The UK Terrestrial Biodiversity Surveillance Strategy

Initial analysis of data needs for understanding air pollution and climate change impacts and the potential role of the Environmental Change Biodiversity Network

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Identification of the knowledge gap

1.1 A range of UK and country reports have identified that there is a need for greater evidence in understanding both air pollution and climate change impacts on biodiversity. As a response to these perceived needs, a review of monitoring of the impacts of air pollution was commissioned by Defra, JNCC, Environment Agency, EHS, and English Nature. This was followed by a scoping study on improving monitoring of air pollution and climate change impacts, which was commissioned by Defra, CCW and English Nature.

1.2 JNCC has been engaged with these developments throughout. In addition to being one of the commissioning organisations of the monitoring review, the Committee has discussed the knowledge gap on at least three occasions.

1.3 In 2005, the Committee discussed the priorities for JNCC and the Country Agencies in air pollution policy[1]. The paper considered two areas in which the evidence base was insufficient to support policy needs:

- Underpinning evidence of ecosystem changes attributable to air pollution that could complement the critical loads approach and support advocacy for emission reductions;
- Ensuring that the condition of protected areas is correctly reported as unfavourable when air pollution is causing a biodiversity impact on the site, given that the current Common Standards Monitoring methods are not able to provide a consistent and robust assessment of these impacts.

The recommended solution was for an "integrated network including a suite of SSSIs (most practically these might be National Nature Reserves) on which climate and/or air pollution parameters and responses are monitored"; in line with the recommendations of the review of monitoring.

1.4 The Committee concluded[2] that:

i. it would be very difficult to take account of the effect of air pollution on designated sites through Common Standards Monitoring;

ii. there would be advantages in monitoring air pollution impacts on a wider range of sites than the existing Environmental Change Network;

iii. additional monitoring and research should be targeted at answering specific questions;

iv. impacts on soils should be taken into account, *e.g.* soil bacteria may be very sensitive to pollution.

1.5 In 2006, the Committee discussed a draft strategy for surveillance, reporting and research[3], which included within it recommendations from BRAG regarding research priorities. Although these were included within the research section of the paper, they included priorities for additional surveillance. One recommendation was for

[1] UK and international air pollution policy: priorities for JNCC and the country agencies; http://www.jncc.gov.uk/pdf/comm05D05.pdf. See in particular Section 4: Monitoring the environmental impacts of air pollution.

[2] Confirmed minutes of the meeting of the JNCC, held on Wednesday 15 June 2005; http://www.jncc.gov.uk/page-3533

[3] Draft strategy for surveillance, reporting and research; http://www.jncc.gov.uk/pdf/comm06D02.pdf. See paragraph 5.15.

"extending the Environmental Change Network to enable monitoring of the impact of air pollution and climate change on the biodiversity of protected areas".

1.6 The full recommendations from BRAG were published as a joint UK BRAG – Defra report in 2007[4]. This includes a longer exposition of the recommendation than was included in the 2006 Committee paper. Specifically, it states:
"There is a need to detect the impacts of climate change on biodiversity and allow them to be distinguished from the effects of air pollution and land management change. This work will provide long term surveillance and data analysis of atmospheric pollution, climate change and aspects of biodiversity on a series of sites across the UK, linked with existing Environmental Change Network (ECN) sites and modelling programmes."

1.7 In 2007, the Committee discussed the advice to government following the conclusion of the first cycle of Common Standards Monitoring reporting[5]. It was noted that the effects of air pollution are under-recorded by monitoring at the site level, and that assessment approaches and surveillance need to be improved to provide a better evidence base of air pollution effects. The Committee recommendation was that: "A targeted monitoring scheme should be established to assess the impact of air pollution on different kinds of features at a sub-sample of sites and to provide a better evidence base to inform policy responses". This advice was sent to the UK Minister.

1.8 In conclusion, JNCC has endorsed a number of explicit needs for surveillance data in the fields of air pollution and climate change, and has identified an extension to the Environmental Change Network as a potential mechanism for delivery of these data needs. Specific needs include evidence to support advocacy for emissions reductions and ability to report biodiversity impacts from air pollution on protected areas, as well as the more general need for evidence to understand and attribute the impacts of environmental pressures on biodiversity.

