McCarthy, A., Ó Teangana, D., Nagle, T., Bayley, S., Heardman, C., Rees, D., Deasy, C., Riordan, N., McDonnell, B. & Lusby, J. (2023). Barn Owl population status and trends in County Cork in 2023. BirdWatch Ireland.

Comhairle Contae Chorcaí
Cork County Council

BirdWatchIreland
birdwatchireland.ie
protecting birds and biodiversity

NPWS
An tSeirbhís Páirceanna Náisiúnta agus Fiadhúlra
National Parks and Wildlife Service

Barn Owl population status and trends in County Cork

Prepared by BirdWatch Ireland for Cork County Council

October 2023

Citation: McCarthy, A., Ó Teangana, D., Nagle, T., Bayley, S., Heardman, C., Rees, D., Deasy, C., Riordan, N., McDonnell, B. & Lusby, J. (2023). *Barn Owl population status and trends in County Cork.* BirdWatch Ireland.

Funding: The Barn Owl survey in County Cork was coordinated by BirdWatch Ireland and funded by Cork County Council, supported by the National Parks and Wildlife Service under the National Biodiversity Action Plan (2017-2021).

Acknowledgements:

The authors wish to thank Sharon Casey, Ecologist with Cork County Council, for her support of this project and her guidance throughout. We would also like to thank Conor Nelligan, Heritage Officer with Cork County Council, for his continued support of nest box initiatives in the county. We are grateful to the National Parks and Wildlife Service for assisting with all aspects of the Barn Owl survey, in particular Cyril Saich, Jay Cornish and Paddy Graham. Special mention goes to Tim Crowley, Damian O'Leary and Brendan Duggan for their work installing nest boxes in their local areas. We wish to extend our gratitude to all the landowners who allowed access to their lands for the purpose of the Barn Owl survey and monitoring and to recognise and thank everyone who took the time to report information on Barn Owls in the county, which provided valuable information. Thanks also to the Cork and West Cork Branches of BirdWatch Ireland for supporting the survey and for their outstanding efforts towards Barn Owl conservation in the county. Thanks to David Cooke, Pat Smiddy, Jack Glennon, James O'Neill, Róisín Towe, Domhnall Finch, Paul Moore, Mark Shorten, Allan Farrell and Donal Sheehan for their monitoring efforts for this survey. Sincere thanks to Tom Mulcahy for providing additional assistance with the survey. We are very grateful for the assistance provided by Rosie and Denis from Animal Magic for caring for rescued Barn Owls found in Cork during the summer of 2023. Many thanks to Gail Tangney for creating a video about the East Cork Barn Owl nest box project for us. Thanks to the National Parks and Wildlife Service for providing funding through the Small Recorders Grant for a thermal imager used for site monitoring during this survey. Finally, we would like to thank BirdWatch Ireland staff and colleagues for their ongoing assistance and support, in particular Niall Hatch and Brian Caffrey and the administration team of Annette Lambkin, Valerie Lowth, Fergus Conway, Louise Barry and Eddie Hellewell.

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.

All other images used throughout are by the authors unless otherwise stated and taken under licence from the National Parks and Wildlife Service where relevant.

Address for correspondence: BirdWatch Ireland, Unit 20, Kilcoole, County Wicklow

Corresponding author: John Lusby, email: jlusby@birdwatchireland.ie

CONTENTS

SUMMARY

This study shows that the Barn Owl population of County Cork is at its greatest recorded extent for the past 50 years. The recorded confirmed breeding range of Barn Owls in County Cork has increased by 480% since the population reached its lowest recorded extent in the 1980s. We demonstrated that many of the traditional Barn Owl nest sites in Cork have remained suitable for Barn Owls over the last 28 to 32 years, and many of these were active in 2023.

Despite the recent significant increase in Barn Owl numbers and range, nest site availability is not yet severely limited, in most part thanks to the provision of nest boxes throughout the county, mainly as a result of Cork County Council funded nest box projects. The success and benefits of nest boxes as a conservation measure is shown by the fact that nest boxes were the most common nest site type in Cork in 2023.

We also showed the importance of ruined structures for Barn Owl, with several used by Barn Owls over a period of 28 to 32 years. Many sites were active in 2023 after years of not having any signs of Barn Owl occupancy, further suggesting an increase in Barn Owl numbers in the county. Ruined stone structures were also used by a range of other species including Kestrel, Peregrine, Raven, Chough, Swift and Stock Dove. 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.

Fifty-seven Barn Owl broods totalling 180 chicks and three adult females were ringed in County Cork in 2023, the most ever to be ringed in any county in a single year in Ireland. Of 114 breeding pairs recorded, 105 pairs successfully fledged chicks while five breeding attempts failed and the outcome of four nests was unknown. This is the highest number of breeding pairs ever recorded in any county in Ireland in a single breeding season.

SUMMARY HIGHLIGHTS

- The Barn Owl population of County Cork is faring well, with the population at its most extensive recorded level over the past 50 years.

- Barn Owls have a widespread distribution throughout County Cork and **were present in 68 (63%) of the 108 10km squares in the county**. Confirmed breeding was recorded in 58 (54%) of the 108 10km squares and probable breeding in ten 10km squares.

- The **confirmed breeding range of Barn Owl in County Cork has increased by 132% over the past ten years**, **and 480% over the past 30 years** when compared to the confirmed breeding range as defined by the Bird Atlas (2007-2011) and New Atlas of Breeding Birds in Britain and Ireland (1988-1991), respectively (Gibbons *et al*. 1993; Balmer *et al*. 2013).

- In 2023, **143 sites were confirmed to be occupied by Barn Owl in County Cork.** This is the highest number of occupied sites documented in any one year for any county in Ireland over the last 50 years.

- There were **114 confirmed breeding sites in Cork in 2023,** with **105 (92%) of these resulting in successful breeding**.

- There has been a high rate of occupancy of traditional breeding sites for Barn Owl in County Cork over the last 28 to 32 years. Of **24 sites known to have been occupied by Barn Owls in the early to mid-1990s, all were still suitable with 16 of these (67%) being occupied by Barn Owl in 2023**. Of **35 sites occupied by Barn Owls between 2006 and 2010, 34 were suitable for Barn Owls in 2023 with 19 (56%) occupied**. This shows the importance of individual sites for Barn Owls and the necessity to protect these sites to ensure they continue to remain suitable.

- The **majority of the 143 occupied Barn Owl sites were in buildings (n = 114)**, with 15 tree nest boxes, 11 natural tree cavities and one quarry also used. **Farm buildings (n = 39) were the most common site type** used, followed by **castles (n = 20), derelict farm houses (n = 19), derelict cottages (n = 13) and ruined mansions (n = 11)**.

- The **most common nest site used by Barn Owl was nest boxes (n = 46), followed by chimneys (n = 26), roof spaces (n = 12) and tree cavities (n = 11).**

- A total of **207 nest boxes were monitored** during this survey. **Barn Owls were using 54 of these boxes. Of the 163 nest boxes in buildings, 39 (24%) were used by Barn Owls**, while of **43 tree nest boxes, 15 (35%) were used.** There was one pole-mounted nest box which was not used.

- Of **383 sites surveyed**, **354 (92%) were deemed suitable or potentially suitable** for nesting by Barn Owls. Of these, 141 (40%) were in use by Barn Owls, meaning **213 sites (60%) were potentially available for nesting by Barn Owls.** A total of **155 sites were suitable for nesting and not already in use by Barn Owls,** i.e., certainly available for nesting Barn Owls.

- Of **151 ruined buildings surveyed, 140 sites (93%) were suitable or potentially suitable for nesting**. Eighty (53%) of these buildings were known to be previously occupied by Barn Owls. Of

the **140 suitable or potentially sites, 74 (53%) were in use by Barn Owls**, meaning that 47% of buildings surveyed were potentially suitable and available for additional Barn Owl pairs to use. In addition to these sites, there are some **140 nest box sites that are suitable but unoccupied and available** for Barn Owls to use.

- The importance of nest boxes for Barn Owls in County Cork is demonstrated by the fact that **nest boxes were the most common nest site type recorded in the county in 2023, with 46 of 114 (40%) nests in nest boxes**.

- Ruined buildings were important for a range of other breeding birds in County Cork as well as Barn Owl, which was shown by the fact that **Kestrel were confirmed to be present in seven sites, Raven in six sites, Chough in four sites, Peregrine in three sites, and Swift and Stock Dove each in two sites. In addition, Kestrels nested in Barn Owl tree boxes at two sites, while Peregrine were present at a quarry (where Barn Owls also nested).**

- Barn Owls had a high breeding success rate in County Cork in 2023. **Of 114 breeding attempts monitored, 105 pairs (92%) were successful, five pairs failed (4%) and the outcome of breeding for four pairs (4%) was unknown.**

- Barn Owl young were **ringed at 57 nest sites** in County Cork in 2023. **The fledging success at these 57 successful sites was 3.2 young per successful breeding attempt.**

Image 1. A Barn Owl chick, one of a brood of five in a tree nest box in County Cork, fitted with a ring in June 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 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 populations are declining (BirdLife International, 2021). This has also been 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 shown 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 Cork

County Cork is the most well studied county for Barn Owls in Ireland. Information on Barn Owls in the county is available through a range of sources (including species-specific monitoring and surveys of their populations and multi-species surveys) 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 widely, though sparsely distributed throughout County Cork, with confirmed breeding recorded in 13 of 108 (12%) 10km squares in County Cork, with their presence (confirmed breeding, probable breeding and birds seen) recorded in 31 10km squares (29%) (Sharrock, 1976). Barn Owl populations declined throughout the country from the 1960s, and this was the case in County Cork, with a significant decline in their 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 17 (16%) 10km squares (Gibbons *et al.* 1993), which represents a range decline of 45% over the twenty-year period since the first Atlas of Breeding Birds in Britain and Ireland (1968-1972). An increase in their range was recorded by the Bird Atlas (2007-2011), with confirmed or probable breeding recorded in 52 10km squares (206% increase from 1988-1991; Balmer *et al.* 2013), therefore suggesting that the population at this time was at a greater extent than 40 years prior during the first Bird Atlas of Breeding Birds in Britain and Ireland (1968-1972). However, increased survey effort for Barn Owls in the most recent Breeding Bird Atlas may exaggerate the apparent increase in breeding range. Site specific and local monitoring of the Barn Owl population in Cork between 1991 and 2004 appeared to show similar, but more detailed trends to that shown by the Bird Atlases (Nagle, 2004). Nagle (2004) notes there was a notable decline in the population between the early 1980s and early 1990s, with a population estimate of 60 to 90 pairs in the county by the early 1990s. This decline appeared to continue into the early 2000s, with a population estimate of 40 to 60 pairs by 2004. These results may point towards under-recording of the Barn Owl population in Cork during both the first and second Bird Atlases, and suggests the decline in the population continued well beyond the period covered by the New Atlas of Breeding Birds in Britain and Ireland (1988 – 1991) (Gibbons *et al.* 1993). The National Biodiversity Data Centre shows that Barn Owls have been recorded in 83 (77%) 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).

