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Biodiversity monitoring by farmers to sustain ecosystem services of high nature value grasslands in Austria

Abstract: *In 2007, the pilot project "Biodiversity monitoring in high nature value grasslands by farmers in Austria – We look at our meadows" started with fifty farmers monitoring indicator plant and animal species in extensive grasslands. Meanwhile, the monitoring methods and processes have been refined, based on first experiences, and lessons learned within the pilot phase. The overall goal of the project is to raise the farmers' awareness and intensity of land management on biodiversity rich grasslands. Another objective of the project is to use this citizen-science scheme to gather in-depth knowledge about the effects of different extensive land management practices on biodiversity and ecosystem services.*

A countrywide network of more than 650 monitoring farmers was set up, supported and instructed by ecologists. Since 2009, also 14 agricultural college schools are participating in the project. Farmers observe and count plant and animal species that are sensitive to cultivation and fertilisation and report the monitoring data to a central online database. An evaluation in 2017 showed that farmers participating in this environmental consciousness raising initiative became significantly more sensitive to the value of biodiversity and ecosystem services and consequently to extensive farmland management methods.

The project creates positive effects on farmers' perspectives to high nature value grasslands, increases sensitivity to management practices and fosters the motivation to sustain these habitats. Farmers can retrieve data reports at farm level,

cumulated evaluations are work in progress. The vision of the project team is to enlarge this biodiversity monitoring network with farmers to a European level in the next years.

Keywords: *biodiversity, monitoring, high nature value grassland, awareness raising, citizen science, environmental consciousness raising, ecosystem services, cultural heritage*

Introduction

Extensively cultivated grasslands and meadows are characterized as species rich ecosystems (Heinz et al., 2014). They provide manifold ecosystem services which can only be maintained by sustainable extensive farming methods (Resch et al., 2012) and the motivation and willingness of farmers.

The loss of biodiversity as a result of inappropriate intensive farming practices, amongst other pressures, is a world-wide documented problem (Pötsch et al., 2012). Several international conventions and initiatives like the UN Convention on Biological Diversity (UN CBD) – in which Austria is participating since 1995 – and the UN Sustainable Development Goals (Goal 15: Sustainably managed forests, combat desertification, halt and reverse land degradation, halt biodiversity loss) as well as the Alpine Convention defined measures to halt the loss of biodiversity. Following article 13 "Public Education and Awareness" of the UN CBD awareness rising about the importance of biodiversity to society is a major contribution in order to sustain biodiversity (UN CBD, 1992). Education experts propose action-oriented knowledge transfer as a successful approach for rising awareness about biodiversity aspects (Ramadoss and Poyya, 2011; European Commission, Directorate-General for the Environment, 2011; url 1). The Eurobarometer 2015 concluded that less than one third of the EU citizens currently know what biodiversity actually means (Eurobarometer 2015). In 2006, the project "MOBI-E – Development of a concept for biodiversity monitoring in Austria" developed 50 indicators as a means of measuring biodiversity in Austria. Assuming that farmers are experts on their own farmland, one of the indicators identified was 'species monitoring by farmers" (Holzner et al., 2006). Based on the fact that farmers directly influence biodiversity according to their farmland management, they should be guided to observe and count plants and animals. (Holzner et al., 2006; Bogner et al., 2006).

Within the EU Biodiversity Strategy, participating Member States committed to develop national biodiversity strategies, which aim at halting the loss of biodiversity and ecosystem services in the EU and help stopping biodiversity loss by 2020 (European Commission, 2001). In the Austrian biodiversity strategy 2020+ under action field "sustainable use of biodiversity", target 3

"agriculture and forestry contributes to conservation and fostering of biodiversity" the measure "preservation of permanent grasslands, particularly extensive grasslands and grasslands with high nature value (HNV)" was defined (Stejskal-Tiefenbach et al., 2014). HNV farmland covers areas in Europe where agriculture is the dominant land use and where agriculture ensures or promotes a high diversity of species and habitats or protected species and habitats. HNV is one of three biodiversity indicators for integrating environmental concerns into the Common Agricultural Policy.

