ASSESSING THE IMPLICATIONS AND SIGNIFICANCE OF ECOSYSTEM EFFECTS OF SO_2, NO_X AND AMMONIA EMISSIONS – A HABITATS DIRECTIVE CASE STUDY

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ABSTRACT
The EU Habitats Directive (92/43/EEC: On the conservation of natural habitats and of wild flora and fauna) makes provision for the conservation of a number of defined habitats and species. Member States have been required to designate a network of Special Areas of Conservation (SACs) under the Directive, and Special Protection Areas (SPAs) for the conservation of wild birds, which together form the 'Natura 2000' sites. Any proposed developments and consents under the Integrated Pollution Prevention and Control Directive will need to consider possible impacts on Natura 2000 sites. Under the Habitats Directive, an environmental regulator may modify or revoke licences to operate.

In the UK, the electricity generation sector has been working with the Environment Agency to define an approach to the assessment of potential impacts on these ecologically valuable sites. Impacts assessed under the Directive which are of particular relevance to the electricity generation sector include acidification and eutrophication and also effects of ambient concentrations of gaseous pollutants.

Some results of applying this methodology to SACs and SPAs in the UK are presented, and a discussion given of key scientific and policy issues which have arisen from this work relating to interpretation and implementation of the Habitats Directive in the UK.

INTRODUCTION
The EU Habitats Directive (92/43/EEC) makes provision for the conservation of a number of defined habitats and species. Member States have been required to designate a network of Special Areas of Conservation (SACs) under the Directive which, together with Special Protection Areas (SPAs) for the conservation of wild birds, form the 'Natura 2000' sites. Any proposed developments and consents under the Integrated Pollution Prevention and Control Directive will need to consider possible impacts on Natura 2000 sites. Under the Habitats Directive, implemented in the UK by the Habitats Regulations, an environmental regulator may modify or revoke licences to operate where it cannot be demonstrated that there is no adverse effect on the integrity of the Natura 2000 sites.

Impacts assessed under the Directive which are of particular relevance to the electricity generation sector include acidification and eutrophication and also effects of ambient concentrations of gaseous pollutants. During 2003 the electricity generation sector, via the Joint Environmental Programme (JEP), has been working with the Environment Agency to define an approach to the assessment of potential impacts on these ecologically valuable sites.

During the course of this work, a large number of significant unresolved issues related to interpretation and implementation of the Directive in the UK have been identified. The most significant of these issues are outlined here and the main points arising discussed.

1) The effects of large combustion plant sources on Natura 2000 sites are relatively small.

Large combustion plant (LCP) have been strongly regulated over past decades and have achieved considerable reductions in emissions. More emissions reductions will result from current improvement programmes, from implementation of the Large Combustion Plant Directive (LCPD), integrated pollution and prevention control (IPPC), and the EU Emission Trading Scheme and the consequent changes to the mix of generation plant that will occur in the future.

In order to identify the source categories responsible for the majority of threats to Natura 2000 sites in England and Wales, and so establish the relative importance of acid and nutrient nitrogen deposition from LCP, the effect of systematically removing the contribution from each of the available source sectors on the number of sites exceeding their site-specific critical loads has been examined. The analysis is based on data provided by the Environment Agency for an assumed emissions scenario for LCP in 2010. Tables 1 and 2 show the changes for the number of Natura 2000 sites exceeded, for the effect relative to acidity critical loads, and the effect relative to nutrient N critical loads respectively.

It can be seen that elimination of all LCP emissions would result in only 4 of the 177 exceeded SAC sites achieving 'protection' from acidity, whilst no additional SPAs would be protected. In the case of nutrient nitrogen, no additional SACs or SPAs would be protected. This contrasts markedly with the case of ammonia (where the agricultural sector is the dominant source), where removal of the emissions would result in almost half of the exceeded SACs and SPAs achieving protection for acidity. Similarly, over half of the SACs and all SPAs would be protected from eutrophication by removing ammonia emissions.

