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Status and Distribution of Breeding Eurasian Curlew in Ireland 2021

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Front cover, from left to right and top to bottom:

A deep water fly trap anemone *Phelliactis* sp., Yvonne Leahy; **Common Newt** *Lissotriton vulgaris,* Brian Nelson; **Limestone pavement**, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Garden Tiger** *Arctia caja,* Brian Nelson; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson; **Coastal heath**, Howth Head, Co. Dublin, Maurice Eakin; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott

Main photograph:

Male Curlew *Numenius arquata* displaying over territory, James O'Neill.

Status and distribution of breeding Eurasian Curlew in Ireland 2021

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Executive Summary

The Eurasian Curlew was once a ubiquitous breeding bird of the Irish landscape, occurring in lowland wet grassland, lowland raised bog and upland blanket bog across all counties. The species is declining throughout its range and the severity of the decline in Ireland has been especially acute. Curlew are near threatened on the IUCN Red List and red-listed on the Irish Birds of Conservation Concern.

The most recent estimate of the population size in Ireland was of 138 breeding pairs in the period 2015-17. This represented an alarming loss of at least 96% over just 30 years since the late 1980s. Drivers of declines across the range vary regionally; in Ireland the loss of habitat due to agricultural intensification, afforestation, peat extraction and predation are all likely drivers.

To provide an update on the status of breeding Curlew in Ireland, the National Parks and Wildlife Service (NPWS) commissioned a survey in the 2021 breeding season. This survey aimed to revisit sites at which breeding birds were located from 2015 to 2020, inclusive, to determine their current status, distribution and generate an updated breeding population estimate.

Surveys were conducted across 167 sites in each of 17 counties during the period April – July 2021 by a combination of contracted bird surveyors, NPWS Regional Staff, and staff from the Curlew Conservation Programme (CCP; run by NPWS in collaboration with the Department of Agriculture, Food & the Marine) and the Irish Breeding Curlew European Innovation Partnership (EIP). All observed Curlew were assigned a breeding status – possible, probable or confirmed – and each site was categorised according to the highest breeding status observed. Sites were also categorised as either retained or lost when compared to the previous survey (2015-17).

Of the 167 sites surveyed, Curlew were absent from 52 sites (31% of sites) which were previously occupied. The remaining 115 sites held a total of at least 58 confirmed breeding pairs, 47 probable breeding pairs, and 14 possible breeding pairs. Thus, the estimated size of the Irish breeding population in 2021 was 105 breeding pairs (confirmed and probable pairs only, as per 2015-17), or up to 119 pairs if possible breeding pairs were also included. This constitutes a further decline of 24% (33 pairs) from the 2015-17 estimate of 138 breeding pairs (confirmed and probable only), and a decline of 98% since the 1980s. Based on presence within 10 km squares, the distribution of breeding Curlew declined by 21%, from 58 squares in 2015-17 to 46 squares in 2021. Fifty pairs held territories at least partially within Natura 2000 sites (Special Protection Areas (SPAs) and/or Special Areas of Conservation (SACs)); the same Natura 2000 sites held 49 pairs in 2015-17.

The species range continues to be highly restricted, primarily to core areas of the midlands and west, and associated with peatland or grassland landscapes. Curlew appear to have been lost as a breeding species from county Cork. The range within counties appears increasingly concentrated towards fewer areas, most of which are now part of active targeted management projects such as the CCP and Curlew EIP. It seems likely that these projects are helping to maintain the presence of Curlew in these areas.

The results of this survey demonstrate that the precipitous decline of Curlew has continued and emphasises the need for urgent action to prevent the population from disappearing from the Irish landscape.

Within the context of this report and its limitations, it is recommended that annual monitoring continue in core areas and a national survey be repeated at five-year intervals. It is recommended that these monitoring data are utilised to inform the design, targeting, evaluation and adaption of conservation measures and policies; and that scientific research to fill knowledge gaps and inform strategy be supported and commissioned. The status of breeding Curlew in Ireland is such that careful and dedicated monitoring and research is needed alongside urgent conservation action in order to prevent the extinction of breeding Curlew in Ireland.

Acknowledgements

First and foremost, the authors extend their sincere thanks to all farmers and landowners who provided permissions and access to their lands to undertake this survey, without which this survey would not be possible. Additionally, we thank the public and the media for supporting the survey via submitting records and raising awareness.

A national assessment of this kind inevitably needs a great deal of manpower to undertake comprehensive field surveys, without which the data presented could not have been collated. We are grateful to the collective effort to contribute to this survey.

The project involved four main groups of surveyors – NPWS Regional Staff, CCP staff, staff of the Irish Breeding Curlew EIP, and the contracted KRC Ecological survey team. In addition, an appeal for public information via social and other media and an online questionnaire yielded further records from members of the public.

We are grateful to the following NPWS regional staff for contributing time and effort to survey Curlew in their areas: Andrew Butler, Helen Carty, Jamie Durant, Robert Edge, Eugene Finnerty, John Higgins, Áine Lynch, Jennifer Lynch, John Matthews, Lee McDaid, David McDonagh, Sue Moles, Ciara Powell, Brian Reidy, Tim Roderick, John Ryan, Sarah Stapleton, Martin Toye, Alyn Walsh and Rob Wheeldon. John Lusby and Laura Kavanagh kindly supplied supplementary data from surveys of a variety raised bog sites.

The staff of NPWS would also like to extend their thanks to the Department of Agriculture, Food and the Marine for their continued collaboration, support and financial contribution to the CCP.

Sincere thanks also to the Irish Breeding Curlew EIP staff for their engagement and data contribution: David Miley, Kieran Flynn, Kathryn Finney, Shane Sweeney, George Taylor, Mike Pearson.

1 Introduction

The Eurasian Curlew (hereafter Curlew) *Numenius arquata* is a well-known species of Irish wetland landscapes. In grasslands and bogs Curlew were once a familiar breeding species across much of Ireland. In autumn and winter, in coastal areas, they are particularly noticeable due to their distinctive call. The species has undergone a dramatic decline in Ireland and Britain and, as a consequence, must be considered amongst one of the most pressing bird conservation issues. This decline has been part of a wider global trend, which has resulted in Curlew being categorised as 'Near Threatened' (NT) on the IUCN Red List of Threatened Species (IUCN, 2017). Its status was upgraded in 2007 to NT and it almost qualifies as Threatened on the basis of several criteria (IUCN, 2017).

The nominate subspecies *N. a. arquata*, which accounts for the majority of the global population (>75%; 700,000 - 1 million individuals; Wetlands International, 2012), breeds across northern Europe, east to the Ural Mountains where it intergrades with *N. a. orientalis*; to the south-east and south the third subspecies *N. a. suschkini* occurs in the steppes around Kazakhstan. A decline in breeding populations have been recorded, or are suspected to be occurring across much of the breeding range, with short- and/or long-term declines recorded in eight of the 10 range states which together hold over 99% of the population (Brown, 2015).

The decline and contraction in range on the island of Ireland has been notable by its scale. In Northern Ireland, the long-term trend has shown an 82% decline between 1987 and 2013 (Colhoun *et al.*, 2015). In the Republic of Ireland, the decline has been even greater – at least 96% over less than 30 years to 2015-17 (O'Donoghue *et al.*, 2019). The Breeding Atlas has shown a 78% contraction in the species range over the 40-year period to 2007-11 (Balmer *et al.*, 2013). In the UK, the decline is considered amongst the most pressing contemporary bird conservation priorities (Brown *et al.*, 2015), with the breeding population having declined by 65% between 1970 and 2015 (Hayhow *et al.,* 2017). Curlew are consequently red-listed in Ireland (Gilbert *et al.*, 2021) and the UK (Eaton *et al.*, 2015).

