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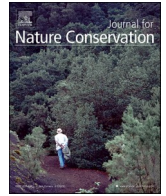
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# Values and perceptions of landowners within remaining breeding territories of Eurasian Curlew *Numenius arquata* in Ireland

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## ABSTRACT

Habitat loss and degradation have been identified as some of the main threats to breeding Curlew (*Numenius arquata*) across much of Europe. In Ireland, marginal habitats such as rough or wet grasslands and peatlands have been fragmented or degraded by activities including afforestation, drainage and intensification. The management implemented by landowners directly affects Curlew breeding territories. However, the values and perceptions held by landowners whose lands contain Curlew breeding territories, or the factors driving the decisions behind farming practices in these areas are rarely considered when looking at the causes of changes in these bird populations. This study, as part of the Curlew Conservation Programme established in 2017, gathered data through the distribution of questionnaires to landowners found within three kilometres of Curlew breeding territories in Ireland. In this study, we identify the current land uses being employed in Curlew breeding territories, and query future projections of land use in these areas. We investigate landowners' perceptions of the requirements to sustain favourable environments for breeding Curlew. We also explore landowner values with respect to farming. The landowners in this study identified habitat loss and predation as the main drivers for Curlew declines. The majority of farming systems in this study were cattle rearing, the sustainability of which is under threat across Ireland. The results indicate that these landowners are not financially motivated, however, the availability of financial aid and expert advice are listed by landowners as requirements for traditional farming practices to continue. These results give an insight to the lifestyle, values and perceptions owners of land adjacent or within Curlew breeding territories. This information can be used to design Curlew conservation programmes that align with these values.

## 1. Introduction

Habitat conversion and expansion within agricultural ecosystems is one of the major conservation challenges facing Europe currently (De Snoo et al., 2013; Vanbergen et al., 2020). This challenge is also being faced in Ireland where the landscape has undergone many changes in recent years, including the intensification and specialisation of agricultural practices, increased levels of afforestation of open landscapes and the introduction of wind farms (Sustainable Energy Ireland, 2003, Pearse-Higgins et al., 2012, DAFM, 2018). These changes have been identified as the main drivers of decline in farmland birds, affecting habitats used for foraging, breeding and increasing predation risk

(Donald et al., 2002, Newton 2004, Butler et al., 2010, Ó hUallacháin et al., 2015, McMahon et al., 2020). A further driver of the decline of ground-nesting birds in Ireland and elsewhere in Europe is the transition of contiguous open landscapes of peatlands and high nature value grasslands to fragmented mosaic habitats consisting of afforested lands (Berg 1992; Guerrero et al., 2012; Reino et al., 2009). As farmland birds depend on farmland systems to meet their ecological and biological requirements, they are also highly susceptible to changes in farming systems that alter these habitats (Ó hUallacháin et al., 2015). One species that has experienced significant population declines and range contraction is the Eurasian Curlew (*Numenius arquata*) (Henderson et al., 2002, Balmer et al., 2013, O'Donoghue et al., 2019), henceforth referred

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to as Curlew, with the European population listed as vulnerable and decreasing (IUCN, 2019). In Ireland, this species demonstrates breeding site fidelity and nests in marginal open habitats such as semi-improved or unimproved rough grasslands, wet grasslands, or peatlands (Bracken et al., 2008; Colhoun et al., 2015; O'Donoghue et al., 2019). Many of these open habitats used by breeding Curlew have become fragmented or degraded with the increase in afforestation, peatland exploitation and agricultural intensification (Partridge and Smith, 1992; European Commission, 2007). Within the areas surveyed by O'Donoghue et al. (2019) upland blanket bog (23.4%), wet grassland (22%), wet heath (21.8%) and raised bog, (16.4%) comprised the majority of the suitable habitat for breeding Curlew, accounting for almost 84% of the total areas surveyed. The grassland and heath habitats are most associated with farming practices in Ireland, with some unintensive grazing and peat cutting on bog habitats. Another threat to breeding Curlew is the abandonment of traditional land management practices in marginal farming locations (Henle et al., 2008). The population of Curlew breeding in Ireland has experienced a significant decline of at least 96% in the past 30 years, with the most recent survey recording 138 breeding pairs (O'Donoghue et al., 2019).

To address the issue of Curlew decline in Ireland, several actions have been put in place. In November 2016, a transdisciplinary workshop was held in Ireland which included a representation of organisations or individuals (80 stakeholders in total) with different approaches to Curlew conservation (Young et al., 2020). The outcomes of this workshop were cross stakeholder jointly agreed conservation actions, divided into short- (less than two years), medium- (between two and five years) and long-term (more than five years) actions. One of these actions comprised the establishment of a Government Task force for Curlew conservation in Ireland in January 2017 and a Curlew Conservation Programme (CCP) aiming to increase the productivity and success of the remaining breeding Curlew population. The management measures identified by the Task Force need to be implemented by landowners whose lands contain Curlew breeding territories. However, the values and perceptions held by these landowners, and the factors driving the decisions behind farming practices, are rarely considered when looking at the causes of changes in these bird populations.

