Draft Ammonia Strategy Consultation

***Sustainability** at the heart of a living, working, active landscape valued by everyone.*

Department of
Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

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Contents

Abbreviations

AFBI	Agri-Food and Biosciences Institute
ASSI	Area of Special Scientific Interest
CAFRE	College of Agriculture, Food and Rural Enterprise
CAN	Calcium Ammonium Nitrate
CANN	Collaborative Action for the Nature Network
Cle	Critical Level
Clo	Critical Load
CMP	Conservation Management Plan
CoGAP	Code of Good Agricultural Practice
CP	Crude Protein
DAERA	Department of Agriculture, Environment and Rural Affairs
Defra	Department for Environment, Food and Rural Affairs
DTA	David Tyldesley and Associates
EFS	Environmental Farming Scheme
EU	European Union
GIS	Geographic Information System
INTERREG-VA	European Territorial Cooperation
LESSE	Low Emission Slurry Spreading Equipment
MLA	Member of Local Assembly
N	Nitrogen
NAP	Nutrients Action Programme
NARSES	National Ammonia Reduction Strategy Evaluation System
Natura 2000	A network of protected areas covering Europe’s most valuable and threatened species and habitats
NBPT	The urease inhibitor (N-(n-butyl) thiophosphoric triamide)

Abbreviations

NH3	Ammonia
NH4	Ammonium
NI	Northern Ireland
NIEA	Northern Ireland Environment Agency
PM	Particulate Matter
PM2.5	Particulate Matter - fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller
PPC	Pollution Prevention and Control
Ramsar	Wetlands of international importance designated under the Ramsar Convention
ROI	Republic of Ireland
SAC	Special Area of Conservation
SCAIL	Simple Calculation of Atmospheric Impact Limits from Agricultural Sources
SES	Shared Environmental Services
SPA	Special Protection Area
SPPS	Strategic Planning Policy Statement for Northern Ireland (2015)
UK	The United Kingdom of Great Britain and Northern Ireland
UKCEH	UK Centre for Ecology and Hydrology
UN	United Nations

Introduction

Ammonia emissions have adverse effects on nature and public health. Agriculture makes a significant contribution to the Northern Ireland economy, however it also produces 97% of current ammonia emissions. Therefore, action on ammonia is required urgently to support our local farm businesses and rural communities and help them to thrive and be sustainable, while at the same time protecting our environment.

Reducing ammonia emissions will require changes to some farming practices including increased uptake of established and new technologies. Optimum use of increasingly valuable nutrients and enhanced production efficiencies will also make important contributions. Change can be a challenge but change is necessary to deliver the short and long term benefits of reduced ammonia emissions.

This draft strategy was developed under the leadership of the former DAERA Minister and it will help us plan the way forward to reduce ammonia emissions from agriculture. In DAERA, we recognise that we do not have all the answers and this consultation will help us strengthen the draft strategy with your help.

We welcome your views and we have posed questions throughout the draft strategy. We are keen to have as many responses as possible to these questions and any other practical and affordable ideas or suggestions. There is more information on page 6 about how to take part in the consultation and your responses will be used to inform a reworked draft Ammonia Strategy for an incoming Minister and new Executive to consider.

We are also developing a Call for Evidence to inform a new operational protocol to assess the impacts of air pollution on the natural environment and we aim to publish this separately in 2023.

How to Respond

This engagement exercise uses the Citizen Space Hub, accessible via the relevant page on the DAERA website, as the primary means of response, in order to make it as accessible as possible.

However, you may download a response template from the DAERA consultation website and reply by e-mail or hard copy respectively to: ammonia@daera-ni.gov.uk

or

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Natural Environment Policy Division
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The consultation will run for an 8-week period from **4 January to 3 March 2023**.

The deadline for responses to this consultation is **23.59** on **Friday 3 March 2023**. All responses should be received by then to ensure they can be fully considered.

Freedom of Information Act 2000, in relation to the Confidentiality of Consultations, is provided in Section 6.4, page 67, for your reference.

If you require any further information, contact Kieran McManus on 028 9052 4528.

Executive Summary

Action on ammonia is required urgently to achieve better outcomes for nature, and for public health. Addressing this challenge is essential to see agriculture thrive while at the same time protecting our environment.

The greater the extent and speed of action to lower ammonia emissions and reduce ammonia concentrations, the greater opportunity there will be to support sustainable farm development.

Northern Ireland has 394 sites of high nature conservation value designated for their protection. Almost 250 of these are sensitive to the impacts of ammonia and nitrogen. The vast majority of designated sites are currently experiencing ammonia concentrations and nitrogen deposition above the Critical Levels and loads at which damage to plants may occur.[1, 2]

Sustained and tangible reductions in ammonia are required to protect nature, to meet Northern Ireland's legal obligations and to ensure a sustainable agri-food sector.

Ambitious and achievable targets are required to drive the ammonia reductions required and to protect nature. The long-term target to 2050 is to reduce ammonia emissions to a point where Critical Loads of nitrogen deposition and Critical Levels of ammonia are at a more sustainable and pragmatic place.

Given the generational challenge posed by the scale of current exceedances, interim targets are required. Box 1 sets out these 2030 interim targets and our plan for achieving them, and Box 2 provides a summary of the farm measures proposed for implementation across Northern Ireland.

We want implementation of reduction measures to be verifiable[3] and recognised within the DAERA decision making processes relating to granting permits, licences, or consents and for industry-led marketing purposes. Not every measure will be appropriate on every farm but these measures provide options which any farm can adopt to contribute to reducing ammonia emissions across Northern Ireland. Timelines for action on key areas are shown in Box 3.

1 https://www.apis.ac.uk/critical-loads-and-critical-levels-guide-data-provided-apis#:~:text=Critical%20loads%20and%20levels%20are,and%20levels%20for%20different%20pollutants.

2 https://www.eea.europa.eu/data-and-maps/indicators/critical-load-exceedance-for-nitrogen

3 For reduction measures to be verifiable in this context, the reductions must have already occurred, or have scientific certainty.

Box 1. DAERA 2030 Ammonia Targets and Plan for Achievement

DAERA 2030 Ammonia Targets

Reduce total NI agricultural ammonia emissions by at least 30% from 2020 levels.

Reduce ammonia at internationally designated sites by 40% or <Cle* from 2020 levels.

Pillars of the Ammonia Strategy

Pillar 1	Pillar 2
An ambitious and verifiable ammonia reduction programme.	**Conservation actions to protect and restore Nature.**
NI wide measures. **Measures around designated sites.**	**Habitat restoration, management, and monitoring.**

Enabling Actions

Review policy and legislative framework.	Support science and innovation to inform best practice.	Identify necessary farming practice and infrastructure change.	Support farmers to deliver change.

Mechanisms to Support Adoption

Cross cutting support through Green Growth and Future Agricultural Policy.	Support through Knowledge Transfer and education.	Legislation.	Spatially targeting measures around designated sites.

Partnership Working

A Stakeholder group representing primary agriculture, the agri-food supply chain and the environmental sector to advise on implementation.

*Cle - the Critical Level for ammonia concentration at a site. See page 17 for definition.

Box 2. Farm Measures for Ammonia Reduction

	Farm Measure	% Potential reduction of total NI ammonia (The % reduction in ammonia varies according to the specific technology adopted.)
	Encourage the uptake of verifiable ammonia reduction technology in livestock housing.	8% (Depending on uptake and the types of housing measures implemented.)
	Encourage the development and implementation of emerging technologies for ammonia reduction.	Dependent on emergence of verifiable technologies
	A requirement to spread all slurry using low emission slurry spreading equipment by 2026.	5-10%
	Developing verifiable systems to encourage implementation of longer grazing seasons.	3%
	Reducing ammonia emissions from fertiliser, including consulting on the potential introduction of a prohibition on the use of urea fertiliser without an inhibitor in 2024.	1.5%
	Establishing systems to implement and verify crude protein reductions in livestock diets. Supporting protein crop establishment through a pilot scheme.	9%
	Identifying and selecting for genetic traits that maximise nutrient use efficiency.	4%
	Encouraging the safe covering of existing above ground slurry stores.	1%
	Using well designed tree plantations established as part of DAERA's Forest for the Future initiative to reduce the impact of ammonia emissions.	15-25% (of emissions from livestock housing recaptured)

The ammonia reduction figures outlined in Box 2 relate to implementation of the individual measures only. They should not be added together. More information on the potential for a combined suite of measures is available in Chapter 2.

The measures to be targeted in the areas around each internationally designated (Natura 2000 sites) nitrogen sensitive site are:

- A prohibition on spreading of manures within 50 metres of a designated site. Similar rules exist in the Nutrients Action Programme (NAP) which prohibit the spreading of organic manures within 50m of a borehole, well or spring.
- Require slurry to be spread by Low Emission Slurry Spreading Equipment (LESSE) within 1km of a designated site by 2025.
- Focused campaigns to achieve significant adoption of ammonia reduction technologies in existing livestock housing and greater implementation of other ammonia reduction measures.

To support the uptake of the NI-wide and targeted programme of measures, DAERA will:

- Provide appropriate financial support for the implementation of ammonia reduction measures on farms through the Green Growth capital investment plan (subject to confirmation) and relevant Future Agricultural Policy Programme Measures.
- Use knowledge transfer and education to support the uptake of ammonia reduction measures.
- Prioritise ammonia reduction and habitat restoration within all future agricultural and environmental policies.

The conservation actions proposed to protect and restore nature are:

- Implementation of Conservation Management Plans and agri-environment schemes measures at designated sites.

We want to engage intensively with stakeholders to optimise our approach to ammonia. We will use a range of communication channels to engage with stakeholders throughout the consultation period. Following the consultation period when the Ammonia Strategy is finalised DAERA will establish a stakeholder group to advise on implementation.

Our aim is to facilitate a flourishing environment and a sustainable and prosperous farming sector. This consultation is a vital step in the journey to putting sustainability at the heart of a living, working, active landscape valued by everyone.

Box 3. Our timeline for action is:

By	Action
1st June 2023	Publish the final Ammonia Strategy.
	Establish a stakeholder group to advise on the implementation of the Ammonia Strategy.
30th June 2024	Legislate to reduce ammonia emissions from chemical fertiliser.
1st January 2025	Introduce mandatory spreading of all slurry exported and imported between farms by LESSE.
	Introduction of a prohibition on slurry spreading within 50m of Natura 2000 designated sites.
	Introduce a requirement for all slurry that is spread within 1km of a Natura 2000 designated sites to be by LESSE.
31st December 2025	Carry out a two year stocktake of the actions of the ammonia strategy to ensure that Northern Ireland remains on course to meet its 2030 targets.
1st January 2026	A requirement to spread all slurry using low emission slurry spreading equipment by 2026.
31st December 2028	Report on the delivery of the ammonia strategy to 2028 and determine the optimal approach to 2030 to meet targets.

Chapter One: Introduction and Background to Ammonia in Northern Ireland

1.1 Purpose of the Document

This Ammonia Strategy aims to address emissions and their impact on the environment in Northern Ireland. It will support the restoration of biodiversity, ecosystems and the services they provide, while facilitating the sustainable development of a prosperous agri-food industry.

This consultation seeks to encourage solutions to the ammonia challenge. It proposes targets for 2030 and outlines a strategic direction for action over the next 5 years to set Northern Ireland on the pathway to achieving those targets. Following the review of the feedback from this consultation DAERA plans to publish the final strategy and begin implementation.

1.2 Strategic Context and the Role of DAERA

The DAERA Plan to 2050 - Sustainability for the Future[4], published in May 2021, identifies the following strategic priorities:

- To enhance our food, forestry, fishery, and farming sectors using efficient and environmentally sustainable models which support economic growth.
- To protect and enhance our natural environment now and for future generations whilst advocating its value to and wellbeing for all.
- To champion thriving rural communities that contribute to prosperity and wellbeing.
- To be an exemplar, people focused organisation, committed to making a difference for the people we serve.

The DAERA Minister, on behalf of the NI Executive, launched the draft Green Growth Strategy[5] for Northern Ireland in October 2021. This over-arching multi-decade Strategy, led by DAERA, will set out the long-term vision and a solid framework for tackling the climate crisis by balancing climate action with the need for a clean, resilient environment and economy.

4 https://www.daera-ni.gov.uk/sites/default/files/publications/daera/SUSTAINABILITY%20FOR%20THE%20FUTURE%20DAERA%E2%80%99S%20-%20PLAN%20TO%202050.PDF

5 https://www.daera-ni.gov.uk/sites/default/files/consultations/daera/Green%20Growth_Brochure%20V8.pdf

This draft Green Growth Strategy provides a vitally important opportunity to embed wider climate change, a green economy and environmental considerations into decision making. This will ensure that new policies and programmes align with the need to address climate change, develop green jobs, and address biodiversity commitments, thereby delivering on the stated commitment "to ensure climate action and environment responsibility is at the heart of all government policy making."

The Environment Strategy will set out Northern Ireland's environmental priorities for the coming decades and will form the basis for a coherent and effective set of interventions that can deliver real improvements in the quality of the environment and thereby improve the health and well-being of all who live and work here; elevate Northern Ireland to an environmental leader; create opportunities to develop our economy; and enable us to play our part in protecting the global environment for decades to come.

Agriculture will have a key role to play in the Green Growth Strategy. The Future Agricultural Policy Framework Portfolio[6], published in August 2021, outlines an agricultural policy framework for Northern Ireland, taking into account the views of key food, farming, and environmental stakeholders.

The Future Agricultural Policy Framework sets out four outcomes and vision for the agricultural industry in Northern Ireland. Outcome 2 seeks an industry that is environmentally sustainable in terms of its impact on, and guardianship of, air and water quality, soil health and biodiversity, while making its fair contribution to achieving net zero carbon targets. These outcomes will be delivered through the Future Agricultural Policy Programme which will oversee the transition from the existing schemes to new approaches and support measures which better address the needs of Northern Ireland agriculture, the environment, and rural communities.

DAERA's Forests for Our Future programme pledges to increase forest cover by planting 18 million trees and create 9,000 hectares of new woodland in Northern Ireland over the next decade to help our environment and economy.

Work is progressing well within DAERA on the development of Northern Ireland's first Clean Air Strategy. In autumn 2020, a Discussion Document was issued to public consultation. It invited views on a range of matters relating to air quality and was an opportunity for stakeholders to put ideas to the Department. The consultation closed in spring 2021 and responses were analysed in detail. A synopsis of the responses was published in June 2022 and is available to view at: https://www.daera-ni.gov.uk/clean_air_strategy_discussion_document.

6 https://www.daera-ni.gov.uk/sites/default/files/publications/daera/21.22.086%20Future%20Agriculture%20Framework%20final%20V2.PDF

An inter-departmental working group has been established to further develop proposals and identify policies for cross-departmental consideration and inclusion within the final strategy. The Draft Clean Air Strategy is to be drafted in late 2022/early 2023. A further public consultation is planned. While work is progressing well at an official level, Northern Ireland currently does not have a functioning Executive, which may impact the planned timeline for this strategy.

DAERA is also responsible for:

- compliance with the Habitats Regulations, which is the relevant EU retained law with respect to habitats and species in Northern Ireland following EU Exit and ensuring that steps are taken to avoid deterioration of habitats and species of community importance.

- compliance with air quality legislation including the National Emissions Ceiling Regulations and the Air Quality Standards Regulations.

DAERA is committed to achieving Programme for Government outcomes 1 and 2 that:

- We prosper through a strong, competitive regionally balanced economy.

- We live and work sustainably - protecting the environment.

The agri-food sector is a key contributor to a strong, competitive regionally balanced economy, referenced in Program for Governance outcome 1. The agri-food sector (comprising the agricultural industry and the food and drinks processing sector) plays a significant role in the economy of Northern Ireland. The value of gross output from the agricultural industry in 2021 was £2.43 billion. This generated a gross value added (GVA) of £673 million. The latest available information shows that in 2020, the value of gross turnover from the food and drinks processing industry was estimated to be £5,424 million and the total valued added from food and drinks processing was £1,088 million. Therefore, taken together, the farming and processing industries are contributing £1.7 billion per annum of value added to the Northern Ireland economy, which represents around 4% of its total GVA. The agri-food sector also accounts for approximately 4.6% of total employment in Northern Ireland.

It is important to note that demand for food has driven production. While demand is there the market will provide the material. If we reduce production we are most likely at risk of out sourcing food production to other areas with lower environmental standards.

1.3 Ammonia and the Environment

Ammonia is a colourless gas and a compound of nitrogen and hydrogen with the chemical formula NH3. In simple terms, this means that it is comprised of one atom of nitrogen combined with three atoms of hydrogen. Ammonia is emitted into the air as a result of many agricultural activities. Nitrogen is critical to our agricultural systems and food production is dependent on the availability and cycling of nitrogen. Ammonia is part of the Nitrogen Cascade shown in Figure 1 and excess nitrogen and ammonia can have negative impacts on the environment. 97% of ammonia emissions in Northern Ireland come from the agriculture sector and over half of all nitrogen deposition in Northern Ireland comes from local agriculture. Analysis shows that the proportion of nitrogen deposition caused by local agriculture at some Special Areas of Conservation (SACs) can be very high while at other sites, alternative causes of nitrogen deposition such as transport and emissions crossing borders are of significant importance. These variations are influenced by the profile of agriculture in particular geographical areas.

