

Biodiversity Trends Associated with SEA and EIA Practices

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ABSTRACT

This chapter compares trends in policies on land uses and economic activity to trends in ecosystem services and biodiversity in cultivated areas as well as in protected areas, using a database defined in Chapter 6. The analysis revealed associations between capacity, priority and process variables on one hand, and impact variables on the other.

For the TESS project, the most important analyses involved the number of EIAs and SEAs. There were relatively more of these in countries where local administrations consulted most with NGOs, were responsible for relatively small populations and perceived nature most positively. Except for consultation, the processes used when conducting assessments and monitoring their results did not positively affect the number of assessments, the environmental and social impacts investigated, or the numbers of those using the resources. Additional analysis indicated interesting relationships with conversion to artificial land-cover, positivity to nature indices, knowing the term “biodiversity”, species conservation status, consultation at local level with NGOs and the proportion of a country’s population that was hunters or anglers.

INTRODUCTION

The analysis reported here is important both for examining the operation of the statutory EIA and SEA assessments across Europe and for the design of a TESS, the ultimate goal of this project. This is because although the legislative framework for EIA and SEA is created at high level in national governments, the actual conduct of the assessments is mostly at the lowest levels Chapters 2 and 7, especially for EIA. Therefore data on the attitudes and consultative processes behind these assessments needed to be collected at the local level. This is also the level at which a TESS must operate in order to guide the decisions made by individual managers of land and species.

Managers and other beneficiaries of wild resources are important because their management has both positive and negative impacts on biodiversity outside the formal assessment process. Their economic significance alone may be considerable, as European anglers, hunters and wildlife watchers spend in excess of €40 billion annually (Kenward *et al.* 2009), with anglers and hunters also having appreciable positive impact on habitats (Oldfield *et al.* 2003; Sharp 2010). Beneficiaries and managers of wild resources could also be important when involved in consultations for formal assessments, depending on the attitudes of the local government

administrations. Here we pay particular attention to these local considerations, which have been overlooked in previous studies.

It was apparent at the start of data-collection that indicators of trends in biodiversity, in terms of changes in specific taxa, were still inadequate for analysis of relationships across countries. Therefore, analyses in this report focussed more on the status of species and habitats (for example as registered annually in reporting for Article 17 of the Habitats Directive), on the status of rural recreations that depend on the abundance of particular species, and on trends in remote-sensed land-cover that are a proxy for the habitat changes which impact biodiversity.

VARIABLES USED FOR ANALYSIS

The construction (survey methodology and data selection) of the database analysed here is described in Chapter 6. The database contains data from 30 countries (26 EU states plus Norway, Switzerland, Turkey and the Ukraine), including 27 variables from the Pan-European Survey. Another 28 variables were selected from data collated by the European Environment Agency (and in some cases reworked extensively) or by the United Nations. We used an additional 10 variables on governance and participation, including World Bank governance indicators, collected in the previous GEMCONBIO project (Manos & Papathanasiou 2008).

In examining the matrix of variables from the database, this report makes extensive use of relational statistics, including bivariate correlations and multiple regression models. Such an analysis can only reveal associations between capacity, priority and process variables on one hand, and impact variables on the other. The causality of such associations cannot be assumed. Thus, if there is an association between A and B such that both increase at the same time, the increase in B may be caused by A, or the increase in A caused by B, or the increase in both be caused by a third factor which influences both A and B. All that can definitely be said if an increase in A is associated with an increase in B, it is unlikely that variable A or B affects the other variable negatively. Finding relationships is also important for identifying variables which could be used in future as indicators of impacts on the environment.

DATA ANALYSIS

To investigate relationships between variables, we use statistics which estimate probability. For a single test of a relationship, if the probability is 0.05, it means that there is a one in twenty chance that the relationship is due to chance. However, the more tests that are done the more likely that a relationship will arise by chance. If 100 statistical tests are done, on average 5 should be significant at $P=0.05$ or less. The problem of chance results can be reduced by setting a level of $P=0.01$ for accepting results as statistically significant; even so, an average 1 in 100 positive results will occur by chance.

In the analysis that follows, correlation coefficients are estimated to compare pairs of variables, and if significant at $P<0.01$, a trend-line is fitted and a R^2 calculated, which indicates the proportion of variation in A explained by variation in B. Conventionally, a relationship in which one variable explains more than 50% of variation in another is considered strong.

Tests of the influence of several variables together on one variable are based on multiple regression analysis, which is a potentially flawed but convenient standard for rapid processing of a large database. For this analysis, it is important that relationships result from a statistically normal distribution of data about lines of best fit trends. If there are outliers, they may have a severe effect on the results. Transformations, such as the use of logarithms, can be used to normalise data, but are not always effective. Visual inspection of results is important to indicate possible outlier effects.

Subject to these considerations, the analysis was performed as follows:

1. To increase comparability between countries, numbers of environmental assessments were expressed per unit area. Numbers of users of natural resources (hunters, anglers) were expressed as densities when considering ecological effects and as prevalence (%) in the population for social effects. To normalise data distributions, these densities and proportions were log-transformed, as were all proportions of surface covered by particular habitats (artificial surfaces, agriculture, forestry, wetland, water and other semi-natural habitats) or protection categories (SPA, SCI and all protection categories). A variable for sufficiency of Natura 2000 coverage tended towards 100% and was therefore given an angular transform.
2. Variables in particular categories that were all likely to correlate strongly were identified and reduced to the ones with the most variation. Thus, among governance variables from the World Bank, were inter-correlated strongly except Political Stability; this variable was kept and Control of Corruption, which was used in previous work on environmental governance analysis (Smith *et al.* 2003), represented the others.
3. A matrix of correlation coefficients was prepared for capacity, priority and process variables on one hand and all impact variables on the other. The index of formal assessments (mean number of EIAs and SEAs registered at national level) was also included. Although this was a Process variable for ecological impacts, it was also important to understand what caused variation between countries in the numbers of assessments. Some socio-economic variables (including four of social attitude and one of Natura 2000 sufficiency) together with density and prevalence of hunters and anglers, were used both as a capacity variables but also as a impact variables to see what might be affecting social attitudes and the abundance of resource users.
4. The correlation matrix was marked to indicate associations significant at $P < 0.01$ and all such relationships were plotted for inspection. Outlying effects were noted, especially for data on hunters and population density from Malta, which also had local area populations exceeding the 150/km² criterion (Figure 1 in Chapter 6). Luxembourg too was an outlier in two respects, with an indicated 25% per annum loss of semi-natural land-cover and low numbers of anglers and hunters. To minimise distortion from outliers, initial regression analyses excluded both Luxembourg and Malta. Cyprus lacked survey data and was therefore omitted entirely.
5. Inspection showed that the effects of outliers from Malta and Luxembourg were not enough to affect conclusions, so these analyses were run again with Luxembourg and Malta included. Analyses were run with and without single country outliers also for Quality of National Data and Numbers of Measures Applied in Assessments; there were no meaningful results for these or for Change in Semi-natural Habitat unless Luxembourg was excluded or set to 0, or for the Farmland Bird Index unless two outliers (Bulgaria and Portugal) were omitted.

RESULTS

The analysis matrix contained 50 variables that were estimated in different ways, for capacity ($N = 31$), priority ($N = 8$) and process ($N = 11$), together with 16 impact variables, giving a total of 800 correlations to examine. Among them, at $P < 0.01$ roughly eight would be expected to arise by chance, and perhaps one at $P < 0.001$. In fact, 31 were significant at $P < 0.01$ and 9 of those at $P < 0.001$. Thus, many of the relationships were not likely to result from chance alone. A tendency for relationships to occur repeatedly for particular variables showed that these variables were at least important as indicators, and that perhaps they involved causal relationships.

Relationships of Ecological Impact Variables

CORINE variables

Two types of ecological impact variables, estimated from CORINE land cover information (see Chapter 6), reflected potentially detrimental changes in land use between 2000 and 2006. Variables from CORINE data were available for 24 of the 27 countries within the European Union and also for Norway and Turkey, making 26 cases for analysis. Twenty four also had estimates at national level of numbers of EIA and SEA. Sample size was reduced to 21 EU countries for analyses contrasting land cover changes inside and outside Natura 2000 over the time periods 1990-2000 and 2000-2006.

Rates of conversion to artificial land-cover

The annual growth rate of artificial surfaces, mainly from building development and road construction (CORINE categories 11 and 12), was an indicator of loss of natural habitats and also likely to be subject to environmental assessment processes that represent decisions taken by government. Rates of conversion to artificial land-cover were computed for each country and then separately for areas inside and outside Natura 2000. This was aimed at examining the drivers of conversion within the most important areas for biodiversity conservation in Europe, which should be under the strictest regulations and management to avoid negative impacts. Similar analysis were carried out for the period 1990-2000, to check whether protection reduced artificialisation

In 1990, across all countries, 0.6% and 4.8% of land surface inside and outside Natura 2000 sites, respectively, was covered by artificial surfaces. Artificial surfaces inside Natura 2000 increased by 4.7% (177.8 km²) in 1990-2000, and by 3.1% (122.1 km²) in 2000-2006. Protection status did not appear to have any positive effect in reducing the mean rates of Conversion to artificial land-cover across countries. Conversion increased significantly between the periods 1990-2000 and 2000-2006, with no significant differences between areas inside and outside Natura 2000 (Figure 1). A considerable proportion of variation in conversion inside Natura 2000 could be accounted for by a linear relationship with artificialisation outside Natura 2000 (Figure 2), both in 1990-2000 ($R^2=0.86$, $F_{1,19}=116.6$, $P < 0.001$) and, to a lesser extent, in 2000-2006 ($R^2=0.59$, $F_{1,19}=27.1$, $P < 0.001$). There was a strongly significant positive correlation between time periods for conversion to artificial land outside Natura 2000 ($r=0.79$, $P < 0.001$), but less so outside Natura 2000 ($r=0.58$, $P = 0.006$).