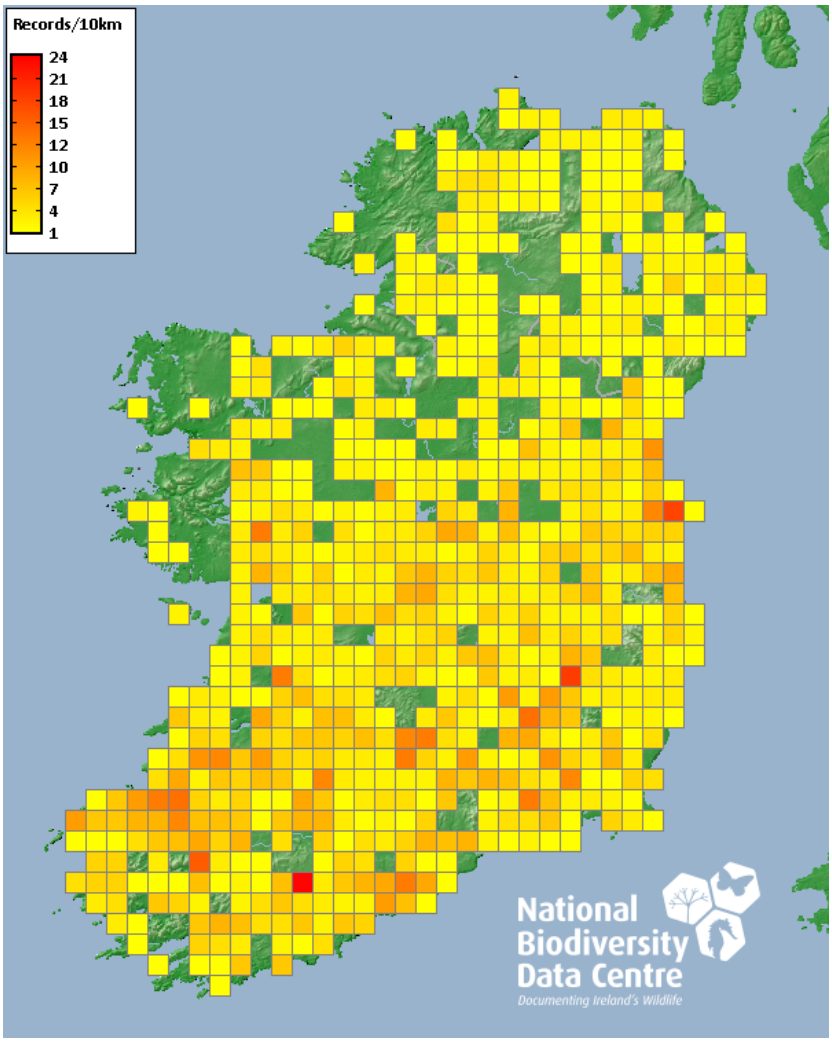

Figure 1. The distribution of Barn Owls in Ireland based on a range of sources including sightings reported to the National Biodiversity Data Centre, which shows a widespread distribution throughout County Cork during the breeding and non-breeding season. National Biodiversity Data Centre, Ireland, Barn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

The first site specific monitoring efforts for which data is available began in 1991 by Nagle and Cooke (Cooke *et al*, 1996; Nagle, 2004). Through this surveying, 33 active Barn Owl sites, including 26 confirmed breeding sites, were identified between 1991 and 1995, all of which were in buildings, and mostly ruined mansions. These 33 Barn Owl sites were revisited during 2003 and 2004, with activity confirmed at 17 (52%) of these sites, and breeding at 12 sites, thereby representing a decline of 54% in the number of known breeding sites over this eight-year period (from 26 to 12 sites). The most significant observed decline occurred in North Cork, with a reduction from eight to one known breeding site in this area during this time. In 2006, monitoring of traditional nest sites began on an annual basis which provided information on occupancy and breeding performance (Lusby *et al.* 2021b). A county-wide survey supported by Cork County Council took place in 2009 and 2010 (Lusby *et al*. 2010). This survey revealed 27 active sites in 2009, and 24 in 2010. Of the 27 sites that were active in 2009, only 18 of these were active the following year. It was also noted during this survey that 47 traditional nest and roost sites had been abandoned over the 20 years that preceded the survey, with 20 of the sites becoming unsuitable for Barn Owls, mostly as a result

of renovation. Smaller scale local surveys also took place, particularly in the Duhallow region of north-west Cork in 2012 and 2013, supported by IRD Duhallow through the LEADER Programme 2007-2013 (O'Clery *et al*. 2013). Between the start of annual monitoring in 2006 and 2022, 154 active Barn Owl sites were monitored in County Cork.

The monitoring of breeding pairs in County Cork has provided information on the occupancy and breeding performance of individual sites as well as local breeding densities. However, it is timely to assess the health of the population more thoroughly, as there has been many changes since the last county-wide assessment in 2007-2011, including the arrival and spread of the Greater White-toothed Shrew throughout the county, increased focus on the provision of nest boxes and changes in fortunes for Barn Owl populations recorded elsewhere in their range. 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 Cork, 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 Cork, 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 Cork
- Determine the breeding range of Barn Owls in County Cork and changes in breeding range over time
- Determine nest site selection and the availability of nest sites for Barn Owls in County Cork
- Determine the occupancy rate of Barn Owl nest boxes installed in County Cork
- Identify the effectiveness of existing conservation measures and make recommendations for future conservation actions 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 Cork. 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 Cork) 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. Three approaches were employed to obtain information on Barn Owls throughout County Cork 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 three approaches, as defined below, included assessing occupancy at all sites where the presence of Barn Owl has been determined through previous surveys over the past 32 years, 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 and breeding performance of Barn Owls.

2.1 Survey area

The Barn Owl survey was undertaken throughout County Cork. 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 Cork (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.

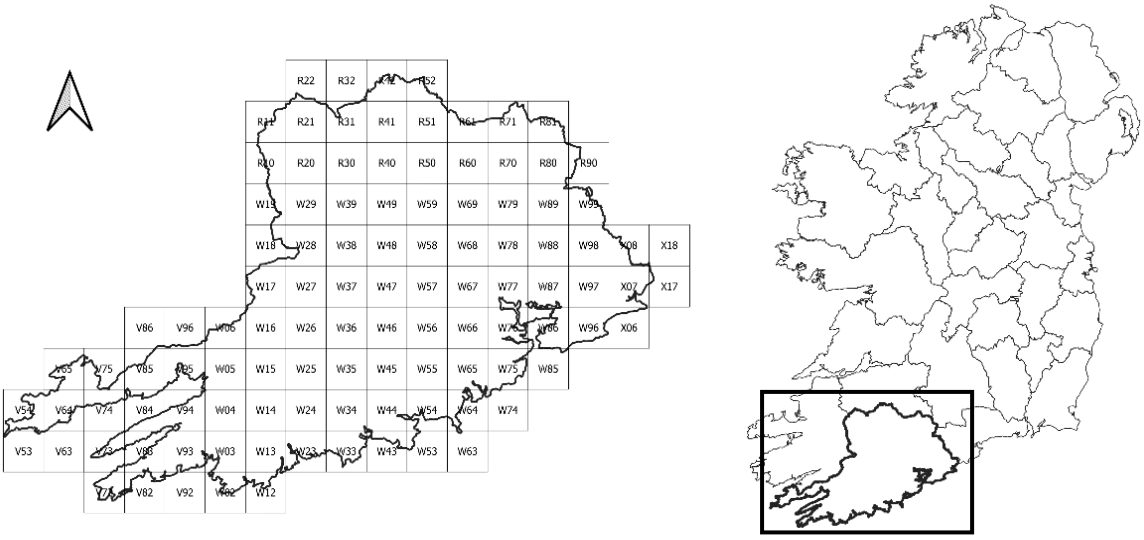

Figure 2. The Barn Owl survey area which included all 10km squares throughout County Cork.

3. METHODS

3.1 Barn Owl survey

We employed three 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 at traditional sites

We collated information on sites which have been occupied by Barn Owl over the past 32 years in County Cork. Sites were selected where the presence of Barn Owl was confirmed in any single year over this period (1991 – 2022) from a range of sources including a national survey of Barn Owls in the mid-1990s (BirdWatch Ireland, unpublished; Cooke *et al*. 1996; Nagle, 2004), a survey of Barn Owls in County Cork in 2009 and 2010 (Lusby *et al.* 2010), survey and monitoring of Barn Owls in Duhallow (north Cork) in 2012 and 2013 (O'Clery *et al.* 2013) and monitoring of Barn Owls in the county over the past 17 years (Lusby *et al.* 2021b). The details of all sites including their location, history of occupancy and the source the information was collated in a single database. All sites were mapped in QGIS 3.12.3 and were prioritised for survey assessments to determine the suitability for and occupancy of Barn Owls. Assessing occupancy of these sites provides information on their use over time and facilitates assessment of occupancy trends. The suitability of these sites for Barn Owls was also assessed and evidence of other birds using these sites (including Kestrel *Falco tinnunculus*, Peregrine *Falco peregrinus*, Raven *Corvus corax*, Swift *Apus apus*, Stock Dove *Columba oenas* and Chough *Pyrrhocorax pyrrhocorax*) was recorded including breeding evidence.

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). There are several ruined built heritage structures which have been used by Barn Owl for more than 28 years. In 2020, 39.6% of breeding Barn Owl pairs were recorded as nesting in ruined stone structures (including castles, ruined mansions, churches and workhouses). We identified a range of built structures in County Cork which provide potential nesting opportunities for Barn Owl, using a range of resources (information on built heritage sites online and Ordnance Survey maps). In addition, we collated information on sites which were previously assessed for Barn Owl over the past 15 years and which were deemed to be suitable for breeding Barn Owl but where there was no evidence of occupancy previously confirmed. All sites were mapped in QGIS 3.12.3 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 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 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 and/or by the relevant landowners. Citizen science (i.e., 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 Cork, we used an online reporting tool where information could be reported, validated and responded to efficiently. We requested information on Barn Owls (including potential nest sites and sightings) in County Cork through articles in the local press, radio, social media and email circulars. All information received was validated and mapped using QGIS 3.12.3. All reliable reports of potential breeding sites were investigated to confirm the presence and breeding status of Barn Owl where this was possible and using the survey techniques described below. This survey approach provided information on the distribution of the population and provided specific information on nest site selection and breeding performance of Barn Owls.

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 for evidence to indicate the presence of Barn Owl following 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 an 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 did 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 could 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 and 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 was 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 confirmed that there were no nesting opportunities available.