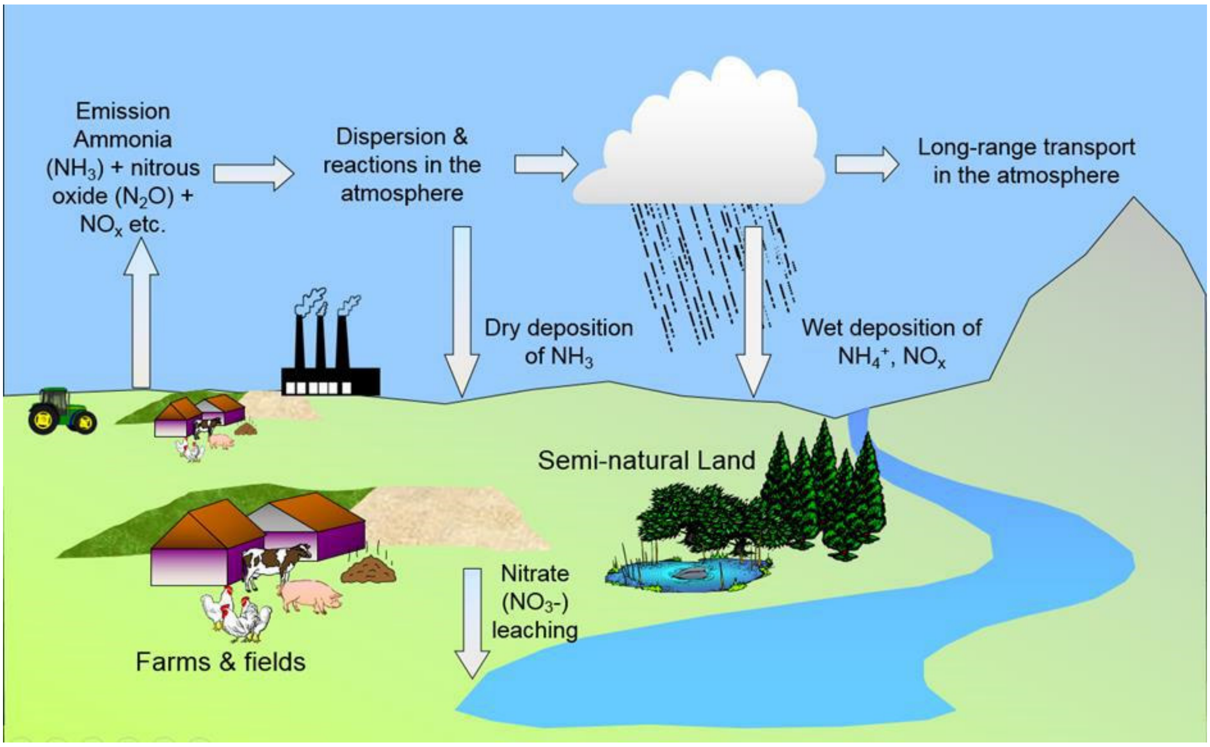

Figure 1. The Nitrogen Cascade showing cycling of nitrogen in the environment [7]

Gaseous ammonia can be particularly toxic to lichen, mosses, and heather. High concentrations of ammonia in the air cause direct damage to plants including bleaching, leaf discolouration and increased susceptibility to damage from drought, frost, and diseases, as shown in Figure 2. These direct impacts reduce plant health and can cause them to be less vigorous and die, with associated impacts at the community and habitat level.

7 Ulli Dragosits, UK Centre for Ecology and Hydrology (CEH)

Studies on the effects of excessive, locally deposited ammonia concentrations and nitrogen deposition to sensitive sites in Northern Ireland have shown clear evidence of direct damage to sensitive species and signs of nutrient enrichment affecting the species diversity and condition of the habitat (see Annex A for more detail on these case studies).

Figure 2. The image above shows Cladonia lichen. Lichens are a combination of both fungi and algae and are nature's indicators of air quality. This species is usually pale grayish-green in colour. The 'pinking' of this species is a studied response from the plant to toxicity from ammonia emissions. This image was taken at Ballynahone bog in Northern Ireland, where concentrations are measured as being above the critical level of 1 µg m^3.

Ammonia in the air can also damage plants and habitats by being deposited onto the land through the process of nitrogen deposition. Nitrogen deposition occurs in two ways:

- Dry deposition of nitrogen compounds, including ammonia, relatively close to the source of the ammonia; and
- Wet deposition of nitrogen compounds, including ammonia compounds, in rainfall which can be carried much further away from the original ammonia source.

The amount of ammonia emitted from a livestock unit depends not only on the number of animals, but also on a variety of factors including how the manure is managed and the technology used in housing, including the ventilation system. The dispersion of ammonia will depend on the prevailing wind direction, wind speed and nature of the surrounding land.

1.4 The Ammonia Challenge in Northern Ireland

Many of our priority habitats and iconic plant species are very sensitive to nitrogenous air pollution, particularly those important for climate resilience, such as lowland raised bog, blanket bog and ancient woodland. Nitrogen deposition arising from ammonia production is a key driver of biodiversity decline and has been linked to declines in invertebrates and other species groups, as well as habitats and ecosystems.

The key policy tool for controlling pollution and the impacts on the environment has been the development of Critical Levels (the concentration of ammonia in the air) and critical loads (nitrogen deposition). Specific Critical Levels of ammonia and Critical Loads for nitrogen deposition have been established for different habitats and plant communities to account for their different sensitivities to air concentrations and the deposition of pollutants.

For each designated site (for example a peat bog), Critical Loads for nitrogen deposition and Critical Levels for atmospheric ammonia have been set based on scientific evidence to protect the habitats from significant harmful effects.[8] Critical Loads are defined as: "a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge." Exceedances of Critical Loads by current or future nitrogen loads indicate risks for adverse effects on biodiversity.[9] These Critical Loads are currently under review.

Critical Levels are defined as "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge".[10] In practical terms, any exceedance of nitrogen deposition above the Critical Load or ammonia above the Critical Level can damage the habitat.

The Trends Report 2022: Trends in Critical Load and Critical Level exceedances in the UK[11] provides key information on UK and DA ecosystems relating to air pollution targets and provides the means to develop targeted action for emission reduction policies. Key data from the Trends Report 2022 for designated sites in Northern Ireland:

- 98% of Special Areas of Conservation (SACs) and 83.3% of Special Protection Areas (SPA) had nitrogen deposition rates exceeding their Critical Load. These are NI's most important habitats.

- 95.7% of Areas of Special Scientific Interest (ASSI) which are nationally important sites had nitrogen deposition rates exceeding their Critical Load for at least one feature.

8 http://www.ammonia-ws.ceh.ac.uk/documents/ece_eb_air_wg_5_2007_3_e.pdf
9 https://www.eea.europa.eu/data-and-maps/indicators/critical-load-exceedance-for-nitrogen
10 https://www.apis.ac.uk/critical-loads-and-critical-levels-guide-data-provided-apis
11 https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2208301034

- 100% of SACs, 100% of SPAs and 99.7% of ASSIs in NI had ammonia concentrations greater than 1 μg m3 (the long term annual average Critical Level for lichens and mosses and for ecosystems in which they are important).
- 27.8% of SACs, 21.4% of SPAs and 24.6% of ASSIs in NI had ammonia concentrations greater than 3 μg m3 (the long term annual average Critical Level for higher plants including heathland, semi-natural grassland, and forest ground flora).

Increasing nitrogen availability can cause excessive enrichment and acidification of naturally nutrient poor habitats, with associated impacts such as: loss of sensitive species; changes to habitat structure; loss of species diversity and homogenisation of vegetation types; changes in soil chemistry; a change in flowering behaviour; and an increased sensitivity to abiotic and biotic stresses (such as disease and climate change). There is also evidence that nitrogen deposition reduces the capacity of habitats such as peat bogs to store and sequester carbon.

1.5 Protecting and Enhancing Nature in Northern Ireland

Northern Ireland is renowned for its diverse natural landscape and hosts an array of habitats and wildlife of national and international importance which we need to safeguard and restore.

Rich biodiversity and healthy ecosystems provide vital support in numerous ways. These are sometimes referred to as ‘ecosystem services’ and include:

- Safeguarding against the effects of climate change - healthy peatlands and wetlands, native woodlands and species-rich grasslands store vast amount of carbon and can provide nature-based solutions, such as flood alleviation.
- Protecting soils, freshwater and air quality - having a rich biodiversity helps to maintain the natural balance necessary for healthy soil, water resources and clean air.
- Provision of pollination which is essential for food supply.
- Supporting jobs; healthy ecosystems support many activities such as agriculture and tourism.
- Supporting our cultural identity; healthy habitats and rich biodiversity provide us with the iconic landscapes and wildlife that we associate with our region.
- Supporting outdoor recreation; having a rich biodiversity supports a healthy countryside and clean open spaces.

Internationally the importance of biodiversity was brought into focus by the recent UN Biodiversity Conference (COP15). Account will need to be taken of the Kunming-Montreal Global Biodiversity Framework which the UK signed up to at COP15 on 19 December 2022. This includes ambitious targets to halt and reverse biodiversity loss, protect 30% of land and sea for biodiversity, restore degraded ecosystems and halve nutrient loss to the environment, all by 2030. A new Biodiversity Strategy for Northern Ireland is under development, to align with the agreed Global Biodiversity Framework vision and targets and will set out the high-level ambition for nature recovery in Northern Ireland, including the need to address key drivers of biodiversity loss, such as nitrogen deposition.

The UK has already committed to put nature and biodiversity on a road to recovery by 2030 as part of the Leaders Pledge for Nature.[12] This Pledge highlights the interdependent crises of biodiversity loss and ecosystem degradation and climate change[13]. It commits world leaders to take ten urgent actions, including on sustainable food production, ending the illegal wildlife trade and implementing nature-based solutions for climate change. UN member states have also adopted the “Colombo Declaration”; a roadmap for action on nitrogen challenges with an ambition to halve nitrogen waste by 2030.[14]

In Northern Ireland we have experienced significant and sustained biodiversity loss since the 1970s, but particularly in the last 20 years. We know that our unique biodiversity in Northern Ireland is at risk, with declines in species and both habitat condition and extent.

This was illustrated through the fourth UK Habitats Directive report (Article 17 report), covering the period 2013-2018, submitted in 2019. The report assessed Northern Ireland habitats based on range, area, structure, functions, and future prospects. It found that the majority of Northern Ireland habitats continue to be in ‘unfavourable-bad’ conservation status, with 1 out of the 49 priority habitats in favourable condition. Northern Ireland priority species[15] (those species which require conservation action) are faring somewhat better at this stage but only 12 out of 28 are deemed to be at favourable conservation status.

Nitrogen deposition is recognised as a key pressure and threat to biodiversity in Northern Ireland. Nitrogen pollution, and in particular, ammonia emissions, threaten existing commitments to safeguard Northern Ireland’s biodiversity. Specific air pollution objectives to maintain or, where necessary, restore concentrations and deposition of air pollutants to at or below the site-relevant Critical Load and level are now listed in the site conservation objectives for each of our Special Areas of Conservation.

12 https://www.gov.uk/government/news/pm-commits-to-protect-30-of-uk-land-in-boost-for-biodiversity
13 https://www.leaderspledgefornature.org/Leaders_Pledge_for_Nature_27.09.20.pdf
14 https://www.unep.org/news-and-stories/press-release/colombo-declaration-calls-tackling-global-nitrogen-challenge
15 https://www.daera-ni.gov.uk/articles/northern-ireland-priority-species

To reverse the loss of biodiversity and ecosystem services and restore nature we must address the key factors driving species and habitat loss. Northern Ireland will be particularly reliant on nitrogen and ammonia-sensitive habitats to deliver nature-based solutions for climate change mitigation and adaptation, so it is vital that we move quickly to address the excessive air pollution contributing to their demise and loss of function. In short, Northern Ireland's biodiversity is not where it should be. We must improve our performance to meet our legal obligations and to protect and enhance our environment. Urgent action is required, including action on reducing ammonia emissions.

1.6 Ammonia and Human Health

Ammonia can persist for a long time in the atmosphere and be transported for long distances. It can react with other air pollutants like nitrogen dioxide and sulphur dioxide to form ammonium aerosols, which are precursors for fine particulate matter, such as PM2.5 and PM10. Particulate matter (PM) consists of fine particles that, once in the air, are harmful to human health.

Although ammonia is one of a number of contributory factors to harmful particulate matter air pollution, it is clear that reducing ammonia emissions will have a positive impact on human health. Particulate matter is cited in the Clean Air Strategy for NI - Public Discussion Document, as being one of the air pollutants of concern in NI.[16] The Discussion Document highlighted a report published by Public Health England which estimated that in 2010, 553 deaths in over-25s in Northern Ireland were attributable to exposure to anthropogenic air pollution ($PM_{2.5}$). The fraction of mortality due to anthropogenic air pollution in Northern Ireland district council areas ranged from 5.2% in Belfast to 2.5% in Fermanagh with an average for Northern Ireland being 3.8%.[17] The report estimated that, overall, deaths in the whole of the UK due to $PM_{2.5}$ exposure was ca. 5.3%.

DAERA is engaged with partners including Defra, the UK Environment Agency, and the National Institute for Health Research, on a number of research projects exploring the link between the health impacts of air pollution (especially that derived from ammonia emissions) and agricultural activities. One of these projects will provide further information on the health effects of air pollution in the vicinity of farms, while another is looking at how air quality is linked with policies on food production and agriculture.

16 https://www.daera-ni.gov.uk/clean_air_strategy_discussion_document
17 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/332854/PHE_CRCE_010.pdf

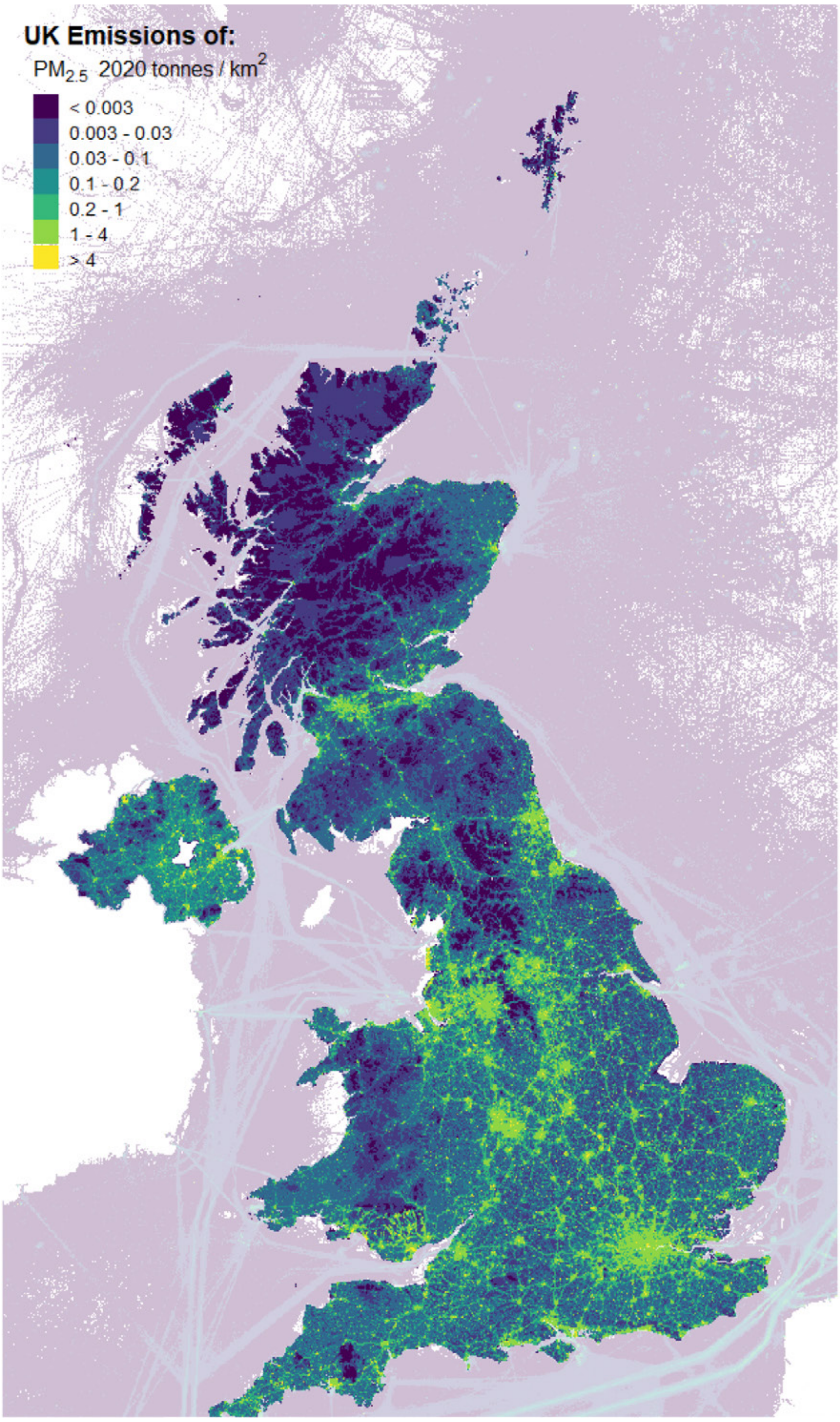

Figure 3. $PM_{2.5}$ emissions in 2020 across the UK [18]

18 https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=122&emiss_maps_submit=naei-20220920143613 .

1.7 Ammonia Trends in Northern Ireland

Northern Ireland has 6% of the UK land area and 3% of the population and is responsible for 12% of UK ammonia emissions. 97% of ammonia emission in Northern Ireland come from the agriculture sector. As highlighted in Figure 4, between 2009 and 2019, ammonia emissions from agriculture in Northern Ireland increased by almost 19% and have reached levels similar to those experienced at peak levels in the late 1990s. This 19% rise in emissions was due to a trend of increasing livestock numbers and greater use of indoor housing systems without a corresponding widespread uptake of ammonia reduction measures.[19] Sustained and tangible reductions in ammonia are required to protect nature, to meet Northern Ireland's legal obligations, and to ensure a sustainable agri-food sector.

A map of ammonia emissions across the UK shown in Figure 5 illustrates the pattern of emissions across different regions. There is a clear difference in ammonia emission levels between areas with lower level of agricultural activities such as the highlands of Scotland and areas with higher levels of agricultural activities.

The UK has committed to reduce ammonia and other emissions under the international Gothenburg Protocol and the National Emissions Ceiling Regulations (2018). The agreed reductions in ammonia emissions are 8% by 2020 and by 16% by 2030, based on 2005 levels. Northern Ireland is expected to contribute to these targets. In the Defra Clean Air Strategy of 2019, the UK reiterated its commitment to the reduction of ammonia emissions by 16% by 2030.

