Developing a Diagnostic Species and Biotope Index for Europe:

A Methodological Note

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Introduction

1. This paper describes work done as part of the fast track implementation of simplified ecosystem capital accounts led by the European Environmental Agency (EEA, 2011). The EEA initiative has resulted in the publication of an experimental framework for ecosystem capital accounting (EEA, 2011), a key element of which is to construct a species and biotopes diagnosis index and consequently to complete a biodiversity capital account for the European countries. Such an account would need to summarise and present information on the status of biodiversity (richness, threats and conservation) in spatially explicit way. It would also need to match the information recorded in the other ecosystem capital accounting elements, such as land-cover, carbon and biomass, and landscape green infrastructure. In this paper we examine the data sources that are available at European scales, and potentially applicable to populate such an account for biodiversity using a multi-criteria approach to produce a diagnosis index as a first step in developing the biodiversity account.

2. Two European data-source inputs were identified for being suitable for the task of an international explorative study on biodiversity at this stage:

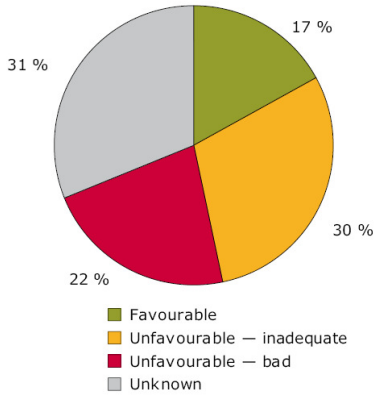
    - Data reported by the EU member states, and harmonized by the European Topic Centre on Biodiversity for assessing the implementation of the European NATURA2000 network (Article 17 of the Habitat Directive).
    - An estimation of an index of community specialization for three classes of animals (mammals, reptiles and amphibians), produced by the Natural History Museum in Paris. It potentially provides an insight into ecosystems integrity in terms of biodiversity, by estimating the share of specialists versus generalist (including alien and invasive) species.

3. Although EU level conservation policies are long established, it was not until 2007 that the Member States first reported systematically on the conservation status of habitats and species covered by the Habitats Directive. These reports, which are known as the 'Article 17 Reports', currently document the conservation status of the habitat types and species of Community interest have carried out across the EU 25 for the period 2001-2006. Future data will be reported on a six year cycle. These data clearly offer the potential for building accounts for biodiversity at pan European scales.

4. Within the Article 17 data 'conservation status' for species and habitats is reported using a set of categories defined by an agreed set of criteria. Thus 'favourable conservation status' (FCS) is the category that represents the overall objective to be reached for all habitat types and species of Community interest. In the context of a species, it describes situations where, the population dynamics are interpreted as indicating that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and that its range is neither reducing for the foreseeable future, and will continue to be sufficiently large to be maintained in the long-term. When a species is assessed as falling short of these criteria it is reported as having 'unfavourable conservation status', that can be deemed either 'inadequate' or 'bad', depending on the severity of the conservation threats that are facing it. Figure 1 shows the current situation for Europe.

5. Figure 1 obviously presents the Article 17 data at a highly aggregated way. The rich body of information that lies beneath it can, however, be used to construct more subtle, spatially specific measures of biodiversity status that could provide one input to the proposed experimental accounts.

Figure 1: Conservation status of species reported for Europe, 2000-2006 (after EEA, 2010).



- Seventeen per cent of the assessments of conservation status of species across the EU were favourable (green).
- Fifty-two per cent were unfavourable (22 % 'unfavourable — bad' in red; and 30 % 'unfavourable — inadequate' in orange).
- Thirty-one per cent of the species assessments are 'unknown' ([11]).

Note: Geographical coverage: EU except Bulgaria and Romania.

Source: ETC/BD, 2008.