An important approach to retaining Curlew breeding territories is to maintain the current land practices ongoing in those locations as it is likely that the way land is currently managed in these locations is beneficial to breeding Curlew. However, it must also be acknowledged that management practices in Ireland overall are not optimal if they have led to severe declines in ground-nesting bird populations (see McMahon et al., 2020), including Curlew. Thus it is important to gain insight into the types of farms which hold Curlew breeding territories and to determine the intentions of the owners of these farms with regard to the use of the land in the future. As this study is a product of the CCP, we expect that this can benefit the habitat management employed in Curlew breeding territories, which in turn would also benefit other declining bird species. Understanding whether the majority of landowners manage agricultural land as a result of financially led decisions or if they are led by other dominant goals and values can allow for better planning and management of traditional farming practices that benefit ground-nesting species such as the Curlew.

Based on the above gaps in knowledge, this study addresses three key aims, which are to determine the: 1) current land uses being employed in Curlew breeding territories and the intentions of landowners in those areas regarding land use in the future and 2) the perceptions of landowners as to what is needed to sustain or deliver a favourable environment for breeding Curlew and what changes they perceive have occurred in the landscape. The values held by landowners with respect to farming, i.e. what farming means to them, and why they farm were also investigated. Having insight into these values can help design future conservation programmes that are better aligned with the values of landowners.

## 2. Methods

### 2.1. Data collection

Questionnaires were distributed by Curlew Advisory Officers in person to landowners throughout CCP areas in Ireland in 2018. The sampling technique chosen for this study was 'key informant sampling' (Newing, 2010), where key participants were targeted as they were knowledgeable about the subject of the questionnaire, i.e. farming, and potentially had Curlew on their land. Landowners issued with questionnaires were either already known to the CCP (through efforts conducted during the breeding season, namely community engagement, surveying, habitat works etc.) or they had been identified as local landowners within the area and were contacted for the first time specifically for the purpose of administering the questionnaire. The number surveyed in the CCP areas were: Monaghan (n = 10), Donegal (n = 10), Roscommon-East Mayo/mid-Leitrim (n = 17), Lough Ree (n = 10), and the Stack's Mountains of County Kerry (n = 15) (Fig. 1). Lough Corrib was not included in the survey as many of the Curlew breeding territories within that area are located on dispersed and uninhabited islands on the lake. The number of participants (62 total) is reflective of the number of landowners available and willing to participate in the questionnaire within each CCP area. No record was retained of any landowner that may have been asked to complete the questionnaire but refused to do so.

### 2.2. Data collation & analyses

The questionnaire which is presented in Supplementary Material (SX) comprised 21 questions. Current land use and future projections for land use in Curlew breeding territories were addressed in the first section of the questionnaire (Questions 1 to 13). The second section of the questionnaire (i.e. Questions 14 to 16) aimed to address the requirements necessary to sustain or deliver a favourable environment for breeding Curlew by ascertaining the participants awareness of Curlew population trends in Ireland and the possible factors driving those trends. Participants were free to provide any answer to what they believed to be drivers of change and the most frequently given answers were graphed. Participants were also questioned on what they believed was required for traditional farm management practices to continue. Similarly, participants were free to provide any answer.

The third section of the questionnaire addressed the third aim of this study which was to determine what the values of the landowners were with respect to farming. Previous UK studies have provided some insight into the values held by the farming community (Gasson, 1973, Ilbery, 1982). In this paper, we make use of a classification of four dominant values described by Gasson (1973) to study the motivation of farming. This classification organises the values and beliefs of an individual into four dominant values (Intrinsic, Expressive, Instrumental or Social) (Table 1). We specifically use Gasson's (1973) classification to understand what a farmer wants to gain from their occupation and possibly discover what is needed to induce new behaviours. Two questions in the questionnaire were used to assess this, one asking participants to rank a predetermined list of reasons why they farm (see Question 18) and another asking them to list five words to describe what farming means to them (see Question 17). Each of the words provided in answer to Question 17 was then assigned to one of the four dominant value categories described by Gasson (1973) and the frequency of words in each category was assessed and a frequency distribution chart produced.

The final questions of the questionnaire queried landowner perceptions of habitat and landscape changes in the past and their hopes for the future. It aimed to ascertain the changes to the local habitat or landscape respondents had observed since they began farming and how they felt about these changes. Participants were also asked about changes they would like to see in the future. These questions were also free-text, and the most frequently given answers were assessed and graphed.