Aim of biodiversity monitoring

Apart from policy driven top-down approaches at international and European level, particularly bottom-up solutions to stop further loss of biodiversity and to create a broad awareness are needed. Against this background, awareness rising amongst farmers and the dissemination of knowledge about flora and fauna depending on grasslands and extensive farming practices is highly important to sustain the biodiversity of grasslands. The initiative "Biodiversity monitoring in high nature value grasslands by farmers in Austria – We look at our meadows" piloted a citizen science scheme where farmers are trained by ecologists and gain knowledge about rare plant and insect species on their own grasslands. Subsequently, farmers are able to observe and document species on their own. Further objectives of the project are to gather knowledge about the effects on biodiversity and ecosystem services resulting from different extensive land management practices.

Monitoring design

In 2007, a pilot-awareness raising project started with 50 farmers. In order to receive valuable data for statistics, the monitoring method was adapted and enhanced in 2014. Farmers who want to participate in the project are visited by ecologists. In this personal training farmers gain deeper knowledge about rare plant and insect species on their own grasslands. They can select up to three different homogenous monitoring spots. According to the characteristics of the meadow, typical indicator species are selected on each monitoring spot. Up to five different plants and insect species can be chosen for monitoring on each spot. The farmers subsequently observe and document the selected species on the same monitoring spot every year. In doing this, they are trained to be "citizen scientists" and deliver valuable data.

About 64 plant species (e.g. *Salvia pratensis*, *Silene flos-cuculi* and *Achillea millefolium*) and 53 animal species (e.g. *Argiope bruennichi*, *Mecostethus parapleurus* and *Lygaeus equestris*) can be observed by farmers.

Depending on whether plant species, insect species or butterflies are being observed, different methods for monitoring can be differentiated (see Fig. 1). For the monitoring of plant species, a circular area of 80 m^2 has to be defined.

The farmers count the number of plant species at this given site. For counting the number of insects and spiders, a circular transect (10 m diameter) is defined, counting then occurs within a width of one meter. For counting the butterfly activity on the site, farmers have to watch from a point outside the plot. They need to monitor three times, on two days for exactly one minute and note how many different butterflies they counted each time.

Personal observations (for monitoring non-defined indicator species and/or personal preferences concerning specific species) may also be documented. For example, 189 farmers observe swallows (*Hirundo rustica* and *Delichon urbicum*) in the barn and in the surrounding area of the farm. They document the date of the first and the last observation of swallows in the year, the number of swallows, broods and offspring.

The centre of the area is signed and documented via GPS coordinates. Via an online data input system monitoring data is reported back by farmers. Thereafter, the data is correlated with data on management options (number of cuts, cut dates, fertilization, etc.) and then harmonised for further evaluations.

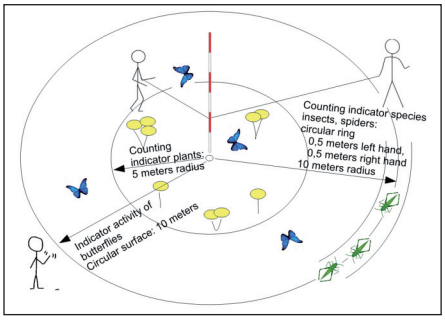


Figure 1. Monitoring design
Source: www.biodiversitaetsmonitoring.at.

Figure 2. Use in practice
Source: www.biodiversitaetsmonitoring.at.

Guidelines and educational materials were developed for the participating farmers, where attention was paid to ensuring easily readable, comprehensible documents and understandable graphs. Furthermore, storytelling methods were used, in order to better understand and memorize comprehensive knowledge.