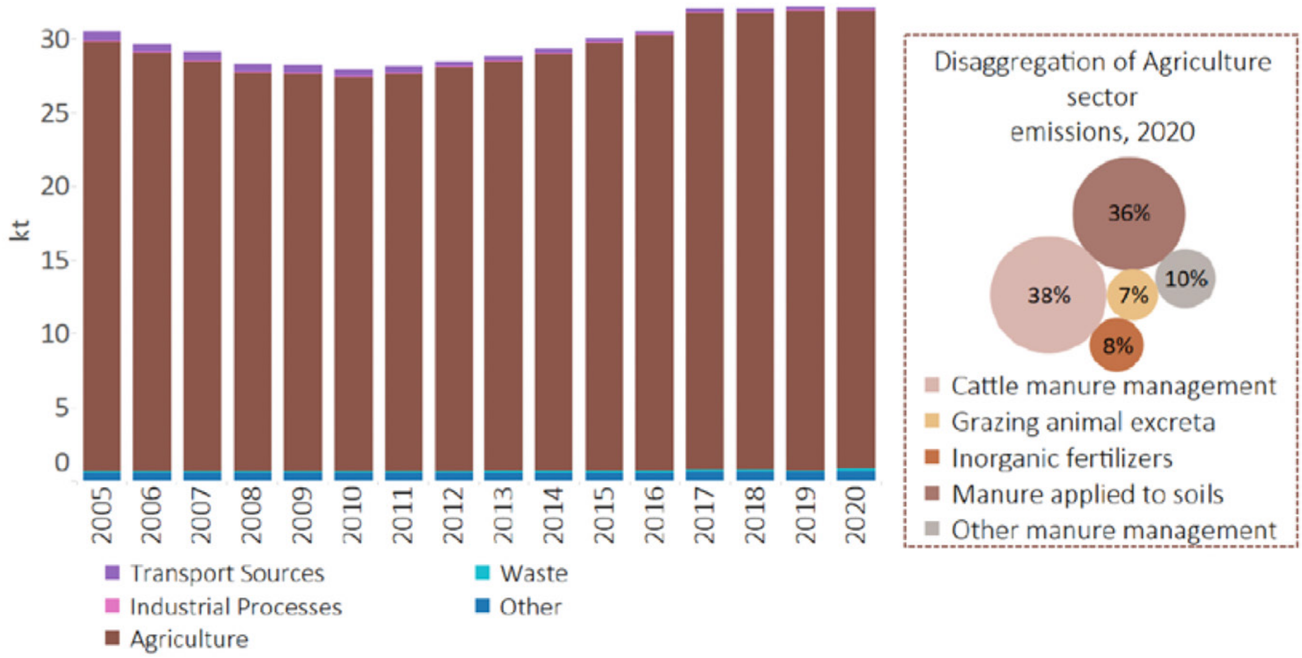

Figure 4. Total Annual Agricultural Ammonia Emissions in Northern Ireland from 2001 to 2020, including disaggregation of agriculture sector emissions.[20]

19 https://www.daera-ni.gov.uk/publications/northern-ireland-environmental-statistics-report-2021

20 https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2210251052_DA_Air_Pollutant_Inventories_2005-2020_FINAL_v1.2.pdf

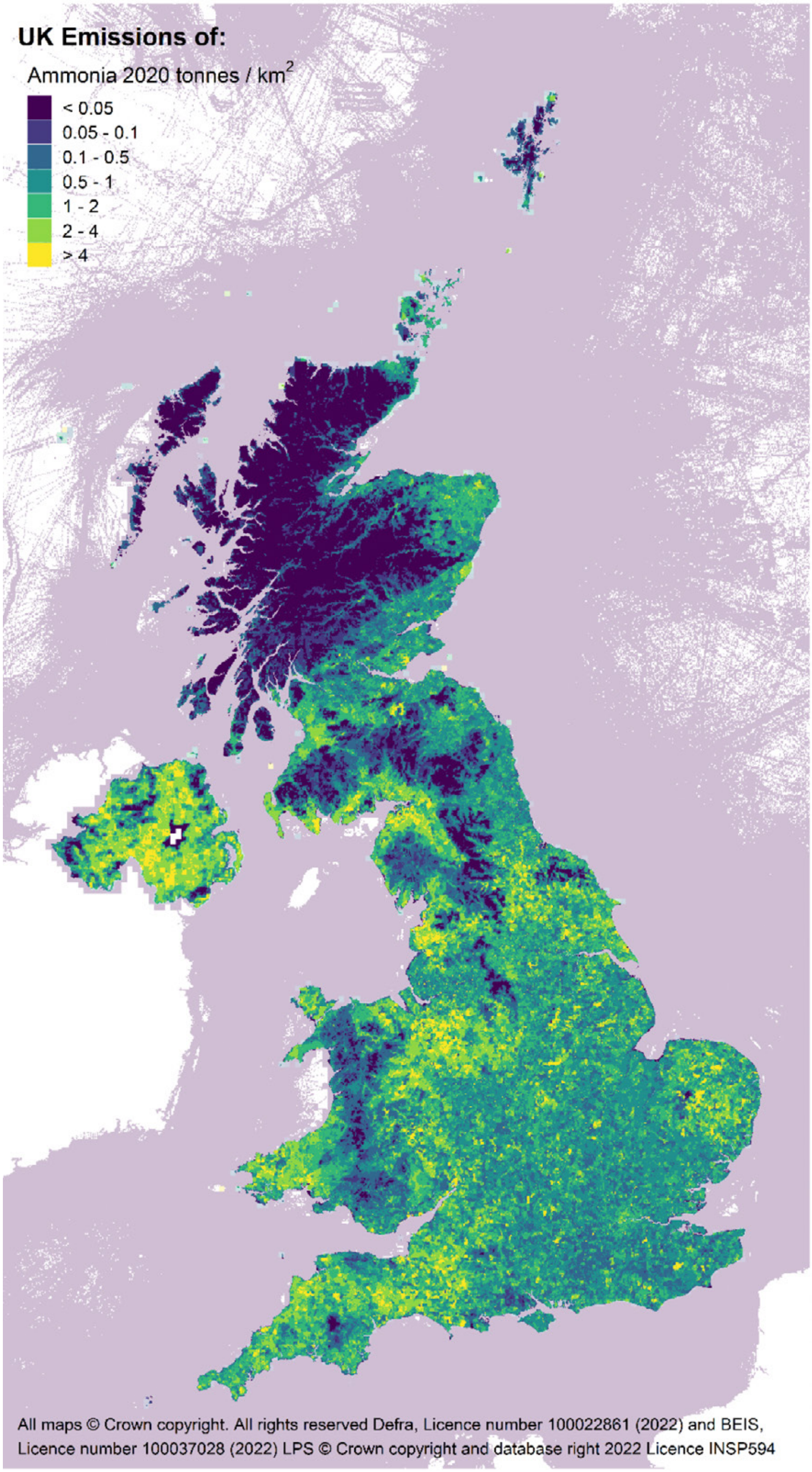

Figure 5. UK Ammonia Emission Map Data in 2020 [21]

21 https://naei.beis.gov.uk/data/map-uk-das?pollutant_id=21&emiss_maps_submit=naei-20220920143613

1.8 The Role of Agriculture in Ammonia Emissions

Agricultural ammonia emissions are spread across the various sectors of the NI farming industry. In 2020 cattle accounted for 66.3%, with the dairy sector producing 37.3% and beef 29% of agri ammonia emissions. The poultry sector was responsible for 12.3% while pigs accounted for 7.8% of total agri ammonia emissions. Sheep produced 2.6% of agri ammonia, 7% of emissions were from fertiliser and digestate to land accounted for 4% of emissions (Figure 6).

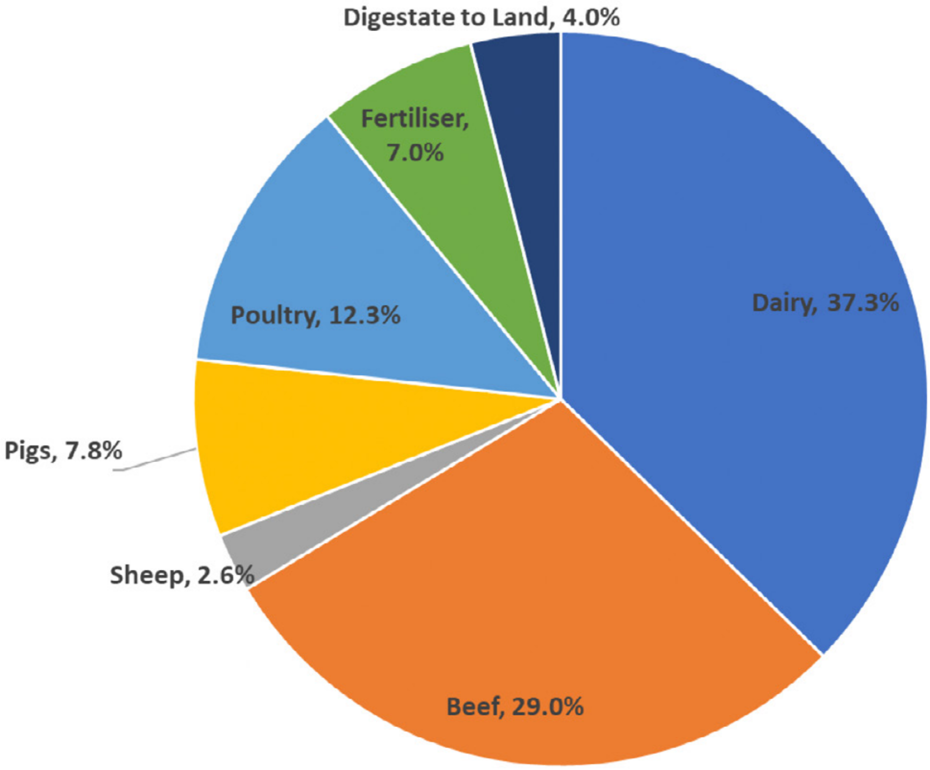

Figure 6. NI agricultural ammonia emissions (2020) by livestock and fertiliser category.[22]

The management and application of manure from livestock housing is the key driver of ammonia emissions in Northern Ireland and is responsible for a combined 81.5% of all emissions. Sources of ammonia emissions by activity in Northern Ireland in 2020 are shown in Figure 7. Application of fertiliser to grassland accounts for 6.6% of emissions while grazing livestock produces 7.4% of ammonia; these relatively low proportions highlight the importance of grassland grazing within cattle systems in limiting ammonia emissions.

22 https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2210251052_DA_Air_Pollutant_Inventories_2005-2020_FINAL_v1.2.pdf

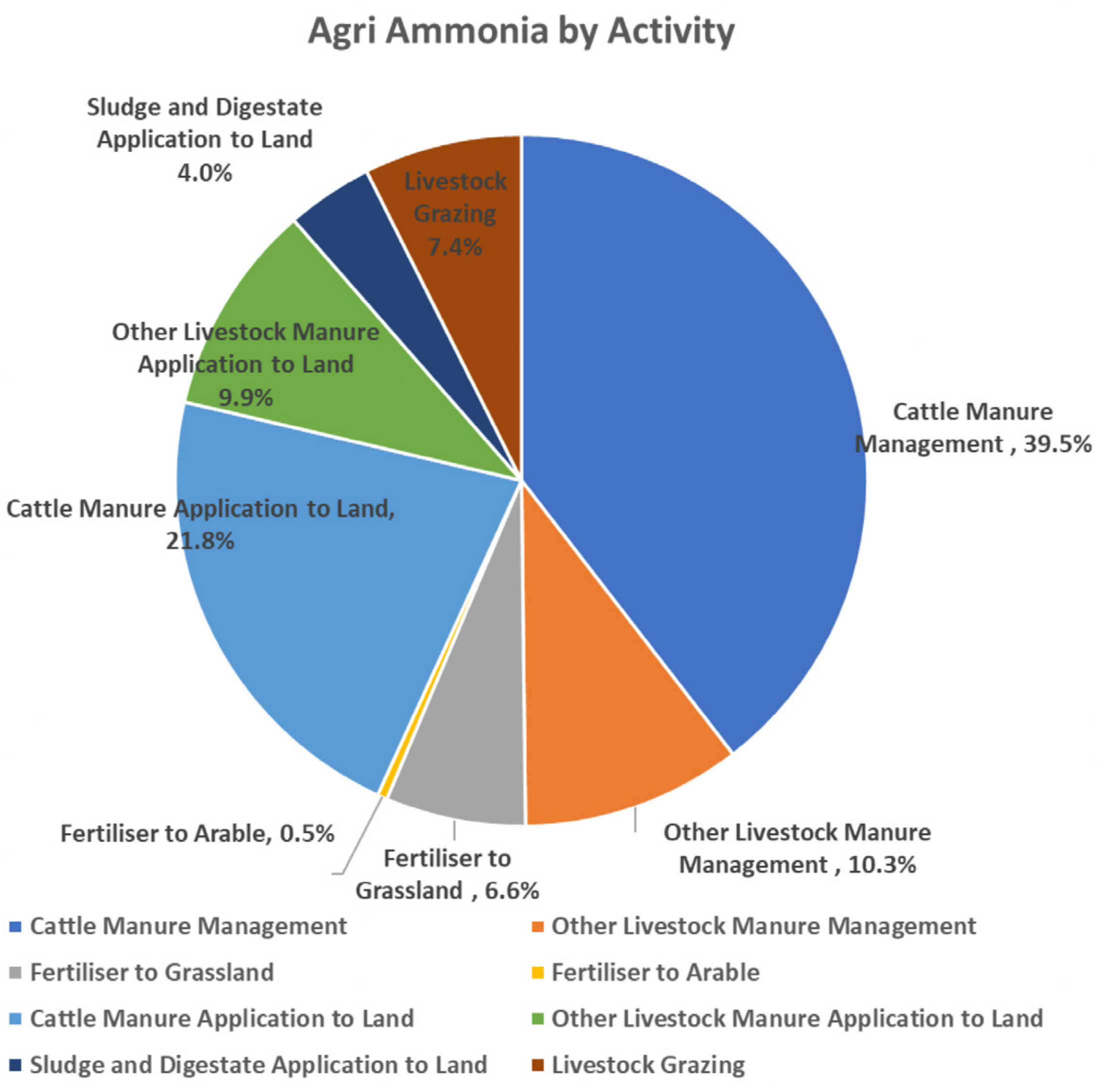

Figure 7. Northern Ireland agricultural ammonia emissions (2020) by activity category.

1.9 Ammonia Emissions and Nitrogen Deposition in the Atmosphere

Ammonia is a mobile gas which travels in the atmosphere in the direction of the prevailing wind away from a source such as a livestock house. Studies have shown that the concentration of ammonia in the air generally drops rapidly from very high concentrations close to the source to much lower levels further from the source. However, depending on the initial concentrations and the distance travelled, these lower ammonia concentrations may still be ecologically damaging.

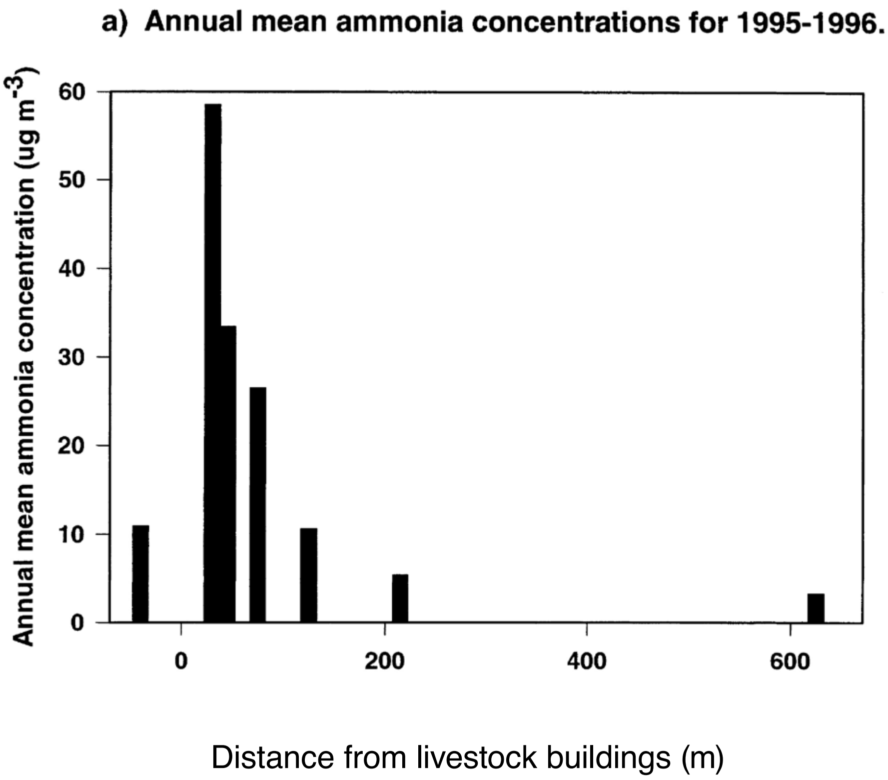

Figure 8a. Measured evidence of drop off in ammonia concentration levels.