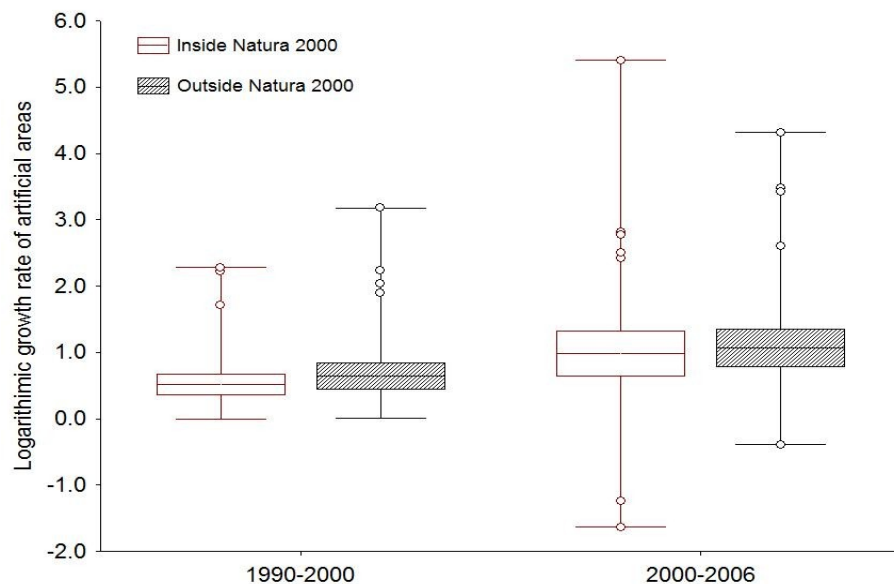


Figure 1. Mean ($\pm$ s.e.; range) of logarithmic growth rates of artificial areas across 21 EU countries, inside and outside Natura 2000 sites, before (1990-2000) and after (2000-2006). Points indicate values at > 4 s.e. from the mean.

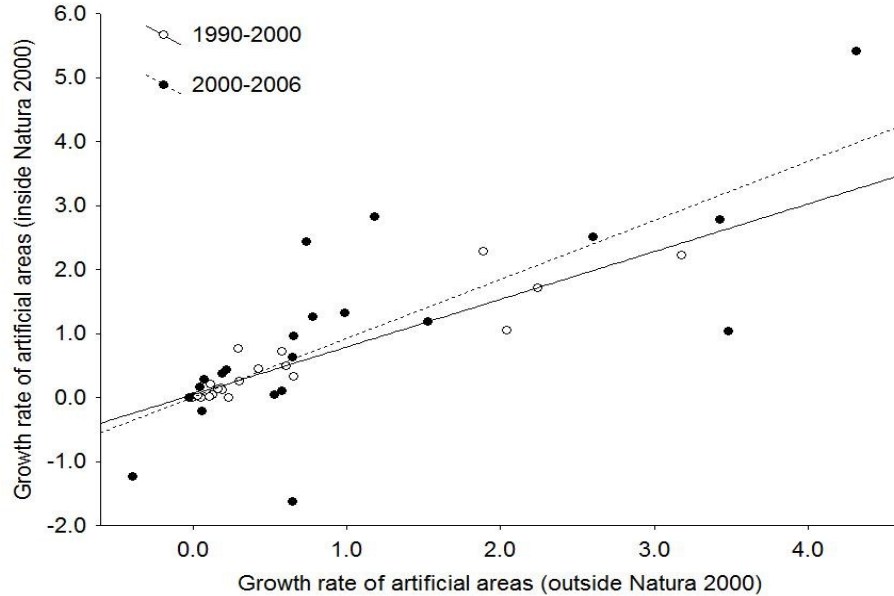


Figure 2. Linear regression fits between the logarithmic growth rates of artificial surfaces inside and outside Natura 2000 sites, in 1990-2000 and 2000-2006, in 21 EU countries.

In the period 1990-2000, conversion to artificial land-cover inside Natura 2000 showed a positive relationship with the annual growth rate of GDP ($P = 0.023$), and a weakly positive one with high GDP ($P = 0.061$) and population growth rate ($P = 0.096$) in combination. Very similar relationships were found outside Natura 2000. There was a strong positive relationship between land-conversion and annual growth rate of GDP ($P = 0.011$) and a weak positive relationship with GDP ($P = 0.076$) and population growth rate ($P = 0.058$). In 2000-2006, no socio-economic variable was related to artificialisation inside Natura 2000, whereas the growth of artificial surfaces outside Natura 2000 sites increased with population growth rates. Taken together, these results suggest that from 1990-2000 to 2000-2006 there was a progressive decoupling of socio-economic processes inside and outside Natura 2000.

The effect of population growth rate on conversion to artificial land-cover was highly significant ($P=0.001$) when combined with the mean number of statutory environmental assessments (SEA, EIA) in the country. Thus, there was more artificialisation in countries with high population growth rates and few statutory assessments (Figure 3), a relationship which explained 56% of the variation in the growth of artificial surfaces.

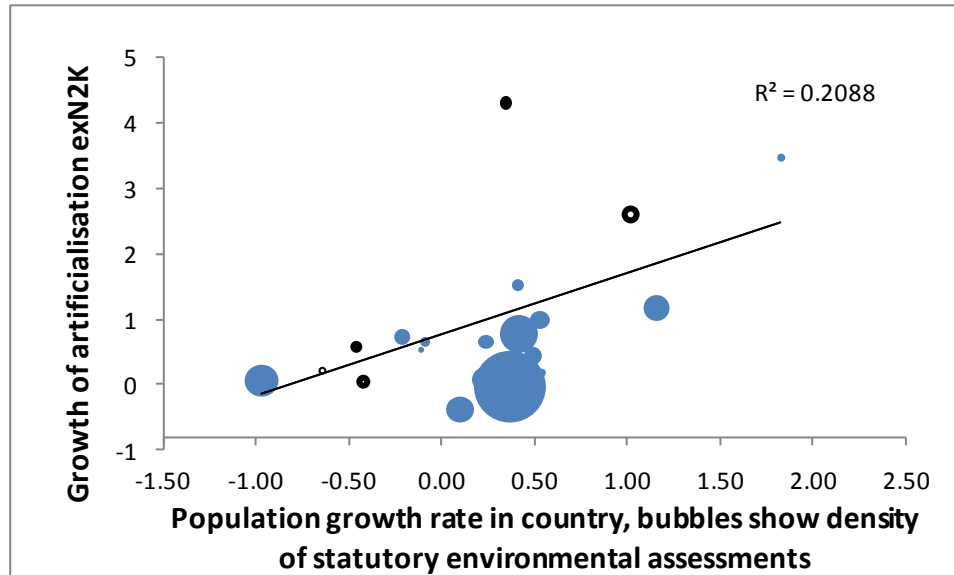


Figure 3. Countries with high population growth rate (horizontal axis) had high rates of conversion to artificial land-cover (vertical axis) outside Natura 2000 sites, unless they had many statutory environmental assessments (as shown by large bubble size).

A separate relationship was found relating more conversion to artificial land-cover where there was the highest number of guidance texts to assist the conduct of statutory assessments. This relationship was the only one detected with conversion within Natura 2000 sites ($P=0.034$), but was highly significant only when areas outside Natura 2000 sites were considered ($P<0.001$) or if both areas were combined ($P=0.007$). The effect was clearly associated with having a large number of assessment texts (greater than eight) rather than fewer (Figure 4).

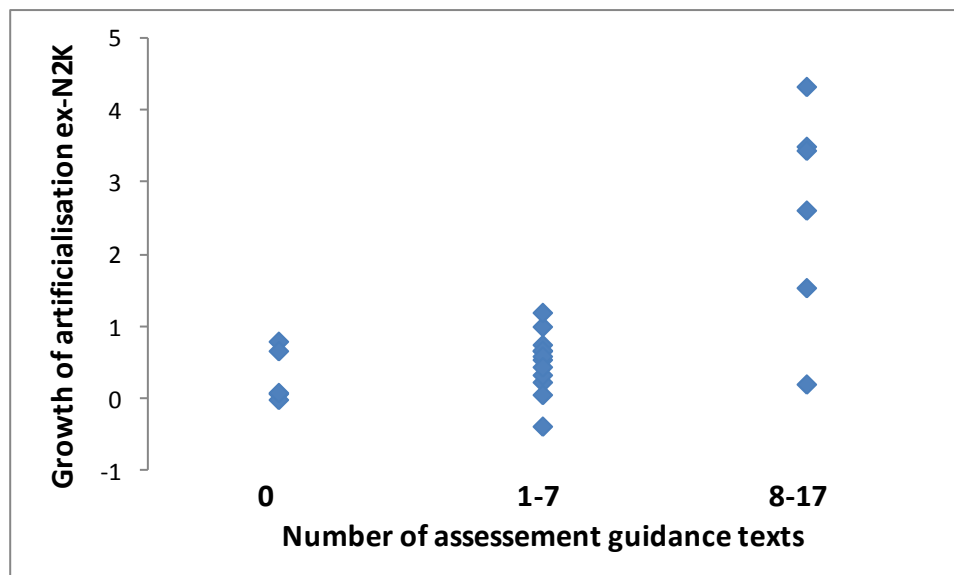


Figure 4. Countries with the highest growth rates of conversion to artificial land-cover outside Natura 2000 sites (vertical axis) tended to have the largest number of guidance texts for environmental assessment (horizontal axis).

Change in semi-natural habitats

Another ecological impact variable based on CORINE data was the annual rate of change in the surface area covered by semi-natural habitat (CORINE categories 32 and 33). This could be an indicator either of loss of habitat (important for biodiversity) or of gain in habitat (after agricultural abandonment that, in some situations but not all, has potential for restoration of biodiversity).

Again, there was a significant relationship ($P=0.011$) between the rate of change of semi-natural habitats and the number of guidance texts for environmental assessments that were listed at national level, indicating that habitat loss was higher (negative rates) where less guidance was provided (Figure 5). It is worth noting that there appears to have been gain of semi-natural habitats in many countries.

