

Comment on Hallmann

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Hallmann et al. (2017) concludes that there is a dramatic decline in insect biomass. Considering the fact that this result was found using data gathered in nature conservation sites, makes this finding even more alarming. The Authors reported a decline of “more than 75 percent” over 27 years. The majority of contributing effects to this development remain unknown.

We want to point out critical aspects of the publication, check for their relevance in the statistical analysis, and discuss the paper within the context of our approach. The following bullet points give an overview over some aspects of the analysis we identified as problematic:

- Years 1989 and 2014 are over-represented
- Few locations were re-sampled
- Only one trap per location
- The exposure time varies greatly among years
- Unknown site selection procedure
- Lack of control group

Considering these issues and taking into account the impact the publication had, and still has, we want to assess the robustness of its results, mainly the decline of insect biomass.

A possible bias in the site selection process and the low number of re-sampled sites, give rise to suspect regression to the mean influencing the findings of Hallmann et al. (2017). Barnett, Pols, and Dobson (2004) describe regression to the mean (RTM) as a statistical phenomenon where the normal variation of repeated measurements appears to be a real change, simply because with every additional measurement the values are closer to the mean. Furthermore, RTM can appear as a selection phenomenon, when there is no control group and no random sampling of measurements sites or individuals (Blomqvist 1987; Kelly et al. 2005). Within ecological research, however, implementing a control group can be impossible, for example when investigating temporal changes as it is the case here. We argue, that during site selection, locations with favorable attributes were chosen to maximize the efficiency of the traps, leading to extreme values in the initial measurements. Over the duration of the sampling process the ‘quality’ of the sites that were yet to be sampled decreased. Since we could not test the original results on RTM by redefining the sampling design, we tried to rule out the effect, by only including the first year of sampling per plot in our analysis.

To deal with the varying exposure times, the insect biomass model was build to account for the temporal differences by calculating the daily latent but unobserved biomass. We ran the basic model with a subset of the original data, using the same presets as Hallmann et al. (2017) (i.e. number of iterations, chains, and amount of thinning). The output showed that even with less data, the model diagnostics were similar to the ones of the complete dataset.

However, the output did not differ substantially from Hallmann et al. (2017). The hypothesis of a intensified insect biomass decline due to regression to the mean could not be verified. We report a decline of flying insect biomass of 81 % within 27 years during times with the highest biomass. This is a discrepancy of 0.4 % from the original result (~ 81.4 % decline). The original results seem to be robust from this point of view.

We found the statistical methods used in the analysis to be reasonable, especially for the given data set, as most of the issues we pointed out were introduced by sampling.

Nevertheless, RTM remains to be a critical aspect in ecological modeling. The low relevance and coverage of RTM in environmental analyses became obvious to us during this course. A quick comparison between search results of RTM effects in ecology revealed this. Compared with RTM in epidemiology (over 100 articles, cited > 1000 times), RTM in ecology was greatly underrepresented (only 3 articles, cited < 200 times). Additionally, in the current issue of Nature magazine, de Haas shares his story of the retraction of an article caused by an overlooked RTM effect (Haas 2021). Therefore, we want to point out the need to further include the phenomenon of RTM in ecological data analysis.

References

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