SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA18221
STSM title: Refining the spatial analysis of amphibian and reptile occurrence in agricultural landscapes across Europe
STSM start and end date: 01/10/2021 to 15/11/2021
Grantee name: Raluca Ioana Bancila

PURPOSE OF THE STSM:

The main purpose of the STSM was to document the distribution of amphibian and reptile species in agricultural landscapes across Europe by refining the spatial analysis performed in the previous STSM. Specifically, the objectives were to investigate: (i) which amphibian and reptile species occur in crops, (ii) what is the extent of different crops in 50km² (UTM 50km × 50km) and in 10km² (UTM 10km × 10km) grid cells, and (iii) how different crop categories affect amphibian and reptiles presence/absence and their diversity patterns for the two resolutions above and for GPS coordinates resolution. As croplands receive high pesticides inputs and exposure to them could play a key role in the observed amphibian and reptile declines in agricultural landscapes, the outputs of this STMS serve to gather scientifically sound and robust information based on which amphibians and reptiles are to be included within the regulations concerning the environmental risk assessment of pesticides on herpetofauna.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

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To fulfil the STMS objectives I compiled distributional data for amphibian and reptile species native to Europe from: (1) four atlases (Atlas of European amphibians and reptiles (Sillero et al. 2014), Atlas of Luxembourg, Atlas of Romania, and Atlas of Sweden, (2) published data (Sillero et al. 2005) (collected from Salamanca, Spain, between 2000 and 2002) and new data (Sillero 2021), and (3) species occurrence data sources including Global Information Facility (GBIF: www.gbif.org), iNaturalist (inat: www.inaturalist.org), and VertNet (vertnet.org). I homogenised the databases by deleting all other information except species names, coordinates, and data source, and projected to the same coordinate system (WGS84). I cleaned the data by removing records with coordinates precision below 100m and duplicated records. To avoid mismatches due to differences in the species nomenclature between the databases we followed the taxonomy from Sillero et al. (2014). We used the European CORINE Land Cover 2018 (version v.2020_20u1) from European Environment Agency (EAA, 2018) as base land-cover maps for Europa, which covers 39 European countries. CORINE land-cover data consist of 44 land-cover types. CORINE land-cover data in raster format has a spatial resolution of 100m. From the 44 CORINE land-cover types, we selected eleven land-cover types and reclassified them in five crop categories, as follows: irrigated crops (codes 212, 213 and 242), dry crops (codes 211 and 241), woody crops (codes 221, 222 and 223), pastures (code 231), and agroforestry crops (243 and 244).
The data analysis built up on a previous STSM project carried by Mateo Lattuada, who analysed the data for UTM 50km². I increased the resolution, i.e., analysing the data for UTM 10km² and GPS coordinates, and reanalysed the data for UTM 50km² including the additional records. The data analysis included a combination of General Linear Models (GLM) and generalized additive models (GAM), using the five selected crop categories as either continuous or factor fixed effects and the presence/absence and species richness of amphibians and reptiles as dependent variables. The continuous crop categories represented the proportion of each of the five crop categories in 50 and 10km² grid cells. All analyses were performed using R 4.0.1 (R Core Team) software.

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DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main outputs consisted in mapping the extent of the five selected crop categories and the species presence and richness of amphibians and reptiles at UTM 50km^2 and UTM 10km^2 resolutions. The preliminary results indicated that amphibian and reptile species presence and richness, in agricultural landscapes across Europe, are influenced by crop extent and crop category. Moreover, the spatial patterns of species presence and richness and of crop extent depend on the spatial scale. More specifically, I found that: (i) the number of species present in crops was different at different scales (i.e. 14 amphibian and 34 reptile species less at GPS coordinates than at 50 and 10km^2 grain size), and (ii) the geographic location of peaks and troughs of species richness and of crop extent at the coarse scale (grain size 50km^2) did not coincide with those at the a finer scale (grain size 10km^2). At coarse spatial scale amphibian species richness in crops was highest in Western-Central Europe, while for reptiles the crops in southern peninsulas had the highest concentration of species, in particular Greece. The analysis at a finer scale led to less obvious hotspots and coldspots of species richness while for crop extent as smaller areas were examined less crop categories were observed, thus increasing the dominance of one crop category, especially on islands. The species distributions differ between scales: while the distribution of all species are well represented at 50 km^2, this is not true at 10 km^2 or GPS resolution. Not all European countries provide distribution data at those spatial resolutions.
The results indicated that agroforestry crop, which in our study include land principally occupied by agriculture fields with significant areas of natural vegetation and agro-forestry areas, had a significant positive effect on the majority of species (60%) for UTM 50km^2 and (75%) GPS coordinates resolution. For UTM 10km^2 we found that woody crops had a significant effect on more than 50% of species. All crop categories had a significant effect on more than 25% of the species. These results indicated that both amphibian and reptile species select for specific crop categories.
Species richness generally decreased while the extent of crops for both UTM 50km^2 and 10km^2 resolutions increased, with some exceptions. Amphibian species richness increased with agroforestry crop extent for UTM 50km^2 and pastures for UTM 10km^2, while reptile species richness showed a significant positive relationship with the proportion of irrigated and woody crops for UTM 50km^2. For GPS coordinates resolution, the models predicted the highest species richness for amphibians in dry crops and for reptiles in woody crops.
Overall our results highlighted group- and scale-dependent responses to crop extent and crop categories and draw attention that taking into account the scale and group dependence is mandatory when documenting the impact of agricultural systems, including pesticide, on amphibian and reptile presence and richness.

FUTURE COLLABORATIONS (if applicable)

The current STMS extended and strengthen the collaboration between Romania, Portugal and Italy, COST Partner Countries. Furthermore, I met Professor Miguel A. Carretero, from the Research Centre in Biodiversity and Genetic Resources. This opens new opportunities for future collaborations.