



Project No 226852

## Securing the Conservation of biodiversity across Administrative Levels and spatial, temporal, and Ecological Scales

SCALES (2009–2014) is a European research project financed by the seventh EU framework programme for research and development (FP7).

SCALES seeks ways to better integrate the issue of scale into policy and decision-making and biodiversity management in the EU.

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## SCALES briefs 6

# Scaling properties and non-linearities of anthropogenic processes affecting biodiversity

### Summary

Natura 2000 sites have been selected for protection based on their conservation importance, and may be particularly vulnerable to environmental pressures. Human-induced drivers (factors that directly or indirectly cause ecosystem changes) can impact with differing intensities at various spatial scales. When driver intensity varies markedly across spatial scales it is described as *non-linear*. An analysis of drivers across administrative levels, from national to local, identified clear non-linearities in drivers. The characteristics of drivers at higher administrative levels (e.g. country) are informative for describing broad land use contexts, but are not reliable predictors of the intensity of drivers at the scale of individual Natura 2000 sites. Therefore it is imperative for policies targeting nature conservation to take into account drivers at multiple scales with mitigation responses targeted at the appropriate administrative level.

### Key words

Biodiversity loss, scaling property, non-linearity, anthropogenic processes, drivers, environmental pressures, policy impact, socioeconomic impact

### Relevance to legislation

Birds Directive 79/409/EEC

Habitats Directive 92/43/EEC

Common Agricultural Policy (CAP)

EU Biodiversity Strategy to 2020

### Relevance to actual environmental problems

Biodiversity loss, climate change, land use change, landscape fragmentation, ecosystem services

### Description of the problem

#### Direct and Indirect Drivers

Our understanding of the way in which environmental, social and economic systems interact is defined very much by the way in which the interacting drivers act (see SCALES policy brief #5). According to the Millennium Ecosystem Assessment a driver is “any natural or human induced factor that directly or indirectly causes a change in an ecosystem”. When the intensity of a driver is similar at both coarse and fine scales then the driver can be characterised as being linear across scales. However, if the intensity of the driver varies markedly across scales (e.g., is low at coarse scales and high at local scales, or vice versa) then the driver can be characterised as being non-linear across scales.



**Figure 1.** Human-induced drivers like construction of technical infrastructure (e.g. wind farms, power lines, roads), agricultural activities and the expansion of settlements, are factors that directly or indirectly cause ecosystem changes. Photo: André Künzelmann.



### Box 1

**Non-linearity example:** Forest harvesting occurs at local scales but changes in evapotranspiration can influence regional weather, and changes in carbon sequestration can affect global climate. This is an example of where ecological, social and economic systems have driven differences in multi-scale pressures creating non-linearities (Figure 2).



**Figure 2a.** Forest harvest on local scale in the floodplain forest in Leipzig, Germany. Photo: André Künzelmann.



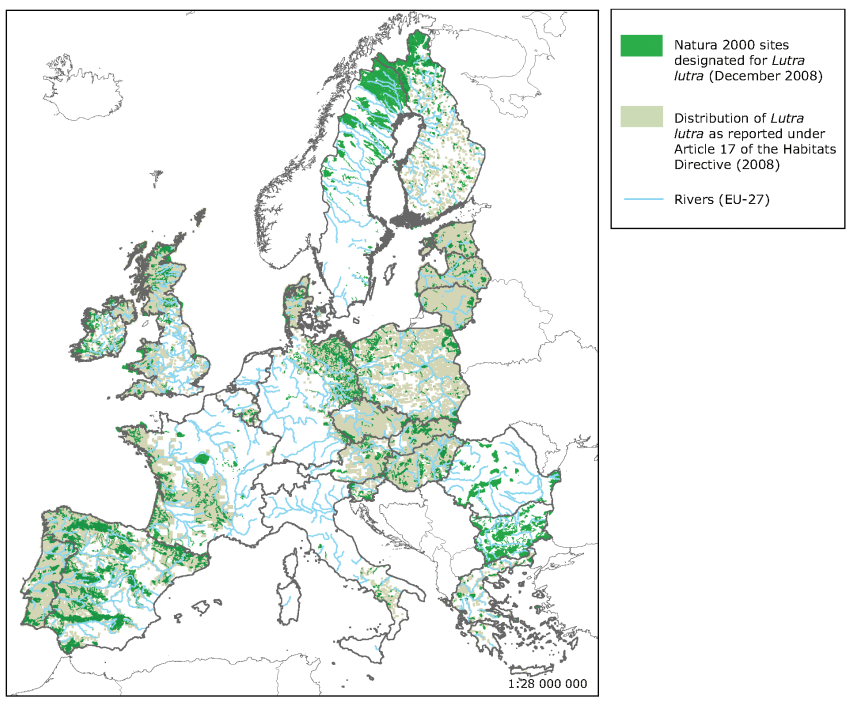
**Figure 2b.** Flooded forest as example of an extreme event caused by climate change in the same forest as shown in Figure 2a. Photo: André Künzelmann.

