Landscape features

Impact: Pests and diseases

Reference 16

Duarte, GT; Santos, PM; Cornelissen, TG; Ribeiro, MC; Paglia, AP 2018 The effects of landscape patterns on ecosystem services: meta-analyses of landscape services LANDSCAPE ECOLOGY, 33(8), 1247-1257. 10.1007/s10980-018-0673-5

Background and objective

We must gain a greater understanding of how landscape composition and configuration influence the services provided. This study aimed to thoroughly review and evaluate the relationship between several aspects of landscape patterns and certain ecosystem services. The primary target of this research was to provide support for more practical decision-making in landscape planning and management in order to ensure the maintenance of key landscape services. Here, results on the relationship between the % of natural areas in the landscape and pests and diseases are reported.

Search strategy and selection criteria

First, authors used articles already reviewed by Chaplin-Kramer et al. (2011; a meta-analysis of the effect of landscape complexity on pest control services), Garibaldi et al. (2011; a synthesis regarding landscape effects on the stability of pollination services), Shackelford et al. (2013; a meta-analysis of landscape and local effects on the abundance and richness of pollinators and natural enemies) and Uuemaa et al. (2013; a review of trends in the use of landscape metrics). Then, they performed an extensive search in the Web of Science database, using the keywords ‘‘landscape metrics,’’ ‘‘landscape indexes,’’ and ‘‘landscape indices’’ to complement the research by Uuemaa et al. (2013)— which reviewed studies between 2000 and 2010 using the same keywords—by adding studies published between 2011 and 2016. Finally, authors reviewed relevant articles provided in the reference lists of all previously selected studies. 1) authors only considered studies that used landscape metrics related to empirical data of functions or ecological indicators that directly benefit human well-being. Habitat function for biodiversity was not considered, except when primary studies explicitly cited biodiversity as being (or potentially being) directly related to certain ecosystem services (e.g., pollination and pest control); 2) authors restricted their research to terrestrial landscapes in rural, agricultural, mixed rural–urban or natural habitats regions, thus excluding strictly urban or marine landscapes; 3) one study inclusion criterion was the reporting of statistical parameters (e.g., r, F, v2, Spearman-rho, t or R2, and sample size) on the relationship between at least one landscape metric and one landscape function, or the partial contribution of at least one landscape metric.

Data and analysis

Pearson product-moment correlation coefficients (r) were used as a measure of effect size, weighted by sample sizes for the meta-analyses. When studies did not report r values, the statistical results provided by the authors (F, v2, Spearman-rho, t or R2) were converted to the correlation coefficient (r). All r values were then converted into Fisher’s Z. The 95% confidence intervals around a cumulative effect size were calculated for each variable of interest. All analyses were conducted using MetaWin software version 2.0. In addition, authors used mixed models to calculate the cumulative effect sizes (E++) for each group of landscape metrics, assuming that studies within a group share a common mean effect and that both random variation and sampling variation exists within a group. Then, the average of z values was weighted by the inverse of their variance. Total and group heterogeneity among effects were examined by partitioning variance within groups and testing whether categorical landscape groups were homogeneous with respect to effect sizes. The Q-statistic was used, and total heterogeneity (QT) was partitioned into within-class heterogeneity (QW) and between-class heterogeneity (QB). Publication bias was checked by calculating Rosenthal's fail-safe number.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
121	Terrestrial landscapes in rural, agricultural, mixed rural–urban or natural habitats regions	High landscape complexity (percentage of natural area)	Low landscape complexity (percentage of natural area)	Metric: 1) Natural enemies (natural enemy abundance, richness, diversity, and direct effects on pest reduction) ; 2) disease control (disease prevalence, host and vector abundances, infection levels); 3) pest response (pest abundance, richness, and damage); Effect size: Fisher's Z-transformed r	81%

Results

- An increase in the percentage of natural habitats (E++ = 0.35, CI 0.15–0.54, df = 22) had positive significant effect on natural enemies' responses.
- The percentage of natural areas in the landscape had a significant and positive effect enhancing disease control by approximately 20% (E++ = 0.20, CI 0.07–0.33, df = 13) in areas with higher percentages of natural habitats. However, fail-safe values indicated that results were not robust and should be interpreted with caution.
- The percentage of natural areas surrounding agricultural areas did not influence the loss of pest control (E++ = 0.08, CI - 0.23 to 0.40, df = 10).
- NA
- NA

Factors influencing effect sizes

- NA : NA
- NA : NA
- NA : NA

Conclusion

The percentage of natural areas had positive effect on disease control and natural enemies, while it has no effect on the loss of pests' response. The meta-analyses reinforce the importance of considering landscape structure in assessing ecosystem services for management purposes and decision-making.