

PLOS Science Wednesday: Hi reddit, we're Caspar and Eelke, and our research shows a more than 75% decline in the biomass of flying insects over 27 years, indicating severe disturbances in many ecosystems – Ask us Anything!

PLOSScienceWednesday¹ and r/Science AMAs¹

¹Affiliation not available

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Abstract

Hi Reddit, My name is Caspar Hallmann and I am PhD candidate at the Radboud University in Nijmegen, the Netherlands. My research focuses on population dynamics of birds and plants in relation to landscape and climate changes. My name is Eelke Jongejans and I am Assistant Professor at the Radboud University in Nijmegen, the Netherlands. My research focuses on spatial population dynamics: I'm interested in the demographic and driving processes that can explain why certain populations increase in number, while others dwindle. We recently published a study titled More than 75 percent decline over 27 years in total flying insect biomass in protected areas in PLOS ONE. The aims were to see whether the total weight of insects flying in German nature areas has changed over time, and whether a change can be understood by considering climate change, land use change and local changes in plant species composition. The insect biomass data were painstakingly collected by our German co-authors of the Entomological Society Krefeld, using highly standardized traps from 1989 till 2016. Approximately every 11 days they placed a new bottle with ethanol, resulting in 1503 samples collected in 63 different sites. About half of the sites were visited in more than 1 year, resulting in 96 site-year combinations. To analyze this complex dataset we modeled daily biomass as a function of explanatory variable like habitat cluster, weather variables, plant species richness, proportion of land covered by agricultural fields in a 200m radius. While these variables explained a considerable amount of variation between the collected samples, they could not explain the overall 76% decline in insect biomass that we found over the 27 years. We will be answering your questions at 1pm ET – Ask Us Anything! Unsure what to ask? Read an interview with Caspar Hallmann on PLOS Research News.

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PLOSSCIENCEWEDNESDAY [R/SCIENCE](#)

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PLOSscienceWednesday ,

Thanks for taking time to answer questions.

What do you think the second order effects of this decline will be for the ecosystem of Germany, and beyond?

Will it affect agriculture?

What can people do to help reduce/reverse this trend?

[Scytile](#)

Hallmann & Jongejans: Insects are the food source for various higher trophic levels, including birds, bats, and other animals, while playing a key role in nutrient cycling themselves. Furthermore, insects

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are pollinators of the significant part of our crops and wild plants species, and also play an important role in biological pest control.

What can people do? In our research we were not able to pinpoint the causes of the decline in flying insect biomass (although we excluded factors like climate change, land use change and local vegetation change), but from a precautionary principle we could stop doing things which are known to be harmful to insects (e.g. overabundant use of pesticides, spilling chemicals and nutrients into waterways and nature areas) and do things which are known to help insects (e.g. increase the size of nature reserves, create safe havens like permanent flower-rich field margins, corridors or small natural areas in the agricultural landscapes where insects can complete their life cycle).

If someone off the street were to ask you why they should care about the issue of insect biomass, what would say to them?

[adenovato](#)

Hallmann & Jongejans: Humans are very successful in shaping the environment to their needs, but fail, in many places, to keep biodiversity intact. This is of course a philosophical discussion, but one could argue that we have a responsibility for maintaining biodiversity in human-dominated landscapes. Besides, if someone is more inclined to be convinced by monetary arguments, it could be pointed out that insects play key roles in crop pollination, nutrient cycling, pest control and are also a prime food source higher trophic levels, and thereby contribute to ecosystem stability.

Is this an across-the-board decline in flying insect biomass? Or were there particular taxons that seemed to decline while others were more stable? And was this decline fairly uniform across locations, or were declines less steep in certain geographic areas?

Thank you for your time!

[kiri-kin-tha](#)

Hallmann & Jongejans: Unfortunately we cannot say at the moment, as the samples have not been identified to species or genus level yet. However, we expect that with a 75% drop in biomass many parts of the insect spectrum are likely to be affected. The decline seems very similar across very different habitats (eg nutrient rich grasslands vs nutrient poor sandy areas). See figure 4 for a between-plot comparison. The sampling setup unfortunately does not allow at this moment to compare large geographical areas.

Well this is pretty concerning! What are the limitations of your study and if you were to undertake a follow-up what changes would you make?

[scienceaccount103040](#)

Hallmann & Jongejans: One of the shortcomings of this study is that the collected insects have not all been taxonomically identified yet. This is ongoing work, but incredibly slow because it involves many specialists and a lot of time before you get at the bottom of it.