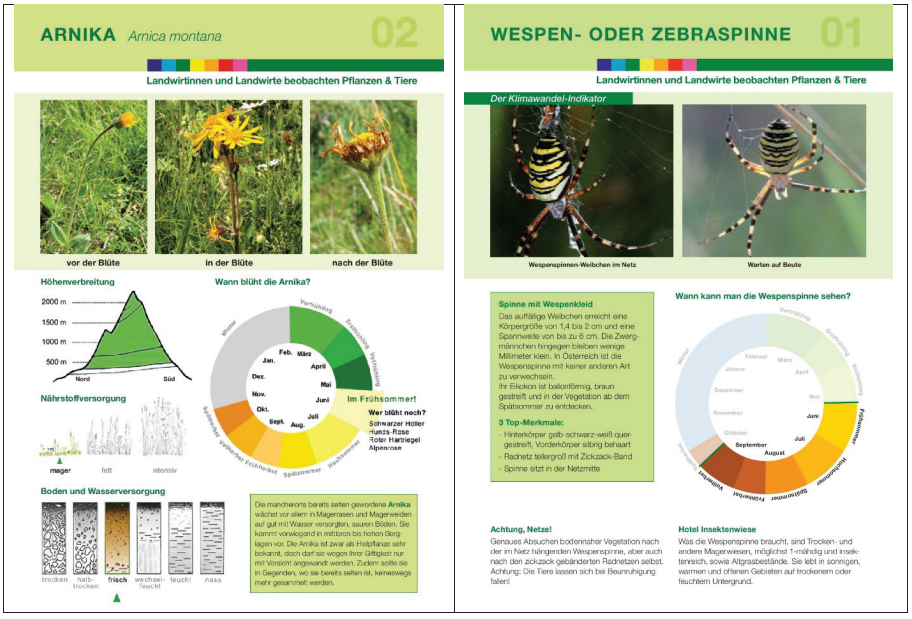


Figure 3. Educational material

Source: www.biodiversitaetsmonitoring.at.

Results

Today the network involves more than 650 participating farmers all over Austria who are monitoring indicator species at more than 850 monitoring spots. In addition, 14 agricultural schools are part of the monitoring team and about 15 active dedicated participants disseminate their knowledge on grassland biodiversity in rural regions all over Austria. More than eight ecologists were instructed to train the farmers on the fields.

Figure 4. Excursion for monitoring farmers with a dedicated participant and an ecologist at a farm in Styria

Source: www.biodiversitaetsmonitoring.at.

Figure 5. On-farm training by ecologists

Source: www.biodiversitaetsmonitoring.at.

Amongst the participating farms, organic farms and farms with nature conservation contracts can be differentiated. The difference is that organic farms are not bound to nature conservation targets within the Agri-Environmental Programme in Austria. Farms with nature conservation contracts have to fulfil defined requirements concerning land management, like for example exact date of mowing or number of cuts per year. In this respect, long-term monitoring could provide knowledge about the impacts of different land management practices.

