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Barn Owl population status and trends in County Meath

Prepared by BirdWatch Ireland for Meath County Council

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Images:

Barn Owl, front cover: Mike Brown; Barn Owl, page 5: Richard Brooks (RSPB-images.com); Greater White-toothed Shrew, page 5: John Murphy; Kestrel, page 7: Colm Clarke.
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CONTENTS

SUMMARY

This study shows that Barn Owl populations in County Meath are showing tentative signs of recovery after a period of extensive declines. Having experienced drastic declines across the first three Bird Atlases between the late 1960s and late 2000s, the current survey has revealed the first tentative signs of a population increase in County Meath for the last 50 years. However, there remains a low number of known breeding pairs (six) with a high proportion (89%) of suitable sites that are not currently occupied by Barn Owl. In addition, despite the recent increase, the breeding range of Barn Owls has not yet returned to the extent of the recorded breeding range 50 years ago, prior to the extensive population declines.

The most likely cause for the recent population increase of Barn Owl in County Meath is due to the spread of the Greater White-toothed Shrew (GWTS). The south-west to north-east spread of the GWTS correlates roughly with the current distribution of Barn Owls in County Meath. The recent discovery of a population of Field Voles in County Monaghan could potentially spread into Meath in the future and become an important component of the Barn Owl diet, further influencing their populations in the county. Continued monitoring of known sites in County Meath will be important to determine this in the future. There was an abundance of unoccupied, suitable sites in County Meath which shows that a lack of suitable sites is not currently limiting the spread of Barn Owls in the county. Old ruined structures were observed to be the most important sites for Barn Owl in the county. These structures were also used by a range of other species including Kestrel, Peregrine, Stock Dove, Tree Sparrow, Swift and Raven. This highlights the importance of built heritage and ruined structures for Barn Owls and other wildlife and the need to ensure these sites are protected and remain suitable.

SUMMARY HIGHLIGHTS

- Barn Owl populations in County Meath have increased in range and numbers over the last ten years.

- Barn Owls have a relatively widespread distribution throughout County Meath and **were present in 20 (44%) of the 45 10km squares in the county**. Confirmed breeding was recorded in ten 10km squares and probable breeding in ten 10km squares.

- The **breeding range of Barn Owl in County Meath has increased by 43% over the past ten years**, when compared to the breeding range as defined by the Bird Atlas (2007-2011).

- Although the breeding range of Barn Owls in County Meath has recently increased, **it remains restricted (-44%) compared to the breeding range of Barn Owls in the county 50 years ago,** as defined by the Atlas of Breeding Birds in Britain and Ireland (1968-1972).

- In 2023, **9 sites were confirmed to be occupied by Barn Owl in County Meath**.

- All **occupied Barn Owl sites were in buildings (n = 9)**. Ruined mansions (n = 3) and ruined castles (n=3) were the most common site type used, followed by ruined churches (n = 2) and a ruined mill (n = 1).

- Of the nine occupied Barn Owl sites, **six were confirmed breeding sites. The most common nest site used by Barn Owl was within chimneys of buildings (n = 3), followed by a cavity (n = 1), a bell tower (n = 1) and a ledge (n = 1).**

- **A breeding density survey** carried out in two 10km squares in County Meath identified 66 sites, of which 44 sites were possible to survey. **Of these 44 sites, 36 were suitable or potentially suitable for nesting Barn Owls, however none of these were in use by Barn Owls.** This suggests Barn Owl densities are **extremely low**, at least in these two 10km squares.

- The suitability for and the **presence of Barn Owl was assessed at 116 sites in County Meath in 2023. Of these 116 sites, 84 were determined to be suitable. Evidence of Barn Owl was confirmed at 9 (11%) sites**. There were 75 sites (89%) which were suitable but where there was no evidence of use by Barn Owl. This high proportion of suitable sites which are available for Barn Owl indicates the availability of nest sites is not a factor which is limiting the population.

- Ruined buildings were important for a range of other breeding birds in County Meath as well as Barn Owl, which was shown by the fact that **Tree Sparrow were confirmed at six sites (7%), Stock Dove at three sites (4%), Raven at two sites (2%), Swift at two sites (2%), Kestrel at one site (1%), and Peregrine at one site (1%).**

- Barn Owls had a good breeding success rate in County Meath in 2023, **of 6 confirmed breeding pairs, five were successful (83%),** the outcome of breeding for one pair was unknown. An additional three sites were occupied by Barn Owls, however their breeding status at these sites could not be confirmed.

- Barn Owl young were ringed at three nest sites in County Meath in 2023. **The fledging success at these three successful sites was 4 young per successful breeding attempt. Two of these chicks were subsequently reported dead, the first after being hit by a train in September 2023, 33km to the south of its natal site, and the second after being struck by a vehicle in November 2023, 107km to the south of its natal site.**

Image 1. A photo of the first Barn Owl chick ever ringed in County Meath, 7th of July 2023.

1. INTRODUCTION

The Barn Owl *Tyto alba* is one of the most widely distributed terrestrial birds occurring on all continents except Antarctica. In Europe, Barn Owls breed in all countries with the exception of Greenland, Fenno-scandia and Malta (Shawyer, 1998). Throughout their European range, Barn Owls are found in a wide variety of habitats, typically associated with lowland farmland, where they specialise on small mammal species (Shawyer, 1998). Although Barn Owls are listed as Least Concern in Europe, their population trends are declining (BirdLife International, 2021). This is the case in Ireland, where the Barn Owl is a Red-listed *Bird of Conservation Concern in Ireland,* due to extensive declines in their breeding population and range (Gilbert *et al.* 2021). The *Breeding Bird Atlas* (2007 – 2011) highlighted a breeding range decline of 39% over the 40-year period since the original *Atlas of Breeding Birds in Britain and Ireland (*1968 – 1972) (Sharrock, 1976; Balmer *et al.* 2013). The Barn Owl population declines reflect land use changes and the intensification of farming practices which have resulted in a decline in the abundance and diversity of natural vegetation and have negatively impacted wildlife associated with farmed habitats (IPBES, 2018, Fitzpatrick *et al.* 2007; Copland and Lusby, 2009; Gilbert *et al.* 2021). The changing agricultural landscape has resulted in the loss of suitable habitats for Barn Owls, including a reduction of prey-rich foraging habitat and nesting sites (Shawyer, 1998; Nagle, 2007). Alongside these land use changes and the loss of habitat, the increased use and increased toxicity of anti-coagulant rodenticides (Roos *et al.* 2021), and the expansion of major road networks (Lusby *et al.* 2021a) are likely to be the main factors which have influenced the declines in the Barn Owl breeding range and numbers observed over recent decades in Ireland (Balmer *et al.* 2013; Gilbert *et al.* 2021).

Although Barn Owl populations have declined over recent decades, there are indications that they are recovering in certain parts of their range in Ireland. This has been identified through monitoring of Barn Owl populations which have showed increases in numbers particularly in the south of the country, including many traditional nest sites, which have not been used in many years, being occupied once again and a significant increase in the uptake of artificial nest boxes (Lusby *et al.* 2021b). Alongside these positive indications of a population recovery, there has been a significant focus on addressing the factors which are known to impact Barn Owl populations. These include the implementation of survey and mitigation standards for national road projects to reduce the extent of mortality on roads (Lusby *et al.* 2021a) and improving awareness and standards regarding the use of rodenticides to limit the effects of secondary poisoning (www.curru.ie). The provision of nest boxes for Barn Owls and protecting known nest sites have also been successful conservation measures in recent years. The Agri-Climate Rural Environment Scheme (ACRES) includes a Barn Owl specific measure which requires the installation of a nest box in a suitable location alongside implementing an integrated pest management approach to rodent control which is available to farmers in this scheme (https://www.gov.ie/en/service/f5a48-agri-climate-rural-environment-scheme-acres/). In addition to these conservation initiatives to help Barn Owl populations, there have also been significant changes in the Irish landscape which can affect Barn Owls and other predatory species, most notably the introduction and subsequent range expansion of introduced small mammal species (primarily the Bank Vole *Myodes glareolus* and Greater White-toothed Shrew *Crocidura russula*) (Tosh *et al.* 2008; McDevitt *et al.* 2014). It is important to identify any changes in Barn Owl population and

breeding trends and to understand and respond to the drivers of these population changes. This information, in addition to determining the effectiveness of applied conservation measures, will help to inform and direct future conservation strategies to benefit Barn Owls and the ecosystems on which they depend.

Indicator species

Barn Owls are apex predators that sit at the top of the food chain. Many of the factors which affect species in the lower levels of the food chain can affect (and may be evident in) Barn Owl populations. Monitoring the health and status of Barn Owl populations can provide insights into the health of the ecosystem, and the environmental processes and anthropogenic pressures that affect other wildlife. In Ireland for example, studies on Barn Owls have been used to detect the presence and spread of introduced small mammals, and to assess exposure of rodenticides and pollutants in the environment.