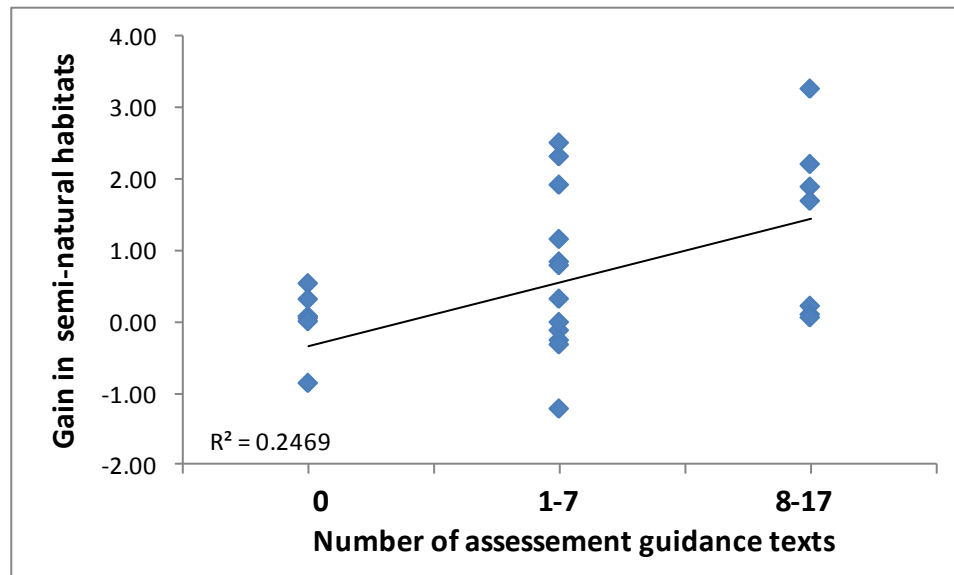


Figure 5. There tended to be most growth of semi-natural habitat cover (vertical axis) where the number of assesement guidance texts (horizontal axis) was highest.

The gain in semi-natural habitats was highest where the quality of data on species and habitats available at national level tended to be low ($P=0.006$). Including the number of guidance texts and the quality of data in the regression produced a relationship (Figure 6) that was statistically highly significant ($P=0.001$) and explained 46% of the variation in change of semi-natural habitats.

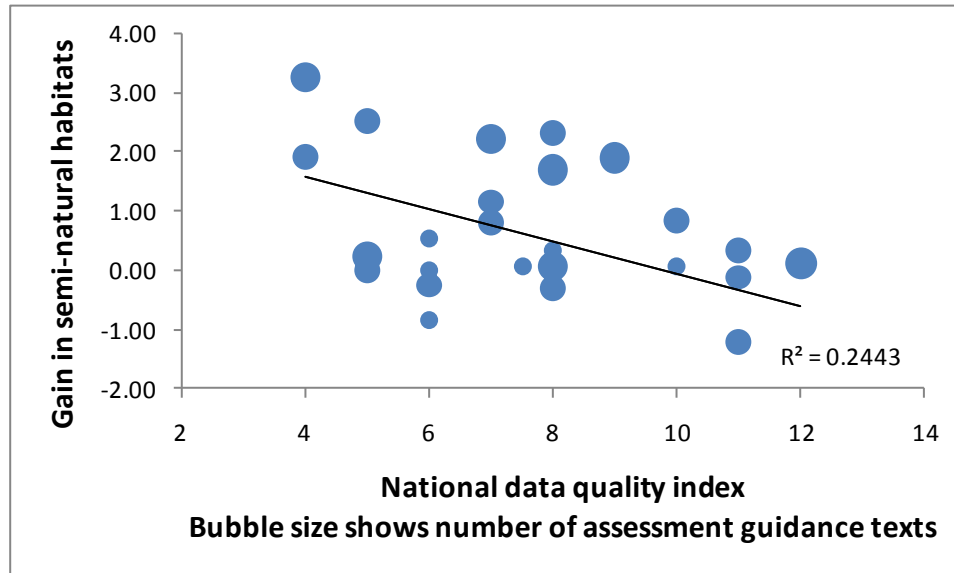


Figure 6. The growth rates of semi-natural habitat cover (vertical axis) tended to be least where the quality of environmental data was highest (horizontal axis), especially if there were many guidance texts for environmental assessment (i.e. bubbles were large).

Variables based on Habitats Directive Article 17 reporting

Variables from Habitats Directive Article 17 reporting were available only for countries within the European Union, and were missing for the two most recent additions (Romania and Bulgaria) as well as Cyprus. This gave a total of 24 cases for analysis.

Habitat Conservation Status showed no relationships that were even weakly significant ($P=0.05$) with process variables, priority variables or governance capacity variables. There was a weak tendency for habitats to be registered as less well conserved where the national human population was most urbanized ($P=0.024$) and in countries where CORINE mapping indicated the lowest proportional forest land-cover ($P=0.019$).

Species Conservation Status had no relationships with process or priority variables at $P<0.01$. However, among societal capacity variables, species conservation status tended to be highest where there was the highest proportion of Hunters plus Anglers in the national population ($P=0.002$) and the densest populations in rural areas randomly selected for the Pan-European Survey ($P=0.012$), as well as where there was the highest growth in Gross Domestic Product ($P=0.032$). Species conservation status was also highest where the ecological capacity indicated the highest proportion of water ($P<0.01$), and especially wetland, as measured by CORINE land-cover mapping ($P=0.001$, Figure 7).

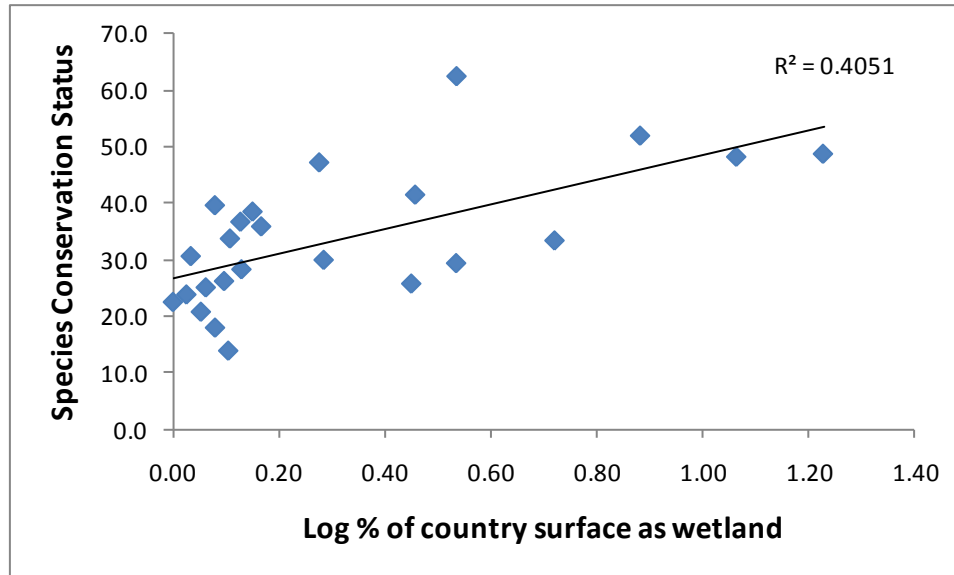


Figure 7. The percentage of species with favourable conservation status (as assessed from Article 17 reporting) tended to be lowest (vertical axis) where the percentage of the country covered by wetlands (from CORINE mapping) was the least (horizontal axis).

The only combination of these variables that gave a significant improvement on the individual bivariate relationships was the combination of Hunters plus Anglers and GDP, which was highly significant ($P < 0.001$) and explained 49% of the variation in Species Conservation Status. The Species Conservation Status was highest where hunters and anglers were more common in national populations and where there had been the most growth in GDP (Figure 8).

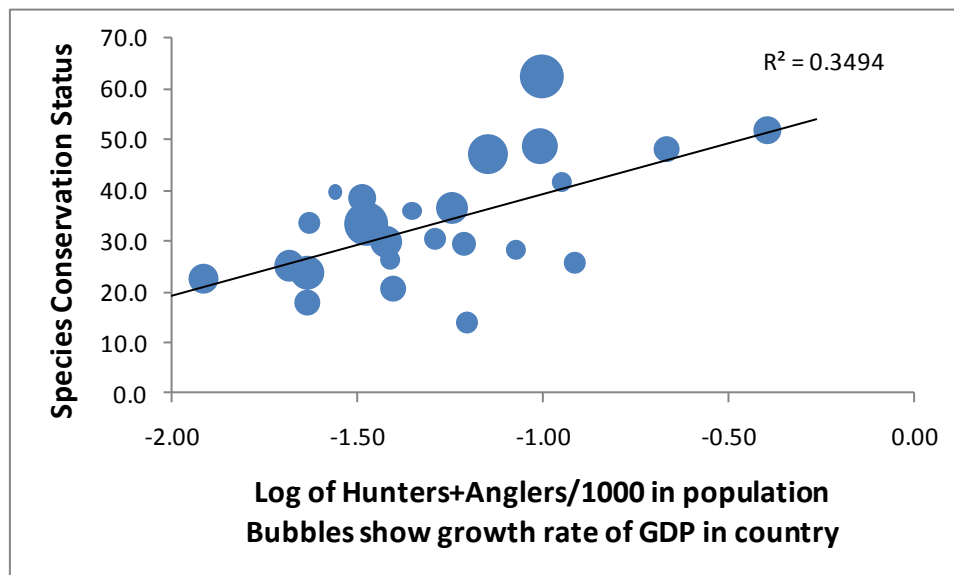


Figure 8. The percentage of species with favourable conservation status as assessed from Article 17 reporting (vertical axis) tended to be highest where hunters and anglers were more common in the population (horizontal axis), especially in countries where the annual GDP growth rate was high (as shown by large bubble size).

