Where have all the insects gone?

BACKGROUND

Having a healthy and varied insect community is critical for the farmed environment and farmland wildlife generally. Insects are an essential component in the diet of most farmland birds, pollinate crops, regulate crop pests and recycle organic matter in the soil. Worryingly, numbers of nearly half of all studied insect groups are falling according to our long-term monitoring of cereal crops in Sussex and this could threaten these vital ecosystem functions. This has come to the attention of the farming community. To better understand the underlying factors influencing this downward trend, we started additional annual monitoring of insect levels on 10 farms across England in 2018, along with the Rotherfield Estate which is part of the PARTRIDGE project. The motivation for many of those in the farming community, and conservationists more broadly, is to understand whether there are sufficient food supplies for grey partridges and other farmland birds, and which habitats provide the highest levels of partridge chick-food insects. We concentrate here on what both the long-term monitoring in Sussex and at our Allerton Project farm in Loddington, and the short-term changes from the wider monitoring, can tell us about changes in grey partridge chick-food and report on first indications on how to reverse insect shortages.

Long-term trends in grey partridge chick-food insect abundance on the Sussex Study and the Allerton Project

Invertebrate sampling on the Sussex Study began in 1970 and for the Allerton Project at Loddington in 1992, with both continuing to the present day. In both of these long-term monitoring studies, sampling is carried out with a Dvac suction sampler, but the detail of what habitat is sampled varies. In Sussex, the emphasis has always been on grey partridge chicks foraging in the headlands of cereal crops, so sampling has been restricted to those areas. For the Allerton Project, a more comprehensive approach has sampled all crops in both the headlands and the middle of fields. Since 2000, sampling in the boundaries of fields (hedgerow bottoms, grass banks) at the Allerton Project has recorded information in semi-natural habitats as well. Information is currently available from 1970 to 2020 for Sussex and from 1992 to 2011, 2015-2017 and 2019 for the Allerton Project.

Long-term monitoring in Sussex, across all samples, shows that only in 1970 and 1976 has the average yearly chick-food index exceeded the threshold of 0.7 needed for stable grey partridge numbers (see Figure 1). There is a great deal of year-to-year variation, with the lowest levels of chick-food in 1977, 1994 and 2013. Examining trends in the different types of cereal crops over 51 years finds that spring cereals (mainly spring barley) have higher average chick-food indices than either winter wheat or winter barley/oat crops (see Figure 2). We observed no significant differences between conventional spring cereal crops and conservation headlands in spring cereals, although in 2016-2018 the average chick-food index in conservation headlands exceeded 0.7 (see Figure 3).

In the Allerton Project, the yearly average chick-food index in headlands across all crops was below 0.7 in all years, whereas in the semi-natural habitat surrounding fields (hedges and grass banks) the average chick-food index exceeded 0.7 for 11 of 16 years (see Figure 4). There is a significant positive correlation between the yearly averages in the semi-natural habitat and the respective yearly average from the crop samples at the Allerton Project, indicating that drivers of annual variation are acting in synchrony across the area – possibly linked to weather conditions as we have shown in Sussex – see *Review of 2015,* pages 28-29.

Chick-food levels across 10 English farms

We sampled nine arable crops across the 10 farms (Yorkshire-1, Northamptonshire-1, Shropshire-1, Norfolk-6, Dorset-1), including both spring- and winter-sown crops, along with permanent pasture, grass leys and a variety of non-crop habitats. To compare findings with the long-term monitoring in Sussex and at the Allerton Project, we used Dvac suction samplers and sampled annually (2018-2020) at the same time (June or early July), when insects are most abundant. This enabled us to calculate the grey partridge chick-food index. Depending on the landowner's interests, we sampled in the headland area of the crop and/or mid-field.

