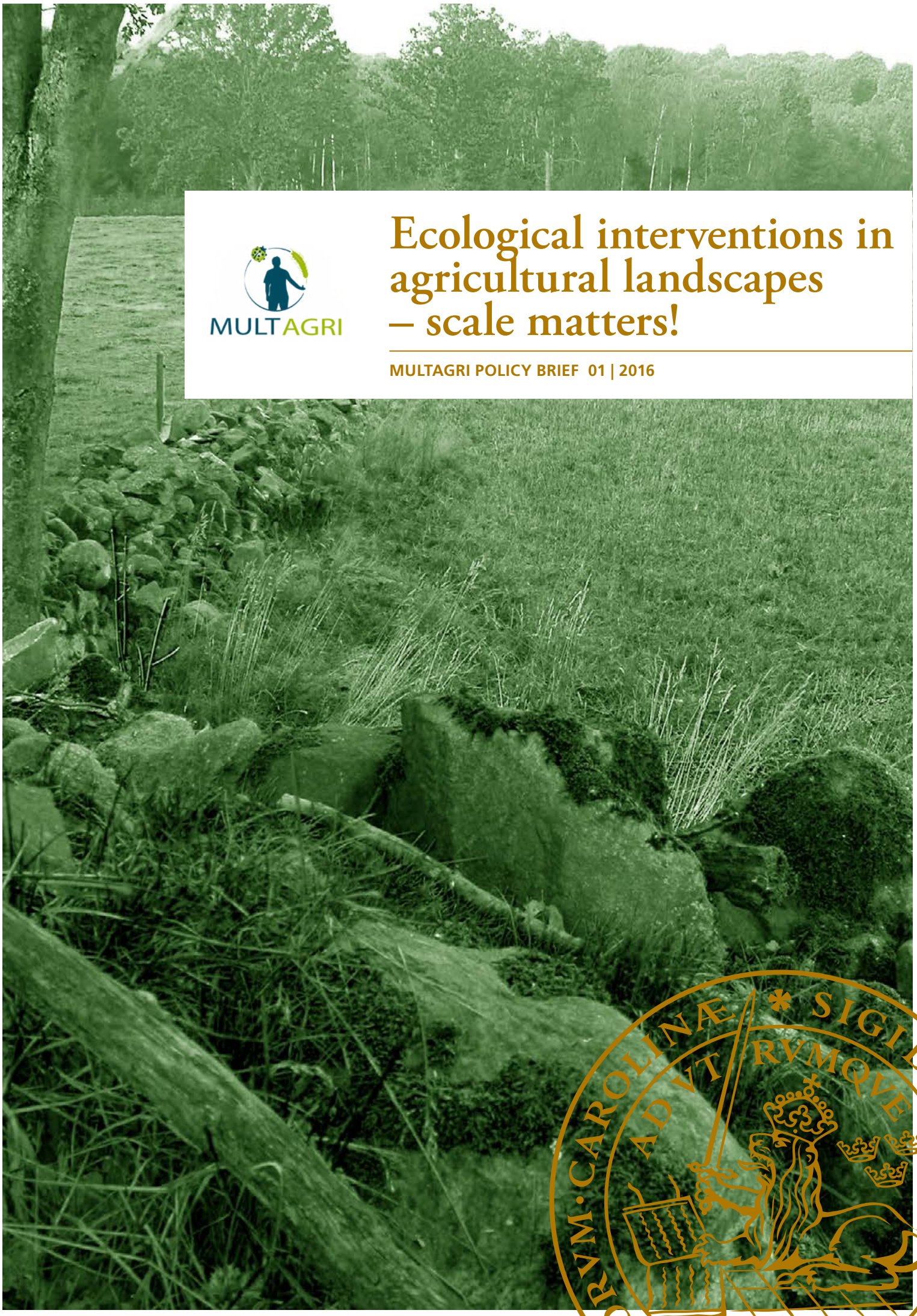

MULTAGRI

Ecological interventions in agricultural landscapes – scale matters!

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Ecological interventions in agricultural landscapes – scale matters!

The Common Agricultural Policy (CAP) affects about half of the land area of the EU and allocates close to 40% of the EU's budget. Consequently, CAP has great potential to guide land management decisions towards multifunctional agricultural landscapes supporting both commodity production and biodiversity. The 2015 "greening" reform was an attempt to increase the multifunctionality of agricultural landscapes, but has been heavily criticized as a failure. Among other things, there are complaints that interventions proposed to benefit public goods are of inadequate quality and the rules for their implementation lack a landscape perspective. The research done in MULTAGRI investigated how a landscape perspective could be used to develop more cost-efficient interventions and agricultural policies.