Invasive Alien Species and the Farmland Birds Index

The number of Invasive Alien Species (IAS) could be estimated for all 30 countries in the analysis. However, IAS showed only one univariate relationship that was weakly significant; IAS was lower when local authorities put a high priority on having data for environmental decisions, especially socio-economic data ($P=0.021$). The regression was improved to $P=0.005$ by adding the proportion of national surface covered by water. However, the relationship for the 26 countries that had the appropriate data (Figure 9) only explained 32% of variance in the prevalence of IAS, so this result could have been due to chance.

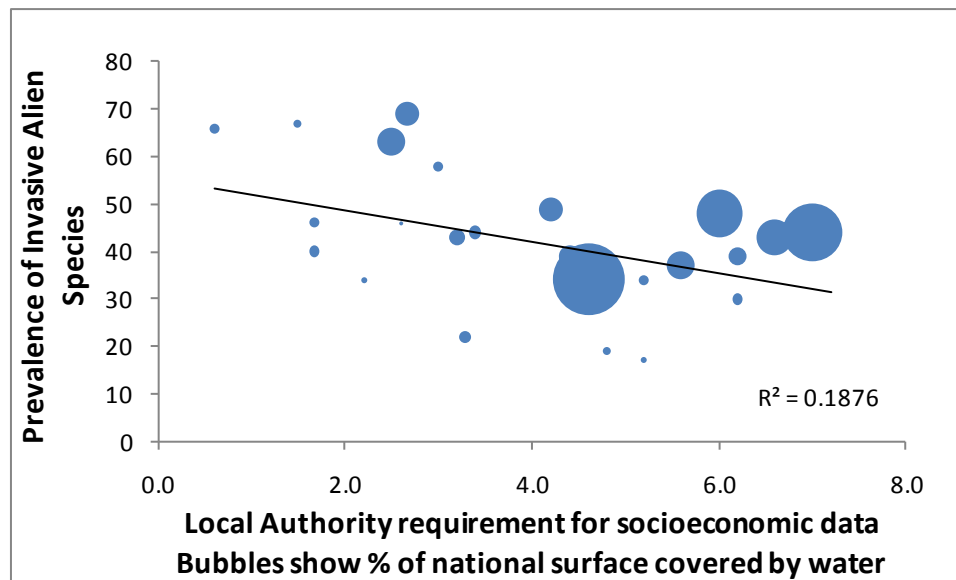


Figure 9. There was a weak tendency for the number of Invasive Alien Species (vertical axis) to be lowest where local authorities had the most demand for data on provisioning, regulating and cultural services of ecosystems (horizontal axis), especially where more of the country was covered by water (i.e. bubble size was large).

Relationships were no more convincing for the Farmland Bird Index. This index was available for only 21 of the 27 EU states, plus Norway and Switzerland. Moreover, although 20 values lay between -3.5 and plus 1, there were outliers at -5.3, -7.9 and +6.4. With these outliers included, the only significant relationships for the Farmland Bird Index depended on the two most extreme outliers (Bulgaria and Portugal), so a further analysis was run without them. In this case, a weak relationship with the regulatory constraints on payments from the national agri-environmental schemes ($P=0.038$) clearly depended on the remaining outlier (Slovakia, Figure 10).

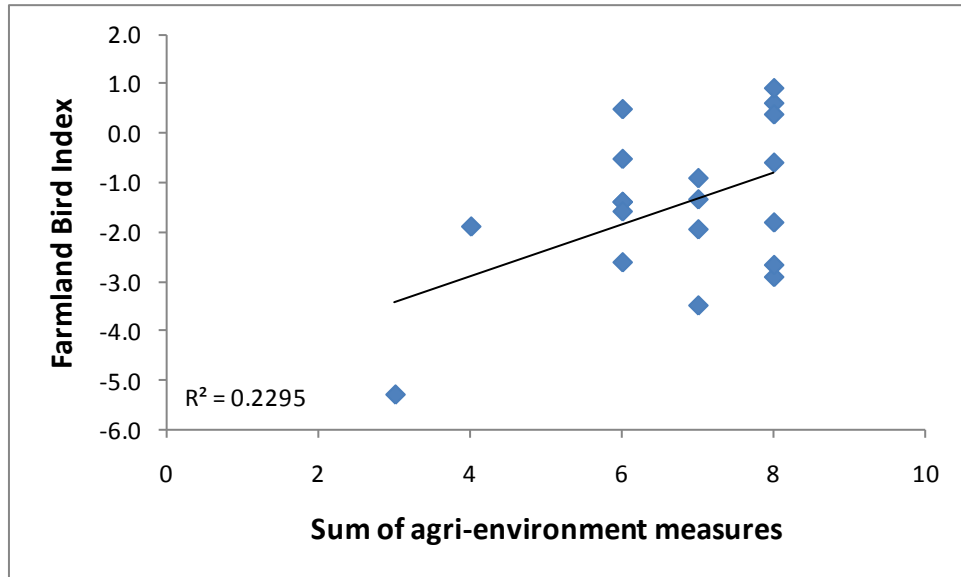


Figure 10. The correlation between the Farmland Bird Index (vertical axis) and the extent of regulatory constraint on payment from national agri-environment schemes (horizontal axis) depended on an outlying point.

A relationship with the index of frequency of consulting at EU level by national government organisations was quite strong ($P=0.014$), though this disappeared if one of the two outliers was included (Figure 11). So the tendency for the Farmland Bird Index to be highest in countries that consult least with the EU about environmental issues could well be due to chance.

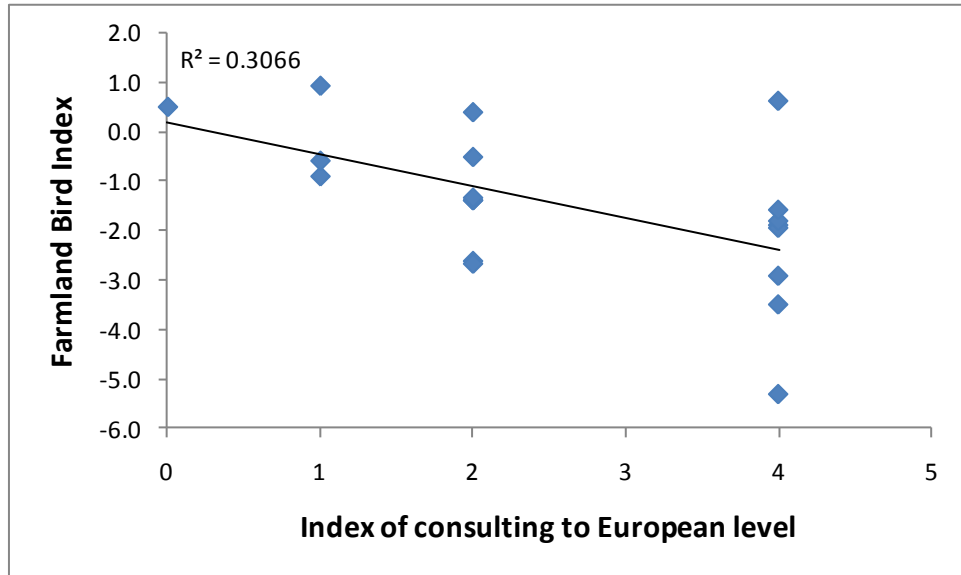


Figure 11. The Farmland Bird Index (vertical axis) tended to be lower in countries where there was most consulting by national ministries on environmental matters with the European Level (horizontal axis).

Relationships of Societal Impact Variables

Of the five impact variables in this category, two showed no relationship greater than $P=0.03$. One of these variables was an estimate of the attitude to the use of land and species, obtained from assessment by the Pan-European survey local administrations of whether contributions to conservation were greater from those utilising land and species consumptively or those watching or otherwise accessing non-consumptively. The other was the proportion of national populations (sampled by Gallup in a survey about biodiversity) who recognised that biodiversity was being lost. Both these variables are given no further consideration here. Two further variables from independent survey and one from the Pan-European survey of local administrations gave relationships worth considering.

Independent survey variables

One indicator of environmental awareness from the Gallup survey was the proportion of national populations in EU states that recognise the word 'biodiversity'. This variable was available for all 26 EU states and showed a positive correlation with country area ($P=0.015$), but a negative relationship with the national density of environmental assessments ($P=0.016$). The tendency for countries with more recognition of 'biodiversity' to do fewer environmental assessments (Figure 12) replaced the effect of country size in a multiple regression.

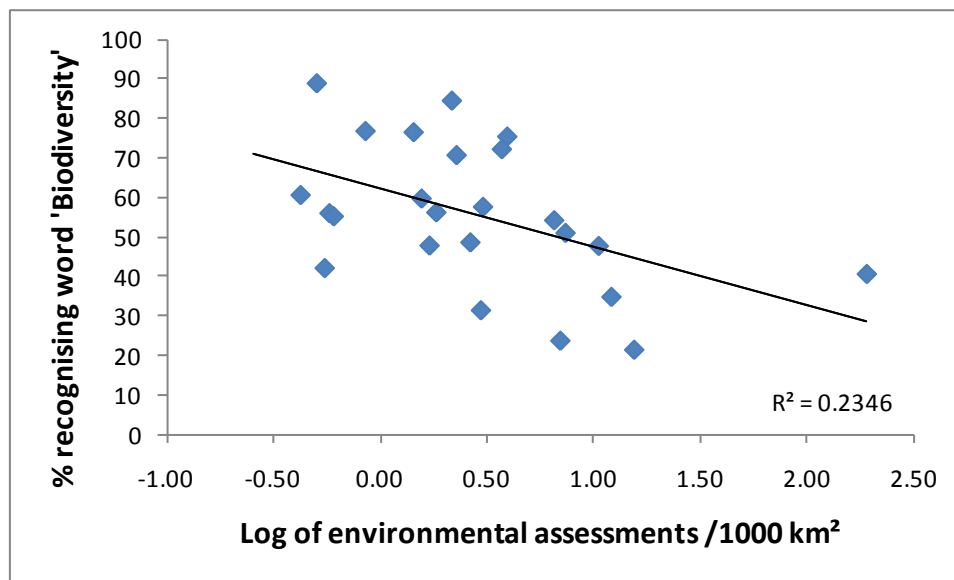


Figure 12. The percentage of populations that know the word “biodiversity” (vertical axis) tended to be lowest in countries where the density of SEA+EIA assessments (horizontal axis) was highest.