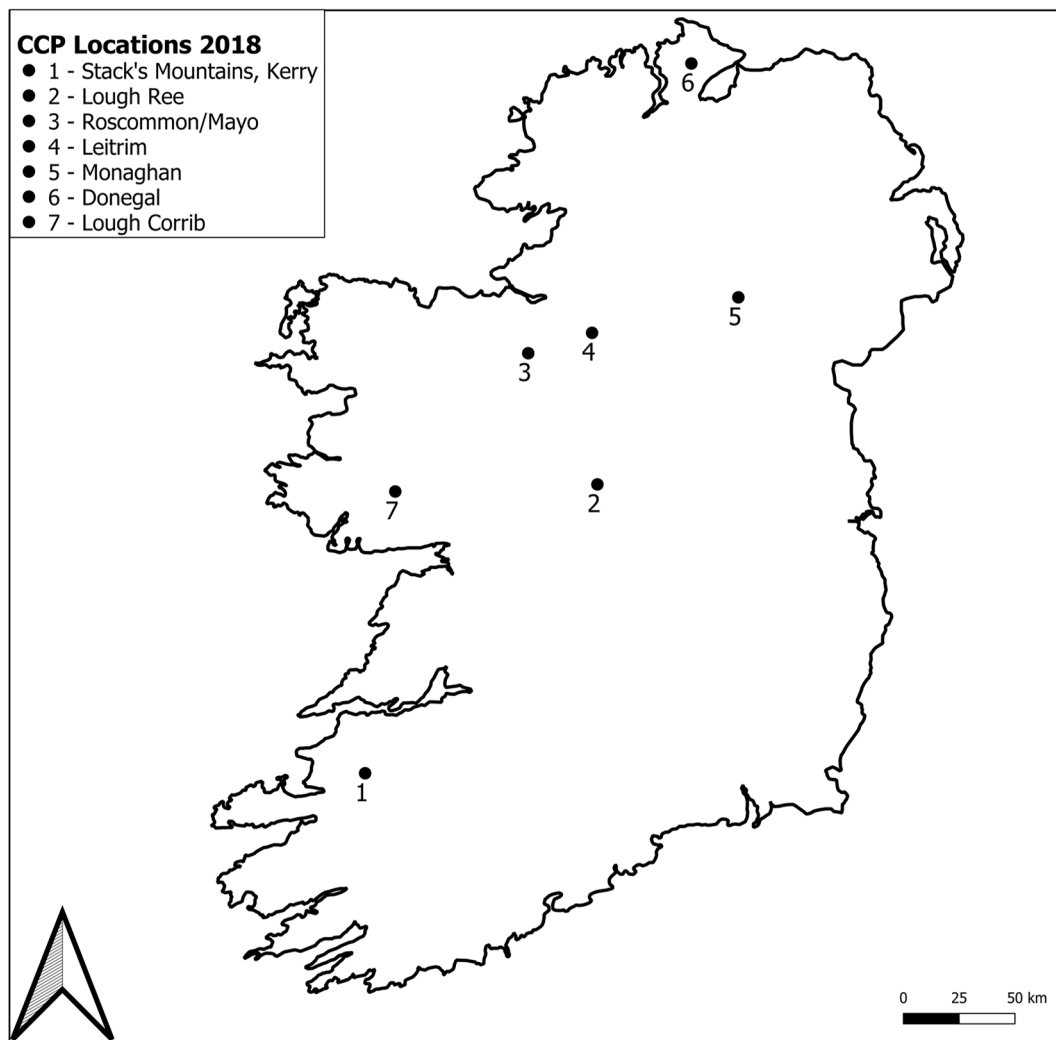


Fig. 1. The location of the seven Curlew Conservation Programme areas around Ireland in 2018.

Table 1

Landowners were asked to list five words describing what farming meant to them. The table indicates examples of answers used in this paper and how they were categorised, using Gasson 1973 examples as a guide.

Dominant Values	Repondent Examples
Intrinsic	Way of life Farming means everything Freedom Connecting with nature Maintaining mental health
Expressive	Pride Ownership Knowledge Skill
Instrumental	Responsibility Income Routine Livelihood Security Profit
Social	Family Heritage Community Tradition Connection

### 3. Results

As not all respondents of this survey were farmers (14% had full-time off farm jobs), we refer to respondents as landowners in this study. Respondents were most frequently in the '55–64 years old' age category (37%). Almost half (48%) were full-time farmers, with a further 30% still farming their land (farming with a part-time off-farm job, retired and farming). Just over one third (i.e. 37%) of landowners had off-farm employment (either full-time or part-time jobs), 37% were located 11–20 km from the participant's land/Curlew territory with 26% working more the 20 km away. The most common (44%) duration of farming was 31 to 50 years.

The average land holding size was 49 ha, with the largest farm listed as 150 ha and the smallest as 7 ha. The most common farm activity was cattle rearing (suckler) farming (47%) (Fig. 2). There were no examples of tillage-only farming reported in this survey, and only one participant listed mixed tillage/grazing livestock as their farm activity. Farm types in the Other category included Horse and Donkey related farm types.