1.1 Barn Owls in County Meath

Information on Barn Owls in County Meath is available through a range of sources and these allow changes in local Barn Owl populations in the county over recent decades to be assessed. The first Atlas of Breeding Birds in Britain and Ireland (1968-1972) showed that Barn Owls were widespread throughout County Meath, with confirmed and probable breeding recorded in 36 of 45 (80%) 10km squares (Sharrock, 1976). The breeding range of Barn Owl in County Meath was quite extensive, which was the case across many counties at this time (Sharrock, 1976). Barn Owl populations declined throughout the country from the early 1970s, and this too was the case in County Meath, with a significant decline in their breeding range recorded by the New Atlas of Breeding Birds in Britain and Ireland (1988 – 1991), which recorded confirmed and probable breeding of Barn Owl in 11 (24%) 10km squares (Gibbons *et al.* 1994), which represents a range decline of 227% over the twenty-year period since the first Atlas of Breeding Birds in Britain and Ireland (1968-1972). There was an increase in breeding range recorded by the Bird Atlas (2007-2011), which recorded confirmed and probable breeding in 14 (31%) 10km squares (Balmer *et al.* 2013), although this was still 61% lower than the range recorded during the first Atlas of Breeding Birds in Britain and Ireland (1968-1972). The National Biodiversity Data Centre shows that Barn Owls have been recorded in all 10km squares in the county over the past 50 years during the breeding and non-breeding season (https://maps.biodiversityireland.ie/Species/11644) (Figure 1).

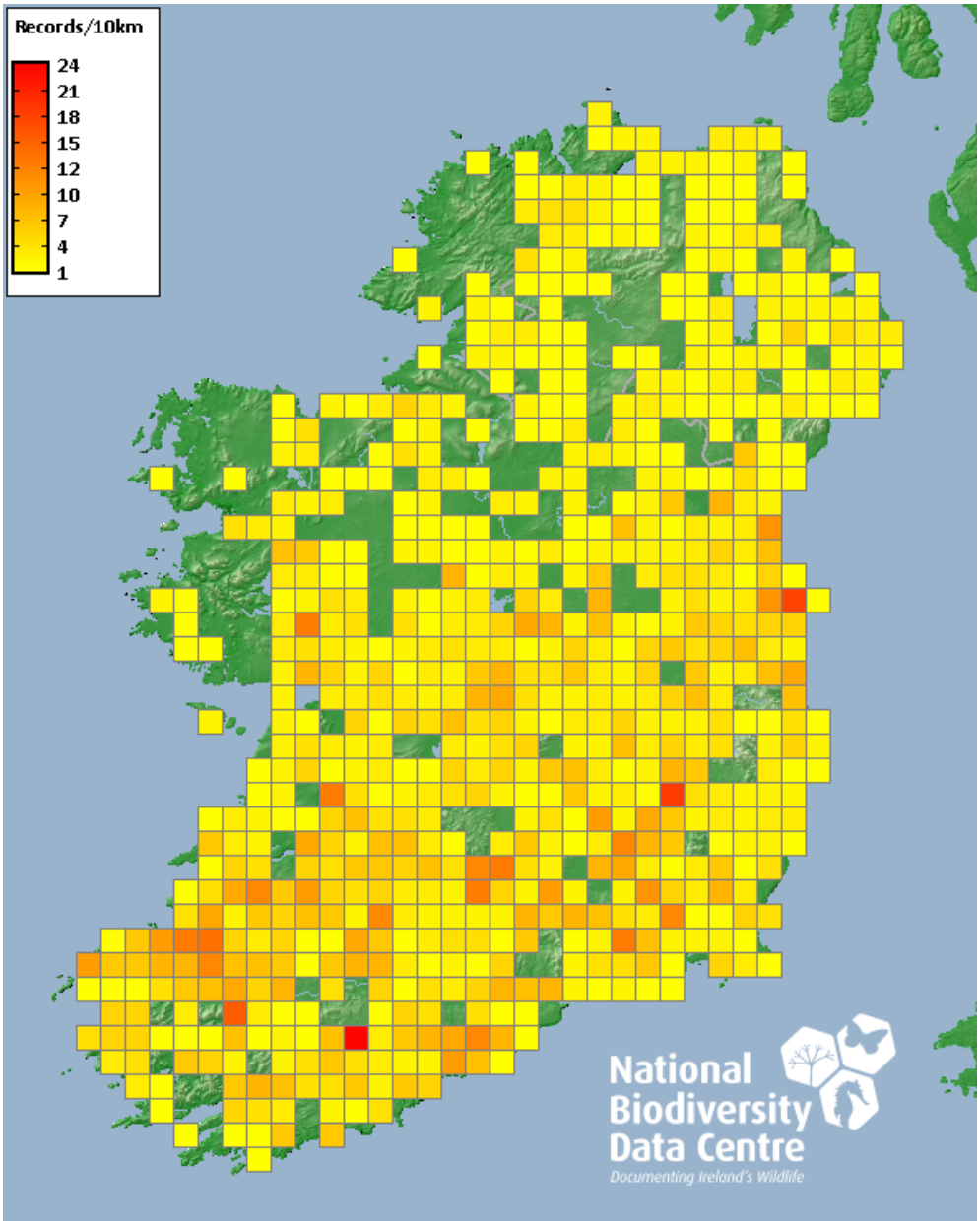

Figure 1. The distribution of Barn Owl in Ireland based on a range of sources including sightings reported to the National Biodiversity Data Centre, which shows a widespread distribution throughout County Meath during the breeding and non-breeding season.

There has been no monitoring of Barn Owls in County Meath since the last Breeding Bird Atlas (2007-2011) and it is timely that a comprehensive survey be carried out to assess changes, if any, in trends of the Barn Owl population and range. There have been significant changes throughout the country since that time, including the arrival and spread of the Greater White-toothed Shrew in the county, increased focus on the provision of nest boxes and changes in fortunes for Barn Owl populations recorded elsewhere in their range and it is important to determine the health of the Barn Owl population and their current conservation requirements.

1.2 Objectives

The Barn Owl survey aims to generate information on Barn Owl populations to assess their status, trends and breeding performance in County Meath, to assess the effectiveness of existing conservation measures and to inform the conservation requirements of Barn Owl populations. To determine the status of Barn Owl populations in Meath, the survey aimed to collect new data on Barn Owls, to determine their distribution and abundance and to compare with existing datasets to assess changes in breeding range, breeding densities and nest site availability. Specifically, the Barn Owl survey aims to:

- Determine the distribution and abundance of Barn Owls in County Meath
- Determine the breeding range of Barn Owls in County Meath and changes in breeding range over time
- Determine Barn Owl breeding densities in County Meath
- Determine the nest site selection and the availability of nest sites for Barn Owl in County Meath
- Identify the effectiveness of existing conservation measures and make recommendations for future conservation action to benefit Barn Owls
- Promote the value of Barn Owls as an indicator species, to understand environmental pressures and threats

Birds of Conservation Concern in Ireland

The 'Birds of Conservation Concern in Ireland (BoCCI)' is a review jointly compiled by BirdWatch Ireland and RSPB NI to assess the conservation status of bird species in Ireland. The review uses a 'traffic light' system – Red (high conservation concern), Amber (medium conservation concern) and Green (low conservation concern) to determine the conservation status of all regularly occurring bird species. Of the 211 species assessed in the fourth and most recent BoCCI review, 54 (25.6%) are on the Red list, 79 (37.4%) on the Amber list and 78 (37%) on the Green list. Barn Owl has been on the Red-list on all four BoCCI reviews due to the extensive declines in its breeding range. When grouped by habitat, farmland birds (35%) have the highest proportion of Red-listed species after upland birds (50%), which shows the current pressures on farmland bird populations. Kestrel is one species which was added to the Red-list in the most recent review and which is affected by similar pressures as Barn Owl, which include changes in land use and in farming practices have affected their prey, while it is possible that secondary poisoning of rodenticides has taken its toll. Reversing the effects of agricultural intensification is essential to restore populations of farmland birds, including Barn Owl and Kestrel.

2. SURVEY DESIGN

The survey is designed to generate information on Barn Owl populations to assess their status, trends and breeding performance in County Meath. We did not attempt to conduct a complete census of Barn Owls in the county (*i.e.* to identify all Barn Owl nest sites in County Meath) as this would require extensive survey resources due to the widespread distribution of the population and the wide range

of nest sites used by the species. The survey is designed to maximise the use of information available on Barn Owl populations in the region through previous species-specific and general surveys, to allow for comparisons to determine population trends and changes over time. Two approaches were employed to obtain information on Barn Owls throughout County Meath to ensure extensive survey coverage over the county and to take advantage of the potential to gather information on the species using citizen science techniques. These two approaches, as defined below, included assessing occupancy and suitability for Barn Owls at selected built structures throughout the county and initiating a citizen science survey to gather information on Barn Owl breeding sites and sightings to assess distribution and nest site selection. These methods combined were used to confirm Barn Owl sites throughout the county and to provide data to inform the specific objectives of the study, including occupancy, nest site selection, breeding densities and breeding performance of Barn Owls.

2.1 Survey area

The Barn Owl survey was undertaken throughout County Meath. To assess Barn Owl breeding range and changes in breeding range over time, Barn Owl occupancy and breeding status were determined in each 10 x 10 km grid square on the Irish National Grid in County Meath (hereafter referred to as the 10km square; Figure 2). This facilitated direct comparisons with the Barn Owl breeding range as defined by the Breeding Atlases which assessed Barn Owl distribution according to the 10km square grid.

Figure 2. The Barn Owl survey area which included all 10km squares throughout County Meath.

3. METHODS

3.1 Barn Owl survey

We employed two approaches to obtain information on Barn Owls and to identify occupied sites to allow us to address the specific objectives of this study. These approaches are outlined below.

Assessing Barn Owl occupancy in suitable structures

Assessing Barn Owl occupancy in suitable structures provides a reliable indication of the distribution and abundance of Barn Owls in an area, and also provides information on nest site availability. Large stone structures are important breeding sites for Barn Owl in Ireland (Sullivan & Lusby 2021; Lusby *et al.* 2021b). We identified a range of built structures in County Meath which provide potential nesting opportunities for Barn Owl, using a range of resources (information on built heritage sites online and Ordnance Survey maps). All sites were mapped in QGIS 3.0 and were prioritised for survey assessments to determine their suitability for and occupancy of Barn Owls. Evidence of other bird species using these sites was recorded including their breeding status.

