Linking European classifications of wildlife habitats and protected species to site observations for ranking high conservation value areas: Towards a universal geospatial model for ecological assessment:

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Abstract:

In ecological impact assessments, wildlife habitats sensibility is determined by experts, and is often difficult to be demonstrated from an objective point of view. However, standardized methods are lacking for producing spatial analyses compiling various ecological sensibilities on site. By linking the European protection classifications to local parameters, the method described fills the gap in assessing sites conservation value at a regional level. Thus, high conservation perimeters can be traced more precisely from an accurate delineation of classified habitats. With field data, a geospatial model is applied to generate a unique index for each habitat unit. The method merges qualitative and quantitative observations made over small landscape units and helps evaluating ecological sensitivity. Using European sensitive species and habitats classifications, the geospatial model can be applied to add value to any ecological assessment by putting in place standardized calculations where the output can be easily verified and demonstrated.

Several European protected species categories and ranking is utilized to calculate indices for every listed taxon. This index is then weighted based on parameters observed locally, such as species population density and habitat quality, or level of environmental degradation. Species occurrences and associated taxa values are aggregated together within a habitat. A synthesis is produced by calculating indices for distinct habitat patches for each biological group. This quantitative evaluation method provides an efficient tool to draw information from field data and European environmental indicators, to generate a scaled and comprehensive analysis. Flora, fauna, and habitat conservation values can be assessed and compared on a similar basis for various places, highlighting locations where a combination of species of interest is present in a suitable habitat.

Introduction

This paper presents an effective and replicable method for accurate mapping and ranking of nature conservation concern areas. Usually methods focus on wild species occurrence distribution maps, or produce an aggregation of observations at the level of an administrative boundary. For high precision level studies, especially Environmental Impact Assessments (EIA), the team developed a method giving more consideration to the wildlife habitats as integrated landscape units. At such a scale, a precise evaluation of the conservation value is critical for designing project plans and selecting site implementation, according to biodiversity protection acts and legal constraints. The accuracy of the scoring system is essential, and should be able to integrate every significant parameter to generate the ecological concern classification.

A high conservation value area is usually defined by the presence of protected species, using ranks according to the species inner and global conservation value. Wildlife observations are spatially linked to comprehensive landscape units of similar patterns, according to the European Nature Information System (EUNIS) and the Corine Biotope coding systems.

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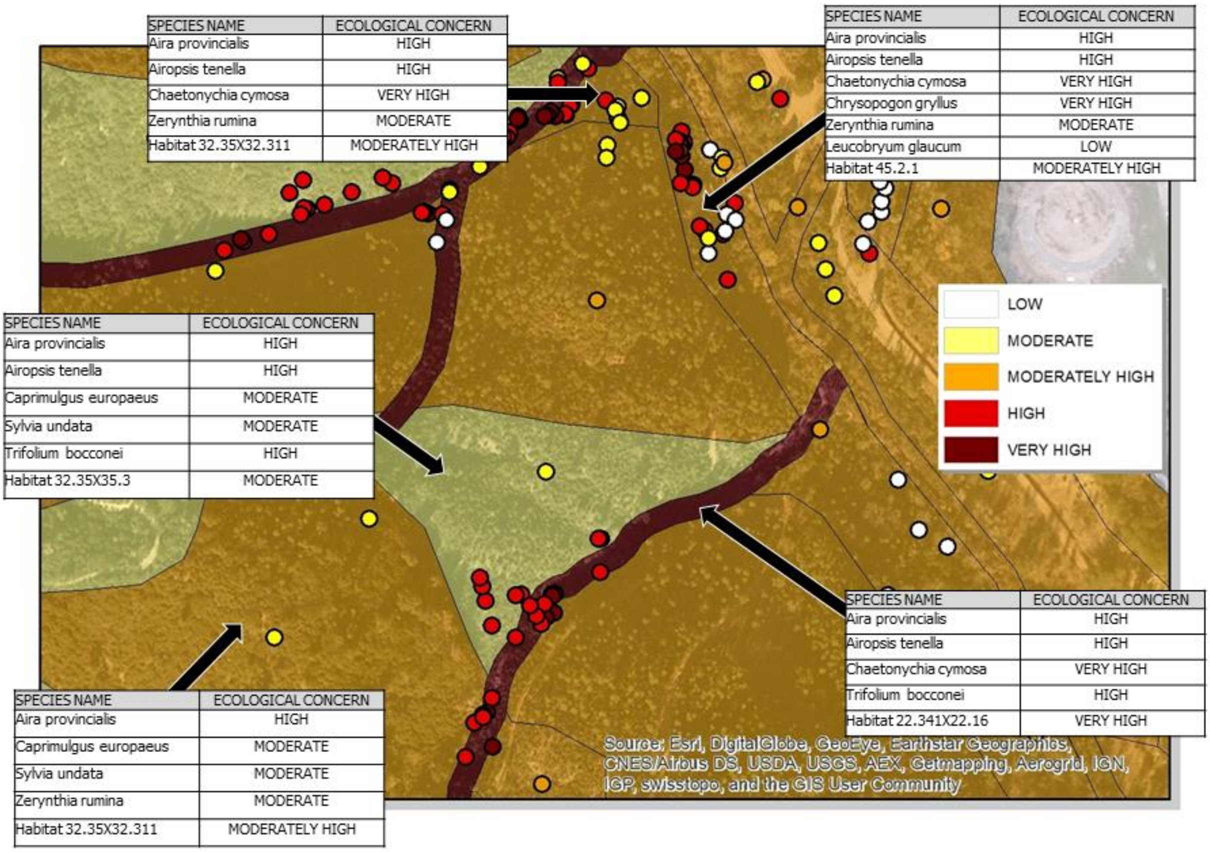
Objectives of the method and description of the ranking system