The majority of landowners in this survey were involved in an AES (Agri-environmental Scheme) (71%). The majority (90%) of these agreed that expert advice on what would help the habitat or species of their AES would be beneficial. Respondents were not asked to specify which AES they were involved. The main scheme in Ireland is GLAS (Green Low-Carbon Agri-Environment Scheme) however, the most recent review of GLAS (ADAS, 2020) did not monitor any increase or

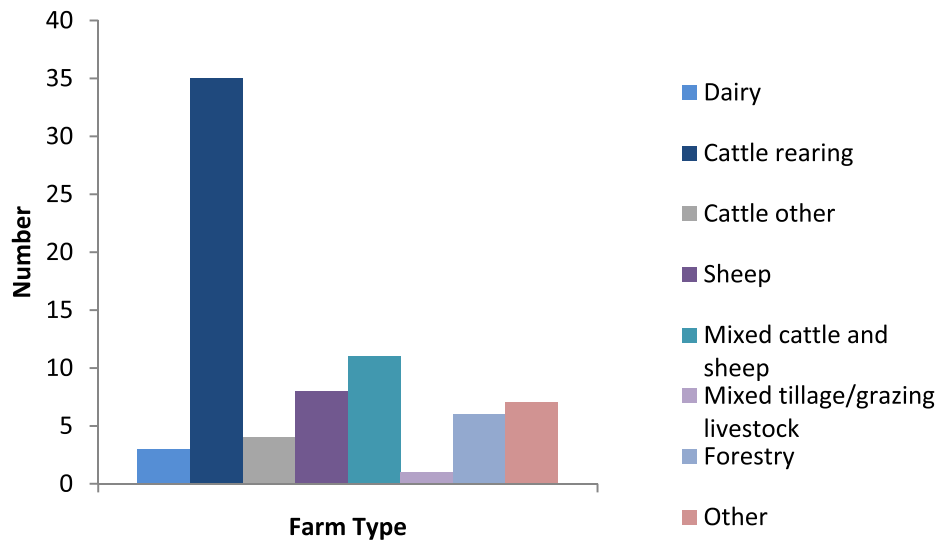


Fig. 2. Farm type practised on Curlew breeding land (Note some respondents listed more than one activity) (N = 75).

decrease in breeding wader numbers. The most recent report of the CCP (Curlew Conservation Programme Report 2021) did not indicate any increase in Curlew breeding pair numbers however an increase in productivity was reported. The Curlew EIP (operating in South Leitrim and Lough Corrib 2019–2021) has recorded stable breeding pair numbers (15–17 pairs) but a reduction in hatching/fledging success.

The majority (76%) of landowners indicated that they intended to be still farming in 10 years and (for those that will continue farming) they did not intend to change farming activities on their land in that time (79%). A minority (i.e.19%) indicated that they did not intend to continue farming in the next 10 years, with 66% of those individuals in an age category of 65 years or older. Of that 19%, half indicated that they did not have family to continue farming on the land. When asked why they believed there might not be a next generation farming on the land, a lack of interest in farming was the most frequent answer given.

Participants were also asked what they believed were the main threats to farming. The most frequent threat listed was financial, making up 26% of total answers (N = 124), with “Poor weather/land” listed second-most frequently with 19% of answers and “Increased forestry” third-most with 10%.

The majority of landowners believe that Curlew populations have decreased both locally and nationally (Table 2). A small number indicated that they believed populations had increased locally, but no landowners indicated a national increase in Curlew numbers. Participants were also asked to state why they believed Curlew numbers were in decline or increasing. The most common cause of decline proffered was predation while the most frequently suggested cause of Curlew increase (N = 8) was involvement in an AES (N = 3), followed by a reduction in predation (N = 2).

The majority of those surveyed indicated that there had been Curlew on their land in the past two years (77%). When asked if the traditional farming practices that benefit Curlew could continue, 67% of participants believed that they could. Landowners most frequently suggested that the provision of financial aid (33%, N = 85) would be required for this traditional farming to continue, followed by the need for support and advice on farming practices (20%), changes to farming practices (8%) and increased control of predators (8%).

Table 2  
Respondents’ perception of Curlew population trends, locally and nationally.

Curlew	Increased	Similar	Decreased	Unsure
Locally	6 (10%)	6 (10%)	44 (73%)	4 (7%)
Nationally	0 (0%)	4 (7%)	33 (59%)	19 (34%)

Respondents were asked to give five words to describe what farming meant to them. A total of 146 words/phrases were given. Of the words provided, 76% could be classed as positive, the most common positive phrase was a ‘Way of Life’. There were 7 different neutral associations, ‘Work’ being the most frequent. There were 5 different negative responses; ‘Financial Strain’ was the most frequent answer. When the responses were categorised according to Gasson’s dominant values, we found that Intrinsic values were most numerous, accounting for almost half of answers provided (Fig. 3 (a)). Approximately one quarter of answers were classed as Social values, followed by Instrumental and Expressive as the least common. Landowners were asked to rank three phrases (provided in the questionnaire) which represent why they farm: (i) Way of life and maintaining links between generations; (ii) Money; and (iii) Managing the land for nature. As seen in Fig. 3 (b), option (i) ‘Way of life’ was ranked first most often (74%), whereas option (iii) ‘Managing the land for nature’ was ranked last most often (47%). It is also worth noting that economic incentives ranked almost equally (last) with managing the land for nature.

