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AES schemes: impacts on the agricultural environment

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Source: Carvell, C., Bourke, A., Osborne, J. & Heard, M. (2015). Effects of an agri-environment scheme on bumblebee reproduction at local and landscape scales. *Basic and Applied Ecology*, 16(6): 519-530. DOI: 10.1016/j.baae.2015.05.006.

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Science for Environment Policy

Sowing larger patches of flowers can increase bumblebee reproduction in areas surrounding intensive arable farms

Agri-environment schemes (AES) have been implemented throughout Europe to mitigate against the negative effects of agricultural intensification. Although these schemes have shown positive effects on the abundance and richness of certain species and taxa, the impact of AES on reproduction of target species at the local and landscape scale is poorly understood. This large-scale study looked for the effect of selected AE measures on bumblebee reproduction. Results indicate that bumblebee reproduction is significantly higher on sown flower patches when compared to conventional management. Although the increase is most pronounced at the plot scale, higher reproduction was found in landscapes surrounding larger sown plots (at least one hectare) compared to smaller sown plots.

Agricultural intensification can result in the loss and fragmentation of habitats, leading in some cases to species decline. To mitigate these declines, the EU has established agri-environment schemes (AES), which compensate farmers for undertaking practices beneficial for biodiversity, such as maintaining existing habitats or creating new habitats.

These practices have been shown to benefit a range of birds, bees and plants by increasing the number of individuals and species, but there is debate as to whether this translates into long-term benefits for biodiversity. In particular, there is limited evidence that AES have positive effects on reproduction of certain taxa (and thus the persistence of populations).

Contributing to the evidence base, this study focused on several species of bumblebees (*Bombus)*, which play an important role as agricultural pollinators, but are now of high conservation concern due to the widespread declines in populations over recent years. The study focused on the importance of flower-rich habitats for bumblebees, more specifically, on the effect of newly sown flower mixtures on bumblebee reproduction (i.e. the abundance of males and queens, i.e. sexuals).

The researchers conducted a large-scale study across seven sites in England, with varying levels of agricultural intensity. At each site, a flower mixture (20% legume and 80% fine-leaved grasses — as recommended under the AES 'nectar flower mixture' option under the Entry Level Stewardship (ELS) scheme in England), was sown in patches of various sizes (0.25–1ha).

The patches were established on land taken out of arable production. Control 'patches' were selected at each of the seven sites to represent non-crop vegetation that was typical of the area, i.e. the non-crop vegetation that would normally be available to bees in the absence of a sown flower patch or margin. Control patches were always within around 3km distance of sown patches — so that all four patches at a site were separated by an average of 3km.

Fixed transects were also established in established patches, controls and also in conventionally managed field margins, surrounding both sown and control patches. This was to assess any 'spillover effect': when flower patches encourage increases in reproduction that can be detected in surrounding landscapes. The numbers of males and queens were recorded in monthly surveys from June to September over a three-year period (2005–2007). Researchers combined the numbers of bumblebee males and queens to create an index of the total biomass of bumblebee sexuals (referred to as MQ), which was used as a measure of reproduction. The MQ index and the density of flowers recorded on each survey were calculated for each patch, and statistical models were used to assess the relationship between the two.

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The reproductive measure (MQ) was significantly higher on the flower-sown, flower-dense patches than on the unsown, conventionally managed patches throughout the three-year period. When the researchers measured the areas surrounding the patches (at 'landscape-scale'), they found far less significant effects, with minimal improvement in biomass relative to the control patches.

However, patch size also mattered. At a local scale, the size of sown flower patches did not have a notable effect on MQ for any species. But more significant effects of patch size were seen at the landscape scale MQ for certain species (and for all bumblebees measured together) was highest in areas surrounding larger sown flower patches (covering 1 hectare) — suggesting that the size of sown flower patches influences reproductive capacity in intensively farmed landscapes.

The researchers also found that the positive effects on reproduction were greater where there was a greater proportion of arable land for certain bumblebee species. There was a higher MQ index on sown patches, than on the control patches in the most intensively farmed landscapes, but MQ indexes were similar on both sown and control patches in the less intensively farmed areas.

Taken together, these results suggest that sown flower patches, which provide forage resources all year round, can improve bumblebee reproduction in intensively farmed areas. Furthermore, if sown flower patches are big enough (at least one hectare), the beneficial effects can extend to surrounding areas. Overall, these positive effects suggest that larger sown patches in intensively farmed areas could provide the greatest benefits for this AES measure.

Although their results support enhancing forage resources in arable farmland by sowing flower patches, the study's authors say this is not a universal solution, and that their findings should not detract from using flower mixtures in other more mixed or grassland-dominated landscapes, or enhancing floral resources using other measures, such as organic farming, which can benefit other important species.

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