Figure 1 Displaying male Eurasian Curlew. Photograph: James O'Neill.

Figure 2 Carrickynaghtan Bog, Co. Roscommon. This bog is partly cut by hand, has encroaching scrub and has been extensively drained around the entire perimeter. It still holds at least one pair of Curlew. Photograph: K. Colhoun.

Curlew breed in a range of agricultural, semi-natural and natural open habitats across boreal and temperate regions throughout Europe eastwards to the Russian steppes, wintering on estuaries and coastal grasslands throughout Western Europe (Cramp & Simmons, 1983). In the UK and Ireland breeding habitats include a range of lowland and upland habitat types which typically comprise high spring water-tables and heterogeneous vegetation structure which provide suitable cover for nesting and penetrable invertebrate-rich soils for adults and chicks. They are still widespread in the UK and Ireland but, particularly in the lowlands, populations have become thinly and patchily distributed. The historical and present distribution in Ireland aligns chiefly to areas of lowland wet grassland, semi-improved and unimproved rough grassland, moorland, heath and bog (Denniston, 2013). In the past, they bred in all counties with the exception of west Kerry, south Cork and most of Wexford (Hutchinson, 1989).

Ireland remains a very important wintering area for Curlew with good evidence that many wintering birds originate from breeding stock in northern England, Scotland and Scandinavia (Bainbridge & Minton, 1978; Wernham *et al.*, 2002), inflating the now meagre numbers of birds of Irish provenance. As few as one in every 200 Curlew that over-winter in Ireland may be from Irish breeding stock, based on the ratio of the Irish breeding and wintering populations. No doubt a reflection of the range-wide decline in breeding populations, the all-Ireland wintering population has declined since the 1980s from an estimate of 100,000 in the 1970s and 1980s (Sheppard, 1993) to just over 35,000 in the 2010s (Lewis *et al.*, 2019).

The long-term trend has thus shown a decline of >40% in Ireland since the mid-1990s, and >60% since the mid-1980s, equivalent to an annual rate of decline over the short (5-year) and long (22-year) of almost 3% (Lewis *et al.*, 2019).

There is clear evidence that habitat degradation due to changes in agricultural land use practices has been the key driver of large-scale declines across the species range (Wilson *et al.*, 2004; Brown, 2015). Drainage and intensification of grassland management has reduced both the quality of foraging habitats for adults and chicks, whilst also increasing vulnerability to predation in increasingly homogenous habitats (Whittingham & Evans, 2004). In Ireland, these major changes in the Irish landscape which have impacted Curlew, other breeding waders and ground-nesting birds, occurred in the latter half of the 20th century and include drainage, habitat loss through agricultural intensification (reseeding, increased use of artificial fertilisers, higher stocking rates), peat extraction, and afforestation (Lauder & Donaghy, 2008). Consequently, the contemporary pattern of distribution of Curlew in Ireland shows small, isolated populations associated with either upland blanket bog habitat, lowland raised bog or lowland wet grassland, chiefly in the west and midlands (O'Donoghue *et al.*, 2019). The factors mentioned here are those driving population declines and range contractions in many other breeding wader species and ground-nesting birds, and thus are not solely affecting Curlew.

Evidence of the role of predation as an important driver of low productivity has grown. Grant *et al.* (1999) showed that very low productivity in Northern Ireland due to high predation rates was sufficient to explain population declines. More recently, Zielonka *et al.* (2020) showed unsustainably high predation rates, primarily attributable to red foxes in the UK's largest lowland breeding Curlew population in East Anglia. With an increase in the abundance of generalist predators across Europe, ground-nesting species are especially vulnerable to unsustainably high predation levels (McMahon *et al.*, 2020) which may be a significant driver in declines of a variety of ground-nesting species including Curlew. Ground-nesting birds likely become increasingly vulnerable to predation as their populations and breeding densities decline, suffering from reduced vigilance and ability to deter predators, for example.

Given the apparent rate of decline and various ongoing efforts to implement effective conservation measures and policy improvements, NPWS commissioned a re-survey of the population in 2021 which is reported here. The aims of this survey were to (a) generate an up-to-date assessment of the size and distribution of the breeding Curlew population in Ireland, (b) assess trends in population size and range change since the 2015-17 survey, (c) identify the locations of current breeding territories (confirmed, probable and possible), including the general habitats within territories, (d) produce an up to date assessment of the conservation status of breeding Curlew in Ireland, including contemporary pressures and future threats.

2 Methods

This survey aimed to re-survey all locations where breeding Curlew were recorded during the 2015-2017 national survey and all locations where Curlew were subsequently recorded breeding from 2018 to 2020, inclusive. The range of sites surveyed in 2021 fell into three categories (a) sites at which breeding Curlew were present in the previous survey 2015-17 (O'Donoghue *et al.*, 2019), (b) sites at which there were more recent records (in the period 2017-2020), and (c) sites for which we received records from the general public or as a result of additional professional ornithological surveys in 2021. In the case of the first two categories, sites were not surveyed in 2021 if recent CCP survey coverage (*e.g.*, in 2019 and 2020) confirmed that Curlew no longer bred there. A total of 167 sites were to be surveyed, with all suitable Curlew breeding habitat within a 3 km radius of each site to be covered.

In addition to seeking information from the professional/volunteer ornithological community, a public appeal for information on Curlew was launched via social media, an online questionnaire, a Curlew hotline and contact email address. Where information appeared credible and filtering unlikely records (*e.g.,* distinguishing Whimbrel from Curlew, and separating migrating flocks of Curlew from resident pairs) these records were followed up for verification via field surveys.

2.1 Field surveys

Typical surveys of Curlew abundance and distribution, as used in upland and lowland parts of the UK and Ireland (*e.g.,* O'Brien & Smith, 1992, Partridge & Smith, 1992; Partridge, 1992; Johnstone *et al.*, 2009) and more recently in the CCP require a minimum of six survey visits at each site (*i.e.*, a defined area that may contain one or more pairs). At these sites, first, second and third visits aim primarily to locate pairs, while subsequent visits aim to monitor breeding success and productivity. As was the case in the 2015-17 survey we were unable to undertake surveys to this level of intensity due to resource limitations, other than at CCP sites, where such frequent monitoring takes place annually. Our methods followed those of O'Donoghue *et al.* (2019) which required a minimum of two visits to all areas of suitable habitat before the end of June.

Given that pairs may move nest location between years by up to approximately 1 km in certain circumstances, our survey approach (survey units) required that we surveyed all potentially suitable habitat (most habitats except permanent waterbodies, urban areas, woodland and forestry) to within a 3 km radius of known locations. Thus, a survey site was considered a circular area of 3 km radius. This follows the approach of O'Donoghue *et al.* (2019).

Our survey methodology was adapted from Brown & Shepherd (1983) to accurately determine the presence/absence of Curlew and assess the breeding status of any individuals/pairs identified within each survey site. At each survey site all suitable Curlew breeding habitat was surveyed to within 200°m of all points during two survey periods: (i) 1 April – 15 May; (ii) 16 May - 30 June, ensuring that successive surveys were at least one week apart. All sites with suitable habitat were visited at least twice even if no Curlew were recorded during the first visit. A third survey visit (during 1 – 31 July) was made to sites at which presence was confirmed during visits one and/or two and if breeding status could not be confidently assessed by the end of the second visit.