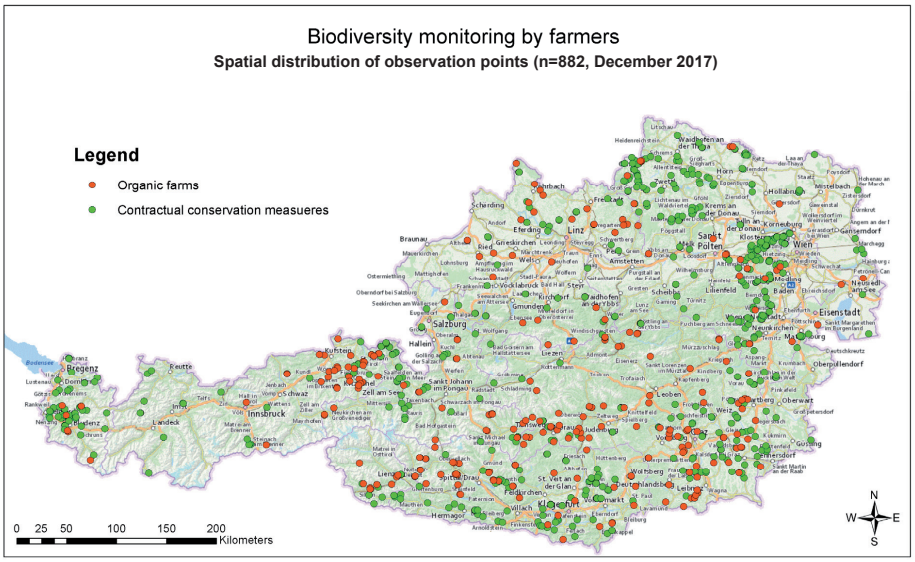


Figure 6. Spatial distribution of observation points

Source: www.biodiversitaetsmonitoring.at.

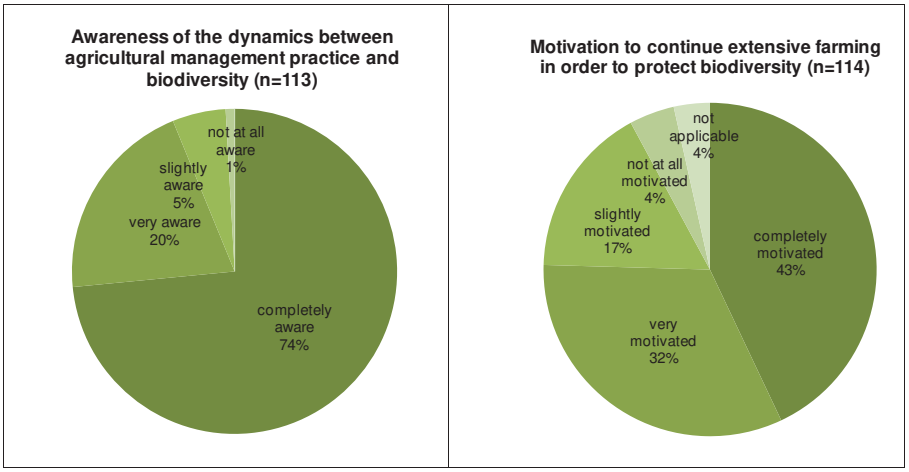
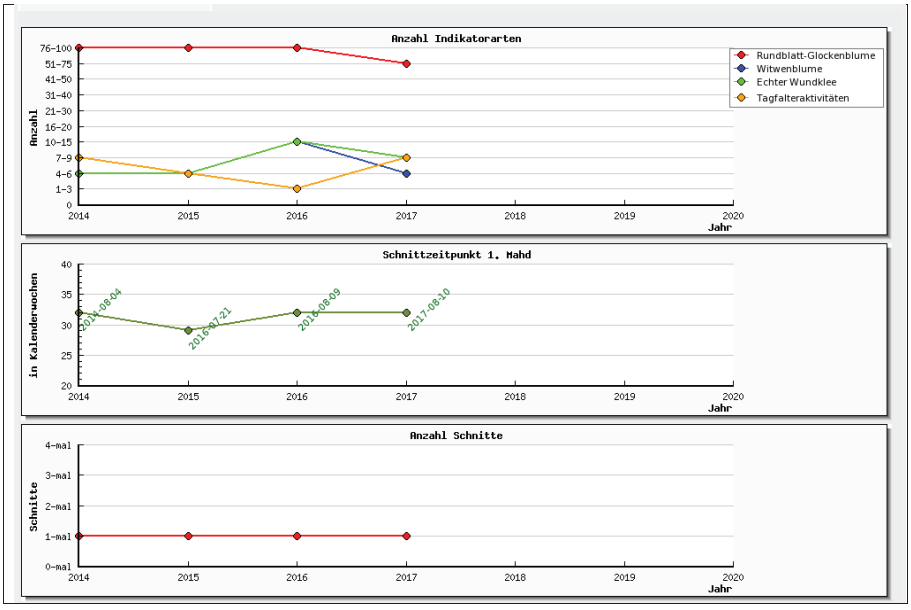


Figure 7. Evaluation of educational effects

Source: www.biodiversitaetsmonitoring.at.