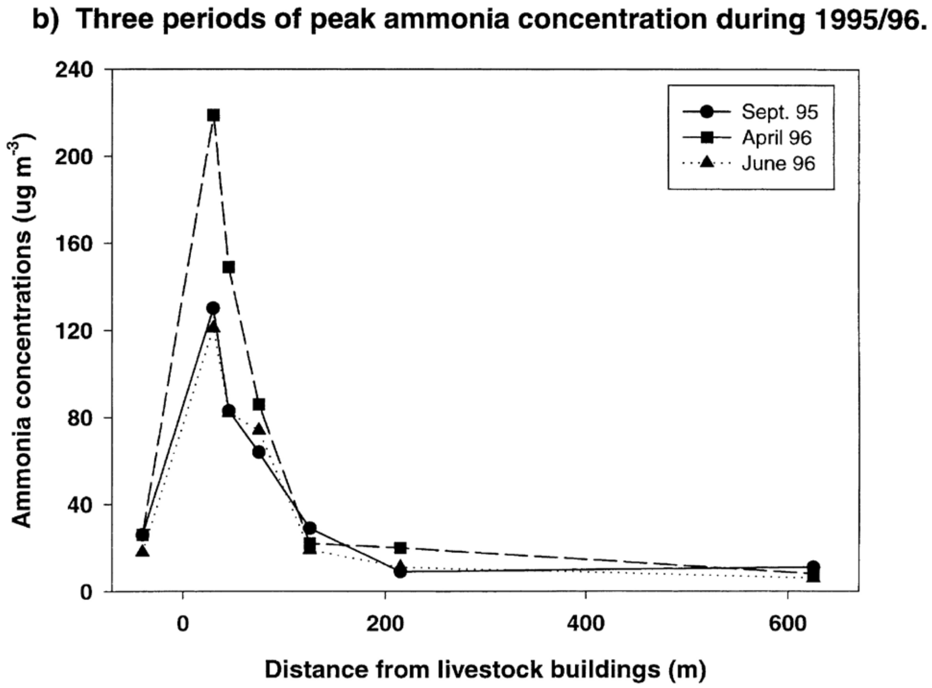

Figure 8b. Measured evidence of drop off in ammonia concentration rates.[23]

Figures 8a and 8b display the initial rapid drop off in concentrations from a poultry farm. In Figure 8a average annual concentration measurements drop from over 200 µg/m3 close to the source to 3 µg/m3 at 650 metres from the source. However, this is still greater than the Critical Level of 1 µg/m3 for mosses and bryophytes. The Critical Level is the concentration above which direct adverse effects may occur.

Figure 8b shows the rapid drop-off in monthly emitted concentrations within the first 200 m from the point source, with concentrations levelling off within 200-600 m (600 m is the greatest distance measured in this study). Ammonia concentrations beyond 200 m can remain relatively high. The lowest level of ammonia measured close to the source increment on the left-hand side axis of this graph is 40 µg/m3 which is 40 times the lower Critical Level for protection of mosses and bryophytes. Ammonia will remain in the atmosphere until eventually deposited or transformed into longer range pollutants.

Wet deposition plays an increasingly significant part in the deposition profile after 10 kilometres, where ammonia has combined with other particles or with moisture in the atmosphere to form an aerosol usually of ammonium (NH4+) compounds. After a 100km transport, about 60% of the released ammonia has been deposited (wet deposition). There is, however, also transport over very long distances: after 1,000km about 20% of the original ammonia is still in the atmosphere in some form.

23 Ammonia concentrations at a Poultry Farm. (a) Annual mean ammonia concentrations for 1995-1996; (b) Three periods of peak ammonia concentration during 1995-1996. C.E.R. Pitcairn et al./Environmental Pollution 119 (2002) 9-2113..

Given that the experimental evidence above shows that a single farm can be responsible for ammonia levels much greater than the Critical Level for sensitive habitats hundreds of metres away, significant contributions to ammonia concentrations at a designated site can be made by farms at a wide range of distances. The Critical Levels at a nitrogen sensitive site are the highest total ammonia concentration that the site can safely tolerate. Therefore, even proportionally small contributions towards this total from individual farms can be of significance. This is why the potential for impacts from new ammonia emitting developments needs to be assessed at many kilometres around a designated site. Currently the screening distance applied to ammonia emitting developments in Northern Ireland is 7.5km.

1.10 Operational Protocol for Assessing Atmospheric Nitrogen Pollution

DAERA, in its role as the Statutory Nature Conservation Body, has a duty to provide advice to planning authorities and other competent authorities in relation to the potential impacts of planning proposals on designated sites and protected habitats. In addition, NIEA must also consider the impacts on designated sites from industry, including intensive agricultural activities, before issuing environmental permits for these operations.

The Department and public bodies, in undertaking their statutory responsibilities, must be cognisant of the requirement that projects or plans should only proceed where the absence of adverse effects on the integrity of any Special Area of Conservation (SAC) can be demonstrated. Projects should not damage or have an adverse effect on ASSI features or site integrity while priority habitats and species are also afforded protection. An Operational Protocol for assessing air quality impacts on protected habitats to inform planning, licensing and permitting decisions. assessment of ammonia emissions was developed in 2012. This Protocol currently provides guidance and assessment criteria for use by Competent Authorities, such as various parts of NIEA as well as local planning authorities, in assessing the impacts of ammonia emissions associated with planning applications and industrial permits.

DAERA plans to develop a Call for Evidence to inform the future Operational Protocol for assessing air quality impacts on protected habitats to inform planning, licensing, and permitting decisions. It is envisaged that the Call for Evidence will set out current evidence for consideration in development of DAERA's future Operational Protocol and give stakeholders the opportunity to provide views and feedback, including the provision of any additional evidence. It will consider environmental issues, the role of new technologies, and the economic impacts of any proposed changes. It will also take into consideration other pressures on designated sites such as changes in weather patterns, water table levels and tree planting, with Case Studies.

Chapter 2: Addressing the Ammonia Challenge: Actions so far

Key actions already taken by DAERA to address the ammonia challenge include:

- Commissioning of a report on ammonia from the Expert Working Group on Sustainable Agricultural Land Management.
- Funding a comprehensive research programme on ammonia in Northern Ireland.
- Publication of a Code of Good Agricultural Practice on Ammonia Emissions.
- Implementing a Nutrients Action Programme which includes actions to reduce ammonia emissions.
- Supporting positive behavioural change through the Environmental Farming Scheme
- Provision of the Small Woodland Grant Scheme which offers support for establishment of tree plantations around livestock housing to reduce the impact of ammonia emissions through recapture.
- Supporting adoption of Low Emission Slurry Spreading Equipment (LESSE) through the Farm Business Improvement Scheme (FBIS).
- Development of the Ruminant Genetics Programme to breed cattle which are more environmentally efficient.

2.1 The 'Making Ammonia Visible' report

In December 2017, the Expert Working Group published an annex to their report titled 'Making Ammonia Visible.' This report highlighted the impact of ammonia on nature and emphasised that nitrogen is a key farm input which should be used efficiently within agricultural systems to avoid release to the atmosphere. The Expert Working Group's overarching recommendation stated that:

To achieve a sustainable future for Northern Ireland's agri-food sector, ammonia emissions must be addressed through a partnership approach which incorporates communication and education on ammonia, investing in filling our ammonia knowledge gaps and implementing a range of ammonia mitigation measures; and not on contracting the size of this sector.

The recommendations of the 'Making Ammonia Visible' document were used to inform the work undertaken in the production of this consultation document. Further detail on 'Making Ammonia Visible' can be found at Annex B.

2.2 Northern Ireland Ammonia Research Programme

To inform policy on ammonia emissions, DAERA has commissioned a research programme on ammonia, led by the Agri Food and Biosciences Institute and incorporating the UK Centre for Ecology and Hydrology (UKCEH) and Rothamsted Research as partners, and informed by the recommendations of the Expert Working Group in 'Making Ammonia Visible'. The key outputs of this research so far have been:

- Provision of detail on NI farming practices to the ammonia inventory to improve the future estimates of emissions from Northern Ireland. Examples of data provided include information on:
    - Cattle housing periods.
    - The proportion of pigs housed on slurry systems.
    - Numbers of free-range poultry systems.
    - Broiler heating systems.
    - Slurry application activity.
- The modelling of a series of ammonia reduction measures for implementation on farms in Northern Ireland. These measures were similar to those outlined in Chapter 4. A combination of measures was assessed with different implementation rates for each measure, based on what was considered to be achievable over a 5 to 10 year policy cycle. The modelling found that implementing this combination of measures would reduce ammonia emissions across Northern Ireland by 25%. Achieving a 25% reduction in ammonia emissions by applying these measures across Northern Ireland would result in 2 SACs and 14 ASSIs being brought out of exceedance of the 1 μg NH3 m-3 Critical Level (based on maximum concentrations at sites). While the large majority of sites continue to experience exceedances despite these measures, the extent of that exceedance would reduce considerably, by over 30% at most sites.
- The modelling also examined the impact of implementing a specific portfolio of ammonia reduction measures in targeted zones around designated sites. This generally meant higher implementation rates of the measures modelled across Northern Ireland, as well as a limited number of additional measures in those areas. Although the modelling of these specific NI-wide and targeted measures found that the greatest bulk of ammonia concentration reductions at designated sites occur due to the implementation of the NI wide measures, an additional 1% to 5% ammonia reduction across Northern Ireland was achieved by implementation of the spatially targeted measures around designated

sites. Implementation of the spatially targeted measures is much more effective in reducing ammonia concentrations and nitrogen deposition at designated sites, per unit of emission saved. Local spatial targeting of measures has been shown to be more effective at "spot- reducing" high concentrations of ammonia and dry deposition than the same amount of emission reduction spread more widely across the country.

- The effectiveness of local measures has also been identified within the Defra funded Nitrogen Futures project final report[24]. The final report recommended consideration of an optimised two-pronged approach, combining UK and DA wide, and locally targeted measures. Ambitious UK and DA wide measures to decrease emissions would provide benefits in both source areas and remote areas, working towards decreasing effects on sensitive priority habitats and designated sites. The report found that spatial targeting through selection of locally relevant, appropriate, and sufficiently ambitious measures can achieve substantial local benefits. Nitrogen Futures provides further detail on the relative effectiveness of the proposed Northern Ireland wide measures and helps to define those sites where Critical Load and level exceedance is still likely to be at a damaging level and which require more spatially defined measures and greater certainty of achieving the necessary level of reduction.

- Case studies (available at Annex C) were produced to analyse a number of typical farm scenarios to highlight and communicate what is possible for ammonia reduction at individual farm level. These case studies show that significant reductions can be achieved at farm level with the implementation of an ambitious combination of reduction measures. For example, ammonia emissions can be reduced by over 40% at farm level in both the dairy and beef sector, by 40% to 80% in the pig sector and around 25% in the poultry sectors. This analysis also shows that dairy systems where cattle are housed all year round produce 57% more ammonia than systems where cattle graze grass during the summer months and 33% more ammonia per litre of milk produced.

- Twenty-eight ammonia monitoring stations were established across Northern Ireland as part of an AFBI research project to boost the existing programme which records ammonia concentrations in the air across the UK (until March 2019 there were only 3 stations in NI). The additional monitoring stations have been used to validate the models which estimate ammonia emissions, concentrations, and deposition. Measurements at these sites provide average monthly data. Reports from the first 3 years of data show that concentration levels being measured by the NI ammonia monitoring networks correlate well with the annual average ammonia concentrations predicted by modelling.[25] This monitoring will continue on a longer-term footing to track trends overtime and determine the efficacy of the ammonia strategy once implemented.

24 https://data.jncc.gov.uk/data/04f4896c-7391-47c3-ba02-8278925a99c5/JNCC-Report-665-FINAL-WEB.pdf

25 Y.S. Tang, Tomlinson S.J., I.N. Thomas, E.J. Carnell, Williams M., B. Tanna, H. Guyatt, I. Simmons, A.C.M. Stephens, D. Leaver, C.F. Braban, P.O. Keenan, A. Lawlor, G. Dos Santos, J. McIlroy and U. Dragosits (2020) Atmospheric ammonia, acid gas and aerosol measurements in Northern Ireland. Year 1 - final report: March 2019 to February 2020. Report to Daera. 66pp. (Feb 2021)

- An AFBI economic analysis examined the farm-based costs of implementing ammonia reduction measures using a Marginal Abatement Cost Curve Approach (MACC). This analysis found that implementing a full range of feasible ammonia reduction measures, including both low and high-cost options, could achieve a total reduction in ammonia of 25 to 28%, depending on the uptake levels achieved for the measures. The annual cost of implementing these measures was found to range from £31.24 million to £43.65 million, depending on the uptake rate achieved. Implementation of the five lowest cost measures only would reduce ammonia emissions by 21% at an annual cost of £6.63 million. While these measures (longer grazing seasons, stabilised urea, lower crude protein, genetic improvement and low emission slurry spreading) are the most cost-effective, it is important to note that there may be more complexities involved in monitoring compliance of uptake of these lower cost measures and transactional costs for farmers relating to changes in daily management practices and decisions on the farm. The cost of monitoring also has to be taken into consideration. This work was presented as part of a series of DAERA Science Webinars on ammonia available to view at: https://www.daera-ni.gov.uk/articles/ammonia-emissions-northern-ireland

The key policy messages from this research are that:

- It is possible to achieve significant ammonia reductions on individual farms.
- Outdoor grazing systems play an important part in minimising emissions.
- A long-term strategic approach is needed to address ammonia emissions and their impact in Northern Ireland.
- An ambitious programme of measures will be required to reduce emissions.
- The selection of measures within this programme should take account of cost- effectiveness.
- Targeting some measures in the areas around designated sites will provide greater benefit to protected habitats.
- Remedial and conservation management actions are required at designated sites to reduce the risk of damage to biodiversity.
- Plans are needed to encourage development of new ‘next generation’ ammonia solutions to drive further reductions in ammonia in the future. The potential of these new solutions is being examined through an AFBI Horizon Scanning project.

Further information on the DAERA funded research programme can be found at Annex B.

Scientific knowledge will be critical to developing the next phase of ammonia reduction technologies and over the next 5 years the DAERA directed Agri-Food and Biosciences Institute (AFBI) research work programme will, in addition to other research:

- Assess how emissions from slurry spreading can be further minimised.
- Assess treatments to reduce ammonia emissions from livestock slurry storage in Northern Ireland.
- Assess mitigation strategies to reduce ammonia emissions from poultry production systems.

2.3 The DAERA Code of Good Agricultural Practice for the Reduction of Ammonia Emissions

DAERA published the Code of Good Agricultural Practice (CoGAP) for the Reduction of Ammonia Emissions in May 2019. The CoGAP is a guidance document explaining how farmers, growers, land managers, advisers and contractors can minimise ammonia emissions from agriculture. It covers how reductions in ammonia emissions can be achieved by making changes to the way in which livestock are housed and fed, the use of fertiliser, and especially through the management of slurries and manures.[26]

The Code sets out voluntary best practice measures to complement existing and future statutory requirements. It was written by DAERA in collaboration with the Ulster Farmers' Union, the Northern Ireland Grain Trade Association and the Agri-Food and Biosciences Institute.

The areas covered by the DAERA CoGAP for the Reduction of Ammonia Emissions are:

- Reducing ammonia emissions when storing organic manures.
- Applying organic manures effectively and efficiently.
- Using chemical nitrogen fertilisers effectively and efficiently.
- Pasture practices - longer grazing seasons, use of clover swards and multi-species swards.
- Reducing emissions through livestock diets.
- Incorporation of ammonia reduction techniques in livestock housing.

Uptake of these CoGAP measures will be of critical importance in reducing ammonia emissions.

26 https://www.daera-ni.gov.uk/publications/code-good-agricultural-practice-reduction-ammonia-emissions

2.4 Reducing Emissions through the Nutrients Action Programme (NAP) and improving soil health.

Although the NAP primarily addresses the impact of agriculture on water quality, many of the farm measures which improve water quality will also reduce emissions. The most recent version of NAP introduced a number of measures which will have a significant positive impact on ammonia emissions:

i. Phasing in a requirement to spread nutrients using low emissions slurry spreading equipment (LESSE) for:

    1. All farms operating under a derogation from the Nitrates Directive after 15th June each year.

    2. All spreading of anaerobic digestate from 1st February 2020.

    3. All spreading of slurry by contractors from 1st February 2021.

    4. All spreading of slurry on cattle farms with 200 or more cattle livestock units and pig farms with a total annual livestock manure nitrogen production of 20,000kg or more from 1st February 2022.

ii. Requiring all new slurry stores (including lagoons and tanks) to be fitted with a cover, and all existing stores which are substantially enlarged or reconstructed.

DAERA has commenced a Soil Nutrient Health Scheme (SNHS). It is aimed at improving soil nutrient health and estimating farm carbon stocks across Northern Ireland. The scheme is being delivered by the Agri-Food and Biosciences Institute (AFBI) with contractors collecting the soil samples. The SNHS will provide farmers with detailed information on soil nutrient levels for each field on their farm, as well as an estimate of the amount of carbon stored in their soils, hedgerows, and trees. They will be provided with specific training on understanding and using the nutrient and carbon data on their farms.

Equipping farmers with this information will help them more accurately match nutrient applications to crop need, thereby increase efficiency, reducing excess run-off to watercourses and improving their economic and environmental sustainability. Where excess use of nutrient is reduced, there will be a positive correlation with ammonia emissions.

2.5 The Environmental Farming Scheme

DAERA's Environmental Farming Scheme (EFS) is a voluntary scheme under the NI Rural Development Programme 2014-2021. EFS offers participants a five-year agreement to deliver a range of environmental measures and opened in 2017. The EFS has two main elements: the wider level EFS (Wider), and the higher level EFS (Higher). There are also a small number of Group Projects in targeted priority areas such as environmentally designated sites. These projects are run by independent facilitators who support EFS agreement holders to help deliver co-ordinated action across the project areas. EFS is spatially targeted using Geographic Information System (GIS) technology.

EFS (Wider) aims to improve biodiversity and water quality and sequester carbon across the wider countryside by creating green infrastructure. Options include establishment of agroforestry, planting native woodland, tree corridors and traditional orchards and riparian margins to protect watercourses. Where implementation of measures under EFS leads to a reduced intensity of farming in a particular area, there will be a corresponding reduction in ammonia emissions.

EFS (Higher) aims to improve habitat condition and biodiversity through site specific management plans on environmentally designated land and priority habitat to deliver favourable management. A wide range of prescriptive measures can be undertaken including conservation grazing, heather regeneration and invasive species removal according to the specific site characteristics. There are currently some 5,500 farmers in the EFS after five tranches, with the agreements covering over 63,000 ha of land. These types of conservation measures will build the resilience required in our habitats, as outlined further in chapter 5.

The range of group projects support a coordinated approach among farmers in EFS to deliver environmental benefit on a landscape scale, for example, on environmentally designated land and within water catchments. DAERA funds external facilitators to implement these group projects. Facilitators encourage EFS uptake in specific areas of environmental importance and provide a range of ongoing support to farmers to help them implement their EFS agreements. This can include regular workshops, farm walks, demonstrations, field trips and one-to-one advice on a range of EFS topics. Six EFS group projects are in place with membership across the groups currently totalling some 600 farmers. Tranche 6 of the EFS opened for applications in 2022.