6. Specifically, the underlying Article 17 database provides:
    - The species distribution ranges harmonized for a 10 km x 10km grid for EU 25, for around 2000 species of Community importance.
    - The detailed status assessments for the elements that informed the final judgment about conservation status for each species, namely,
        - Information on the **trends** in range, habitat, population and future prospects; and,
        - The conclusions made in relation to: the size of the species range; the size of the species population; the quality the species habitat; the future conservation status of the species; and, the overall assessment about the species conservation status
7. The analysis of these nine parameters can be used to define a degree of consensus on the species conservation status and future. In this paper we examine how they can be combined to develop a prototype species and biotopes diagnosis index, in the experimental accounting framework.

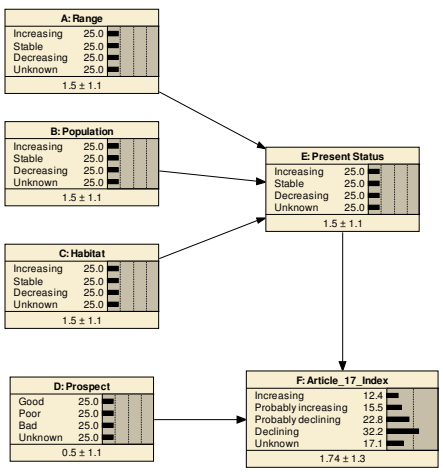
Methods

8. The data used for this work consists of a version of the Article 17 data downscaled to a 1kmx1km resolution so that it is consistent with the European Accounting Grid (EEA, 2006). The downscaling was achieved by intersecting the grid with the 10kmx10km resolution data for each species. While for a given species each 'child' cell in the 1km grid had the same value in the 'parent' cells in the 10km grid, by stacking the grids for all species at the 1km scale, more specially heterogeneous mapping can be achieved using aggregated measures. For each point the number of species and the proportions falling into the different parameter classes defined in the Article 17 data were recorded.
9. To speed up the processing and enable more rapid prototyping, the work was undertaken using a sample database, constructed by selecting one cell per 5km from across the accounting grid. Each cell formed one record in the resulting database, which contained information on the nine parameters

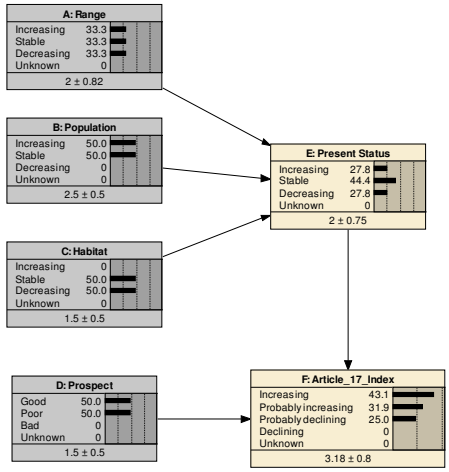
recorded in the Article 17 data, plus location information, the % area of the level 1 CORINE land cover types in each cell, plus the biogeographic region in which the cell was located.

10. The Netica Bayesian Belief Network (BBN) software package was used to help define and explore the way the different Article 17 components could be combined to produce aggregated metrics that could be used as the basis for diagnostic indices for each of the cells of the accounting grid. The approach is illustrated in Figure 2. The prototype uses only four of the Article 17 parameters; three documenting current trends and the fourth on future prospects. These input variables are combined in the BBN is a two stage process (Figure 2), so that the consequences of different assumptions can be tested more easily. From the sample database, the proportions of the total species recorded there falling into the different conservation status categories for range, population and habitat were used to set the probabilities of the inputs for the index 'present status'. Al three input variables had the same weight, and their influence is only determined by the proportions of species falling into the different conservation status categories. The 'present status index' could then be combined with the data on 'future prospects' to define a further aggregate, referred to here as the 'Article 17 Index'. Once again the inputs are equally weighted and affected only by the proportions of species at a point falling into the different status categories. The basic network is shown in Figure 2A, while in Figure 2B the configuration of the network for a single point is shown; these are the index values that are mapped using this approach.