None of the nine arable crops sampled reached the threshold level of 0.7 in the grey partridge chick-food index (see Figure 5). The maximum recorded was 0.42 in the headland area of spring beans, while spring oats and grass leys also had higher

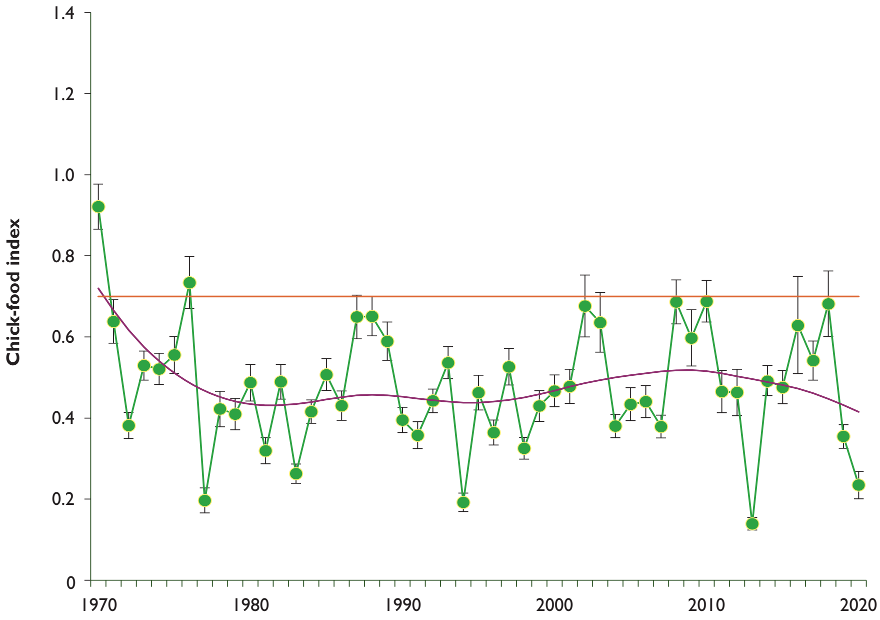

Figure 1

Long-term trend in the average grey partridge chick-food index in Sussex from all cereal crops

An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers

Significant long-term trends

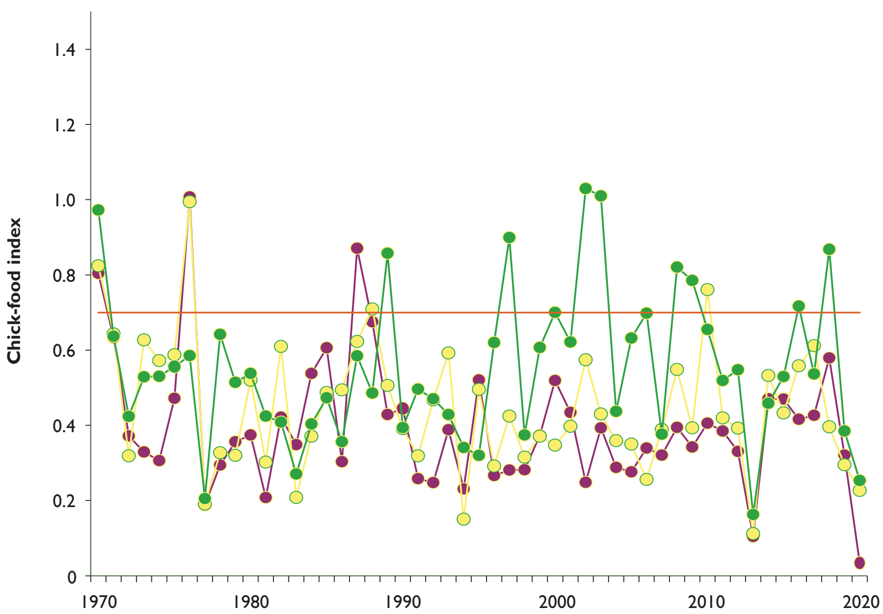

Figure 2

Long-term trends in chick-food index in the three types of cereal crops sampled in the Sussex Study across 51 years

