AN EVIDENCE REVIEW ON THE INFLUENCE OF LOWLAND AGRICULTURE AND LAND USE CHANGE ON BIODIVERSITY IN NORTHERN IRELAND

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Executive Summary

A large body evidence demonstrates that agricultural intensification and associated land use change is one of the key drivers of biodiversity loss throughout Europe. As farms have responded to policy signals agricultural landscapes have become increasingly simplified and homogenous impacting a range of taxa. Although there have been attempts to address these challenges through agriculture, land management and environmental policy, they have been insufficient in averting the precipitous declines that have been witnessed throughout Europe.

The challenges facing biodiversity in Northern Ireland are as stark as anywhere else. The country currently ranks as the 12th worst country in the world for biodiversity loss, with 1 in 12 species facing extinction with several others experiencing significant rates of decline. With over three quarters of Northern Ireland's land dedicated to agriculture, this sector will play a key role in efforts to address biodiversity loss at a sufficient scale and within a suitable timeframe.

Developing an effective response to biodiversity loss across Northern Ireland's lowland farmland is dependent on a strong understanding of what has driven declines in the first place. By reviewing the existing evidence, this report demonstrates the profound impact that changes in farming practice have had on biodiversity across Northern Ireland's lowland landscapes. In doing so, it demonstrates that the situation in Northern Ireland mirrors much of Europe, with a large-scale push for agricultural improvement resulting in a significant loss of high quality semi-natural habitat across the lowland environment. This has subsequently had a major impact on several species which were previously widespread, including a number of farmland birds which have experienced severe declines.

In recent decades it is unlikely that direct land use change poses the same threat due to the removal of some of the most harmful agriculture and land use policies. However, the evidence suggests recent large-scale expansion in intensive livestock production is becoming increasingly problematic for freshwater and terrestrial biodiversity.

The evidence complied in this review indicates that Northern Ireland's policy response, like that of much of Europe has been inadequate in addressing the threats and pressures facing biodiversity on lowland farmland. Despite strong evidence on the interventions that can be deployed to mitigate losses and support species recovery they have not been implemented effectively, or at a sufficient scale to be successful.

Introduction

Since the 1950s, agricultural intensification and associated land use change have resulted in significant declines in biodiversity throughout Europe.[1] Driven by post-war agriculture policies which sought to increase yields and maximise productivity, farming became increasingly specialised and intensive. This resulted in widespread increases in the use of chemical fertilisers and pesticides; increased stocking rates; changes in crops and cropping patterns,[2] increases in farm size, greater mechanisation and a loss of semi-natural habitats.[3] Such changes have contributed to consistent increases in agricultural productivity but have come at a cost for biodiversity. There is a wealth of evidence demonstrating that the intensification of agricultural practices has led to a loss of high-quality semi-natural habitats driving significant declines in a range of taxa including birds,[4] mammals,[5] amphibians,[6] reptiles and invertebrates.[7] The profound changes in agricultural management and associated land use have been identified as the most important driver of biodiversity change over the last 50 years, with the majority of effects recognised as negative.[8] Lowland farming systems are generally more conducive to supporting higher levels of productivity, as they are generally associated with a favourable climate and more fertile soils compared to upland areas. As such, the lowland environment has often experienced the most transformational changes in the pursuit of increased productivity.

As evidence on the impacts of modern farming practices on biodiversity has grown, public policy has attempted to respond, with several reforms being instigated in a bid to improve the environmental performance of the EU's agriculture sector. These included a shift away from direct production subsidies to area-based payments in the 1990s, as well as the introduction of agri-environment schemes (AES) to provide financial incentives for farmers to undertake actions that are known to benefit biodiversity. But despite several programmes of policy reform and substantial investment in AES delivery, farmland biodiversity continues to decline at a European scale.[9]

In Northern Ireland, agriculture represents the dominant form of land use with 76% of the total land area used for farming.[10] Livestock farming dominates with over 60% of Northern Ireland's land area

[1] Benton, T. G., Vickery, J.A & Wilson, J.D. 2003, 'Farmland biodiversity: Is habitat heterogeneity the key? Trends in Ecology and Evolution, 18 (4), 182-188.
[2] Such changes include the widespread shift in grassland management from hay to silage production with associated drainage, reseeding and fertilisation, as well as the move from Spring sown to Autumn sown crops
[3] Boatman ND, & others. 2007. Impacts of agricultural change on farmland biodiversity in the UK. Biodiversity under threat: 1–32.
[4] Rigal, S & others 2023 'Farmland practices are driving bird population decline across Europe' Ecology Sustainability Science 120 (21)
[5] Gentili, S. & others 2014 'Decreased small mammals species diversity and increased population abundance along a gradient of agricultural intensification' The Italian Journal of Mammalogy: Available at http://www.italian-journal-of-mammalogy.it/article/view/9246/pdf
[6] Arntzen J. W. & others 2017 'Amphibian decline, pond loss and reduced population connectivity under agricultural intensification over a 38-year period' Biodiversity Conservation 26. 1411 – 1430
[7] Cole, L.J. & others 2019 'A critical analysis of the potential for EU Common Agricultural Policy measures to support wild pollinators on farmland' Journal of Applied Ecology 10, 1365-2664
[8] Burns F, & others. 2016. Agricultural management and climatic change are the major drivers of biodiversity change in the UK. PloS one, 11: e0151595.
[9] *Ibid*
[10] DAERA, Statistical review of NI agriculture 2007 onward. 2022, DAERA

devoted to grass production,[11] with 89% of farms engaged in ruminant livestock production.[12] Over three quarters of farms in Northern Ireland are classified as very small based on economic output, whereas the average size of farm is roughly half the UK average.[13] Total income from farming has increased by as much as 20% since 2019,[14] although this is not uniform across all sectors. In comparison to the rest of the UK, Northern Ireland generally supports higher stocking densities of grazing livestock as well as higher densities of pigs and poultry, which have grown significantly in recent years.[15]

Like much of Europe, Northern Ireland has undergone a process of historic agricultural intensification and associated land use change. A major programme of land use change took place in the late 80s resulting in a significant increase in the total area of intensive grassland found in the country.[16] During this time the loss of significant areas of semi-natural habitat was also witnessed, largely due to activities aimed at improving agricultural productivity.[17][18] Other changes synonymous with agricultural intensification were witnessed, including substantial increases in livestock numbers,[19] a towards continental breeds of livestock[20] and an increase in the use of artificial fertilisers.[21]

In recent decades, improvements in agricultural productivity have been achieved alongside a reduction in the use of use of artificial fertilisers such as nitrogen and phosphorus,[22] while total numbers of beef and sheep have remained relatively stable. In contrast sustained growth in intensive pig, poultry and dairy production has occurred during this time, as has increased consumption of livestock feed,[23] the vast majority of which is imported. The expansion in these sectors is thought to have been driven in part by the Agri-food strategy board's Going for Growth Strategy which set an overarching target to increase total agricultural turnover by 60% between 2013 and 2020 with specific targets for each sector.[24]

As a previous member of the European Union, Northern Ireland implemented a suite of policies aimed at mitigating the agriculture sector's impact on biodiversity. This has included the rollout of several iterations of AES, from the Environmentally Sensitive Areas (ESA) Scheme in the late 1980s to the Environmental Farming Scheme (EFS) today. As is the case throughout Europe, AES have

[11] DAERA. Farmlands and grasslands. 2023 Available at: <https:// www.daera-ni.gov.uk/articles/ farmlands-and-grasslands>
[12] DAERA 2023 'The Agricultural Census in Northern Ireland Results for June 2023: accessed 13/06/2024: Available at: < Agricultural Census 2023 Publication.pdf (daera-ni.gov.uk)>
[13] *Ibid*
[14] DAERA, Statistical review of NI agriculture 2007 onward. 2022, DAERA
[15] NISRA 'Northern Ireland Livestock 1923 – 2019 accessed 13/06/2024: Available at <Northern Ireland livestock 1923 - 2019 (nisra.gov.uk)>
[16] Cooper, Dr A, Murray, R., McCann, T. (1997) The Northern Ireland Countryside Survey
[17] *Ibid*
[18] These include activities like hedgerow removal for field enlargement, field drainage etc.
[19] NISRA 'Northern Ireland Livestock 1923 – 2019 accessed 13/06/2024: Available at <Northern Ireland livestock 1923 - 2019 (nisra.gov.uk)>
[20] DAERA 2021 'Farm Animal Populations' accessed 13/06/2024: available at: <Farm animal populations | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)>
[21] DAERA 2023 'Fertiliser Statistics' accessed 13/06/2024: Available at < Fertiliser statistics | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)>
[22] *Ibid*
[23] DAERA 2023 'Animal feed statistics' accessed 13/06/2024 available at: Animal feed statistics | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)
[24] DAERA, 2017 'Going for Growth – a strategic action plan in support of the NI agri-food industry' available at < Going for Growth - a strategic action plan in support of the NI agri-food industry | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)> accessed 22/06/2024

resulted in some localised success stories, but have ultimately failed to address biodiversity loss on lowland farmland. This is clearly evidenced by the recent State of Nature Report, which highlights that 1 in 12 species is at risk of extinction, with continued declines in the abundance and distribution a range of taxa, including farmland birds, vascular plants and bryophytes. Recent monitoring highlights that nutrient enrichment is becoming increasingly common in freshwater[25] and terrestrial[26] environments.

At the time of writing, there are several policies in development which could play an important role in improving the performance of lowland agriculture in relation to biodiversity in Northern Ireland. These include the development of a new Agricultural Policy Framework to replace EU farm payments and the introduction of Northern Ireland's first Environmental Improvement Plan. To be effective, such policies must be underpinned by robust evidence, which helps to identify the pressures and threats facing lowland biodiversity, at the same time as helping to identify opportunities for addressing them. The following report seeks to contribute to this evidence base by conducting a review of the existing evidence relating to changes in lowland biodiversity resulting from agricultural management in Northern Ireland.

Methodological approach

A literature search was undertaken as part of the project, with the aim of finding a comprehensive body of academic research relating to the impacts of lowland agricultural management on biodiversity. To provide sufficient depth the search focused on studies in Northern Ireland, the British Isles and Europe. A systematic search for published academic studies was completed using the Web of Science database in early 2024. To add to and validate the accuracy of the search it was compared against a reference list of papers placed in an existing reference library. Details of search strings are presented in the report Appendix, as is a PRISMA flow chart, which shows the stages at which studies are disqualified or eventually included in the review based on the work of Moher.[27] Zotero was used as the reference manager.

To be included in the review, studies needed to meet five key criteria. First, studies had to be published papers (apart from relevant grey literature such as theses and relevant government reports and data) with comparators, replicates, and controls. Second, studies needed three years or more data analysed. Studies with less than three years of data were included on a case-by-case basis. Thirdly, studies which were not Northern Ireland wide (e.g, the north-west of the province) were de-prioritised. Fourth, only papers from 2014 onwards were included unless the study represented baseline data or helped to show long-term trends. Finally, studies in Northern Ireland were prioritised as the main area of interest, followed by Ireland, the British Isles then Europe.

Rayyan software was used to screen titles and abstracts.[28] Abstracts were screened, using a decision tree (Figure 3). Approximately 98% of the 3,169 abstracts were excluded after screening. Full-text screening was used for the remaining papers included after abstract screening using Elicit. After searching the reference lists of these papers accepted for evaluation, an additional 53 papers were found to be suitable for inclusion. These were used primarily for the development of the case studies on breeding waders and hedgerows.

[25] DAERA 2023 Northern Ireland Environmental Statistics Report: Available at < NI Environmental Statistics Report (daera-ni.gov.uk)> accessed 12/06/2024

[26] Rowe EC, et al., Trends Report 2022: Trends in critical load and critical level exceedances in the UK. 2022, Report to Defra under Contract AQ0849, UKCEH project 07617

[27] Moher, D & others 2009 'Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement BMJ 2009; 339

[28] Ouzzani, M. & others2016 'Rayyan a web and mobile app for systematic reviews' 5:210

Alongside the academic literature search, the project reviewed relevant Government reports, public consultations and existing and proposed strategies in relation to the agri-environment. These were used to gather evidence on current and previous trends within Northern Ireland's agriculture sector and for relevant analysis of previous, existing and proposed policies with influence on lowland agriculture and biodiversity.

Review findings

The available evidence suggests that the situation in Northern Ireland mirrors that found throughout the UK and Europe, with agricultural intensification and land use change resulting in the widespread loss of quality semi-natural habitat and declines in a range of species associated with lowland farmland. More recently, growing levels of freshwater and nitrogenous air pollution has had an impact on the condition of both freshwater and terrestrial habitats.