Citizen science survey

The survey methods outlined above are suited to assessing Barn Owl occupancy and to identifying Barn Owl breeding pairs using traditional nest sites and large stone built heritage structures. However, Barn Owls also use a range of other nest sites including derelict farmhouses, farm buildings, trees and artificial nest boxes, mostly located on private lands. A citizen science approach to assessing Barn Owl distribution and abundance has significant benefits, as Barn Owls have a widespread distribution but their presence in specific sites and on farmed lands is often only known locally or by the relevant landowners. Citizen Science (requesting information from the general public) has been successfully used as a survey tool to identify Barn Owl sites (Project Barn Owl in the UK) and is particularly beneficial when combined with strategic survey methods as outlined above. To gather information on Barn Owls throughout Meath, we used an online reporting tool to allow information to be reported, validated and responded to efficiently. We requested information on Barn Owls (including potential nest sites and sightings) in County Meath through articles in the local press, radio, social media and email circulars. All information received was validated and mapped using QGIS 3.0. All reliable reports of potential breeding sites were investigated to confirm the presence and breeding status of Barn Owl where possible. This survey approach provided information on the distribution of the population and provided specific information on nest site selection and allowed us to assess breeding performance.

3.2 Survey techniques

All sites identified to assess the presence of Barn Owl were inspected to determine their suitability for breeding Barn Owl and evidence to indicate the presence of Barn Owl according to the methodology for surveying for Barn Owls in Ireland as defined by BirdWatch Ireland and Transport Infrastructure Ireland (2017 & 2021).

Determining site suitability for Barn Owls

Sites were considered to be 'potentially suitable' if they provided suitable or potential nesting opportunities for Barn Owls such as cavities or other dry, dark and secluded spaces with a floor space greater than 30cm x 30cm (Taylor, 1994) and access point of approximately 7cm x 7cm or greater (Barn Owl Trust, 2012), also blocked chimneys, roof spaces, wall cavities, chutes, hollow tree cavities, artificial nest boxes and any other cavities which meet these specifications. Where the suitability of a site was not possible to accurately determine but where it is suspected there may be nesting opportunities available, the site was recorded as 'potentially suitable' and further survey effort was invested to determine Barn Owl occupancy. Sites which do not provide nesting opportunities for Barn Owls were confirmed to be 'unsuitable' and were excluded from further survey effort on the basis that Barn Owl would not breed in these locations. All sites classed as 'potentially suitable' for Barn Owls were recorded, including an accurate location (10-figure grid reference using the Irish National Grid), the site type according to specific criteria (listed below in Section 3.6) and the landowner contact details for future correspondence.

Determining the presence of Barn Owl

At all sites considered to be 'potentially suitable' for breeding Barn Owl, a thorough day-time inspection was carried out during May to July (on the same day as assessing the suitability of the site if possible) to record the presence of signs indicating Barn Owl occupancy, including pellets, white-wash and moulted feathers. All areas of the interior and exterior of the site which were safe and possible to access were checked, with particular attention given to the ground underneath suitable cavities and perches both inside and outside the site, and the entrance to potential nesting or roosting sites. All signs which may be attributed to Barn Owl were collected in a sealable bag and labelled with the site location and date. Collection of signs facilitates assessment of future use by conducting a follow up visit to record the presence or otherwise of fresh signs. Collecting signs also allows confirmation of the species identification should this be necessary. In sites where it was not possible to fully assess site suitability or occupancy from ground level, a drone was used to visually inspect high chimneys and cavities for nesting suitability and signs of occupancy (e.g. pellets on high ledges).

If it was possible to access all areas of the site and a thorough inspection confirmed no signs to indicate the presence of Barn Owls, then the site was classed as 'unoccupied' and was excluded from further survey effort. At sites where sign searching may not be effective as a stand-alone method for determining Barn Owl occupancy (e.g. where part or all of the site is inaccessible, unsafe to search, or where the nest site may be concealed), where possible a nocturnal survey was carried out to confirm Barn Owl presence or absence.

Nocturnal surveys

Nocturnal surveys were conducted at all sites where Barn Owl activity was confirmed, suspected or deemed to be possible by a day-time inspection, as well as sites which were not possible to effectively check and rule out the presence of Barn Owl based on a day-time inspection alone.

Nocturnal surveys involved observing the potentially suitable or active Barn Owl site from a selected vantage point during the period when the birds are active in order to establish occupancy and breeding status based on observations, vocalisations and/or behaviour of birds associated with the site. Nocturnal surveys were conducted during the breeding period between May to August. A thermal imager was used (under licence from NPWS) to aid nocturnal surveys, allowing easier determination of breeding status and identification of nest site locations compared with visual assessments alone.

Nocturnal surveys were carried out from a discrete vantage point to avoid disturbance to breeding birds. The position of the vantage point was informed by the specific characteristics of the site to ensure a good view of the site, and/or area of suspected activity, including flight paths to and from the site, and preferably so that the site/area of interest is against a light background or clear sky to aid observations.

Confirming occupancy and breeding status

Sites were recorded as **'unsuitable'** for breeding Barn Owl if the day-time inspection confirms that there are no nesting opportunities available.

Sites were classed as **'potentially suitable'** if the day-time inspection records confirmed, suspected or possible nesting opportunities for breeding Barn Owls.

Potentially suitable sites were confirmed as **'unoccupied'** if best practice survey methods effectively recorded no evidence of Barn Owl activity at the site. The site is recorded as **'previously occupied'** if signs to indicate the presence of Barn Owls are confirmed, however no indication of recent use is established via follow up day-time inspections and nocturnal surveys. The site may have been used as a seasonal or temporary roost or may have been previously used as a nest site and since been abandoned.

The site is recorded as **'active'** if Barn Owl activity is confirmed via evidence of fresh signs or confirmation of one or both adults via observation or vocalisation, but there is no indication of breeding. This could be a non-breeding site, used for roosting, or a 'breeding site' which may have failed prior to the survey visits.

Sites were confirmed as a **'breeding site'** based on confirmation of; a pair present at the site by observation or vocalisation; a female attending a nest, or confirmation of pre-laying, incubation or brooding behaviour; defensive behaviour by one or both adults; confirmation of a prey delivery or if young are observed or heard.

Figure 3 shows each step of the Barn Owl survey and the determination of the suitability and occupancy of sites surveyed.

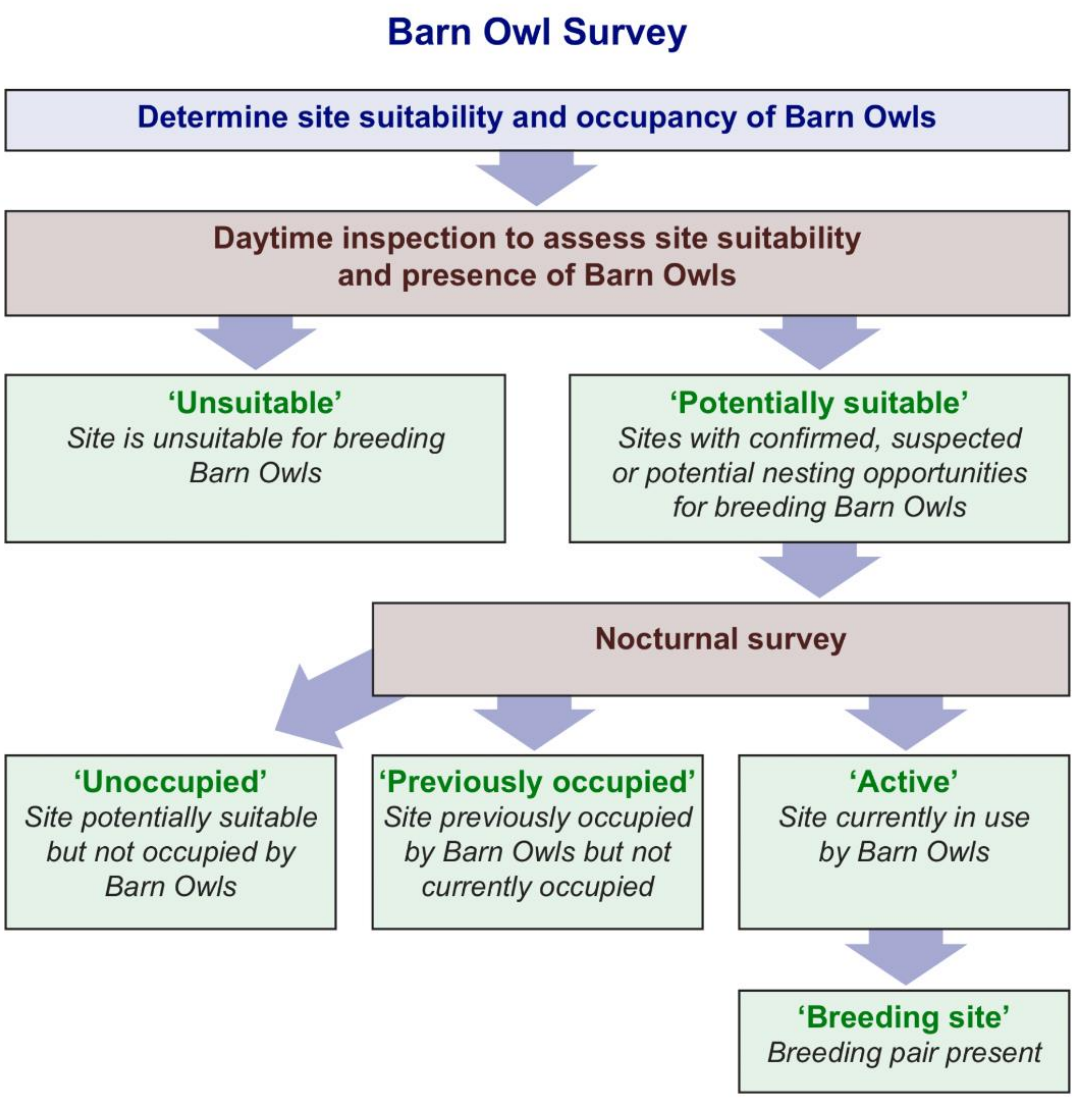

Figure 3. The steps of the Barn Owl survey to determine the suitability and occupancy of sites assessed.