Why are spatial scales an issue?

In agricultural systems, ecological and human processes interact in complex networks and at various spatial and temporal scales. Ecological processes occur at multiple spatial scales as determined by material fluxes and movement of organisms. Similarly, farm management decisions are driven at multiple scales from local conditions to agricultural policies and international markets. As ecological and social processes inevitably interact, the matching of these scales becomes a central issue when pursuing a sustainable agriculture that combines economically viable production with the production of public goods.

MULTAGRI has focused on interventions that benefit ecosystem services, i.e. ecosystem processes contributing to human wellbeing. In agricultural landscapes, these processes may benefit farm production (e.g. crop pollination) or public goods (e.g. biodiversity conservation). Through various ecological interventions, such as created habitats suitable for service-providing organisms, farmers may promote these services. However, several scale-related challenges constrain the optimal function of such interventions.

One such challenge studied by MULTAGRI is a phenomenon known as the *tragedy of ecosystem services*. In situations when those carrying the costs for generating an ecosystem service are not able to take full advantage of the benefits derived, the incentive to carry out actions to support the service will be low and the service likely to be under-provided. This usually applies to public goods; however, some ecosystem services benefit both the local farmer and neighbouring farms (so-called *quasi-public goods*). For instance, a farmer who invests in flower strips to boost crop pollination on his/her farm, may at the same time also benefit pollination on adjacent farms.

We demonstrated this using coupled ecological-economic models working with two different scenarios. In one scenario we assumed profit-maximizing individual farmers to make land-use decisions – here: whether or not to implement flower strips, an intervention beneficial for crop pollination. In the other scenario, farmers were forced to collaborate by letting the model manage the whole landscape as one single farm. Collaboration resulted in both more flower strips being sown and a more even distribution in the landscape. This shows that coordinated land-use management of larger scales is beneficial for both pollinators and crop pollination. At the same time, it implicates that if decision-making is left to individual farmers, there is a risk for underproduction of ecosystem services even if they benefit agricultural production.

Ecological interventions and their benefits at different scales

In the recent CAP reform, some of the direct payments (pillar 1) have been made conditional on so called greening measures. The aim of these measures is to benefit environment and climate-related public goods, but they also have the potential to enhance quasi-public goods (e.g. biological pest control and pollination). However, the greening measures have already been deemed as inefficient, because they are of insufficient quality or fail to consider a landscape perspective. We used a case study approach to investigate whether biological pest control benefits from two greening interventions: fallow land (in Sweden) and permanent grasslands (in France).

Our preliminary results show that the quality of the interventions (indicated by the age of grasslands and fallows) has no generally beneficial effect on production, density or movements of natural enemies on a local scale (i.e. between adjacent fields).

However, in overall more grassland rich landscapes, the number of aphids in cereal fields was lower (Sweden), and ground beetle diversity was higher (France). These results indicate that – independently of the type of intervention – ecological processes at larger (landscape) scales play an important role. This also supports parallel studies, where biological control of aphids was affected by grasslands at a scale of 500-1000 m.

Photo: Maj Rundlöf

Since it is difficult to deduce the exact scales relevant to different processes from ecological field studies only, we develop mechanistic modelling. An early model for aphid biocontrol in spring barley showed biological control of aphids to be affected by habitat at scales of 135-1500 m, depending on organism and habitat type. New models being developed for biological control of aphids in winter wheat include a large-scale (>2km) positive dependence of aphids on grasslands – their overwintering habitat. However, this large scale effect can be counteracted by beneficial effects of interventions (e.g. permanent grassland and flower strips) at smaller spatial scales. The latter are often most relevant for field- and farm-scale decision making, whilst large-scale grassland cover may be related to the regional suitability for growing arable field crops.

We conclude that the studied interventions often fail to affect natural enemy populations and biological control at local scales, possibly because organisms move at larger scales. Instead, processes at larger scales seem important. These results concur with previous research, that the quality of the surrounding landscape (e.g. 1 km radius) affects biodiversity in general, the abundance of beneficial organisms and many quasi-public goods. Scale-related issues may also be important for biodiversity conservation. Focussing on bird abundance, we investigated the effect of landscape composition at different scales. We found that the scale which best explained bird abundance varied greatly between species, with some of the variation being explained by bird traits. Such information can be used when identifying the necessary scales to affect landscape composition to preserve farmland bird communities.

The solution: Embedding multi-scale conservation in a multi-level governance context

So how can these findings be used to develop multifunctional landscapes benefitting both agricultural production, biodiversity and ecosystem services?