Declines in species abundance and distribution

A lack of long-term monitoring data makes it impossible to assess trends in biodiversity loss prior to 1988 when the earliest monitoring efforts began. This means that the impacts intensification and land use change which took prior to this time may not be adequately captured. Despite significant and rapid declines in the abundance and distribution of several species have occurred over relatively recent timeframes. For example, the abundance of farmland bird indicator species has fallen by 43% on average since 1996 despite the indicator starting after the most widely known period of agricultural intensification.[29] Within this, some species have experienced profound declines, such as breeding waders which declined by close to 90% between 1999-2013 thought to be because of a loss of suitable breeding habitat and increased predation pressure driven by agricultural intensification and land use change.[30] Other farmland species such as yellowhammer have experienced similar levels of decline, largely as a result of habitat loss caused by intensification and specialisation away from arable production to intensive grassland production.[31] As a result, they are now largely confined to arable farmland in East County Down.

Populations of vascular plants and bryophytes have both experienced significant declines in their distribution. Between 2006 and 2021 the average abundance of 14 butterfly species has declined by 16% representing a moderate decline. Wild bee populations have declined by up to 50% on the island of Ireland as a result of a loss of suitable food resources and nesting habitat. [32][33] Recent research highlights that intensively managed agricultural habitats have the lowest level of pollinator species richness compared to any other. [34] Agrochemical exposure has been found to influence plant growth as well as on flower-visitation by insects.[35]

[29] State of Nature Partnership, State of Nature Northern Ireland 2023 accessed 13/06/2024 available at: <TP26055-SoN-N_Ireland-summary-report-v4-1.pdf (stateofnature.org.uk)

[30] Colhoun, K & others 2015 Population estimates and changes in abundance of breeding waders in Northern Ireland up to 2013 62(3) bird study 394-403

[31] Colhoun, K & others Agri-environment scheme enhances breeding populations of some priority farmland birds in Northern Ireland 64(4) Bird Study 545-556

[32] Cole, L.J. & others 2019 'A critical analysis of the potential for EU Common Agricultural Policy measures to support wild pollinators on farmland' Journal of Applied Ecology 10, 1365-2664

[33] Russo, L. & others 2022 'Conserving diversity in Irish plant-pollinator networks' Ecology and Evolution 12(10) e934

[34] *Ibid*

[35] Russo, L. & others 2020 'low concentrations of fertiliser and herbicide alter plant growth and interactions with flower-visiting insects' Agriculture, Ecosystems and Environment 304(1)

Land use change and habitat loss

A similar picture emerges when attempting to assess the extent of land use change and its impact on biodiversity. Over a relatively short timeframe very large changes in grassland extent have been recorded. Between the late 1980s and early 1990s a significant increase in the area of improved grassland was witnessed following a large-scale programme of field drainage. However, it is thought that improved grasslands declined by 31% between 1990 and 2020.[36] Estimates suggest that semi-natural grassland currently represents around 20% of Northern Ireland's land cover, although most recent estimates suggest that less than 5% of Northern Ireland's grassland resource is species rich.[37] It is thought that Northern Ireland experienced similar losses in the extent of semi-natural grasslands as England and Wales with up to 90% being lost from lowland environments.[38] The intensification of agricultural grasslands including the increased use of inorganic fertiliser, increased stocking rates and a shift hay to silage production are thought to have significantly reduced the quantity and quality of semi-natural grasslands found throughout Ireland.[39]
Most recent monitoring programmes demonstrate that other semi-natural habitats, such as farm wetlands and linear features such as hedgerows have also been subject to substantial declines.[40]

Habitat condition

The condition of many of Northern Ireland's priority semi-natural habitats has been compromised due to a range of factors. Northern Ireland's Environmental Statistics report highlights that 36% of all features in Northern Ireland's Areas of Special Scientific Interest (ASSIs) were in unfavourable condition.[41] Declines in the condition of many semi-natural grassland and woodland habitats is eutrophication resulting from agricultural improvement, such as the addition of fertilisers, which increase nutrient levels in the soil influencing species composition. Nitrogenous air pollution is also a significant issue, with ammonia levels above the critical ecological threshold for bryophytes and lichens at a national level and above critical thresholds for vascular plants across over a third of the land area[42] (and roughly a quarter of protected sites). Agriculture is responsible for the majority of ammonia emissions in Northern Ireland, with emissions from agriculture rising by 19% between 2009 and 2019.[43] This rise in emissions has been caused by an increase in livestock numbers and a shift towards the increased adoption of 'housed' livestock systems. In 2020, cattle were responsible for 66% of emissions the majority of which came from dairy (37.3%) followed by beef (29%). Poultry were responsible for 12.3% of emissions, with 7.8% coming from sheep.[44]

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[36] SLR Consulting 2023 ' Review of trends in Grasslands Across the UK' <available at SLR Report Template Blank (plantlife.org.uk)> accessed 13/06/2024
[37] Cooper, A & others Northern Ireland Countryside Survey 2007: Broad Habitat Change 1998-2007, Northern Ireland Environment Agency Research and Development Series No. 09/06 NIEA Belfast
[38] Bullock, J, M & others 'UK National Ecosystem Assessment: Technical Report Chapter 6: Semi-Natural Grasslands'
[39] Fritch, R, A & others 2011 'Methods of enhancing botanical diversity within field margins of intensively managed grassland: a 7 – year field experiment' Journal of Applied Ecology 48(3) 551-560
[40] Cooper, A & others Northern Ireland Countryside Survey 2007: Broad Habitat Change 1998-2007, Northern Ireland Environment Agency Research and Development Series No. 09/06 NIEA Belfast
[41] DAERA 2023 Northern Ireland Environmental Statistics Report: Available at < NI Environmental Statistics Report (daera-ni.gov.uk)> accessed 12/06/2024
[42] Rowe EC, et al., Trends Report 2022: Trends in critical load and critical level exceedances in the UK. 2022, Report to Defra under Contract AQ0849, UKCEH project 07617
[43] DAERA 2023 'Draft ammonia strategy for Northern Ireland' available at: <Draft Ammonia Strategy Consultation (daera-ni.gov.uk)> accessed 13/06/2024
[44] *Ibid*

In some cases, a reduction in grazing management is a driving factor in the poor condition of many priority semi-natural habitats.[45] As low intensity livestock farming has become less viable, the management of some semi-natural priority grasslands has reduced or ceased, resulting in a decline in habitat condition as grasslands revert to a rank state and reduced species diversity. Many lowland grassland habitats are reliant on annual seasonal grazing or mowing, to maintain their value for biodiversity. Without sufficient economic return for the delivery of these practices, the biodiversity value of these habitats is likely to be compromised.[46] Abandonment and undermanagement are threats which could deplete the condition of existing tracts of lowland species rich grassland found in Fermanagh and West Tyrone.[47]

Freshwater ecosystems are being impacted by agricultural runoff which results in increased nutrient concentrations. Concentrations of Soluble Reactive Phosphorus (SRP) in Northern Ireland's rivers have increased from a low of 0.047 mg/l in 2012 to 0.062mg/l in 2023.[48] Agriculture is responsible for 62% [49]of the phosphorus found in freshwater ecosystems which can lead to increased growth of algae and other plants, impacting the composition of plant species, affecting water quality. One of the key reasons for a growing P surplus in Northern Ireland has been the growing use of imported livestock feed.[50] Research conducted in Upper Lough Erne explored the impact of Eutrophication on macrophyte heterogeneity and species richness and found that both are reduced in lakes with intensified eutrophication where invasive Zebra Mussels are not present.[51]

Policy response

A wide range of policies have been implemented in a bid to mitigate the impact of agriculture on biodiversity in Northern Ireland. These include a mix of strategies, action plans, policies and legislation, which ultimately aim to influence farm decision making through incentives or regulation. The academic literature provides wealth of evidence which demonstrates how in many cases relatively simple changes to agricultural land management can benefit biodiversity,[52][53] [54][55]often without significantly compromising other farm objectives. In many cases this evidence has informed the design of government supported AES which represent the most well-known policy intervention aimed at supporting farmland biodiversity. However, despite 30 years of AES implementation in Northern Ireland these schemes have ultimately failed to address the drivers of biodiversity loss on lowland farmland. This is due to a range of reasons including delivery at an

[45] SLR Consulting 2023 ' Review of trends in Grasslands Across the UK' <available at SLR Report Template Blank (plantlife.org.uk)> accessed 13/06/2024
[46] Barnes A.P. & others 2011 Alternative payment approaches for non-economic farming systems delivering environmental public goods LUPG
[47] Ulster Wildlife, 2017 ' Save our Magnificent Meadows' accessed 13/06/2024 available at: <118455 Ulster Wildlife - Magnificent Meadows Report.indd>
[48] DAERA 2023 Northern Ireland Environmental Statistics Report: Available at < NI Environmental Statistics Report (daera-ni.gov.uk)> accessed 12/06/2024
[49] Doody, G & others. 2020 Phosphorus Stock and Flows in the Northern Ireland Food System: Available at < RePhoKUs report October 2020x.pdf (afbini.gov.uk)> accessed 12/06/2024
[50] *Ibid*
[51] Salgado, J. & others 'Eutrophication homogenizes shallow lake macrophyte assemblages over space and time' 2018 Ecosphere 9 (18) e02406
[52] Fritch, R.A & others 'Enhancing the diversity of breeding invertebrates within field margins of intensive managed grassland: Effects of alternative management practices' 2017 Ecol Evol 19(7) 9763-9774
[53] O'huallachain D. & others 2014 'Field margins: a comparison of establishment methods and effects on hymenopteran parasitoid communities' Insect Conservation and Diversity 7(4) 289-307
[54]Larkin, M & Stanley, D. 2021 'Impacts of management at a local and landscape scale on pollinators in semi-natural grasslands' 2021 Journal of Applied Ecology 58(11) 2505-2514
[55] Colhoun, K & others Agri-environment scheme enhances breeding populations of some priority farmland birds in Northern Ireland 64(4) Bird Study 545-556

insufficient scale and poor scheme design choices such as the inclusion of free unlimited free choice, a lack of targeting and dead weight options.

Broader agriculture policy has not been in step with meeting domestic biodiversity objectives. The development of incentives aimed at supporting biodiversity has been undermined by a wider strategic objective of growth, resulting in the expansion of intensive sectors without sufficient environmental safeguards being put in place. There are also legitimate questions as to whether existing environmental regulation is properly understood by farmers or is being effectively monitored and enforced by Governmnent. The development of new agriculture and environmental policy offers an opportunity to address some of these challenges, by providing a coherent policy framework which can deliver sustainable food production and biodiversity recovery simultaneously. However, at this stage it appears that the development of new policies aimed at supporting the recovery of farmland biodiversity are low down in the order of priorities, with a new system of AES yet to be developed, whereas several other schemes in the framework are already in operation.[56]

Species Case study: Farmland birds with a focus on Lowland Breeding Waders

Farmland birds as indicator species

The health of farmland bird populations is viewed as a proxy to help assess the impact that agricultural landscapes are having on biodiversity throughout Europe. As birds are high up the food chain, they are considered good indicators for the overall state of biodiversity on farmland.
In Northern Ireland, there are several data sources which give an indication of how farmland bird populations are faring. Recent estimates suggest that the abundance of farmland bird species declined on average by 43% between 1996 and 2021,[57] which is broadly in line with declines that have been experienced throughout the rest of the UK.[58] Contrastingly, Ireland's Common Farmland Bird Index (CFBI) which is based on 14 farmland birds demonstrates an increase of 133% compared to the year 2000 baseline[59]. Within this, increases were shown in eight species, with four in decline and two others remaining stable. However, these results should be viewed with caution for several reasons, including the limited number of species being monitored and the relatively short timeframe in which the index has been in operation. The Birds of Conservation Concern Ireland[60] (BOCCI) provides a comprehensive overview of the state of farmland bird species on the island of Ireland. By providing trends for all of Ireland's bird species it demonstrates how specialist farmland species have been affected by changes in agricultural land management. The most recent assessment highlights further significant declines in breeding waders alongside some marked declines in generalist species. When grouped by habitat farmland species represent 35% of red listed species, second only to upland specialists.