Chapter 3: The Strategic Approach to Ammonia

3.1 Targets

Building on the policy messages arising from the scientific evidence base and in recognition of DAERA's legal obligations to reduce emissions and protect habitats, a series of targets are required to set an ambition and guide action.

The long-term target is to reduce ammonia emissions to a point where Critical Loads of nitrogen deposition and Critical Levels of ammonia are not being exceeded at designated sites.

Given the generational challenge posed by the scale of current exceedances, interim targets are required. The targets DAERA proposes for 2030 are to:

- Reduce agricultural ammonia emissions from Northern Ireland by at least 30%, based on the 2020 emissions levels (from 31.2 kt in 2020 to 21.8 kt in 2030).
- Reduce ammonia concentrations at all designated sites by at least 40% (using 2020 as the baseline year) or to below Critical Levels.

Q1: What are your views on the Northern Ireland wide 2030 targets outlined in the 3.1 Targets section?

3.2 Pillars of the Ammonia Strategy

A coherent approach to ammonia which can deliver on the targets must include the following elements:

1. An ambitious and verifiable ammonia reduction programme:
    - Implemented on a Northern Ireland-wide basis; and
    - Spatially targeted in areas around designated sites.
2. A strategic programme of conservation, restoration, and management of our most valuable habitats.

Q2: What are your views on the proposed pillars of the Ammonia Strategy?

This is a 5-year strategy which will set Northern Ireland on a pathway to achieving the 2030 and 2050 targets. To enable this strategy, DAERA will:

- Support a science and innovation agenda that informs best practice on delivery of the targets.
- Support farmers to deliver changes through appropriate mechanisms.

Q3: What are your views on how DAERA will enable this strategy?

Chapter 4: Pillar One: An Ammonia Reduction Programme

A programme of measures to achieve the required tangible and sustained reductions in ammonia in Northern Ireland to restore habitats should be:

- Ambitious
- Proportionate
- Well evidenced
- Clear
- Deliverable on farm
- Verifiable

The measures highlighted below represent an analysis of the best means to reduce ammonia emissions and improve environmental outcomes using these guiding principles. Not all measures proposed are at the same stage in their development. For example, low emissions slurry spreading is already in the process of implementation, while lowering crude protein in livestock diets will need partnership working between government and stakeholders to deliver verifiable systems to enable widespread adoption.

This series of measures is informed by the scientific evidence outlined earlier on the need for ammonia reduction and how this can best be achieved. Some measures appear most appropriate for spatial implementation close to designated sites where the investment required in ammonia reduction technologies will have the greatest impact. Not every measure will be appropriate on every farm, but these measures provide options which any farm can adopt to contribute to reducing ammonia emissions across Northern Ireland. As a package, they offer an opportunity to take a crucial leap forward in our drive to reduce emissions, restore habitats, and support a sustainable and prosperous agriculture sector.

4.1 The Measures

The proposed measures listed in Box 1 and outlined in this draft strategy present a clear and well evidenced rationale for action over the next four years to set Northern Ireland on a pathway to achieving the 2030 targets.

Box 3: Proposed Measures to Reduce Ammonia

1. **Low Emission Livestock Housing**
2. **Emerging Technologies**
3. **Low Emission Slurry Spreading Equipment (LESSE)**
4. **Longer Grazing Seasons**
5. **Move to Stabilised Urea Fertiliser**
6. **Reducing Crude Protein in Livestock Diets**
7. **Improving Feed Efficiency Through Genetic Improvement**
8. **Establishing Tree Plantations around Livestock Housing**
9. **Covering Above Ground Slurry Stores**

4.1.1 Low Emission Livestock Housing

Installation of appropriate technologies in livestock housing has the potential to deliver large reductions in ammonia emissions. For example, scientific evidence has shown that installation of appropriate slat mats with scrapers in cattle housing can reduce housing emissions by up to 49%. [27] There has already been good uptake of slat mats across Northern Ireland. There are other potential husbandry benefits from such systems, including improvements in animal health and productivity due to greater comfort and reduced lameness. Technology is constantly evolving with innovative ways of managing manure and urine to prevent ammonia emissions emerging onto market, such as those highlighted in section 4.3. These types of technologies can be used to significantly reduce ammonia emissions in cattle housing.

There are also many options for pig and poultry systems to reduce emissions from housing. Progress has been made towards this objective in the poultry sector through the uptake of indirect hot water heating systems. Belt removal systems, litter drying, and heat exchangers will reduce emissions in poultry systems. Technological methods to reduce ammonia emissions in pig housing include adapted flooring systems, slurry cooling, frequent slurry removal, pit flushing with water, installation of scrapers in under-slat pits, and installation of acidification systems. Air scrubbers in enclosed pig and poultry units also have very significant potential to reduce emissions. New developments in air scrubbing systems mean that practical options for

27 Annex AFBI Beef Case Studies

retrofitting are becoming increasingly available but capital and running costs remain relatively high.

This strategy aims to drive significant levels of uptake of ammonia reduction technologies in livestock housing across all sectors. Some livestock housing technologies will be capable of retrofitting, but others will require replacement of existing housing stock. DAERA's plan to support farmers in this transition are laid out in section 4.2.1 on Green Growth.

We want to:

- **Support farmers to install ammonia reduction technologies in livestock housing through financial assistance.**

Q4: Do you have any comments on the proposals for low emission livestock housing?

4.1.2 Emerging Technologies

As highlighted in the Executive's draft Green Growth strategy, harnessing new technology and embracing innovation is the bedrock of our future plans. This principle applies in our efforts to address ammonia emissions. To achieve the ambition of this strategy, new technological solutions will be required. DAERA have commissioned a horizon scanning study to seek and review novel approaches for ammonia reduction across the globe. The aim of the study is to determine the potential for innovative and cost-effective ammonia reduction strategies to be introduced to NI agriculture.

Amongst these technologies there are immense opportunities for farmers to harness the nutrient potential of their farm to achieve better outcomes. There are a series of technologies not currently widely utilised in NI but which have immense potential to reduce ammonia emissions and deliver on other environmental metrics such as GHGs and nutrient efficiency. These include:

- Slurry cooling systems.
- Nutrient recovery and renewable energy systems (ammonia stripping).
- Plasma treatment of slurry.
- Acidification of slurry.
- Reverse osmosis.
- Nitrogen capturing systems within livestock housing.
- Technologies which facilitate the separation of urine and faeces in cattle housing.

We want to enable the uptake of verifiable ammonia reduction technologies in appropriate ways across Northern Ireland. While these types of systems can be very effective in reducing ammonia emissions, we need to ensure that the overall impact on the environment is positive and well understood. Research is ongoing throughout the UK, including within Northern Ireland to further examine the impacts of acidification and other slurry amendments. The AFBI horizon Scanning project is examining a range of new technologies for ammonia reduction. Ammonia reduction technologies should not have unacceptable unintended consequences elsewhere in the environment. In particular, emerging evidence on the impact of acidified or lower pH slurry on soil health should be monitored.

In order to encourage and facilitate the development of innovative solutions to ammonia reduction DAERA has established a Science Workstream within its Project Board on Ammonia Reduction. This incorporates leading scientific experts on ammonia from across the UK and advises statutory authorities on novel ammonia reduction technologies.

As technologies evolve, new tools for ammonia reduction are likely to emerge and be taken into consideration through research programmes and available DAERA support schemes. As emerging technologies become established and verified, DAERA will support their uptake through the Green Growth financial package highlighted in section 4.2.1

We want to:

- **Encourage the development and implementation of emerging technologies for ammonia reduction.**
- **Ensure that all available scientific evidence is fully considered to verify the environmental benefits, and any avoid unintended consequences.**

Q5: Do you have any comments on the proposals for emerging technologies?

4.1.3 Low Emission Slurry Spreading Equipment (LESSE)

Low emission slurry spreading is one of the most effective ammonia reduction techniques. Based on existing emission factors, implementation of low emission slurry spreading techniques would achieve by itself a 5 to 10% reduction in total ammonia emissions across Northern Ireland agriculture.[28] Low emission slurry spreading equipment (LESSE) applies slurry at ground level, meaning more nitrogen is retained and less nitrogen is lost to the air as ammonia. Currently the best known LESSE methods are trailing shoe, trailing hose (also referred to as dribble bar), and injection systems.

A trailing shoe can achieve a 60% reduction in ammonia emissions compared to spreading slurry by splashplate. Trailing shoe is the most effective means of reducing ammonia emissions

28 Frost (2007) Occasional publication No. 38, British Grassland Society. Methods of spreading slurry to improve N efficiency on grassland.

on a large portion of Northern Ireland's grassland. Spreading slurry with a trailing hose as shown in Figure 10 also achieves substantially improved environmental performance, currently assessed as a 30% reduction in ammonia emissions compared to spreading slurry by splashplate. A trailing hose is suitable for grassland and arable land (where the slope is less than 15%). Slurry injection systems can achieve a 70-90% reduction in ammonia emissions compared to splashplate.

There are significant agronomic benefits to LESSE use. AFBI research has demonstrated that low emission slurry application increases grass growth by 18% and 26% for trailing hose and trailing shoe respectively. Inorganic nitrogen fertiliser application rates for grass silage crops can be reduced by up to 38 kg per hectare when typical rates of slurry are applied by trailing shoe.

Figure 9. Low Emission Slurry Spreading Equipment: Top - a trailing shoe system; middle - a trailing hose system; bottom - a shallow injection system.

Spreading slurry using low emission techniques has been an important part of government policy on reducing the impact of farming on the environment for many years with financial support first provided in 2009. The Farm Business Improvement Scheme - Capital (Tier 1 of FBIS-C) has substantially increased the use of low emission slurry spreading in Northern Ireland, particularly for the trailing hose technology. Trailing hose has been favoured as it combines nutrient efficiency and environmental performance with ease of use and practical application.

Given the potential for ammonia reduction and the associated benefits for farmers in terms of grass growth and nutrient management, DAERA is proposing that all slurry spreading should be required to take place by low emission techniques by 2026.

An additional progression point for LESSE adoption is proposed which would require slurry which is being exported between farms to be spread by LESSE from 1st February 2025.

Proposals on the spreading of slurry close to designated sites are discussed in the section below on spatially targeted measures.

We want to:

- **Take views on extending the requirement for use of LESSE to slurry exported between farms from 1 January 2025.**
- **Require all slurry to be spread by LESSE from 1 January 2026.**

Q6: Do you have any comments on the proposed additional progression point in the move towards LESSE adoption requiring slurry which is being exported between farms to be spread by LESSE from 1st January 2025?

Q7: What are your views on the proposal to require all slurry to be spread by LESSE by 2026?

4.1.4 Longer Grazing Seasons

Seven percent of ammonia emissions come from grazing livestock whereas 61% of ammonia comes from the management and landspreading of cattle manures and slurries produced in housing (Figure 7). AFBI Case Studies on Farm Modelling of Ammonia Reduction Strategies presented in Annex C show that, for a given herd size, systems where cattle are always indoors produce 57% more ammonia emissions than grazing/housing systems with equivalent cow numbers. All year-round housing systems will cause a reduction in the average days at grazing across the Northern Ireland herd.

Making a significant difference on increasing days at grazing will require a cross-sectoral effort. According to Rothamsted Research data, achieving grazing seasons that are on average one week longer at the beginning and end of each season will reduce total cattle ammonia emissions by 3.5%.[29]

Given the variability of weather in Northern Ireland, the appropriate metric to judge whether a longer grazing season is being achieved should be a five-year rolling average. Optimising grassland management will continue to be a central focus of CAFRE's programmes.

There are a number of successful examples of schemes to implement and verify longer grazing seasons, both in the UK and in other parts of the world. Examples are shown in the case studies below.

Case Study 1. The Free Range Dairy Network (UK)

The Free Range Dairy Network is a social enterprise, with farmer members supplying milk to 365 Asda stores, under the Pasture Promise logo. Cows must spend 75% of their time grazing, achieving a minimum of 18 hours grazing, for 180 days a year.

Independent audits are carried out by SAI Global in addition to Red Tractor inspections.

Producers keep additional records, including a daily diary of the fields grazed and the number of cows grazed. Random inspection of 5% of producers also takes place. Farmers supplying Pasture Promise milk receive a 2.5 ppl premium.

30, 31

29 NARSES modelling conducted by Rothamsted and AFBI.

30 https://freerangedairy.org/

31 https://www.frieslandcampina.com/our-farmers/foqus-planet

Case Study 2. Friesland Campina (Netherlands)

Friesland Campina is a multinational dairy cooperative which rewards grazing and sustainability through their Campina Foqus planet programme. Producers can operate either a full or a partial grazing programme. With full grazing cows must be at grass for 6 hours per day and 120 days. The full grazing premium is €0.125 / 100 kg milk. With partial grazing 25% of cows must be at grass for 6 hours per day and 120 days. The partial grazing premium is €0.46 / 100 kg milk. The programme is partly cooperative with dairy farmers contributing €0.35/100 kg.

DAERA wishes to work with supply chain and farming organisations to agree how best to encourage uptake of this vital measure. We foresee an approach which will:

- Support grazing platform infrastructure: emphasising the importance of simple measures such as laneways, fencing and water troughs to maximise the benefits of controlled grazing systems for rotational grazing.
- Improve recording systems to ensure that farmers can get credit for their efforts to increase grazing, including smart use of technology.
- Encourage and support actions to improve soil structure.

Widely spaced trees within grazing areas have significant potential to produce drier soil conditions which mean swards can be grazed for longer periods over the year. Support for this type of agroforestry has been provided through numerous iterations of agri-environment schemes under the Rural Development Programme with increased uptake achieved in recent years. DAERA will look at how successor schemes can support agroforestry and other measures to encourage grazing, taking into account the multiple benefits in terms of biodiversity and carbon sequestration of increasing farm woodland.

We want to:

- **Work with industry to develop systems which will encourage implementation of longer grazing seasons.**
- **Work with industry to examine the potential for technology to support systems for recording and verifying grazing.**
- **Integrate support for agroforestry (wide spaced trees in fields) as part of DAERA's plans for increasing tree cover.**

Q8: Do you have any comments on the proposals to encourage implementation of longer grazing seasons?

4.1.5 Move to Protected Urea Fertiliser

Urea is a highly concentrated chemical nitrogen fertiliser which has an NPK (nitrogen-phosphorus-potassium) ratio of 46-0-0. Protected (or stabilised) urea is urea which is treated with an active ingredient called a urease inhibitor. Urease is the enzyme which catalyses the conversion of urea to ammonium. It is during this conversion that ammonia gas is lost from untreated urea. A urease inhibitor blocks the active site of the urease enzyme and this slows the rate at which urea is converted to ammonium, thus stabilising it, as illustrated in Figure 10.

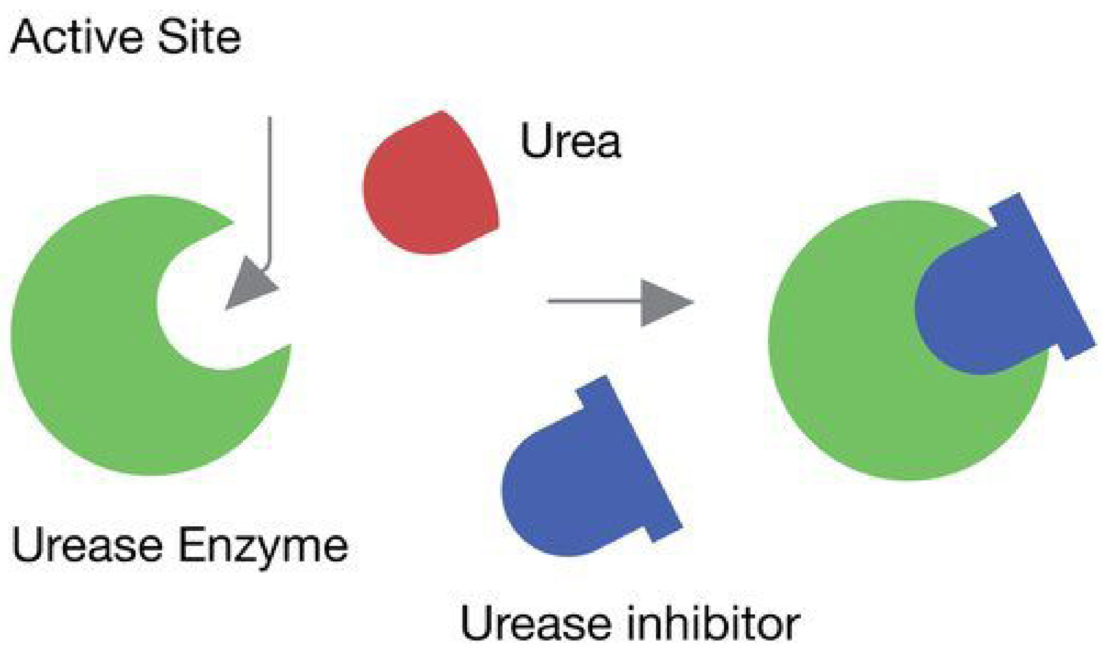

Figure 10: Urease inhibitors bind to urease and prevent conversion to ammonia (basf).

Switching from straight urea to protected (or stabilised) urea will reduce total ammonia fertiliser emissions in Northern Ireland by 32%. Between 7% and 53% of the nitrogen in urea fertiliser can be lost as ammonia compared with an average of 4% for Calcium Ammonium Nitrate fertiliser (CAN). However, CAN is susceptible both to nitrate leaching and to denitrification, having significantly higher nitrous oxide (a potent Greenhouse Gas) emissions than urea. Results from a study by AFBI and Teagasc have shown considerable benefit from using urea in combination with the urease inhibitor NBPT (N-(n-butyl) thiophosphoric triamide). Urea + NBPT offered a reduction in ammonia losses of 78.5% compared with straight urea, whilst maintaining similar agronomic yields to CAN.[32]

Total annual grass yields are comparable between CAN, solid urea or protected urea coated with an inhibitor. Protected urea can deliver a significant saving per unit of Nitrogen when compared

32 https://www.afbini.gov.uk/news/balancing-greenhouse-gas-and-agricultural-production-targets-irish-farms

to Calcium Ammonium Nitrate (CAN). AFBI research in 2018 found that paddocks treated with stabilised urea performed well against the paddocks treated with CAN, with similar yields at every cutting date. This confirms that comparable levels of productivity, as well as reduced volatile N losses, are achievable. Teagasc trials have shown that CAN, urea and protected urea frequently give similar yields, but urea has the lowest N recovery.