Development of the Environmental Change Biodiversity Network concept

2.1 In response to the identified knowledge gap, a number of contracts were let with the intention of developing appropriate mechanisms to provide the necessary surveillance data. These have led eventually to the production of 'The Environmental Change Biodiversity Network Business Case', which has just been published. In response to this Business Case, organisations will need to evaluate whether the proposed network will fulfil their needs, and whether they are prepared to make the necessary investments. JNCC also needs to evaluate its position on the further development of the Environmental Change Biodiversity Network (ECBN).

2.2 JNCC was one of the contracting partners in the production of a scoping study on monitoring the impacts of air pollution published in 2005[6]. This considered the general need to understand impacts, but particularly focussed on impacts on protected

[4] Research needs for UK biodiversity; http://www.jncc.gov.uk/pdf/BRAG_REPORT_2003-2006.pdf In particular page 31, but pages 6 and 20 are also relevant.
[5] This was an 'in confidence' committee paper. The recommendation was included in paragraph 2.10.4.
[6] Monitoring the impacts of air pollution (acidification, eutrophication and ground-level ozone) on terrestrial habitats in the UK: a scoping study; http://www.jncc.gov.uk/pdf/airpollution_impactsscopingstudyreportfinal.pdf

areas, and the need for stronger evidence of causation. This study considered a number of options, but did not make a strong recommendation to build an extension to the ECN.

2.3 A follow-up study on 'targeted monitoring' developed the option of providing the surveillance data through an extension of the ECN, which would include a minimum of 40 new monitoring sites to be placed mainly on National Nature Reserves[7]. This study continued to place a focus on the need for strong evidence of causation and a need to concentrate the new network on sites with high biodiversity value.

2.4 The final business case retains the plan to monitor a range of parameters on 40 new monitoring sites, mostly on National Nature Reserves. These would be an extension of the ECN, but would not have the full range of ECN parameters monitored. The focus would be on monitoring biodiversity, nitrogen deposition and climatic parameters. A wide range of potential data uses are considered within the business case, but the focus on causality and protected areas remains.

Analysis of selected policy requirements for surveillance data

3.1 Oxidised nitrogen. Current policy is leading to a gradual reduction in pollution from oxidised nitrogen species, and this reduction is predicted to continue. An important driver for reducing pollution has been human health impacts, and this will continue to be important in maintaining the policy direction. There is however some potential for policy to come under pressure for change, possibly leading to renewed increases in oxidised nitrogen pollution; this could particularly be the case if fuel security becomes an important policy issue. Additionally, some climate change mitigation measures such as increasing aircraft fuel efficiency and increasing the use of diesel for road transport, could lead to increases in oxidised nitrogen emissions. Therefore, it is important for biodiversity impacts to be quantifiable, in order to provide support for the current policy direction. The current situation does not demand significant levels of biodiversity surveillance information to maintain policy direction, however, if the policy were to come under pressure, strong evidence regarding attribution of the biodiversity impacts to air pollution would be necessary.

3.2 Reduced nitrogen. Biodiversity damage from ammonia and ammonium is a local, regional and long-range issue. Hence policy focuses on site, regional and transboundary responses. For local impacts, regulation of current polluters and planning decisions on proposed polluters requires evidence of biodiversity damage to high nature value sites or areas. Regulation of polluters will also have potentially high economic costs, and hence a reasonable degree of confidence in the attribution of the damage will be necessary. Site-based assessments of damage or potential for damage will be needed. For non-local impacts on a wider landscape scale, current policy is leading to a gradual reduction in emissions and this is predicted to continue. However, to reduce risk to sensitive ecosystems significantly, current risk assessment models (critical load exceedance) show a much greater decline in emissions is necessary. Since this is technically challenging and potentially costly, there is an

[7] Targeted monitoring of air pollution and climate change impacts on biodiversity; http://www.jncc.gov.uk/pdf/apol_FINALREPORT_Targeted_Mon_Air_Poll_CC_Impacts_ZM_1Jun06.pdf

increasing requirement for evidence of impacts biodiversity and attribution. Note that it is difficult to differentiate reduced nitrogen impacts from oxidised nitrogen, in the field and they are usually dealt with collectively. Currently, a number of indicators that can be used on site are under development[8].