Drivers of trends

The intensification of agriculture in Northern Ireland, like in much of Europe has led to simpler, more homogenous farm landscapes, which in turn have driven significant declines in some farmland

[56] For instance, DAERA's Soil Nutrient Health Scheme has been in operation since 2022
[57] State of Nature Partnership, State of Nature Northern Ireland 2023 <TP26055-SoN-N_Ireland-summary-report-v4-1.pdf (stateofnature.org.uk)> accessed 11/03/2024
[58] Department for Environment Farming and Rural Affairs, Wild bird populations in the UK, 1970 to 2022 <Wild bird populations in the UK, 1970 to 2022 - GOV.UK (www.gov.uk)> accessed 11/03/2024
[59] BirdWatch Ireland, Countryside Bird Population Indicators <Countryside Bird Population Indicators - BirdWatch Ireland> accessed 11/03/2024
[60] Gilbert Gillian and others, Birds of Conservation Concern In Ireland 4: 202-2026, (2021) (Birdwatch Ireland)

bird populations. Such changes have been significant and widespread. Agricultural policies which have focused predominantly on agricultural intensification and specialisation drove rapid changes in both land use and farming practice across the country. This resulted in a significant and rapid increase in the area of land devoted to intensive grassland production.[61] Such grasslands are associated with practices such as land drainage, fertilisation and increased frequency of grass cutting which have all had impacts on farmland biodiversity.[62][63] The increase in intensive grassland production has inevitably resulted in wider landscape change. For example, the increase in intensive grassland production has in part resulted in the contraction of low intensity arable land in Northern Ireland, in turn impacting several seed eating passerine species such as the Yellowhammer, which is now largely confined to the mixed and arable farmland of East County Down.[64]
For other farmland species, such as the Kestrel the drivers of recent declines are not clear but are thought to be related to several factors including agricultural intensification, reduced feeding opportunities, prey availability[65] and the impact of second-generation coagulants[66]. For other species, the reason for decline is clear, but not necessarily related to agricultural land management. For example, the decline in Greenfinch populations both within the UK and Ireland have been driven, at least in part by the outbreak of trichomonosis.[67]

Although significant declines have been witnessed across several specialist farmland bird species, there are a number whose populations have remained stable or increased in recent decades. These mainly comprise generalist species such as wood pigeon, magpie, hooded crow and several finches, which can exploit a wider variety of ecological niches, enabling them to adapt to less complex, homogenised landscapes.[68] There is evidence to suggest that recent changes in farming practice and land use have benefitted some of these species directly. For example, the population of hooded crows increased by 179% between 1995 and 20202, thought to be in part driven by changes in farm practice such as an increase in sheep grazing and an increase in permanent grassland, which has consequently increased the availability of carrion and soil invertebrates.[69] In the case of wood pigeon, there is evidence to suggest that recent changes in agricultural practices have helped lead to an increase in body mass during the winter, thereby reducing mortality and contributing to an increase in population size.[70]

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[61] Cooper, A & others Northern Ireland Countryside Survey 2007: Broad Habitat Change 1998-2007, Northern Ireland Environment Agency Research and Development Series No. 09/06 NIEA Belfast
[62] Plantureaz, S & others Biodiversity in intensive grasslands: Effect of management, improvement and challenges, 2005, 3(2), Agronomy Research 153-164
[63] Copland A & others 2012 Habitat associations of Eurasian Skylarks Alauda arvensis breeding on Irish farmland and implications for agri-environment planning 59 Bird study 155-165
[64] Colhoun, K & others Agri-environment scheme enhances breeding populations of some priority farmland birds in Northern Ireland 64(4) Bird Study 545-556
[65] Wilson-Parr, R. & O'Brien, I. (Eds.) 2019. Irish Raptor Study Group Annual Review 2018
[66] Roos, S & others 2021 Annual abundance of common Kestrels (Falco tinnunculus) is negatively associated with second generation anticoagulant rodenticides, 30(4) Ecotoxicology 560-574
[67] Lawson, B & others 2012 The emergence and spread of finch trichomonosis in the British Isles 367 Phil Trans. R. Soc. 2852-2863
[68] Martin J. P & others 2016 Changing densities of generalist species underlie apparent homogenization of UK bird communities, 158 International journal of avian science 645-655
[69] Harris S, J. & others 2020 The Breeding Bird Survey 2019. BTO Research Report 726. Thetford.
[70] D. Ó hUallachain & J. Dunne 2013 Seasonal variation in the diet and food preference of the Woodpigeon *Columba palumbus* in Ireland 60 (3) Bird study 417 -422

A focus on lowland breeding waders

Breeding waders represent several species that have been significantly impacted by shifting agricultural practices and land use change. The term wader, or wading bird is used to describe certain families of birds which primarily feed on invertebrates and are largely associated with wetlands or shallow water for at least part of the year, although many may make use of drier habitats including farmland and moorland particularly during the breeding season. All species have bills that are suited for foraging in soft ground for invertebrates, and most have long legs to enable them to wade into shallow water to feed in soil, mud and sand. Breeding waders in Northern Ireland are exclusively ground nesting species, with many making use of farmed habitats for this purpose. In Northern Ireland, there are four species of breeding wader that are most closely associated with lowland agricultural land management, and which have been subject to the highest level of monitoring over recent decades.

Lapwing

All Images courtesy of Ronald Surgenor

Largely associated with agricultural habitats during the breeding season, with a preference for short grasslands, spring-sown crops, or fallow ground with clear distance from predator habitat such as scrub, hedgerows and trees. However, Lapwing can also breed successfully in upland and marginal habitats, such as heath, bogs, or wetlands with short vegetation near more improved pasture. Lapwings will form loose colonies in suitable conditions where greater numbers can help to drive away predators, with chicks generally hatching in May.

Curlew

The UK's largest wader with a long, curved bill and distinctive call during the breeding season. Curlews are generally associated with upland habitats such as heather moorland, rush pasture and blanket bog, but can be found breeding in suitable lowland habitats such as wet grassland sites. In the breeding season, Curlews diet consists mainly of earthworms which they obtain using their bill to forage in soft soil and mud. Curlews generally return to their breeding areas in March, with eggs laid in May and chicks appearing in early June. This later breeding season is in part to account for the need for nests to be concealed in vegetation of at least 15cm tall, such as tussocky grassland, rush pasture, or heath.

Snipe

The Snipe is more dependent on wetland habitats, requiring dense vegetation of at least 15cm tall. Although dense wetland vegetation is essential, Snipe require more open vegetation and bare ground for foraging. Snipe can be found nesting in appropriate lowland habitats such as wetlands and wet grasslands as well as in upland habitats such as bogs and moorlands. Unlike other waders, which generally migrate to our coasts and estuaries, Snipe can be found on farmland throughout the year, with many wintering on grassland sites.

Redshank

Redshank tend to be less common on farmland, but can be found where suitable conditions allow them to breed successfully. They favour a mosaic of grassland habitat with wet grassland, or wetlands with grass or rush tussocks that effectively conceal the nest near shorter areas of vegetation for foraging. Pools of shallow standing water are important to Redshanks due to the small invertebrates that they support. Redshanks lay eggs around mid-April, with chicks hatching in late May. By July the majority of Redshank will have departed their breeding grounds, to migrate to coastal habitats for the winter.

Breeding wader declines in Northern Ireland

Breeding waders were once common and widespread throughout much of Ireland and were found breeding in all counties across the island as recently as the middle of the 20th century.[71] However, breeding wader populations have experienced steep declines from the mid-1900s, in Ireland, the UK and throughout much of Western Europe.[72][73]

[71] Holloway, S. 1996. The Historical Atlas of Breeding Birds in Britain and Ireland: 1875–1900. T. & A.D. Poyser, London.

[72] Wilson, J.D., Evans, A.D. & Grice, P.V. 2009. Bird Conservation and Agriculture. Cambridge University Press, Cambridge.

[73] Balmer, D., Gillings, S., Caffrey, B., Swann, R.L., Downie, I. & Fuller, R. 2013. Bird Atlas. 2007–11: The Breeding and Wintering Birds of Britain and Ireland. British Trust for Ornithology, Thetford.

Several breeding wader surveys have been carried out since the early 1980s, with the first province wide survey being undertaken between 1985-87[74] and repeated in 1999.[75] This has been followed by a national survey in 2013[76] and a specific survey of lowland wet grassland sites in 2018-19.[77] These efforts highlight that breeding wader populations in Northern Ireland have experienced significant declines in recent decades. Between 1987 and 2013 populations of Lapwing, Curlew and Snipe declined by 84%, 89% and 80% respectively.

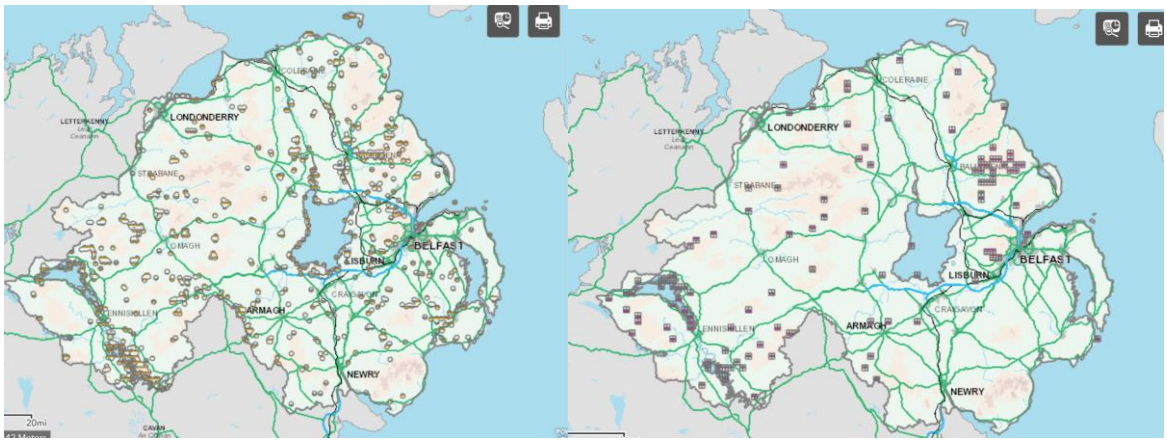
Table 1: *Population estimates (estimated number of breeding pairs) of selected breeding waders in Northern Ireland in 1987, 1999 and 2013 taken Colhoun and others 2015*

Species	1987	1999	2013	Estimated population change (%)
Northern Lapwing	5250	1771	860	-84
Eurasian Curlew	5000	2091	526	-89%
Common Snipe	5725	3993	1123	-80
Redshank	Not available	Not available	119	Not available

The work of Booth Jones has demonstrated similar declines of breeding waders in a subset of lowland wet grassland sites, with declines of 70% for breeding Lapwing, 80% for Curlew, 76% for Redshank and 71% for Snipe between 1985-87 and 2018-19 in the sites in question. This study demonstrates that despite being a vital habitat for breeding waders, lowland damp grasslands in Northern Ireland have undergone a marked decline in the numbers of breeding waders they support, with 64% of sites that previously held breeding wader populations no longer able to support any pairs.[78]

[74] Partridge, J.K. & Smith, K.W. 1992. Breeding wader populations in Northern Ireland, 1985–87. Irish Birds 4: 497–518.
[75] Henderson, I.G. & others 2002. Population estimates, trends and habitat associations of breeding Lapwing Vanellus vanellus, Curlew Numenius arquata and Snipe Gallinago gallinago in Northern Ireland in 1999. 49 Bird Study 17–25.
[76] Colhoun, K & others 2015 Population estimates and changes in abundance of breeding waders in Northern Ireland up to 2013 62(3) bird study 394-403
[77] Booth Jones & others 2020 Northern Ireland Lowland Breeding Wader Survey <bto_rr731_booth-jones_et_al_northern_ireland_breeding_waders_final_draft_high_res_version.pdf> accessed 11/03/2024
[78] Booth Jones & others 2020 Northern Ireland Lowland Breeding Wader Survey <bto_rr731_booth-jones_et_al_northern_ireland_breeding_waders_final_draft_high_res_version.pdf> accessed 11/03/2024

Figure 1: Breeding wader breeding pairs from 1987 (left) and 2013 (right) taken from NIEA Natural Environment Map Viewer



Significant contractions in range have also been witnessed for most breeding waders over recent decades. Excluding some parts of County Antrim, the work of Colhoun found that populations of Curlew and Snipe are now largely limited to the Western counties of Fermanagh and Tyrone, while the distribution of breeding Lapwing is more widespread. These findings are reinforced by Booth who found that declines in breeding wader populations were less severe in Lower Lough Erne, compared to the other sites within the study.