3.3 Barn Owl breeding range

To define the breeding range of Barn Owls in County Meath all sites confirmed to be occupied by Barn Owls and all sightings of Barn Owl during the breeding season 2023 (mid-March to mid-July) were mapped in QGIS 3.0 to visually explore the data. Each 10km x 10km square in County Meath was categorised according to the presence and status of Barn Owls within, as 'confirmed breeding' if one or more breeding pairs were recorded in the 10km square, 'probable breeding/seen' if Barn Owls were observed during the breeding season and 'not seen' if there was no evidence of Barn Owl recorded in that 10km square. The highest level of breeding was used to define each square (*e.g.* if a square held a confirmed breeding pair and sightings of Barn Owl, then this square was classed as 'confirmed breeding').

To assess breeding range change over time we compared the number and distribution of 10km squares in which confirmed breeding and probable breeding/seen of Barn Owl was recorded, to the breeding range of Barn Owl using the same metrics as defined for the Bird Atlases. To determine the long-term breeding range change we compared the current range of Barn Owls in County Meath with the range defined by the Atlas of Breeding Birds in Britain and Ireland (1968 – 1972) (Sharrock, 1976) thus providing an assessment of breeding range change over the last 50 years. To determine the medium-term breeding range change we compared the current range of Barn Owls in County Meath with the range defined by the New Atlas of Breeding Birds in Britain and Ireland (1988-1991) (Gibbons *et al.* 1994). This provided an assessment of the change in breeding range of Barn Owl in County Meath over the last thirty years. To determine the short-term breeding range change we compared the current range of Barn Owls in County Meath with the range defined by The Breeding Bird Atlas (2007 – 2011) (Balmer *et al.* 2013). This provided an assessment of the change in breeding range of Barn Owl in County Meath over the last ten years.

3.4 Barn Owl occupancy

To assess Barn Owl occupancy trends in County Meath, 170 potentially suitable sites were selected using online resources, as well as information on sites reported via the citizen science survey. In addition and to increase the sample size of sites to survey, other potentially suitable sites were also identified by surveyors during the course of survey work (e.g. if a site which looked potentially suitable was encountered or if local information helped to identify potentially suitable site).

Site specific information on previous Barn Owl occupancy was extremely limited. There was only one confirmed breeding site previously identified in County Meath, which was a nest box in a barn in 2021, and this pair seemingly moved to a nearby tree nest in 2022.

3.5 Barn Owl breeding densities

To assess Barn Owl breeding densities we attempted to identify all Barn Owl breeding sites and occupied sites in two selected 10km squares (200km^2) in County Meath (Figure 4). Breeding densities were presented as the number of confirmed breeding sites and probable breeding sites per 100km^2. The two 10km squares were randomly selected from the 45 10km squares that cover County Meath.

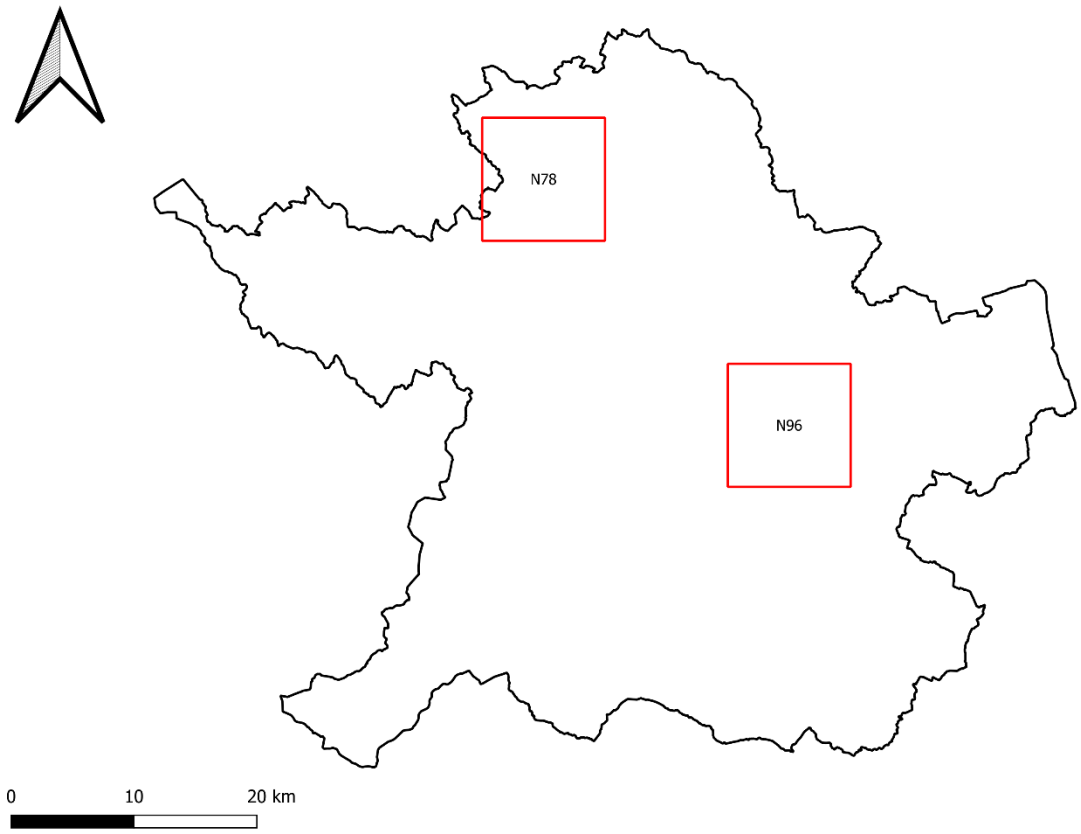

Figure 4. The two randomised 10km squares (in red) in which we attempted to assess breeding densities.

3.6 Barn Owl nest site selection

To determine Barn Owl site and nest site selection we categorised all occupied sites according to the criteria below. All sites used by Barn Owls were defined according to one of four categories which include the range of site types that have been used by Barn Owls in Ireland. These sites were further defined according to 13 site types to understand the specific site types selected and used by Barn Owl. Where possible the nest site location was determined for confirmed breeding attempts and defined according to ten categories.

Table 1. The sites, site types and nest site types used to define Barn Owl sites.

Site	Site type	Nest site type
Building	Castle	Belfry
Tree	Church	Cavity (in building)
Pole nest box	Derelict cottage	Chimney
Quarry	Derelict two-storey farmhouse	Chimney chute
	Farm building	Ledge
	Mill	Roof space
	Nest box in farm building	Nest box (including barrel)
	Nest box in derelict building	
	Nest box on tree	Hollow cavity (tree)
	Nest box on pole	Alcove
	Occupied house	Water tank
	Other building	
	Quarry	

To assess the availability of nest sites for Barn Owls in County Meath, we identified all sites surveyed and the proportion of these which were occupied by Barn Owl, suitable for breeding Barn Owl but not occupied and unsuitable for breeding Barn Owl. We determined the proportion of suitable sites which are suitable and available for Barn Owl which provides an indication of nest site availability. All sites were mapped in QGIS 3.0 to visually assess their spatial distribution.

3.7 Barn Owl breeding performance

Breeding attempts were monitored and accessible nest sites were visited under licence to collect information on Barn Owl breeding success, productivity, the timing of breeding and the condition of young. Information on mortality incidents and any relevant characteristics of the nest site which could impact breeding success were recorded.

Three measures were used to define the breeding performance of Barn Owls. The outcome of breeding attempts was determined as successful, if the breeding attempt resulted in one or more young fledging, or failed, if a breeding attempt did not result in young fledging. Productivity was determined as the number of young at or close to fledging for all breeding attempts, and fledging success was determined as the number of young at or close to fledging for successful breeding attempts.

4. RESULTS

4.1 Barn Owl survey

A total of 170 sites in County Meath were identified using online resources, previous information on Barn Owls in the county, citizen science and identified by the surveyor while navigating the county during the survey period. Of these 170 sites, it was possible to assess the suitability for and presence of Barn Owls at 116 sites. Of the sites surveyed, 84 sites were determined to be suitable for breeding Barn Owl, 13 as potentially suitable, 15 as unsuitable and the suitability of four sites was not possible to determine. Of the 84 suitable sites, nine (11%) were occupied by Barn Owl and a further six (7%) were deemed to have been previously used by Barn Owl. Of the nine active sites, six were confirmed breeding sites, one was not used for breeding but was potentially associated with a nest and the status of two sites was unknown (Figure 5). One of these breeding sites was identified through the citizen science survey, with a total of 19 sightings reported during the breeding season by members of the public.

