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SUMMARY FOR POLICY MAKERS

1.1 Introduction

Atmospheric nitrogen deposition represents a major threat to European biodiversity. Nitrogen emissions to the atmosphere have increased substantially over the 20th century, mainly in the form of ammonia from agriculture and nitrogen oxides from industry. Following atmospheric dispersion and chemical transformation, these nitrogen forms are deposited across European landscapes, providing unplanned nitrogen inputs and adversely affecting many sensitive habitats.

The issue represents a serious challenge for the conservation of natural habitats and species under the Habitats Directive (92/43/EEC).

The Habitats Directive is a cornerstone of Europe's nature conservation policy. It promotes the maintenance of biodiversity and requires Member States to take measures to maintain or restore natural habitats at a favourable conservation status. The Directive established the Natura 2000 network with the aim to assure the long-term survival of Europe's most valuable and threatened species and habitats. These sites are afforded the highest degree of protection under European legislation: the provisions of the Directive require strict site protection measures and avoidance of deterioration and introduce a precautionary approach to permitting "plans or projects" which are likely to have significant effect on a site.

The Habitats Directive does not directly address nitrogen impacts and until now there has been no common European approach for determining the impacts of nitrogen deposition on individual sites or on conservation status. At the same time, the scale of pollution exposure suggests that there are widespread threats to the Natura 2000 network and, more widely, to conservation status due to the concentrations and deposition of reactive nitrogen species.

Noting these problems, this volume reports on a workshop organized to bring together scientists, environmental managers and policy makers to clarify the current understanding of the key issues. The workshop was held in Brussels in 2009 and addressed the different components of science, environmental management and future policy development needs. The overall workshop goal was to harmonize approaches for determining the impacts of atmospheric nitrogen deposition on Natura 2000 sites across Europe. The following conclusions and recommendations were agreed in plenary at the workshop.

1.2 General Conclusions

The workshop agreed that nitrogen deposition represents a major threat to European biodiversity, including sensitive habitats and species listed under the Habitats Directive. Many Annex I habitats are naturally adapted to low nitrogen supply, so that fertilization with nitrogen compounds from the atmosphere alters the natural ecological balance. This results in the loss of the most sensitive

species, which are often a priority for protection, and their replacement by invasive species that prefer high rates of nitrogen supply. In addition, the evidence also points to a net loss in the overall number of species.

The workshop noted that both atmospheric nitrogen deposition and air concentrations of reactive nitrogen compounds were appropriate indicators of the scale of threat. The use of critical loads and critical levels, as effects thresholds for nitrogen deposition and air concentrations, respectively, have demonstrated their usefulness at the European and local site scales.

The workshop agreed that in many cases across Europe, nitrogen deposition and concentrations substantially exceed the critical loads and levels. Examples were presented of predicted and actual habitat change, demonstrating that this is a major current threat, implying serious management challenges to achieving favourable conservation status and to prevent deterioration of Natura 2000 sites.

The working groups addressed the different components of science, environmental management and future policy development needs across a series of five themes. The working group conclusions for each theme, that were agreed in plenary at the workshop, are presented below.

1.3 Comparison of impact assessment approaches in the context of Habitats Directive 6.3 (Theme 1)

The Habitats Directive requires that all 'plans and projects' which are likely to have a significant effect on a Natura 2000 site have an appropriate assessment of the implications for the site. Subject to certain exemptions, the plans or projects can only be approved where they are shown to have no adverse effect on any Natura 2000 site. However, at present, there is no common approach for evaluating the effects of nitrogen deposition and concentrations on these sites. The workshop therefore reviewed the practices in use across Member States. A key challenge was how to handle the situation where local background levels of deposition (or concentrations), resulting from existing activities, already lead to exposure in excess of critical thresholds. In this case, the question was raised of how to define an acceptable additional pollution burden when, in principle, any further exposure will give rise to an increasing risk and magnitude of adverse impact.

The impact assessment and decision making approaches applied in the different Member States, for 'plans and projects' under Article 6(3) of the Habitats Directive, were found to be clearly influenced by national policy, national aspirations, and national court decisions. However, an examination of the different approaches identified a number of common components which were used to develop a 'best practice framework' relevant across Europe.