The analysis clearly demonstrates that the total LCP emissions represent a minor risk to sites protected under the Habitats Directive. Total elimination of all LCP emissions would result in an insignificant increase in protection from both acidification and nutrient nitrogen deposition. It is evident that LCP may no longer be considered to dominate either acid or nutrient nitrogen deposition impacts and it is clear that action to further reduce LCP emissions would result in only trivial increased protection for Natura 2000 sites.

Table 1: Change in number of exceeded Natura 2000 sites when source sector contribution is removed – acidity critical loads

Source	SACs		SPAs	
	Sites exceeded	Net change	Sites exceeded	Net change
All sources	177	-	46	-
No 42 LCP	174	4	46	0
No Ammonia	94	83	30	16
No EMEP	170	7	45	1
No low-level	174	3	46	0
No Natural	175	2	46	0
No non-LCP point	175	2	46	0
No Global background	177	0	46	0

Table 2: Change in number of exceeded Natura 2000 sites when source sector contribution is removed – nutrient N critical loads

Source	SACs		SPAs	
	Sites exceeded	Net change	Sites exceeded	Net change
All sources	206	-	34	-
No 42 LCP	206	0	34	0
No Ammonia	89	117	0	34
No EMEP	202	4	32	2
No low-level	205	1	34	0
No Natural	206	0	34	0
No non-LCP point	206	0	34	0
No Global background	206	0	34	0

2) Power station emission controls are not the most cost-effective solution.

An analysis of the cost effectiveness of controls on power station emissions of SO_2, compared with controls of ammonia emissions from agriculture has been made. The modelling framework used in Europe for the setting of National Emission Ceilings is the RAINS integrated assessment model. This model contains databases on activity levels and control options for SO_2, NO_x and NH_3 which are used to construct marginal cost curves for abatement [1]. Existing information available from the IIASA web site has been used to examine these marginal costs. The approach followed has been to identify the marginal cost for emission reduction at the level of the NECD emissions.

The NEGTAP report [2] gives budgets for the UK which allow the % of emissions deposited to the UK to be derived, with the results: SO_2: 19%; NO_x: 30%; NH_3: 74%. Using these factors a relative cost effectiveness index (CEI) can be defined as:

CEI (€/keq) = € / t emitted x t emitted / t deposited x 1 / (keq/ t deposited)

with the following results:

SO_2: € 205.3 /keq (other industry)
SO_2: € 704 /keq (power sector)
NH_3: € 31.7 € /keq

This index represents the typical cost of reducing acid deposition to the UK by 1 keq. It does not indicate the cost effectiveness of controlling emissions from a given source to a hectare of a specified receptor, which would require the application of a deposition model. Nevertheless this result indicates that the cost of reducing acid deposition to Natura 2000 sites by controlling emissions from power stations may be an order of magnitude more costly than achieving the same environmental benefit by implementing cost effective ammonia emission measures.

3) Demonstration of no adverse effect on site integrity

The procedure defined in the UK by the Environment Agency for the review of existing consents is based on Article 6(3) of the Habitats Directive and has four stages:

Stage 1: Identifying relevant applications
Stage 2: Assessing likely significant effects
Stage 3: Appropriate assessment
Stage 4: Determination of existing permission

All of these measures should correspond to the objectives of the Habitats Directive and respect the principle of proportionality, which means that measures should achieve their intended objectives without going beyond what is necessary to achieve those objectives. The aim of Stage 3 appropriate assessments is to determine whether or not the permitted activity will *not* have an adverse effect on the integrity of the site. Effectively, the burden of proof is to demonstrate no adverse effect. However, as all measurements have a margin of uncertainty, no experiment can distinguish between the case of no effect and an extremely small change, and it is therefore difficult to establish the case of no adverse effect. Some measurable effects may be allowed, but not if they are considered to have an adverse effect on site integrity, ie the key structural and functional relationships that create and maintain the favourable conservation status of the site.

It seems likely that there will be many sites where it will not be possible to discount the possibility of adverse effects on site integrity associated with SO_x and NO_x deposition. It is not clear how this will be translated into the regulation of industrial and other emissions. However, it will be important to ensure that any mitigation and monitoring requirements are

proportionate to the possible risks to the Natura 2000 sites and also that any resulting control measures are implemented in a proportionate manner.