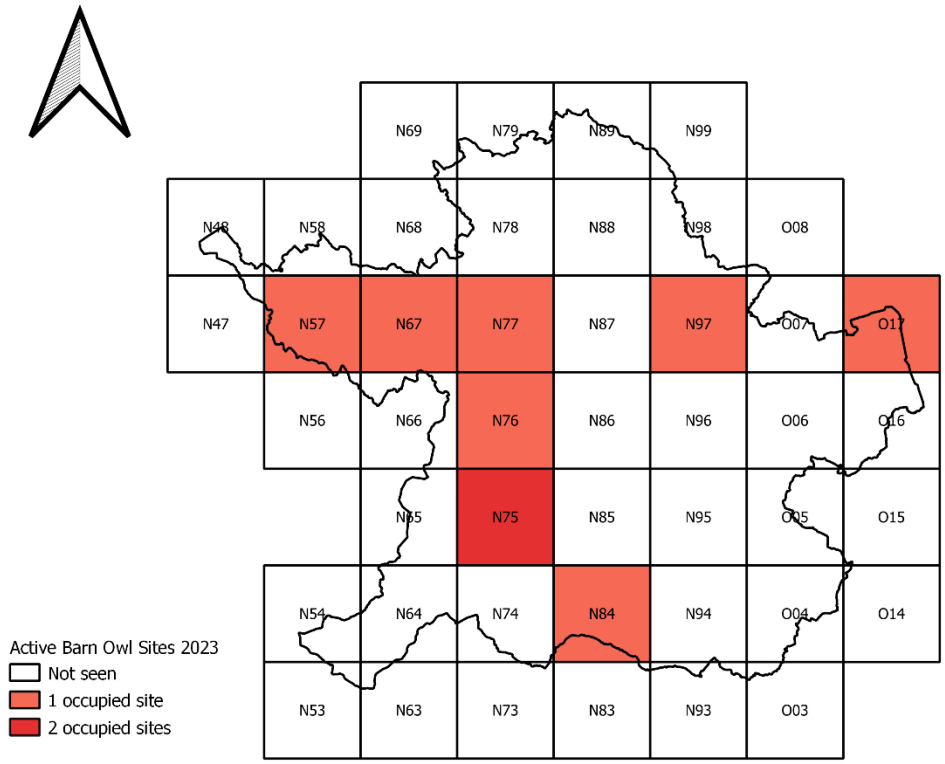

Figure 5. The distribution and abundance of active Barn Owl nest sites (n = 9) in County Meath per 10km square in 2023.

4.2 Barn Owl breeding range

Barn Owl were recorded in 20 (42%) of the 45 10km squares in County Meath. Confirmed breeding was recorded in ten 10km squares and probable breeding in nine 10km squares. The distribution of Barn Owls in County Meath according to breeding status in each 10km square is shown below (Figure 6).

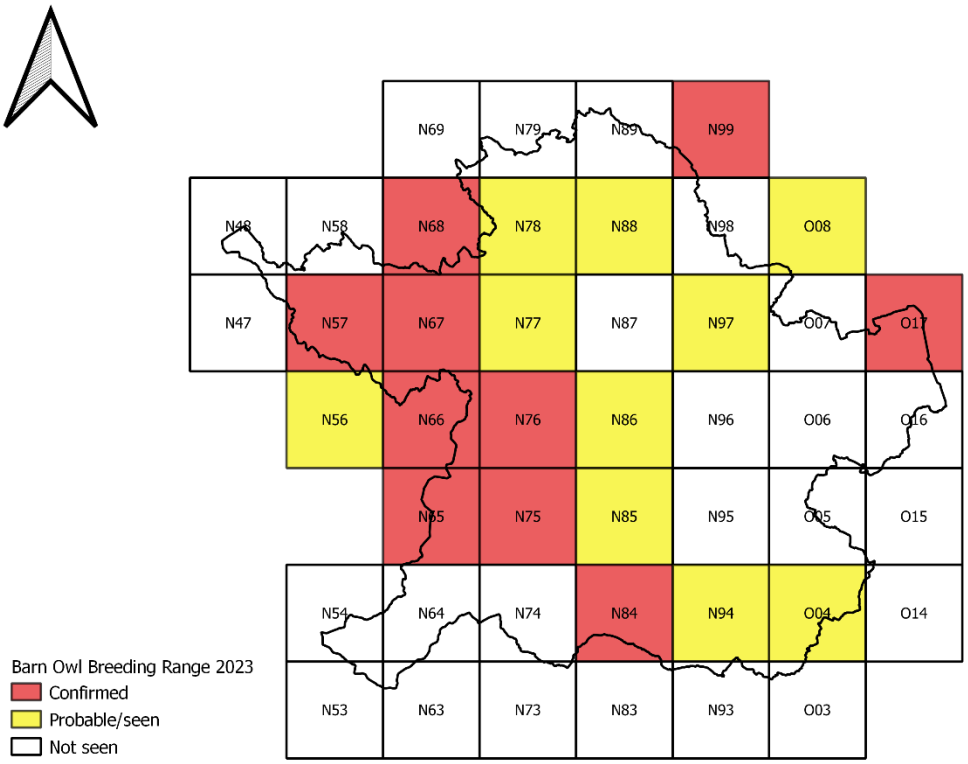

Figure 6. The breeding range of Barn Owls in County Meath according to breeding status in each 10km square in 2023.

A comparison of the current Barn Owl breeding range (Figure 7) to the breeding range as defined by the first Breeding Atlas (1968-1972) shows a long-term breeding range decline of 44% over the 50 year period. Confirmed and probable breeding was recorded in 36 10km squares during the first Breeding Atlas compared to confirmed and probable breeding in 20 10km squares during 2023.

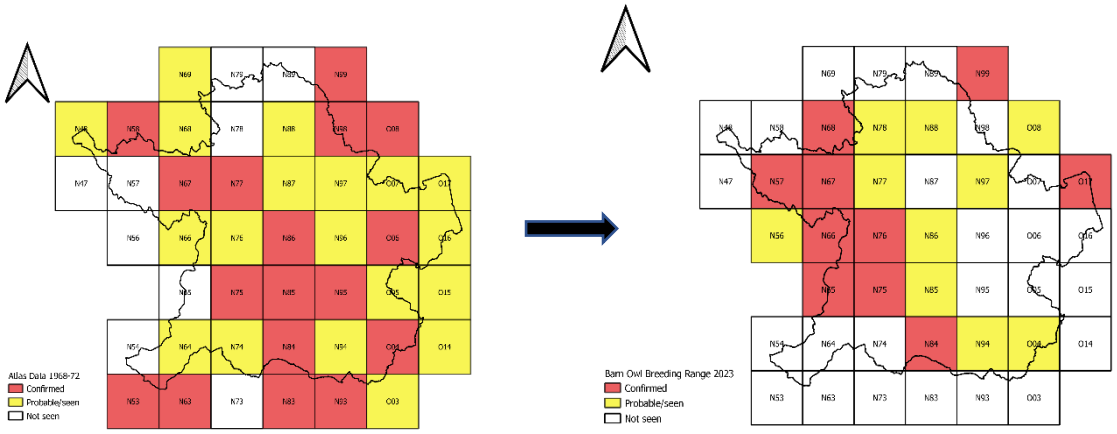

Figure 7. The breeding range of Barn Owls in County Meath recorded by the first Atlas of Breeding Birds in Britain and Ireland (1968-1972) (left) compared to the current distribution recorded by this survey (right).

A comparison of the current Barn Owl breeding range to the breeding range as defined by the New Atlas of Breeding Birds in Britain and Ireland (1988-1991) shows a medium-term breeding range increase of 82% over this thirty year period (Figure 8). Confirmed and probable breeding was recorded in 11 10km squares during the first Breeding Atlas compared to confirmed and probable breeding in 20 10km squares in 2023.

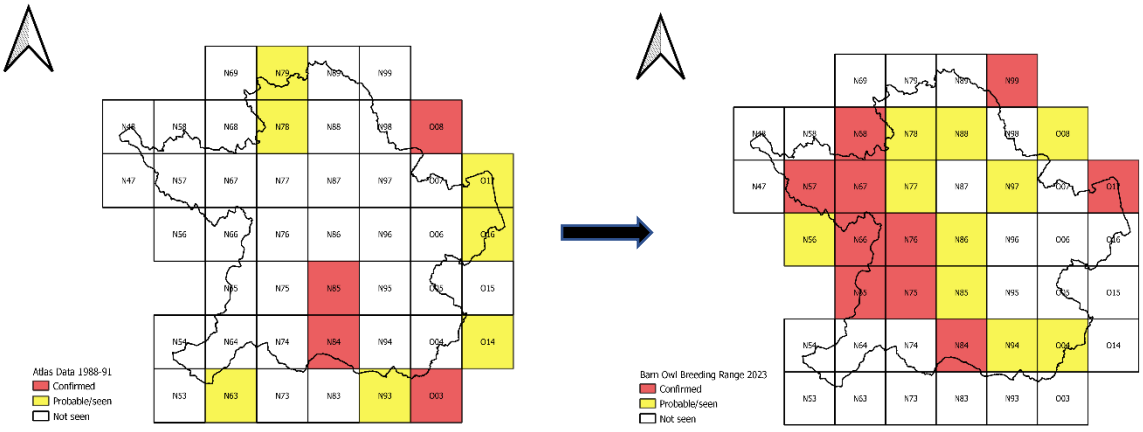

Figure 8. The breeding range of Barn Owls in County Meath recorded by the New Atlas of Breeding Birds in Britain and Ireland (1988-91) (left) showing the change in breeding range to the current distribution recorded by this study (right).

The short-term breeding range change indicates an increase in Barn Owl breeding range of 43% over the past ten years. Confirmed and probable breeding was recorded in 14 10km squares during the Breeding Bird Atlas (2007-2011) compared to 20 10km squares in 2023 (Figure 9).