All visits were made during daylight hours, typically between 07:00 and 20:00 hours, where possible targeting visits to sites at least once during the early morning and evening periods when Curlew activity is greatest and thus detection probability highest. Surveys were not undertaken when weather conditions could affect detectability – therefore conditions with wind (> F5), heavy rain or fog were avoided.

We used Breeding Atlas behavioural codes to categorise breeding status as non-breeding, confirmed breeding, probable breeding or possible breeding (Balmer *et al.*, 2013). Potential breeding pairs were assigned to one of these categories on the basis of observed behaviour (Table 1).

We determined the approximate centre of Curlew territories (COT) based on the central co-ordinates of observations of birds. Typically, these were the centre point of multiple observations within days or across multiple visits. In cases where more intensive survey work was conducted (such as the CCP and EIP sites) the determination of the COT was made either on the basis of the exact or approximate nest location, or repeated observations of birds within territories.

Table 1 Behavioural categories and codes indicating the breeding status of observed Curlew.

Category	Code	Definition
Non-breeding	FO	Bird(s) observed **F**lying **O**ver
Possible Breeding	SH	**S**ingle Curlew seen/heard in suitable nesting **H**abitat
	PH	**P**air of Curlew seen/heard in suitable nesting **H**abitat
Probable Breeding	CD	**C**ourtship and **D**isplay observed (in/near breeding habitat)
	PT	**P**ermanent **T**erritory presumed, after territorial behaviour (song, display etc.) seen on at least two different days a week or more apart, at same location
	AN	**A**gitated behaviour and/or alarm calling from adults, but left the site or flew away from observer, did not return (*i.e*., **N**ot AP, as per below)
	NS	Seen dropping down and moving to probable **N**est **S**ite, or seen sitting and presumably incubating
Confirmed Breeding	AP	**A**gitated showing **P**ersistent and **V**ociferous, remained in area or returned quickly, possibly flew in tight circles above observer (see above, indicates nest/young)
	NE	**N**est with **E**ggs found
	NY	**N**est with **Y**oung found
	CH	**Ch**icks recorded (with or without adult present)
	FL	Recently **FL**edged young (seen in suitable habitat or near suspected nest or territory)

2.2 Assessment of land cover in Curlew territories

The 2018 CORINE Land Cover layer (available: https://data.gov.ie/dataset/corine-landcover-2018) was used to characterise the general land cover within Curlew territories that were occupied in 2021. The CORINE layer provides a coarse-level insight into the general habitat types in each occupied Curlew territory. The land cover within a 3 km radius of all occupied Curlew territories was characterised.

2.3 Current pressures

All surveyors made an assessment of the primary pressures observed that were suspected or known to be having a negative impact on breeding Curlew at the surveyed sites. Surveyors identified no more than five of the most important pressures at each site.

The categories used (Appendix 1) followed those set out in the guidance for national reporting under Article 12 of the Birds Directive (Directive 2009/147/EC), falling into the categories of (a) Agriculture, (b) Forestry, (c) Extraction of resources (minerals, peat, non-renewable energy resources), (d) Energy production processes and related infrastructure development, (e) Development, construction and use of residential, commercial, industrial and recreational infrastructure and areas, (f) Extraction and cultivation of biological living resources (other than agriculture and forestry), (g) Climate change, (h) Disturbance and abandonment and (i) Predation.

Figure 3 Windfarms represent just one of the many pressures on upland habitats which reduce the availability and suitability of habitat for breeding Curlew. Photograph: K. Colhoun.

3 Results

3.1 Breeding pairs recorded in 2021

Surveys were carried out at a total of 167 survey points (3 km survey buffers) which included sites where birds were present in 2015-17 or subsequently (see Methods section). Curlew were absent from 52 (31%) sites and the remaining 115 sites held a total of at least 105 breeding pairs (classified as probable or confirmed) with a further 14 pairs categorised as possible breeders (Table 3). This gives a total potential breeding population of 119 pairs, if possible breeders are included.

Table 3 Total numbers of Curlew pairs recorded according to breeding evidence category, and number of sites (3 km radius) at which those categories applied.

Breeding Category	No. of sites	No. of pairs
Confirmed	59	58
Probable	42	47
Possible	14	14
Absent	52	0
Total	167	119

3.2 Distribution of breeding pairs in 2021

In 2021, confirmed or probable breeding Curlew occurred in 46 10-km squares (n=105 pairs) compared to 58 10-km squares which held 138 pairs in the 2015-17 survey (Figure 4). Of these 58 historic squares, twelve were not revisited in the 2021 survey as there were no records from two or more years in the period 2018 to 2020. The change represents a reduction of 21% in range between the two survey periods. Losses (red squares in Figure 4) were most prevalent in counties Donegal, Kildare, Kerry and along the Shannon system, with most gained and retained 10-km squares being in midland counties. The distribution of breeding pairs according to their status is shown in Figure 5.

3.3 Population estimate and changes since 2015-17

The results from the 2021 survey estimate an Irish breeding Curlew population of 105 pairs in 2021, based on probable and confirmed pairs and excluding possible breeders. If the latter are included the breeding population may be up to 119 breeding pairs.

Based on the more conservative counts of confirmed and probable breeding pairs, which enables direct comparison with the 2015-17 surveys, 33 pairs of Curlew have been lost since then (declined from 138 to 105 breeding pairs), representing a further loss of 24% in the breeding population since 2015. Birds have been lost from a number of sites in many counties, most notably Donegal where pairs have been lost across the entire county, in Kerry where the already depleted population has declined further, and in Kildare and Laois where losses exceed gains (Figure 6).