The current ammonia inventory recognises that a 70% reduction in ammonia emissions will be achieved by switching from straight urea fertiliser to protected urea. Whilst urea use is not widespread throughout Northern Ireland and represents only 8% of all fertiliser use[33], there is still potential for a notable saving in ammonia. DAERA is working with other UK administrations to devise an approach to fertiliser which maximises benefit across environmental metrics DAERA will engage closely with the fertiliser and associated industries to identify the best way to reduce ammonia emissions from fertiliser, including examining the safe and effective use of urease inhibitors.

We want to:

- **Introduce legislation to reduce ammonia emissions from fertiliser, including the potential introduction of a prohibition on the use of unprotected urea fertiliser.**

Q9: Do you have any comments on how to reduce ammonia emissions from chemical fertiliser, including the potential introduction of a prohibition on the use of unprotected urea fertiliser?

4.1.6 Reducing Crude Protein in Livestock Diets and Establishing Protein Crops

The level of crude protein consumed by livestock has a significant influence on ammonia emissions. Reducing the amount of nitrogen in animal feed reduces the amount in excreta, leading to less N being available for ammonia generation. Scientific evidence shows that ammonia emissions are reduced by 8 -10% for every 1% fall in crude protein in pig diets.[34] Ammonia reductions of up to 35% are thought to be possible in poultry diets. Across the livestock sectors, including cattle, reducing crude protein in all livestock diets can achieve an industry wide reduction in ammonia of around 9%.[35]

Crucially, the AFBI / Rothamsted modelling suggests that this significant reduction can be achieved at relatively little cost through more precise livestock nutrition.

33 https://www.daera-ni.gov.uk/publications/fertiliser-statistics-2009-2021
34 The impact of diet and 'flushing' on ammonia and odour emissions from pig housing; AFBI
35 Estimated costs of ammonia mitigation measures for Northern Ireland Agriculture; AFBI

DAERA wants to work with farmers and the feed industry to identify the best strategies to reduce crude protein in livestock diets. DAERA recognises that crude protein intake is more difficult to control in forage-based diets and that all diets must be appropriately balanced to maintain animal health and performance. However, all sectors have potential to reduce crude protein efficiently and make ammonia savings. DAERA is committed to working with industry to measure and verify ammonia reductions through livestock nutrition. Valuable work has been completed by DAERA, AFBI and NIGTA to enhance the level of detail about dairy livestock dietary inputs to the NI Ammonia Inventory. This will make it much easier for the ammonia inventory to track changes in the protein levels of dairy diets so that the benefits of appropriate changes in diets can be recognised.

We are mindful that those in the animal feed sector are crucially important to the implementation of lower crude protein diets across livestock farms. We want to work with the industry to meet this challenge in a proactive and positive manner.

Growing protein crops has the potential to reduce ammonia emissions in a number of ways. Protein crops can contribute to a reduction in the total amount of fertiliser needed on farms. Protein crops like field beans can also be included in dairy cow diets at 4 - 5 kg/cow/day with no loss in performance. These crops can form part of low protein livestock diets to reduce ammonia emissions. Increasing the overall area of cropland will also contribute to reduced emissions.

There are opportunities for farmers who can use protein crops to lower their own feed costs and increase farm profitability.

Northern Ireland is currently almost totally dependent on imported soya and other proteins in the manufacture of animal feed. In 2019, the use of soya alone in feedstuffs manufacture was 369,000 tonnes and adding other high protein animal feeds brings this total to over half a million tonnes. A Pilot Protein Crops Scheme was introduced in 2021. The aim of the pilot scheme is to create a domestically produced source of protein for animal feed, provide agronomic benefits within arable rotations and provide an alternative source of income for farmers. This is expected to create environmental benefits by reducing the need to import animal feed and the associated carbon footprint. The scheme represents an important investment in promoting sustainable, diversified agriculture in Northern Ireland. In its first year of operation, the scheme delivered payments totalling £208,655 and almost tripled the number of farmers in Northern Ireland growing protein crops.

ROI Nitrates Derogation Crude Protein Requirements from 2022

Following a review of the ROI Nitrates Derogation in 2019, derogation farmers must limit the crude protein in concentrate feed for grazing livestock with a maximum of 15% crude protein permissible between April 15th and September 30th 2022. This cap on crude protein in concentrate feeds for grazing livestock on farms with a grassland stocking rate greater than 170 kg/ha is designed to reduce excess protein in livestock diets.

This measure provides a number of co-benefits to both water and air, with a reduction in Greenhouse Gases. Excess protein causes losses from a financial and environmental perspective. Striking the balance between production and the environment is critical.

[36]

We want to:

- Work with industry to identify the best strategies to implement and verify crude protein reductions in livestock diets.
- Provide a pilot protein crop scheme to create a domestically produced source of protein for animal feed.

Q10: Do you have any comments on the proposals to reduce crude protein levels in livestock diets?

4.1.7 Improving Feed Efficiency through Genetic Improvement

Selecting high genetic merit replacement breeding females and sires has the potential to reduce ammonia emissions by reducing the amount of nitrogen excreted per kilogram of milk or meat produced. Genetic improvement programmes across the livestock species have been shown to lead to significant improvement in productivity. This genetic improvement not only reduces the amount of nitrogen excreted per unit of output but also reduces the number of replacement animals which are required to maintain the same herd/flock size, further contributing to lower nitrogen outputs. More recently, cattle and sheep breeding programmes are looking at the potential to incorporate direct traits for individual animal feed efficiency; a long-standing approach taken in the pig and poultry sectors.

A Ruminant Genetics Programme is being developed under Future Agricultural Policy, whereby farmers will provide data to support the provision of animal and herd level performance indicators. This information will allow farmers to identify and breed from the most productive and environmentally sustainable animals.

Q11: What are your views on the proposals relating to improving feed efficiency through genetic improvement?

36 Department of Agriculture, Food and the Marine. Nitrates Derogation Review 2019.

4.1.8 Establishing Tree Plantations to Reduce Ammonia Impacts

Establishing tree plantations around livestock housing has been shown to reduce the impact of ammonia emissions as a secondary mitigation technique by “capturing” some of the emissions. If air from nearby livestock houses is naturally directed into a tree covered canopy, it is to some degree prevented from being deposited more widely in the environment. The use of tree belts surrounding ammonia sources helps to reduce nitrogen deposition at designated sites and may be particularly useful for farms close to nitrogen sensitive habitats. Research shows that appropriately designed tree plantations placed downwind of the prevailing wind around livestock housing can “capture” 15 to 25% of ammonia emissions from livestock housing and 10 to 20% of ammonia released from slurry lagoons. Tree cover can also capture 60% of ammonia released from livestock ranging under the tree canopy.[37]

Tree shelter belts have many additional environmental benefits, such as increasing biodiversity and carbon sequestration and will play a role in achieving the UK’s emission reduction targets for greenhouse gases. They provide visibility screening around housing units and when used as silvopastoral systems can provide shelter for protection from predators and various weather conditions improving productivity and reducing mortality.

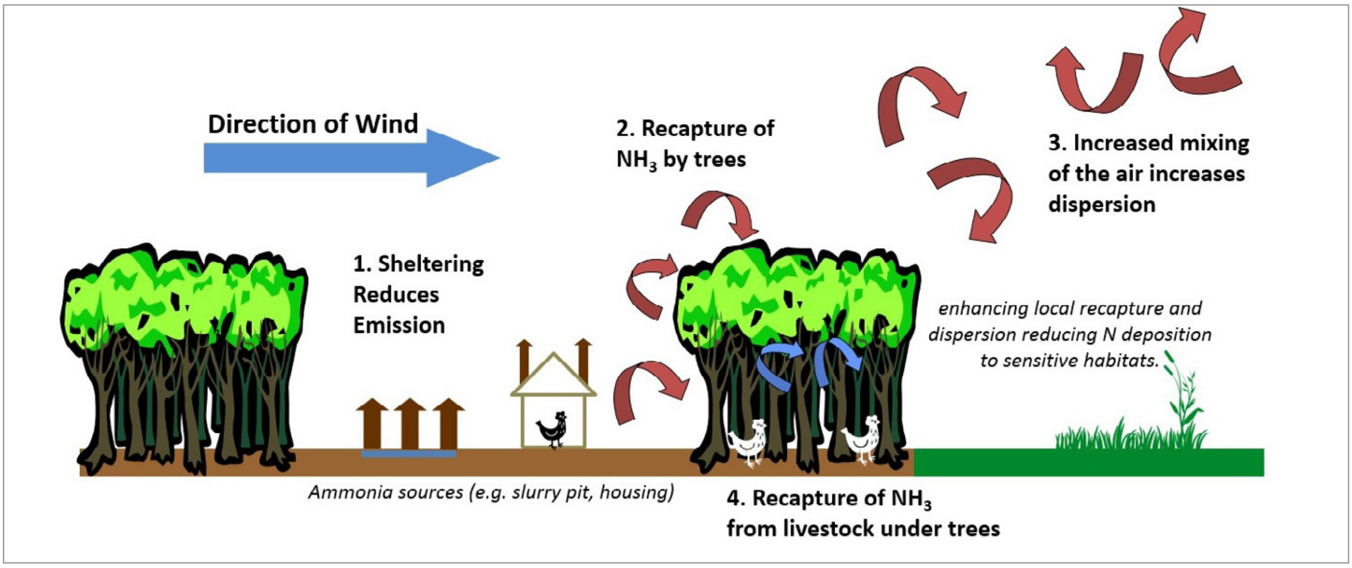

Figure 11. Effects of shelterbelts on ammonia in the landscape.

37 https://www.farmtreestoair.ceh.ac.uk/sites/default/guidance/index.html https://shiny-apps.ceh.ac.uk/pollutionremoval/

There are two important considerations when designing tree systems for ammonia recapture:

1. To get the ammonia into the woodland and through the main canopy, a reasonably open understorey would be necessary to prevent the ammonia passing over the top of the woodland and acting as a block to the airflow.

2. Prevention of the loss of ammonia out of the downwind edge of the woodland. To stop this happening, a region of dense vegetation should be planted at the downwind edge (and sides if possible) to act as a backstop and force the ammonia up through the canopy.

The Centre for Ecology and Hydrology and the Forest Research Agency have created an online tool that uses the latest research to calculate the type of tree belt that would be suitable for farms, based on their location, soil type and the prevailing wind.

We want to:

- **Work with farmers to use strategically positioned tree cover to reduce the impact of ammonia emissions.**

Q12: What are your views on the proposals to encourage tree plantations around livestock housing?

4.1.9 Covering Above Ground Slurry Stores and Lagoons

Modelling from Rothamsted Research has shown that covering all above ground slurry stores would achieve at least a 60% reduction in ammonia emissions compared to uncovered stores (60% for floating covers, the addition of a rigid cover may reduce ammonia emissions by up to 80%). Across Northern Ireland, covering all slurry stores would reduce total manure storage emissions by 16% and overall agricultural emissions by 1.3%.[38]

Analysis of data from the DAERA Survey of Nutrient Management Practices on cattle farms in NI for 2020 showed that for farms producing slurry only, 94% of slurry was stored in below ground tanks. On farms producing both slurry and farmyard manure 81% of slurry was stored in below ground tanks. Above ground tanks accounted for 14% of slurry storage and this was dependent on farm type, with dairy farms and large beef farms having more above ground slurry storage. Preliminary analysis for farms with above ground slurry storage indicated that 80% of above ground stores were not covered in 2020.

38 Tom Misselbrook, Rothamsted Research.

Since 1st January 2020 there has been a requirement under the Nutrients Action Programme for all new above ground slurry stores (lagoons and tanks) to be covered. The requirement to cover also applies to lagoons and tanks which are substantially enlarged or substantially reconstructed.

In respect of existing above ground slurry stores, there is significant potential to reduce ammonia emissions in three separate ways:

- Installing a rigid cover on these stores.
- Installing a floating cover.
- Ensuring that a crust forms on existing uncovered stores (crusts will reduce ammonia emission by up to 50%, compared to uncrusted slurry).

Not all existing above ground slurry stores and lagoons will be suitable for retrospective covering due to potential health and safety risks. DAERA wants to work with industry to examine if these issues can be addressed and to develop ways of increasing the number of above ground slurry stores being covered or crusted.

We want to:

- **Encourage the safe covering of existing above ground slurry stores and lagoons.**

Q13: What are your views on how to encourage the safe covering of existing above ground slurry stores and lagoons?

4.2 Mechanisms for Adoption of Ammonia Reduction Measures

DAERA are committed to supporting the adoption of the ammonia reduction measures highlighted in section 4.1. Box 2 lists the mechanisms DAERA intends to use to deliver the objectives and targets within this strategy.

Box 4: Mechanisms to Support Adoption of Ammonia Reduction Measures

1. **Cross cutting support through Green Growth and Future Agricultural Policy**
2. **Support through Knowledge Transfer and education**
3. **Legislation to require uptake of ammonia reduction measures**
4. **Spatially targeting measures around designated sites**

4.2.1 Cross cutting support through Green Growth and Future Agricultural Policy

The Green Growth Strategy is an Executive Strategy and is seeking to adopt a holistic approach to tackling the climate crisis in the right way by balancing climate action with the environment and the economy in a way that benefits all. The Green Growth Strategy's vision is for a more resilient environment with a healthy ecosystem and a strong sustainable economy. To achieve this, action on ammonia is necessary. Green Growth has been developed following extensive stakeholder engagement with internal NICS Departments and external stakeholders from local government, the private sector, voluntary and community sectors and others.

The cross-cutting Green Growth strategy will be delivered through a series of Climate Action Plans, which will set out the actions to meet sector-specific greenhouse gas (GHG) emission targets and to deliver a cleaner environment rich in biodiversity; delivering a more efficient use of resources within a circular economy; and green jobs.

The themes of DAERA's Green Growth Capital Investment Profile, set out in the table below, include linkages to ammonia reduction measures. This table shows how, for example, genetic improvements in ruminant livestock, sustainable management of slurry, investment in appropriate technologies on farm including livestock housing, and nature-based solutions link with ammonia reduction measures proposed in this draft Strategy. A proportion of the proposals within the current Green Growth Capital Investment Profile will be used to deliver measures which can contribute to reductions in ammonia emissions.

Table 1: Linkages between the Ammonia Strategy and DAERA's Green Growth Capital Proposals

Green Growth Capital Proposals		Ammonia Reduction Measures: Low Emission Slurry Spreading Equipment (LESSE)	Longer Grazing Seasons	Move to Protected Urea Fertiliser	Reducing Crude Protein in Livestock Diets and Establishing Protein Crops	Improving Feed Efficiency through Genetic Improvement	Establishing Tree Plantations to Reduce Ammonia Impacts	Low Emission Livestock Housing	Covering Above Ground Slurry Stores and Lagoons	Emerging Technologies	Spatially targeted measures at and around Designated sites
Agri Food	Genetic Improvements					●					
	Slurry Management									●	
	On-farm Capital Support	●	●					●	●	●	
	AFBI Instrumented living landscape	●	●	●	●	●	●	●	●	●	●
	Animal Research Platforms		●		●	●		●			
Challenge and Innovation Fund	Green Challenge and Innovation Fund	●	●	●			●	●	●	●	
	Industry Research Challenge Fund				●						
	Innovation Fund	●	●					●	●	●	●
	Research Centres	●	●	●	●	●	●	●	●	●	●
Nature	Nature (includes Peatland Restoration)						●				●

DAERA's 2021 Future Agricultural Policy Framework Portfolio for Northern Ireland sets out the vision and key strategic outcomes for the agricultural industry in Northern Ireland. The Framework's four key strategic outcomes are increased productivity, environmental sustainability, improved resilience and an effective functioning supply chain.

DAERA's Future Agricultural Policy Programme achieves the Portfolio's vision for a future agricultural regime that promotes productive, efficient practices through greater innovation and capacity, whilst protecting the environment, animal health and welfare and public health. The Future Agricultural Policy Programme oversees the transition from existing schemes to new approaches and support measures which better address the needs of Northern Ireland agriculture, the environment, and rural communities.

A series of Future Agricultural Policy workstreams incorporating diverse measures and cross cutting initiatives are being developed to deliver the Framework's four strategic outcomes. Given the scale of the environmental and other challenges facing the agriculture sector, and the significant aspirations of other DAERA strategies, the agricultural support framework will drive the behavioural change needed to achieve the four strategic outcomes. This includes delivering on the imperative to reduce ammonia emissions.

Going forward agri-environment schemes will aim for a co-ordinated approach to delivering environmental benefits by encouraging group participation at a catchment or landscape scale. Incentives for group participation will be sufficiently attractive to promote large scale uptake of targeted measures designed to achieve specific, demonstrable environmental outcomes.

We want to:

- **Provide appropriate financial support for the implementation of ammonia reduction measures on farms through the Green Growth capital investment plan and relevant Future Agricultural Policy Programme Measures.**

Q14: What are your views on DAERA's plans to support ammonia reduction measures through Green Growth and future agricultural policy?

4.2.2 Support through Knowledge Transfer and education

DAERA recognises that Knowledge Transfer and Innovation programmes will be critical to ensure adoption of on-farm ammonia mitigation measures. The programmes will include:

- Incorporation of ammonia mitigation measures within the Business Development Group programme.

- Knowledge transfer events including on-farm demonstrations on ammonia mitigation technologies.

- Demonstration on the CAFRE Estate of ammonia mitigation technologies which can be adopted on-farm and these include:

    - Animal nutrition - e.g. targeted protein content of ruminant diets.

    - Livestock housing - e.g. emission reducing livestock flooring systems.

    - Slurry management - e.g. covered slurry storage facilities.

    - Nutrient application - e.g. use of Low Emission Slurry Spreading Equipment (LESSE).

    - Vegetative recapture - use of nitrogen fixing legumes.