We propose that *multiple scale land sparing* may be part of the solution. Land sparing is a commonly suggested way to enhance farmland biodiversity by sparing parts of the agricultural land to be used for conservation measures, such as nature reserves (large scale) or ecological interventions (small scale). The effectiveness of this method has been heavily debated (and opposed to land sharing, where conservation and production are done on the same land, e.g. in organic farming). By sparing land at relevant multiple scales and for interventions targeted at the organism or service concerned, we propose that land sparing can be made more efficient.

To achieve this, ecological interventions should be developed and carried out from small scales (e.g. single fields for protecting below-ground organisms and soil services) to large scales (e.g. covering entire landscapes for the conservation of wide-ranging species or cultural values; *Fig 1*).

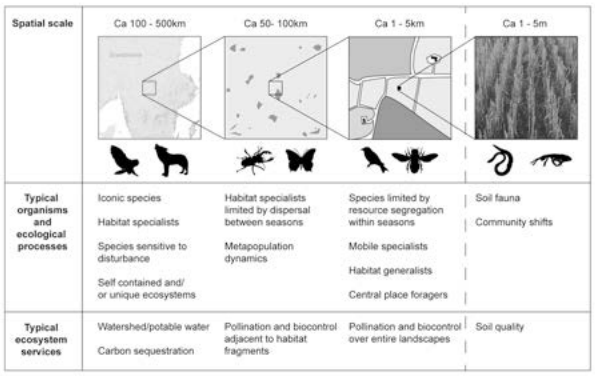

Fig. 1: A simplistic representation of spatial scales at which ecological processes modulating biodiversity and ecosystem services operate (from Ekroos et al. 2016).

In addition, accounting for temporal scales such as an organism's needs throughout their life cycle (e.g. seasonally shifting resource availability in the landscape) is needed. Consequently, a multi-scale conservation approach would minimize trade-offs between agricultural production and biodiversity conservation, and thus enhance the development of cost-efficient interventions.

The potential for multi-scale conservation will though be affected by the prevailing governance system in a region. When decisions are taken at (too) local levels, recommended interventions may be more locally adapted and generally well accepted and implemented by farmers. However, they may not cover the whole geographical range at which ecological processes occur nor the full variety of ecosystem services of concern to society. On the other hand, decisions taken at (too) high levels may not consider local conditions, preventing the design of efficient, locally adapted management actions. Thus, the effectiveness of ecological interventions could be further improved by embedding multi-scale conservation principles in the existing multi-level governance context.

To realize this, we propose that local conservation interventions are developed based on broad-scale ecological principles and general evidence, but refined at increasingly lower levels. This allows taking into account relevant local-scale evidence and priorities. This should be complemented with the active involvement of practitioners, policy-makers and scientists throughout the process in order to identify stakeholder-relevant questions and highlight existing knowledge gaps. This way, an appropriate balance between democratic legitimacy and ecological efficacy could be achieved by jointly fitting administrative and ecological scales.

IMPLICATIONS AND RECOMMENDATIONS

Adopt landscape perspective when developing and implementing interventions by encouraging coordination and collaboration over scales larger than farms

Taking into account landscape characteristics when developing interventions guarantees management actions to be targeted according to the policy goals and adapted to the conditions prevailing in the landscape. Coordination and collaboration during implementation makes sure that interventions are distributed in the landscape in an optimal way, which increases cost-efficiency.

Embed conservation actions in a framework of multi-level governance

This will ensure that recommended interventions are locally accepted and implemented, while they at the same time also fulfil broader policy goals set at national or global levels.

Read more

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About the project

This policy brief is a result of the work done within the ERA-NET project MULTAGRI, a collaboration between Lund University (coordinator), Animal Ecology Team Alterra, Kalaidos University, Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Leuphana University Lüneburg, Institut National de la Recherche Agronomique (UMR SAVE, UMR IGEPP) and the Swedish University of Agricultural Sciences (SLU).

MULTAGRI investigates how governance of agricultural landscapes can promote rural development by harnessing landscape and biological diversity as assets that synergistically promote the production of public goods and sustained intensive agricultural production. MULTAGRI uses a strong interdisciplinary approach combining empirical field work, synthesis studies, and ecological-economic modelling and governance analysis at the regional level. Involved scientists come from a variety of fields including ecology, economics, agronomy and social sciences. MULTAGRI aims to contribute to the development of European policies to promote multifunctional agricultural landscapes and rural development. **www.cec.lu.se/research/multagri**

Results from our work are summarized in the following three independent policy briefs covering ecological, economical and governance aspects of the project, respectively:
"Ecological interventions in agricultural landscapes – scale matters!"
"Impacts of the CAP's environmental policy instruments on farm structures, agricultural incomes and public goods"
"Governance approaches to address scale issues in biodiversity management – current situation and ways forward"

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