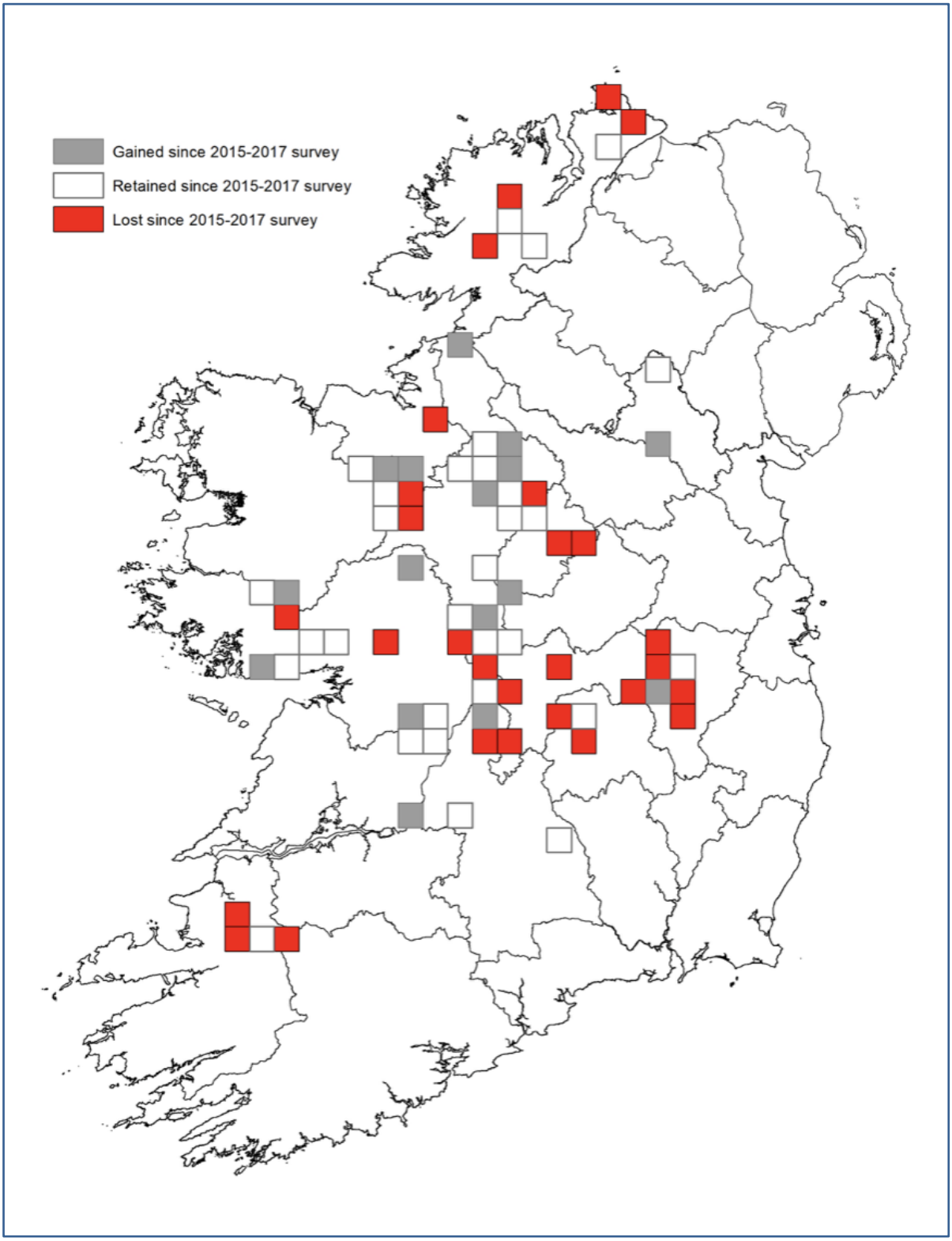

Figure 4 Distribution of breeding Curlew in 2021 in Ireland compared to 2015-17, based on the occupancy of 10-km squares (n=109 10-km squares).

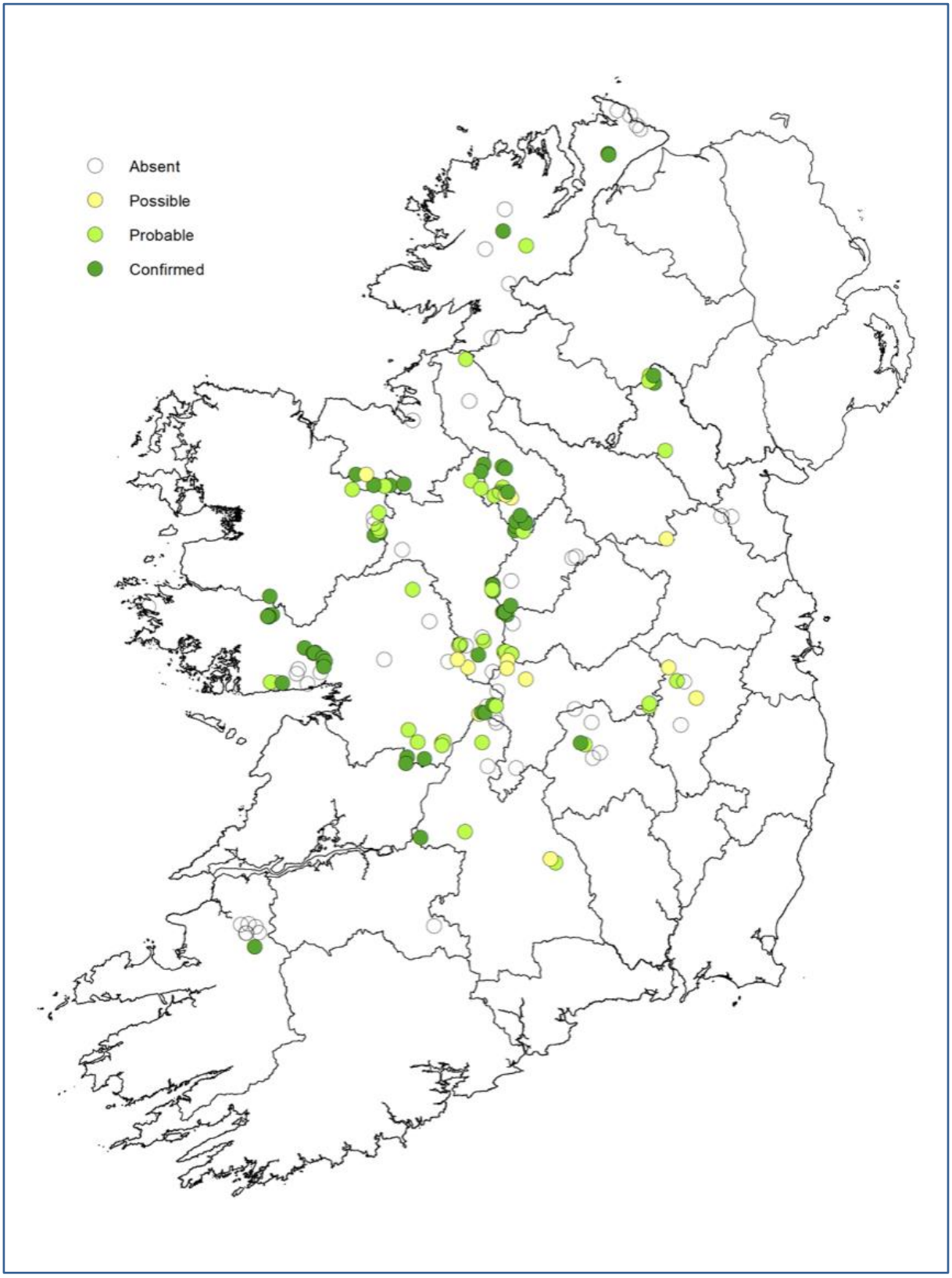

Figure 5 Distribution of breeding Curlew in 2021 in Ireland, classifying territories as no longer occupied (absent n=52) or breeding (n=115), with breeding status being categorised as possible (n=14), probable (n=48) or confirmed (n=58).

