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USING SURVEILLANCE OF TERRESTRIAL BIODIVERSITY TO DETECT AND ASSESS CAUSES OF CHANGE

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JOINT NATURE CONSERVATION COMMITTEE

USING SURVEILLANCE OF TERRESTRIAL BIODIVERSITY TO DETECT AND ASSESS CAUSES OF CHANGE

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1. Background

1.1 The JNCC terrestrial[1] surveillance programme includes a number of projects that undertake direct surveillance of UK biodiversity; these are listed in Annex 1. The surveillance provides basic outputs, such as species status and trends, which are used for outcome reporting at UK and country scales (*e.g.* wild bird indicators). In addition, JNCC has also developed the UK Terrestrial Biodiversity Surveillance Strategy, which has the purpose of making surveillance information from many sources available and relevant for policy as efficiently as possible. The Strategy sets out ways in which surveillance should aim to be multi-purpose, and should provide information for a range of different needs[2]. One of the important uses of surveillance data is to help determine the causes of biodiversity loss in order to inform the necessary actions to halt or reverse those trends.

1.2 A review was carried out of the information provided by surveillance on the impacts of pressures on biodiversity in the UK. The review included an assessment of the current limitations to using these data to provide evidence of the pressures (See Figure 1). This paper notes the findings of the review and sets out options to improve the ability for biodiversity surveillance to detect pressures and hence to support advice on how to address the causes of biodiversity loss.

[1] In this paper, terrestrial also includes freshwater habitats.
[2] See http://www.jncc.gov.uk/pdf/comm08D02.pdf for the previous Committee paper on the Strategy.

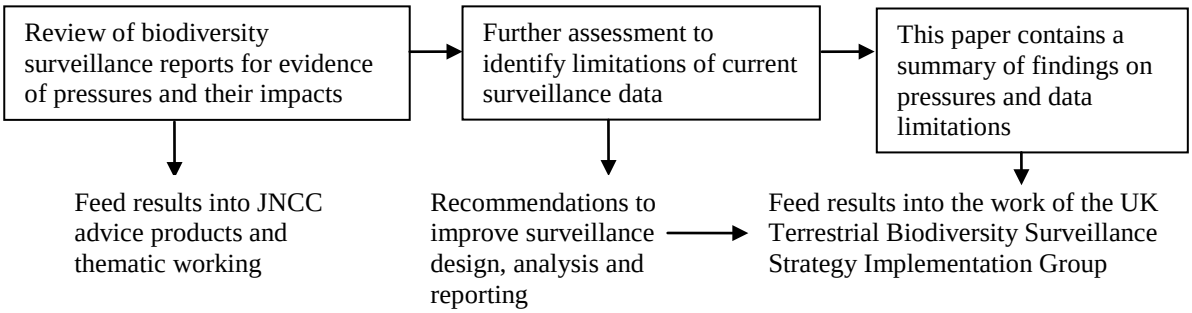

Figure 1. Structure of the review and assessment of biodiversity surveillance data, and how these relate to recommendations

1.3 Major sources of biodiversity surveillance data, not just those funded by JNCC, were included in the review. Additional supporting information on the pressures themselves was also used. Comparisons were made between different sources of biodiversity information, for instance between Common Standards Monitoring reports and species surveillance, as well as comparisons with measurements of the pressures as opposed to the impacts.

1.4 The review considered the current combination of evidence sources that can be used to assess the impacts of pressures, and the balance between the use of pressure information and impact information. It also considered the limitations that exist in the current surveillance and how these limitations might be addressed.

1.5 The review provides an overview of the information gained about the impact of pressures using evidence from biodiversity surveillance. This review can be used as an input to JNCC reporting and advice products, and in the evidence base for thematic working. The further assessment of the scope and limitations of surveillance data can be used to improve both the design of surveillance schemes and the reporting of surveillance data analyses. These improvements can be adopted by both JNCC and other partners within the UK Terrestrial Biodiversity Surveillance Strategy. The analysis also provides a rationale for using direct measures of pressures as a complement to measurements of biodiversity.

1.6 The review used a modified version of the pressures framework included in the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005), as shown in Figure 2. The focus of the review was the relationship between pressures and impacts on biodiversity. Drivers were sometimes included when considering the likely trend in a pressure (*e.g.* increased production of biomass and biofuel may require further agricultural intensification and an increase in land in agricultural production).