Sites were classed as **'potentially suitable'** if the day-time inspection recorded 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 was recorded as **'previously occupied'** if signs to indicate the presence of Barn Owls were confirmed, however no indication of recent use was 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 was recorded as **'active'** if Barn Owl activity was confirmed via evidence of fresh signs or confirmation of one or both adults via observation or vocalisation, but there was 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 were observed or heard.

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

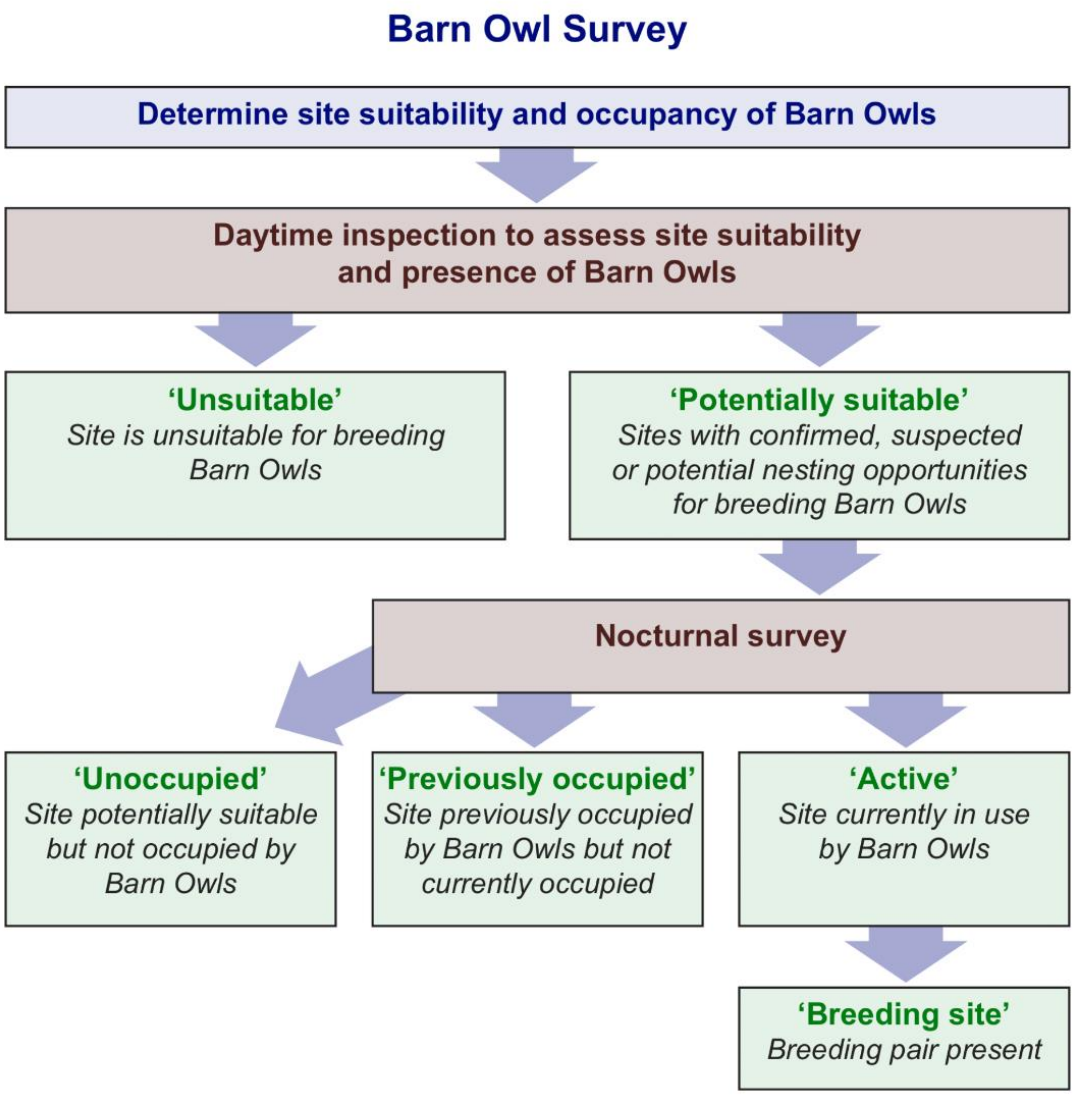

Figure 3. The steps of the Barn Owl survey to determine the suitability and occupancy of sites assessed.

3.3 Barn Owl breeding range

To define the breeding range of Barn Owls in County Cork, 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 3.12.3 to visually explore the data. Each 10km x 10km square in County Cork 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 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 Cork 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 Cork with the range defined by the New Atlas of Breeding Birds in Britain and Ireland (1988-1991) (Gibbons *et al.* 1993). This provided an assessment of the change in breeding range of Barn Owl in County Cork over the last thirty years. To determine the short-term breeding range change we compared the current range of Barn Owls in County Cork 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 Cork over the last ten years.

3.4 Barn Owl occupancy

To assess Barn Owl occupancy trends in County Cork, we determined the presence of Barn Owls at selected sites for which there is information available on the presence and use of the site by Barn Owls over the past 32 years (1995 – 2022). To assess long-term occupancy trends, we assessed the suitability of and presence of Barn Owls at sites which were known to be occupied by Barn Owl 32 years ago (during 1991 - 1997). This provided information on the suitability and occupancy of traditional breeding sites in County Cork over the last 32 years. To assess short-term occupancy trends, we assessed the suitability of and presence of Barn Owls at sites which were known to be occupied by Barn Owl during the period 2006-2010. This provided information on the suitability and occupancy of traditional breeding sites in County Cork over the last ten-to-fifteen-year period.

3.5 Barn Owl 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	Hollow cavity (tree)
	Nest box on tree	Alcove
	Nest box on pole	Water tank
	Occupied house	
	Other building	
	Quarry	

To assess the availability of nest sites for Barn Owls in County Cork, 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 3.12.3 to visually assess the spatial distribution of occupied and suitable but unoccupied sites in the county.

3.6 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 was considered or confirmed to result in one or more young fledging (based on recorded young at or close to 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.

3.7 Barn Owl nest box occupancy

All Barn Owl nest boxes installed in County Cork prior to February 2023 were identified and surveyed where possible. Many of these nest boxes were made courtesy of funding from Cork County Council and installed by volunteers. Other nest boxes included those installed by BirdWatch Ireland and IRD Duhallow and some installed privately by landowners. The survey techniques described above for assessing site occupancy were used for nest boxes, however in some cases, even if no signs (pellets, whitewash, moulted feathers) are not found under nest boxes, the site may still be occupied. This is particularly the case for Barn Owl nest boxes on trees. In such cases, nocturnal visits were carried out to determine the occupancy status of the nest box, or nest visits were carried out by licenced and experienced bird ringers.

4. RESULTS

4.1 Barn Owl survey

We surveyed 383 sites and confirmed 143 occupied Barn Owl sites in County Cork in 2023, of which 114 were confirmed breeding sites. Of the 143 occupied sites, it was not possible to determine whether or not breeding occurred at 13 sites. Eighty-nine (62%) of the occupied sites were traditional Barn Owl sites which were known to be previously used by Barn Owl during the last 32 years. Fifty-four sites (38%) were confirmed for the first time in 2023. Twenty-two of these sites were reported through the citizen science survey by members of the public and 32 sites were confirmed via strategic survey efforts which involved checking suitable built structures in the county. One-hundred and ninety-six sites that were deemed suitable or potentially suitable for Barn Owls were surveyed where no signs of use by Barn Owls were found. The majority of these sites (139) were nest boxes, most of which have been installed only within the last 2 or 3 years. We were unable to effectively determine Barn Owl occupancy status at nine sites due to difficulties with access and the possibility that young birds may have already dispersed and breeding completed by the time of our survey visits as it was an earlier than average breeding season for Barn Owls. We received 41 reports (sightings) of Barn Owl during the breeding season in County Cork. The distribution and abundance of Barn Owl nest sites according to the 10km square grid in County Cork is shown below (Figure 4), along with the approximate locations of nest sites and active non-breeding sites (Figure 5).

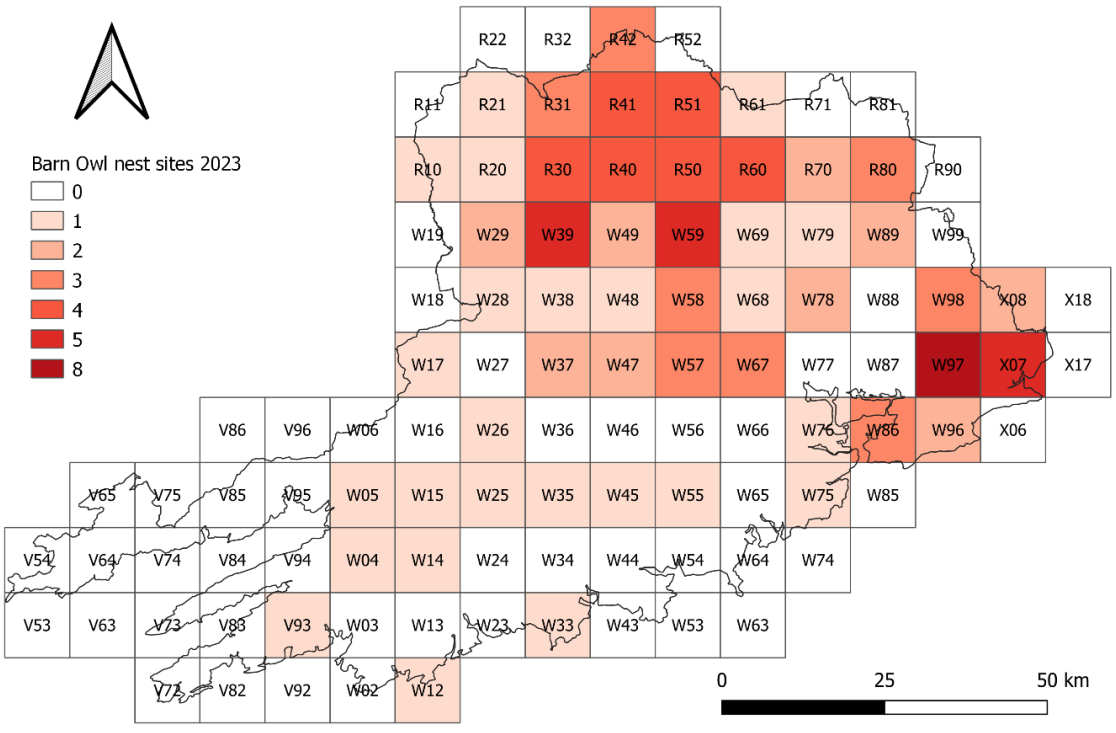

Figure 4. The distribution and abundance of Barn Owl nest sites (n = 114) in County Cork per 10km square in 2023.