The precipitous decline in breeding waders across Northern Ireland is a cause for concern. The UK and Ireland are estimated to support around 28% of the European breeding population of Curlew,[79] with Northern Ireland making a significant contribution to these figures. The rapid loss of breeding waders from large parts of Northern Ireland's countryside are therefore important in a national and international context

Threats and pressures

Northern Ireland previously held a rich assemblage of habitats suitable for supporting breeding waders, including large quantities of wet grassland and intact peatlands.[80][81] These habitats provide ideal conditions for breeding waders during the breeding season, providing optimum conditions for nesting and foraging. However, like the rest of the UK and Europe the increased intensification of agriculture and land management in Northern Ireland is widely viewed as a driving cause of habitat loss, reduced breeding productivity and consequent population decline. Such intensification can impact wader populations directly, through the loss of habitat, or indirectly through reduced food availability and a reduction in the quality of nesting sites.[82]

A significant programme of agricultural intensification and associated land use change took place in Northern Ireland between the late 80s and 90s largely driven by agriculture policy. During this time the area under intensive grassland management increased by 33%, resulting in an agricultural

[79] British Trust for Ornithology Curlew Appeal <BTO Curlew Appeal | BTO - British Trust for Ornithology> accessed 12/03/2024

[80] Partridge, J.K. & Smith, K.W. 1992. Breeding wader populations in Northern Ireland, 1985–87. Irish Birds 4: 497–518.

[81] Cooper, A & others Northern Ireland Countryside Survey 2007: Broad Habitat Change 1998-2007, Northern Ireland Environment Agency Research and Development Series No. 09/06 NIEA Belfast

[82] Fuller, R. J. & Gough, S. J. 1999 Changes in sheep numbers in Britain: implications for bird populations', 91 Biological Conservation 73–89.

landscape dominated by simple improved grasslands,[83] which now account for around 40% of Northern Ireland's land area. Such grasslands, which are synonymous with field drainage, chemical fertilisation, increased cutting and machinery use are often hostile for breeding waders.[84] Taller, more uniform swards, drier ground and increased stocking densities reduce the suitability of pasture for nesting as well as reducing the availability of appropriate food sources.[85]

The historic intensification of agriculture land management has been exacerbated by nest predation during the breeding season.[86] Several generalist predators have increased in parallel with the intensification of agricultural land management, including corvids and foxes.[87] Reduced food availability may also contribute to increased predation risk as chicks increase their foraging range in search of food, increasing their visibility to predators.[88] Nest predation was previously identified as the main cause of breeding failure for Curlew in Northern Ireland, accounting for 85-97% of failures and 74% of chick mortality.[89] Although recent studies speculate that nest predation is a significant contributing factor to local wader population decline, a more detailed and up to date understanding of the contact between breeding waders and predators in a Northern Ireland context is needed.[90]

Although less represented in the literature, land abandonment and under management also poses a risk to breeding wader populations.[91] The cessation of low intensity grazing management of breeding wader habitats enables shrub and tree encroachment which slowly changes open landscapes of hay meadows, pastures and wetlands which then become unsuitable for most ground nesting birds.[92] Although land abandonment is more associated with wader declines in Eastern, Northern and Central Europe[93] It cannot be discounted as a potentially important factor in driving breeding wader declines in some parts of Northern Ireland. This may be particularly relevant in areas of low agricultural productivity, where economic returns from farming and food production are outweighed by the associated costs of land management.[94]

Although not studied in an Northern Ireland context, climate change is likely to have an increasingly significant impact on the fortunes of breeding waders.[95] Throughout western Europe lowland

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[83] Cooper, A & others Northern Ireland Countryside Survey 2007: Broad Habitat Change 1998-2007, Northern Ireland Environment Agency Research and Development Series No. 09/06 NIEA Belfast

[84] Franks, S & others 208 Evaluating the effectiveness of conservation measures for European grassland-breeding waders 8(21) Ecology and Evolution 10555-10568

[85] Vickery, J. & others 2001 'The management of lowland neutral grasslands in Britain: effects of agricultural practices on birds and their food resources', 38(3), Journal of Applied Ecology, 647–664.

[86] McMahon, B. 2020 European bird declines: Do we need to rethink approaches to the management of abundant generalist predators 57(10) Journal of Applied Ecology 1885-1890

[87] *Ibid.*

[88] Macdonald, M. & others 2008 Predation on wader nests in Europe 150(1) Ibis 54-73

[89] Grant, M.C. & others. 1999. Breeding success and causes of breeding failure of Curlew Numenius arquata in Northern Ireland. 36: J. Appl. Ecol. 59–74.

[90] Booth Jones & others 2020 Northern Ireland Lowland Breeding Wader Survey <bto_rr731_booth-jones_et_al_northern_ireland_breeding_waders_final_draft_high_res_version.pdf> accessed 11/03/2024

[91] Silva-Monteiro, M 2021 Habitats supporting wader communities in Europe and relations between agricultural land use and breeding densities: A review 28 Global Ecology and Conservation e01657

[92] Douglas, D.J.T.T., & others Upland land use predicts population decline in a globally near-threatened wader. 51 J. Appl. Ecol, 194–203

[93] Kamp, J. & others Farmland bird responses to land abandonment in Western Siberia. Agric. Ecosyst. Environ. 268, 61–69

[94] Barnes A.P. & others 2011 Alternative payment approaches for non-economic farming systems delivering environmental public goods LUPG

[95] Smart, J & Gill, J.A 2003 Climate change and the potential impact on breeding waders in the UK 100 Wader Study Group Bull 80-85

breeding wader habitats are already being affected by drier, hotter summers which result in the dying out of wet grasslands and salt marshes during the breeding season.[96] Climate change also increases the likelihood of strong winds and rains in the spring and summer, increasing flood risk and nest and chick mortality.[97]

Conservation Interventions

AES are widely viewed as the most important tool in addressing declines in farmland biodiversity across Europe.[98] They seek to reverse the negative impacts of agricultural intensification on farmland biodiversity by providing financial incentives for the delivery of specific environmental actions at the farm level. Although uptake of schemes across Europe has traditionally been high, their impact in delivering their intended environmental outcomes has been mixed.[99][100] However, there are several examples which demonstrate when effectively designed, targeted and supported by expert land management advice these schemes can deliver significant biodiversity benefits.[101] [102] The track record of AES delivery in Northern Ireland mirrors that experienced throughout Europe, with schemes that have delivered some impressive results[103] without turning the tide on biodiversity decline.[104] Such schemes have been in place since the late 1980s supporting environmental actions at a range of scales. Previous schemes, such as the Northern Ireland Countryside Management Scheme secured high levels of uptake with up to 32% of Northern Irish farmland covered by an agreement in 2011.[105] More recently, uptake of the Environmental Farming Scheme has been significantly lower with 4.5% of farmland covered by an agreement in 2023.[106] These figures may be explained in part by the fact that as little as 1% of farm payments were directed towards AES in Northern Ireland in 2021, compared to 12% in England, 4% in Scotland and 6% in Wales.[107] Recent economic analysis suggests that the level of funding allocated to environmental land management

[96] Mason, L, R. 2019 Conservation management for lowland breeding waders in the UK Phd thesis University of East Anglia School of Biological Sciences

[97] *Ibid*

[98] Vickery, J. & others 2004 'The role of agri-environment schemes and farm management practices in reversing the decline of farmland birds in England', 119(1), Biological Conservation, 19–39.

[99] Santana, & others 2014 Mixed effects of long-term conservation investment in natura 2000 farmland, 7(5), Conservation Letters 467–477.

[100] Batáry, P. & others . 2015 The role of agri-environment schemes in conservation and environmental management, 29(4) Conservation Biology 1006–1016

[101] Perkins, A. J. & others . 2011 Adaptive management and targeting of agri-environment schemes does benefit biodiversity: A case study of the corn bunting Emberiza calandra, 48(3) Journal of Applied Ecology 514–522.

[102] Vickery, J. & others 2004 'The role of agri-environment schemes and farm management practices in reversing the decline of farmland birds in England', 119(1), Biological Conservation, 19–39.

[103]Colhoun, K & others Agri-environment scheme enhances breeding populations of some priority farmland birds in Northern Ireland 64(4) Bird Study 545-556

[104] State of Nature Partnership, State of Nature Northern Ireland 2023 <TP26055-SoN-N_Ireland-summary-report-v4-1.pdf (stateofnature.org.uk)> accessed 11/03/2024

[105]Colhoun, K & others Agri-environment scheme enhances breeding populations of some priority farmland birds in Northern Ireland 64(4) Bird Study 545-556

[106] NISRA, Northern Ireland Environmental Statistics Report. 2023, Northern Ireland Statistics and Research Agency.

[107] Defra. National Statistics. Chapter 10: Public payments. 2022 <https://www. gov.uk/government/statistics/agriculture-in-the-united kingdom-2022/chapter-10- public-payments> accessed 13/03/2024

in Northern Ireland represents an eighth of what would be required in order to meet our current environmental commitments.[108]

In respect to breeding waders, habitat management and predator control are often both needed to ensure optimal conditions for breeding waders.[109] AES have traditionally focused on supporting appropriate habitat management, without addressing reductions in predation pressure, although some options for predator control have been incorporated into the EFS.[110] To date, evidence suggests that previous interventions aimed at securing wader recovery have been ineffective [111] [112] for a variety of reasons including delivery at insufficient scales[113], low quality agreements[114], a failure to low rates of uptake of high ambition options, and a reliance on generic options for multiple species occupying different ecological niches.[115] Although predator control isn't commonly supported through AES a recent study casts doubt on its effectiveness in supporting the recovery of Curlew and Snipe in the absence of landscape scale interventions to address the underlying drivers of high predator densities in the UK.[116]

The Department for Agriculture, Environment and Rural Affairs (DAERA) are currently funding at least six group schemes within the EFS to help deliver coordinated land management in high priority landscapes. Of these, group schemes in Lough Neagh and Lough Erne will provide financial support for actions aimed at benefiting lowland breeding waders. At this stage, it isn't possible to comment on the effectiveness of these AES on breeding waders in a Northern Irish context. However, DAERA is currently undertaking a six-year programme of monitoring on the effectiveness of EFS options for birds, which is due for completion in 2026.

An approach which may help in overcoming some of the limitations of AES noted above may be found in the provision of tailored land management advice, alongside access to appropriate land machinery. Recent evidence from the Halting Environmental Loss Project, demonstrates that such an approach can help enhance and encourage positive trends in wader breeding density at a relatively low cost per hectare. This work serves to demonstrate the role that expert advice can play

[108] Rayment, M 2019 Paying for public goods from land management: How much will it cost and how might we pay? <Paying for public goods final report.pdf (wildlifetrusts.org)> accessed 13/03/2024
[109] Smart, J., & others 2014. Synergies between site protection and agri-environment schemes for the conservation of waders on lowland wet grasslands. 156(3) Ibis, 576–590.
[110] DAERA 'EFS Higher Non-Productive Investments (NPIs) - Predator control < EFS Higher Non-Productive Investments (NPIs) - Predator control | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)> accessed 14/03/2024
[111] Franks, S. E., & others. 2018 Evaluating the effectiveness of conservation measures for European grassland-breeding waders. 8, Ecology and Evolution, 10555–10568
[112] Kelly, L. A.,& others 2021. Inter-Specific Variation in the Potential for Upland Rush Management Advocated by Agri-Environment Schemes to Increase Breeding Wader Densities. 9, Frontiers in Ecology and Evolution, 2021a.
[113] O'Brien, M., & Wilson, J. D. 2011. Population changes of breeding waders on farmland in relation to agri-environment management. 58, Bird Study, 399–408
[114] McCracken, M. E.& others. 2015. Social and ecological drivers of success in agri-environment schemes: The roles of farmers and environmental context. 52, Journal of Applied Ecology, 696–705.
[115] Pearce-Higgins, J. W., & Grant, M. C. 2006. Relationships between bird abundance and the composition and structure of moorland vegetation. 53 Bird Study, 112–125.
[116] Douglas J.T. 2023 Varying response of breeding waders to experimental manipulation of their habitat and predators 72 Journal for Nature Conservation 126353

in supporting the delivery of higher quality environmental outcomes as part of or in combination with AES delivery.[117]

Given the extent of breeding wader declines in Northern Ireland (and across the UK) significant investment has been made in projects which seek to arrest their decline. The most recent of these being the Curlew LIFE Project which aims to reverse declines in Eurasian Curlew across five UK sites.[118] These include the Antrim Plateau and the Erne Lowlands in Northern Ireland. Over the course of four years, the project seeks to enhance conditions for breeding Curlew, while creating long term management plans aimed at building viable populations. Monitoring data for 2023 indicated that in Upper Lough Erne no chicks fledged despite 8 pairs of Curlew using the site that season.[119] For Lower Lough Erne the network of small islands meant that reliable productivity scores for the area were impossible to produce, although monitoring indicates that this site has one of the highest breeding densities of Curlew.[120]

Conclusion

The existing literature clearly demonstrates that breeding wader populations in Northern Ireland have undergone a period of significant and rapid decline since at least the 1980s when monitoring programmes began. The driving factors for this loss appear to be a major programme of agricultural intensification, resulting in habitat loss and a dominance of simple intensive grasslands which are less suitable in supporting breeding waders. Additionally, the increased prevalence and impact of nest predation is thought to be a major driving factor in recent declines, although more specific Northern Ireland research is needed in this area. These declines have been most keenly felt in lowland environments, which appear to be at risk of losing populations of breeding waders altogether. Although the pressures of agricultural intensification, habitat loss and predation are well known within the literature, the impacts of localised land abandonment and climate change may warrant further investigation. Although AES have been in existence since the late 1980s, they have ultimately failed to arrest the decline of Northern Ireland's breeding waders. Positive results in isolated locations are set against a picture of consistent loss in the wider countryside, raising questions of the effectiveness of current approaches both in terms of scheme design, resource allocation and their ability to deal with pressures that emanate from the surrounding landscape such as the increased prevalence of predators.