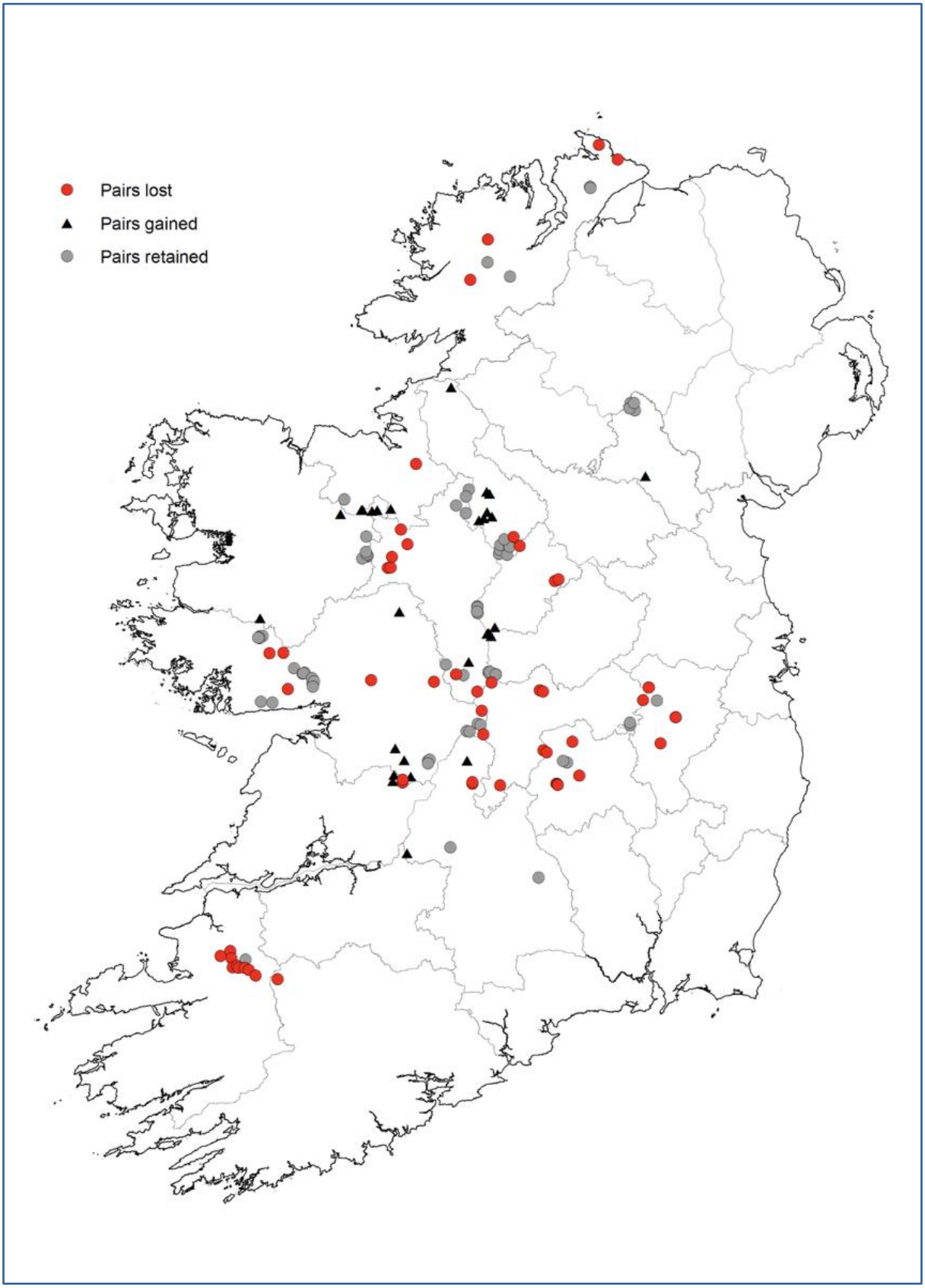

Figure 6 Distribution of breeding Curlew in Ireland in 2021 where territories were defined within 3 km buffers and territories were classified as lost, retained or gained between 2021 and the previous survey in 2015-17.

In 2021, 33 pairs occurred within eight SPAs in Ireland (Lough Corrib SPA, Lough Mask SPA, Lough Ree SPA, Middle Shannon Callows SPA, Slieve Bloom Mountains SPA, Stack's to Mullaghareirk Mountains SPA, Slievefelim to Silvermines Mountains SPA, Slieve Aughty Mountains SPA) and 40 within SACs. Given the overlap between both designations, 50 pairs in 2021 occurred within the SPA and/or SAC network. The same assessment in 2015-17 showed a similar number (49 pairs) within the network of designated Natura 2000 sites.

3.4 Land cover in occupied Curlew sites

As inferred from the 2018 CORINE dataset, the categories of land cover and their proportional cover across all occupied Curlew sites (3 km buffer) is outlined in Figure 7. Land cover in occupied Curlew sites was dominated by pastures, peat bogs, land primarily used for agricultural purposes, waterbodies, and coniferous forests (Figure 7). It is important to note that these characterisations of land cover in Curlew territories do not represent land cover (or habitat) preferences of Curlew in Ireland, but rather describe the composition of landscapes in which Curlew occurred in 2021.

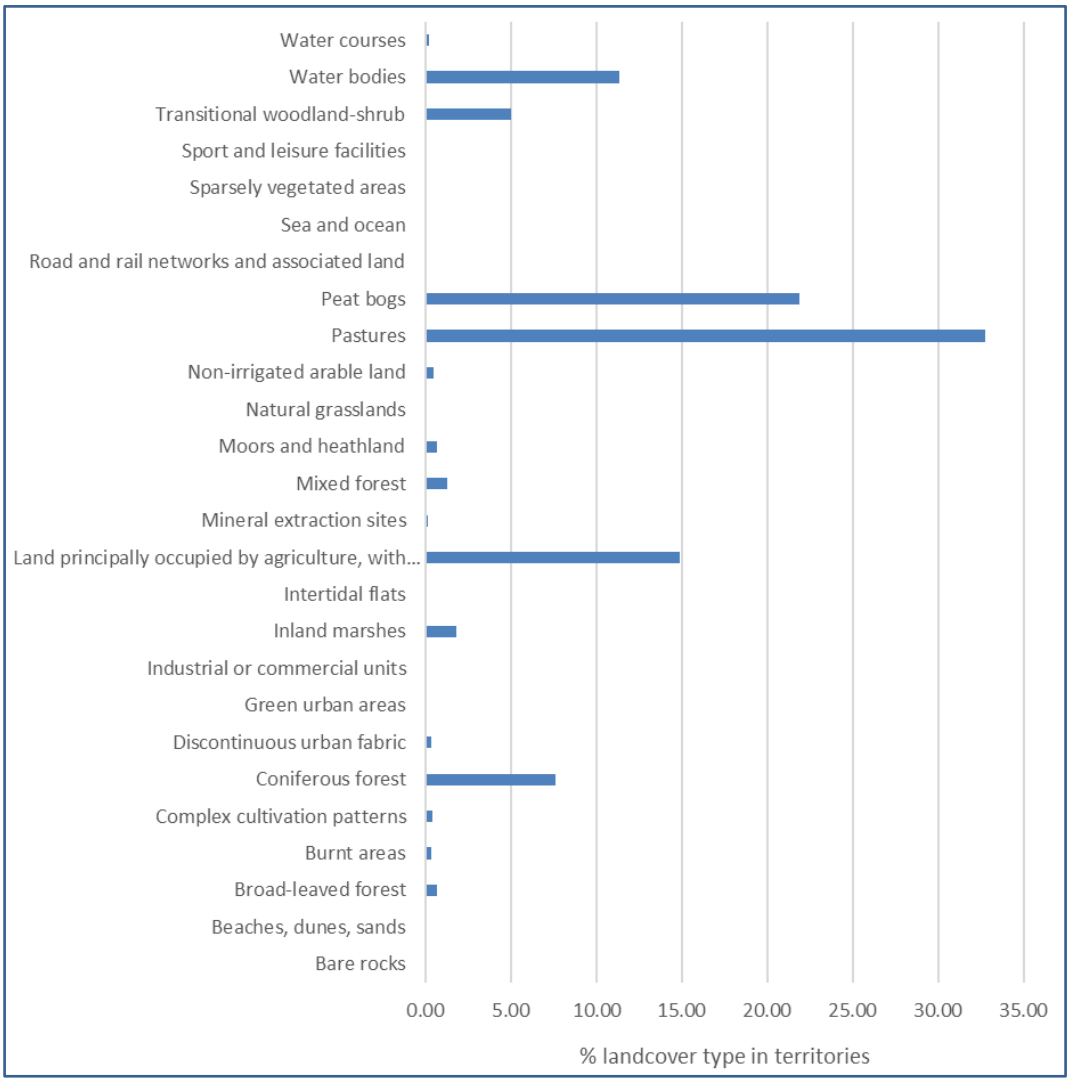

Figure 7 Habitat characteristics of territories at all occupied sites surveyed in 2021. Analysis was based on CORINE land cover types within a 3 km buffer of the presumed centre of territory

3.5 Current Pressures

Across a sample of 32 sites, the most commonly recorded pressures, in descending order, were: peat extraction (C01), drainage (A12), afforestation (B01), mowing/cutting (A07), over-grazing (A08) and abandonment of grassland management (A05) – see Appendix 1 for full pressure/threat definitions. The most frequent pressure in bogs was peat extraction, while in grasslands mowing (A07), over-grazing (A08) and under-grazing (A09) were the most highly ranked pressures.