Another societal variable from the SEBI set was the government assessment of the adequacy of the proportion of land designated within Natura2000. For the 26 EU countries, this variable correlated positively both with GDP per capita ($P=0.01$) and with the World Bank governance variable ‘Control of Corruption’ ($P=0.002$). However, variation in Control of Corruption explained 67% of variation in GDP/capita, and was the only variable that remained significant in a multiple regression (Figure 13).

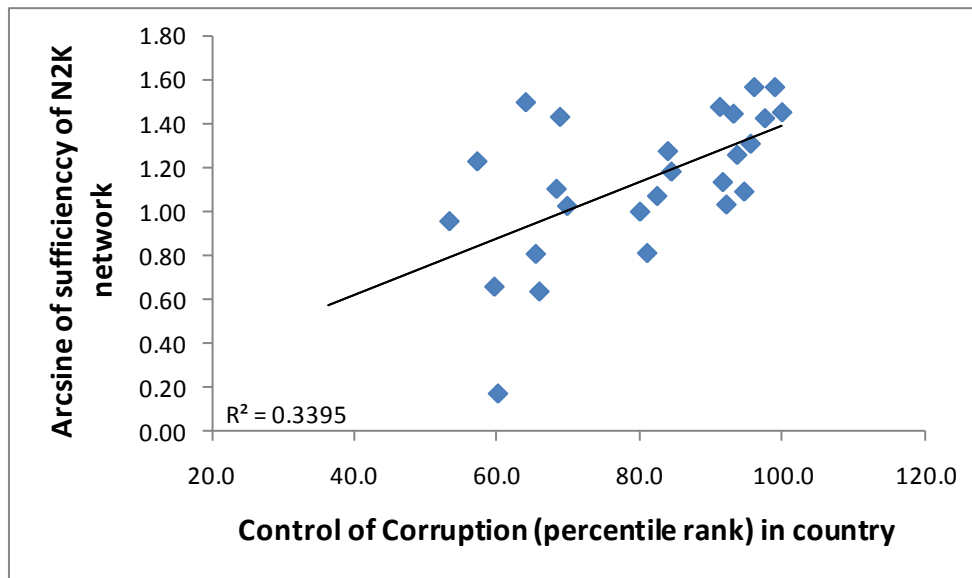


Figure 13. The sufficiency index of Natura 2000 coverage (vertical axis) tended to be highest in countries with a high World Bank index of corruption control (horizontal axis).

Positivity to nature from the Pan-European survey

The Pan-European survey asked local administrations to score how strongly residents perceived a benefit from biodiversity (in terms of food, materials, recreation, tourism, etc), and also how strongly they perceived costs from the environment (in terms of pests or risks from wildlife disease or habitats supporting wildfire, etc). The scores for perception of benefit and cost were used to derive a 'nature positivity' index.

This index, which was available for 28 countries, proved to be strongly related to different capacity, priority and process variables. The strongest relationship (explaining 41% of the variation on the positivity index) was with the World Bank governance capacity variable 'Political Stability' ($P=0.008$). The relationship of nature-positivity with Political Stability was improved to explain 50% of variation if the effect of LAU2 populations density was included, higher density was related to higher nature positivity ($P=0.046$, Figure 14).

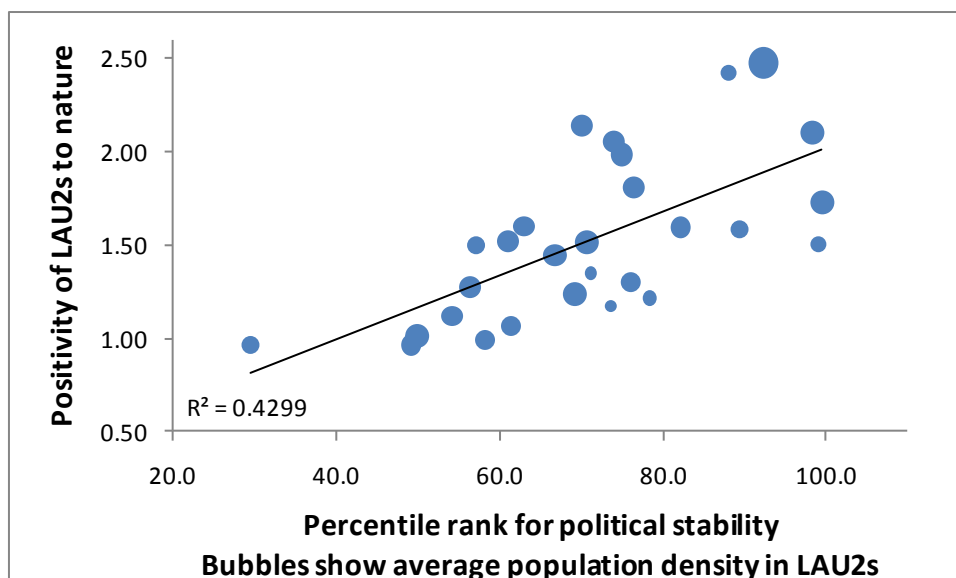


Figure 14. The index of positivity to nature at local level (vertical axis) tended to be highest in countries with a high World Bank index of political stability (horizontal axis), especially where the average rural population density tended to be high (as shown by large bubbles).

There was also a strongly positive correlation ($P=0.005$) between the nature positivity perceived by LAU2s and their tendency to consult with NGOs for environmental decision-making (Figure 15). Including the extent of consulting with NGOs in the previous analysis with political stability and population density explained 60% of the variation in nature positivity.

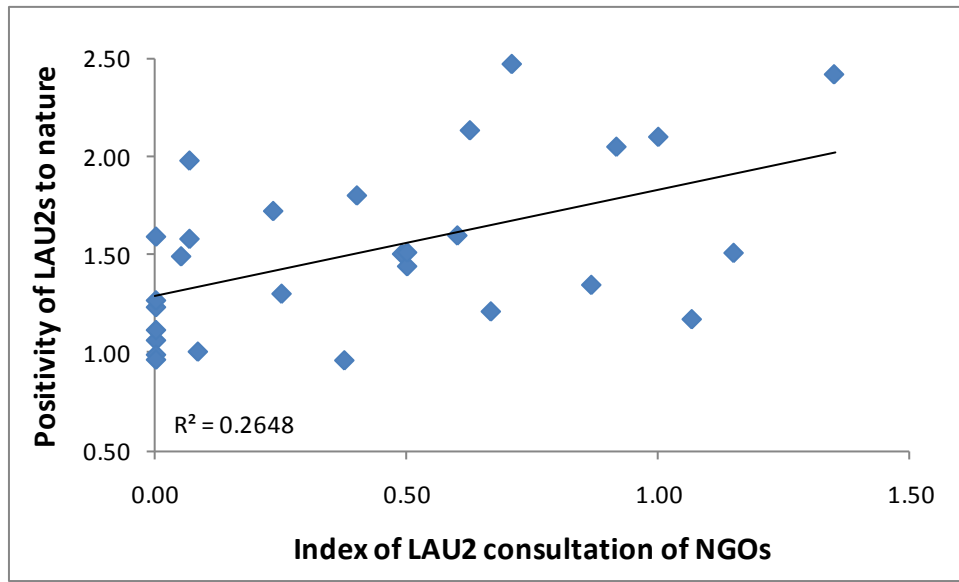


Figure 15. The index of positivity to nature (vertical axis) tended to be higher for local administrations that consulted most with NGOs (horizontal axis).

There was also a relationship between nature positivity as perceived by LAU2s administrators and whether they tended to place greater importance on the environment in their local decision-making ($P=0.008$). Another regression model, which explained 51% of the variance in nature-positivity, was a combination of environmental priority decision-making and Political Stability (Figure 16). The addition of a third variable, GDP growth rate, improved this model too, which explained 58% of variance in nature-positivity.

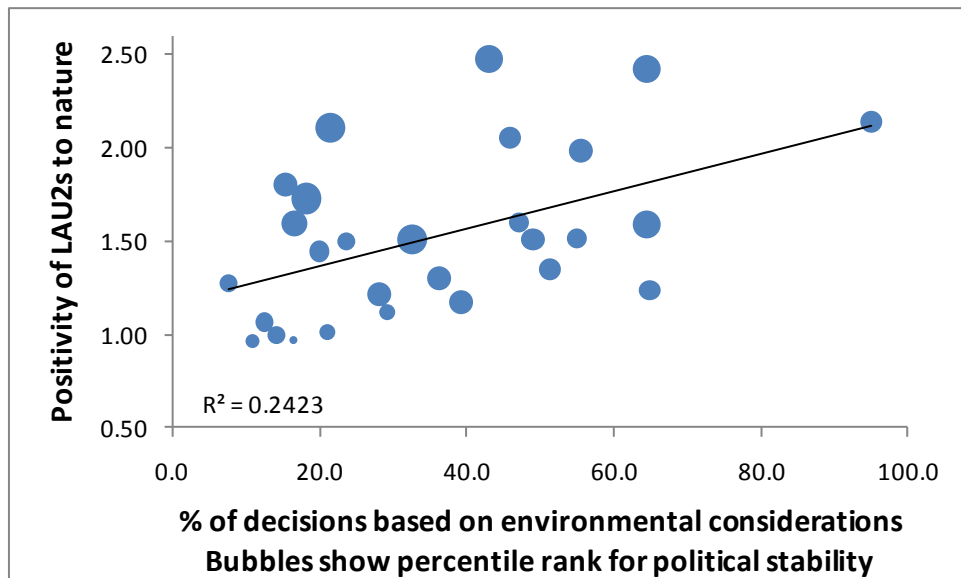


Figure 16. The index of positivity to nature (vertical axis) tended to be highest in local administrations that took decisions mostly on an environmental basis (horizontal axis), especially where the index of political stability was high (i.e. bubbles were large).