The method is focusing on building a link between the observed species and their territory, as well as on finding solutions to compile data significantly within their habitats. The objective is to produce a comprehensive synthesis of individual habitat units, taking in account all the conservation concern parameters. This is done with a ranking methodology calibrated to the source data, and applied through a complex aggregation process.
The methodology makes use of qualitative rank attribution through a multi-criteria notation process. The system converts these qualitative ranks to quantitative indices to be computed as numeric values using a calibrated formula. There are several levels of iterative notation process. Each level corresponds to a level of data aggregation, from punctual field observations to a list of fauna and flora taxa in a classified habitat. Within a habitat, several taxa of same or different rank are compiled together (Fig 1).

Fig 1: Synthesis of observations per taxa, rank, and habitat



In order to generate a synthesis of ecological concerns, a calculation model has been defined from the quantitative values produced with the ranking notation system. The geospatial model operates on the numeric coded values corresponding to the qualitative assessments. The formula uses numeric coefficients calibrated on the level of ecological concern. A stronger coefficient is applied to compute taxa of high ranks, and a lower coefficient is used for taxa of lower ranks. Therefore, the incremental computing takes into consideration the number of taxa of each rank, and uses thresholds to classify aggregated data of various ranks. For instance, if there is an important number of different taxon of moderate ecological value, the synthesis will attribute a moderately high ecological value to that habitat unit.

Description of the process

The method follows three major steps.

The first step consists in precisely delineating and ranking the local habitats where the protected species are located. This is a major step as the result will be the base for the spatial data aggregation performed in further steps. The habitats suitability for species of interest will be considered in the process. Once identified and traced by interpretation on very high resolution satellite imagery, the habitats are named and defined according to the European Nature Information System (EUNIS) referential. The effort made on habitat typology standardization is a key feature in the process. This will allow a better traceability on the results. According to the EUNIS typology, habitats are noted on their intrinsic ecological value. This intrinsic value note combines notes on frequency in the region, regional responsibility, and extinction threat level. The result is further calibrated by weighting this value according to local parameters observed on site, such as the habitat authenticity, and its current conservation status.

The second step looks at the species observations to evaluate their level of ecological concern. As for habitat ranking, the species ranking is based on standard references, using official red lists available from the International Union for Conservation of Nature (UICN) and the French Natural Heritage National Inventory (INPN). The notation parameters included are the species rarity, the regional responsibility and its vulnerability. The level defined from this notation is then weighted according to population and functional factors observed on site. For instance, a prolific population will give a higher note than a reduced population. At the contrary, an unusual presence in a particular habitat will result in a lower note than a presence in a typical habitat with standard functional ecology. Fauna and Flora taxa are evaluated separately with specific weighting criteria.