Figure 2: The BBN tool used to define weights for the prototype biodiversity diagnostic



A: General structure of BBN



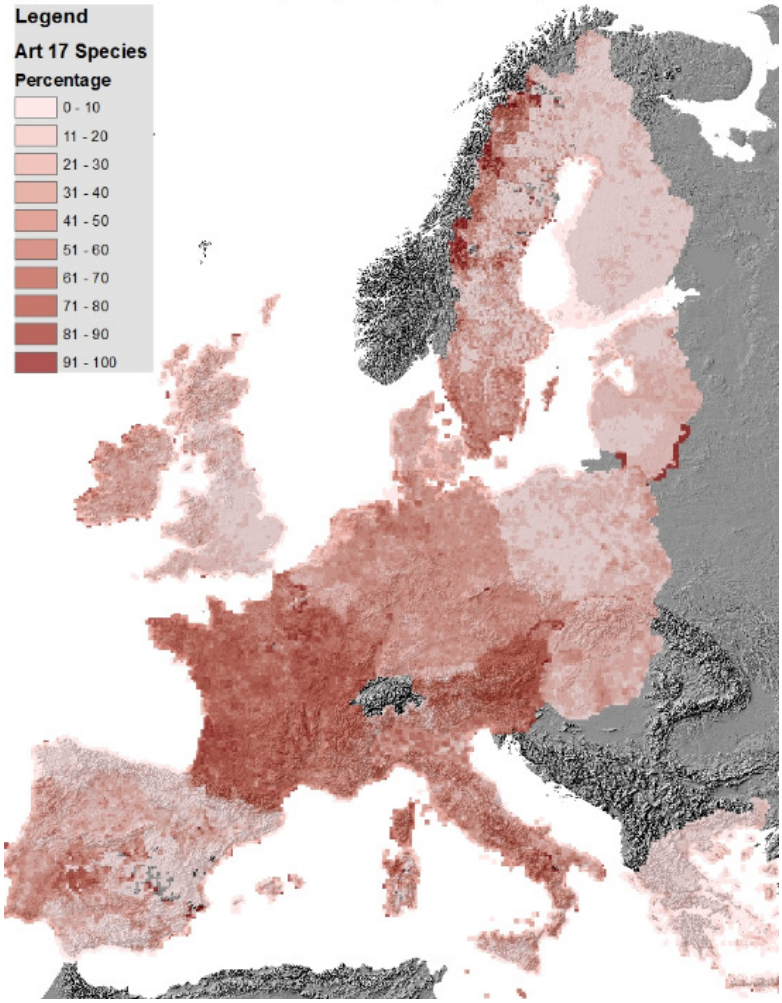
B: BBN configuration for a particular case

11. The BBN approach is useful in that it allows the rapid evaluation of different weighting approaches. The diagrammatic representation of the method shown in Figure 3 also suggests how separate accounts for each of the Article 17 elements would formally be related, and how they are combined into a diagnostic species and biotope index.

Results

12. The method enables the exploration of important aspects of biodiversity conservation at the European level, despite the difficulty of achieving a harmonized picture with sufficient spatial detail to match with land-cover and other ecosystem accounts.