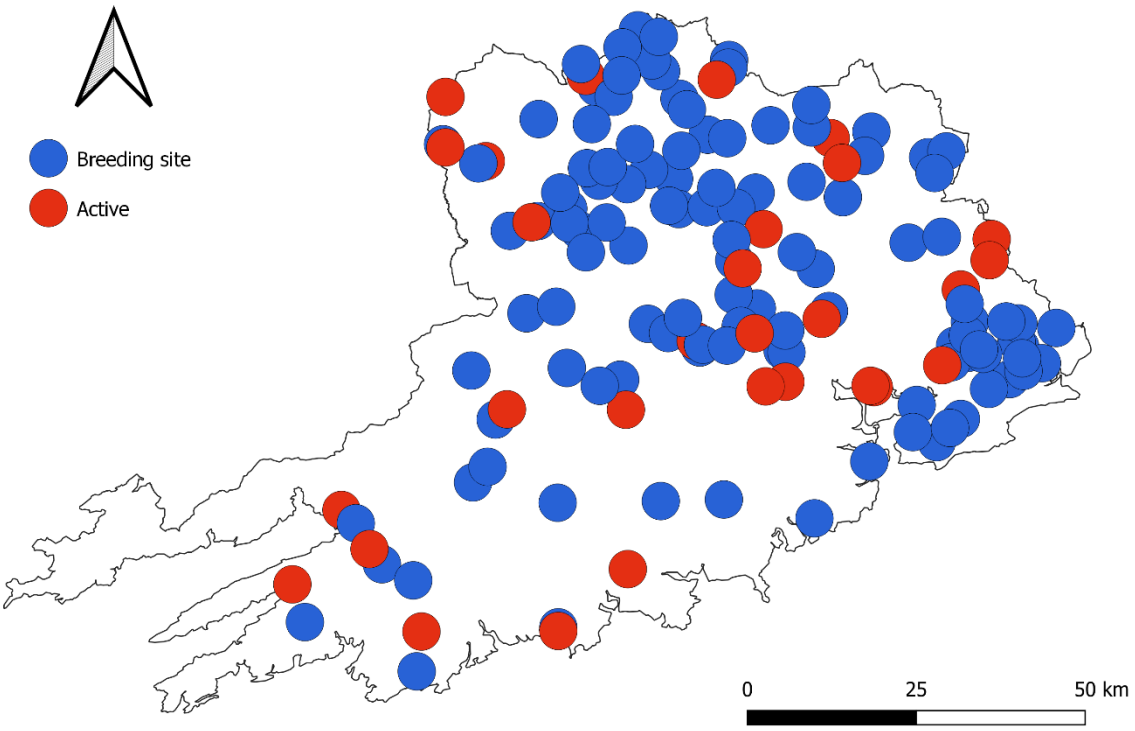

Figure 5. The distribution of Barn Owl breeding sites and active sites where breeding did not occur/was not confirmed (n = 143) in County Cork in 2023.

4.2 Barn Owl breeding range

Barn Owls were recorded in 68 (63%) of the 108 10km squares in or including the border of County Cork during the 2023 breeding season. Confirmed breeding was recorded in 58 10km squares (54% of 10km squares in County Cork). The distribution of Barn Owls in County Cork according to breeding status in each 10km square is shown below (Figure 6).

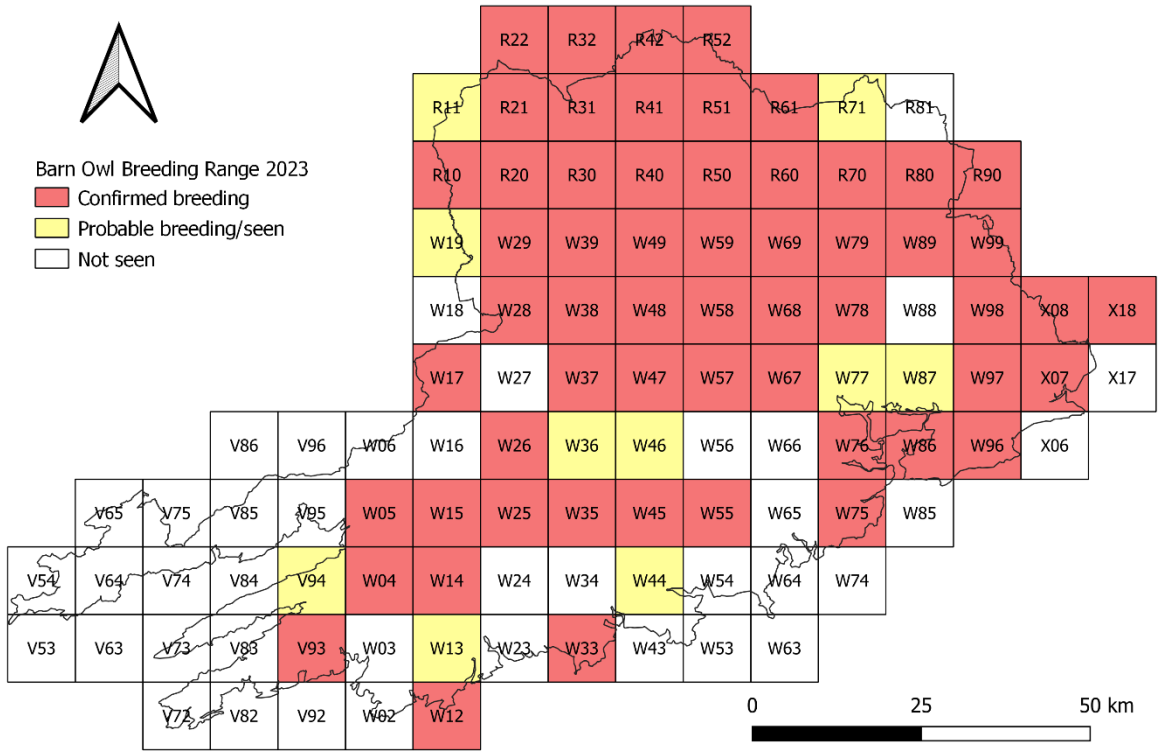

Figure 6. The breeding range of Barn Owls in County Cork according to breeding status in each 10km square in 2023.

A comparison of the current confirmed Barn Owl breeding range to the breeding range as defined by the first Breeding Atlas (1968-1972) shows a long-term increase in breeding range of 346% over the 50-year period (Figure 7; Sharrock, 1976). Confirmed breeding was recorded in 13 10km squares during the first Breeding Atlas compared to confirmed breeding in 58 10km squares during 2023.

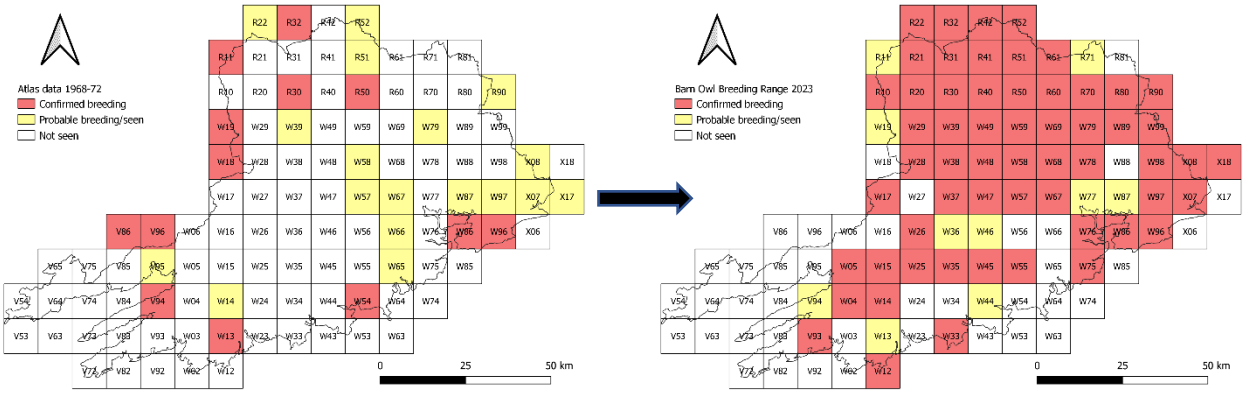

Figure 7. The breeding range of Barn Owls in County Cork recorded by the first Atlas of Breeding Birds in Britain and Ireland (1968-1972) (left) compared to the current distribution recorded by this survey (right)

A comparison of the current confirmed Barn Owl breeding range to that as defined by the New Atlas of Breeding Birds in Britain and Ireland (1988-1991) shows an increase of 480% over this thirty-year period (Figure 8; Gibbons *et al*. 1993). Confirmed breeding was recorded in ten 10km squares during the New Atlas of Breeding Birds in Britain and Ireland (1988-1991) compared to confirmed breeding in 58 10km squares in 2023.

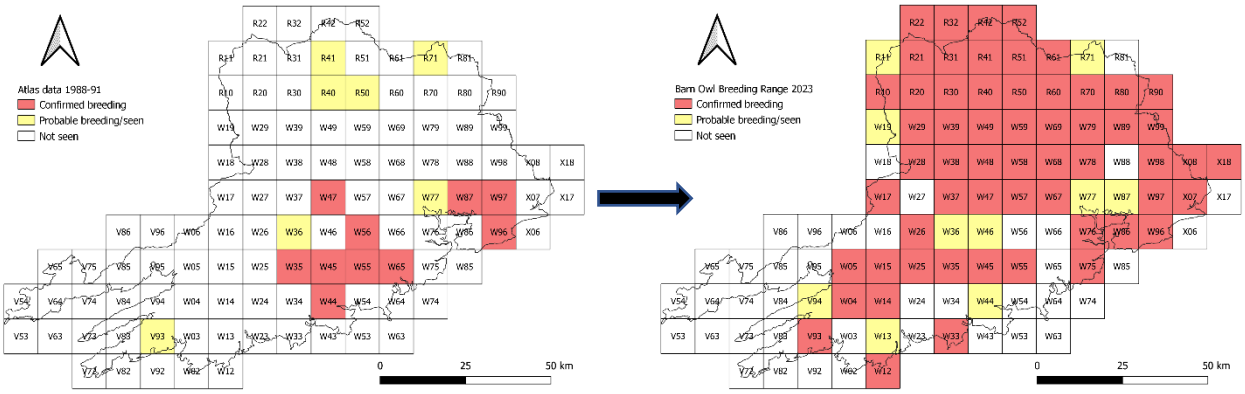

Figure 8. The breeding range of Barn Owls in County Cork recorded by the New Atlas of Breeding Birds in Britain and Ireland (1988-91) (left) showing the change in breeding range to the current distribution recorded by this study (right)

The short-term confirmed breeding range change indicates an increase in confirmed Barn Owl breeding range of 132% over the past ten years. Confirmed breeding was recorded in 25 10km squares during the Bird Atlas (2007-2011) compared to 58 10km squares in 2023 (Figure 9).

