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Temporal Habitat Heterogeneity in Cultural Grassland Landscapes is a Crucial Factor of Population Dynamics

Introduction

Agricultural intensification has led to a widespread loss of biodiversity in cultural landscapes in Europe. On the other hand abandonment of land-use on less productive sites and following succession to forests threatens species of open habitats which are characteristic for cultural landscapes. The changes in agricultural practice affect many different aspects of habitats in cultural landscapes. The decline in ecological heterogeneity at multiple scales in space and time is at the heart of the processes of land-use change. Here we focus on temporal variability and uniformity of agricultural practice in grasslands that affect directly habitat availability and hence contribute to population dynamics of a grassland butterfly species.

Species

- Dusky Large Blue (*Maculinea nausithous*)
- typical species of moist semi-natural grasslands;
 - on the wing from early July to mid August;
 - reproduction specialised to flowering buds of host-plant Great Burnet (*Sanguisorba officinalis*);
 - afterwards larvae parasitise in nests of red ants (not considered here);
 - after management, e.g. mowing, host-plants need 4 weeks for regeneration of flower buds;
 - during this time butterflies cannot oviposit on the plant (see inset on the right: *M.nausithous* egg between petals).



Landscape without consideration of temporal habitat heterogeneity

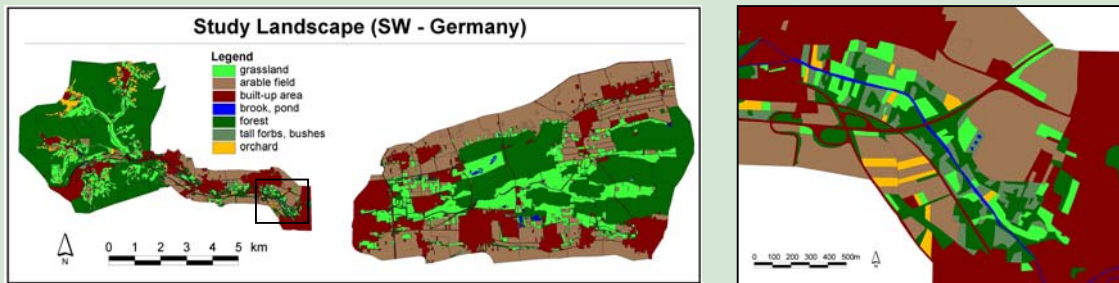


Fig. 1: Simple landcover maps of the study area „Queichtal near Landau“ in Rhineland-Palatinate, Germany (rectangle: position of the close-up region on the right).

Landscape including temporal habitat heterogeneity

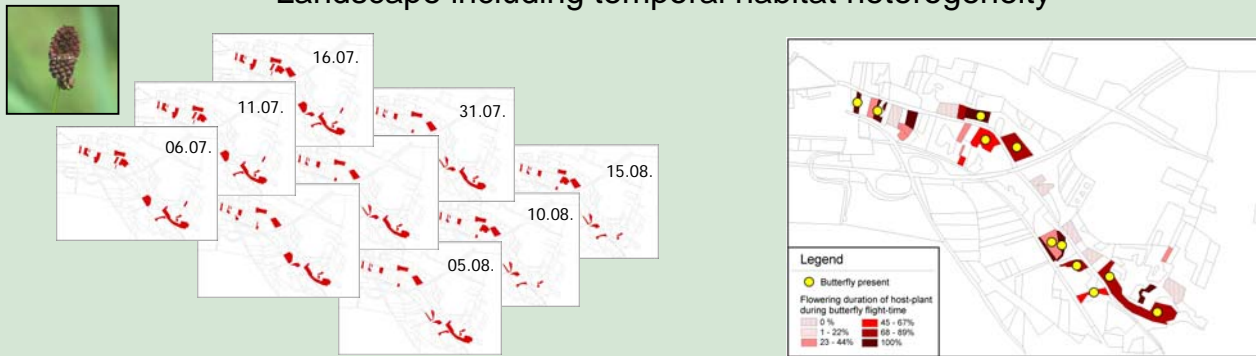


Fig. 2: Maps of close-up region (see Fig. 1). Each map shows in red host-plant patches with available flower buds during a single time-step (5-days-intervals from July 6th to August 19th) in 2004. Time-frame encompasses > 99% of the butterfly's flight-period.

Fig. 3: Map of cumulative flowering duration of host-plants (as shown in Fig. 2) and position of *Maculinea nausithous*-populations in the close-up region (see Fig. 1) in 2004.

Response of populations to temporal habitat heterogeneity

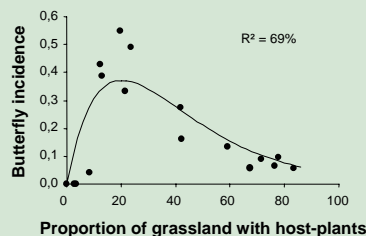


Fig. 4: Probability of occurrence (incidence) of *M. nausithous* during 2002-2005 against proportion of grassland area where the host-plant *S. officinalis* is present. Data shown is on basis of 17 municipalities situated in the study landscape. Ricker model: $y = 0,049974 \cdot x^e \cdot e^{-0,049435x}$, $p < 0,001$.

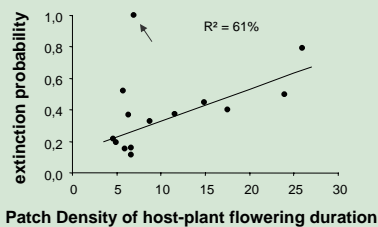


Fig. 5: Probability of extinction of *M. nausithous* during 2002-2005 against patch density (PD) of host-plant flowering duration (PD is a landscape diversity metric: number of patches per 100 ha). Data shown is on basis of 17 municipalities situated in the study landscape. Linear model: $y = 0,0202 \cdot x + 0,1278$, $p < 0,01$ (outlier marked with arrow excluded from the analysis).

Conclusion

- grassland habitats are highly dynamic due to human land-use
- dynamics create spatio-temporal heterogeneous landscapes
- response of insect populations to temporal heterogeneity is unexpected on larger spatial scales

➔ more studies on habitat heterogeneity and populations dynamics at landscape scale needed