4 Discussion

4.1 Changes in population size and distribution

This is the second national survey of breeding Curlew in Ireland. By replicating the methodologies used by O'Donoghue *et al.* (2019), this survey provides a robust contemporary assessment of the population size, distribution and associated trends of breeding Curlew in Ireland. The results confirm that the downward trend in the national breeding population continues. A further 24% of the breeding population has been lost since 2015-17, declining from 138 pairs to 105 pairs (based on confirmed and probable pairs only). This constitutes a catastrophic loss of around 98% of the breeding population in just 40 years. A simple arithmetic projection of a continuation of this rate of decline every five years shows that only approximately 20 pairs will be breeding by 2050 if trends continue, but more detailed population modelling would be required for accurate predictions. The extinction of the breeding Curlew population in Ireland remains a clear and present threat unless a range of effective conservation measures and policies can rapidly halt and reverse the population decline.

Curlew were absent from 31% of the 3 km sites surveyed and the breeding distribution has contracted by 21% (based on a 10-km square distribution grid, a standard reporting framework for birds). The losses in distribution are spread across the breeding Curlew range in Ireland (see Figures 8 and 9). The loss of breeding Curlew in some areas has been dramatic since 2015-17; for example, in Donegal as few as two pairs now occur where seven occurred in 2015-17.

While many areas lost Curlew, there were 'gains' in some areas where Curlew were not recorded present during the 2015-17 survey. The available evidence suggests these are unlikely to be actual population gains, but rather likely represent improved knowledge as a result of increased survey effort and outreach in recent years. Some sites where Curlew were absent in 2021 have recorded pairs present in 2022; this should be noted in the context of the reported range declines and future surveys. Additionally, as more has been learned about breeding Curlew ecology and their movements (*e.g.*, from GPS tracking work), it is possible that the population in some areas was over-estimated during the 2015-2017 survey. Future research findings will inform adaptions and improvements to survey design and analysis. While bearing these points in mind, the evidence remains in support of a continued population decline and range contraction for breeding Curlew in Ireland.

It is clear from the distribution of breeding Curlew in 2021 that the CCP and Curlew EIP conservation projects have been operating in the core population areas, largely centred on the Shannon system, with several isolated areas of uplands, lowland wet grassland, raised bogs

and large lakes (Figure 9). There is some indication that, in general, more breeding Curlew territories are being retained or gained in the areas where Curlew-specific conservation initiatives are in operation (the CCP and Curlew EIP projects) relative to those areas outside the geographical scope of these initiatives (Figure 9). This highlights the importance of having these conservation programmes operating in the critically important core areas of the Curlew breeding distribution. Additionally, approximately two-thirds of breeding Curlew pairs occur within the designated Natura 2000 network, which may assist in implementation of conservation actions and policies for Curlew.

Undertaking a national survey of such a species is challenging. While Curlew can be vociferous and somewhat obvious at times on territory, detectability varies with factors such as time of day and season, and detection is therefore sometimes difficult. For these and other reasons the population estimate provided here must be taken as a conservative minimum estimate. Sufficient field surveying has been undertaken across Ireland in recent years to identify the vast majority of Curlew breeding locations, such as the 2015-2017 survey, commercial windfarm surveys, the Countryside Bird Survey and routine surveys by NPWS Conservation Rangers. All of these data were collated since the last survey to inform the selection of sites for 2021. In addition, our public appeal for records via social media did help to locate several pairs which were previously unrecorded.

There is some evidence to suggest that the areas in which targeted conservation activities have been taking place (such as the CCP and Curlew EIP) are more effective at retaining breeding territories than areas where no measures are in place. In part this is a likely a consequence of projects such as the CCP and EIP operational areas intentionally targeting the core breeding areas (which are also surveyed much more intensively). However, it is also more likely that losses will be greater in areas where no active conservation measures are in place to support and protect breeding Curlew (such as habitat management and nest protection).

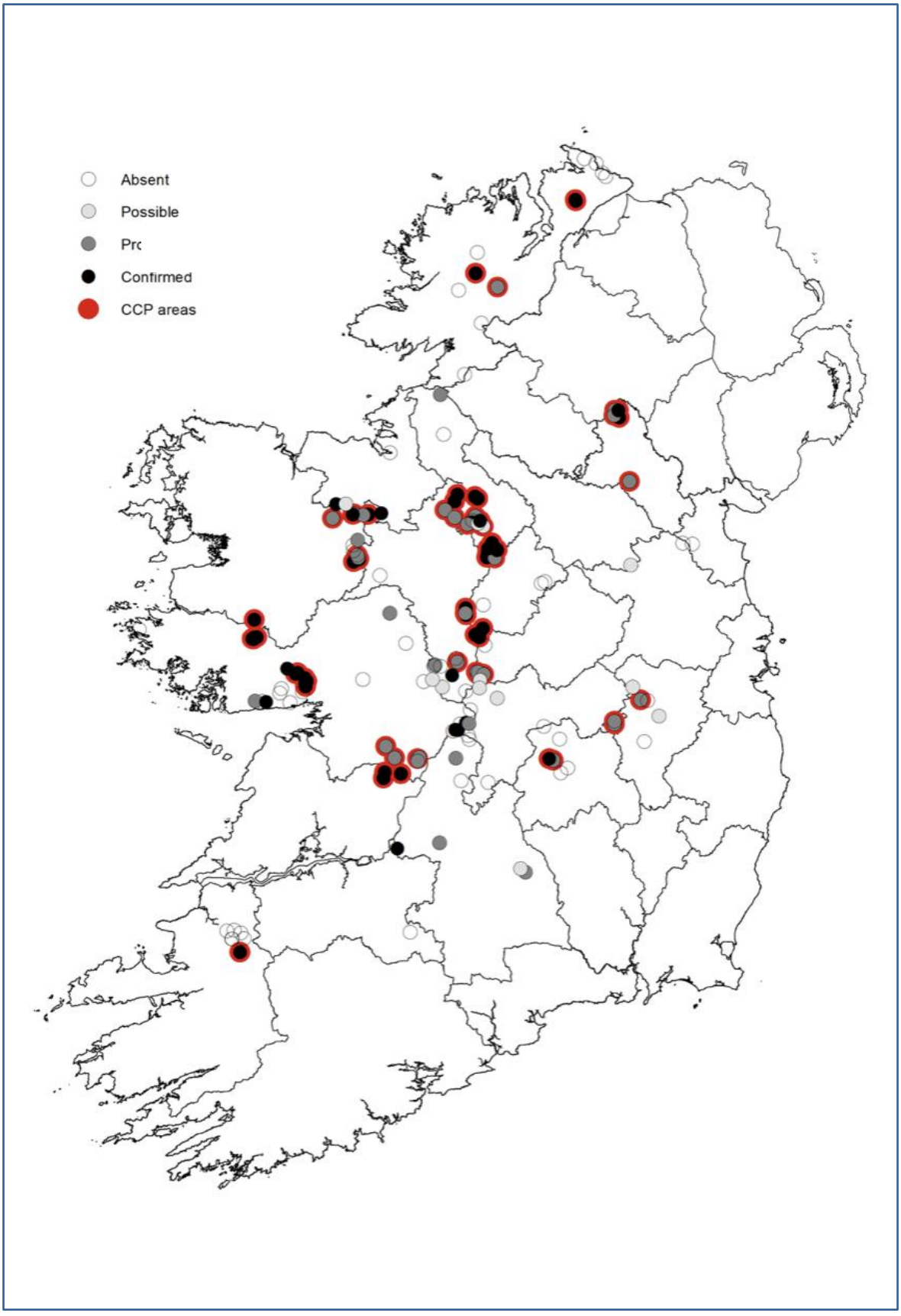

Figure 8 Operational areas of the Curlew Conservation Programme and the Curlew EIP (both shown in red) in 2021 relative to the overall distribution of occupied breeding sites (possible, probable, and confirmed) in 2021.