[117] Hunt, C.L. & others 2023 Positive responses of breeding waders to targeted conservation advice and habitat management used to enhance existing wader conservation initiatives in Northern Ireland 75 Journal of Nature Conservation 126465

[118] Curlew Life 'About the Project' <About the project - Curlew LIFE> accessed 11/03/2023

[119] Curlew Life Curlew Life Newsletter Winter 2023 <A Year of Action for Curlews (mailchi.mp)>

[120] Curlew Life Curlew Life Newsletter Winter 2023 <A Year of Action for Curlews (mailchi.mp)>

Habitat Case study: Hedgerows and biodiversity

Introduction

Hedgerows are a ubiquitous feature in most lowland farming landscapes of Western Europe[121], where they deliver a range of important functions. Although they were originally created for the purposes of boundary demarcation and stock proofing fields, they are important for many reasons, including biodiversity recovery, carbon storage and sequestration, flood risk mitigation, and the preservation of culture and heritage.[122] Well managed hedgerows can also provide a range of benefits for farming and food production, delivering shelter for livestock, pollination, pest control[123] and protection against soil erosion.

In Northern Ireland, hedgerows are an integral part of a landscape which is dominated by relatively small-scale pastoral farming.[124] As a result, there is a high density of field boundaries, the majority of which are made up of managed hedgerows.[125] Most recent monitoring programmes suggest that there are 113648km of hedgerows, accounting for 52% of all primary field boundary types.[126] Compared to the rest of the UK, hedgerows are generally younger, make up a higher proportion of field boundaries and are found at significantly higher densities.[127]

The biodiversity value of hedgerows

Well managed hedgerows are crucial for biodiversity, providing valuable habitat for birds, mammals, vascular plants and insects.[128] In many farmed landscapes, hedgerows represent the main, and sometimes only source of semi-natural habitat, providing refuge for a range of species in homogenous, intensively managed landscapes.[129] Hedgerows include elements of woodland especially woodland edge scrub, and grassland supporting a range of species which occupy various ecological niches.[130]

In total 36 bird species regularly rely on hedgerows for food, shelter and breeding habitat. These consist of a mixture of farmland and woodland species, many of which are listed as UK Birds of

[121] Hannon, L.E., Sisk, T.D., 2009. Hedgerows in an agri-natural landscape: potential habitat value for native bees. Biol. Conserv. 142 (10), 2140–2154

[122] Montgomery, I and others, Hedgerows as Ecosystems: Service Delivery, Management, and Restoration' Annual Review of Ecology, Evolution and Systematics, 202 51:81-102

[123] Morandin, L.A., Long, R.F., Kremen, C., 2016. Pest control and pollination cost-benefit analysis of hedgerow restoration in a simplified agricultural landscape. J. Econ. Entomol. 109 (3)

[124] McCann, T, 'The Woody Species Diversity of Hedges in Relation to Environment, Landscape, History, Management and Structure in Northern Ireland' 2012, PhD thesis, University of Ulster

[125] Cooper, Dr A, Murray, R., McCann, T. (1997) The Northern Ireland Countryside Survey

[126] McCann, T., Rogers, D. and Cooper, A. (2012) Northern Ireland Countryside Survey NICS2007: Field Boundary – Summary Report 1998-2007. Northern Ireland Environment Agency Research and Development Series No.12/13, Belfast.

[127] McCann, T, 'The Woody Species Diversity of Hedges in Relation to Environment, Landscape, History, Management and Structure in Northern Ireland' 2012, PhD thesis, University of Ulster

[128] Graham, L and others, The influence of hedgerow structural condition on wildlife habitat provision in farmed landscapes, Biological Conservation, 2018, 220, 122-131

[129] Weibull, E.C., Ostman, O., 2003. Species composition in agri-ecosystems. The effect of landscape, habitat, and farm management. Basic Appl. Ecol. 4 (4), 349–361.

[130] Hinsley, S.A., Bellamy, P.E., 2000. The influence of hedge structure, management and landscape context on the value of hedgerows to birds: a review. J. Environ. Manag. 60 (1), 33–49.

Conservation Concern or Irish Birds of Conservation Concern.[131] Evidence shows that in the absence of woodland, or other significant woody features, hedgerows often support a greater number of breeding birds than any other farmland habitats.[132]

Several species of mammal regularly utilise hedgerows, including wood mouse, fox, badger, stoat, hedgehog, Irish Hare, and pipistrelle bats.[133] Hedgerows are used by these species for a range of purposes, including nesting, foraging and possibly as travel corridors.[134]

Invertebrates represent the largest number of species found in hedgerows. These include spiders, beetles, true flies, true bugs, butterflies and moths, bees, wasps and ants.[135] Hedgerows support a greater diversity of invertebrate life than most other farmed habitats.[136] They provide food and shelter for a range of arthropods; nectar sources for several pollinators, and support prey populations of natural enemies such as parasitoid wasps. As well as providing shelter, breeding habitat and food resources, there is evidence that suggests that hedgerows provide valuable linear corridors that enable the dispersal of invertebrates within agricultural landscapes.[137] Healthy populations of hedgerow invertebrates provide a food source for many mammals and birds.

Hedgerows can also support a variety of plant life, both within the hedge and at its base. They often contain large numbers of tree standards, including species such as Rowan, Birch and Ash, with recent estimates suggesting that Northern Ireland hedgerows are home to approximately 5.3 million hedgerow trees.[138] The base of the hedgerow is equally important, supporting ground flora such as Primrose, Wood Anemone, Bluebell, and Common Dog-violet. In total over 170 species of trees, shrubs and wildflowers have been recorded in Northern Ireland's hedgerows.[139] Hedgerows can contain Invasive Alien Species such as Rhododendron, Laural, Fuchsia, Japanese knotweed and Himalayan balsam.

The impact of management on the biodiversity value of hedgerows

The value of a hedgerow for biodiversity is not guaranteed by its presence alone. A comprehensive body of evidence illustrates that management is a key factor influencing the condition and

[131] Department for Agriculture Environment and Rural Affairs, Northern Ireland Habitat Action Plan Species-Rich Hedgerows Final Draft - April 2003 Northern Ireland Habitat Action Plan - species rich hedgerows (daera-ni.gov.uk) accessed 18 June 2024

[132] Lack, P., 1992. Birds on Lowland Farms. HMSO, UK

[133] Department for Agriculture Environment and Rural Affairs, Northern Ireland Habitat Action Plan Species-Rich Hedgerows Final Draft - April 2003 Northern Ireland Habitat Action Plan - species rich hedgerows (daera-ni.gov.uk) accessed 18 June 2024

[134] Dondina, O.,and others, 2016. How to manage hedgerows as effective ecological corridors for mammals: a two-species approach. Agric. Ecosyst. Environ. 231, 283–290.

[135] Graham, L and others, The influence of hedgerow structural condition on wildlife habitat provision in farmed landscapes, Biological Conservation, 2018, 220, 122-131

[136] Maudsley, M.J., 2000. A review of the ecology and conservation of hedgerow invertebrates in Britain. J. Environ. Manag. 60 (1), 65–76.

[137] Moorhouse, T.P., Palmer, S.C.F., Travis, J.M.J., Macdonald, D.W., 2014. Hugging the hedges: might agri-environment manipulations affect landscape permeability for hedgehogs? Biol. Conserv. 176 (0), 109–116.

[138] Spaans, F and others, 'The abundance and condition of hedgerow tree standards in Northern Ireland' Biology and Environment: Proceedings of the Royal Irish Academy' 2018;3;129-145

[139] Hegarty, C. A. 1992. The Ecology and Management of Hedges in Northern Ireland. PhD thesis. University of Ulster at Coleraine.

subsequent biodiversity value of hedgerows.[140][141] Management is required to help hedgerows provide food, shelter and nesting space for a range of different species throughout the year, with both timing and the type of management important in this respect.[142]

In general, management which helps to maintain larger, wider hedgerows will benefit biodiversity by providing a greater habitat area and a greater variety and quantity of resources for a range of taxa.[143][144] Maintaining the connectivity of hedgerows is also important for mobile species which may use hedgerows to commute through a landscape. Management has a strong influence on the availability of seasonal resources including berries and flowers which are important for a range of species that use hedgerows at different times of the year.[145]

In the case of farmland birds, hedgerows that have been left uncut for several years support more species at higher densities than those managed annually or biennially.[146][147] It is generally assumed that larger hedgerows are able to support more birds through increased provision of shelter from predators and extreme conditions, food sources and nesting opportunities. Evidence demonstrates that reduced cutting frequency can have a significant impact on hawthorn berry production, with uncut hedgerows supporting up to 83% and 75% more berries and flowers than those which are annually cut.[148] Research has shown that the berries produced by other hedgerow plants also produce significantly lower yields when subject to more frequent cutting.[149] Research from Porter reinforces this link between reduced cutting and the abundance of food resources in a Northern Irish context, demonstrating that hedgerows subject to reduced management produce significantly more berries of higher nutritional quality, providing more food for a range of species during the Winter months.[150]

Structurally complex hedgerows have been shown to support high levels of invertebrate diversity.[151] Larger hedgerows provide a greater habitat area, which is often more complex and able to fulfil

[140] Hinsley, S.A., Bellamy, P.E., 2000. The influence of hedge structure, management and landscape context on the value of hedgerows to birds: a review. J. Environ. Manag. 60 (1), 33–49.
[141] Maudsley, M.J., 2000. A review of the ecology and conservation of hedgerow invertebrates in Britain. J. Environ. Manag. 60 (1), 65–76.
[142] Graham, L and others, The influence of hedgerow structural condition on wildlife habitat provision in farmed landscapes, Biological Conservation, 2018, 220, 122-131
[143] Graham, L and others, The influence of hedgerow structural condition on wildlife habitat provision in farmed landscapes, Biological Conservation, 2018, 220, 122-131
[144] Barr, C.J.,and others 2005. Hedgerow Management and Wildlife - A review of Research on the Effects of Hedgerow Management and Adjacent Land on Biodiversity (BD2108). Defra, UK.
[145] Porter, S, 'Assessing the efficacy of hedgerow management policies in farmland bird conservation' 2017, PhD thesis Queen's University Belfast
[146] Porter, S, 'Assessing the efficacy of hedgerow management policies in farmland bird conservation' 2017, PhD thesis Queen's University Belfast
[147] Hinsley, S.A., Bellamy, P.E., 2000. The influence of hedge structure, management and landscape context on the value of hedgerows to birds: a review. J. Environ. Manag. 60 (1), 33–49.
[148] Staley, J.T.,and others 2012. Long-term effects of hedgerow management policies on resource provision for wildlife. Biol. Conserv. 145 (1), 24–29.
[149] Sparks, T.H., Croxton, P.J., 2007. The influence of timing and frequency of hedgerow cutting on hawthorn flowering and berry yields: preliminary results. Asp. Appl. Biol. 82, 103–106.
[150] Porter, S, 'Assessing the efficacy of hedgerow management policies in farmland bird conservation' 2017, PhD thesis Queen's University Belfast

[151] Pollard, K.A., Holland, J.M., 2006. Arthropods within the woody element of hedgerows and their distribution pattern. Agric. For. Entomol. 8 (3), 203–211.

more niche requirements.[152] The density of hedgerow vegetation at the base and shrub layer of a hedge may also provide a potential windbreak for invertebrates. Many invertebrate groups benefit from older growth hedgerows, which provide a range of flowers and cavity nesting spaces for pollinators. For example, mature hedgerows have been shown to support a higher abundance of Apoidea.[153] Mature hedgerows also provide a greater variety of ageing and dead plant material which is beneficial to detritivores and hole boring invertebrates.[154] The species composition of hedgerows can also have an influence on the diversity and abundance of invertebrates found using it. Management which helps secure larger more complex hedgerows will benefit invertebrates, providing increased availability and diversity of food sources, cover and shelter from predation[155] as well as favourable microclimates.[156]

Hedgerow management can have a direct impact on several mammals. Significant declines in the population of European hedgehogs are thought to have been driven in part by a deterioration in the quality of hedgerow habitat, which has increased the risk of predation from European badgers. Steps to create dense base vegetation in hedgerows is viewed as a key strategy in reducing predation risk as well as increasing the availability of invertebrate food sources. Research from Northern Ireland[157] highlights that frequently trimmed, low standing hedgerows are less favoured by bats, suggesting that hedgerow height may be important for multiple species of bat, with larger, taller hedgerows supporting greater food availability.