An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers

Spring cereal

Winter wheat

Winter barley and oats

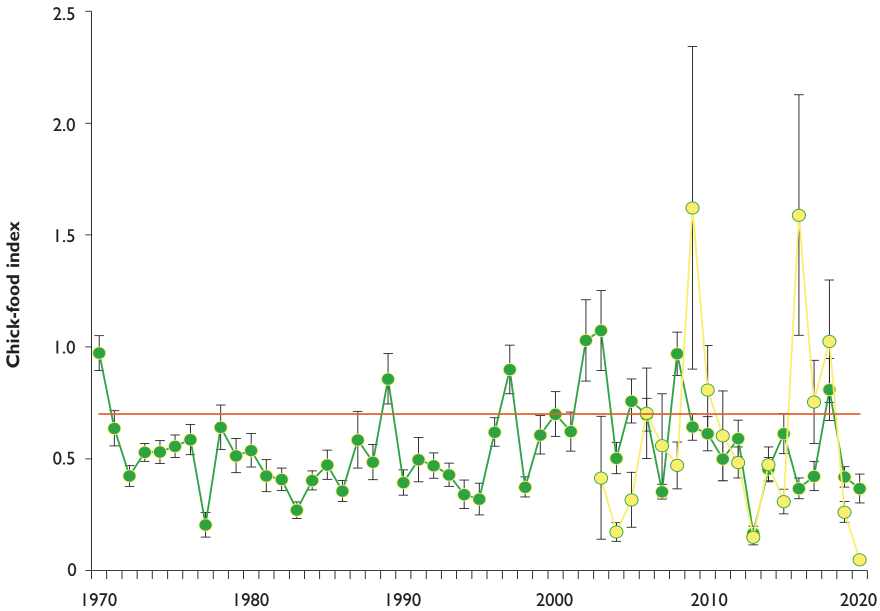

Figure 3

Long-term trends in the chick-food index in spring cereals in Sussex, comparing those in conventional fields with the yearly average in spring cereal conservation headlands

An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers

Conventional fields

Conservation headlands

An uncropped margin at Rotherfield was one of three agri-environment scheme habitats that delivered high insect numbers. © Francis Buner/GWCT

KEY FINDINGS

- Levels of chick-food insects are extremely low in all sampled arable crops across England, except peas at Rotherfield.
- Spring cereals tend to have higher levels of chick-food than other cereal crops.
- Semi-natural habitats, such as hedgerows and grass banks that surround fields, may hold higher levels of chick-food, with correlation between levels in this habitat and in crops.
- Non-crop agri-environment scheme habitats failed to deliver target levels of chick-food insects except at Rotherfield, where PARTRIDGE wild bird mixes, arable margins and extended overwintered stubbles delivered above target. In Sussex, conservation headlands contained more chick-food insects than conventional crops in some years.

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levels than the other crops. These values are lower than those in conventional spring cereals in the Sussex Study from 2018 to 2020 (0.53 ± 0.14 SE), but similar to those in crops at the Allerton Project in 2015-2017 and 2019 (0.18 ± 0.02), suggesting widespread depletion of insect levels among all crops.

In the non-crop planted conservation habitats (see Figure 6) the chick-food index was also very low; flower strips and the cornfield-annuals mix were the best performing habitats, although these were still below the threshold level.

Chick-food levels at the Rotherfield PARTRIDGE demonstration site

Sampling started in 2018 and followed the method described above, focusing on the PARTRIDGE agri-environment scheme (AES) habitats (wild bird seed mix, cultivated uncropped margins and extended overwintered stubbles) in comparison with winter wheat and peas. In line with the results across all other farms reported here, winter wheat contained very low insect numbers, yielding an average chick-food index far below 0.7 (0.23 ± 0.04, n = 15). However, contrary to the other 10 English sites, the three AES habitats delivered values above 0.7 (PARTRIDGE mixes: 0.82 ± 0.16, n = 39; cultivated uncropped margins: 0.93 ± 0.30, n = 8; extended overwintered stubbles: 1.40 ± 0.31, n = 6). Peas also harboured high insect numbers (primarily aphids) in two of the three years sampled, thanks to a non-insecticide policy on the outer 24 metres (index = 0.87 ± 0.39, n = 5).