**Non-linearities can also mask problems within the environment:** A species could be locally abundant within a region, but at a National and European level the species could be rare and protected. If therefore

we were to look only at the regional scale, the survival of the species could be substantially distorted and mitigation and protection strategies would be misguided (Figure 3).



**Figure 3a.** Eurasian otter (*Lutra lutra*). Photo: André Künzelmann.



**Figure 3b.** Sites of Community Importance (SCI) designated for the Eurasian Otter (*Lutra lutra*) in the EU-27 and its current distribution in the EU-25 Member States according to Article 17 EU Habitats Directive Reporting in 2008. Source: EEA (<http://www.eea.europa.eu/data-and-maps/figures/sites-of-community-importance-sci>).





Policy can significantly affect non-linearities because policy makers and land managers at different levels have different economic, social and political agendas, issues and pressures to deal with. The hierarchy of administrative levels in Europe is based upon national and local government regions. These are the levels at which most decisions are made, policies are created and drivers act. There is often a mismatch between these levels, and the scale at which organisms and biodiversity function (Henle et al. 2010). At a European level there is a network of protected Natura 2000 sites, which are considered particularly important for preserving biodiversity and functionality in the wider landscape. However, at a local level, social or economic drivers may result in needs and actions, which are difficult to reconcile with the wider conservation objectives.

### Application to Decision Making

The SCALES project collected information on the drivers at different spatial scales and administrative levels. A top down approach characterises drivers based on administrative levels (NUTS, Nomenclature of Units for Territorial Statistics) while a bottom up approach characterises drivers at the individual Natura 2000 site level. The project assessed the effects of top down and bot-

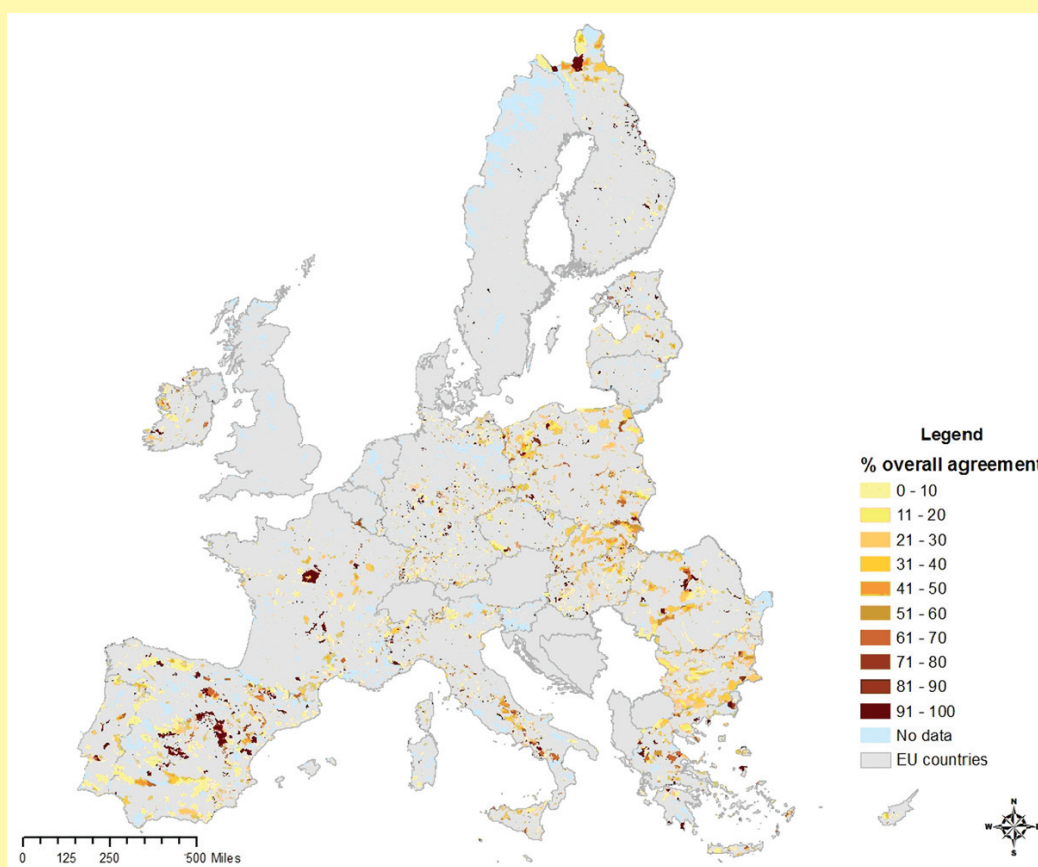
tom up approaches to measuring drivers and quantified how this can affect the non-linearity of such drivers across different scales and administrative levels.