- Online support material which will include development of a suite of Nutrient Calculators, decision support tools for farmers including the organic nitrogen loading, storage capacities of organic manures and crop nutrient calculators.

The new information emanating from the AFBI-led research programme, as outlined in chapter 2.2, will be communicated to farmers to support understanding of how simple behaviour changes on farm can reduce ammonia emissions. This will address the goal outlined in 'Making Ammonia Visible' to "increase understanding at farm level of how farming activities impact upon ammonia emissions and empower farmers to take up one or more of the mitigation options".

We are mindful that knowledge transfer and education occurs across the public, private and voluntary sectors. We want to work with the private and voluntary sectors to achieve best practice in driving the behavioural change on ammonia emissions that is required.

We want to:

- **Use knowledge transfer and education to support the uptake of ammonia reduction measures.**

- **Work with the private and voluntary sectors to demonstrate best practice in ammonia reduction technologies.**

Q15: What are your views on DAERA's plans for knowledge transfer and education on ammonia reduction?

4.2.3 Spatially targeted measures around Designated Sites

In combination with NI-wide ammonia reduction measures, the greater implementation of additional reduction measures in areas around nitrogen sensitive designated sites will further reduce ammonia exceedance and contribute to improving habitats. Nitrogen sensitive sites which receive a large degree of their nitrogen from local sources will particularly benefit from spatially targeted measures.

Scientific analysis shows that, per unit of ammonia emissions abated, enhanced measures targeted within 1km of designated sites are on average 4.6 to 5.8 times more effective at reducing ammonia concentrations in the air. On average they are also approximately 4 times more effective at reducing dry deposition of ammonia at designated sites when compared to applying enhanced measures across the whole of NI.[39] Therefore the closer enhanced mitigation measures are applied to designated sites, the greater effect these measures have at reducing ammonia. The importance of this message has been emphasised through the findings of the Nitrogen Futures project.[40]

This evidence provides a rationale for targeting ammonia reduction measures in a strategic and focused way in areas around designated sites. These measures will be particularly important in achieving the target of reducing ammonia concentrations at all internationally designated sites by at least 40% or to below Critical Levels. Existence of these measures will provide reassurance to competent authorities in considering planning and permitting applications, and whether they align with the necessary reduction profile. Detailed analysis will be used to identify spatially defined measures to address particular emission sources around designated sites, necessary to support habitat and species restoration. Implementing a successful spatially targeted approach at suitable sites will require this additional assessment of local sources, practices, and an understanding of mitigation measures already in place.

As part of a strategic approach to reducing ammonia concentration and nitrogen deposition at designated sites, DAERA proposes to introduce the following mandatory measures around all internationally designated sites:

- A prohibition on spreading manures within 50 m of an internationally designated site by January 2025. This aligns with the regulations in NAP which prohibit the spreading of organic manures or dirty water within 50 m of a borehole; and
- A requirement for all slurry within 1km of an internationally designated site to be spread by LESSE by January 2025.

39 Scenario modelling - spatial targeting of ammonia mitigation measures in Northern Ireland.
40 https://jncc.gov.uk/our-work/nitrogen-futures/

DAERA recognises the need for focused campaigns and bespoke site-specific reduction plans to achieve significant adoption of ammonia reduction technologies in existing livestock housing and greater implementation of other ammonia reduction measures in the areas around internationally designated sites.

These targeted measures should be tailored for the specific ammonia emission sources in the vicinity of the individual sensitive habitats. Measures could include, but are not limited to:

- Identifying and addressing particularly high local emission sources.
- Covering slurry stores.
- Incorporating the most effective ammonia reduction technologies within animal housing around designated sites.
- Campaigns and advisory programmes for all regulatory frameworks associated with nutrient management.
- Habitat creation.

DAERA is committed to making available the appropriate advisory and financial resources to support the establishment of this site-specific targeted approach.

We want to:

- **Introduce a strategic approach to ammonia reduction around internationally designated Natura 2000 sites.**
- **Tailor this approach to individual site circumstances and provide appropriate financial and advisory resources.**
- **Prohibit slurry spreading within 50 metres of all Natura 2000 designated sites by January 2025.**
- **Require all slurry within 1km of an internationally designated site to be spread by LESSE by January 2025.**
- **Work with and support farmers around designated sites to reduce ammonia emissions.**
- **Recognise that additional actions around valuable habitats will deliver a public good to society.**

Q16: What are your views on the proposals for spatially targeted measures around designated sites?

Chapter 5: Pillar Two - Conservation Actions to Protect and Restore Nature

Northern Ireland's semi-natural habitats require specific conservation measures to be put in place to restore them to, and maintain favourable conservation status, helping to build ecological and climate resilience.

Our designated sites receiving excess nitrogen and ammonia emissions require a strategic approach to be put in place, specifically national reduction measures to reduce the overall background levels, as well as spatially targeted measures to address N-related pressures at sites, with clearly defined trajectories for emission reductions at the NI and site-levels, as set out in Chapter 4.

This will also need to be accompanied by habitat restoration measures on-site to address existing damage, improve condition and enhance resilience to N loading while efforts continue to reduce emissions at source.

It is intended that these interventions align with an emerging Operational Protocol which is designed to afford effective protection to our designated sites and provide greater clarity for authorities in determining capacity for sustainable agricultural development.

5.1 Habitat Restoration Measures

Many of our special habitats and species features across our protected sites are in unfavourable condition due to nitrogen deposition and a range of other pressures and threats. Protected habitats require on-site conservation actions to address these current pressures, particularly as the impacts of ammonia and nitrogen deposition can be more significant where other issues are not being addressed.

Protected sites will also require off-site measures designed specifically to meet the sites' needs, in particular, reducing local ammonia emission sources, as well as those required to afford greater protection to the site features, such as support for traditional farming practices or nature buffers (habitat creation or nature recovery areas) in the immediate vicinity of the site. This is particularly important for small or narrow sites which are particularly exposed to intensive farming in the surrounding landscape.

These measures will all be of particular importance for our current Programme for Government target for biodiversity - to have protected areas 'under favourable management', to meet the specific ecological requirements of the site, and therefore support achievement of favourable conservation status.

5.2 Northern Ireland Peatland Strategy

DAERA has consulted on a robust Draft Northern Ireland Peatland Strategy 2021-2040. The vision of this draft Strategy is to ensure that all semi-natural peatlands are protected, managed and where possible, prioritised for restoration, so that they can maintain their natural functions, biodiversity and ecosystem services. It has proposed measurable targets, milestones, delivery partners and costings identified, in order to return semi-natural peatlands in Northern Ireland to a healthy state.

This Ammonia Strategy and the draft Peatland strategy are interlinked. The draft actions within the Peatland Strategy will deliver conservation benefits for our designated sites. A selection of these include:

- Secure funding and initiate a programme of Peatland restoration projects on both publicly and privately-owned land, in conjunction with stakeholders.
- Establish peatland restoration demonstration sites on land in public or private ownership with agreement of the landowner.
- Provide funding for and build on research already carried out into the long-term effects of nitrogen deposition on peatlands in Northern Ireland.
- Build capacity and develop practical skills training courses for peatland restoration contractors and landowners.
- Provide funding to facilitate restoration and appropriate management on peatlands with multiple ownership.
- Develop bespoke training courses for landowners/organisations involved in peatland conservation and restoration.

These actions are vital to protect and restore Northern Ireland's peatlands. This draft Ammonia strategy will complement the Peatland Strategy by addressing the exceedance of Critical Loads and levels. Site management, restoration measures and ammonia reductions must work in tandem to protect these habitats.

5.3 SAC Conservation Management Plans

Obligations under the Habitats Directive require us to put in place the necessary conservation measures to restore protected sites that satisfy the ecological requirements of protected habitats and species on each site (SACs, SPAs, Ramsar). The development of Conservation Management Plans (CMPs) for our designated sites is a key mechanism for defining the necessary conservation measures to move towards favourable condition.

Clearly defined Conservation Management Plans are currently being prepared for our SACs. These CMPs consider pressures and threats and set out measures aimed at delivering against each site's conservation objectives. Where ammonia/nitrogen deposition is identified as a pressure, the key conservation measure will be to reduce emissions at the site level, particularly the more damaging local ammonia sources.

Unless specific measures are designed and implemented to address the excessive pollution above Critical Levels and loads, then the habitat cannot be considered to be under 'favourable management' or hope to recover fully.

The Conservation Management Plans are being developed through a number of mechanisms, with advice and support from NIEA: INTERREG VA projects, the Northern Ireland Rural Development Programme and the DAERA Environment Fund, as well as in-house by NIEA. Draft CMPs have been prepared for 25 Special Areas of Conservation. CMPs for the full suite of terrestrial SACs (58) are to be prepared by December 2022.

The necessary conservation actions are based on detailed assessment of the site features, their condition, and the key pressures on the site. The results of these condition assessments are used to inform the management required to remedy adverse condition. Examples of site management typically identified in Conservation Management Plans are outlined in the table below:

Site feature	Condition	Management recommendation
Wet woodland	Unfavourable due to overgrazing.	Repair existing boundary fences and exclude grazing livestock.
Oakwood	Unfavourable due to presence of non-native species (sycamore).	Remove sycamore seedlings and saplings, and initiate programme of phased removal of mature sycamore.
Fen	Unfavourable due to scrub encroachment.	Land to be managed by light grazing with additional tree/scrub control works to be carried out as required.
Raised bog	Unfavourable due to vegetation structure and composition - drainage and peat cutting at periphery has led to scrub encroachment and reduced cover of Sphagnum mosses.	Undertake works to remove scrub. Also, block drains to improve hydrology, Sphagnum cover, and reduce further scrub encroachment.
Blanket bog	Unfavourable due to vegetation structure and composition caused by drainage and overgrazing.	Undertake works to block drains and reduce stocking levels on site.

Site feature	Condition	Management recommendation
Maritime cliff and slope	Unfavourable due to vegetation structure and composition caused by undergrazing.	Undertake works to install fencing & water supply, and establish appropriate grazing regime.
Purple moorgrass and rush pasture	Unfavourable due to poaching and high cover of soft-rush.	Undertake works to reduce cover of soft-rush and ensure that low intensity grazing and grasslandmanagement is maintained.

Some on-site conservation measures are already being delivered through INTERREG projects (Collaborative Action for the Nature Network and Cooperation Across Borders for Biodiversity). Further CMP measures will be rolled out through Group pilots. They will also form the basis of site remedial management plans for individual agri-environment agreements. The CMP management measures undertaken during the pilots will be site-specific and will not be a roll out of every measure identified in all of the CMPs.

DAERA is liaising with the Special EU Programmes Body and ROI counterparts to secure funding under the new EU-funded PEACE PLUS cross-border programme 2021-27, to provide sustained funding for habitat restoration at protected sites, species recovery, and nature recovery in the surrounding landscapes.

5.4 The Role of Agri-environment Schemes

There is potential for agri-environment schemes to support on-site habitat restoration, as well as low-emission land management and habitat enhancement in the wider countryside and around designated sites. The Future Agricultural Policy Programme for Northern Ireland includes a Farming with Nature Package. A number of measures already available through the current EFS wider scheme could be further developed and enhanced to provide long-term, targeted measures around the most severely impacted sites. These include but are not limited to:

- Creation of woodland to enhance local recapture and dispersion of ammonia and reduce deposition to sensitive habitats.
- Planting of woodland downwind from livestock housing and slurry storage facilities to act as a buffer to ammonia emissions from these facilities (excluding sites protected for breeding waders or other bird species).
- Establishment of agroforestry and natural regeneration of native woodland.
- Restoration or creation of habitat around sensitive sites to provide protection from local emission sources and support nature recovery.
- Sowing low N-input grassland, with herb rich swards and N-fixing species forming part of the grassland composition to extend grazing periods.

5.5 Ecological Research, Monitoring and Reporting

Further work is currently ongoing to profile the NI designated site network, based on characteristics such as nitrogen input pathways (e.g. local, national or transboundary), key sectors contributing to emissions locally, and to deposition and the level of threat through atmospheric N input. This work will inform the most appropriate mitigation approaches for sites, the effectiveness of proposed measures for each site, and indicate those sites that would most likely respond to a spatially targeted approach. Continued research is also required on ecological impacts and response, bio-indicators of N-enrichment, ecological and nitrogen profiling, and building habitat resilience.

Ongoing research and development of projects includes:

1. A focused programme of monitoring and modelling at DAERA owned Ballynahone Bog SAC.

   Ballynahone Bog is one of the largest intact active raised bogs in Northern Ireland, with hummock and hollow pool complexes. It is managed by Ulster Wildlife.

   A current DAERA NIEA project in collaboration with UKCEH is modelling and measuring NH3 concentrations on and around the bog to determine the levels of atmospheric N input and advise on potential mitigation strategies.

   The information from this study will provide the scientific basis that could be used to develop approaches to ammonia concentrations for Natura 2000 sites in NI. It is also hoped that this will allow indicative costs to be developed that could feed into financial forward planning for the management of designated sites in NI.

2. Wider NH3 Monitoring across the protected network.

   DAERA has increased ammonia monitoring within sites managed under the INTERREG VA Programme Collaborative Action for the Natura Network (CANN). The areas being monitored include a range of sites located in differing areas of the landscape, with both upland and lowland sites being involved.

   It will be important to monitor and report on progress in reducing emissions affecting protected habitats and improving habitat condition - report annually.

3. Ecological response and bio-indicator work.

To investigate the impact and quantify the uptake of atmospheric nitrogen/ammonia by sensitive peatland vegetation, targeted surveys across several sites have been undertaken including at ammonia monitoring sites and transects away from local sources near the edge of the site. This includes the collection of vegetation samples for analysis of N content & soluble N, and a check for visible indicators of NH3 related damage e.g. lichen indicator species, algal growth on trees, mosses etc. The findings from this work will add to our understanding of how sensitive species respond to elevated levels of NH3 and how these visible indicators can inform assessment of site condition in the future.

Detailed reports will be published on the DAERA website or on request from AQBU at: aqbu@daera-ni.gov.uk

We want to:

- **Support landowners and the necessary conservation actions to restore habitats and support sustainable development.**
- **Continue research to improve our understanding of ecological responses to air pollution and the role that restoration can play in building habitat resilience and accelerating recovery.**
- **Maximise opportunities through future agricultural policy frameworks to support nature recovery and low emission farming.**
- **Secure funding to support long-term restoration and management of our important protected sites and wider landscapes.**
- **Monitor and report annually on progress in reducing emissions affecting protected habitats and improving habitat condition**.

Q17. What are your views on the proposed conservation actions to restore habitats and support sustainable development?

Q18. What are your views on the appropriate delivery and funding mechanisms to deliver habitat restoration?

Chapter 6: Conclusions and Timelines

6.1 Assessing the Impact

This document seeks views on a series of measures designed to reduce ammonia emissions. A range of implementation approaches will be required to achieve the uptake of the measures needed on farms to reduce emissions and support sustainable agriculture. As part of the policy development process, a number of assessment processes examining the impact on the environment, habitats, equality, and rural needs has been undertaken. Screening reports have concluded that the Ammonia Strategy should be subject to a full assessment on each of these issues. A Regulatory Impact Assessment (RIA) has also been carried out.

The evidence base for these assessments will draw significantly on the detailed environmental and economic analysis highlighted above. This consultation gives stakeholders an opportunity to draw to our attention any evidence they feel should be considered or to highlight any issues which they feel should be incorporated in the assessments. As DAERA moves to finalise its approach to ammonia reduction and reducing the impact of nitrogen deposition on designated sites, these assessments will be completed.

Q19: Do you have any comments on what evidence or issues should be considered when assessing these impacts?

6.2 Partnership Working

DAERA has engaged with stakeholders in developing its approach to ammonia. This engagement included the opportunity for stakeholders to propose their suggested solutions to the ammonia challenge in a series of events. The publication of the consultation marks an opportunity to intensify that engagement as we seek to build consensus around a balanced and proportionate approach to ammonia. DAERA wants to continue to work with stakeholders to inform the direction and delivery of this strategy, as well as the detail of the various measures. A stakeholder group including representatives from primary agriculture, the agri-food supply chain and the environmental sector will be established to advise on the implementation of the Ammonia Strategy.

Q20: What are your views on how DAERA should work with stakeholders to inform the direction and delivery of the strategy, and the detail of the various measures?

Q21: Do you have any other comments or contributions on this document?

6.3 Timeline for Action

Our Timeline for Action is:

By	Action
1st June 2023	Publish the final Ammonia Strategy.
	Establish a stakeholder group to advise on the implementation of the Ammonia Strategy.
30th June 2024	Legislate to reduce ammonia emissions from chemical fertiliser.
1st January 2025	Introduce mandatory spreading of all slurry exported and imported between farms by LESSE.
	Introduction of a prohibition on slurry spreading within 50m of Natura 2000 designated sites.
	Introduce a requirement for all slurry that is spread within 1km of Natura 2000 designated sites to be by LESSE.
31st December 2025	Carry out a two year stocktake of the actions of the ammonia strategy to ensure that Northern Ireland remains on course to meet is 2030 targets.
1st January 2026	A requirement to spread all slurry using low emission slurry spreading equipment by 2026.
31st December 2028	Report on the delivery of the ammonia strategy to 2028 and determine the optimal approach to 2030 to meet targets.

6.4 Freedom of Information Act 2000: Confidentiality of Consultations

The Department will publish a summary of responses following completion of the consultation process. Your response, and all other responses to the consultation, may be disclosed on request. The Department can refuse to disclose information only in exceptional circumstances.

Before you submit your response, please read the paragraphs below on the confidentiality of consultations and they will give you guidance on the legal position about any information given by you in response to this consultation.

The Freedom of Information Act 2000 gives the public a right of access to any information held by a public authority (the Department in this case). This right of access to information includes information provided in response to a consultation. The Department cannot automatically consider as confidential information supplied to it in response to a consultation. However, it does have the responsibility to decide whether any information provided by you in response to this consultation, including information about your identity, should be made public or treated as confidential. This means that information provided by you in response to the consultation is unlikely to be treated as confidential, except in very particular circumstances.