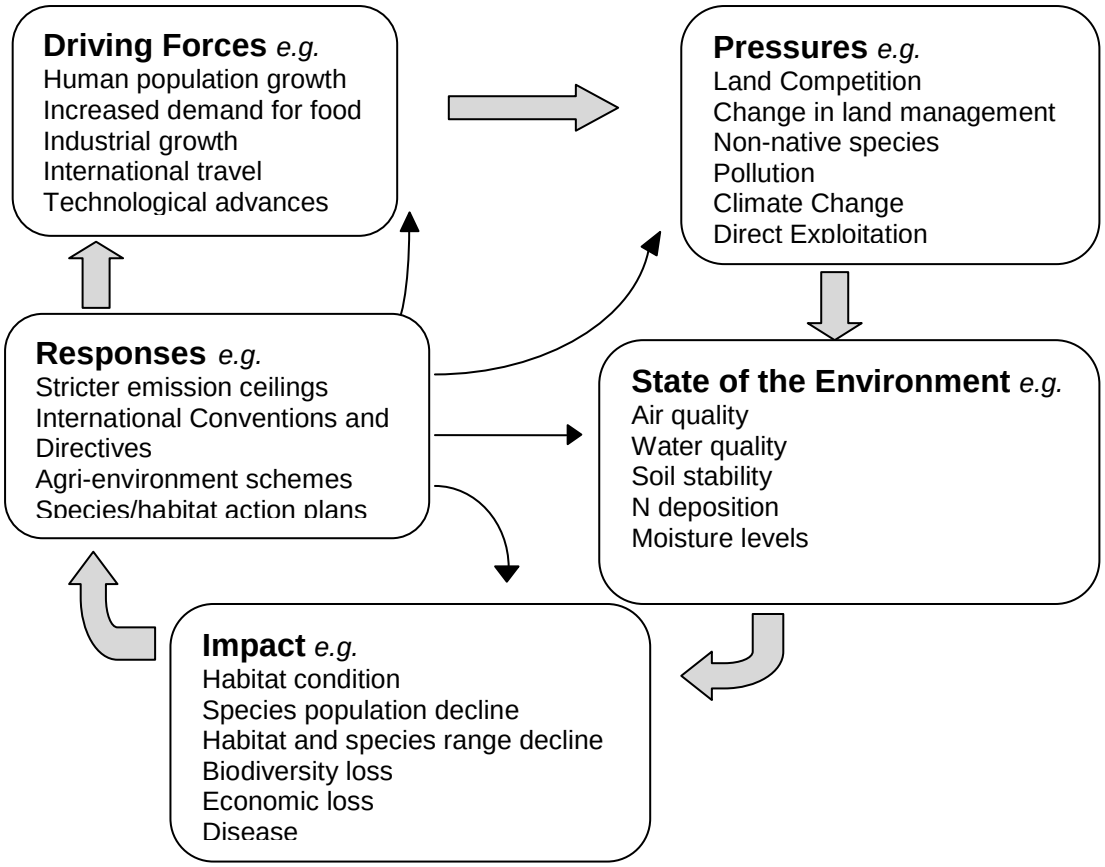

Figure 2. The DPSIR Framework. Adapted from Global International Waters Assessment (GIWA), 2001; European Environment Agency (EEA); Copenhagen

2. Data sources and limitations

2.1 A wide range of species and habitat surveillance data from the last 30 – 50 years are available for the UK. Many of these data have not yet been analysed in a pressures framework. Finding references to the impacts of pressures frequently requires recourse to secondary analyses that are derived from the original data sources. It is often unclear how the analysis of pressures has been undertaken. Annex 2 contains an indicative list of data sources.

2.2 Three main methods were found to have been used to relate surveillance data to pressures:

i. trend detection for a particular species or habitat, that triggered research to determine the causes of the trend, which were then attributed to pressures;

ii. expert interpretation of particular trends;

iii. co-analysis of multiple species datasets against pressure data, sometimes using common attributes to group species, or a spatial analysis.

2.3 These methods vary in their ease of access and suitability for combining within an overarching review. Research on particular species or habitats generates reports that are scattered through the literature and time-consuming to access. The results are also hard to combine with information from other species or habitats in order to provide a more complete measure of pressure impact. Expert interpretations are also hard to collate and frequently lack clarity regarding the level of expert judgement used. Co-analysis methods can be very powerful but are often part of secondary analyses not linked with the main results for a surveillance scheme, making the results more difficult to access.

