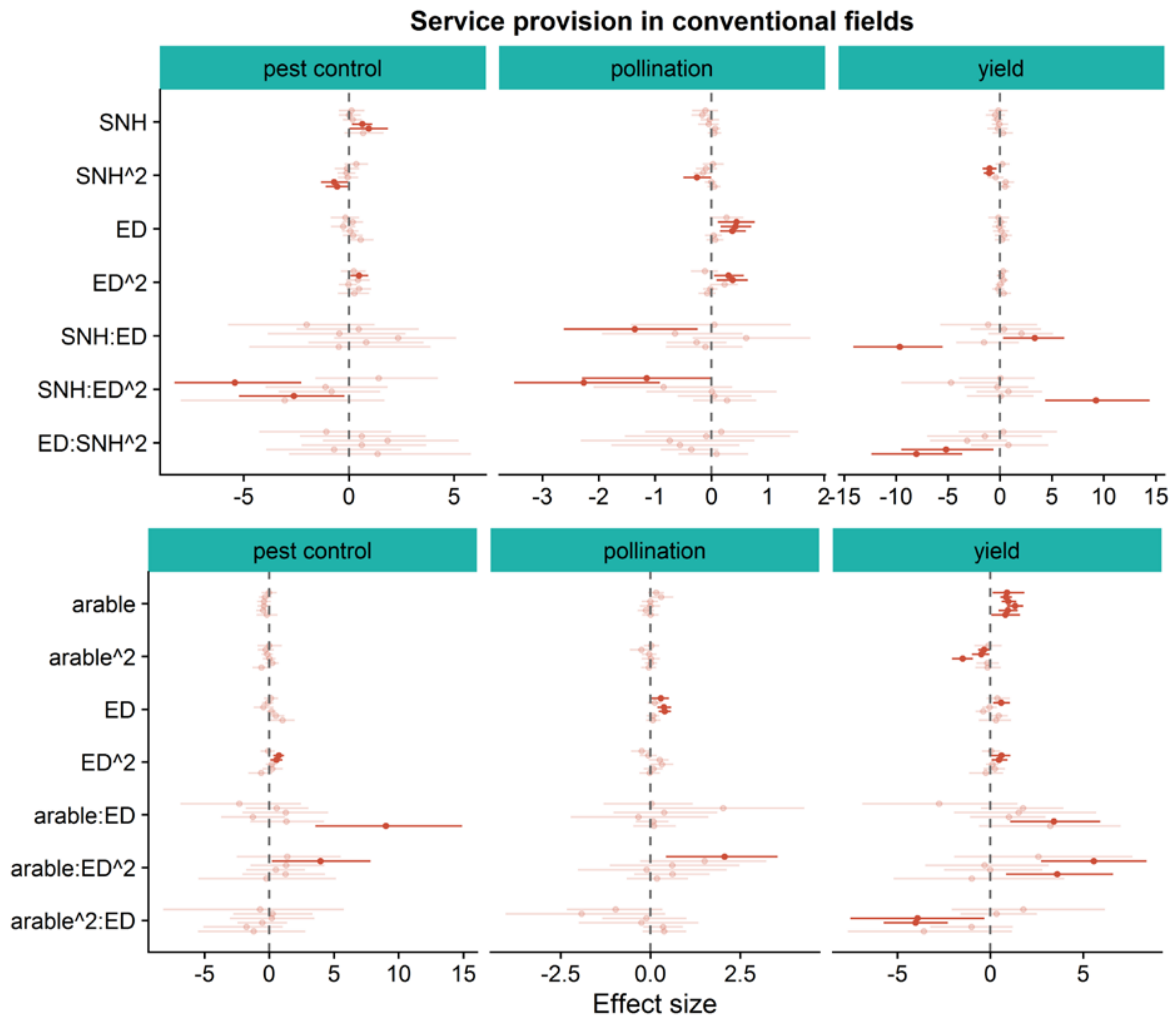
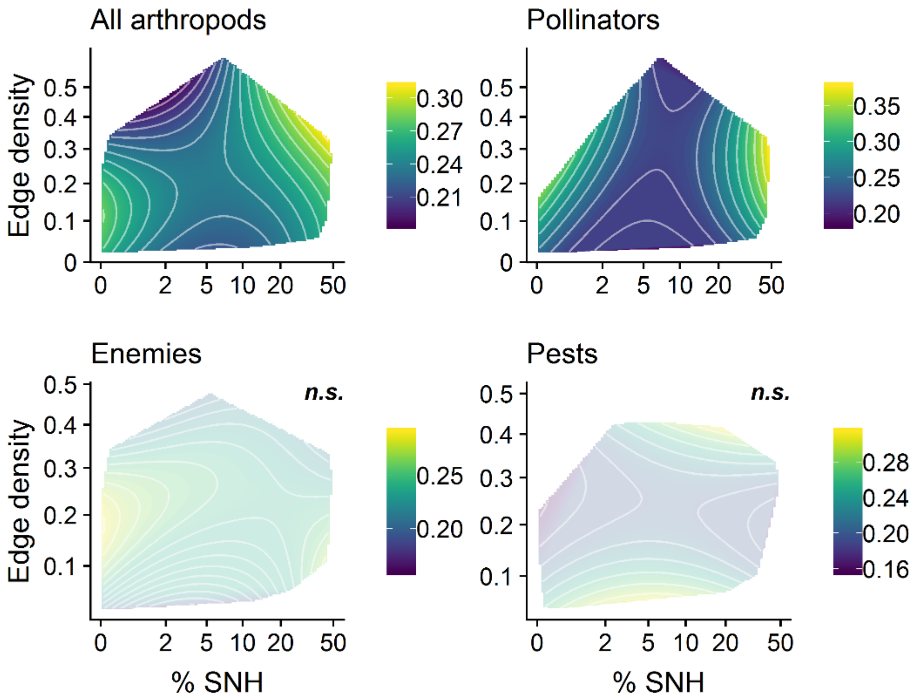
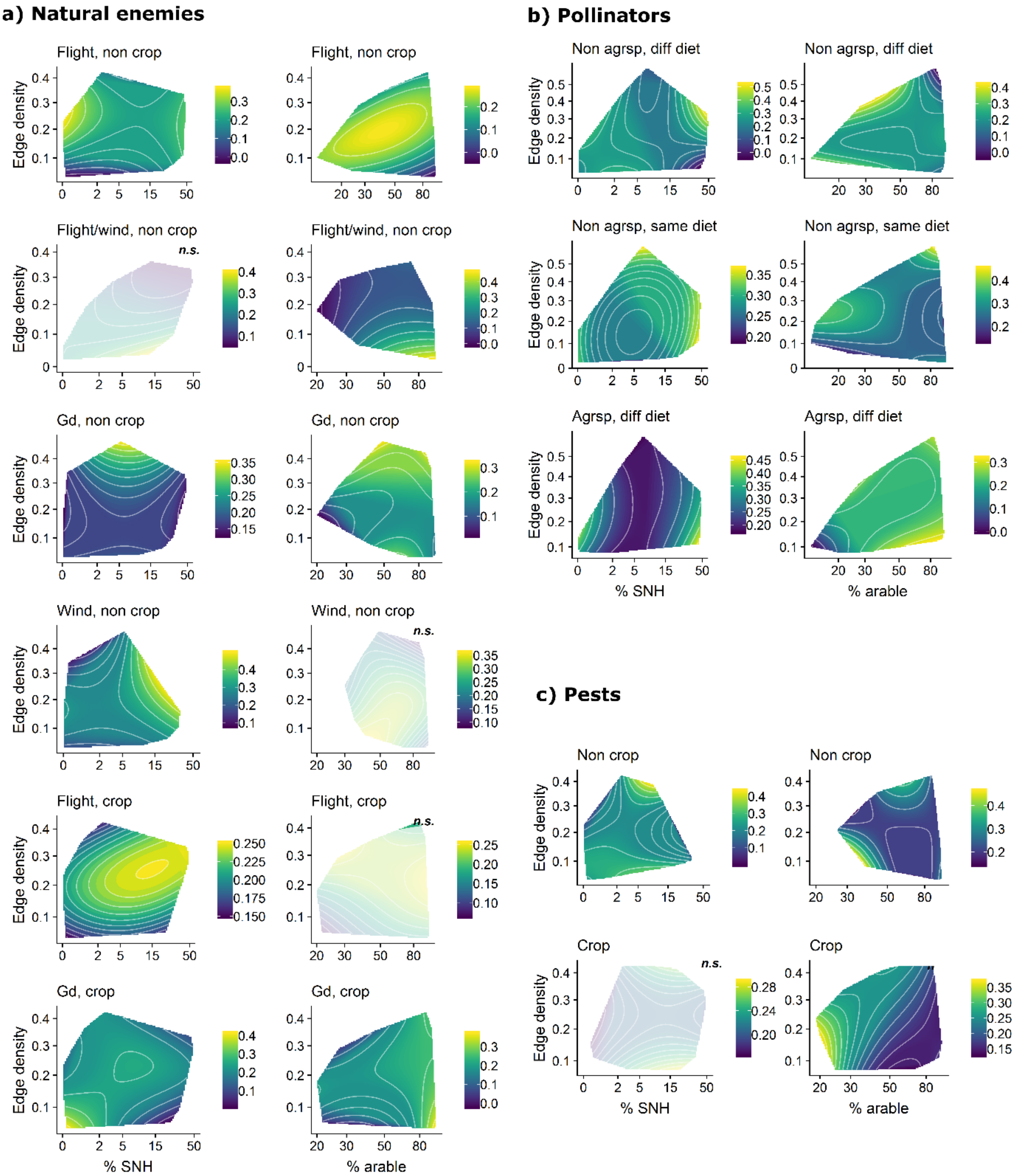
Appendix S3 Figure 2. Results of models explaining the abundance of functional trait syndromes of enemies, pollinators and pests a function of landscape composition (% SNH, top panels; % arable land, bottom panels) and configuration variables (ED: edge density of crop/crop and crop/non-crop boundaries) in conventional fields. Trait syndromes were determined for each functional group by cluster regression of categorical traits. Effect sizes are estimates and bootstrapped 95% CI of full model terms, calculated at six successive spatial scales (0.1, 0.25, 0.5, 1, 2 and 3 km radii around sites) shown from top to bottom for each term. Radii at which CI do not overlap with zero are highlighted. Separate models were run with either % SNH or % arable as composition variable. Intercept estimates are not shown. Only effects for which CI do not overlap with zero at more than one radius are considered for interpretation. In contrast to Fig. S6, results presented here were obtained using standardized (mean-centered) landscape variables within studies and refer to the within-study effects of these variables on abundances.