The Lord Chancellor's Code of Practice on the Freedom of Information Act provides that:

- the Department should only accept information from third parties in confidence if it is necessary to obtain that information in connection with the exercise of any of the Department's functions and it would not otherwise be provided.
- the Department should not agree to hold information received from third parties 'in confidence' which is not confidential in nature.
- acceptance by the Department of confidentiality provisions must be for good reasons, capable of being justified to the Information Commissioner.

For further information about confidentiality of responses, please contact the Information:

Commissioner's Office
Tel: (028) 9027 8757
Email: ni@ico.org.uk
Web: https://ico.org.uk

Annex A - Habitat Case Study

Case Study: Moninea Bog

Moninea Bog Special Area of Conservation (SAC) is a 45 ha active raised bog located in County Fermanagh, with the highest level of protection in the UK. This protection afforded by its designation under the Habitats Regulations means the site needs to be restored to Favourable Condition.

Favourable Condition is defined as “the target condition for an interest feature in terms of the abundance, distribution and/or quality of that feature within the site”. Air pollution can affect the ability to achieve this target by degrading habitat, reducing its resilience to extreme weather, and often affecting ability for sensitive species to grow.

In this case study, a farm 50 m west of Moninea Bog SAC led to greatly increased concentrations of NH_3 (10-40 $\mu g\ m^{-3}$) compared with local and regional background values of 1.5 and 0.5 $\mu g\ m^{-3}$. The annual critical level for this site is 1$\mu g\ m^{-3}$, due to the presence of lower plants; lichens and bryophytes.

The damage to sensitive plants on site was detected during ongoing monitoring of Moninea Bog by NIEA, which showed a 50 per cent loss of sphagnum over the period 2004-2007 for locations less than 400 m from the farm. As the first case study of its kind in NI, scientists from the Centre of Ecology and Hydrology (UKCEH) were invited to advise on the health and condition of Moninea Bog in relation to this local source of atmospheric ammonia pollution.

Additional atmospheric modelling, ammonia monitoring and plant nitrogen accumulation work was undertaken on expert advice by UKCEH. Additional monitoring at 7 locations was undertaken on bog using conventional ALPHA passive sampling diffusion tubes (see figure 12). Mean 4-weekly concentrations were tested for three months.

Extremely high ammonia concentrations were reported in the woodland on Moninea Bog (40$\mu g\ m^{-3}$), immediately to the east of the farm, with excessive growth of algae growing on trunks of Birch trees (*Betula pubescens*) 50-100 m from the farm, replacing the natural acidophyte lichen flora. Other signs of ammonia damage were seen to the vegetation of the open area of Moninea Bog. The most dramatic effects were in visible injury to lichen species, such as *Cladonia uncialis* and *Cladonia portentosa*, and to the bog mosses *Sphagnum spp*, which are particularly important for the peat building function of such sites.

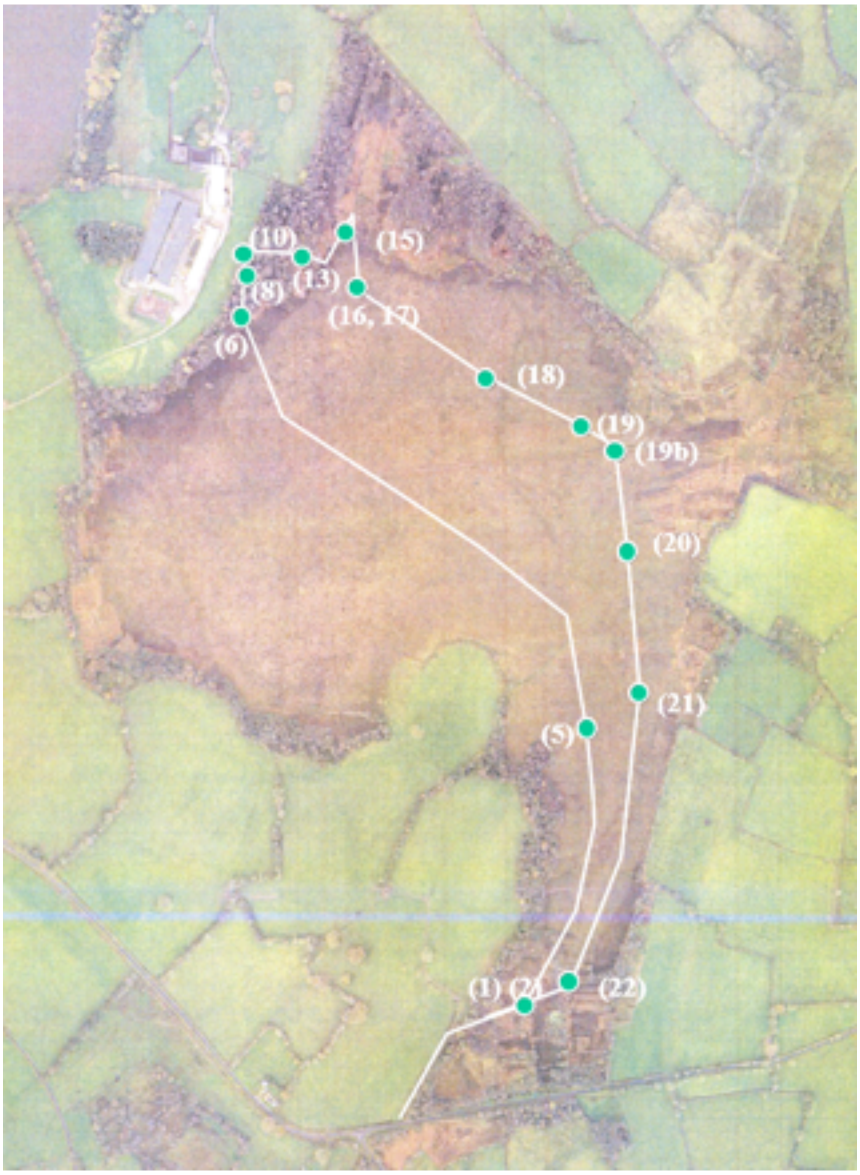

Figure 12: Ammonia monitoring locations installed at Moninea Bog (7 total) with poultry farm visible in top left corner. From Sutton 2007.

It was estimated that up to 200 m downwind (near site 17) of the farm, the *Cladonia* and *Sphagnum spp* were more than 90 per cent eradicated or injured. At 400 m distant from the farm (near site 19) these species were estimated to be around 50 percent eradicated or injured. Even at far distances of 800m - 1000m from the farm, injury attributed to ammonia was still recorded but to a lesser degree (<10-20 per cent).

The farm ceased operation in 2010, allowing examination of ecosystem recovery. Observations in 2017 showed mean NH_3 concentrations of 1.5 $\mu g\ m^{-3}$, with substantial recovery of *Cladonia portentosa* and *Sphagnum spp*. As all large hummocks (c. 200-400 mm diameter) of *C. portentosa* had been eradicated, only uniformly small specimens (c. 50-70 mm) were found in 2017 in the previous eradication zone.

The extent of *Cladonia* and *Sphagnum* growth indicated that recovery is likely to have started within 2-4 years of the reduction in NH_3 concentrations. Conversely, it was not obvious whether the condition of *Calluna* had improved, while residual algae levels on Birch trees <100 m from the farm indicated only partial recovery. Continued colonization of a Sphagnum hummock by algae, seven years after NH_3 concentrations reduced, suggest an ongoing competition.

This case study illustrates an extreme case of ammonia exposure and damage to a Natura 2000 site. However, at the same time, it highlights the widespread nature of the ammonia threat to such ecosystems where lichens and bryophytes are essential to their integrity. As the NI exceedance figures above illustrate, a large percentage of protected areas are receiving levels about recommended thresholds (1km resolution estimates), showing how widespread adverse effects can be expected.

Annex B - The Production of the 'Making Ammonia Visible' report

In July 2016, the then Minister for Agriculture, Environment and Rural Affairs, Michelle McIlveen MLA, asked an independent Expert Working Group to examine the challenge of Northern Ireland's rising ammonia emissions. The Expert Working Group on Sustainable Agricultural Land Management were established in 2014 and published their original report 'Delivering Our Future, Valuing Our Soils: A Sustainable Agricultural Land Management Strategy for Northern Ireland' in October 2016.[41]

In December 2017, the Expert Working Group published an annex to their report, titled 'Making Ammonia Visible.' This report highlighted the impact of ammonia on nature and emphasised that nitrogen is a key farm input which should be used efficiently within agricultural systems to avoid release to the atmosphere. The Expert Working Group's overarching recommendation stated that:

To achieve a sustainable future for Northern Ireland's agri-food sector, ammonia emissions must be addressed through a partnership approach which incorporates communication and education on ammonia, investing in filling our ammonia knowledge gaps and implementing a range of ammonia mitigation measures; and not on contracting the size of this sector.

'Making Ammonia Visible' made a range of recommendations which are summarised as follows:

- Scientific research to establish an emission factor for slatted floor slurry systems in cattle housing, assess the impact of slurry additives on ammonia reduction and examine the cumulative impact of multiple ammonia reduction measures.
- An enhanced regime for monitoring ammonia.
- DAERA should focus on the implementation of ammonia reduction measures when assessing planning applications for farm development.
- Government should support farmers to implement the 10 ammonia mitigation measures highlighted in the report. These were:
    - Extending the grazing season;
    - Moving to stabilised urea fertiliser;

41 https://www.daera-ni.gov.uk/sites/default/files/publications/daera/16.17.079%20Sustainable%20Land%20Management%20Strategy%20final%20amended.PDF

- Adjusting the timing of slurry and manure spreading;

- Spreading slurries and manures using low emission techniques;

- Improving the cleanliness of livestock housing and farm yards;

- Reducing crude protein in livestock diets;

- Improving feed efficiency through genetic selection;

- Establishing woody species around livestock units;

- Covering above ground slurry stores; and

- Installing ammonia reduction technologies in livestock housing.

• The existing Greenhouse Gas Implementation Partnership (which includes government, industry, and environment sector membership) should be revamped to incorporate ammonia within its remit.

Annex C - Farm Case Studies

Farm Case Study Modelling

The case studies examined the impact of implementing a combination of reduction strategies on emissions at individual farm level and their production was recommended by the Expert Working Group described at Annex B. The NARSES UK national inventory model was used to estimate NH3 emissions from farm systems of various types, sizes and with different manure management practices.

Scenarios were designed around survey and statistical review data default NARSES parameters/ emission factors and expert advice from AFBI staff on typical sectoral practices. Ammonia reduction measures were applied to all scenarios to determine the overall effect on farm emissions. The case studies below provide examples of the type of mitigation that could be applied at a farm level along with the ammonia reductions that a farmer could expect on an individual basis. They are representative of potential reductions at a typical farm, rather than examples from a specific business.

Dairy Case Studies

Mitigations Applied in Dairy Case Study Scenarios:

- Reduction in Crude Protein (CP) of concentrate feed (18% to 16%).
- Increase in scraping frequency.
- Move from slurry storage under house to outdoor covered storage.
- Move from slurry spreading by splashplate to trailing shoe.
- Substitute use of straight urea fertiliser with stabilised urea fertiliser.
- Increase Days Grazing from 186 to 200 (Only applicable for the Grazing/Housing Systems modelled).

Dairy Scenario 1	• 50 cow herd, 15 replacements reared per year producing on average 7,220 litres of milk per annum with a grazing/housing system. • Impact: ammonia emissions were reduced by 42.1%.
Dairy Scenario 2	• 100 cow herd, 15 replacements reared per year producing on average 7,220 litres of milk per annum with a grazing/housing system. • Impact: ammonia emissions were reduced by 42.4%.
Dairy Scenario 3	• 100 cow herd, 15 replacements reared per year producing on average 8,500 litres of milk per annum with a confined system. • Impact: ammonia emissions were reduced by 57.6%.
Dairy Scenario 4	• 300 cow herd, 15 replacements reared per year producing on average 8,500 litres of milk per annum with a confined system. • Impact: ammonia emissions reduced by 57.3%.

Summary

- A minimum of 42% reduction in ammonia emissions was observed in all scenarios.
- Zero grazing systems produce more ammonia, and mitigation measures resulted in a 57% drop in ammonia emissions.
- The expected milk yield for fully housed systems is higher, so per litre of milk the modelled zero grazing systems produce around 33% more ammonia emissions than the grazing/housing systems.

Beef Case Studies

Mitigations Applied in Beef Case Study Scenarios:

- Increase Days Grazing by 14 Days.
- Installation of Slat Mats with scrapers (achieving c. up to 49% reduction).
- Moving to Trailing Shoe slurry spreading from inverted Splashplate.
- Replace straight urea application with stabilised urea (except in Less Favoured Area scenario where no fertiliser application modelled).

Beef Scenario 1	• 24 month steer dairy origin beef. • Impact: ammonia emissions were reduced by 34%.
Beef Scenario 2	• Lowland suckler cow Feb/Mar calving. • Impact: ammonia emissions were reduced by 41%.
Beef Scenario 3	• Less Favoured Area hill suckler cow spring calving. • Impact: ammonia emissions were reduced by 42%.
Beef Scenario 4	• Finishing suckler steer calves at 24 months. • Impact: ammonia emissions were reduced by 40%.

Summary

- Scenarios 2-4 achieve a reduction in total annual ammonia emissions of 40-42%.
- Scenario 1 achieves a total annual ammonia reduction of 34%.
- It was felt that applying a storage mitigation option, such as that applied in the dairy scenarios (outdoor covered tanks), was not realistic for the small beef herds modelled.

Pig Case Studies

Baseline in Pig Case Study Scenarios:

- Annual N Excretion: NARSES Default.
- Crude Protein in Diet: NARSES Default.
- Housing: Mechanically ventilated, slatted, slurry system.
- Manure Storage: Under-slat store.
- Slurry Spread: Inverted Splashplate.

Mitigations Applied in Pig Case Study Scenarios:

- Annual N Excretion: 5% improvement in Feed Conversion Ratio for an 11% reduction in N excretion.
- Manure Storage: Outdoor covered stores.
- Slurry Spreading: Trailing Shoe, associated with a 60% reduction in landspreading emissions.

Note - Scenarios 2 + 3 have further mitigation measures.

Pig Scenario 1	• 250 sows, 1125 weaners (to 40 kg). • Impact: ammonia emissions were reduced by 45%.
Pig Scenario 2	• 1500 Finishing pigs (40 - 115 kg). • Additional Mitigation: Crude Protein in Diet reduction from 17% to 15% resulting in a reduction of 23% of N excretion. • Impact: ammonia emissions were reduced by 55%.
Pig Scenario 3	• 1500 Finishing Pigs (40 to 115kg). • Additional Mitigation: Acidification with under-slat slalom slurry circulation and outdoor covered reception tank. • Impact: ammonia emissions were reduced by 79%.

Summary

- The mitigation strategies outlined reduce ammonia emissions for the sow (250 places) and weaner (1125 places) system described from 3.9 tonnes to 2.1 tonnes NH3 per annum, a 45% reduction.

- The finishing pig (1500 places) system has a baseline of 8.1 tonnes NH3 per annum which is reduced to 3.6 and 1.7 tonnes, reductions of 55% and 79% respectively, under the two different mitigation scenarios tested.

- Reduction in N excretion, by both a reduction in dietary CP and Feed Conversion Ratio improvement, is a powerful and cost-effective strategy for reducing NH3 emissions from the manure management chain. Significant reductions are also achieved by end of line techniques such as slurry spreading by trailing shoe.

- A move from under-slat slurry storage to outdoor covered stores achieves proportionally more reductions in the pig sector than in the cattle sector, due to the higher total ammonia nitrogen content of pig slurry, compared with cattle slurry, and the fact that pig slurry does not crust as readily as cattle slurry which often forms a crust and a natural barrier to a proportion of the NH3 emission from storage.

- In-house acidification of slurry significantly reduces housing, storage and landspreading emissions but at a high economic cost. It is not currently possible to retrofit existing facilities and requires the bespoke engineering of slurry storage infrastructure to accommodate this type of solution.

Poultry Case Studies

Baseline in Poultry Case Study Scenarios:

- Annual N excretion: NARSES Default.
- Crude Protein Diet: NARSES Default.
- Manure Storage: Litter heap.
- Manure Spreading: Broadcast.

Mitigations Applied in Poultry Case Study Scenarios:

- Reducing N excretion by 12% by achieving a 5% improvement in the Feed Conversion Ratio.
- Reducing N excretion a further 10%, achieved by reducing crude protein (CP) by 1%.
- In-house litter drying to increase litter dry matter (DM) associated with a 30% reduction in Emission Factor.

Note - Poultry Scenario 1 has additional mitigation.

Poultry Scenario 1	• Standard broiler production • Additional mitigation: moving from a 23% CP starter / 21% CP grower / 19% CP finisher diet to a 22% CP starter / 20% CP grower / 18% CP finisher diet • Impact: ammonia emissions were reduced by 24%
Poultry Scenario 2	• Broiler breeders (18-60 weeks). • Impact: ammonia emissions were reduced by 25%
Poultry Scenario 3	• Multi-Tier Free-Range Layers • Impact: ammonia emissions were reduced by 24%
Poultry Scenario 4	• Standard Free-Range Layers • Impact: ammonia emissions were reduced by 26%
Poultry Scenario 5	• Colony Layers • Impact: ammonia emissions were reduced by 24%

Summary

Looking at emissions from the 5 poultry scenarios:

- The mitigation strategies applied achieve a 24-26% ammonia reduction across all scenarios.
- A 5% improvement in broiler Feed Conversion Rate, applied across broilers / layers in all scenarios and which would result in a 12% reduction in N excretion, is seen as a realistic prospect within c. 5 years.
- Air scrubbers offer significant reduction potential (up to 90% reduction of housing emissions) for both pigs and poultry facilities but were not modelled as these are seen as cost-inhibitive. Scrubbers are most effective in mechanically ventilated accommodation and not as effective in free-range systems.
- Unless incorporated rapidly into tilled land it is difficult to reduce emissions from the landspreading of poultry manure, making NH_3 reductions during landspreading on grassland inherently difficult. Other options may include acidification of poultry manure by aluminium sulphate (alum), as used in the USA, which may incur reductions of over 70% from storage and landspreading.

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