Thus, being strongly positive about nature was a product of the most stable, low growth societies, where the environment was a priority in local decision-making and there was a lot of consulting with NGOs. Interestingly, weak correlations of nature positivity with knowing the word ‘biodiversity’ and recognising loss of biodiversity were both negative. It is also worth noting that, although an LAU2 priority for the environment in decision making was not strongly related to consulting with NGOs at local level ($P=0.045$), a combination of consultation with NGOs at national level and local level explained 37% of the variance in the influence of the environment in decision-making at the local level ($P=0.001$). It appears that the setting of priorities for the environment in decision-making is associated with NGO consultation, but locally not nationally.

Relationships with economic impact variables

Hunters as a proportion of national populations

Treating the prevalence of hunters and anglers as impact variables is appropriate not only on economic grounds, but also because they tend to form NGOs which are organised down to local levels in the EU, and therefore have an impact on environmental decision-making at all levels of government. Their representation in the population is likely to change relatively slowly and be influenced by the most durable capacity variables rather than by priority or process variables, for which numbers of hunters and anglers may serve as influences rather than outcomes.

Relationships with the proportion of hunters tended to be strongly impacted by the demographics of Malta, which has the highest population density in the EU and hence an untypical rural population density overall (Figure 17). Excluding Malta, there was a very strong negative relationship ($P<0.001$) between the proportion of the national population that hunted and the rural population density.

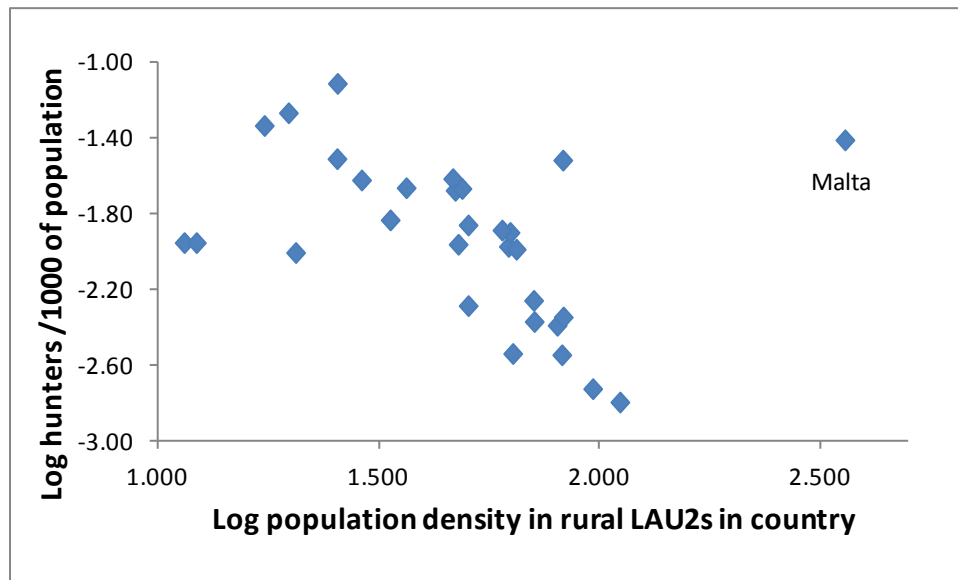


Figure 17. Except for Malta, the proportion of hunters in the national population (vertical axis) was high where the local rural population density was low (horizontal axis).

There was a similarly strong relationship with overall population density, excepting Malta; an increase in population density of a country explained 37% of the decline in the proportion of hunters in the population. However, hunter prevalence was also related to land-cover, increasing with a reduction in artificial surfaces ($R^2 = 0.24$, $P=0.005$) and with increase in semi-natural habitats ($R^2 = 0.50$, $P<0.001$), even when Malta was included. With Malta included, the combination of population density and availability of semi-natural habitats explained 58% of the proportion of hunters in the population of a country (Figure 18).

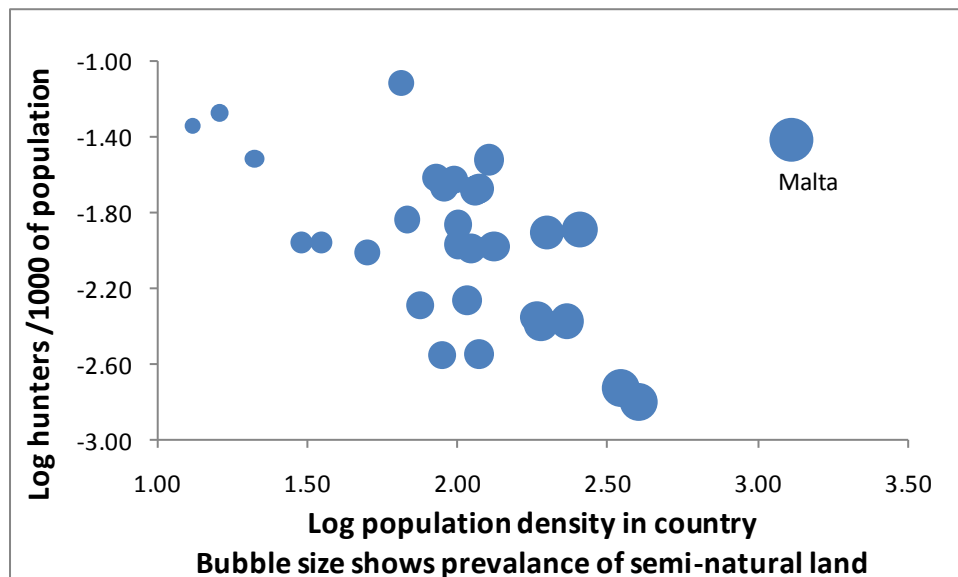


Figure 18. The proportion of hunters in the national population (vertical axis) was high in countries with low population density (horizontal axis), especially where there was relatively little semi-natural habitat (as shown by small bubble size).

Hunter prevalence in the population was also related to the population growth rate ($P=0.009$) of countries even with the inclusion of Malta (Figure 19). A combination of population density,

abundance of semi-natural habitat and population growth explained 67% of the increase in hunter prevalence, if Malta was excluded due to its exceptional population density.

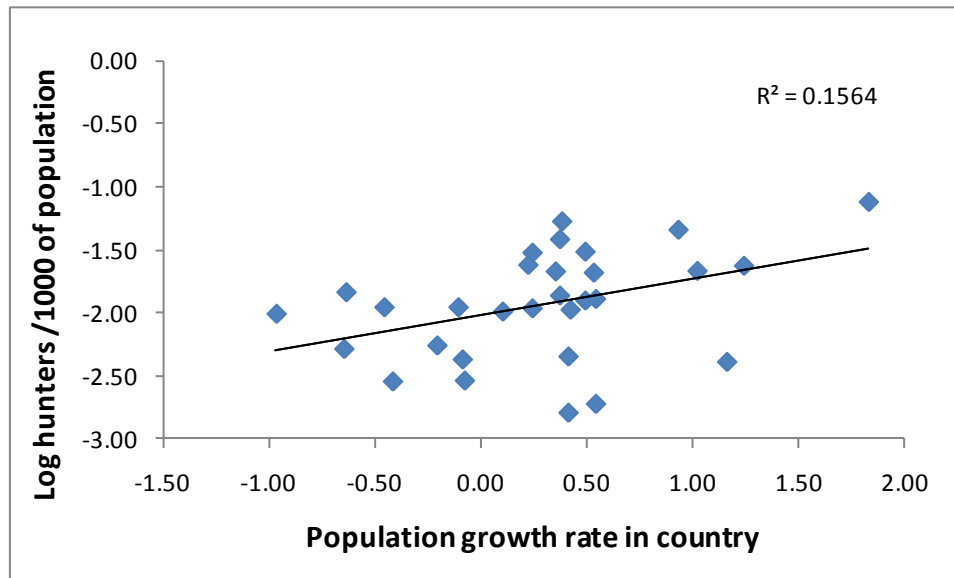


Figure 19. The proportion of hunters in the national population (vertical axis) tended to be higher in countries with a higher population growth rate (horizontal axis).

Anglers as a proportion of national populations

In terms of ecological or societal capacity variables, the proportion of anglers correlated strongly ($P=0.001$) only with the proportion of a country's surface that was water (Figure 20). Thus, more than 30% of variation in the prevalence of anglers was explained by an ecological variable likely to have been causal.