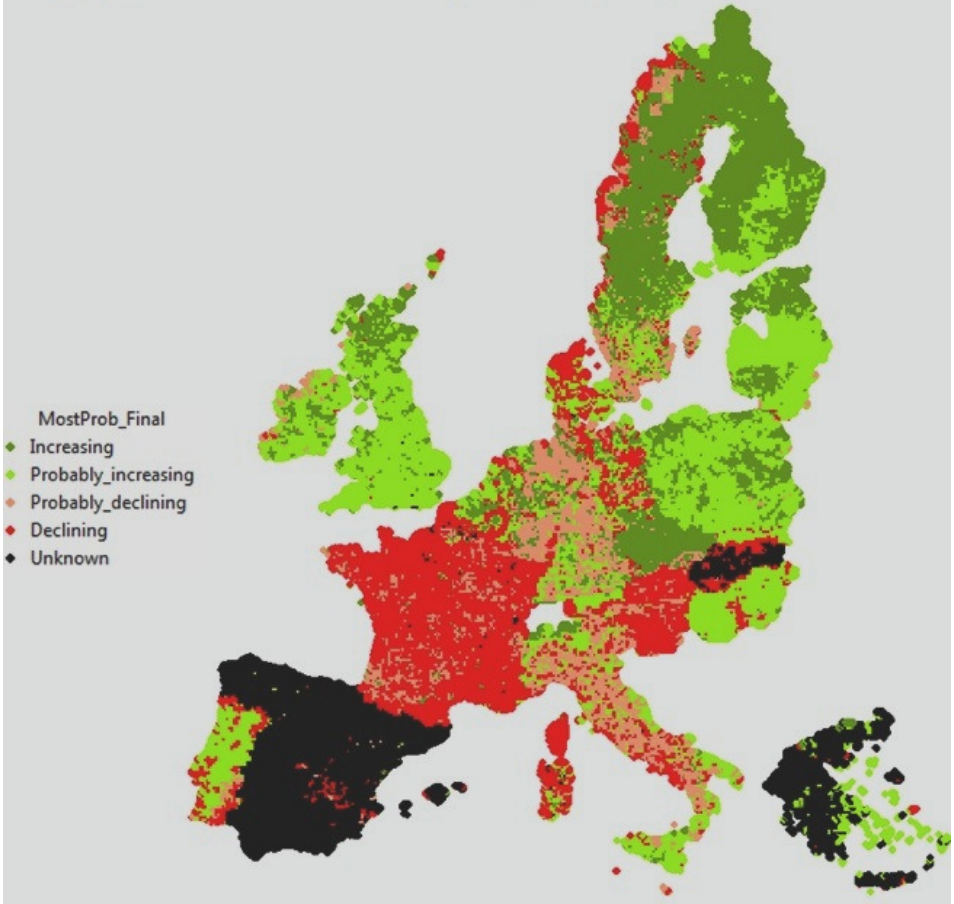
Figure 3:
Species with bad future prospects, in percentage from all assessed



13. Figure 3 illustrates one aspect of the conservation of Europe's biodiversity. It shows the number of incidences per 10km^2 grid cell, of species assessed to expect bad future prospects (or high number of threatened species), expressed as a percentage from all species assessed. Patterns of highest percentages within a country may be observed in areas where many species exist and a big share of them pertains to this category. However, when trying to comprehend an international comparative view, one should bear in mind that higher percentages may also result from more precise data

reporting in certain countries compared to others. Therefore, a more comprehensive analysis was pursued through the BBN application.

Figure 4: Article 17 index based on assessment of present condition of range, population, habitat and future prospects (node F)



14. Figure 4 shows the most probable state at each point given the different Article 17 elements for the final ARTICLE 17 Index (calculated using Node F, Figure 2). Thus where a node is given as 'probably increasing', the system identifies which of the possible state has the highest probability given the states defined by nodes E and D. These data can be mapped in a variety of ways, and further tests are being made to determine which are most useful.

Next steps

15. The work done has helped to define next steps in processing the available data to develop the biodiversity account more completely. A main limitation identified so far is the varying quality of the data reported by the Member States for the Article 17, both in terms of the assessed species conservation elements and also the spatial precision of the species distributions and ranges. To address the first deficiency it is proposed to extend the analysis to capture the degree of 'consensus' between the different elements in Article 17 assessments, as well their concordance with other data, such as CSI and other, regional and /or national biodiversity assessments. To address the second limitation, namely that of varying spatial quality in the reported data, the development of an additional procedure for enhancement and harmonization of the species' and habitats' distribution ranges is proposed. This will involve adjusting the 10 km distribution ranges for species with known preference for certain land-cover types with the more detailed CORINE Land cover classes where possible.

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