It is recommended that a staged approach is applied to the impact assessment, including: i) a relevance screen, ii) test of likely significant effect, iii) appropriate assessment and iv) final decision. Modelling predictions should be compared against the relevant critical loads and critical levels (applied at the Natura 2000 site scale).

It is recommended that assessment needs to consider 'in combination' effects. Therefore, the plan/project should be considered both alone and in combination with other plans and projects, as well as in the context of existing ambient air quality (and prevailing environmental conditions). An integrated management/assessment plan (at, for example, the province/region scale) could assist with this.

It is recommended that all relevant EU Directives and national regulations should be considered during the assessment, to ensure the requirements of the IPPC Directive, Nitrates Directive, Water

Framework Directive, EIA Directive etc, are considered alongside those of the Habitats Directive, allowing an integrated approach to be applied.

It was concluded that ongoing problematic issues include whether consideration of the spatial scale of impact, survey data, and/or application of *de minimis* criteria, in respect to the plan or project contribution, are appropriate. A Member State might choose to apply a *de minimis* criterion to allow new plans or projects in situations where the critical load/level is already exceeded. In the absence of any sound ecological justification for such a position, this would have to be a policy decision.

It was concluded that further work is required on the development and dissemination of a best practice approach, including the involvement of a larger number of Member States.

1.4 Assessing nitrogen impacts on conservation status (Theme 2)

The Habitats Directive requires Member States to provide an assessment of conservation status of habitat and species listed in the Annexes of the Directive every six years. At the highest level, 'favourable conservation status' is defined and there is a standardized approach as regards the parameters to assess and descriptive statements of condition (e.g. favourable, unfavourable, unknown). Across Europe nitrogen deposition is increasingly recognised as a major issue for biodiversity. However, there is currently no standardisation of methods to consider nitrogen deposition impacts on conservation status. There is a high likelihood that the scale of nitrogen deposition effects on conservation status of habitats and species is not being accurately reported.

The workshop compared experience between countries as a basis for investigating what might be considered best practice in the assessment of conservation status. Different approaches to assessing whether nitrogen deposition is a 'pressure' on the 'structure and function' of habitats or a 'threat' to the 'future prospects' were considered. These include critical loads exceedance, field survey and bioindicators. Limitations to implementation were considered, including financial and expertise requirements.

It was concluded that nitrogen deposition represents a major threat to semi-natural vegetation across Europe. There is widespread exceedance of critical loads for nutrient nitrogen and acidification and substantial field and experimental evidence of the impacts. Such responses threaten the achievement of favourable conservation status for a large number of Annex I habitats.

It was concluded that the impact of nitrogen deposition on conservation status should be explicitly considered in Article 17 reporting, and the results should inform air pollution policy development.

It was concluded that there is a need for a common methodology for assessing the threat from nitrogen deposition to conservation status to be developed for application across Europe. This requires an improved dialogue between air pollution and biodiversity communities, building on recent progress in this area such as the development of a nitrogen deposition indicator under the Streamlining European Biodiversity Indicators (SEBI) programme.

It is recommended that a harmonisation of the methodology for nitrogen deposition assessment in conservation status reporting is required.

It is recommended that the lists of pressures and threats used for Article 17 reporting of conservation status should include nitrogen deposition explicitly and be more clearly defined.

It was noted that there is a requirement for greater clarity in the definition of 'favourable conservation status' for different habitats or groups of habitats, particularly with respect to defining

important elements of structure and function. It is recommended that a series of habitat working groups should be established between interested Member States to take this forward.