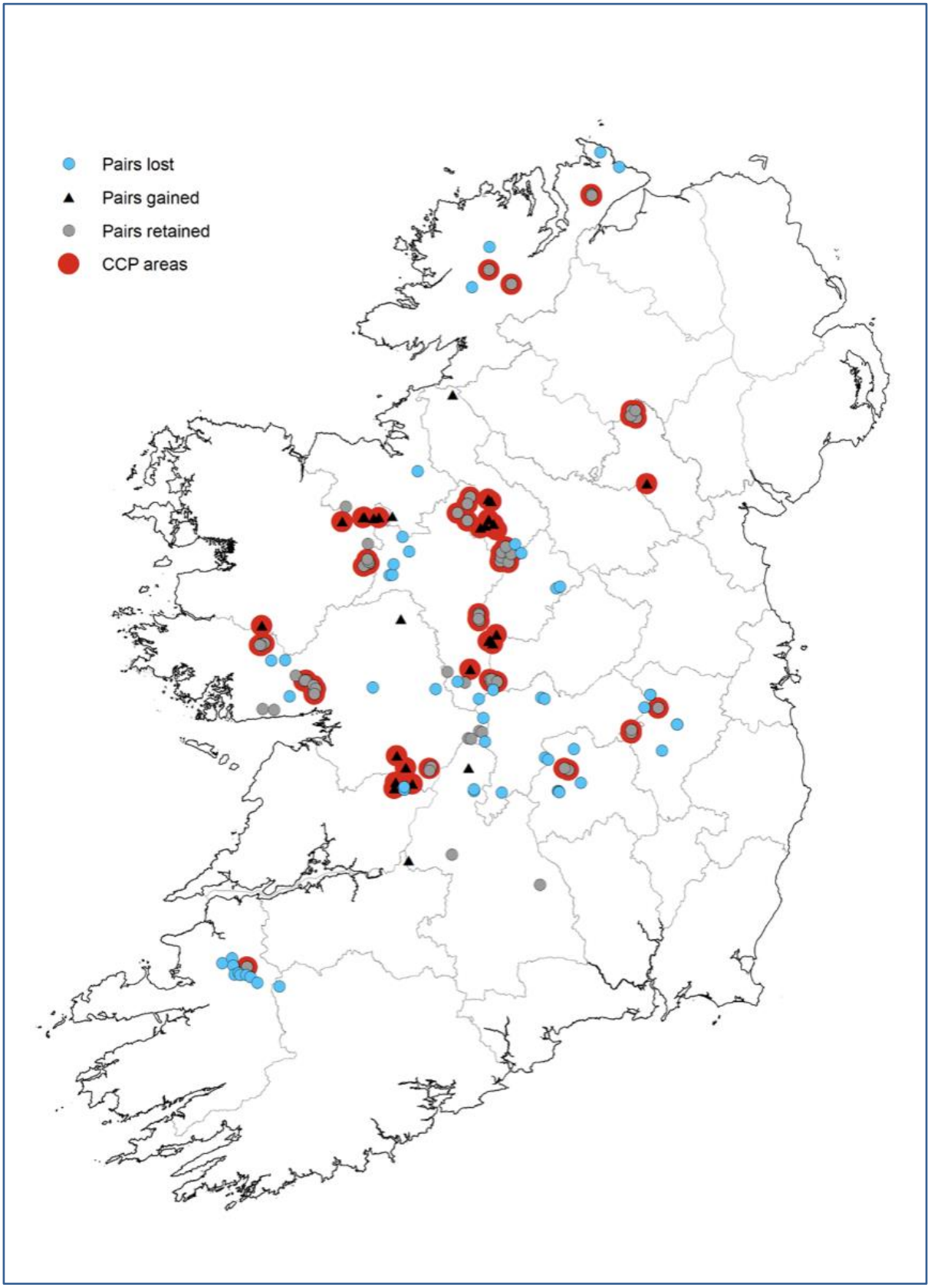

Figure 9 Distribution of surveyed sites where breeding Curlew territories were lost, retained or gained in 2021 relative to the distribution in the previous survey 2015-17. The areas in which the CCP and Curlew EIP were active in 2021 are shown in red.

4.2 Drivers of population change

The principal drivers of Curlew declines are well understood and the recent growth of research and conservation work on the species in Ireland, the UK and on the continent has and will help to further elucidate these. As discussed by O'Donoghue *et al.* (2019) it is apparent that a combination of factors which are ultimately linked to large-scale habitat change has been key. These include intensification of agriculture and more recently abandonment, large-scale commercial peat extraction, afforestation and predation. A number of studies have confirmed that predation is having a considerable effect on the remaining population (*e.g*., Grant *et al*., 1999). McMahon *et al.* (2020) reviewed the evidence for predation effects on ground-nesting species across Europe and highlighted the need for management of generalist predators for halting declines of species such as Curlew.

Recent analyses of adult Curlew survival conclude that the observed Curlew population declines in Ireland and the UK are likely driven primarily by low productivity, *i.e*., Curlew cannot rear sufficient young to maintain or increase the population (Cook *et al*., 2021). Available evidence suggests this low productivity is primarily driven by the loss of eggs and chicks to predators and agricultural operations (such as mowing during the nesting or chick rearing period), but other factors such as disturbance at nests sites, burning of peatlands and infrastructure development also contribute (*e.g*., Grant *et al*., 1999; Pearce-Higgins *et al*., 2017).

4.3 Pressures

The primary pressures potentially acting on breeding Curlew pairs in 2021 were described by surveyors familiar with Curlew ecology and conservation management. These pressures were consistent with those recorded over many decades and which are understood to have been the primary drivers of decline (see section 4.2): grassland management (activities such as mowing), peat extraction, drainage, and afforestation; see Figures 10-12. Predation is also a likely pressure, however the survey methods employed here are not sufficient to capture predation risk or impact. The mechanisms by which these pressures impact on Curlew are well understood and are primarily associated with total loss or quality degradation of suitable breeding habitat (for feeding, nesting and chick-rearing) and increasing the predation risk to both Curlew eggs and chicks. It is clear that an understanding of the socio-economics of Irish agriculture, including attitudes and opportunities amongst landowners for Curlew conservation, as outlined by Sheridan *et al.* (2022), will be required to inform an overall conservation strategy.

Figure 10 The consequences of peat extraction, especially at an industrial scale are catastrophic for wild bird populations. The removal of vegetation and disturbance inhibits nesting and the associated drainage provides few if any feeding opportunities. Photograph: K. Colhoun

Figure 11 Modern grassland management activities, especially where intensive, provide some feeding opportunities for Curlew but difficult nesting conditions – drainage, topping, rolling,

fertilisation, repeated mowing and other activities greatly reduce the probability of nesting successfully. Photograph: K. Colhoun

Figure 12 In some areas, patches of lowland raised bogs hold isolated pairs of Curlew but only where peat extraction is limited. Habitat loss, drainage and associated scrub encroachment negatively impact Curlew directly and indirectly. Photograph: K. Colhoun

4.4 The future

The results of the 2021 survey concluded that breeding Curlew populations in Ireland have continued to decline. It is likely that without the policy developments and targeted conservation actions that have taken place since 2015, the declines would have been significantly worse, particularly in core areas where the CCP and Curlew EIP are in operation. However, it is clear that more action is required to halt the ongoing decline and allow populations to recover in size and distribution.