Landowners were asked about habitat and landscape changes they had observed in their locality or community since they began farming, as well as the changes they would like to see in the next twenty years. The most common change observed by respondents was an increase in forestry (Fig. 4) with 20% of respondents noting this trend. The majority of landowners were not in favour of changes that have occurred since they began farming, with 63% responding negatively when asked for their opinion on these changes. When landowners were asked about the changes they would like to see in the next twenty years, the most common response (16%, N = 126) was an increase in diversity of wildlife.

#### 4. Discussion

The data presented are from a subset of landowners across the CCP areas in Ireland which is indicative of where curlew are breeding within the Irish landscape. The Curlew is facing rapid declines across Europe in Ireland in particular (BirdLife International, 2020). The drivers of this decline in Europe are similar to those in Ireland (agricultural intensification, increased predation) (Grant et al., 1999; Ławicki & Wylegała, 2011; Brown, 2015; McMahon et al., 2020). Following on from the objectives stated previously, we consider how the knowledge gathered from this study can be applied to improve practices within agricultural settings which benefit the sustainable use of resources which would be exemplified by the existence of waders such as Curlew.

The majority of landowners in this study were cattle rearing (suckler)

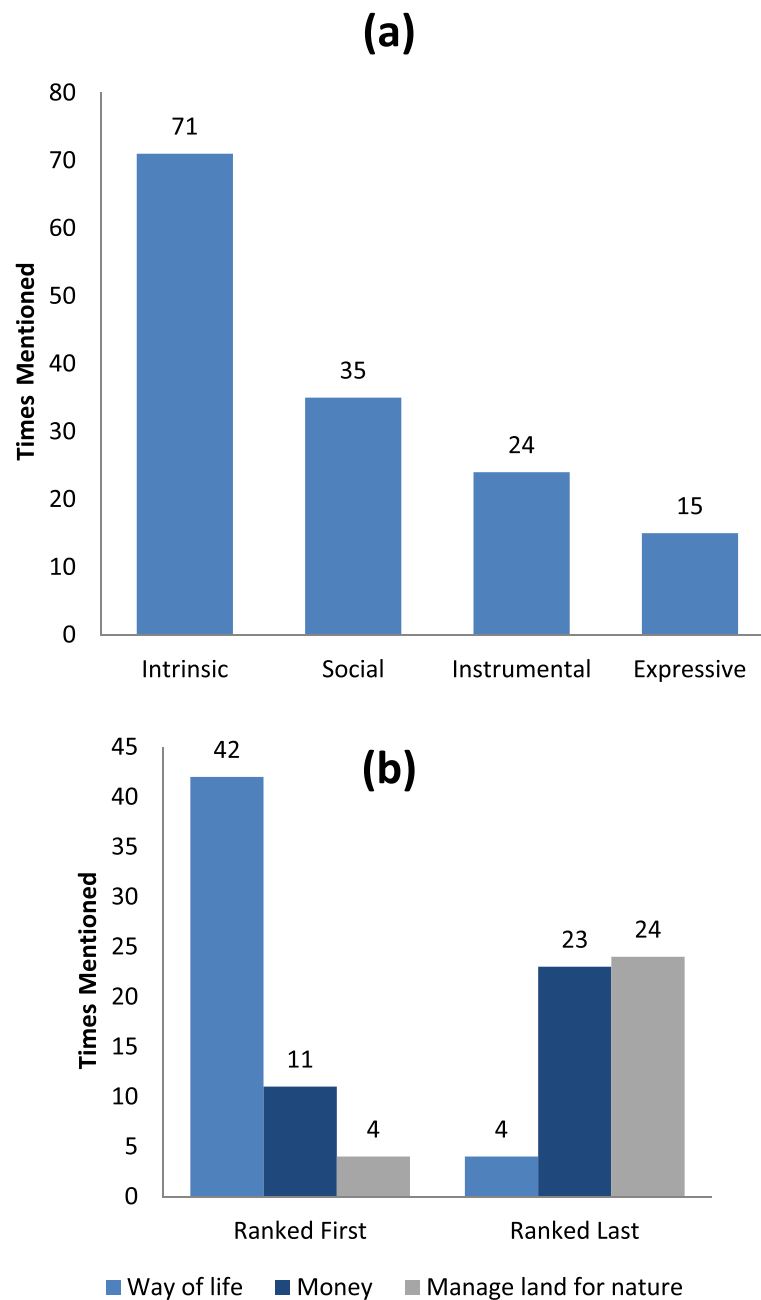


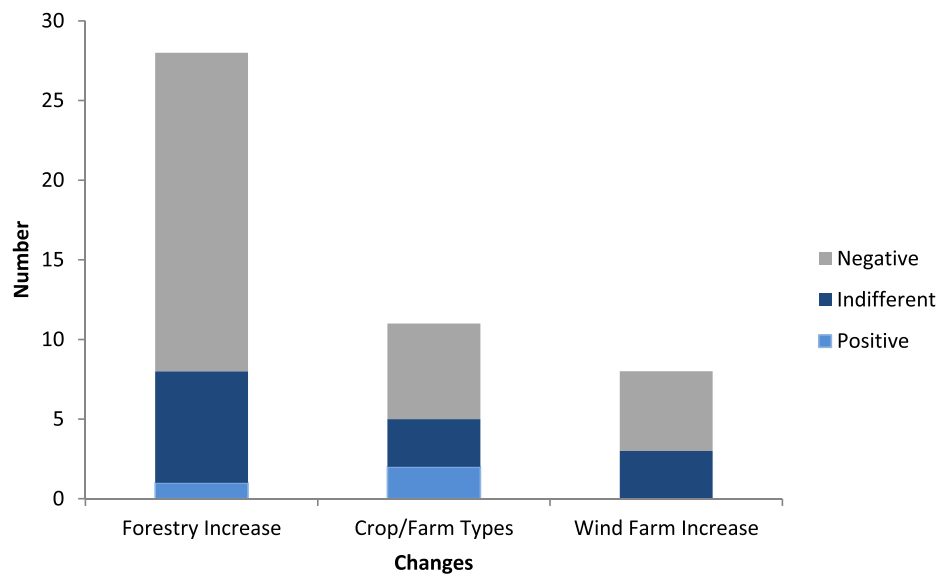
Fig. 3. (a) Meaning of farming to respondents (b) Reasons for farming.

farmers. This follows the national statistics, with over half of farms (54% of 139,600) falling under the category of specialist beef production (Central Statistics Office, 2013). The threats to farming most frequently mentioned by the landowners in this study were financial issues. There has been much discussion regarding future prospects for cattle specialised farms in Ireland in recent years (Casey & Holden, 2006, O'Donovan et al., 2011, Donnellan et al., 2018) with most recent estimates indicating that only 13% of such farms in Ireland are economically viable in 2019 (Donnellan et al., 2020). Across Europe, the beef industry is facing numerous challenges such as origin, authenticity, animal welfare and environmental impacts (Hocquette et al., 2018). Landowners in this survey consider financial issues to be the biggest threat to farming, which indicates the awareness of economic viability of some farming practices. An important factor in the conservation of a declining species is to maintain landscapes which are utilised by this species. This economic threat to farming is therefore also a threat to breeding Curlew,