3.3 Ozone. Ozone pollution is predicted to increase, and has complex linkages with climate change. Both peaks in pollutant levels and the average levels are likely to be of importance. Ozone is known to cause injury to plants, but long-term impacts or potential for changes in community composition are unclear or unknown. The priority knowledge gap is in understanding whether ozone can cause ecologically significant biodiversity impacts, and this knowledge gap should be closed through targeted research rather than through surveillance. Ongoing work in the ICP Vegetation programme will assist in closing the knowledge gap.

3.4 Climate change mitigation. An important aspect of mitigation policy of high relevance to biodiversity is the maintenance of good carbon sequestration by soils and vegetation. Responses to climate change are likely to include significant land use change, both due to economic drivers and due to climate change adaptation activities. Therefore, it will be vital to ensure that land use change does not threaten or reduce the current levels of sequestration. Other mitigation measures with moderate to high relevance for biodiversity are the various proposals for fuel switching. Some of the issues were discussed under policy for oxidised nitrogen. Other issues will tend to have more localised effects on biodiversity, which potentially could be controlled through careful spatial planning policy, for instance consideration of the siting of individual 'wind farms'. The use of land for growing crops for biofuels also has potential to cause localised biodiversity losses, some of which may be modelled through tracking land use change.

3.5 Climate change adaptation. Adaptation policy is still in a formative phase, and includes both policy for allowing biodiversity to adapt to climate change, as well as policy for a wide range of other sectors. The understanding of aspects of biodiversity that will allow it to adapt effectively is still at an early stage, and planning is also required to ensure that adaptation measures for other sectors do not cause unacceptable impacts to biodiversity (for instance through land use change). Information that can help form understanding of 'resilience' or guide management decisions will be of great importance. Policy questions, particularly in relation to biodiversity adaptation policy, are likely to include:

- Are land use changes linked to climate change affecting biodiversity?
- Is the development of ecological networks helping biodiversity adapt to climate change?
- Are species and habitats moving as predicted within their climate space and what are the likely factors restricting them?
- Is there a difference in change for a species or habitat across the whole range as compared to in the UK, thus changing the UK responsibility for their conservation?
- Are extreme weather events and phenological effects significant drivers of change, such that adaptation needs to respond to these drivers?

[8] See for instance http://www.jncc.gov.uk/page-3832. Further work is ongoing to develop site-based indicators of damage.

3.6 Soils. Although the ECBN was not designed with an explicit goal of assisting in understanding soils policy, the inclusion of soil measurements makes this a potentially relevant policy area. Soils policy seeks to maintain the service functions that soils provide, including the carbon sequestration service discussed under mitigation policy. Other important services include buffering pollution and water and flood regulation. The primary need for surveillance data is in understanding the overall status and trend in soils and their ability to provide services. In addition to this need there is a requirement for smaller scale studies to improve the understanding of how soil processes are linked and affected by drivers of environmental change, including climate change.

Evaluation of the coverage of current surveillance and the potential role of ECBN within these policy areas

4.1 Oxidised nitrogen. Current biodiversity sampling is capable of picking up vegetation change that is attributable to eutrophication, and which can be partially correlated with nitrogen deposition mapping (including reduced and oxidised forms of nitrogen). However, total N impacts from air pollution appear to be under detected in Common Standards Monitoring, possibly due to lack of awareness of the impacts, and possibly due to compensatory site management obscuring air pollution effects. Where eutrophication is detected it is not always possible to know if air pollution is the cause. ECBN would provide the clearest correlation between total nitrogen deposition and biodiversity impact, in a manner that would distinguish between air pollution and other possible nitrogen sources.