The third step corresponds to the core process. At this stage, we run the geospatial model to generate a compiled synthesis of ecological concern par habitat unit. The model has been designed in the form of a geospatial script written in Python coding language. The script applies iterative transformations on input variables from the features attributes and their spatial parameters, e.g. the occurrence of species of interest within habitat units (Fig 2). Indices are calculated according to the weighting criteria, the ranking coefficients,and the aggregation formula. The result generates thematic layers in the Geographical Information System (GIS) for habitat, flora, and for all biological groups of fauna. Finally, the highest rank of each group determines the rank applied to the global ecological value of the parcel (Fig 3).

Fig 2 : Iterative process of data enrichment with the geospatial model

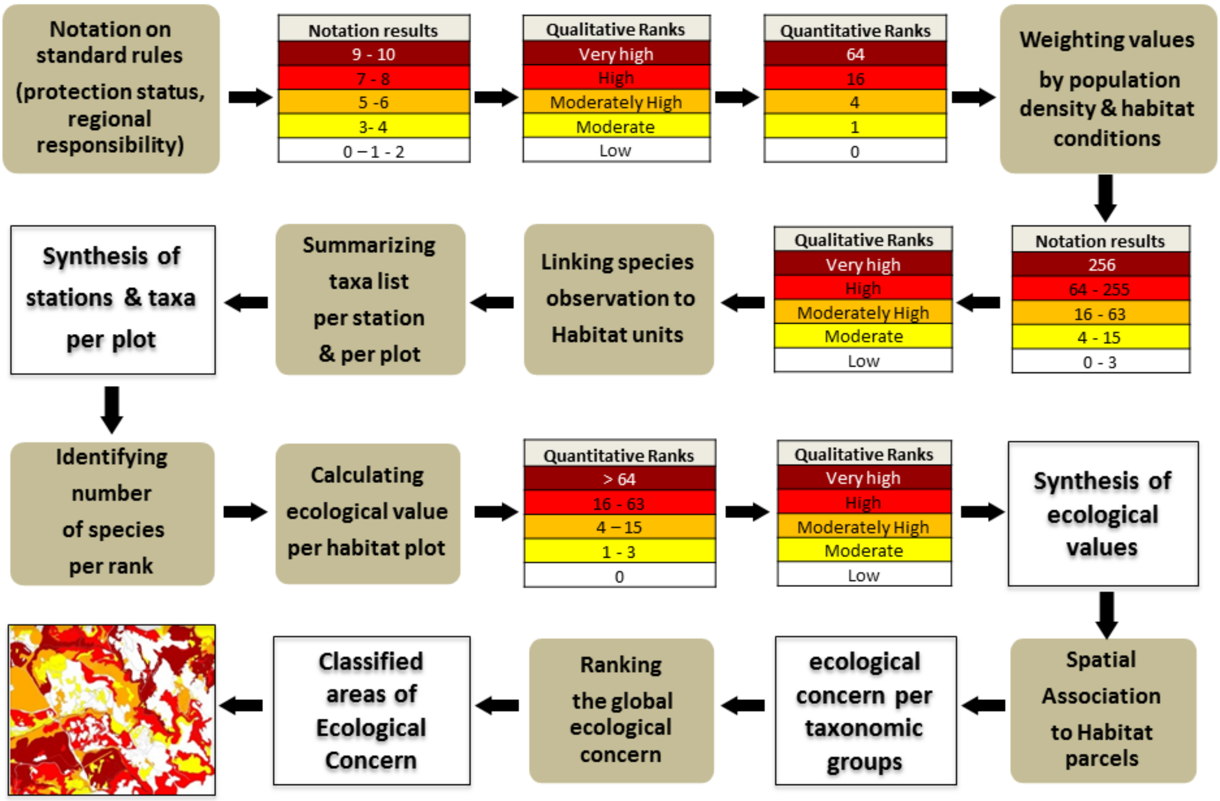
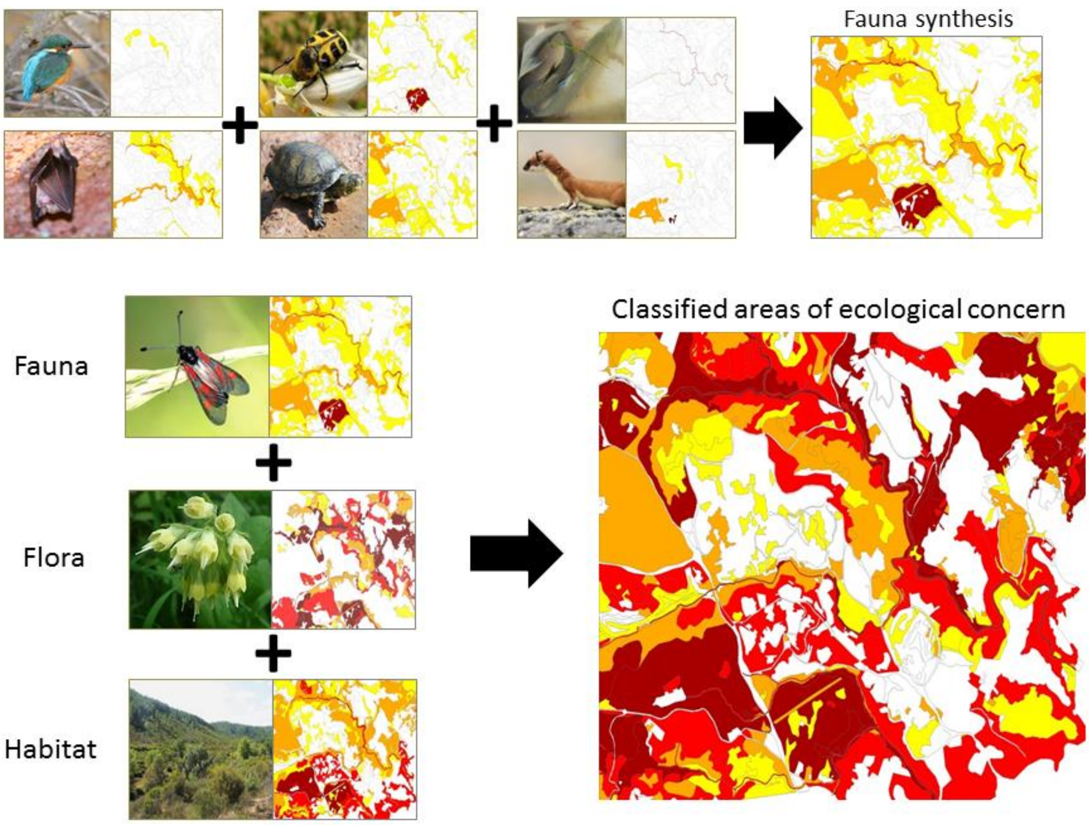