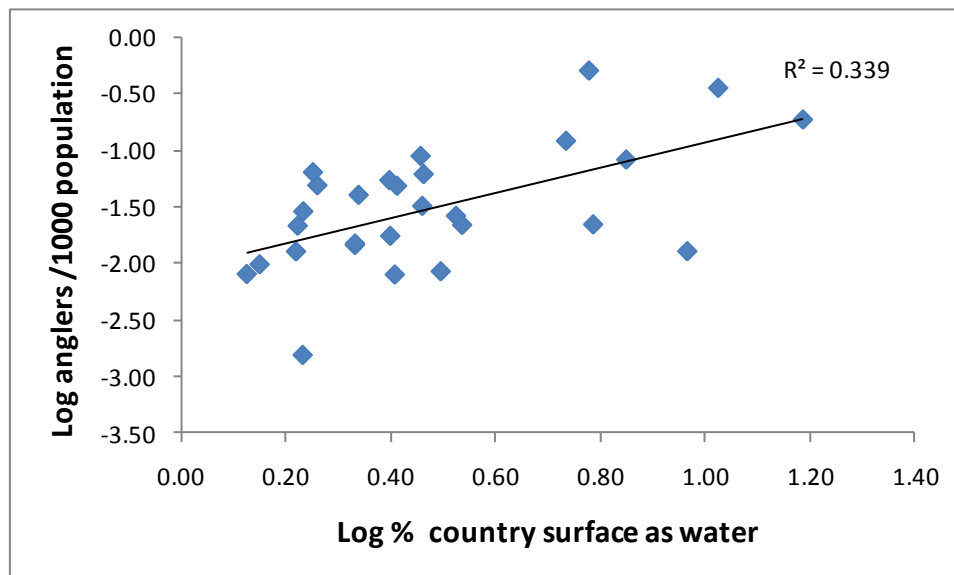
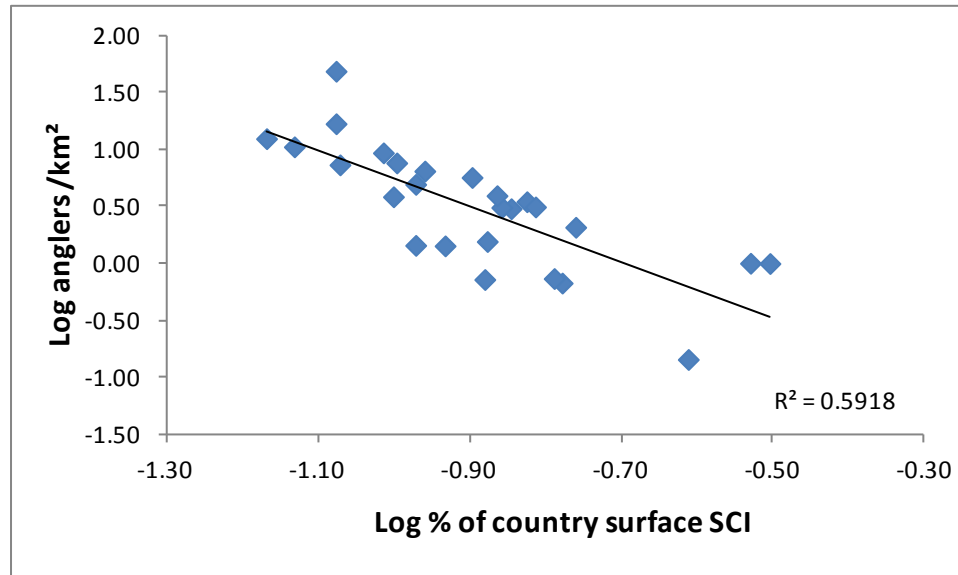


Figure 20. The proportion of anglers in the national population (vertical axis) tended to be highest where percentage cover by water surfaces was highest (horizontal axis).

However, if governance variables were also included, two further variables increased the explanatory power of the regression model. There were fewer anglers as the proportion of country area (Figure 21) protected for its special conservation interest increased.

This variable explained 58% of variation in angler density with 69% explained if the influence of NGOs on local environmental decision-making by LAU2 officials was included in the analysis.



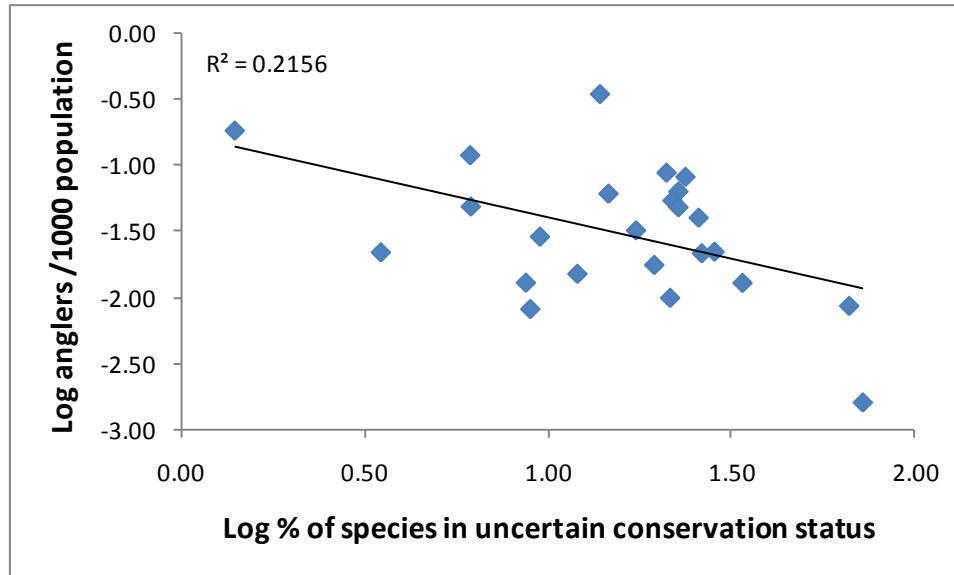


Figure 22. The proportion of anglers in the national population (vertical axis) tended to be lower in countries where the proportion of species with uncertain conservation status (as reported in Article 17 assessment) was higher (horizontal axis).

Numbers of EIA and SEA assessments

The strongest capacity predictor of the density of statutory environmental assessments was the density of national (and rural) populations. This relationship, which explained 25% of variation in the density of assessments ($P=0.004$) is improved by adding the World Bank index of Political Stability (Figure 23). Population density and political stability explained 42% of the variance in assessment density ($P<0.001$). However, the significance of this regression depends greatly on the relatively high density of environmental assessments in Malta; the model is marginally significant ($P=0.018$) with Malta excluded.

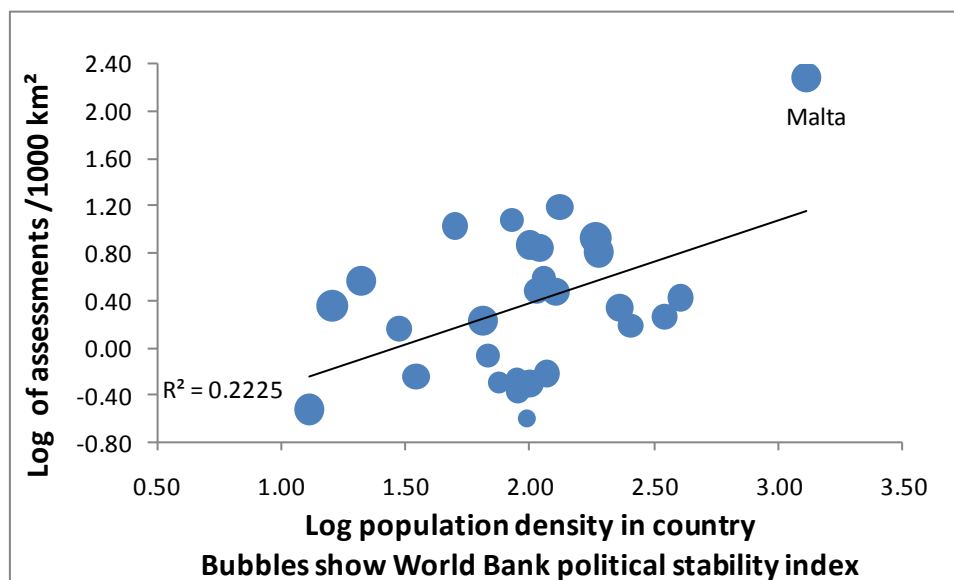


Figure 23. The density of SEA+EIA assessments (vertical axis) tended to increase with the national population density (horizontal axis), especially where the World Bank index of political stability was higher (as shown by larger bubbles).

However, it was attitudes at local level that proved the strongest predictor of numbers of SEA+EIA assessments. The index of positivity at local level displaced all others in predicting the statutory assessment density (Figure 24), both with Malta included ($R^2 = 0.47$, $P < 0.001$) and excluded ($R^2 = 0.34$, $P = 0.001$).

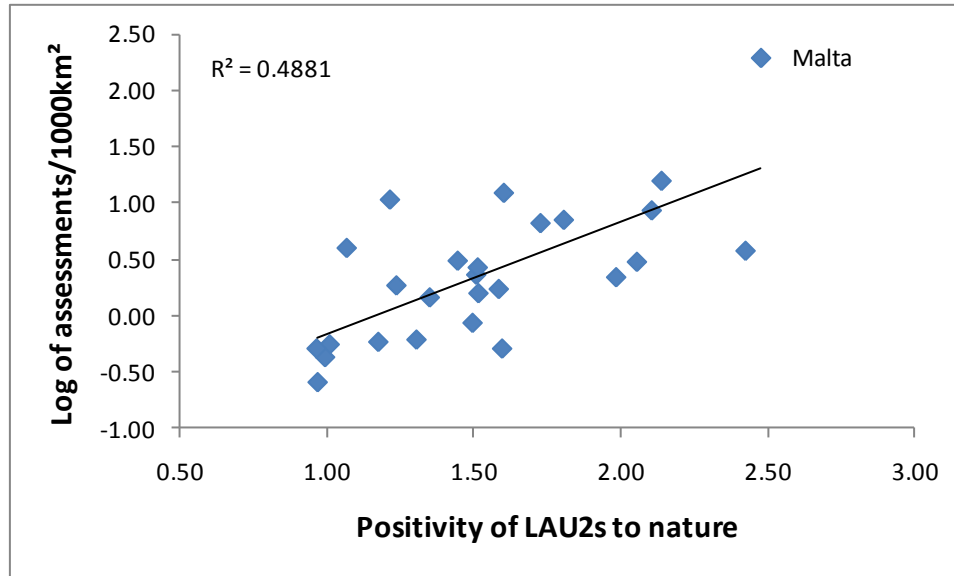


Figure 24. The density of SEA+EIA assessments (vertical axis) tended to be higher where local administrations considered that local people were more positive towards nature (horizontal axis).

Nevertheless, it was possible to explain equal proportions of the variation in number of statutory assessments from capacity variables without including an attitude variable, if a third capacity predictor was included in the regression model. This is justified by the presence of 26 cases with these variables and because correlation of assessment density with population density is essentially a correction for variation in assessment numbers with size of country. Including population density in the regression model, there was a positive correlation between assessment frequency and NGO consultation at local level that explained 38% of variance in assessment frequency ($P = 0.002$), further improved by including the area of local authorities ($R^2 = 0.47$, $P = 0.001$) in the model. Taking population density into account, there were most statutory assessments where the LAU2 population was relatively small and where there was most local level consultation with NGOs.

DISCUSSION

Capacity, Priority and Process variables all had significant correlations with socio-economic and ecological impact variables. In general, our results suggest that variation in biodiversity trends across Europe may result from a combination of institutional settings, regulatory and management frameworks, information availability and demand, and the physiographical, ecological and socio-economic characteristics of each country.