Thank you so much for this AMA. What a coincidence that I have decided to take a look at this subreddit during this interesting opportunity. As a pretty hardcore insect guy, I have noticed this decline over the past 10 years. I can't help but realize that the beloved creatures I knew in my area have

disappeared and are disappearing.

1. Where did you acquire malaise traps, and how so at a good deal assuming these were your goals? Large tent-sized malaise traps tend to be very expensive, costing hundreds and thousands of dollars.
2. I briefly noticed you brought forward the theory that plant succession is accounting for this decline. Is this succession in a cyclic sense (meaning plant species will spring up again) or is this succession in more of a permanent sense, that some human disturbance for example has reduced the species richness of the plants and therefore insects without recovery?

[AISP_Insects](#)

Hallmann & Jongejans: The entomological society in Krefeld has constructed (and is continuously constructing) each year's Malaise traps based on a self-made prototype similar to that of Henry Townes. This ensures that the collection stays identical over the years and that you do not depend on external providers. We brought plant succession forward as an hypothesis because in the reserves you may have the case that due to succession, open areas over time might close up and become woodland. Flying insects numbers are lower in forests, and this might affect the collected biomass.

Are there any other studies that suggest a similar decrease in biomass over time, or was this the first study to observe/suggest this effect? Was this result what you expected?

[odder135](#)

Hallmann & Jongejans: This is the first study to document a decline in biomass in nature reserves. We know of one study looking at insect biomass collected with suction traps in the UK: <http://onlinelibrary.wiley.com/doi/10.1111/j.1752-4598.2009.00062.x/full> We suspected declines in insects are present, but we were quite surprised by the extent of it.

What are the major ecological impacts of this level of decline?

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Hallmann & Jongejans: It is not unlikely that the reported decline in flying insect biomass goes hand in hand with impoverished abundance and diversity in other species groups. For instance, see for instance the parallel declines in pollinators and insect-pollinated plants (Biesmeijer et al. 2006 Science). Coincidentally the German nature Conservation Society (NABU) published a report on bird decline in the agricultural landscape the day after our PLoS ONE paper came out. They suggested mayor impacts of agricultural intensification and insect losses.

Does the insect decline affect bird migration patterns?

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Hallmann & Jongejans: Although we know of no study looking specifically at this, we may expect that a decline in prey base may affect the condition of newborns, and this may have it's toll on the way to the winter grounds. This is speculation at this point.

Obviously one of the major concerns about this is how it might propagate throughout an ecosystem.

It's easy to construct stories about why this is extremely worrying (for example, I've seen arguments about impact on plant species that rely on insect pollinators), but I'm not sure if there is good science to back this up. Can we reliably say how this might impact an ecosystem in the long run?

[XerxesInPersia](#)

Hallmann & Jongejans: See for instance the parallel declines in pollinators and insect-pollinated plants (Biesmeijer et al. 2006 Science) While long-term research is indeed scarce, e.g. Scheper et al. 2014 (PNAS) studied museum specimens, linking declines in plant pollen diversity to wild bee declines.

Coincidentally the German nature Conservation Society (NABU) published a report on bird decline in the agricultural landscape the day after our PLoS ONE paper came out. They suggested mayor impacts of agricultural intensification and insect losses.

I rarely hear about ecological concerns regarding insects, except for invasives. Is this the first time major declines in insects have been detected? If so, how has this been going on so long without us noticing? Do you think there are other taxa that are suffering from human impacts much more than we realize?

[Kenley](#)

Hallmann & Jongejans: We think that part of the problem is that, apart from some well investigated species of butterflies, moths and bees, there are no standardized monitoring systems in place anywhere that look at insects as a community. This by itself may explain why we have missed this decline in earlier stages. We think this problem is not restricted only to the insects, but also to other life forms that are underinvestigated.

How is the regenerative capacity of insects in general and of the insects affected (which insect were affected most) if the source of this decline is taken away will they reproduce fast enough to recover or do you think it will do long lasting damage ?

[ROGGOGG](#)

Hallmann & Jongejans: As the 53kg (!) of collected flying insects have not been taxonomically sorted yet, when cannot say yet which groups of insects were affected most. Given the short life span and high reproductive potential of most insects, one could optimistically expect that, when circumstances improve, insect populations could recover quickly. Dispersal limitation could slow such a recovery in certain species.

Are certain species more represented in the 76% decline or is that not known because of how the trapping works?

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Hallmann & Jongejans: This is subject to current investigation, so at the moment we unfortunately cannot say what species, or species groups, are affected most.