4) Critical loads and levels may not be suitable indicators of damage to site integrity.

Critical loads and levels are defined as thresholds above which a pollutant load may cause harm to the environment. Different receptors within the environment have different sensitivities and, hence, critical loads and levels need to be defined with reference to specified species/ecosystems. Although simple in concept, this gives rise to several practical problems in interpretation for purposes of implementation of the Habitats Directive:

- Environmental responses to pollutants (for example to acidity) may be continuous functions and a threshold may not exist. In practice this results in application of very low or zero (or even negative) critical loads for some ecosystems that will always have been exceeded. Thirteen sites are identified in the modelling undertaken for the U.K. Environment Agency that have critical loads $CL_{max}S$ values that are 2 to 6 times less than 'natural' sulphur deposition.
- In support of this, examination of published estimates of historic UK SO_2 emissions extending back to 1850 [3] shows that SO_2 emissions in the UK have been greater than 1 Mt SO_2 since 1850. When compared with the 2010 NECD target of 0.585 Mt SO_2, it is clear than historical sulphur depositions to Natura 2000 sites have exceeded the expected 2010 levels for more than 160 years.
- Exceedance of critical loads and levels offers no indication of the severity or significance of damage, or how that may relate to the integrity of the site and its European interest features.
- There is also a tendency to assume that if the critical load remains exceeded the ecology will deteriorate. In fact this is false, as there may possibly be some recovery while exceedance is reducing.
- Critical loads are set for very long–term equilibrium conditions that are at the threshold for causing any ecological damage, rather than a threshold for maintenance of the favourable conservation status of the fauna and flora of Community interest.
- JNCC [4] have indicated that the general intention of the Directive is to maintain habitats and species at their contemporary levels (ie at the coming into force of the Directive in 1994). This contrasts with any intent to restore sites to some pristine state that would perhaps correspond to levels of pollution less than critical loads/levels. Acid deposition is expected to fall further from current levels by 2010.
- The estimates of critical loads and levels have been made for a limited number of broad ecosystem types. These have been taken and assigned by an expert judgement process to the features of interest for each European site. The appropriateness of many of these assignments may be debated and so the anticipated accuracy of the resulting critical loads and levels may be questionable.

The initial critical loads/levels assessments are designed to be used in a preliminary screening process, prior to undertaking more thorough 'appropriate assessments'. However, if the screening thresholds adopted are not well founded for the reasons given above, this undermines confidence that the most threatened sites have been identified and that appropriate possible regulatory controls will be well directed.
A further problem arises from use of critical loads that are estimated based on long-term equilibrium calculations. It is well established that there may be considerable time lags in response of ecosystems to changes in pollutants. This means there is a practical difficulty in undertaking any ecological survey at a particular time to demonstrate that any exceedance of a critical load/level is having no significant impact as equilibrium conditions will never be applicable. This will inevitably give rise to problems in undertaking robust appropriate assessments if critical loads and levels are to be assumed to be a sound basis for judging conservation threats to all Natura 2000 sites.

Thus there are a range of fundamental issues identified with the interpretation of critical loads and levels exceedances in relation to protection of the integrity of Natura 2000 sites. Use of critical loads may be considered to be useful only as an initial, and fairly crude, screening tool. Simple exceedance of a critical load should not then be interpreted as providing an indication that additional control measures are required.

CONCLUSIONS

- Although initial screening suggests that very many UK sites appear to be threatened by acid and nutrient nitrogen deposition, the effects of large combustion sources on Natura 2000 sites are relatively small compared to emissions from agricultural sources. Futhermore, an analysis of the cost effectiveness of controls shows that power station emission controls are not the most cost-effective approach to reducing acid deposition.
- Greater clarity is needed in the regulatory control framework for implementation of the Habitats Directive in the UK than has currently been proposed. Particular issues to be addressed by DEFRA and the Environment Agency are:
    - practical appropriate assessment methodologies which could reliably establish whether or not the integrity of sites is under threat.
    - how control measures are to be fairly applied across all contributory sources, of which some significant sources are not currently subject to regulatory control.

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