2.4 Analyses using these methods typically include information over relatively long time periods in order to detect a trend from background variation. Many studies discuss long time periods, or are even cumulative in their conclusions, such that the major losses during agricultural intensification in the 1950s-1970s still tend to be discussed. This is a difficulty when assessing whether current pressures are having an impact or whether policy approaches are helping prevent impacts.

3. Summary of the findings of the review

3.1 Evidence for biodiversity impacts relating to each pressure within the framework was reviewed, as well as the likely trends in the pressure. Limitations in using surveillance for each pressure type were also assessed. The results are summarised within Annex 3, with a simplified overview in Table 1. A more detailed review of information will be published on the JNCC website as a part of the redevelopment of the website.

3.2 The assessment found that current biodiversity surveillance is best able to detect impacts from widespread pressures, not those with a patchy or localised distribution. Impacts from non-native species, urban development (or other development in rural areas) or loss of small relic habitat patches are very difficult to detect without targeted studies. Habitat quality assessments, such as Common Standards Monitoring, can complement other surveillance by measuring some site-specific effects, but they are biased towards protected areas.

3.3 More analysis is now being undertaken using co-variables in order to understand pressure impacts. Greater use is being made of modelling and biological recording data. Considerable research development work is required to produce broad-scale trends interpreted by pressure impact regularly; this work is beginning, but still requires some years of development. Systematic surveillance will still tend to miss localised pressures, and more targeted approaches may be required to measure these impacts. More work is needed to improve the time resolution of surveillance, such that recent impacts can be assessed

rather than cumulative impacts over long time periods. Surveillance reporting needs to be more thematic by pressure, such that principal causes of change can be easily identified from the reports; the UK Seabirds in 2008 (JNCC, 2009) may provide a model for how such thematic reporting might be organised.

3.4 Direct measures of the pressures are important as co-variables for analysis and to understand trends in the pressure. However, it remains necessary to measure the impacts on biodiversity, since safe thresholds for pressures are generally unknown, and impacts are complex showing interactions, cumulative effects and lags.

3.5 Surveillance data can also be used directly in making predictions of likely consequences for policy. New analysis of existing datasets that model the likely impacts of change in policy may represent one of the most effective means to make the best use of the biodiversity data that are held. A clear understanding of priorities for investigation will be required so that resources can be used most productively.

TABLE 1

BRIEF INDICATIONS OF THE FINDINGS OF BOTH THE REVIEW AND THE ASSESSMENT OF SURVEILLANCE

Pressure	Current impact	Trend in impact	Spatial s cale of pressure	Type of surveillance	Limitations
Land competition	Indeterminate	Overall, land competition has had a major impact on UK biodiversity; the trend recently has been for the pressure to decrease. The contribution of habitat re-creation is unquantified.	Impacts tend to be localised at points of development	Biological recording data provide a longer term view of impact. Long-term surveillance networks[3] provide some indications of the current impact.	Localised impacts are poorly sampled by systematic surveillance. Urban areas are often excluded from sample designs. Small habitat patches are difficult to sample. No mechanism to pick up habitat re-creation.
Land management	High	Variable. Change in management options requires careful evaluation. Can have positive and negative effects on trend.	Ubiquitous	Most surveillance sources can report against land management pressures. Data rich sources, such as bird or butterfly surveillance, can be used to assess impacts of changing management.	Difficult to discriminate between management and the effects of other pressures.
Non-native species	Indeterminate	Increasing	Patchy but widespread	Biological recording data can be used to measure the pressure. Impacts are best derived from site-specific habitat quality measures.	Habitat quality surveys are limited in coverage with a focus on protected areas.

[3] Long-term surveillance networks - for example, Countryside Survey, BSBI Local Change plots, UK Butterfly Monitoring Scheme transect network, Breeding Bird Survey squares.

Pressure	Current impact	Trend in impact	Spatial s cale of pressure	Type of surveillance	Limitations
Pollution	Medium	Slowly decreasing. The overall impact has been high, but the current impact is lower since much of the change has already occurred.	Widespread	Long-term surveillance networks	Relationship with land management is particularly complex to understand.
Climate change	Low	Increasing	Ubiquitous	Biological recording data and long-term surveillance networks	Annual data are required for many analyses, but these are limited for many taxonomic groups. Notably, it is difficult to include plants in analyses.
Direct exploitation	Low	Unknown	Localised	Expert knowledge only.	Not detected by surveillance.