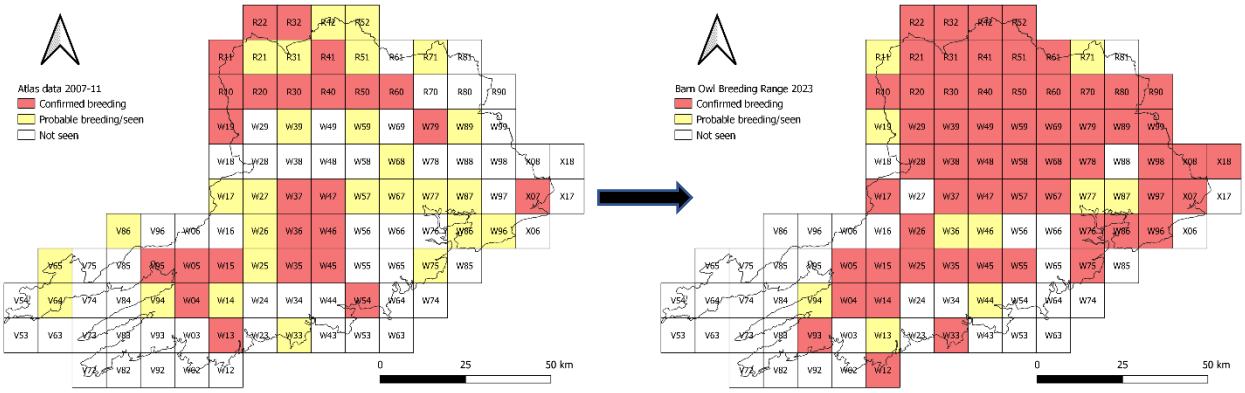

Figure 9. The breeding range of Barn Owls in County Cork recorded by the Bird Atlas (2007-2011), (left) showing the change in breeding range to the current distribution recorded by this study (right)

4.3 Barn Owl occupancy

There were 24 sites in County Cork which were known to be occupied by Barn Owl between 1991 and 1997 (BirdWatch Ireland, unpublished data; Cooke *et al*. 1996; Nagle, 2004) which we identified and revisited during the current survey to determine their suitability and the presence of Barn Owls (Figure 10). All of these sites were deemed likely suitable for nesting Barn Owl in 2023, though for three of these sites, the ruined stone structures where the Barn Owls had nested in the 1990s had been renovated, and nest boxes were installed nearby to serve as alternative nesting sites. One of these three nest boxes was used for nesting in 2023, with signs of previous occupancy (moulted feather) at another. Sixteen (67%) of the 24 historically occupied sites were occupied by Barn Owls in 2023, including 12 sites (50%) that were used for nesting. We therefore recorded a minimum occupancy rate of 67% over the last 32 years.

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

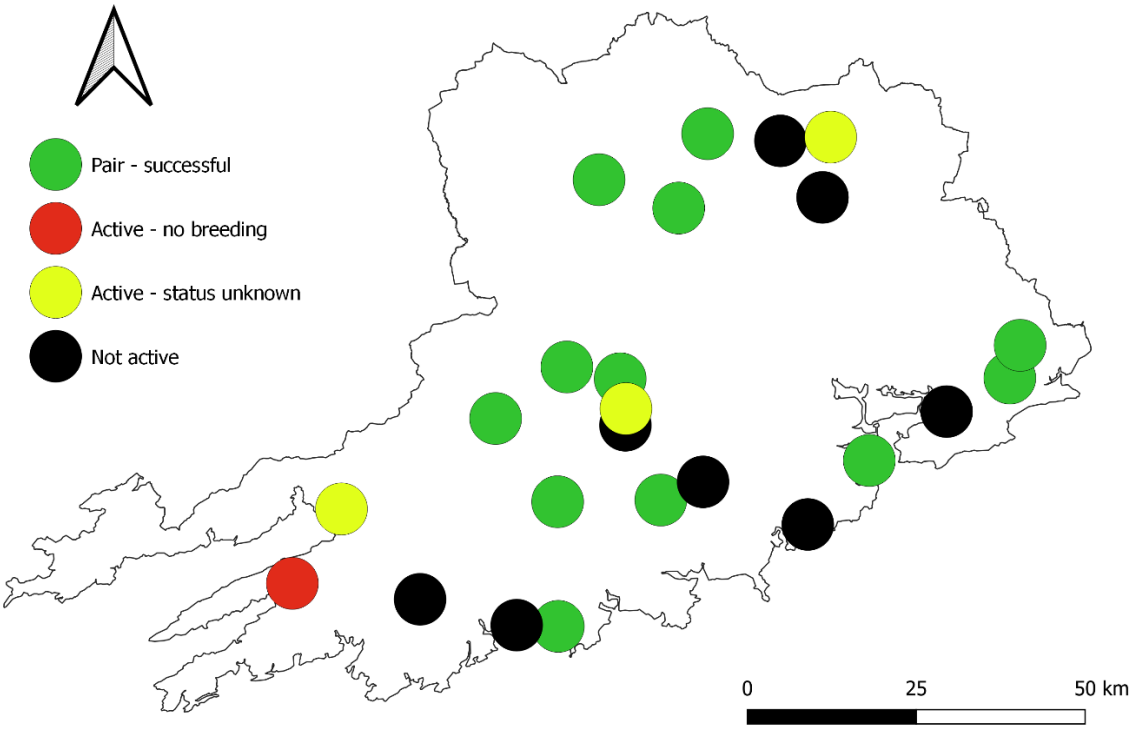

Figure 10. Distribution and status of sites in 2023 that were active in the early to mid 1990s (n = 24)

We surveyed 35 sites in 2023 which were occupied by Barn Owl between 2006 and 2010. One of these sites was determined to be unsuitable for breeding in 2023 due to building renovation. Of the 34 sites surveyed that were suitable/potentially suitable, 19 (56%) were confirmed to be occupied by Barn Owl in 2023, with 17 confirmed to be breeding sites.

Between 2006 and 2022, 154 sites were confirmed to be used by Barn Owls in Cork. The number of recorded active sites in any one year varied over this period, though overall there has been a significant increase in the number of known active sites in recent years (Figure 11).

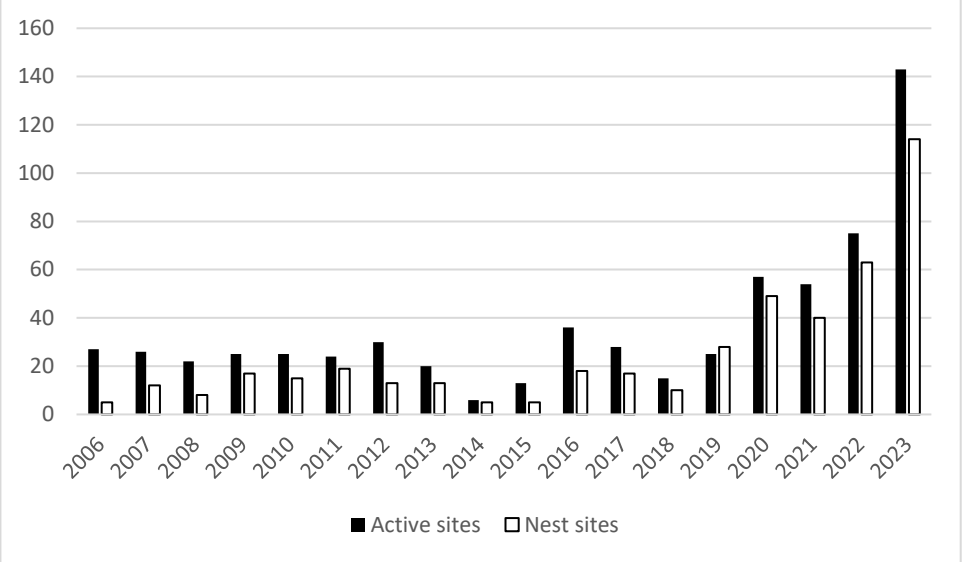

Figure 11. Number of all active sites and nest sites recorded in County Cork each year between 2006 and 2023.

4.4 Barn Owl site selection

The majority of the 143 occupied Barn Owl sites (nests and roosts) were in buildings (n = 114), with 15 tree nest boxes, 11 natural trees cavities and one quarry also used. It was not possible to determine the site type in two cases. Farm buildings were the most commonly used site type (39), followed by trees (26, nest boxes on trees and natural cavities in trees), castles (20), derelict farm houses (19), derelict cottages (13) and ruined mansions (11). Other site types included derelict churches (3), derelict schools (2) and derelict pig farms (2). All site types used by Barn Owls in County Cork in 2023 are shown below in Figure 12.

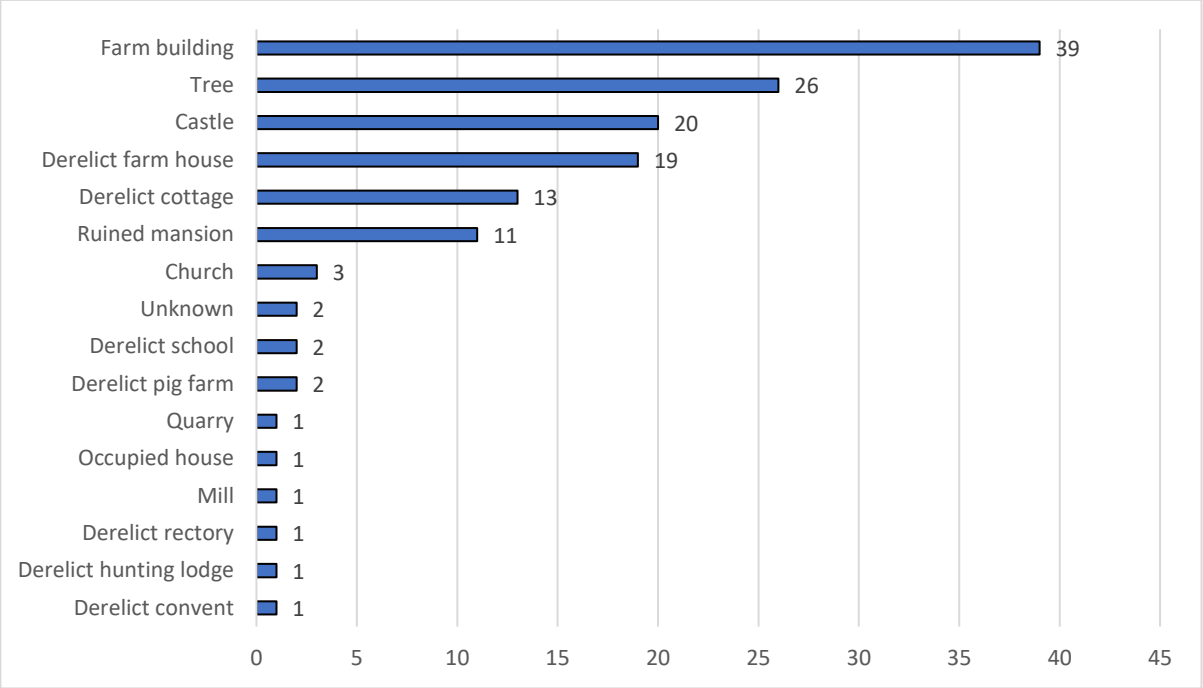

Figure 12. The range of sites used by Barn Owl in County Cork in 2023 (n = 143)

Image 3. Example of a site which was surveyed and which was deemed to be suitable for Barn Owl in County Cork

The most common nest site used by Barn Owl was nest boxes (n = 46), followed by chimneys (n = 26) and roof spaces (n = 12). There were 11 nests in tree cavities and 10 nests in cavities in buildings. One nest was on an open ledge in a castle. It was not possible to determine the nest site of eight breeding

pairs. The range of nest site types used by Barn Owl in County Cork in 2023 are shown below (Figure 13).