Management can have a key impact on plant life both within the hedge and at its base. Frequent cutting reduces woody biomass and results in a lower sub-branching density resulting in a simpler structure.[158] The woody species composition of hedgerows may be impacted by frequent cutting with species that are more tolerant to intensive management dominating at the expense of others which are less resilient to its effects.[159]

The effect of hedgerow management and structure on ground flora has not been studied to the same extent as the impact of management on plant species within hedgerows. However, structurally diverse hedgerows are expected to support greater plant species richness. Management can have a key influence on light levels, temperature and disturbance which all influence the diversity of plant life found at the hedgerow base.[160] The decline in traditional hedgerow

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[152] Weibull, E.C., Ostman, O., 2003. Species composition in agri-ecosystems. The effect of landscape, habitat, and farm management. Basic Appl. Ecol. 4 (4), 349–361.

[153] M'Gonigle, L.K., Ponisio, L.C., Cutler, K., Kremen, C., 2015. Habitat restoration promotes pollinator persistence and colonization in intensively managed agriculture. Ecol

[154] Marshall and others, 2001 Effects of management on the biodiversity of English hedgerows', Hedgerows of the world: their ecological functions in different landscapes. In: Proceedings of the 10th Annual Conference of the International Association for Landscape Ecology, held at Birmingham University, 5th-8th September 2001. International Association for Landscape Ecology, Birmingham University, UK. Aberdeen, UK, pp. 361–365.

[155] Maudsley, M.J., 2000. A review of the ecology and conservation of hedgerow invertebrates in Britain. J. Environ. Manag. 60 (1), 65–76.

[156] Langellotto, G.A., Denno, R.F., 2004. Responses of invertebrate natural enemies to complex-structured habitats: a meta-analytical synthesis. Oecologia 139 (1), 1–10

[157] Russ, J, M and Montgomery W.I, 'Habitat associations of bats in Northern Ireland: implications for conservation, Biological Conservation, 2002, 108(1);49-58

[158] Facey, S.L., Botham, M.S., Heard, M.S., Pywell, R.F., Staley, J.T., 2014. Moth communities and agri-environment schemes: examining the effects of hedgerow cutting regime on diversity, abundance, and parasitism. Insect Conserv. Divers. 7, 543–552.

[159] Wolton, R., 1994. Hedges in decline? Enact 2.

[160] Graham, L and others, The influence of hedgerow structural condition on wildlife habitat provision in farmed landscapes, Biological Conservation, 2018, 220, 122-131

management techniques, coupled with increased eutrophication from intensive surrounding land management are thought to be key drivers in the loss of diversity in hedgerow ground flora.[161] Dense hedgerows may provide a protective effect for hedgerow ground flora by helping to limit the drift of agri-chemicals towards the base.[162]

Timing of management is also a key factor influencing the value of hedgerows for a range of taxa. The most well-known example is the impact of hedgerow management on birds during the breeding season where a wealth of evidence exists to demonstrate the negative impact of management during this time.[163] To address this a closed cutting period applies to landowners, prohibiting hedgerow management between 1 March and 31 of August each year. The response among species of moths and butterflies to hedgerow cutting varies by species based on life history, indicating that management regimes may need to alter to deliver positive outcomes for some species found in the hedgerow.

On the other side of the scale, under-management and neglect will also have a significant impact on the biodiversity value of hedgerows. If left unmanaged for long periods of time, hedgerows will transition into lines of trees.[164] This transition will have negative impacts for many species that rely on scrub and woodland edge type habitats provided by well managed hedgerows.

Management which helps secure larger and denser hedgerows should enhance hedgerow habitat for a wide range of taxa. However, consideration needs to be given to the needs of conservation priority species in any local area or region. By way of example, yellowhammer, a red listed species in Northern Ireland, confined largely to arable farmland in East County Down shows a distinct preference for shorter hedgerows with lower densities of hedgerow trees,[165] which does not conform with general recommendations in relation to hedgerow size and composition. This example highlights a risk in over-relying on general hedgerow management recommendations, that some species of conservation concern could be negatively affected by a loss of suitable habitat.[166]

Despite the strong evidence demonstrating the value of a reduced frequency of management, like most farming practices, hedgerow management has become increasingly mechanised and intensive over time.[167] This is particularly pertinent in relation to hedgerow cutting which is usually performed with a mechanical flail, removing all the previous season's growth. Annual autumnal cutting has become the most common cutting regime practised throughout the UK,[168] despite recommendations for reduced management intensity through government supported AES. Hedge laying is not widely practiced in Northern Ireland, it was available as a management tool through past AES but was withdrawn recently as a prescription due to low take up.

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[161] *Ibid*

[162] Tsiourus, S., Marshall, E.J.P., 1998. Observations on patterns of granular fertiliser deposition beside hedges and it's likely effects on the botanical composition of field margins. Ann. Appl. Biol. 132, 115–127

[163] Porter, S, 'Assessing the efficacy of hedgerow management policies in farmland bird conservation' 2017, PhD thesis Queen's University Belfast

[164] Carey P,D and others 'Countryside Survey: Uk Results from 2007' CEH 2008 (revised June 2009)

[165] Hinsley, S.A., Bellamy, P.E., 2000. The influence of hedge structure, management and landscape context on the value of hedgerows to birds: a review. J. Environ. Manag. 60 (1), 33–49.

[166] Staley J and others 'Improving and expanding hedgerows - Recommendations for a semi-natural habitat in agricultural landscapes' Ecological Solutions and Evidence, 2023;4:e12209

[167] Graham, L and others, The influence of hedgerow structural condition on wildlife habitat provision in farmed landscapes, Biological Conservation, 2018, 220, 122-131

[168] Sparks, T.H., Croxton, P.J., 2007. The influence of timing and frequency of hedgerow cutting on hawthorn flowering and berry yields: preliminary results. Asp. Appl. Biol. 82, 103–106.

The hedgerow network in Northern Ireland

The Northern Ireland Countryside Survey (NICS) provides the most comprehensive picture of hedgerow extent in Northern Ireland.[169] The most recent monitoring programme took place in 2007, with previous iterations in 1998[170] and 1991.[171] These surveys demonstrate that hedgerows are more abundant here than any other part of the UK. Hedgerows represented 52% of all boundaries in 2007, in comparison to 30% for the UK, 39% for England, 26% for Wales and 6% for Scotland. Hedgerows are also found at a significantly higher density in comparison to other parts of the UK, four times more than the average figure of 2.1km/km2.[172] Although hedgerows are found throughout most of Northern Ireland, regional differences are observed. Previous iterations of NICS have shown a significant hedgerow network both in terms of length and average density in Fermanagh.[173]
Data from these surveys demonstrates that a significant decline in Northern Ireland's hedge network took place between 1991 and 2007 with the total length of the network decreasing by over 11,000km. Monitoring found that the dominant cause of these declines was the removal of hedgerows to make way for construction and for field enlargement. Another significant driver of declines was existing hedgerows being subsumed within woodland planting or scrub development. The declines evidenced above coincided with a significant period of agricultural intensification and wider land use change, which is likely to be a key factor driving hedgerow removal. These causes differ from the rest of the UK, where reductions in the hedgerow network were largely caused as a result of 'managed' hedges transitioning to lines of trees, shrubs and relict hedges as a result of under management.[174] Given that the last countrywide survey of hedgerows took place nearly two decades ago, it is difficult to say with certainty whether Northern Ireland's hedgerow network has continued to decline at the same rate. There is a repeat of NI Countryside Survey taking place in 2024 which will update the hedgerow statistics.

Table 2: *Changes in the length and density of Northern Ireland's hedgerow network between 1991-2007 based on data from the Northern Ireland Countryside Survey*

Year	KM	KM/km2	Net change
1991	124,000	Not available	Not available
1998	119120	8.8	-4%
2007	113648	8.03	-4.6%

Although a comprehensive condition assessment of NI's hedgerows is not available, the most recent NICS estimated that up to 48% of Northern Ireland's hedgerow network could potentially be species rich, based on a number of set criteria related to the level of plant diversity found within the hedge and its base.[175] Species rich hedges tend to be concentrated in specific regions, often

[169] Cooper, A & others Northern Ireland Countryside Survey 2007: Broad Habitat Change 1998-2007, Northern Ireland Environment Agency Research and Development Series No. 09/06 NIEA Belfast
[170] Cooper, A., McCann, T. & Meharg, M. (2002). Habitat change in the Northern Ireland countryside: summary report of the Northern Ireland Countryside Survey 2000. Environment and Heritage Service. Belfast
[171] Cooper, Dr A, Murray, R., McCann, T. (1997) The Northern Ireland Countryside Survey
[172] McCann, T, 'The Woody Species Diversity of Hedges in Relation to Environment, Landscape, History, Management and Structure in Northern Ireland' 2012, PhD thesis, University of Ulster
[173] Cooper, A., McCann, T. & Meharg, M. (2002). Habitat change in the Northern Ireland countryside: summary report of the Northern Ireland Countryside Survey 2000. Environment and Heritage Service. Belfast
[174] Carey P,D and others 'Countryside Survey: Uk Results from 2007' CEH 2008 (revised June 2009)

[175] The following definition of species rich hedges was used for the purposes of NICS 2007
a. Hedges with six or more woody species in a 30m length.

associated with extensive farming systems on low nutrient status soils. The majority of species rich hedges are concentrated in County Fermanagh,[176] where adjacent habitats are more likely to be semi-natural. These hedgerows are often dominated by hazel, willow and blackthorn. In comparison, species poor hedgerows are more often associated with intensively managed land with higher nutrient status. These hedgerows tend to be smaller, less structurally diverse and dominated by hawthorn and ash.

Northern Ireland's Habitat Action Plan for Species-Rich Hedgerows[177] outlined an ambition for 50% of species-rich hedgerows to be in favourable condition by 2015. Although it is unclear if this target has been met. Research from McCann, which compared the number of woody species per 30 metres (one of the key metrics of species richness) between 1998 and 2007 using NICS data, found a significant decline in woody species diversity over this time.[178] In comparison, no significant change was witnessed in GB.

Is there scope to increase hedgerow extent in Northern Ireland?