### Critically we asked the question:

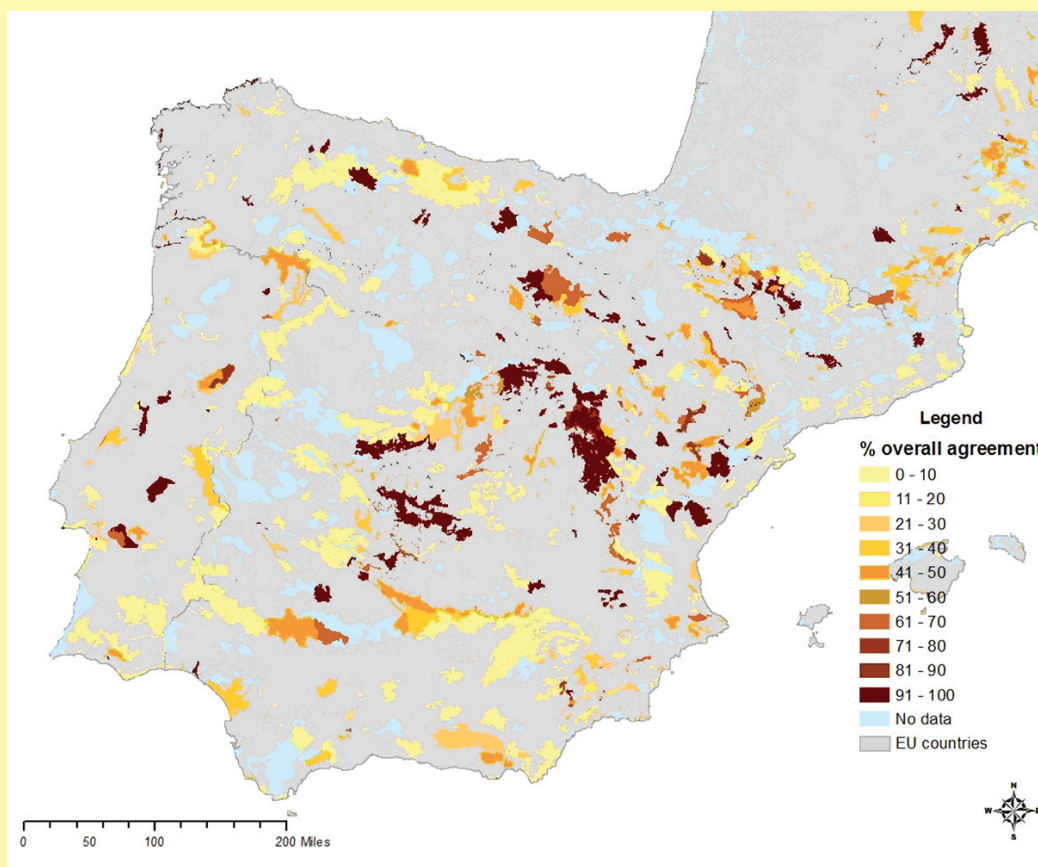
***Can the intensity of drivers estimated at higher administrative levels be used as a proxy for the intensity of the drivers recorded at the Natura 2000 site level?***

If so then a lack of non-linearity (i.e. consistency) would allow policies directed towards influencing drivers for better nature protection operating at higher administrative level to effectively benefit individual Natura 2000 sites.

However, we found strong non-linearities between the data at different scales. Figures 4 and 5 illustrate the level of similarity between the two data sets, and demonstrates a high level of non-linearity. Therefore, a top down approach to using information on drivers at the NUTS level to define decisions at the Natura 2000 sites level is poorly supported. This suggests that nature conservation policies need to be flexible enough in their approach to incorporate variation and stratification of drivers at a local scale in order to be effective at an appropriate scale.



**Figure 4.** Average percentage similarity between NUTS3 and Natura 2000 driver intensity data across Europe, based on all drivers (Natura 2000 data sourced from European Environment Agency, copyright of Directorate General for Environment).



**Figure 5.** Same information as in figure 4 but zoomed in to show more details across the Iberian peninsula.

These non-linearities are consistent with those found across NUTS levels (see SCALES policy brief #5) suggesting that non-linearities run through all spatial scales and administrative levels down to the individual protected area. The data presented here shows that many drivers become even more intense at a Natura 2000 level when compared to the NUTS levels, illustrating how localised these drivers are. This could be due to the non-random selection of special landscapes for protection as Natura 2000 sites.

## Recommendations

From the results of our research mentioned above we conclude that administrative levels (e.g. NUTS) are not a reliable or appropriate way to map and examine drivers relevant for Natura 2000 sites. Policies need to take this into account and include a level of flexibility to target actions towards localised drivers and/or protected sites, such as Natura 2000.

Using information at higher administrative levels can still be very informative on describing the broader land use context but are not effective on providing an accurate picture at very local level. In the presence of such non-linearities the complementary use of information at various administrative levels becomes imperative for policy and decision making.

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## Publication date

01.10.2012

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