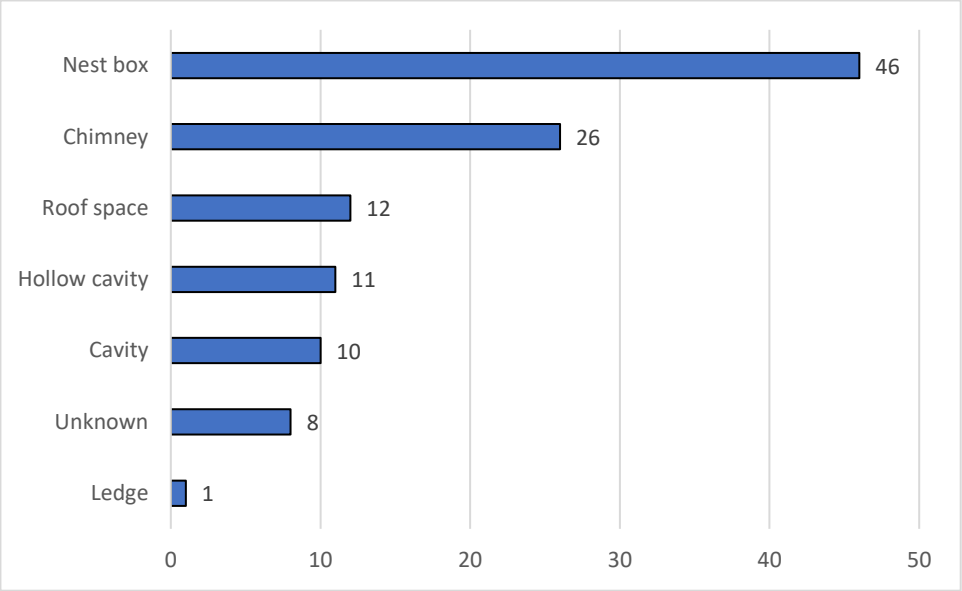

Figure 13. The range of nest site locations used by Barn Owl in County Cork in 2023 (n = 114). Note- "hollow cavity" refers to cavities in trees, while "cavity" refers to those in buildings.

Image 4. A nest box funded by Cork County Council through a Heritage Council Heritage Grant, installed in 2022 and used by nesting Barn Owls for the first time in 2023.

We assessed the suitability and presence of Barn Owl in 383 sites, which included sites reported via the citizen science survey, nest boxes installed by local volunteers, sites where Barn Owls have previously been recorded and stone structures where there was no previous information on Barn Owl use. Of these, 354 were deemed to be "suitable" or "potentially suitable" for breeding Barn Owl. Of

these 354 sites, evidence of current use by Barn Owl was found at 143 sites (40%). Of 288 sites that were deemed "suitable", 133 (46%) had fresh signs of Barn Owl use. There were an additional nine sites where there was evidence of past use by Barn Owls (pellets and moulted feathers), but these sites had likely not been used during the 2023 breeding season (i.e., before March 2023) and were therefore categorised as "not active" during the 2023 breeding season.

Of 151 ruined buildings surveyed, 140 sites (93%) were suitable or potentially suitable for nesting. Eighty (53%) of these buildings were known to be previously occupied by Barn Owls. Of the 140 suitable or potentially suitable sites, 74 (53%) were in use by Barn Owls, meaning that 47% of buildings surveyed were potentially suitable and available for additional Barn Owl pairs to use. In addition to these sites, there are some 140 nest box sites that are suitable but unoccupied and available for Barn Owls to use.

The importance of buildings for other bird species

A number of other species of note were recorded at building sites surveyed. Kestrel were present in seven sites, Raven in six sites and Peregrine in four sites. Chough were recorded in four sites and both Swift and Stock Dove were each recorded in two sites. Of the seven sites occupied by Kestrel, two were also occupied by Barn Owl. One site occupied by Barn Owl also had signs of both Kestrel and Raven. In terms of nest sites, three sites that had nesting Barn Owls also had nesting Raven, three other sites that had nesting Barn Owl also had nesting Peregrine, and one site that had nesting Barn Owl also had nesting Swift. There were also two cases of Kestrels nesting in Barn Owl nest boxes on trees.

4.5 Barn Owl breeding performance

Barn Owl broods were ringed at 57 nest sites in County Cork in 2023, with a total of 180 chicks and three adult females ringed. It was not possible to ring one chick at one nest site as it remained out of reach. The mean brood size at these sites was 3.2 young per successful breeding attempt (n = 57, range = 1 – 5). In addition to the 57 nest sites where the young were ringed, we were able to determine an exact brood size for four other breeding attempts, with the overall mean remaining at 3.2 young per successful breeding attempt (n = 61, range = 1 – 5, 194 chicks). The mean productivity for nest boxes was 3.3 young per successful breeding attempt (n = 41, range = 1 - 5, 134 chicks), and 3.0 young per successful breeding attempt for non-nest box sites (n = 20, range = 1 - 4, 60 chicks). For 44 successful breeding attempts where broods were not ringed, we were unable to determine an accurate brood size. Of the 114 nesting attempts recorded, 105 (92%) were regarded as having a successful outcome, with five breeding attempts failing and the outcome of four breeding attempts unknown.

One breeding attempt failed after the adult male of the nest was apparently killed on a primary national road 350 metres away from the nest, which was in a cavity of a derelict farm outbuilding. Another late breeding attempt failed when three chicks died in the nest when they were between six and seven weeks old. All three chicks were typical weights when they died, however post-mortem results showed their digestive systems were depleted of food. Therefore, the cause of death is unclear. One nesting attempt failed at the egg stage after the female seemingly abandoned during egg laying as a result of farm equipment being removed from the barn in which the nest box was located. The

cause of failure of two other breeding attempts (one at egg stage and the other at young chick stage) was not known.

4.6 Barn Owl nest box occupancy

A total of 207 nest boxes were monitored during the survey. Fifty-four nest boxes (26%) were occupied during the breeding season in 2023 while four nest boxes had signs of recent activity but not during the breeding season. Forty-six (22%) nest boxes were used by Barn Owls for nesting in 2023. Seven nest boxes were located in ruined buildings where Barn Owls were nesting in another part of the building rather in the nest boxes. At least one of these seven boxes was used for roosting. A total of 163 nest boxes were installed in buildings, 43 were on trees and there was one pole nest box. Of the 163 nest boxes in buildings, 39 (24%) were used by Barn Owls, while of 43 tree nest boxes, 15 (35%) were used.

Since 2020, 125 Cork County Council funded nest boxes have been installed at 109 sites across Cork. During the 2023 survey, 97 of these sites (113 nest boxes) were surveyed. Nest boxes were used by Barn Owls at 20 of these sites (20.6%). Breeding occurred in nest boxes at 18 of the 97 sites surveyed (18.6%), with breeding occurring at an additional three sites where the nest box was not used as the nest site. At five sites where two boxes had been installed per site, Barn Owls used both boxes: one as the nest site, and one as the roost site for the adult pair.

5. DISCUSSION

The survey was designed to identify Barn Owl sites to assess their distribution and abundance in County Cork, and to maximise the use of existing datasets on the species. Three 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 of the three survey techniques. In particular, the citizen science survey techniques used through this survey proved beneficial. The potential Barn Owl sites that were reported via the citizen science survey and subsequently confirmed to be occupied were not likely to be identified by the other survey techniques, due to the site types and their location. Incorporating a citizen science element also facilitated 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. The citizen science survey techniques complemented the other survey techniques, and it would not have been possible to rely on the citizen science survey alone, which would not have provided a sufficient number of Barn Owl sites or information on nest site availability as required. The citizen science survey required data validation, as several reports of 'Barn Owl' were received which related to other species, thus highlighting the need to confirm information received. The use of an online survey tool also improved the efficiency of reporting and receiving the information and performing validation. Based on our findings, we recommend 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 we 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 Cork. This approach had significant merit, and allowed trends in numbers, occupancy and range to be determined through

comparisons with existing datasets. 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.

Assessments of the status of Barn Owl populations in Ireland have been primarily informed by observed changes in breeding range over time (Article 12 reporting; Gilbert *et al.* 2021). It is important to recognise the potential for bias in the comparisons which inform estimates of breeding range change, which can be influenced by variation in observer effort between surveys. In all cases, and particularly for multi-species surveys, such as the Bird Atlases, the recorded breeding range should be considered to be an underestimate of the true breeding range, as it is unlikely that all breeding pairs or occupied sites will be identified. This is also the case with the current survey, which did not employ a comprehensive census to identify all Barn Owl sites throughout the county. Nevertheless, provided that the survey effort invested and the survey methods employed allow for comparisons, then changes in breeding range can be inferred and this has been a widely used method to track Barn Owl range changes over time (Article 12 reporting Gilbert *et al.* 2021). For Barn Owls in County Cork, it appears that under-recording likely occurred in the initial two Bird Atlases, given the findings of surveying that took place in the early 1990s and the anecdotal reports from members of the public at this time (Nagle 2004).

The survey findings show that Barn Owls have a widespread distribution throughout County Cork, occurring in a minimum of 63% of 10km squares in the county, and that the population is faring well compared to recent decades as shown by Bird Atlas surveys over the past 50 years. After declining in range between the 1960s and the 1980s, the Barn Owl population in Cork had increased by the latest county-wide population assessment in 2007-11 (Sharrock, 1976; Gibbons *et al*., 1993; Balmer *et al*. 2013). It is likely the population recovery started in the mid to late 2000s, given the declines in Cork that had been recorded right up to 2004 (Nagle, 2004). The Barn Owl range in Cork has increased further since the 2007-11 Atlas survey (Figure 14).

