Intensification of land use leads to the same species everywhere

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The common restharrow or *Ononis repens* is a host plant for the insect *Macrotylus paykulli*, which feeds on its sap. Credit: Lars Skipper

In places where humans use grasslands more intensively, it is not only the species diversity which decreases—the landscape also becomes more

monotonous, and ultimately only the same species remain everywhere. This results in nature no longer being able to provide its 'services', which range from soil formation for food production to pest control. Led by the Technical University of Munich (TUM), 300 scientists studied the consequences of land-use intensification across different species groups at the landscape level for the very first time.

Normally, every meadow is different, and different species are able to find a suitable habitat somewhere. Intensified human land use leads to a smaller number of distinct plant communities on grasslands, which can therefore sustain fewer and fewer species: This is the catalyst for the increasing loss of species. In previous studies, only individual groups of species, such as birds, were studied within a particular habitat, and only over a specified area. But could the local loss of species not have a much greater effect if it were to be studied on a larger spatial scale and viewed in the context of the full diversity of life—from single-celled organisms to vertebrates?

For a study published in *Nature*, scientists analyzed and evaluated a unique data set with exactly this question in mind. For the very first time, it provided statistical evidence that intensified use led to all grasslands becoming homogeneous and only being able to provide habitats for a few species, and this proved to be the case across regions.

"The data comes from the Biodiversity Exploratories, which are funded by the German Research Foundation (DFG), and were collected from 150 grassland areas starting from 2008," according to Professor Wolfgang Weisser from Terrestrial Ecology Research Group at TUM, who is also one of the founders of this focus project. "These are probably the most comprehensiveecological field research sites in Europe," says Weisser.

4,000 species evaluated for the study

The research areas, whose data was used in the study, include the UNESCO Biosphere Reserve Swabian Alb, the Hainich National Park and its surroundings, and the Biosphere Reserve Schorfheide-Chorin. All three regions differ in terms of climate, geology, and topography, but are cultivated by farmers in a manner typical for Europe. More than 4,000 species were analyzed using an innovative statistical procedure. This new method allows for nonlinear effects on the the dissimilarity of species communities between grassland areas to be tracked along a continuous land-use gradient (cutting of grass, fertilizing, and grazing).

Data along the food chain ranged from single-celled soil organisms to birds

What was unique in this case was that data from organisms in the ground such as from bacteria, fungi, and millipedes were also included. "For the first time, we investigated all groups of species along the food chain on grasslands with different forms of land use in a variety of regions," said Dr Martin M. Gossner, lead author of the study, who is now working at the Swiss Federal Research Institute WSL. The species were subdivided into twelve groups according to their position on the food chain, and whether they live above- or belowground. For example, one group of aboveground species is that of the primary producers, which mainly comprises plants. Other groups include herbivores and plant pollinators, as well as their predators.

Even moderate land use results in a decline in species

The findings showed that it did not matter whether grassland areas were used moderately or intensively by humans. For example, a distinction was made between areas where grass was cut twice or four times a year. "According to our observations, the homogenization of species does not progress proportionally to the intensity of use. Instead, even a moderate

management of grassland results in cross-regional communities being reduced to the same, less demanding all-rounders," said Gossner—"a further increase in the intensity of use simply doesn't have a comparably large effect."

An example for a high-maintenance species: The common restharrow (*Ononis repens*, pictured) is a host plant for the insect Macrotylus paykulli, which feeds on its sap, or occasionally also on insects which get stuck to the glandular hairs of *Ononis repens*. If the common restharrow becomes increasingly rare due to the cultivation of common grass species with a high fodder value, *Macrotylus paykulli* no longer has a suitable habitat, and ultimately both go extinct. This means that even a slight intensification of the use of meadows and pastures makes it impossible for many species of flora and fauna such as the common restharrow and *Macrotylus paykulli* to survive, resulting in only those species remaining which do not have specific requirements regarding host plants or abiotic environmental conditions. This effect is called 'biotic homogenization'. "More intensive mowing is the main cause of biotic homogenization," said Professor Eric Allan from the University of Bern, the senior author of the study.

"What is new here is the finding that the homogenization of species takes place across landscapes, thereby reducing the diversity of species at a regional and national level," said Gossner—"which is probably a more significant consequence of the intensification of land use than the local loss of species alone."

Less interaction between species changes the ecosystem

Hence, grassland areas that are cultivated extensively by humans are essential for protecting species diversity because the decline in species

diversity also results in less interactions between individual species: "Interactions between plants and their consumers are increasingly weakened by more intensive agricultural usage," says Gossner—"which ultimately causes processes in the ecosystem to shift and change."

It is only when as many species as possible are able to find the unique habitats they require across large areas that 'ecosystem services', which improve human well-being, can remain intact. Because 'nature's services' help increase food production by improving soil formation, for example, but they also help keep pests in check.

More information: Martin M. Gossner et al, Land-use intensification causes multitrophic homogenization of grassland communities, *Nature* (2016). DOI: 10.1038/nature20575

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