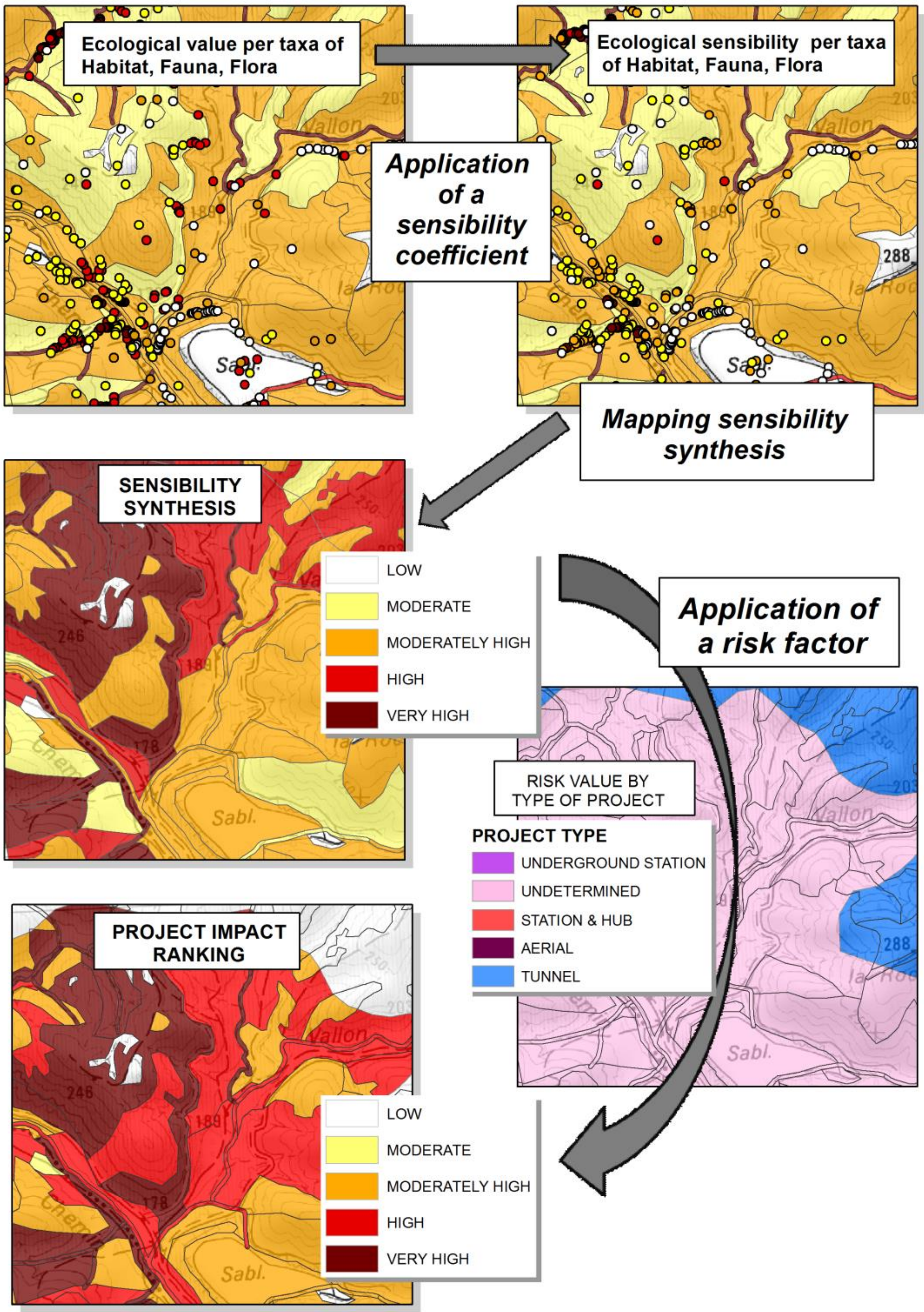
Fig 3: Ecological value computing by taxonomic group



