Agroforestry and biodiversity

Reference 11

Nichols, E; Larsen, T; Spector, S; Davis, AL; Escobar, F; Favila, M; Vuline, K. 2007 Global dung beetle response to tropical forest modification and fragmentation: A quantitative literature review and meta-analysis. Biological Conservation 137 : 1-19. doi: 10.1016/j.biocon.2007.01.023

Background and objective

Although insects are crucial for maintaining ecosystem function, our understanding of their overall response to human activity remains limited. This is no less true of dung-burying beetles (Coleoptera: Scarabaeidae: Scarabaeinae), which provide a suite of critical ecosystem functions and services, yet but face multiple conservation threats, particularly from landscape conversion. To summarise the effects of tropical forest modification and fragmentation on dung beetle community structure. Modified habitats along an approximate disturbance gradient ranging from selectively logged, late and early secondary forest, through agroforestry, tree plantations, to annual crops, cattle pastures and clear-cuts.

Search strategy and selection criteria

Science Citation Index Expanded with the following keywords: Scarabaeinae, dung beetle, tropical forest, anthropogenic, deforestation, modification and fragmentation for the years 1990–2005. In addition, authors added publications cited by these works that were not retrieved by the keyword search, resulting in 43 publications. Also requested unpublished datasets from members of the Scarabaeinae Research Network, which resulted in six unpublished studies. Studies that address the response of tropical Scarabaeine dung beetles to the modification and fragmentation of predominantly moist tropical forest. For the quantitative assessment, they selected only one publication if an author published upon identical data multiple times (e.g. in different languages). However they incorporated all useable studies when multiple publications based on independent sampling events were conducted within a single landscape. They selected only those studies which used internally consistent sampling methods across all sites and treatments, had minimal elevation differences across sites with a study and sampled dung beetles with standardized dung-baited pitfall traps. Further selection within the ‘modification’ subset was conducted by selecting only studies which sampled both one or more modified habitat types and intact forest within the same system, defining ‘intact’ forests as those defined by individual authors as ‘contiguous’ or ‘primary’ forest. For the ‘fragmentation’ studies, they additionally removed those studies that sampled within a single fragment.

Data and analysis

1)To test which modified habitats deviated from intact forest values for a given community parameter, they incorporated standardized community parameters as unweighted effect sizes in a fixed-effect categorical model with resampling (5000 iterations). For each parameter in each modification type, they determined the cumulative effect size and bias corrected bootstrap 95% confidence intervals. 2) Framentation meta-analysis. They correlated beetle response parameters with fragment characteristics (fragment size, isolation and mammal density) across a pooled dataset composed of the seven studies that sampled both intact and fragmented forest (n = 109 fragments). They used partial Pearson correlations because of related independent variables, although they also provide linear regressions to illustrate patterns using scatterplots. Ntotal, Nintact, fragment area and distance to intact forest were log-transformed to achieve normality. SPSS 11.0 was used for all correlations and figures.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
33	Tropical forest land use categories.	Selectively logged forest (14–168 m3 wood extracted/ha; n = 4, late secondary forest (>15 yr; n = 7), early secondary forest (610 yr; n = 8), agroforests (coffee or cacao under native forest cover; n = 4) tree plantations (monoculture timber, sun coffee or cacao; n = 6), annual crops (predominantly corn fields; n = 3), cattle pastures (grass monocultures with no tree cover; n = 9) and clear-cuts (small clearings, often embedded within forest; n =7).	Intact forest.	Proportion of studies that found an increase or decrease in six dung beetle community parameters in each modified habitat type, relative to the intact forest value of 1.0 within each study.	94%

Results

- Secondary forests, selectively logged forest and agroforests supported rich beetle communities with many intact forest species, while cattle pastures and clear-cuts contained fewer species overall with few forest-dwelling species.
- Abundance generally declined with increasing modification, but was quite variable.
- Across fragmentation studies, dung beetle species richness, abundance and evenness declined in smaller forest fragments.
- Richness and abundance sometimes declined in more isolated fragments, although this response appeared to depend on matrix quality.
- NA

Factors influencing effect sizes

Across both habitat modification and fragmentation studies, geographic location and landscape context appeared to modify dung beetle response by influencing the available pool of colonists.

Conclusion

Strong and negative response of tropical forest dwelling dung beetle communities to increasing modification of tropical forest and declining fragment size.