4.2 Reduced nitrogen. Methods for assessing site-based damage are under development, but are not yet available for widespread usage. ECBN will not be able to provide an assessment of damage that is relevant to a particular site outside of the ECBN. However, ECBN would provide a clearer understanding of the linkage between reduced nitrogen deposition and biodiversity impact; it could also provide a validation of the proposed indicator methods that would need to be used more locally. The ECBN could provide 'signature' biodiversity changes that would help in understanding the likely drivers of change on other sites.

4.3 Ozone. Currently no biodiversity surveillance scheme is designed to pick up impacts due to ozone pollution, other than the work carried out under the ICP Vegetation programme. ECBN does not currently include proposals for measurements of ozone and hence would not provide relevant information; this is in part due to the high costs of ozone measurements and the uncertainty regarding biodiversity impact. Once further research has been carried out on the impacts of ozone, then it might be appropriate to consider including relevant measures within ECBN.

4.4 Climate change (mitigation and adaptation). Current coverage of biodiversity surveillance needs is assessed as moderate. Range change for species is well covered, and meteorological data are good. Mechanisms for increasing the range of species for which population trends are available at a range of different landscape scales can be explored with the relevant species surveillance schemes. The need for improved understanding of habitat change has been identified in a range of policy areas. Improvements in understanding of connectivity will also be important. Such

improvements in the understanding of habitat trends, including both quality and connectivity, are unlikely to require new habitat detection mechanisms to be implemented, but modifications to the current detection. ECBN through its measurement of both soil and vegetation parameters, would provide an important valuation of the sequestration service provided by key semi-natural habitats in an era of increased land use pressure. However, it will not be able to provide any measures of the localised biodiversity impacts from mitigation measures. It may be able to provide a comparative approach to the understanding of plant community resilience. If experimental management is included on ECBN sites, there is potential for ECBN to help guide management decisions. Further, by providing a clear attribution of the relative impacts of environmental pressures, it may be possible to use ECBN in prioritising management interventions according to the likely driver that is being targeted by management. Other aspects of climate change biodiversity adaptation policy may be better targeted by the developing BICCONET work programme.

4.5 Soils. ECBN will not be able to provide national statistics on the status and trend in soils and soil qualities. However, it will be able to provide information on carbon sequestration, and more generally it will help increase the understanding of impacts of climate change and air pollution on soils, including soil functions and soil biodiversity. The UKSIC are considering means of improving surveillance of soils status and trend.

Conclusions

5.1 JNCC is among a number of organisations that have identified biodiversity data needs in the fields of air pollution and climate change policy. Detailed analysis of data need is necessary in order to evaluate any proposal for producing biodiversity data. JNCC is developing the UK Terrestrial Biodiversity Surveillance Strategy as a tool for analysing and assessing data needs and comparing these against current surveillance coverage.

5.2 The ECBN has been proposed as a potential solution for delivering the necessary biodiversity data for air pollution and climate change policy. The particular focus of ECBN is on achieving strong correlation with potential drivers of change on areas with high biodiversity value.

5.3 ECBN will detect change at its sample locations, but it is not intended to provide representative sampling at the national scale in the way that, for example, Countryside Survey or the Breeding Bird Survey do. It is not a general detection mechanism, which is well provided by existing schemes. It will not directly contribute to assessing the status of wider networks of designated sites, but will contribute to understanding Common Standards Monitoring results in some habitats. It will provide useful sampling to measure the outcome of management and pressures at a small number of individual sites, but its principle value will be in the knowledge of habitat/pressure relationships it produces. This knowledge can then be used to influence the way in which habitats are managed across sites, and the wider landscape.

5.4 ECBN is a ‘research scale’ activity, with relatively intensive monitoring focused on a small number of sites. This needs to be borne in mind when considering potential for

expansion: in general it may be more cost effective to consider supplementing lower intensity sampling programmes, than to increase the number of sites within ECBN to make it representative of a larger range of habitats or conditions. ECBN is not designed to be a representative network.

5.5 Analysis of the policy areas of air pollution and climate change suggests that ECBN will provide useful and complementary information, but will still leave important information gaps. In particular, site-based measures of air pollution impact and more sensitive measures of habitat change will still be required.