4. Recommendations for improvement of biodiversity surveillance and its applications

4.1 It is recommended that, within existing resources, the JNCC Support Company should:

i. improve the value of JNCC-funded surveillance schemes in providing evidence relating to pressures and their impacts, whilst continuing to deliver outputs on status and trends. This will require adjustments to schemes so that they are better able to detect and discriminate the impacts of different pressures. Key areas to be addressed:

Accessibility of the evidence

a. make available a periodic synthesis of recent research findings on pressures and impacts, alongside status and trend information, in scheme reports via the website;

Frequency of surveillance and interpretation of recent trends

b. consider how to improve the ability of surveillance to detect and explain pressure impacts over recent time periods by undertaking more frequent sampling (eg. using indicative plants species);

c. develop cost-effective analytical techniques for routine broad-scale analysis of recent trend data to provide outputs more relevant to policy;

Fill gaps in detection ability

d. consider how adjustments to methods could improve representation of small habitat patches and urban areas in sampling protocols;

Improve capacity to provide analysis of policy options

e. undertake phased investment in the development of statistical methods and modelling techniques to evaluate the likely biodiversity responses to policy options;

Improve collaborative work

f. seek to mobilise additional resources and expertise in analysis of pressures through better collaboration with

country agencies, other research funders, research groups and academic bodies;

ii. share the knowledge gained from this review in order to:

a. improve the design of surveillance undertaken by others including the country agencies and other partners in the implementation of the Terrestrial Biodiversity Surveillance Strategy and UK Environmental Observation Framework. For example providing advice to agencies to help ensure habitat sampling, on protected sites and in the wider countryside, allow detection of impacts of non native species;

b. develop advice on policy, in particular, concerning the strength of evidence of different pressures, the interpretation of indicators, the application of models to test policy options, and investment in related research and monitoring;

iii. publish the technical findings of the review so that they can be used more widely as evidence to support European, UK and country level assessments and reporting. Provide the findings to the UK National Ecosystem Assessment.

ANNEX 1

SCHEMES THAT JNCC HELPS TO FUND

Birds:

Breeding Bird Survey (BTO, JNCC, RSPB)
3604 x 1km squares in UK surveyed 3 times in 2007, covering 101 species. Scheme started in 1994.

Rare B reeding Birds P anel col lation of b reeding bird rep orts (RBBP, JNCC, RSPB, BTO) Around 8000 sites in UK reported on annually, covering 130 species. Scheme stated in 1972.

Nest Record Scheme (BTO, JNCC)
34,202 records in GB submitted in 2005, covering 90 species. Scheme started in 1939.

National Ringing Scheme (BTO, JNCC)
Around 880,000 birds ringed each year of 270 species, including birds from 120 Constant Effort Survey (CES) sites and 100 Retrapping Adults for Survival (RAS) studies. National scheme started in 1909, whilst CES started in 1983, and RAS in 1998.

Wetland Bird Survey (BTO, JNCC, RSPB, WWT)
Around 2,000 wetlands in GB monitored up to once a month for waders and other waterbirds. Over 100 species recorded. Scheme started in 1947.

Goose and Swan Monitoring Programme (WWT, JNCC)
13 goose and swan populations monitored in the UK. Scheme started in 1955.

Seabird Monitoring Programme (JNCC, CEH, NTS, RSPB, SG, SOTEAG)
All 26 species of regularly breeding seabirds monitored at a sample of colonies in the UK, since 1984.

Invertebrates:

The UK Butterfly Monitoring Scheme (BC, CEH, JNCC, CCW, DEFRA, NE, N IEA, F C, S Gov, S NH) Includes transect walks and timed counts. Butterflies counted on 850 transects, 16 times a year. 63 species have data collected regularly, and some trends go back to 1976.

Mammals:

National Bat Monitoring Programme (BCT, JNCC, NE)
Approximately 2500 sites monitored. Long terms trends available for 11 of the UK's 17 bat species. Scheme started in 1996.

National Gamebag Census (GWCT, JNCC)
600 estates across GB return information on game and predator bags. 16 species of mammal recorded. JNCC funds analysis of the data. Scheme started in 1961.

Breeding Bird Survey/Waterways Breeding Bird Survey – Mammal Data (BTO, JNCC) Mammal data collected at 2400 Breeding Birds Survey sites since 1995, and 300 Wetland Breeding Bird Survey Sites since 1998.

JNCC also funds the Biological Records Centre. Whilst this does not carry out or commission surveillance directly, it provides support and access to data from a wide range of recording schemes, for example the British Bryological Society Recording Schemes, and numerous invertebrate recording schemes.