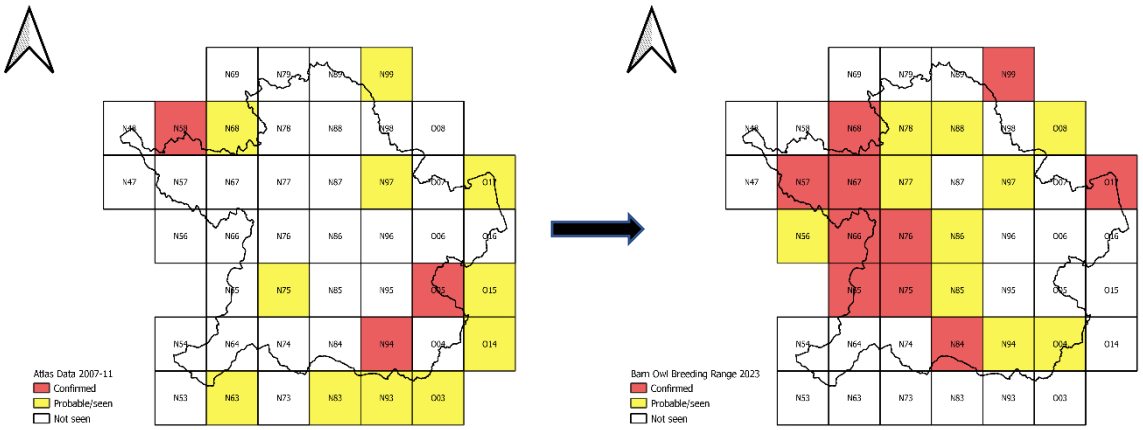

Figure 9. The breeding range of Barn Owls in County Meath recorded by Bird Atlas (2007-2011), (left) showing the change in breeding range to the current distribution recorded by this study (right).

4.2 Barn Owl occupancy

There was no evidence of breeding Barn Owl in 2023 at the only known site where Barn Owls had bred in previous years (2021 and 2022). During the 2023 survey, however, information shared on the citizen science portal confirmed that one of the confirmed breeding sites in 2023 was also used by Barn Owls during the early 1990s.

Image 2. Ruined stone structures such as this are incredibly important for a range of wildlife, and such buildings have supported Barn Owls for many decades.

4.3 Barn Owl breeding densities

A total of 66 sites were identified within the two density survey 10km squares. It was possible to survey 44 (67%) of these. Of the 44 sites surveyed, 36 (82) were deemed to be suitable or potentially suitable for Barn Owls. None of these sites were in use by Barn Owls during the 2023 breeding season, though there was evidence to suggest previous use at one of these sites, prior to the 2023 breeding season.

4.4 Barn Owl site selection

All of the nine occupied Barn Owl sites in Meath were in buildings. Three were in ruined mansions, three were in castles, two were in ruined churches and one was in a ruined mill. All site types used by Barn Owls in County Meath in 2023 are shown below in Figure 10.

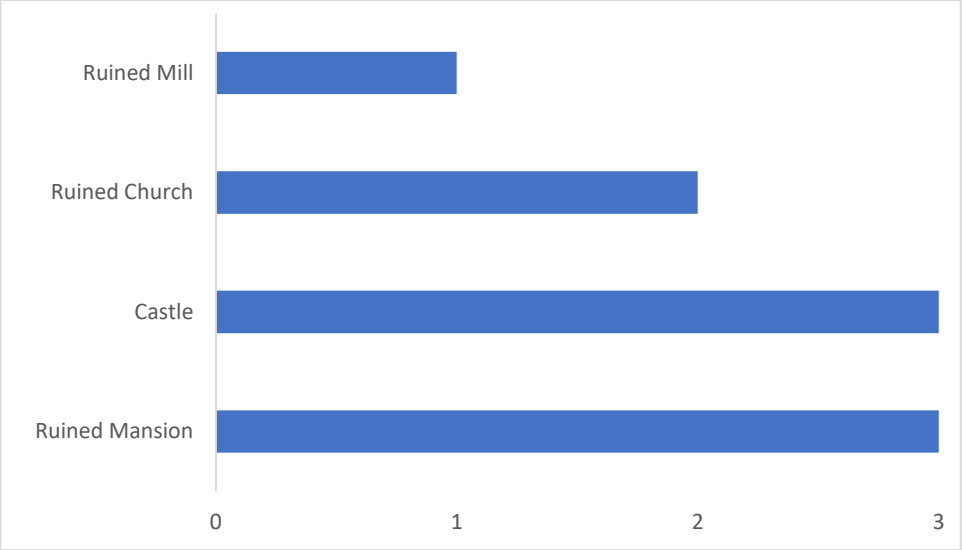

Figure 10. The range of sites used by Barn Owl in County Meath in 2023 (n = 9).

Image 3. Examples of sites which were assessed and which were deemed to be suitable for Barn Owl in County Meath.

The most common nest site used by Barn Owl was within chimneys of buildings (n = 3). There was one nest in a cavity, one in a bell tower of a church and one on an open ledge. The open ledge nest was particularly unusual as the chicks were exposed to the elements as the nest was on the top of a wall, with a light covering of ivy providing the only shelter for the chicks. The range of nest site types used by Barn Owl in County Meath in 2023 are shown below (Figure 11).

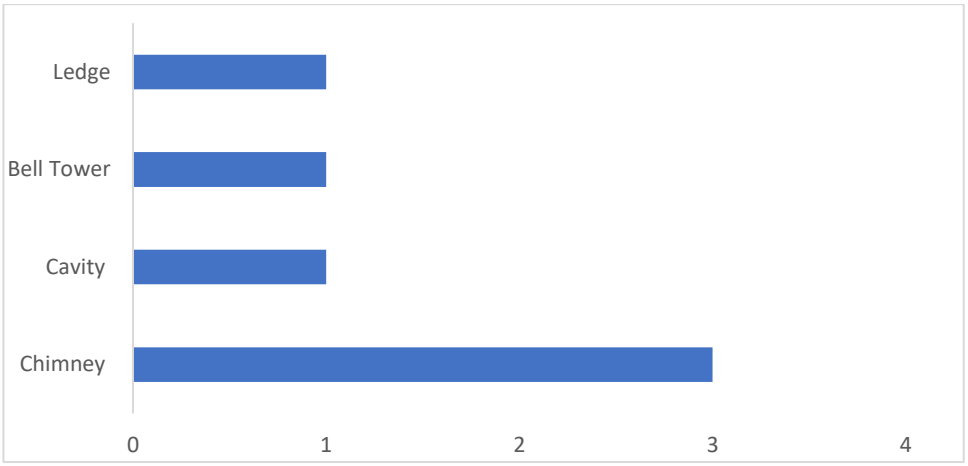

Figure 11. The range of nest site locations used by Barn Owl in County Meath in 2023.

Image 4. An example of a Barn Owl brood in a chimney nest in a castle in Meath 2023.

We assessed the suitability and presence of Barn Owl in 116 sites, which included sites reported via the citizen science survey. Of these, 84 were deemed to be suitable for breeding Barn Owl. Of these 84 sites, evidence of Barn Owl was confirmed at 9 (10.7%) sites. There were 75 sites (89%) which were suitable but where there was no evidence of use by Barn Owl.

The importance of buildings for other bird species

Of 116 sites surveyed, Tree Sparrow were found at six sites, Stock Dove at three sites, Raven at two sites, Swift at two sites, Kestrel were found at one site and Peregrine at one site.

In the single site were Kestrels nested, Barn Owls also nested. One site where Tree Sparrows were nesting also had Barn Owl nesting. Barn Owl were also present at two of the three sites where Stock Dove were recorded. There was no evidence of Barn Owl at any of the sites where Swift, Peregrine or Raven were found.

4.5 Barn Owl breeding performance

Of the nine active sites, six of these were confirmed breeding sites. Of the other three sites, one had an alarm calling male, suggesting the presence of a nest but no chicks were confirmed. One of the sites was confirmed as occupied by Barn Owls but due to access issues the breeding status of Barn Owls at the site could not be determined and the other site confirmed the presence of a single adult and was most likely a roost as there was no evidence of breeding recorded.

Broods were ringed at three of the six confirmed nests. Three of four chicks were ringed at one site (one of the chicks was too young to be fitted with a ring). Broods of five and three were ringed at two other sites. Another brood of three was observed but couldn't be ringed due to their precarious position on an exposed ledge. The last two broods were in nests that could not be accessed so the exact number of chicks in each was unknown, however there was a minimum of two chicks in each nest.

5. DISCUSSION

The survey was designed to identify Barn Owl sites to assess their distribution and abundance in County Meath, and to maximise the use of existing datasets on the species. Two different approaches were employed to identify Barn Owl sites, and the benefits of adopting these approaches is shown by the fact that Barn Owl sites were identified using each survey technique. The citizen science survey technique used through this survey was successful, with one of the six breeding sites identified through a report from a member of the public. Although the number of sites identified through reports from the public was less when compared with other county surveys, this is most likely the result of very low Barn Owl densities in County Meath. Incorporating a citizen science element facilitates increased coverage over the county in addition to providing other benefits such as increased engagement and participation in the survey and awareness of the species and its conservation requirements. Indeed, over 90 people attended a public talk at the start of the survey in May 2023. The citizen science survey technique complimented the strategic site surveying, however it would not

have been possible to rely on the citizen science survey alone. The citizen science survey also required data validation, as several reports of Barn Owl were received which related to other species. The use of a specific online survey tool improved the efficiency of reporting and receiving the information and performing validation. Based on the findings, it is recommended that citizen science techniques can form an important element of Barn Owl surveys if structured appropriately and the limitations are recognised. Citizen science surveys should include validation of information received and should be accompanied by strategic survey methods, as were employed in the current study. This survey was also designed to maximise the use of existing datasets on Barn Owl and specifically information on the species in County Meath. This approach had significant merit, and allowed trends in range to be determined through comparisons with existing datasets, namely the Bird Atlases. This shows the value of recording data in a standardised way and in making the data available for the purposes of future studies and comparisons.