Given the average density of hedgerows in Northern Ireland is considerably higher than the rest of the UK, it is worth considering whether an increase in hedgerow extent is necessary to deliver outcomes for biodiversity. Although relatively little research has been conducted to determine what impact an increase in hedgerow extent would have, or what is an 'optimal' hedgerow density at a national scale, there are some studies which aim to address this question. Research from Dicks,[179] found that providing 13.8km of flowering hawthorn and blackthorn per km2 would provide the pollen and nectar requirements to support healthy populations of six wild bee species if delivered in combination with other late flowering habitats. Average densities of 8km/km2 are thought to result in increases in birds, which would reduce once density exceeds 12 km/km2.[180] Although a further study indicates a lower threshold for bird species with maximum numbers recorded at 1.2km'km2 after which they point, they remained stable.[181]

An increase in the hedgerow network could also result in adverse impacts on species that occupy different ecological niches, such as open grassland habitats. One study suggests that hedgerow densities should not exceed 9.5km/km2 to ensure that large enough grassland parcels are retained

b. Hedges containing fewer woody species (<= 5) in a 30m length, but which have a rich ground flora of herbaceous species.

c. Townland hedges. These are considered the oldest, most ancient, hedge types in Ireland

[176] Hegarty C, A & Cooper, A, 'Regional Variation of Hedge Structure and Composition in Northern Ireland in Relation to Management and Land Use' Biology and Environment: Proceedings of the Royal Irish Academy, 1994, 94(3);223-236

[177] Department for Agriculture Environment and Rural Affairs, Northern Ireland Habitat Action Plan Species-Rich Hedgerows Final Draft - April 2003 Northern Ireland Habitat Action Plan - species rich hedgerows (daera-ni.gov.uk) accessed 18 June 2024

[178] McCann, T and others, 'How hedge woody species diversity and habitat change is a function of land use history and recent management in a European agricultural landscape' Journal of Environmental Management, 2017;196; 692-701

[179] Dicks, L. V.,and others . How much flower-rich habitat is enough for wild pollinators? Answering a key policy question with incomplete knowledge. Ecological Entomology, 2015, 40, 22–35.

[180] Fuller, R. J.,and other . Distributions of birds in lowland agricultural landscapes of England and Wales: How distinctive are bird communities of hedgerows and woodland? Agriculture, Ecosystems & Environment, 2001 84, 79–92

[181] Carrasco, L., Norton, L., Henrys, P., Siriwardena, G. M., Rhodes, C. J., Rowland, C., & Morton, D. (2018). Habitat diversity and structure regulate British bird richness: Implications of non-linear relationships for conservation. Biological Conservation, 226, 256–263.

to support grassland birds.[182] Other potential impacts could arise, such as the spread of invasive species, tree diseases and pathogens. This is already a considerable problem in Northern Ireland, with between 5%-30% of hedgerow trees showing signs of disease in a recent study.[183]

Current evidence suggests that broad biodiversity benefits would result from an increase in hedgerow extent to densities between 8-13.8 km/km2. To avoid potential negative impacts on grassland species occurring at the top end of this range (9.5km -12km/km2) an increase in the average extent to 10km/km2 is recommended.[184] These figures suggest that there is scope to significantly increase the average density of Northern Ireland's hedgerow network to benefit biodiversity.

There are no specific targets aimed at increasing hedgerow extent in Northern Ireland for biodiversity at present. However, recommendations to increase the extent of Northern Ireland's hedgerow network have been made for the purposes of climate mitigation. The Climate Change Committee calls for a 30-40% increase in the extent of hedgerows across the UK to meet net zero by 2050.[185] Although increases would not be uniform across the UK, it is likely that a significant increase in hedgerow extent in Northern Ireland would be required.

***Table 3**: Estimated annual increase in hedgerow extent required to achieve UK net zero under a range of scenarios. It is assumed that annual increases remain uniform between 2024 and 2050 with the 2050 target based on a percentage increase using 2007 as the base year. It is likely that a higher rate of annual planting will be required to compensate for hedgerows that are removed annually.*

Percentage increase by 2050	Length of hedgerow network in 2050 km	Average Hedgerow density km/km2	Annual rate of net increase needed km
20%	136,377	9.6	874
30%	147,742	10.4	1311
40%	159,107	11.2	1748

Improving hedgerow condition

Hedgerow condition in the UK is currently measured using a standard survey, which assesses several different characteristics. These include hedgerow size, the amount and size of gaps, the presence of non-native species, the width of undisturbed ground and herbaceous vegetation, as well as the presence of indicators of nutrient enrichment.[186] In 2007 the Countryside Survey estimated that 48%

[182] Besnard, A. G., & Secondi, J. (2014). Hedgerows diminish the value of meadows for grassland birds: Potential conflicts for agri-environment schemes. Agriculture, Ecosystems & Environment, 189, 21–27.
[183] Spaans, F and others, 'The abundance and condition of hedgerow tree standards in Northern Ireland' Biology and Environment: Proceedings of the Royal Irish Academy' 2018;3;129-145
[184] Staley J and others 'Improving and expanding hedgerows - Recommendations for a semi-natural habitat in agricultural landscapes' Ecological Solutions and Evidence, 2023;4:e12209
[185] Climate Change Committee, The Sixth Carbon Budget, Agriculture and land use, land use change and forestry Sector-summary-Agriculture-land-use-land-use-change-forestry.pdf (theccc.org.uk) accessed 18 June 2024
[186] Department for Environment Farming and Rural Affairs, Hedgerow Survey Handbook, A Standard Procedure for Local Surveys in the UK 2007 Hedgerow Survey Handbook (publishing.service.gov.uk) accessed 20 June 2024

of hedgerows were deemed to be in good condition, based on three of the criteria listed above.[187] However, no figure was provided for hedgerow condition in Northern Ireland.

Although detailed and up-to- date data on hedgerow condition in Northern Ireland is not available, there is likely considerable scope to improve it. Given the similarities between Northern Ireland and Great Britain in relation to hedgerow management it is reasonable to expect a similar situation, with a large proportion of hedgerows failing to meet favourable status due to the impact of over frequent cutting and surrounding land use pressures.

Assessment of policies aimed at increasing extent and condition of Northern Ireland's hedgerow network

Agri-environment schemes

For over 30 years AES have provided the most consistent and comprehensive form of financial support to farmers and landowners to create, restore and sensitively manage hedgerows. Since the late 1980s several iterations of these schemes have been rolled out in Northern Ireland. Although field boundaries have featured prominently in AES since their inception, insufficient funding, low levels of uptake, and the recent removal of hedgerow management actions have undermined their ability to deliver an increase in hedgerow extent, or improved condition at the necessary scale.

Recent research suggests that £75 million per annum is needed to meet objectives for the maintenance, restoration and expansion of hedgerows in Northern Ireland.[188] This figure exceeds the total figure paid for all actions undertaken within the Environmental Farming Scheme (EFS)[189]since its inception in 2018.[190] Inevitably, levels of uptake for hedgerow options have been insufficient. For example, since the beginning of EFS 100km of new hedgerow has been created each year, 9-17 times less than what's recommended by the CCC to meet net zero. At a broader scale, the proportion of farmland covered by scheme agreements and AES expenditure have declined significantly. In 2010 close to 500,000 hectares of Northern Ireland farmland was entered into AES, compared to less than 100,000 hectares in 2023.[191] Between 2007 - 2013 £158.2 million was paid out to AES participants[192] compared to £66 million between 2018 - 2024 representing a 58% decline.

Despite the importance of favourable hedgerow management for biodiversity, payments and actions related to hedgerow management are not present in the EFS, the most recent AES operating in Northern Ireland. This contrasts to both the Countryside Management Scheme

[187] Norton, L.R.,and others 2012. Measuring stock and change in the GB countryside for policy – key findings and developments from the Countryside Survey 2007 field survey. J. Environ. Manag. 113 (0), 117–127.
[188] Rayment, M. 2023 An assessment of the financial resources needed for environmental land management across the UK 'Finance for UK Environmental Land Management, June 2023.pdf (wildlifetrusts.org)
[189] Department of Environment Farming and Rural Affairs, Environmental Farming Scheme Environmental Farming Scheme (EFS) | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk) accessed 22 June 2024
[190] Department of Agriculture Environment and Rural Affairs, Muir announces payments of more than £9m to Environmental Farming Scheme participants April 2024 Muir announces payments of more than £9m to Environmental Farming Scheme participants | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk) accessed 23 June 2024
[191] Northern Ireland Statistics and Research Agency, Northern Ireland Environmental Statistics Report, May 2024
[192] NISRA Environment Statistics Environment statistics | Northern Ireland Statistics and Research Agency (nisra.gov.uk) 22 June 2024

(CMS)[193] and NI Countryside Management Scheme (NICMS),[194] in which all participants had to adhere to a set of management requirements aimed at improving the biodiversity value of existing hedgerows. The absence of hedgerow management options in the EFS means that Northern Ireland is the only part of the UK not providing financial incentives for hedgerow management under AES.

Although the Department for Agriculture, Environment and Rural Affairs have committed to developing a Farming with Nature Package to replace the EFS as part of its Future Agricultural Portfolio,[195] little detail has been provided in relation to funding, scheme design, or implementation meaning it is unclear to what extent the challenges above will be addressed. It would be important to view hedgerows as important landscape features, to ensure losses of hedgerow trees due to Ash die-back are replaced, to manage invasive alien species and encourage hedgerow management for biodiversity and carbon sequestration.

Regulation

There are a range of regulations in place which seek to protect hedgerows from practices that can damage or destroy them. For farmers many of these have been consolidated into basic sets of rules which seek to ensure that farmers in receipt of public subsidy are meeting minimum standards for the environment, health and animal welfare. In respect to hedgerows and other boundary features, farmers must abide by rules[196] which protect them against encroachment by invasive species, removal, and cutting during the bird breeding season.[197]

Although a set of basic rules aimed at protecting hedgerows and other boundary habitats exists in Northern Ireland, evidence suggests that farmer understanding of them is low, thereby undermining their effectiveness. For example, research indicates that although 97% of farmers with hedgerows on their land were aware of the Closed Cutting Period (CCP) 74% of respondents were unable to give the correct start and end dates of the CCP.[198] Furthermore, low rates of inspection make it difficult to determine the level of non-compliance with the rules and may not provide a sufficient deterrent against non-compliance.[199]

Furthermore, it could be argued that hedgerow protections applying on farmland in Northern Ireland are weaker than in the rest of the UK. In Wales, Scotland and England a wider set of restrictions apply to deter over forms of management which could significantly impact hedgerow

[193] Department of Agriculture and Rural Development, Agri-environment Scheme Explanatory Booklet, Environmentally Sensitive Areas Scheme, Countryside Management Scheme cms-esa-booklet-2000-2006.pdf (daera-ni.gov.uk) accessed 23 June 2024

[194] Department of Agriculture Environment and Rural Affairs, 'Countryside Management Scheme 2007-2013 information booklet, NICMS information booklet (daera-ni.gov.uk) accessed 22 June 2024

[195] DAERA 2022 Future agricultural policy decisions for Northern Ireland accessed 13/06/2024 Available at: 'Future Agricultural Policy Decisions for Northern Ireland | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)

[196]96
Department of Agriculture Environment and Rural Affairs, Northern Ireland Cross-Compliance Verifiable Standards 2024 Cross-Compliance Verifiable Standards - Full Version.pdf (daera-ni.gov.uk) accessed 22 June 2024

[197] Department of Agriculture Environment and Rural Affairs, Northern Ireland Cross-Compliance Verifiable Standards 2024 Cross-Compliance Verifiable Standards - Full Version.pdf (daera-ni.gov.uk) accessed 22 June 2024

[198] Porter, S, 'Assessing the efficacy of hedgerow management policies in farmland bird conservation' 2017, PhD thesis Queen's University Belfast

[199] Porter, S, 'Assessing the efficacy of hedgerow management policies in farmland bird conservation' 2017, PhD thesis Queen's University Belfast

health and condition. These include restrictions which seek to avoid damage to the base of the hedge, caused by ploughing or spraying fertiliser and pesticides in close proximity.[200][201][202] Such restrictions appear to be absent in Northern Ireland meaning that hedgerows could be damaged by practices which are not permitted elsewhere.

As part of the transition to a Future Agricultural Policy Framework, DAERA will seek to create a new system of Farm Sustainability Standards, which aims to be 'simpler, more flexible and more responsive to meet the challenge of current and emerging issues". Six standards have been proposed, including protection of waters from pollution, protection of farm habitats and protection of landscape and heritage.[203] As yet, no detail is publicly available to give insight into what level of protection will be afforded to hedgerows, and how standards will be monitored and enforced.

Conclusion

Although Northern Ireland is home to an extensive hedgerow network, the most up to date evidence indicates it has been subject to significant declines over a relatively short time frame. Unlike the rest of the UK, this was driven by hedgerow removal for construction and field expansion as opposed to the undermanagement and neglect which was witnessed elsewhere. In the absence of up to date data it is difficult to determine whether existing regulations have been effective in stemming the rate of hedgerow loss, either through direct removal, by poor management or neglect. In this respect it does appear that the level of protection afforded to hedgerows is weaker than the rest of the UK, which may have implications for Northern Ireland's hedgerow network.