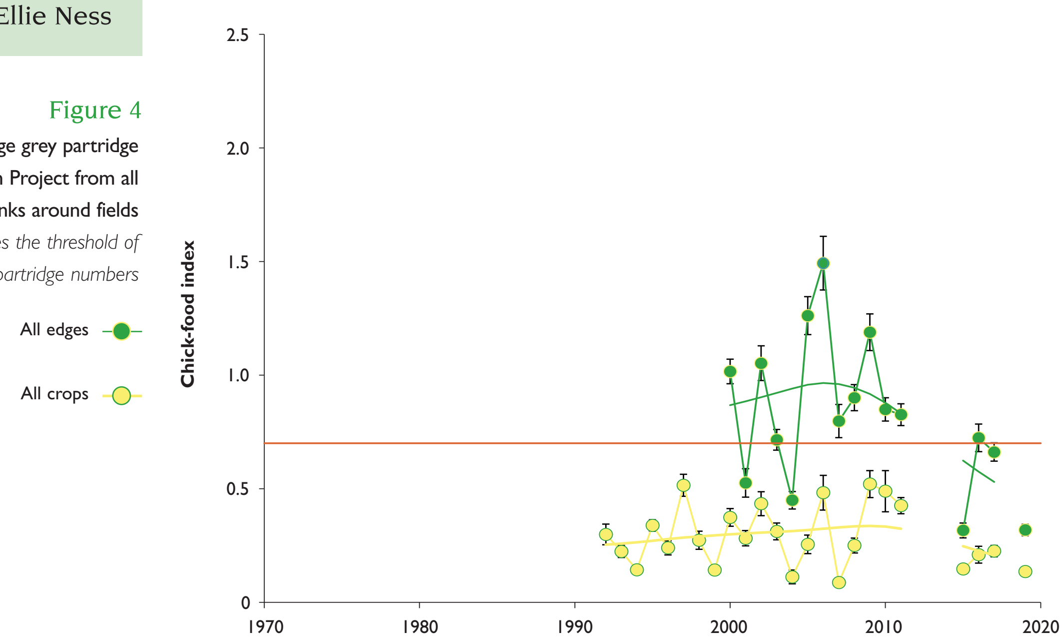
Conclusions

Having such low levels of insects across arable crops generally is of grave concern and backs worldwide reports of a collapse in insect populations. Of added concern is the

Figure 4

Long-term trend in the average grey partridge chick-food index in the Allerton Project from all crops and in the hedges/grass banks around fields

An orange horizontal line indicates the threshold of 0.7 needed for stable grey partridge numbers