Disentangling the effects of the large number of variables was difficult, as they were often inter-correlated, and sample sizes for the analysis were relatively small (< 30 countries). Therefore, only one or two potential predictor variables could generally be analysed in regressions, and interactions terms were not considered, in order to avoid inflating the possibility of spurious correlations. Another potential problem was that in some analysis there were one or two countries that were outliers. Usually, these countries had extreme values in some dependent or independent

variable (e.g., disproportionately high population density on Malta), and so significant relationships could only be observed after removing the outlier(s) from the analysis. In these cases, analyses were made with and without outliers, and the reasoning for outlier removal was duly considered.

A final problem was that relationships derived from a study like this cannot be taken to imply direct causality between the independent and dependent variable, as for instance the effect may be mediated by an unmeasured variable that is correlated with both. Furthermore, there is also the possibility that the impact variable (dependent) is actually influencing the independent variable that was used to explain it, rather than the inverse. For instance, many guidance documents (Figure 5) or much consultation with the European Commission (Figure 11) occurred in countries where there was changing habitat and species declines. In such cases, guidance and consultation probably related to deterioration not because the texts and talk promoted negative trends, but because negative trends resulted in more guidelines and consultation.

Nevertheless, one clear finding was that significant relationships with socio-economic and ecological impacts were concentrated (77.5%) in the 31 of 50 variables (62%) that were capacity variables, compared with 22% of 38% that were priority and process variables. When impact variables for public awareness and economic variables were included as capacity variables 82.5% of significant relationships with other impact variables were from capacity variables (*versus* 66.1% of variables tested), whereas the opposite was found for priority (7.5% *versus* 14.3%) and process (10.0% *versus* 19.6%) variables. Considering only the capacity variables, 35% of significant relationships occurred among the 9 variables (16.1%) that were for societal capacity and 25.0% among the 7 variables (12.5%) that were for ecological capacity, compared with 17.5% among the 15 variables (26.8%) that were for governance capacity. Thus, impact variables related more strongly to capacity variables, especially for those measuring ecological and societal capacity, than to variables for governance capacity, priorities or processes.

As a whole, these results suggest that structural ecological and socio-economic characteristics of each country, for instance wealth, population density, urbanization level, and dominant land cover types, may be primary drivers for differences in the indicators of biodiversity change used in this study. Reasons for this are unclear, but it may be hypothesised that these strongly influential features have acted over long time frames, with a resulting lasting effect on biodiversity patterns and processes, and how society perceives and uses such biodiversity. In contrast, variables reflecting relatively volatile factors such as governance, and particularly the priority and process variables, may have much smaller effects at the country scale because they have acted over shorter time frames. Process variables in particular, mainly reflect regulatory frameworks enforced through management practices that have generally been in place for just a few years, and so they may not have had the time to change long-standing trends.

Such delays may explain why our analyses detected no positive associations for conservation with the presence of national regulation (for alternative proposals, mitigation and monitoring), or with practises associated with monitoring, or with numbers of ministries and organisations responsible for conservation at national level. It could also explain why a reduction in rates of artificialisation has yet to become apparent within Natura 2000 areas and why increases in semi-natural habitats do not seem to be associated with improvements in biodiversity. Nevertheless, our analyses did find evidence of weaker relationships (especially since 2000) with some factors, such as population growth, being associated with artificialisation. This could indicate that Natural 2000 designation and associated processes are gradually decoupling these designated areas from detrimental effects.

Moreover, it was clear that higher EIA+SEA assessment density was associated with reduced artificialisation. It is also interesting to note that a nature-positive attitude is the factor most

strongly associated with the number of these assessments, and that this in turn is associated with NGO consultation at a local level and having smaller population units at local level (this is important in view of a tendency to de-tier LAU2 within the EU). That raises the question of whether recording nature-positivity could be a useful indicator of conservation tendency in future. Indicators of attitude tend to self-reinforce once respondents know what is expected. However, this would in itself be evidence of awareness of the importance of conservation. Thus, carefully constructed questions at individual level might provide useful measure of gains in nature-positive attitudes.

Relationships between assessment numbers, positivity to nature and sufficiency of the Natura 2000 network were also related to World Bank indicators of governance quality. It is especially interesting that completeness of Natura 2000 was associated with Control of Corruption, which as well as being very strongly correlated with GDP in Europe, is also a variable that was linked to the control of factors associated to biodiversity loss (e.g. poaching) in developing countries (Smith *et al.* 2003).

The strong association between hunters and anglers and positive effects, such as prevalence of wetland, water and semi-natural habitats, and with good species conservation status may merely reflect a socio-economic response to environmental capacity. However, the links between these recreational users of resources and knowledge of species status, and with consulting at local level, may also reflect the positive relationships between hunting and angling and habitat conservation recorded within some countries (Dickson *et al.* 2009, Sharp & Maclean 2010). Whether as indicators or as drivers of conservation, it would seem wise for the Europe to include a regular census of these and others using wild resources as indicators of sustainable use, as has been done since the 1980s in North America (USDI, FWS & USDC 2007).

Summary

1. Population growth rate was the strongest associate of the rate of change of land-cover to artificial surfaces (e.g. buildings, roads). This ‘artificialisation’ was most strongly related to growth and to the relative rarity of EIAs and SEAs nationally in areas outside Natura 2000; semi-natural habitat increased most rapidly where environmental data were considered poor but where guidance texts were most available.
2. The rate of growth of artificial land-cover has increased since 2000 to a similar extent both within and beyond areas designated for Natura 2000; since 2000 the relationships between population growth, economics and conversion to artificial land-cover have tended to decouple within Natura 2000.
3. Numbers of EIAs and SEAs were highest where local administrations perceived nature most positively (and where fewest people understood the term biodiversity). This positivity was associated with population density, political stability, more consultation at the local level with NGOs and an administrative priority on the environment (rather than economics) when managing land and species.
4. The government assessment of the adequacy of the proportion of land designated within Natura2000 was highest in countries with the highest World Bank governance scores. However, habitat conservation status was not linked to socio-economic or environmental variables to an appreciable extent.
5. Species conservation status was best in countries with the most wetland, and generally where GDP was high and hunters and anglers more common in the populations.
6. Hunters were a higher proportion of populations of countries with low human population density and abundant semi-natural habitat; anglers were more common where there was more water and a lower area of Special Conservation Interest designated. The conservation status of

species was highest, as was the influence at local level of NGOs, in countries with more anglers.

7. Except for consultation, the processes used during EIA and SEA assessments and monitoring of their results did not positively affect the number of assessments, the environmental and social impacts we investigated or the numbers of those using natural resources.

CONCLUSIONS

1. Conversion to artificial land-cover is probably caused by population growth but this can be decoupled through conservation designation.
2. Frequent EIAs and SEAs were associated with low rates of artificialisation.
3. Frequent EIAs and SEAs, but not the processes within assessments, were associated with positive attitudes to nature and consultation of NGOs by administrations at local level.
4. Numbers of hunters and anglers were linked positively to species conservation status, to knowledge of conservation status and to influence during local consultation.
5. The Nature Positivity index estimated in this study was a better indicator of beneficial environmental attitudes than being aware of the word biodiversity or of biodiversity loss.

REFERENCES

Dickson, B., Hutton, J. & Adams, W.M. (2009). *Recreational hunting, conservation and rural livelihoods*. Oxford, UK: Wiley-Blackwell.

Kenward, R. Manos, B., Arampatzis, S. & Papathanasiou, J. 2009. A transactional environmental support system for Europe. In Hřebíček, J., Hradec, J., Pelikán, E., Mírovský, O., Pilmann, W., Holoubek, I., & Legat, R. (Eds.) *Towards eEnvironment (Challenges of SEIS and SISE: Integrating Environmental Knowledge in Europe)*(pp. 58-65). Brno, Czech Republic: Masaryk University.

Kenward, R.E., Whittingham, M.J., Arampatzis, S., Manos, B., Hahn, T., Terry, A., Simoncini, R., Alcorn, J., Bastian, O., Donlan, M., Elowe, K., Franzén, F., Karacsyonyi, Z., Larsson, M., Manou, D., Navodaru, I., Papadopoulou, O., Papathanasiou, J., von Raggamby, A., Sharp, R., Söderqvist, T., Soutukorva, Å., Vavrova, L., Aebischer, N. J., Leader-Williams, N., & Rutz, C. (2011). Identifying governance strategies that support biodiversity, ecosystem services and resource sustainability. *Proceedings of the National Academy of Sciences*, 108, 5308-5312.

Manos, B., & Papathanasiou, J. (2008). *GEMCONBIO: Governance and Ecosystem Management for Conservation of Biodiversity*. Thessaloniki, Greece: Aristotle University of Thessaloniki.

Oldfield, T.E.E., Smith, R.J., Harrop, S.R. & Leader-Williams, N. (2003). Field sports and conservation in the United Kingdom. *Nature*, 423, 531-533.

Sharp, R. (2010). The Great Game: the interaction of field sports and conservation in Britain from the 1950s to 2008. In Mclean, N. (Ed.) *Silent Summer: the state of Wildlife in Britain and Ireland* (pp.84-106). Cambridge, UK: University Press.

Sharp, R. & Maclean, N. (2010). Going fishing: recent trends in recreational angling. In Mclean, N. (Ed.) *Silent Summer: the state of Wildlife in Britain and Ireland* (pp.107-124). Cambridge, UK: University Press.

Smith, R., Muir, R., Walpole, M., Balmford, A. & Leader-Williams, N. (2003). Governance and the loss of biodiversity. *Nature*, 426, 67-70.

USDI, FWS & USDC (2007). *National survey of fishing, hunting and wildlife-associated recreation in 2006*. US Department of the Interior Fish and Wildlife Service, Fish and Wildlife Service and US Department of Commerce Census Bureau, Washington DC.

KEY TERMS

Keywords

Angling, Artificial Land-cover, Biodiversity, CORINE, Environmental Assessment, Habitats Directive, Hunting, Natura 2000, Nature Positivity, World Bank Governance Indicators