Evidence that low breeding productivity was the primary demographic driver of Curlew population decline in Ireland has been available since the work of Grant *et al.* (1999), which showed predation of chicks and eggs at a level which could explain the rate of population decline. More recent work, analysing long-term ringing datasets by Cook *et al.* (2021) showed that long-term survival rates for adults are high and have increased in recent years. Considering other evidence, Cook *et al.* (2021) concluded that the observed population declines in the UK and Ireland are likely to be driven primarily by low breeding productivity. Therefore, conservation in Ireland should focus on breeding productivity as a key demographic parameter, aiming to increase productivity to at least 0.43 fledglings per pair annually. Only by increasing breeding productivity to this level, whilst also maintaining high annual survival of

both breeding adults and juveniles, will the population stabilise. This would be the first step towards population recovery.

It is clear that improvements in Curlew breeding productivity need to be achieved as soon as possible in order to avoid further population declines in the coming years. Improving breeding productivity to the required levels, whilst maintaining high annual survival rates and maintaining and creating suitable breeding habitat, presents a significant challenge that would require significant investment by a wide range of stakeholders. Further interventions to enhance breeding productivity in the short-term such as captive-rearing Curlew chicks (known as 'head-starting'), may be required in the short term to stabilise the core population and range, and ultimately prevent extinction of the breeding population in Ireland.

Comprehensive monitoring and research of Irish Curlew populations in the breeding and wintering periods is required to inform the design, targeting, assessment and adaptation of the aforementioned conservation actions, and ultimately to inform the strategy for Curlew conservation in Ireland. Robust monitoring and research is required to assess the responses of the population to conservation interventions, both on the ground and at policy level, which will inform the adaptation and improvement of interventions, policies, and investments.

4.5 Recommendations

Within the context of the aims of the 2021 national breeding Curlew survey and the status of breeding Curlew in Ireland, the following recommendations are made (**note**: these do not extend to recommendations for conservation action at policy or ground level as that is beyond the scope of this report):

1. **Annual monitoring should be undertaken in the core breeding areas to determine the location, site use and breeding productivity of pairs.** This monitoring is essential to the precise and timely targeting of necessary conservation interventions during the breeding season – such as the erection of nest protection fences and agri-environment agreements (*e.g.*, delayed mowing in chick-rearing fields) – and to the assessment of the efficacy and potential improvement of these interventions. The information gathered via this monitoring will also help inform assessments for development applications in breeding Curlew areas. Such monitoring has largely been delivered in recent years (*e.g.*, via the CCP and Curlew EIP) and will need to continue for at least the next 5-10 years.

2. **Undertake a national breeding Curlew survey at appropriate intervals.** It is recommended national surveys be undertaken at five-year intervals, thus the next should be delivered in 2026. These surveys will provide an update on the national status of breeding Curlew in Ireland, including information on the population size and distribution and associated trends. These surveys should be used to inform the improvement/development of national strategies and policies for the conservation of Curlew in Ireland. Coordinated undertaking of national surveys in Ireland and Northern Ireland would also be beneficial, helping to improve monitoring and conservation strategies of the population at an island scale.

3. **Continue to utilise the data gathered under annual monitoring and national surveys to assess the efficacy and success of conservation measures and**

policies in recent years. It is of vital importance to objectively assess the effectiveness of any conservation intervention and policy at appropriate intervals to determine if, how and where they can be improved, drawing robust conclusions supported by data. Where data is insufficient to draw robust conclusions, this should serve as a direction to review and refine methods and data recording.

4. **Promote, facilitate and commission scientific research to inform the progression of conservation management and policy for breeding Curlew in Ireland.** Such research should be supported to fill data gaps (*e.g.*, landscape use and optimal landscape management for breeding Curlew) and to assess the efficacy of conservation interventions and policies (as per Recommendation 3). The relevant bodies should utilise the expertise of the wider scientific community in this regard.

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Appendix 1

Threats and Pressures

CODE	PRESSURE
	A - Agriculture
A01	Conversion into agricultural land (excluding drainage and burning)
A02	Conversion from one type of agricultural land use to another (excluding drainage and burning)
A03	Conversion from mixed farming and agroforestry systems to specialised (*e.g.,* single crop) production
A04	Removal of small landscape features for agricultural land parcel consolidation (hedges, stone walls, rushes, open ditches, springs, solitary trees, etc.)
A05	Abandonment of grassland management (*e.g.*, cessation of grazing or mowing)
A06	Abandonment of management/use of other agricultural and agroforestry systems (all except grassland)
A07	Mowing or cutting of grasslands
A08	Intensive grazing or overgrazing by livestock
A09	Extensive grazing or under-grazing by livestock
A10	Burning for agriculture
A11	Agricultural activities generating soil pollution
A12	Drainage for use as agricultural land
A13	Agriculture activities not referred to above
	B – Forestry
B01	Conversion to forest from other land uses, or afforestation (excluding drainage)
B02	Conversion to other types of forests including monocultures
B03	Replanting with or introducing non-native or non-typical species (including new species and GMOs)

B04	Illegal logging
B05	Burning for forestry
B06	Forestry activities generating pollution to surface or ground waters
B07	Forestry activities generating soil pollution
B08	Modification of hydrological conditions, or physical alteration of water bodies and drainage for forestry (including dams)
	C – Extraction of resources (minerals, peat, non-renewable energy resources)
C01	Peat extraction
C02	Extraction activities generating noise, light or other forms of pollution
C03	Abstraction of surface and ground water for resource extraction
	D – Energy production processes and related infrastructure development
D01	Wind, wave and tidal power, including infrastructure
D02	Energy production and transmission activities generating pollution to surface or ground waters
D03	Energy production and transmission activities generating noise pollution
D04	Utility and service lines (power-lines, pipelines)
D05	Energy production and transmission activities generating light, heat or other forms pollution
	E – Development, construction and use of residential, commercial, industrial and recreational infrastructure and areas
E01	Drainage, land reclamation and conversion of wetlands, marshes, bogs, etc. to settlement or recreational areas
E02	Drainage, land reclamation or conversion of wetlands, marshes, bogs, etc. to industrial/commercial areas
E03	Improved access to site
E04	Urbanisation, residential and commercial development
	F – Extraction and cultivation of biological living resources (other than agriculture and forestry)
F01	Illegal shooting/killing
F02	Hunting
F03	Illegal harvesting, collecting and taking
	G - Climate change

G01	Temperature changes (*e.g.,* rise of temperature & extremes) due to climate change
G02	Droughts and decreases in precipitation due to climate change
G03	Increases or changes in precipitation due to climate change
G04	Other climate related changes in abiotic conditions
	H – Disturbance and abandonment
H01	Recreational activities (dog walkers - domestic and gun dogs etc)
H02	Clay pigeon shooting
H03	Wildlife photographers
H04	Intrusive surveyors/landowners
H05	Site or nest abandonment
	I - Predation
I01	Adult (Mammal/Avian)
I02	Chick/egg (Mammal/Avian) *e.g.,* Fox, Mink, Pine Martin, Badger, Hooded crow, Magpie, Bird of Prey
XXX	Other threats and pressures not listed above

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