It is recommended that the Working Group on Effects (WGE) of the UNECE Convention on Long -range Transboundary Air Pollution (CLRTAP) and the Expert Group on Reporting under the Nature Directives should be brought together in order to develop a methodology for the assessment of nitrogen deposition impacts on conservation status. A two-tiered approach is recommended as the basis of further development:

- Tier 1: An assessment based on empirical critical loads for nutrient nitrogen deposited to sensitive Annex I habitats. This would build on the already established critical loads exceedance methodologies developed under the CLRTAP, but requires further development to apply the concept consistently to Annex I habitats of the Habitats Directive and to recommend the most appropriate deposition data. It would enable identification of nitrogen deposition as a "threat to future prospects" and also be used to help interpret species or biogeochemical based monitoring data in order to identify whether nitrogen deposition is a 'pressure to current structure and function'.
- Tier 2: Monitoring (likely to be non-mandatory) should be made up of biotic and abiotic variables to determine where nitrogen deposition is a significant pressure on structure and function. This would require agreement of abiotic and biotic variables/values relating to favourable conservation status and the production of a first set of European guidelines on this topic.

1.5 New science on the effects of nitrogen deposition and concentrations on Natura 2000 sites (Theme 3)

Actions to manage the Natura 2000 network and to assess conservation status must be based on a sound scientific understanding of how reactive nitrogen deposition causes impacts on sensitive habitats. The workshop reviewed the latest evidence to:

- provide a clear picture of the scale of threat from nitrogen deposition to the Natura 2000 network and to their conservation status;
- consider the relative effects of different nitrogen forms, including ammonia versus nitrogen oxides (especially as this relates to different polluting source sectors) and to dry versus wet deposition (as this relates to near source impacts versus long range transport);
- evaluate the critical loads and levels approach, and consider the role of other approaches, including indicators from site level measurements to the European scale;
- consider the potential to improve relationships between concentrations/dose and biodiversity loss, as well as the use of management practices to mitigate nitrogen impacts.

It was concluded that the latest science supports and strengthens the already established empirical critical loads approach, encouraging their use in environmental decision making.

The workshop concluded that there are no acceptable exceedances above a critical load or critical level. Discussions regarding "acceptable exceedances" are not a science issue and should be addressed at a policy level. In order to improve the situation, one should aim at reducing nitrogen deposition below the critical loads and levels.

New data has strengthened the view that it is important to consider different nitrogen forms when evaluating effects of nitrogen deposition. It was concluded that evidence of responses for the different nitrogen forms is consistent across ecosystems and species. Moreover, because the effects from nitrogen deposition differ between different nitrogen forms (dry/wet deposition and oxidized/

reduced nitrogen) it is important to evaluate their effects independently. Hence several types of critical loads/levels for a particular habitat type are needed. For example, the critical level for ammonia may be well below the critical load set for total nitrogen deposition. Hence it is important that both critical loads and levels are used.

Important new data from Southern Europe have emerged over the last five years, for example, during the workshop results from experiments and surveys conducted in Portugal and Spain were presented. These should inform future revisions of critical loads for nitrogen

The workshop concluded that improved conditions following reduction in nitrogen deposition are only relevant when nitrogen deposition is reduced below the critical load/level. Reduction of exceedance will only improve the situation in the sense that it reduces the risk of further worsening of the effects. Information about the effects on recovery time following reductions below critical loads/levels is still largely lacking. Available data suggests that the rate of improvement will differ depending on type of function/species studied, and is often site specific.

It was concluded that management to reduce the impact of nitrogen deposition will only work in combination with reductions in nitrogen deposition and should not be seen as an alternative to reducing the nitrogen deposition. For semi-natural habitats, positive effects from reducing the nitrogen inputs will only be possible in combination with appropriate management.

The workshop agreed that there are important interactive effects between nitrogen deposition and climatic factors. Therefore a changing climate may also influence the effects of nitrogen deposition. Currently, the knowledge of such interactive effects, and how they may change with a changing climate is, however, poorly understood. The climatic factors most important for interactive effects with nitrogen are also the most uncertain in climate change modelling (e.g. precipitation), making predictions of future interactions between nitrogen deposition and climate change difficult.

It is recommended that future research should prioritize the assessment of relative impacts of different nitrogen forms in relation to critical thresholds and dose response relationships, the relationships between nitrogen dose and site- and landscape-level management practices as a basis for minimizing adverse effects on ecosystem integrity, and the quantification of the interactive effects between climate change and nitrogen deposition.