who depend on the sustainability of these landscapes to continue breeding successfully.

Financial aid, followed by support and advice were the most frequently suggested requirements for traditional farming (which delivers a favourable environment for Curlew) to continue. Farm profitability is an important factor in the maintenance of farms. Cattle rearing farms have the lowest income by farm system and as highlighted above many are non-viable (Dillon et al., 2018, Donnellan et al., 2020). Thus it is understandable that financial viability would be one of the common requirements listed for traditional farming to continue. It is likely that the best way forward would be one that includes a form of financial support, even if it is likely that the motivations and goals of farmers are not financially driven. It also appears that landowners would be in favour of receiving non-financial assistance in the form of expert advice on the best practices to improve sustainability of some farming systems.

It is interesting to note that landowners perceived a local increase of



**Fig. 4.** Perception of changes since respondents began farming. These answers were divided into whether participants responded positively, negatively or indifferently to the change (N = 141).

Curlew numbers in this survey. The reason for this may largely be due to the fact that only landowners in CCP target areas were addressed, where Curlew numbers may be more apparent. The overall perception of national curlew numbers is a general decline.

Of the four dominant values, intrinsic values were listed most often, with instrumental values (such as finance-related values) ranking second lowest. These results are similar to those of previous studies carried out with landowners in the UK, who also found that farmers had a predominantly intrinsic orientation to farm work (Gasson, 1973, Ilbery, 1983) however, Ilbery (1983) found that farmers in the UK valued social values lowest of all, whereas in our study, social values are ranked second highest. It is important to note that the sample of respondents involved in our study was not randomly selected, but were specifically targeted as they live in CCP areas, thus the emphasis they placed on this value may not be reflective of landowners overall in Ireland. The majority of landowners ranked the option of 'Way of life' higher than the option of 'Money' for reasons why they farm. Both of these results indicate that the majority of landowners in this study (most of whom are suckler farmers) are not financially motivated. The majority of landowners also ranked 'manage land for nature' last, which indicates that while they are not farming purely for profit, their motivations are also not purely environmentally oriented.