Despite over two decades of AES delivery focused on hedgerow creation, restoration and sensitive management it appears that schemes have failed to deliver these objectives. Scheme expenditure and uptake appear to be well below what is required to deliver hedgerow creation and restoration at the scale necessary to provide broad benefits for biodiversity, whereas options for sensitive management, a key component in securing good hedgerow condition, have recently been removed entirely. Taken together, the evidence suggests that existing protections are inadequate, while opportunities to harness Northern Ireland's hedgerow network in pursuit of several public policy objectives are being missed.

Gaps in evidence, understanding and data

There is a relative paucity of up to date, relevant research and data regarding the impact of lowland agriculture on biodiversity in Northern Ireland. The earliest biodiversity monitoring programmes began in 1988 (with many starting later) making it impossible to assess long term trends in a Northern Irish context. This baseline will miss earlier periods of land use change and agricultural intensification which could be significant. In comparison to the rest of the UK Northern Ireland has less available data to build up accurate trends for the abundance and distribution of several species. There is a reasonable amount of academic research on agricultural land management, and it's

[200] Welsh Government, Cross compliance: landscape features (GAEC 7) (2023) December 2023 Cross compliance: landscape features (GAEC 7) (2023) [HTML] | GOV.WALES accessed 22 June 2024

[201] Scottish Government Rural Payments and Services, Retention of landscape features (GAEC 7) 2020 Retention of landscape features (GAEC 7) (ruralpayments.org) accessed 22 June 2024

[202] RSPB Hedgerow protections reinstated in England Hedgerow protections reinstated in England (rspb.org.uk) 22 June 2024

[203] Department of Agriculture Environment and Rural Affairs, Future Agriculture Policy Decisions for Northern Ireland Future Agricultural Policy Decisions for Northern Ireland (Final) (002).pdf (daera-ni.gov.uk) accessed 22 June 2024

impacts on some species of farmland birds, but relatively little outside of that, both in relation to other taxa and for broader habitats. Inevitably, this has meant that the review has had to assess relevant academic literature from further afield, while utilising grey literature from Northern Ireland. The fact that the Northern Ireland Countryside Survey (NICS) has not been undertaken since 2007 creates a significant evidence gap in assessing broad changes in land use since 2007. As a result, proxy measures such as AES uptake has been used to estimate the likely changes as far as possible. A lack of up-to-date condition monitoring for protected sites has made it difficult to understand how they have responded to change in management over time.

Conclusion and key findings

The best available evidence demonstrates that lowland biodiversity has been profoundly affected by broadscale changes in agricultural land management in Northern Ireland. Historic land use change served to create a landscape that is dominated by intensive grassland production. In doing so, many semi-natural habitats that would have been widespread have declined significantly in lowland environments. Evidence suggests that those which remain are often fragmented and continue to be subjected to a range of pressures including nutrient enrichment, overgrazing and in some cases under-management. Inevitably the loss of quality semi-natural habitat has had consequences for several species, including breeding waders which experienced sharp declines between the 1980s and early 2010s to such an extent that some species are rarely found in the lowlands. Agricultural specialisation has also been problematic for biodiversity, with the contraction of arable and mixed farming likely to have been partly responsible for the decline of several seed eating species of birds. A lack of comprehensive and reliable habitat monitoring data since 2007 makes it difficult to comment on what broadscale changes may have occurred at a landscape scale. However, it is unlikely that levels of habitat loss experienced between the late 80s and early 2000s given the discontinuation of the most harmful forms of agriculture and land use policy, such as direct payments for production and large-scale arterial drainage schemes. More recently, evidence suggests that the significant expansion of Northern Ireland's intensive livestock sector is having an increasingly deleterious impact on freshwater ecosystems and priority grassland habitats as a result of rising concentrations of SRP and ammonia. For those habitats that require ongoing low intensity management to maintain favourable condition, low economic returns and high opportunity costs of alternative forms of land management are likely to be threats. So far, agriculture and land use policy has been insufficient in addressing these pressures. Funding for AES has been insufficient, while fundamental design flaws have undermined its effectiveness. Aside from this, wider agriculture policy risks being incoherent with those aimed at improving the fortunes of biodiversity on lowland farmland.

Appendices

Figure 2. PRISMA flowchart summarising search methods and screening for studies included in analysis, and reasons for excluding studies.

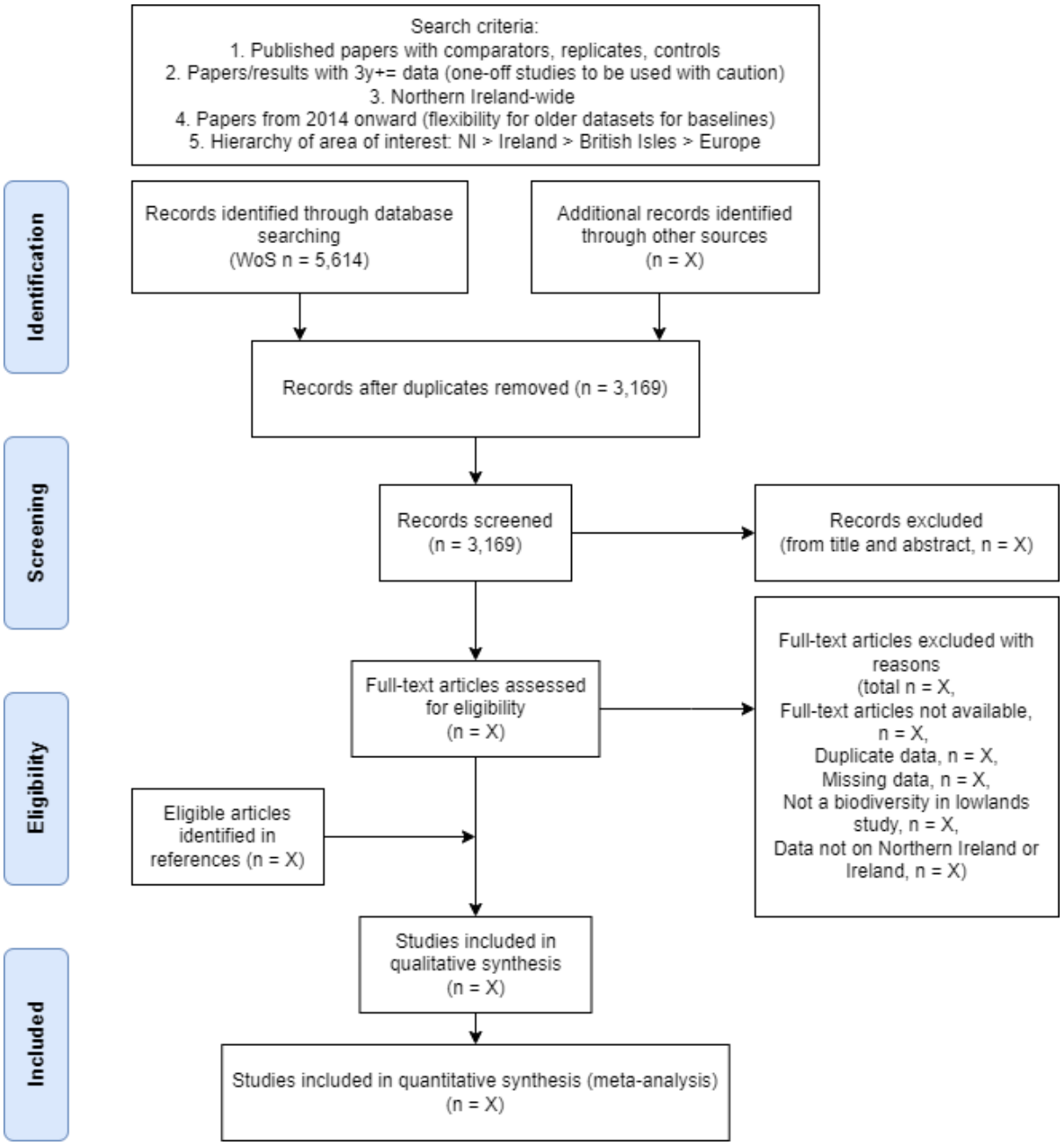

Figure 3. Decision tree used to evaluate studies and reports for inclusion and exclusion at the stage of title and abstract screening

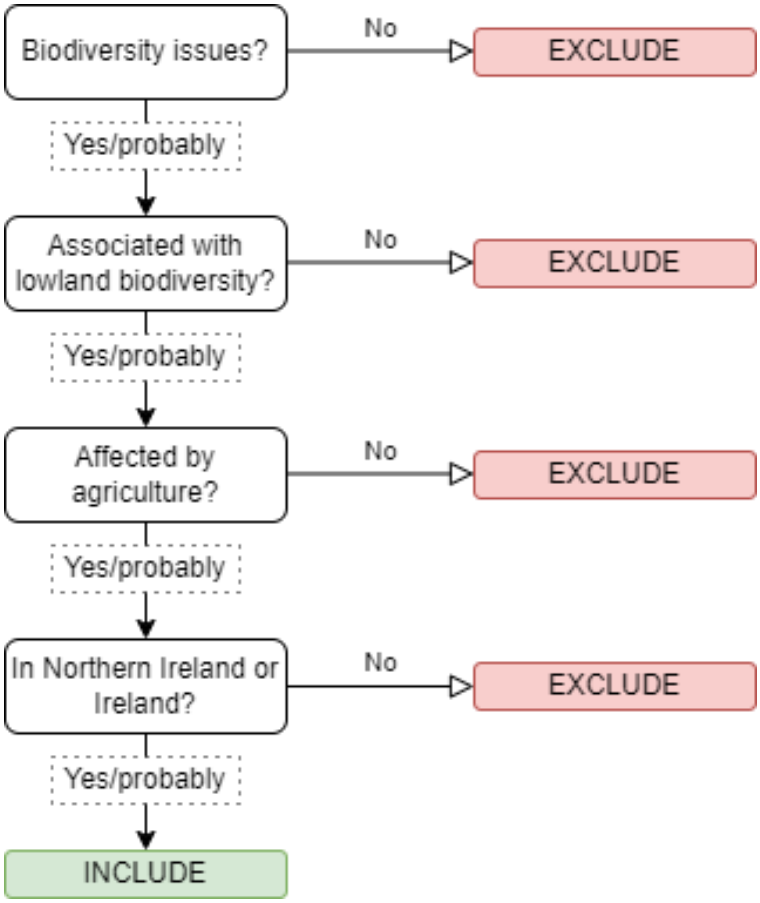

Table 1 Example of search strings used for systematic literature review

	Main	Farmland birds	Native grasslands
Population	hedgerow woodland native grassland species-rich grassland lowland peat bog wetland fen swamp wildlife bird insect mammal tree plant fungi	Kestrel Woodpigeon Swallow Pied Wagtail Stonechat Magpie Jackdaw Hooded Crow House Sparrow Chaffinch Greenfinch Goldfinch Linnet Yellowhammer Curlew Snipe Lapwing Redshank	species-rich grassland semi-natural grassland high nature value grassland" OR "HNV grassland lowland dry acid grassland" OR "lowland acid grassland neutral grassland calcareous grassland purple moor-grass and rush pasture floodplain grazing marsh fen" OR "swamp hay meadow dune" OR "machair

		Barn Owl Skylark Meadow Pipit Reed Bunting Corn Bunting Grey Partridge	
Exposure	agricultural intensification nutrient application agri-chemicals tillage methods productivity forestry abandonment cattle grazing" OR "sheep grazing" OR "mixed grazing	habitat loss agrochemical exposure land use change predation forestry drainage abandonment cattle grazing" OR "sheep grazing" OR "mixed grazing	agricultural improvement reclamation" OR "drainage" OR "reseeding agrochemical exposure" OR "fertiliser" OR "slurry" OR "nutrient application land use change" OR "abandonment forestry" OR "afforestation under grazing" OR "overgrazing" OR "conservation grazing
Outcome	extinction decline" AND "population decline" AND "extent increase" AND "population increase" AND "extent	Population Decline" OR "Population increase Population Decline extinction Population increase	decline" OR "decrease" OR "loss" OR "reduction" AND "extent" OR "habitat loss" OR "area decline" OR "decrease" OR "loss" OR "reduction" AND "species diversity increase" AND "extent" OR "area increase" AND "species diversity
Location	Northern Ireland Ireland United Kingdom Europe	Northern Ireland" OR "Ireland" OR "UK Northern Ireland Ireland UK	Northern Ireland" OR "Ireland" OR "UK" OR "United Kingdom Northern Ireland Ireland UK" OR "United Kingdom