The feedback from participating farmers is positive: most participating farmers reported that they gained deeper understanding and appreciation for flora and fauna on their farmland (more than 89%). All in all, 94% of all participants of the last online evaluation in 2017 quoted that they are more aware of the dynamics between agricultural management practice and biodiversity. More than 75% of all participants of the evaluation report stated that they are more motivated to continue extensive farming in order to protect biodiversity.

The analyses of the monitoring data are still at the beginning due to the fact that long-term series are needed. The re-setting for standardized monitoring started in 2014 with 80 farmers, and since the end of 2017 all participants submit data based on the same monitoring design, which can be used for valid evaluation.



Translation of German variables:

Anzahl Indikatorarten = number of indicator species
Anzahl = number
Schnittzeitpunkt 1. Mahd = time of first cut (grass mowing)
In Kalenderwochen = calendar weeks
Anzahl Schitte = number of cuts
Schnitte = cuts (one times, two times three times)
Rundblatt-Glockenblume = *Campanula rotundifolia*
Witwenblume = *Knautia ssp.*
Wundklee = *Anthyllis vulneraria*
Tagfalteraktivitäten = Butterfly activity

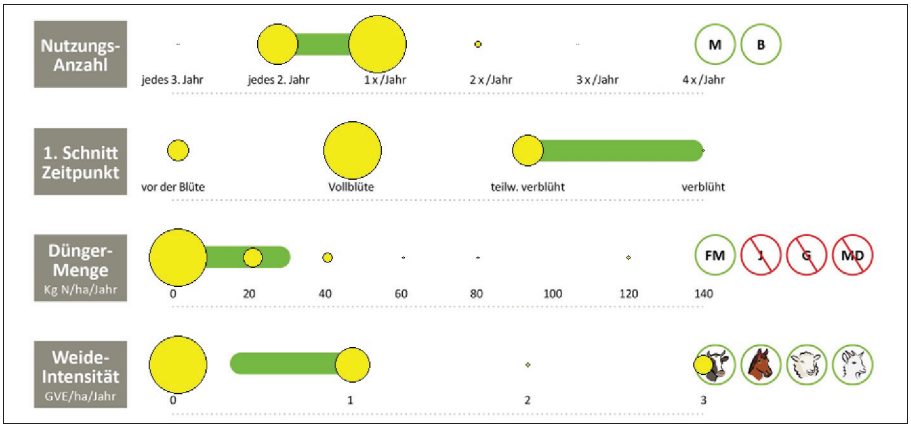
Figure 8. Reports at farm level

Source: www.biodiversitaetsmonitoring.at.

All monitoring data is documented like a diary for every farm. Reports at farm level are prepared and visualized with graphs. For example, the number of indicator species, the weather conditions, the type of land management for different time frames, even on a yearly basis can be retrieved by farmers. Participants have the possibility to look up changes in abundance of species within defined time frames, as well. Whenever monitoring data alters (e.g. changes in abundance of species) farmers can reflect the reason and the influential factors (weather, climate, land use management practices, changes in management, etc.). Participants have the opportunity to look at their farm-specific reports at any time.

Besides individual reports at farm level, aggregated on-site data analyses of all farms can provide in-depth knowledge about the ecology of plant and insect species and relations to (extensive) farm management.

In a first step, selected experts (vegetation ecologists, botanists and zoologists) assessed (based on their own experiences and expert knowledge), which types of land cultivation are recommended and optimal for different indicator plants and insect species (= ecological tolerance) and thus, result in stable numbers of indicator species.