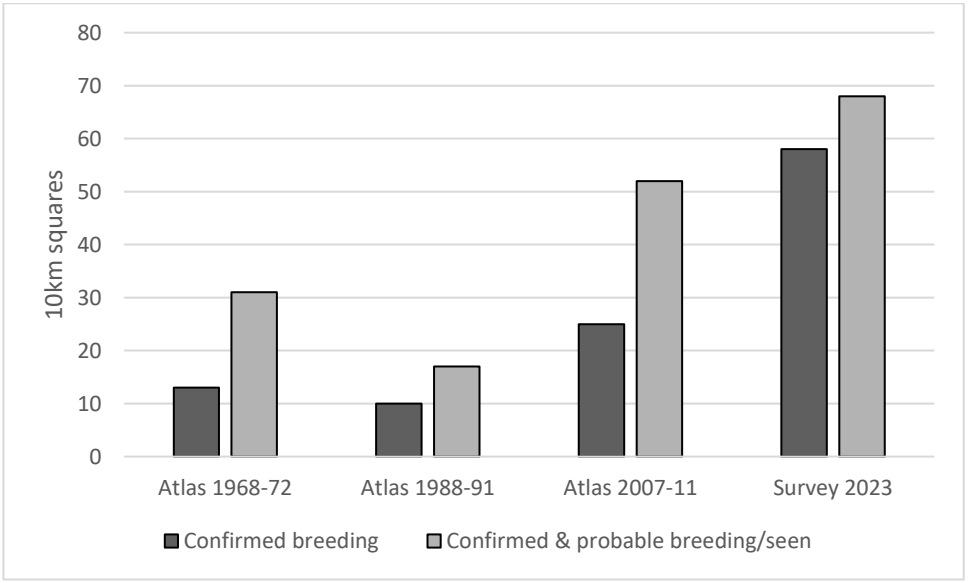

Figure 14. Number of 10km squares with confirmed breeding and probable breeding/seen Barn Owls during the three Bird Atlases and the current survey.

While Barn Owls have increased in number, other farmland bird species, such as Kestrel, continued to decline over the same period (Gilbert *et al.* 2021). The reasons behind the Barn Owl population increase are complex, and not yet fully understood. Although local, small-scale actions by landowners, farmers and conservationists have created and protected some suitable Barn Owl foraging habitat, it is unlikely that the positive population trajectory is linked to these habitat changes, as more suitable habitat continues to be lost rather than gained through agricultural intensification. Increasing awareness in relation to the use of rodenticides is also unlikely to have had an impact due to the local, small-scale implementation of rodenticide alternatives. The provision of nest boxes has contributed to the observed increase in numbers of Barn Owl pairs in the county, however it cannot be the only contributing factor in the increase in numbers. The arrival and spread of the Greater White-toothed Shrew, a species which has colonised the county in the last 10 to 15 years and which is now an important component of Barn Owl diet, is the most likely primary driver of the increase in Barn Owl numbers. Research is currently on-going to further our understanding of the impact of the Greater White-toothed Shrew, nest boxes and other factors on Barn Owl populations. The information collected as part of the current study will help inform these effects. Regardless of the factors influencing these population changes, there is a real opportunity to take advantage of these increases. This includes the continued provision of nest boxes to ensure that nest site availability does not limit population growth. In addition to the provision of nest boxes, the protection of known nest sites, habitat creation and enhancement measures would deliver significant benefits for Barn Owl populations and other wildlife, which should be delivered through targeted agri-environment measures, such as that seen in the new Agri-climate Rural Environment Scheme (ACRES).

Despite the recent breeding range expansion to its greatest known extent in the last 50 years (Sharrock, 1976), many 10km squares only contained one or two breeding sites, particularly in the south and west of the county where many squares had no breeding sites at all. There is a clear south-west versus north-east divide in Barn Owl breeding range and densities in Cork. This contrast in densities across the county can most likely be explained by the small mammal communities found in these areas. Higher densities of Barn Owls in the north and east of the county overlay the current known distribution of the Greater White-toothed Shrew in Cork. Similar patterns of increasing Barn Owl numbers where Greater White-toothed Shrews occur has been witnessed in other counties in Ireland, including Offaly and Limerick (Lusby *et al*., 2022; McCarthy *et al*., 2022). There is also some evidence that Barn Owls are increasing in areas outside the current range of the Greater White-toothed Shrew in Cork. In some cases, ruined stone structures that were occupied by Barn Owls in the 1990s, but which have been largely inactive over the last 10 to 20 years, have recently become reoccupied. This was widely observed during the 2023 breeding season in areas just beyond the edge of the Greater White-toothed Shrew range and is likely a spill-over effect from higher Barn Owl density areas.

The density that Barn Owls now occur in through parts of Cork is higher than seen anywhere else in Ireland. The highest density occurred in East Cork with eight occupied nest sites found in one 10km square (W97), with a neighbouring square (X07) containing five known nest sites, the joint second highest density for one 10km square in Cork. Several 10km squares in North Cork also contained five known nest sites. It is likely that the highest density in Cork was recorded in the east of the county partly as a result of observer bias, as one of the authors dedicated great survey effort in this area and has a large network of local contacts who provided information on Barn Owls. In addition, a local nest box project contributed to high densities in this area, further contributing to observer bias due to

the comparative ease of detecting Barn Owl nests in nest boxes. Regardless, these results demonstrate the densities that Barn Owls can reach, even in areas where there does not seem to be an abundance of high-quality foraging habitat, as is the case with square W97 and X07 (large areas of intensive dairy and tillage farming). It is likely that there are more nests yet to be discovered in W97. The previous highest known density of occupied Barn Owl sites in any county was seven active sites per 10km square in Offaly in 2021 (Lusby *et al*., 2022), while 4.7 – 6 breeding pairs per 100km^2 were recorded in Limerick and Kerry in 2022 (Lusby, pers. comms.).

The majority of occupied Barn Owl sites were in buildings (n = 114), with 15 tree mounted nest boxes, 11 natural tree cavities and one quarry also used. Farm buildings were the most important building used (n = 39), followed by castles (n = 20), derelict farm houses (n = 19), derelict cottages (n = 13) and ruined mansions (n = 11). This shows the importance of ruined structures for Barn Owls, which is further demonstrated by the fact that several of the large, ruined structures have been used by Barn Owls extending over the last 32 years. These sites should be protected, and if the suitability of these sites is compromised, then alternative sites should be provided in the form of nest boxes, the effectiveness of which is demonstrated by the fact that the most common nest site type recorded was nest boxes (interior and tree nest boxes combined). The practice of installing nest boxes at sites that become unsuitable through renovation has proven successful in Cork. A traditional site, a ruined mansion, used in the 1990s by Barn Owls for nesting was last occupied in 2012. In 2019, renovation work began on the building, and so a nest box was installed in a tree nearby to provide Barn Owls with a suitable alternative nest site. In 2023, Barn Owls nested in the nest box for the first time, with the pair successfully raising five chicks. This has been replicated at a number of other sites in Cork. The sites used by Barn Owls in 2023 is in stark contrast to those they were recorded as being used during the early years of monitoring in Cork in the 1990s. Then, the most commonly known site to be used by Barn Owls was ruined mansions, with natural tree nests, as well as nest boxes, rarely recorded as being used in the county (Nagle, 2004). At the time, the theory behind few natural tree nesting pairs was that the climate in Cork was too wet for Barn Owls to nest in trees. Given the findings of the current survey, this explanation seems unlikely, rather they may have been missed during the 1990s due to the difficulty of detecting Barn Owl tree nests. As for nest boxes, this can simply be explained by the fact that few nest boxes were being installed for Barn Owls in County Cork at this time.

This has very much changed in the time since then, and the effectiveness of nest boxes as a conservation tool for Barn Owls in Cork has been demonstrated by the results of this survey. Nest boxes were the most commonly recorded nest site type in Cork in 2023, with 46 pairs nesting in boxes. Although survey bias likely exaggerates the proportion of nests in nest boxes compared with (in particular) natural tree cavities, these results nonetheless demonstrate the importance and effectiveness of nest boxes. The occupancy rate of interior boxes (24%) and tree boxes (35%) in Cork is high, given they are targeted at a red-listed and still uncommon species. The higher occupancy rate of tree boxes compared with interior boxes is likely because tree box installations have been focussed in the most optimal areas due to the expense of making and difficulty of installing tree nest boxes. As interior boxes are easier and cheaper to make, there may have been a higher likelihood of these being installed in less than perfect (but still suitable) sites. In most cases, it took at least two years for boxes to become occupied. However, in some cases, occupancy occurred much faster. In one case this year, a nest box installed in January 2023 was used for nesting by Barn Owls by June. In previous years, a nest box installed in December 2020 was used by Barn Owls for nesting by April 2021. Nest boxes

provide safe, secure nest sites that allow easier monitoring, and in some parts of Cork they provide nest sites where nesting would otherwise not be possible. Although a large proportion of the known Barn Owl population in Cork now nests in boxes, it is still far less than Barn Owl populations in other countries, such as in the United Kingdom where 80% of the Barn Owl population nest in boxes.

Barn Owls have occupied some sites, mostly ruined stone structures, over several decades in County Cork. We surveyed 24 sites in 2023 which were occupied by Barn Owl in the early to mid-1990s (BirdWatch Ireland, unpublished data; Cooke *et al*., 1996; Nagle, 2004). All 24 sites are still suitable or potentially suitable for nesting Barn Owls. In three cases, the ruined stone structures that the Barn Owls had been nesting in during the mid-1990s underwent renovation, however site suitability was maintained by the installation of nest boxes by the landowners and BirdWatch Ireland volunteers. Indeed, the loss of these ruined stone structures as nest sites for Barn Owls was highlighted by Nagle (2007), and was, at the time, identified as one of the main causes of population decline. Between the 1990s and the County Cork survey of 2009/2010, 20 of 47 Barn Owl sites had become unsuitable, mostly as a result of renovation (Lusby *et al*., 2010). The installation of nest boxes at such sites was outlined as the most appropriate mitigation measure, which has subsequently been shown to be effective. Of the 24 sites, 16 (67%) were confirmed as occupied in 2023. The 16 historic sites still occupied by Barn Owls included seven castles, six ruined mansion, one mill and one derelict rectory. One of the 16 sites has changed as Barn Owls now nest in a tree nest box rather than the derelict mansion they used to nest in, which is now under renovation. In addition, three of the historic sites that were not active in 2023 have been active within the last two years. One of these sites was a nest box which has been regularly occupied between 1996 and 2020. The long-term occupancy of 15 ruined stone structures shows just how important it is to preserve large stone structures for Barn Owls as they can cater for the species for many decades, with some nest boxes also catering for the species across several decades. The short-term occupancy rate of Barn Owls in ruined stone structures was also high. There were 34 sites which were known to be occupied by Barn Owl between 2006 and 2010 which were suitable for nesting in 2023. Of these, 19 (56%) were confirmed to be occupied by Barn Owl in 2023. In addition, two of the 34 sites that were not active in 2023 were active in 2022. These results further highlight the importance of such sites for Barn Owls across years.