(**BC** – Butterfly Conservation, **BCT** – Bat Conservation Trust, **BTO** - British Trust for Ornithology, **CCW** – Countryside Council for Wales, **CEH** – Centre for Ecology and Hydrology, **DEFRA** – Department for the Environment, Food and Rural Affairs, **FC** – Forestry Commission, **GWCT** – Game and Wildlife Conservation Trust, **JNCC** – Joint Nature Conservation Committee, **NE** – Natural England, **NIEA** – Northern Ireland Environment Agency, **NTS** – National Trust for Scotland, **RBBP** - Rare Birds Breeding Panel, **RSPB** – Royal Society for the Protection of Birds, **SG** – Seabird Group, **SGov** – Scottish Government, **SNH** – Scottish Natural Heritage, **SOTEAG** – Shetland Oil Terminal Environmental Advisory Group, **WWT** – Wildfowl and Wetlands Trust)

ANNEX 2

INDICATIVE DATA SOURCES FOR PRESSURES AND IMPACTS

Pressure	Pressure data source	Impact data source
Land competition	Land Cover Map, Land use and agricultural statistics	Countryside Survey, Butterfly Atlases, Plant Atlases, Plant 'Local Change', State of UK Birds, Article 17 reporting
Changes in land management	Various: land use policy options can be analysed in a focussed manner	Countryside Survey, Common Standards Monitoring, Article 17 reporting, Butterfly Monitoring Scheme, Breeding Bird Survey, Butterfly Atlases
Non-native species	Analysis of pressure included in UK Biodiversity Indicators In Your Pocket, based on a range of datasets	Tracking Mammals Partnership, biological recording data, Seabirds, Common Standards Monitoring, Article 17 reporting
Pollution	Pollutant monitoring: environment agencies and CEH, agricultural statistics	Countryside Survey, Plant 'Local Change'
Climate change	UKCP09	Biological recording data, BICCO-Net
Direct exploitation	Trade data, Wildlife Crime Unit	Article 17 reporting, specific studies

ANNEX 3

ANALYSIS OF PRESSURES, EVIDENCE OF BIODIVERSITY IMPACTS AND LIMITATIONS

Pressure	Trend in pressure	Evidence of biodiversity impacts	Limitations of surveillance data
Land Competition	• Major losses of semi-natural habitat have clearly occurred in the UK in the past 50 years. • Pressure from building development is likely to remain high, due to rising population and housing demand in many areas of the country. • Most developments occur on either agricultural land or brownfield sites (see Defra, 2009a for land use statistics). • Countryside Survey measured an overall decline in the area of enclosed farmland (arable, horticulture and improved grassland). • The pressure for land to be converted to intensive agricultural use is currently low, but may rise in the future due to rising food prices, increased policy emphasis on improving food security, and requirement of land for biomass and biofuel production. • Small land parcels of semi-natural habitat may continue to be lost to	• Major losses of semi-natural habitat are responsible for a large proportion of the range losses that have been recorded in biological recording data (see for instance Preston *et al.*, 2002 or Asher *et al.*, 2001). • Conversion of brownfield sites may have negative impacts, particularly for invertebrate species, e.g. Fox *et al.* (2006) report colony extinctions of the dingy skipper due to brownfield sites development. • Some studies have demonstrated possible benefits of housing with green space such as increased numbers of 'wider countryside' butterflies (Fox *et al.*, 2006) or improved spotted flycatcher productivity (in gardens compared to woodlands, Eaton *et al.*,2009). • Loss of small fragments of habitat may be responsible for plant losses from tetrads in the last 20 years (Braithwaite *et al.* (2006)) • 38 of 73 species of European Community Interest reported a significant threat from land	• Development is localised and patchy and hence poorly sampled by systematic surveillance schemes such as Countryside Survey • Urban areas are frequently excluded from sampling • Small habitat parcels are often missed from habitat inventories • Loss of species from small parcels of land is very likely to be missed without targeted surveillance or monitoring

Pressure	Trend in pressure	Evidence of biodiversity impacts	Limitations of surveillance data
	both development and agriculture.	competition (Article 17 reporting).	