Nutzungsanzahl = number of cuts
1. Schnittzeitpunkt = date of first cut
Düngermenge = quantity of fertiliser
Weideintensität = intensity of grazing
Vor der Blüte = before flowering
Vollblüte = full flowering
Teilweise verblüht = partially withered
Verblüht = withered

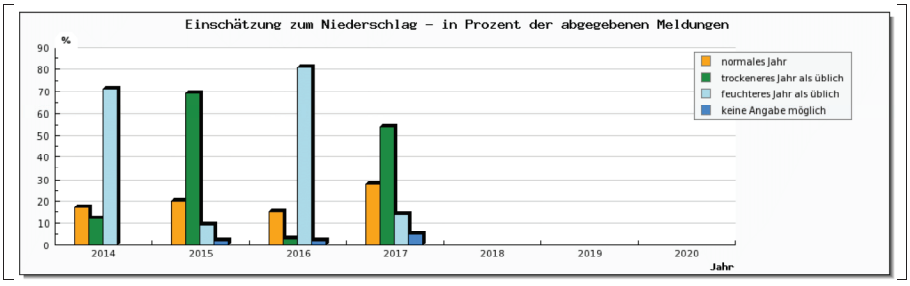
M = mowing
B = grazing
FM = solid manure
J = slurry
G = liquid manure (fermented)
MD = mineral fertilizer
jedes 3. Jahr = every third year
jedes 2. Jahr = every second year
4x/Jahr = 4 times a year

Figure 9. Analyses of land use on the example of the indicator species Arnica (*Arnica Montana*)

Source: www.biodiversitaetsmonitoring.

The green bars in Figure 9 present the expert knowledge about the plant species *Arnica montana*. The yellow bubbles visualize the actual land use from on-site data analyses. The size of the bubbles indicates the relative frequency of submitted data about land use by farmers. For example, regarding the number of cuts (*Nutzungs-Anzahl*) expert knowledge and actual land use are concurrent. Contrary, most farmers mow their monitoring site earlier (date of first cut = 1. *Schnittzeitpunkt*) than experts defined it as best practice.

Abiotic factors like weather conditions have an impact on biodiversity as well. Therefore, many farmers record precipitation and/or date of first blooming of plant species. In addition, famers can enter their observations about weather conditions in the database. An analysis demonstrates a high level of consistency of the farmer´s observations. As shown in Figure 10, the vegetation period in 2016 was monitored as a wet year above average while in 2017 the year tended to be dryer and above average.



Translation of German variables:

Normales Jahr = typical year
Trockeneres Jahr = dry year above average
Feuchteres Jahr als üblich = wet year above average
Keine Angaben möglich = no entries

Figure 10. Observed weather conditions: aggregated assessment of farmers about precipitation

Source: www.biodiversitaetsmonitoring.at.

Conclusions and Economic aspects

The overarching goal of the project is preservation of extensive grassland habitats. The economic value of the project lies in the collected biodiversity data, which shows potential for various analyses concerning biodiversity and ecosystem services on agricultural land. A further economic value is to preserve biodiversity and ecosystem services (carbon capture, soil fertility, biodiversity, climate change resilience, cultural heritage, tourism, recreation) for future generations by participating farmers. Moreover, extensive grasslands with a higher level of biodiversity than intensive grasslands have the potential to contribute to animal health, and thus to healthy food. It can be observed that the consumer demand for high quality products (organic products, fair trade,

standards of animal welfare, less CO_2 emissions, etc.) has been rising steadily in the last years. Well-directed marketing of such high quality products from species-rich grasslands can account for higher profit margins on farms.

Outlook

In the further run, it is intended to use the collected monitoring data for environmental consciousness raising initiatives for farmers all over Austria and for analysing trends of biodiversity on contracted nature conservation sites.

The vision of the project team is to apply the biodiversity monitoring with farmers at the European level in the next years. The biodiversity monitoring by farmers could also include endangered species and habitats within the European Natura 2000 network, since farmers are relevant actors with a high influence on biodiversity.

More information on similar biodiversity monitoring projects can be found on the project website: www.biodiversitaetsmonitoring.at and in the final reports of the biodiversity monitoring projects (Steurer et. al., 2016; Steurer et. al., 2017).

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As project lead, the Austrian Council for Agricultural Engineering and Rural Development (ÖKL) coordinates the project with the consulting engineers e&p Umweltbüro GmbH, LACON and Suske Consulting.

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