The survey findings show that the Barn Owl range in County Meath has increased by 43% since the last Breeding Bird Atlas (2007-2011). Although relatively widespread, there were more breeding sites confirmed in the west and south of the county than the north and east. The reasons for the recent population increases are not yet fully understood. Other farmland bird species are continuing to decline over the same period that Barn Owl populations showed signs of recovery (Gilbert *et al.* 2021). It is unlikely that the positive population trajectory is linked to habitat changes or improvements in habitat. Although there has been an increase in awareness in relation to the use of rodenticides, it is not clear whether this has translated to a widespread reduction in its use. The provision of nest boxes has not, at least to date, had a notable impact on Barn Owls in County Meath. Perhaps the most likely explanation for the recent range increase of Barn Owls in County Meath is the spread of the invasive Greater White-toothed Shrew (GWTS), which was first discovered in Barn Owl pellets from sites in County Tipperary in 2007 (Tosh *et al*., 2008). Since that time the population of GWTS has increased rapidly and the distribution of the species has generally moved in a south-west to north-east direction across the country which correlates with the current Barn Owl range in County Meath. Evidence of GWTS was found in pellets at all confirmed breeding sites in County Meath in 2023, indicating that they are now an important prey species for Barn Owls where they occur in the county and their presence may influence the observed Barn Owl breeding range. Another invasive small mammal that has become an important food source for Barn Owl is the Bank Vole. This small mammal species was first recorded in Listowel, County Kerry in 1964 (Smal and Fairley, 1984) and has spread across most of Munster, albeit at a much slower rate than the GWTS. Bank Vole have been shown to be a very important prey item for Barn Owl where they occur, consisting of up to 80% of the diet (BirdWatch Ireland, unpublished data). They have been found as far north as County Mayo (National Biodiversity Data Centre, 2023) but have not yet been recorded in County Meath. While the Bank Vole cannot be attributed in aiding the current increase in Barn Owl numbers in County Meath, given time, trends should follow that as other counties where they occur, further bolstering the population of Barn Owl in the county. Similarly, the spread of the newly discovered Field Vole (*Microstus agrestis*) throughout the north of Ireland (Moynagh and Viscardi, 2022), a species which is an importance part of Barn Owl diet in Great Britain (Shawyer, 1998), will likely have further impacts on the Barn Owl population of County Meath.

Although there has been a short-term increase in range from 2007-2011 to 2023, there is still a long-term breeding range decline of 44% from the first Breeding Bird Atlas (1968-1971) to 2023. This is the most significant long-term decline for any county where a county-wide survey of Barn Owls has taken place since the most recent Bird Atlas. The reasons for the decline in Barn Owl numbers in County Meath are multi-faceted and have been responsible for declines experienced previously in other parts of Ireland. One of the suspected reasons for the decline is the widespread use of anticoagulant rodenticides (rat poison). These poisons are laid by landowners, farmers, business owners and homeowners as a means to control vermin, in particular rats. Rats consume this poison but aren't immediately killed, continuing to roam their habitats until they slowly die over a period of days. This makes them easy prey for Barn Owl and as a result they become casualties themselves from secondary poisoning (Lusby and O'Clery, 2014). This increased use of rodenticides coincides with the intensification of agriculture in Ireland. During the survey period it was observed that most of the agricultural practices in County Meath were a mixture of intensive tillage and beef farming with some sheep and dairy farming. This intensive farming model, implemented widely since the 1950's, also led to dramatic land use changes which often included the removal of species rich, rough grassland and wet meadows where Barn Owls traditionally hunted. This agricultural intensification was evident in County Meath and brings with it issues that need to be addressed to ensure the return of Barn Owls numbers to what they were during the first Breeding Bird Atlas.

Another factor which has potentially driven the decline in Barn Owl numbers across the county since the first Breeding Bird Atlas (1968-1972) was the construction of the major motorway and national roads network throughout the county. Along the edge of most of these major roads is high-quality, rough grassland habitat, that provides a major food source for birds of prey like Barn Owl. This, however, is a double-edged sword, as Barn Owls become victims to roadside collisions with vehicles. Barn Owls typically fly low in their hunting behaviour and as a result are easily hit by passing vehicles. One means of mitigating and reducing this risk is to allow trees to grow tall or erecting a high fencing during construction or post construction along the motorway verges. This encourages the Barn Owl to naturally fly higher which reduces their risk of being hit. County Meath has been heavily impacted by the development of major road networks in the last 50 years (Lusby *et al*., 2021a). The M1, N2, N3/M3 and M4 all run through the county. It is interesting to note that the six confirmed nests found during the course of this study were west and north-west of the N3/M3 which is the furthest major road west in the county. This could suggest that these major roadways are another factor slowing the spread and increase of Barn Owl in the east of the county.

In some counties a lack of available nest sites has been shown to be a limiting factor in the continued increase and spread of the Barn Owl range (Lusby *et al*., 2022). Barn Owl occupancy was observed at nine of the 84 suitable sites that were surveyed in County Meath. This clearly shows that a lack of available nest sites is not a limiting factor in the current and future spread of Barn Owl in County Meath (Figure 12). In addition to suitable buildings, there was a high abundance and widespread distribution of mature trees throughout County Meath. Barn Owls regularly nest in cavities in mature trees and it is important to note that the total figure of nests found during this survey is an underestimate of the actual abundance and range of Barn Owl in the county. Unless tree nests are

reported by members of the public, they are very difficult to locate. Given the time and work hours it takes to survey specifically for tree nests, it was deemed unfeasible to carry out this type of methodology in conjunction with the assessment of built structures. Going forward it may be worth carrying out a specific tree nest survey in order to broaden the knowledge of Barn Owl breeding range and abundance in County Meath.

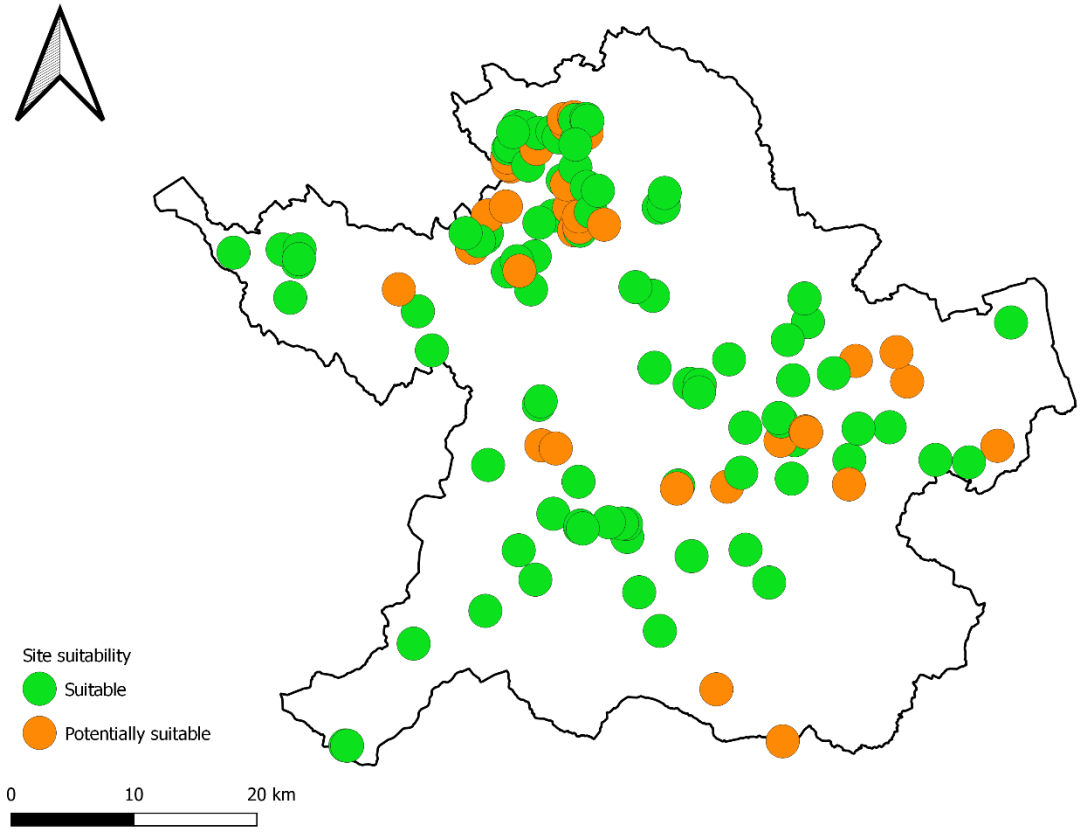

Figure 12. Distribution of suitable and potentially suitable sites for Barn Owls in County Meath in 2023.

All of the occupied Barn Owl sites were in buildings (n = 9). Ruined mansions (n = 3) and castles (n = 3) were the most important site type, followed by ruined church (n=2) and ruined mill (n=1). This shows the importance of ruined structures for Barn Owl, as demonstrated by the fact that at least one of the large, ruined structures has been used by Barn Owl extending over the last 30 years. These sites should be protected and if the suitability of these sites is compromised, then alternative sites should be provided. These sites are not only suitable for Barn Owl but also support a range of other species of conservation concern, including Kestrel, Peregrine, Raven, Tree Sparrow, Stock Dove and Swift.