A perceived increase in forestry was the most frequently suggested change noted in the landscape, with the majority of landowners having negative perceptions towards this increase. This negative perception of an increase in forestry has been reflected in other Irish studies, with a lack of community involvement and consultation regarding forest planting identified as a key issue (Ní Dhubháin et al., 2009, Duesberg et al., 2013). There have been incentives for landowners to convert unprofitable agricultural lands to afforested habitats across Ireland (McCarthy et al., 2003) and despite negative views towards afforestation, it is likely that in the face of ongoing financial threats that afforestation of marginal lands will continue. A change in crop or farm types (such as a reduction in dairy or tillage farms or a reduction in cereal farms) was the second most frequently perceived change to landscapes. These changes were also viewed negatively. This observation reflects past trends in Irish agriculture, with the area of cereal farms in Ireland declining (Taylor & Halloran, 2002). These changes to agricultural environments have had detrimental consequences for species depending on these landscapes in past years, such as the extinction of the Corn bunting (*Emberiza calandra*) (Taylor & Halloran, 2002) thus

demonstrating how species can be adversely affected in a relatively short period of time in Ireland. An increase in wind farms was the third most commonly suggested change to the landscape. Once again, the majority felt negatively towards this change. Interestingly, while there were some landowners who felt positively towards the perceived increase in forestry and changes in farm or crop types, none of the landowners who listed an increase in wind farms felt positively about this change. Similar views towards the introduction of wind farms have been observed in previous literature, with negative perceptions of visual impacts and noise levels of wind turbines the most frequently reported cause (Devine-Wright, 2005). The responses to this survey indicate that landowners are aware of the landscape changes occurring across Ireland and the majority feel negatively towards these changes. It is likely that afforestation and wind farm installation will increase as the financial viability of farms decline as a result of increased production costs and reduced milk or beef prices (IFAC, 2021).

An increase in biodiversity or wildlife or a wish to find a balance between farming and wildlife were the most common suggestions for what landowners would like to see in the future. Some landowners also listed a wish to keep up farming traditions. The answers in this section indicate that although the majority of landowners in this survey farm due to intrinsic motivations ('Way of life') and although they still show awareness towards trends that benefit biodiversity they do not primarily farm in order to manage the land for nature. The landowners in this study do not display reluctance towards maintaining traditional farming practices.

The subject of predation and predator control occurs in several responses throughout the survey. Predation is given as the leading cause of Curlew decline. In cases where landowners believed Curlew numbers to be increasing, they also listed reduced predation as the second-most common reason for this increase (with involvement in an AES as the first). A need for predator control is also given as a requirement for traditional farming practices to continue. Predator control was an element of the Curlew Conservation Programme, with Red fox (*Vulpes vulpes*), American mink (*Neovison vison*), hooded crow (*Corvus cornix*) and magpie (*Pica pica*) listed as predator species to be managed. Predators which are protected in Ireland (such as pine marten (*Martes martes*) and badger (*Meles meles*)), were managed by exclusion from possible Curlew nesting habitats. Landowners were not asked in the survey as to whether they participated in predator control themselves, however this is something that could be considered in future social science studies.

Research continues to indicate that the control of generalist predators is an important step in the conservation of ground-nesting birds (Roos et al., 2018, Sheridan et al., 2020, McMahon et al., 2020). Over the past 60 years in Ireland, habitat fragmentation has increased alongside a decrease in habitat quality for ground nesting birds (Sheridan et al., 2020). This has resulted in an abnormally large number of predators in Ireland with limited control being implemented. If ground nesting birds are to avoid further declines in Ireland, the control of predator numbers should be a priority. As Ireland continues to undergo landscape changes with an increase of afforestation and habitat mosaics within agricultural landscapes, it is likely that predation pressure on ground-nesting birds will continue to increase in the absence of predator control (Shapira et al., 2008, Reino et al., 2010). While predator control is an ongoing challenge, the results of this study indicate that the landowners are in our Curlew breeding territories are aware of this necessity and in favour of predator control.