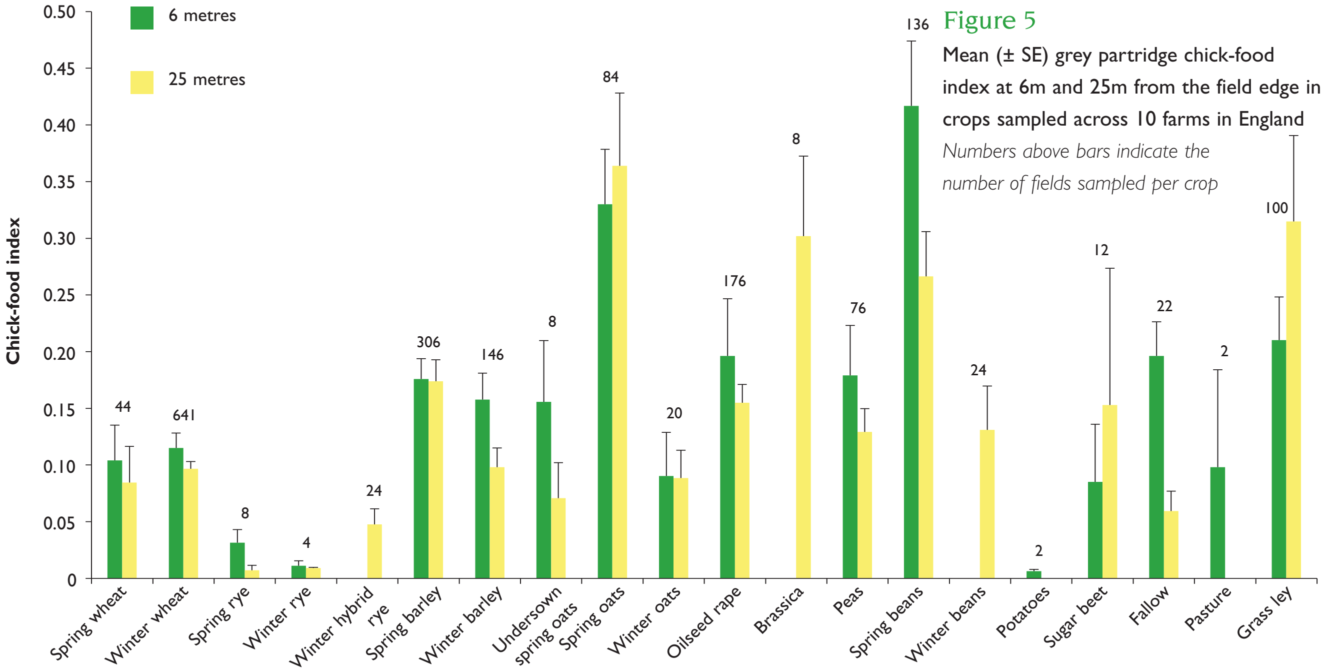


Figure 5

Mean (± SE) grey partridge chick-food index at 6m and 25m from the field edge in crops sampled across 10 farms in England

Numbers above bars indicate the number of fields sampled per crop

poor number of chick-food insects in the non-crop AES options at the 10 English farms. These low insect levels may explain why many farmland bird species continue to decline or have failed to recover nationally despite the widespread uptake of AES options focused on their recovery. Such insect declines also have far-reaching consequences for food production as they make crops more vulnerable to new pests that may spread with climate warming, there now being potentially fewer natural enemies to regulate them.

Within crops and the studied AES habitats it is mainly the arable plants (weeds) that support the most insects. Hence, floristically diverse conservation headlands such as in Sussex or cultivated uncropped margins like at Rotherfield – where most have been sown with a mix of native rare arable flora – play an important role in restoring insect numbers and diversity. Further successes may be achieved by making existing wild bird seed mixes more species-rich, including native annual and perennial flowers as is the case with the PARTRIDGE mix (available as a wildlife plot option under Defra's Test and Trials Scheme), and by promoting extended overwintered stubbles. The effort required to increase the abundance of chick-food insects is considerable and success is reliant on weather conditions as well as diverse high-quality habitat provision at a landscape-scale.

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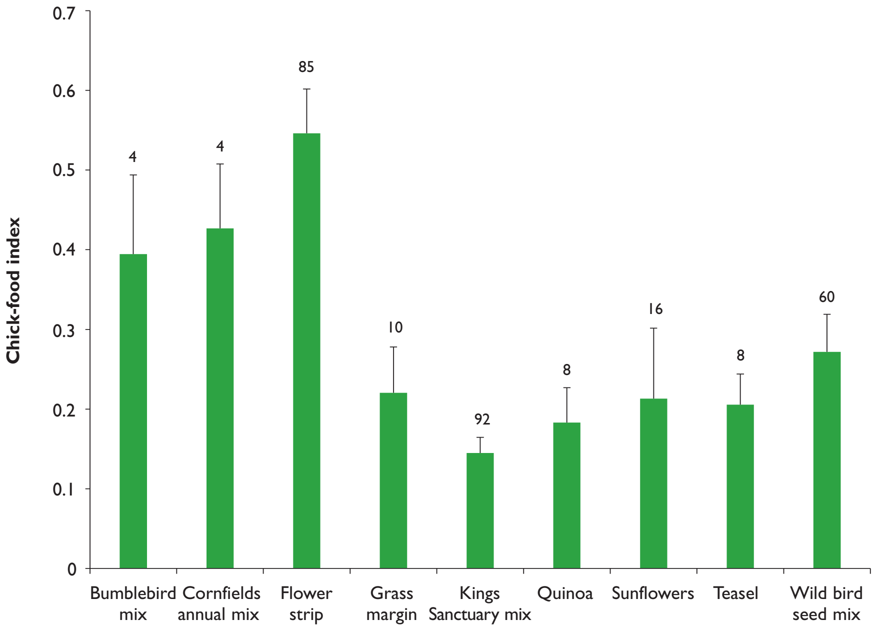

Figure 6

Mean (± SE) grey partridge chick-food index for seven non-crop habitats across 10 farms in England

Numbers above bars indicate the number of sites sampled per habitat