1.6 Approaches to modelling local nitrogen deposition and concentrations in the context of Natura 2000 (Theme 4)

Assessments of the threat of nitrogen to the Natura 2000 network are fundamentally dependent on the ability to model the pathway from emissions, though air chemistry to deposition. There are currently many atmospheric models available, and recent reviews (for ammonia) have considered these at both local and regional scales. The challenge of the present workshop was to address the effectiveness of such models for assessments in relation to the protection of Natura 2000 sites, including the different nitrogen forms, and consideration of relative contributions from short range, mesoscale and transboundary (international) atmospheric transport.

Key questions included, how well we can simulate measured air concentrations for comparison to critical level estimates, and to what extent ecosystem specific dry deposition rates are treated in models. Specific examples were considered of where models have been applied in existing case studies to investigate the relative contribution of emissions from different sources to nitrogen deposition and concentrations experienced at Natura 2000 sites.

It was noted that modelling assessment approaches differ widely from country to country, both in terms of the type of models used and the level of detail considered. In particular, two types of assessment can be used (source-based or receptor-based) and the workshop recommended the type used should be clearly specified in all assessments.

The workshop concluded that the uncertainty in concentration predictions by models is much smaller than the uncertainty in the deposition predictions. This has the practical implication that, from the perspective of the atmospheric modelling, assessments based on air concentrations will have less uncertainty than those based on atmospheric deposition.

The workshop noted that the emissions from fertiliser (including both inorganic mineral fertilizers and organic manures) when applied to land is not usually modelled in current assessments. This is a major gap in current practice, given the substantial contribution to nitrogen deposition at many Natura 2000 sites from the nearby land application of fertilizers to agricultural land.

The workshop concluded that estimation of dry deposition of nitrogen compounds remains highly uncertain. In particular, uncertainty analysis for dry deposition is needed but remains a difficult task.

The workshop recommended that validation datasets for both concentration and deposition need to be developed and compiled in a form that can be made readily available for the purpose of model verification.

The workshop recommended that further development and testing of nitrogen dry deposition parameterisations are needed as a means to reduce uncertainties in assessing total nitrogen inputs to Natura 2000 sites. In particular, further assessment of ammonia canopy compensation points is needed for different habitat types. Overall, much more field deposition data is needed for model verification.

The workshop recommended that the emissions of ammonia to the atmosphere following fertiliser application (including both organic manures and mineral fertilizer) should be included in future environmental assessments of the impact of current and future activities on Natura 2000 sites.

It was recommended that a harmonised approach to uncertainty analysis for the models needs to be developed to aid the regulatory assessment of nitrogen emission, dispersion and deposition to sensitive habitats.

1.7 Options for future policy development to manage and mitigate the impacts of nitrogen deposition effects on the Natura 2000 network (Theme 5)

One of the motivations for the workshop was the perception that current practices to protect Natura 2000 from nitrogen deposition are far from optimal. While, in principle, the Habitats Directive affords the highest level of protection, much of the Natura network remains under threat. The workshop therefore reviewed the options for future policy development to better protect the Natura 2000 network. While the focus was on Natura 2000, the challenge was also viewed in the context of the wider aims of the Habitats Directive (inc. habitats/species outside of Natura 2000 sites) and other European biodiversity policy.

The workshop analyzed the current mechanisms by which the Habitats Directive affords protection to Natura 2000 sites, including the application of cross-compliance with other European Community legislation. It discussed the existence of potential loopholes, where certain polluting

activities continue without formal review and assessment, including the relative roles of industrial, transport and agricultural emissions.

The workshop then reviewed a wide range of potential future options that could support Natura 2000 protection from nitrogen deposition, including: the strengthening of existing legislation, the application of spatial and land use-based policies, the role of ecosystem services, consideration of air quality objectives and local air quality management for the protection of Natura 2000 sites.