The results of this study indicate that landowners show positive perceptions towards their involvement in AES. The majority of landowners in this study were involved with AES at the time of interview, and indicated that they believed advice on habitat management from these schemes would be beneficial. The advice available to these landowners would largely come from organisations such as Teagasc or the IFA, unless involved with a scheme such as GLAS. With upcoming environmental land management schemes (ELMS) such as those targeting the environmental quality of agricultural lands surrounding raised bogs (DAFM, 2021), there may be potential for support through future schemes. Landowners that indicated a local increase of Curlew on their lands also indicated that AES were the cause most frequently. AES have been shown to be successful with birds facing population declines (Aebischer et al., 2000) however, the outcomes of some schemes have varied with breeding waders of particular concern (O'Brien et al., 2011). Across Europe, many wader species which breed on agricultural lands have been in decline. As well as Curlew, waders such as Northern Lapwing (*Vanellus vanellus*), Common Snipe (*Gallinago gallinago*), Black-tailed Godwit (*Limosa limosa*) and Common Redshank (*Tringa tetanus*) are listed as species of unfavourable conservation status (Birdlife International, 2004). While these schemes can be successful, in some cases, AES can only slow rates of decline without improving numbers of breeding birds (Audsen & Hirons, 2002, Ottvall & Smith, 2006). One study in Scotland compared numbers of breeding waders between 1992 and 2005 and aimed to test if numbers had increased on lands managed under AES (O'Brien et al., 2011). This study found some positive effects on lands managed under 'Grassland' schemes; Lapwing numbers declined at a slower rate on AES sites than non-AES sites and Redshank numbers increased on AES sites. No significant effects were found for other waders (Oystercatcher (*Haematopus ostralegus*), Common Snipe and Curlew). Furthermore, no positive effects were found on sites under 'Wetland' schemes and it is possible that during the five year AES agreement, land grazing was reduced or abandoned leading to the spread of rank vegetation (O'Brien et al., 2011). If AES are to be successful, they need to be evidence based and tailored to individual habitats and monitored over time to ensure efficacy (O'Brien et al., 2011).

The actions of those owning land that overlaps with Curlew breeding territories can potentially have a huge influence on the outcome of these birds. Yet there is a paucity of social science data for these landowners in Ireland. This study provides some insight to the values and perceptions of a targeted sample of owners of land overlapping with Curlew breeding territory. While these results will be useful in adapting the management of traditional and sustainable agriculture and the management and conservation of breeding Curlew in these landscapes, there is still much to be researched in terms of fully understanding the goals and values of agricultural landowners across Ireland. It appears that the majority of agricultural breeding territories for Curlew are found in Suckler farming systems, which are largely non-viable across Ireland.

The 2015 Paris Agreement lists several international obligations that can be relevant to the protection or restoration of Curlew breeding

habitats. One aspect of the Paris Agreement and following COP meetings is the importance of carbon capture and maintenance of carbon sinks. Curlew breed on marginal habitats such as peatlands and semi-natural wet grasslands (Young et al., 2020, Bracken et al., 2008). It has already been well documented that peatlands are hugely important carbon sinks (Chaudhary et al., 2020, Freeman et al., 2012) however a better understanding is needed of the carbon capture capacity of all Curlew breeding habitats. Incorporating framework initiatives (such as REDD + or upcoming ELMS) which aim to reduce greenhouse gas emissions and improve carbon capture in agricultural ecosystems to increase the carbon capture capacity of Curlew breeding habitats may act as an alternate financial incentive and advice platform to landowners with lands overlapping Curlew breeding territories.

While many landowners are receptive to assisting in conservation efforts, many believe they are limited in finance and practical knowledge or experience to carry these out effectively. Following on from the requirements suggested to maintain traditional farming practices which benefit breeding Curlew, we suggest four recommendations for change: 1) Increase predator control on and around Curlew breeding territories; 2) Direct funds towards habitat restoration initiatives which can further incentivise landowners to employ practices which are both financially stable and support breeding Curlew; 3) Enable mechanisms which support landowners of vulnerable farm types; and 4) Continued restoration and protection of marginal habitats and reduction of habitat fragmentation. Short term actions, such as predator control, are needed to give ground nesting birds more time to allow for long term actions, like habitat restoration, to come into effect. There is an urgent need for financial support and advice that can assist in the maintenance of at-risk farming practices such as those non-viable cattle-rearing farms mentioned previously. Already in Ireland, we have seen examples of changes to agricultural environments resulting in extirpation of a species over a short period of time. Directing climate action funds towards habitat restoration initiatives for the restoration and protection of vulnerable ecosystems should be a priority.

## 5. Conclusion

While Curlew is the focus of this study, many other breeding wader species are affected by the farming practices that occur in their breeding habitats. With the majority of landowners in this study engaging in vulnerable farm practice types, these breeding habitats may be at risk of land use changes. These changes such as reduced grazing, land abandonment and encroachment of rank vegetation which would deplete breeding grounds would be detrimental to many wader species. If breeding territories are to be preserved, it is important to conserve these at-risk landscapes. The results of this survey indicate that the primary driver of these landowners is not financial. However, the financial vulnerability of the farming systems practised in Curlew breeding territories, means there needs to be a balance of financial aid and expert advice in order to facilitate the survival of Curlew within these farming systems. This study highlights that farming activities in Ireland which facilitate the existence of certain biodiversity are not financially viable therefore, if we are to retain certain species, such as Curlew, we must develop tools and methods which align the co-existence of a sensitive breeding birds with accommodating agricultural activities. The Curlew population in Ireland has faced major and rapid declines over a short period of time. With fast-paced land use changes ongoing in Ireland, funding to protect vulnerable agricultural landscapes and support landowners is much needed in order to halt these declines and to employ urgent conservation measures for Curlew.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.



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