Changes in land management	• Changes in land management are variable and heavily influenced by economic drivers, *e.g.* CAP. • Woodland has been undergoing a period of low management intervention due in part to the low value of timber; however wood fuel is emerging with strong potential as biomass energy • Overgrazing in the uplands is now reducing, but under grazing in the lowlands remains	• Countryside Survey general results "show a shift along an ecological gradient of succession … perhaps a consequence of … reduced intensity of management" (Carey *et al.*, 2008). • The impacts of changing woodland management are reflected in Kirby *et al.* (2005) for plants, BTO surveillance of woodland birds (Defra, 2009b), and the Butterfly Monitoring Scheme. These are consistent with the Countryside Survey results • Fox *et al.* (2006) report that Duke of Burgundy has declined due to lack of necessary mosaic habitat management. • Effects of over/undergrazing are well reported within Common Standards Monitoring results (Williams, 2006) and Article 17 reporting, and are likely to be even more prevalent outside protected areas, for example see Hewins *et al.* (2005).	• Changes in land management can radically modify the impacts of other pressures and hence can be hard to disentangle • Custom analyses are often necessary to assess particular management changes

Non-native species	• The numbers of non-native species that are widely established in the environment in the UK continues to increase (see for instance, Defra 2009b). • Increasing international trade means that pressure from new introductions is likely to remain high and increasing. • Targeted surveillance has shown that established non-native mammal species (rat, grey squirrel, sika deer, muntjac) are continuing to increase in abundance (Tracking Mammals Partnership).	• Some non-native species directly compete with a similar native species, causing their decline, *e.g.* non-native crayfish or squirrels • Impacts of non-native species on seabird abundance is reported in UK Seabirds in 2008 (JNCC, 2009) • Non-native diseases can cause major biodiversity impacts, *e.g.* historically Dutch Elm disease had major impacts. *Phytophthora* has the potential to cause a massive impact, particularly on ericaceous shrubs and tree species. *Sturmia bella* may be impacting small tortoiseshell butterflies (Fox *et al.*, 2006). • 10/73 species of European Community interest are reported as threatened by non-native species • Habitat quality surveillance is included within Common Standards Monitoring, and this shows that approximately 10% of 'adverse activities' are associated with the presence of non-native species (Williams, 2006).	• Pressure information is itself derived from biodiversity surveillance and monitoring • Impacts are patchy and localised and hence difficult to detect from systematic surveillance • Habitat quality surveys can indicate impact, but are currently limited in coverage with a focus on protected areas

Pollution	• Data from the Country Environment Agencies suggest that water quality is generally improving. • Sulphur emissions have reduced by 89% since 1970, and soil acidity is now reducing • Nitrogen compound emissions remain relatively high, although industrial emissions have been reduced. Road transport remains a substantial emitter of NO_x, whilst ammonia emissions from agriculture remain high. Nitrogen compounds now replace sulphur compounds in dominating acid deposition . • Peak ozone levels have reduced, but background ozone levels have risen (Royal Society, 2008).	• Sulphur emissions have caused major losses of epiphytic bryophytes and lichens in the past in polluted areas. Some species have been returning in recent years. However 58% of broad habitats are still considered to exceed the critical load for acid deposition, and hence remain at risk of further damage. • Critical loads for nutrient nitrogen deposition are exceeded in over 60% of sensitive habitats. • Impacts of N deposition on species composition have been measured in a number of experimental studies. Countryside Survey has also measured changes in species composition. • Many impacts have already occurred, and hence the current rate of impact can appear to be slowing	• Pollution is under-reported in expert judgement collations, as the relationship with management is complex • Co-analysis of both pressure and biodiversity data is possible and can provide more information regarding the impact

Climate Change	• In the last thirty years, the Central England Temperature has risen by about 1°C (Jenkins *et al.*, 2008). • Slightly smaller increases have been measured in Scotland and Northern Ireland. • Precipitation has changed in its seasonality.	• Range changes for a wide set of species are being observed and attributed to climate change (see for example Hickling *et al.*, 2006). Impacts of range change are hard to interpret, vary between species, and often have knock on effects on other species. • Changes in species abundance (+ve and –ve) have been related to climate change in preliminary results from the BICCO-Net project. • Phenological changes are being observed, *e.g.* extra broods being raised and changing flowering times (Thackeray *et al.*, 2010). This can be desirable (showing adaptive capacity) or can cause problematic impacts.	• Annual data are necessary for climate analyses, but these are limited in their taxonomic scope
Direct Exploitation	• Reviews of wildlife crime continue to show that illegal exploitation occurs. • Legal exploitation of biodiversity is very patchily studied. • Trend unknown.	• 21 of the 73 species of European Community interest are reported as being threatened by collection and exploitation.	• Systematic surveillance data do not show an impact of direct exploitation • Expert judgement of threats to rare species as well as crime data suggest that exploitation may have biodiversity impacts