Overview of current situation with regard to nitrogen deposition impacts to Natura 2000 sites

Regarding the current policies and their adequacy for the protection of Natura 2000 sites from the threat of nitrogen deposition, the workshop concluded that:

- The Natura 2000 network remains under threat from atmospheric nitrogen deposition despite the Habitats Directive affording it a high level of protection.
- Atmospheric nitrogen deposition is a Europe-wide problem but with very high spatial variability in severity of impacts and a high variability in national policy responses.
- Natura 2000 sites are not routinely assessed for the risk of nitrogen deposition effects and present policies and /or their enforcement are not sufficient.
- A lack of awareness of the nitrogen threat is the main problem in many Member States.
- Ammonia emissions present the greatest policy challenge in Europe.
- There is currently insufficient linkage between biodiversity and air pollution policy development.
- Economic and conservation priorities clash particularly in countries with significant levels of nitrogen deposition.

Recommendations for policy development

The role of existing legislation
It was recommended by the working group that:

- Those Member States that have advanced policies integrating several legislative instruments could provide practical advice for other Member States.
- International agreements (NEC Directive and Gothenburg Protocol) should have a higher level of environmental ambition (especially for ammonia), in particular to improve protection at local scale.
- Exceedance of critical loads (including in Natura 2000 sites) should be more explicitly considered in optimization of abatement measures.
- Ammonia should be included in the Air Quality Directive (2008/50/EC) and there is potential for setting standards for annual mean concentrations of ammonia to protect ecosystems.
- The potential for 'cross compliance' of different legislative measures to address nitrogen deposition issues should be more actively promoted.
- All existing projects should be captured by Article 6.3 of the Habitat Directive.

Future options for protection of Natura 2000 sites
The working group discussions captured the following suggestions and recommendations:

- Legislation at both regional and local scales is needed, including measures to deal with within-country atmospheric transport.

- Policies and procedures should be considered that distinguish between the management of nitrogen oxides and ammonia, and to address the role of organic nitrogen compounds emitted to the atmosphere.
- It is recommended that new approaches are explored in future policy development to complement existing approaches to managing the nitrogen deposition threat in relation to Natura 2000 and the wider objectives of the Habitats Directive, including:

  - Multi-media regional reactive nitrogen ceilings, limited by the most sensitive N_r species and effect, should be explored as a basis for further policy development. This approach could enable the optimization of all nitrogen emissions of a region in relation to the adverse impacts;
  - Nitrogen reduction plans could include a long-term plan to attain critical loads on a regional level in countries with high levels of exceedance;
  - Spatial Planning (operated at local and regional levels) can optimize the location of existing pollution sources to minimize the overall threats, exploiting where possible landscape structures to buffer impacts (including buffer zones and tree belts);
  - Nitrogen impact assessment techniques should be further developed to take into account the objectives of the Habitats Directive more specifically;
  - The Ecosystem Services concept may provide a holistic framework for examining the links between air pollution effects on ecosystems and human well-being.

- The following specific measures were recommended for further consideration:

  - Improve ammonia coverage in the Intergovernmental Panel on Climate Change (IPCC), i.e. include manure spreading, consider the current farm size thresholds and inclusion of cattle;
  - Set strict emission limits and management obligations to encourage abatement technology development;
  - Strategic Environmental Assessment (SEA) has a role to play at high level planning for pollution abatement;
  - Develop and encourage non-technical measures (societal behaviour);
  - Consider establishing a high-level goal as part of a package of actions, for example to ensure that 95 per cent of Natura 2000 designated sites do not exceed critical loads or levels for reactive nitrogen compounds by 2030.

1.8 The way forward

The outcomes of the Workshop will be used to inform future research, environmental practice and policy development in relation to the threat of nitrogen deposition on European habitats. It was noted that there is currently no established framework for the harmonization of decision making approaches related to the threat of nitrogen deposition to the Natura 2000 network or on conservation status. Further effort is needed to consider how to develop such a framework in future.

The scientific outcomes, regulatory experience and policy options reported at the workshop will be considered for feeding into future plans at national, European and international scales. In particular, the messages will be fed into the Expert Group on Reporting under the Nature Directives, the UNECE Convention on Long Range Transboundary Air Pollution, through its subsidiary bodies (e.g. Working Group on Effects, Task Force on Reactive Nitrogen), and into work of the UN Convention on Biological Diversity on development of the nitrogen deposition indicator.