Conservation

Robust evidence of insect declines

William E. Kunin

Data are mounting that document widespread insect losses. A long-term research project now provides the strongest evidence of this so far, and demonstrates the value of standardized monitoring programmes. **See p.671**

There are certain times in life — whether in our relationships, personal health or scientific research — when we think that we know something but the evidence is less than conclusive. An accumulation of clues or symptoms might suggest a particular interpretation without being strong enough to clinch the argument. In such situations, it can be a relief to finally get a definitive answer, even if the news is bad. Once we know that a problem definitely exists, we may be able to do something about it. Readers might feel the same way when they read the results reported on page 671 by Seibold *et al.*[1], which provide compelling evidence of a major problem — large-scale declines in the numbers and diversity of insects and other jointed invertebrates known as arthropods.

Insects have pivotal roles in terrestrial ecosystems. These organisms dominate global animal biodiversity in terms of their biomass, species numbers and total population numbers, and they perform important ecosystem functions and services such as pollinating flowers, disposing of dead organisms and waste, and forming crucial links in food webs. Insect declines have been implicated as possible drivers of declines in insect-eating birds[2] and in animal-pollinated plants[3]. Thus, massive losses in insect diversity (Fig. 1) and abundance would be grounds for serious concern.

The rumours of such declines have been around for some time. In the 1990s, researchers warned that extinctions among insects probably outstripped those of more highly studied organisms such as vertebrates and plants[4]. Evidence subsequently grew of declines in particular insect groups, including butterflies[5] and bees[3]. Most such studies have focused narrowly on particular insect orders or families, although a recent global meta-analysis[6] provides strong indications that insect losses are geographically widespread and occur across a range of taxonomic groups.

However, much of this evidence has come from biodiversity databases — records of species sightings, mostly collected by volunteers, and usually gathered in a haphazard fashion. Analytical techniques can use such records to assess changes in the local species richness[3] or species' distributions[7], but analyses of this sort are frustratingly indirect. The models used to analyse data can attempt to take into account the often strong temporal and spatial biases in these data sets. However, such results could still be influenced by changes in the nature of the biodiversity recording over time, fuelled by changes in observers' goals and methods. Such analyses are also limited in scope. Although they can reveal changes in diversity, such data, recording a glimpse of a species at a given site on a particular date, do not reveal shifts in insect abundance, which is arguably the most crucial aspect to assess when monitoring ecosystem services[8].

Standardized sampling can fill that gap. A previous study[9] reported the data collected from a network of standardized insect traps set by amateur entomologists in German nature reserves over a 27-year period. That study indicated that the biomass of insects captured declined by 75% over the period studied. This research raised serious concerns, but it had limitations: the sampling of sites was opportunistic and not always consistent over time, and although the biomass of the specimens caught was recorded, the species were not identified or even counted, meaning that species richness and abundance couldn't be assessed.

Seibold and colleagues finally complete the circle by reporting species richness, abundance and biomass for a wide range of arthropod taxa recorded using standardized sampling[1]. They describe the results of monitoring over nearly ten years of intensive study in grasslands and woodlands in three regions of Germany as part of the country's interdisciplinary Biodiversity Exploratories project[10].

The results show clear evidence of substantial declines in arthropod abundance and biodiversity (Fig. 2). Grasslands were particularly badly affected: species richness of arthropods fell by 34% over the monitoring period, and the arthropod biomass and numbers recorded dropped by 67% and 78%, respectively. These declines were particularly strong in landscapes dominated by farmland, suggesting that agricultural management could be driving this drop. The losses among forest-dwelling arthropods were less precipitous by comparison, with a 36% drop in species richness, a 41% loss of biomass and no statistically significant population decline. The verdict is clear. In Germany at least, insect declines are real, and they're every bit as severe as had been feared.

Such long-term standardized monitoring as carried out by Seibold and colleagues is not cheap. However, the expense is dwarfed by the expenditure needed to address the problem. Agri-environmental programmes in the European Union, for example, spend tens of billions of euros to encourage farmland biodiversity, a substantial portion of which is aimed specifically or partially at insects (see go.nature.

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Figure 1 | The meadow plant bug, *Leptopterna dolabrata*. Rumours of a decline in the numbers of insects such as the meadow plant bug are a cause for concern.

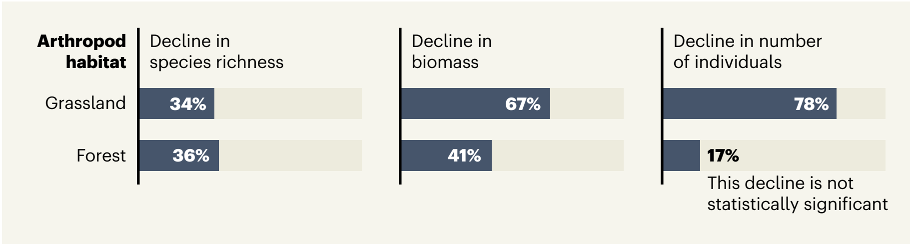

Figure 2 | Arthropod declines recorded in Germany. Seibold *et al.*[1] report nearly a decade's worth of standardized sampling of arthropods – jointed invertebrates such as insects – at grassland and forest sites. The authors provide compelling evidence of declines in arthropod populations over time. These large-scale changes will probably have a negative effect on key ecosystem services such as pollination. Seibold and colleagues found that species richness and biomass declined significantly during the course of the study in both types of habitat, as did the number of arthropod individuals recorded at grassland sites. The decline in arthropod population sizes noted at forest sites was not statistically significant.

com/35pvdtv). Similarly, EU restrictions on the use of neonicotinoid insecticides were instituted specifically to protect insect pollinators, and (industry-funded) research[11] suggests that this restriction has cost EU oilseed-rape farmers more than €500 million (US$549 million) annually, because of reduced production and the consequential increased costs.

Ignorance is expensive. Given that substantial investments of public and private funds for insect conservation are deemed appropriate by society, then surely it is sensible to spend a tiny proportion of such funds on monitoring, allowing us to assess the effectiveness of these actions and to adjust them if necessary.

The Biodiversity Exploratories project would be a good model for such an effort. This is because it extends beyond population monitoring to provide a platform for cross-disciplinary science to address the large-scale and long-term issues that are crucial in driving declines of insect communities, but which aren't amenable to analysis by controlled experimentation. The project not only helps to document declines in insect populations and biodiversity, but also assists with diagnosing their potential causes. If such in-depth, landscape-scale field research and monitoring were rolled out more widely across Europe and beyond, we could begin to build land-use and agricultural policies on the basis of compelling scientific evidence. The results reported by Seibold and colleagues might not be good news, but at least now we know where we stand and what we should start to do.

William E. Kunin is in the School of Biology, University of Leeds, Leeds LS2 9JT, UK.
e-mail: w.e.kunin@leeds.ac.uk

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