The wildlife habitats are classified in five classes, and a map is produced showing an ecological concern ranking from low to moderate, moderately high, high, and very high.

Additionally, the model includes an option to generate a sensibility index according to a project potential impact on the landscape. This index describes the level of ecological sensibility to a specific impact, such as a road, highway, new housing settlement, or any development project. The approach is similar to the calculation of the ecological concern value, where a sensibility value is attributed to the wildlife habitats and species according to taxa resilience capacity and related characteristics. A risk factor is then applied according to the type of project (Fig 4).

Fig 4 : Evaluating impact sensibilities



Conclusion

Overall, the process follows a standardization approach in order to be applied consistently when used by different people, as well as facilitate a balanced comparison of ecological concern among different territories. Traceability of the results was one of the key requirements to design the model. The standardization is strengthened by the notation system based on official referential such as the EUNIS codes, and the IUCN and INPN red lists. The method described in this paper is aimed to build an automated geospatial application that operates with field observations inputs, and generates a thematic map layer representing the ecological concern at the scale of small landscape units.

The method elaborates a mathematical model for spatial and thematic data aggregation, following computation rules corresponding to the underlying scientific concepts in ecological concern evaluation. The complexity of the model relies mostly on selecting the computing factors and calibrating the coefficients. An iterative process of data enrichment is implemented, and is supported by setting up a dynamic relation between qualitative and quantitative values. The model provides an effective solution to integrate ecological ranking system into a GIS and mapping application.

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