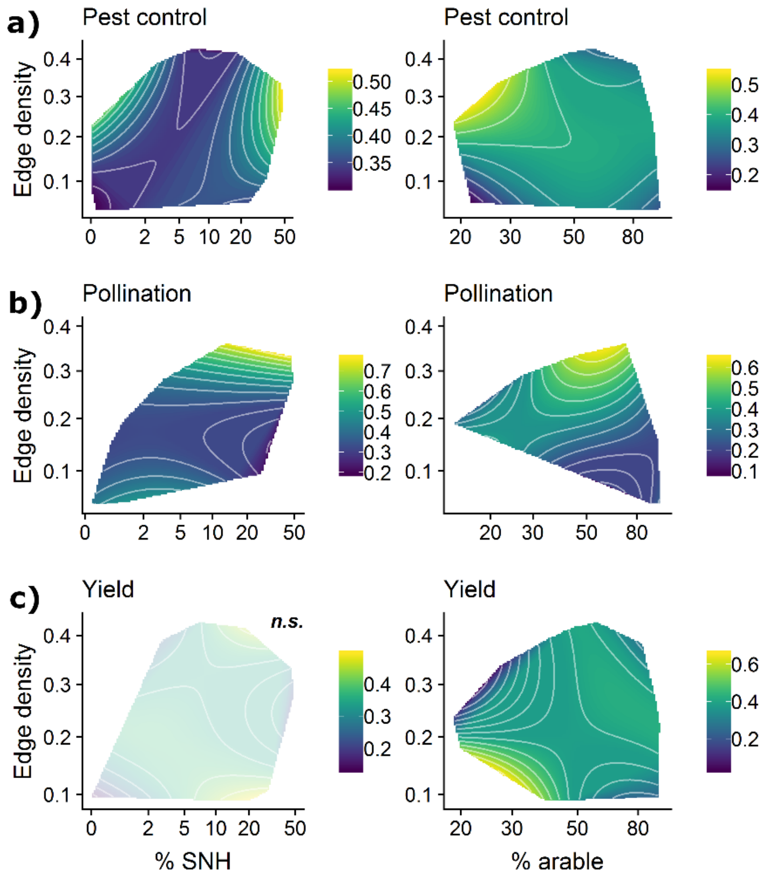
Appendix S3 Figure 3. Results of models explaining the provision of pest control, pollination and yields as a function of landscape composition (% SNH, top panel; % arable land, bottom panel) and configuration variables (ED: edge density of crop/crop and crop/non-crop boundaries). Effect sizes are estimates and bootstrapped 95% CI of full model terms. Effects were calculated at six spatial scales (0.1, 0.25, 0.5, 1, 2 and 3 km radii around sites) shown from top to bottom for each model term. Scales at which CI do not overlap with zero are highlighted. Separate models were run with either % SNH or % arable as composition variable. Intercept estimates are not shown. Only effects for which CI do not overlap with zero at more than one radius are considered for interpretation in the main text. In contrast to Fig. S7, results presented here were obtained using standardized (mean-centered) landscape variables within studies and refer to the within-study effects of these variables on ecosystem services.



Appendix S3 Figure 4. Heatmaps of the effects of seminatural habitat amount (SNH; composition variable) and edge density (in km/ha; configuration variable) on the abundance of arthropods (top left) and on functional groups of pollinators, natural enemies, and pests. Here, abundances were standardized within studies by subtracting the study mean and dividing by 2 standard deviations (function rescale in R package arm). Results at 1 km radius are shown ('n.s.' refers to results at all scales). Please see Fig. 2 of the main manuscript for additional legend details.



Appendix S3 Figure 5. Heatmaps of the effects of landscape composition (% SNH, left columns; % arable land, right columns) and edge density (in km/ha) on the abundance of functional response groups of a) natural enemies, b) pollinators, and c) pests. Here, abundances were standardized within studies by subtracting the study mean and dividing by 2 standard deviations (function rescale in R package arm). Results at 1 km radius are shown ('n.s.' refers to results at all scales). Please see Fig. 3 of the main manuscript for additional legend details.



Appendix S3 Figure 6. Heatmaps of the effects of landscape composition (% SNH, left columns; % arable land, right columns) and edge density (in km/ha) on on a) pest control, b) pollination and c) crop yield in weight per unit area. Here, abundances were standardized within studies by subtracting the study mean and dividing by 2 standard deviations (function rescale in R package arm). Results at 1 km radius are shown ('n.s.' refers to results at all scales). Please see Fig. 4 of the main manuscript for additional legend details.