In counties where a lack of available nest sites was observed to be an issue, artificial nest box schemes were put in place. This has proven to be very successful with high uptake of artificial nest boxes, particularly in counties Offaly, Clare and Cork (Lusby *et al*., 2022; McCarthy *et al*., 2022a; 2023). The Meath Birdwatch Ireland Branch established a nest box project and have erected 20 nest boxes throughout the county with the plan to expand this in the future. None of these boxes were occupied by Barn Owl in 2023, however many of these boxes have been in place for less than a year. Continued

monitoring into the future will determine their effectiveness. Although the number of available sites for Barn Owls to nest is not currently limiting the population from further expansion, it would be a proactive measure to install a limited number of Barn Owl nest boxes in the most suitable available locations in County Meath, particularly in the west of the county, in anticipation of a potential population recovery. Additionally, it would be valuable to determine whether Barn Owls would preferentially occupy nest boxes over ruined buildings.

A density assessment was carried out in two 10km squares in County Meath during this survey. Despite 44 sites being surveyed, with 36 of these being suitable or potentially suitable for Barn Owls, no active Barn Owl sites were identified. One site was identified where previous Barn Owl activity had been noted. One of the two squares, N96, had no sightings reported during the course of the 2023 breeding season, while N78 had one sighting reported in April 2023. Unfortunately, it was not possible to survey an additional 22 sites within these squares due to difficulties with obtaining landowner permission, including some cases where permission was refused. Therefore, even though no active sites were discovered, it is not possible to say with certainty that there were no active sites in these squares. However, given the low number of sightings and lack of recent activity at any of the 44 sites surveyed, it appears that Barn Owl densities in these squares are extremely low. These results are in stark contrast to areas within the stronghold of Barn Owls in Ireland, for example in Cork, up to eight breeding sites have been confirmed in a single 10km square, with several squares in Cork having four and five pairs (McCarthy *et al*., 2023). High densities have also been recorded in other counties, including Limerick and Offaly (Lusby *et al*., 2022; McCarthy *et al*., 2022b).

On the 20th of September 2023, the second Barn Owl chick ever to be ringed in County Meath was found dead on a train line along the Kildare/Dublin border, having been hit by a train. This chick was originally ringed on the 7th of July 2023 at a derelict mill and was the second oldest of 4 chicks. It had undergone a 33km dispersal before it was killed. On the 4th of November 2023, another Barn Owl that was ringed on the 7th of July 2023 as a chick, the oldest of a brood of three, at another nest site in Meath was found dead on a road near Freshford in Kilkenny having been struck by a vehicle. This chick had dispersed 107km between leaving its natal site and its death (Figure 12).

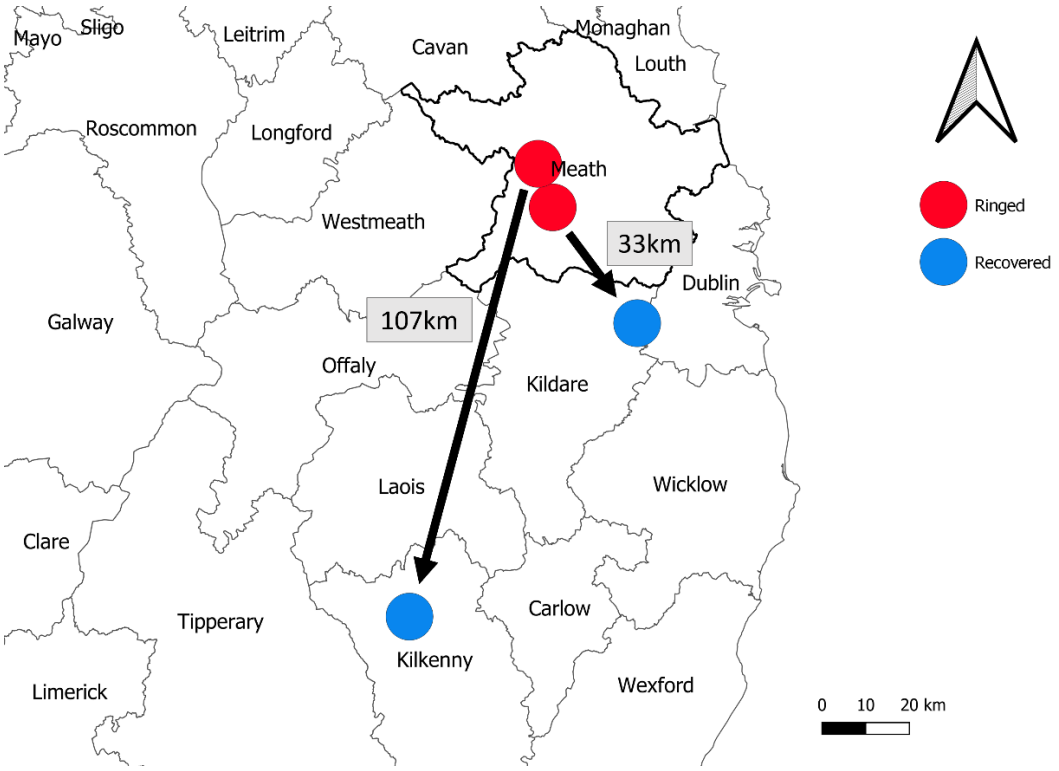

Figure 12. Location of the natal sites and recovery locations of two Barn Owls chicks ringed in Meath in 2023.

6. RECOMMENDATIONS

We showed that Barn Owls have increased in range over the last ten years in County Meath, however their range is still far below that of 50 years ago. It is important to implement measures to ensure the health of the population in the long-term and to maximise the recent increase in numbers observed in the county. We set out several recommendations to secure and improve the conservation status of Barn Owls in County Meath which are informed by the findings of this study.

- Given the increasing population trajectory in County Meath, **we recommend that Barn Owl nest boxes are installed in a small number (20 to 30) of ideal sites (e.g. derelict or disused hay barns) in the western half of the county**. This will both provide safe nesting sites and also enable conservationists to determine whether Barn Owls preferentially nest in nest boxes or ruined buildings when both are available. Sites can be identified using aerial imagery and followed up with ground-truthing site suitability and obtaining landowner permission.

- We showed the importance ruined buildings as nest and roost sites for Barn Owls in County Meath, with one of these known to be used by Barn Owls across a period of 30 years. Due to the importance of built heritage structures and other large, ruined structures for Barn Owl, and the identified limited availability of nest sites, **it is important that existing and traditional nest sites are appropriately protected, to ensure they remain suitable**. If known and traditional sites may be affected by disturbances or if the suitability of the site is compromised, then artificial nest boxes should be provided in the immediate area to provide alternative nest sites.

- This study showed the benefits of collecting data on Barn Owl populations over time, and **we recommend that monitoring of selected sites is continued on an annual basis, in order to track future changes in local Barn Owl populations, as well as assessing the effectiveness of conservation measures applied and informing direct and site-specific conservation requirements.**

- Conservation measures for Barn Owls are most effective when they are targeted to the areas where they are required and to address the issues which affect local populations. The data generated through this study can be used to direct such conservation efforts and **we propose that the data gathered during this survey is used to develop a landscape suitability map for Barn Owls in County Meath to identify the areas which are suitable for the species and where conservation measures should be focused.**

- **Conservation measures should be implemented through the agri-environment scheme and focus on improving the quantity and quality of habitats for Barn Owl** (which would have benefits for a wide range of biodiversity) **and reducing pesticide input, including the implementation of Integrated Pest Management to rodent control**.

- **Research on the response of Barn Owls to habitat provision and improvement measures (such as Wild Bird Cover) is important, as is developing a better understanding of the risks and impacts to the species associated with the use of rodenticides**.

- During this survey, it became apparent that there was a high availability of potential natural tree nests for Barn Owls in parts of County Meath, however this survey was not designed to focus on identifying tree nests. Therefore, **we suggest a small scale tree nesting Barn Owl survey is conducted within defined areas (e.g. on a 1km or 2km square scale) in County Meath in order to determine the prevalence of tree nesting Barn Owls in the county.**

- New major road developments in County Meath will be subject to Barn Owl mitigation measures to reduce road collision risk, as set out by TII (2021). However, there is currently no mechanism through which existing roads can be retrofitted with mitigation measures to reduce Barn Owl collision risk. Therefore, **we propose trialling of mitigation measures on existing roads**, particularly in collision hotspot areas, in order to determine their effectiveness at reducing collision risk on existing roads.

- **An Integrated Pest Management approach for rodent control should be publicised and promoted** in order to reduce the use of rodenticides in various industries and settings in County Meath, including (but not limited to) in agriculture, private dwellings, on council properties etc.

How is this information used to inform practical conservation for Barn Owls

At the core of the Barn Owl survey is generating information to inform policy and practical conservation initiatives to benefit the species. At a basic level, identifying breeding sites allows us to ensure that these sites are protected and to make improvements to nest sites as required. The information is used to inform the requirement for and delivery of conservation measures, including providing nest boxes where they are most required and the targeting of agri-environment measures to benefit Barn Owls. Specifically, the information generated through this survey is used as follows:

- Information on Barn Owl sites is provided to Meath County Council and NPWS to help ensure that important breeding sites are protected (e.g. renovations, developments etc.)
- Information on the condition of breeding sites is used to inform maintenance or improvements to ensure that existing sites remain suitable
- Information collected on Barn Owl sites and nest site availability is used to inform the provision of nest boxes
- Information on Barn Owl nest sites is used in the farmland bird hotspot mapping to identify priority areas for conservation actions
- Information on Barn Owl nest sites is used to inform the targeting of species-specific agri-environment measures to benefit Barn Owls

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