Built structures are not only important for Barn Owl but also support a range of other species, which includes Kestrel, Peregrine, Raven, Swift and Stock Dove. Kestrel is a recent addition to the Red-list on the *Birds of Conservation Concern in Ireland* (Gilbert *et al.* 2021), and we showed that buildings are an important nesting site for the species as they were the most common raptor recorded in buildings surveyed, behind Barn Owl. Kestrels nested in Barn Owl tree nest boxes at two sites in Cork in 2023, with one of these pairs raising five chicks and the other pair raising at least one chick. Although Kestrels were not the intended species for this conservation measure, it shows the unexpected positive consequences that installing Barn Owl nest boxes can have for other red-listed species.

The continued availability of suitable nest sites is an important consideration for Barn Owl conservation in Cork going forward. Of 151 ruined buildings surveyed, 140 sites (93%) were suitable or potentially suitable for nesting. The high proportion of sites being suitable results from the fact that 80 (53%) of these buildings were surveyed as they were known to be previously occupied by Barn Owls. Of these 140 sites, 74 (53%) were in use by Barn Owls, meaning that 47% of buildings surveyed were potentially suitable and available for additional Barn Owl pairs to use. In addition to these sites,

there are some 140 nest box sites that are suitable but unoccupied and available for Barn Owls to use. Most of these boxes have been installed within the last three years, therefore it is likely that the availability of nest boxes will decrease in coming years with a continued increase in Barn Owls using them. It is necessary to prevent situations developing whereby the availability of nest sites becomes limited for the species. Such patterns have been developing in other counties in Ireland that are also experiencing an increase in Barn Owl numbers, with 80% of suitable sites surveyed in County Offaly being occupied by Barn Owls leaving only 20% available for new breeding pairs (Lusby *et al.* 2022). This is to be expected with an increasing population, and particularly for Barn Owl based on their specific nesting requirements. Although trees may become available to Barn Owls, most buildings which are suitable for Barn Owl are already present in the landscape and it is likely that more buildings will be lost (due to renovation or dilapidation) than become available. Based on our findings we recommend the continuation of nest box schemes to maximise the increases in Barn Owl numbers and to ensure that the availability of nest sites does not limit the population recovery, particularly in South and North Cork where the availability of nest sites is more limited compared with East Cork.

6. RECOMMENDATIONS

Barn Owls have increased in range and number over the last 50 years in County Cork to the greatest extent recorded during this time period, however the reasons driving the population change are not yet fully understood. It is important to implement measures to ensure the health of the population in the long-term and to maximise and sustain 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 Cork which are informed by the findings of this study.

- Our survey findings show that the availability of suitable structures and buildings for breeding Barn Owl has reduced in County Cork in recent years. To ensure that there are suitable nest sites available in the areas where natural or built structures may be limited, **we recommend the continuation of the Barn Owl nest box schemes in County Cork.**

- We also showed the importance of specific sites, many of which have been occupied by Barn Owls over several decades and have remained suitable for Barn Owls over this time. 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, as has been done with success in previous years. The provision of the data collected during this survey to Cork County Council should enable them to carry out this recommendation.

- 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.**

- Results from areas of East Cork demonstrate the **densities of Barn Owl nests that can be reached.** However, to get a more comprehensive understanding of densities that are possible in certain areas**, we recommend a focussed survey of Barn Owl breeding density is undertaken in defined areas of Cork** that will capture all nesting pairs, including those in natural tree nests.

- **The Barn Owl nest live stream** revealed the secret lives of this species to hundreds of thousands of people **across Ireland and the world** and engaged them with Barn Owl conservation. We recommend **this initiative is continued as a means of increasing awareness of Barn Owls in Cork and increasing engagement with Barn Owl conservation issues.**

- 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 are currently developing a landscape suitability map for Barn Owl in the county is developed**

to identify the areas which are suitable for the species and where conservation measures should be focused.

- **Conservation measures should be implemented through agri-environment schemes and other mechanisms 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**.

- The **application and effectiveness** of the **Barn Owl nest box measure in ACRES** should be **assessed to determine its benefits** to Barn Owls in Cork.

- **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**.

- **Research efforts** should focus on developing a better **understanding of the effects of different small mammal species compositions on Barn Owl diet, foraging success, prey delivery patterns, and breeding success.**

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 Cork 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

7. REFERENCES

Balmer, D., Gillings, S., Caffrey, B., Swan, B., Downie, I. & Fuller, R. (2013). *Bird Atlas 2007-11. The breeding and wintering birds of Britain and Ireland*. British Trust for Ornithology, Thetford.

Barn Owl Trust (2012). *Barn Owl Conservation Handbook*, Pelagic Publishing, Exeter.

BirdLife International (2021). European Red List of Birds. Luxembourg: Publications Office of the European Union.

Cooke, D., Nagle, A., Smiddy, P., Fairley, J. & Ó Muircheartaigh, I. (1996). The diet of the Barn Owl *Tyto alba* in County Cork in relation to land use. *Biology and Environment: Proceedings of the Royal Irish Academy*, 96B (2), 97-111.

Copland, A. & Lusby, J. (2009). Lowland Farmland. In: R. Nairn & J. O'Halloran, eds. *Bird Habitats in Ireland*. 124-137. The Collins Press, Cork.

Fitzpatrick, U., Murray, T. E., Paxton, R. J., Breen, J., Cotton, D., Santorum, V. & Brown, M. J. F. (2007). Rarity and decline in bumblebees – A test of causes and correlates in the Irish fauna. *Biological Conservation*, 136(2): 185-194.

Gibbons, D.W., Reid, J.B. & Chapman, R.A. (1993). *The New Atlas of Breeding Birds in Britain and Ireland: 1988–1991*. T. & A.D. Poyser, London.

Gilbert, G., Stanbury, A. & Lewis, L. (2021). Birds of Conservation Concern in Ireland 2020 – 2026. *Irish Birds*, 9: 523—544.

IPBES (2018). The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany.

Lusby, J., Watson, D. & Nagle, T. (2010). Cork Barn Owl Research Project 2010 Report. BirdWatch Ireland, Wicklow.

Lusby, J., O'Clery, M., McGuinness, S., Tosh, D. & Crowe, O. (2021a). The interactions between Barn Owls and major roads: informing management and mitigation. TII Publications reference RE-ENV07004.

Lusby, J., McCarthy, A., O'Clery, M., Lynch, Á., Bayley, S., Nagle, T., Forkan, C., Stanley, M. & Nolan, B. (2021b). Barn Owl Monitoring Report 2020. BirdWatch Ireland, Wicklow.

Lusby, J., Purcell, D. & Franks, D. (2022). Barn owl population status and trends in County Offaly. BirdWatch Ireland, Wicklow.

McCarthy, A., O'Donohoe, S. & Lusby, J. (2022). Barn Owl population status and trends in County Limerick. BirdWatch Ireland, Wicklow.

McDevitt, A.D., Montgomery, W.I., Tosh, D.G., Lusby, J., Reid, N., White, T.A., McDevitt, D.C., O'Halloran, J., Searle, J.B. & Yearsley, J.M. (2014). Invading and Expanding: Range Dynamics and Ecological Consequences of the Greater White-Toothed Shrew (*Crocidura russula*) Invasion in Ireland. PLoS ONE 9(6).

Nagle, T. (2004). The status of Birds of Prey and Owls in County Cork. In: C. Cronin, C. Barton, H. Hussey & M. Carmody, eds. *Cork Bird Report 1996 – 2004*. 285 – 308. Cork Bird Report Editorial Team.

Nagle, T. (2007). The loss of Barn Owl *Tyto alba* breeding and roosting sites in County Cork: A contributory factor in the species decline. *Irish Birds*, 8: 314-315.

O'Clery, M., McDonnell, B. & Lusby, J. (2013). Duhallow Raptor Conservation Project, Final Report 2013. James O'Keeffe Institute, Newmarket.

Roos, S., Campbell, S.T., Hartley, G., Shore R.S., Walker, L.A. & Wilson, J.D. (2021). Annual abundance of common Kestrels (*Falco tinnunculus*) is negatively associated with second generation anticoagulant rodenticides. *Ecotoxicology*, 30: 560–574.

Tosh D.G., Lusby, J., Montgomery, W.I. & O'Halloran, J. (2008). First record of greater white-toothed shrew *Crocidura russula* in Ireland. *Mammal Review*, 38: 321-326.

Sharrock, J. T. R. (1976). *The Atlas of Breeding Birds in Britain and Ireland*. T. & A. D. Poyser, Berkhamsted.

Shawyer, C.R. (1998). *The Barn Owl*. Arlequin Press, Wheathampstead.

Sullivan, I. & Lusby, J. (2021). *Wildlife in Buildings: Linking our built and natural heritage.* BirdWatch Ireland, Wicklow.

Taylor, I.R. (1994). *Barn Owls: Predator–Prey Relationships and Their Conservation*. Cambridge University Press, Cambridge.

Transport Infrastructure Ireland (2017). Barn Owl Surveying Standards for National Road Projects. T.I.I. Publication no. RE-ENV-07005.

Transport Infrastructure Ireland (2021). Survey and Mitigation Standards for Barn Owls to inform the Planning, Construction and Operation of National Road Projects. TII Publications reference PE-ENV-07005.

8. Appendix

Outreach and public participation in the survey and Barn Owl conservation was an important aspect of this work. During the summer, we contributed to and participated in two television programmes: a children's science programme and a documentary about bird vocalisation. These are due to be broadcast in late 2023 and will engage a wide audience, from young to old, in Barn Owl conservation.

Image 5. Filming of children's science programme "Let's Find Out" at a Barn Owl site in East Cork

In addition to television contributions, articles about the Barn Owl survey in Cork were published in several newspapers during the summer of 2023, including the Cork Independent, the Irish Examiner and the Avondu. These articles generated interest from the public and lead to reports being submitted of sightings and nest sites in Cork.

Image 6. News article in the Irish Examiner on Barn Owl conservation and survey in Cork in 2023

In January 2023, with the support of Cork County Council and the National Parks and Wildlife Service, we installed livestream cameras at a Barn Owl nest site in the roof space of a derelict cottage in North Cork. The livestream went live to the public in early April 2023 after the female of the pair had laid her first egg. Between then and the end of August, there were nearly 720,000 views of the livestream from 83 countries (Figure 15). Ireland had the highest proportion of views (28%), followed by the United States (16%), Great Britain (15%), Japan (8%) and Denmark (5%). The BirdWatch Ireland YouTube channel, where the livestream was broadcast, gained over 2,800 subscribers, which is an increase of 216% compared with before the livestream started broadcasting. The livestream generated massive interest in Barn Owls and their conservation as well as increasing public awareness of the threats and pressures that the species faces. The livestream was also an excellent way to communicate the work done by BirdWatch Ireland for Barn Owls, particularly in Cork, and it helped to garner great support.

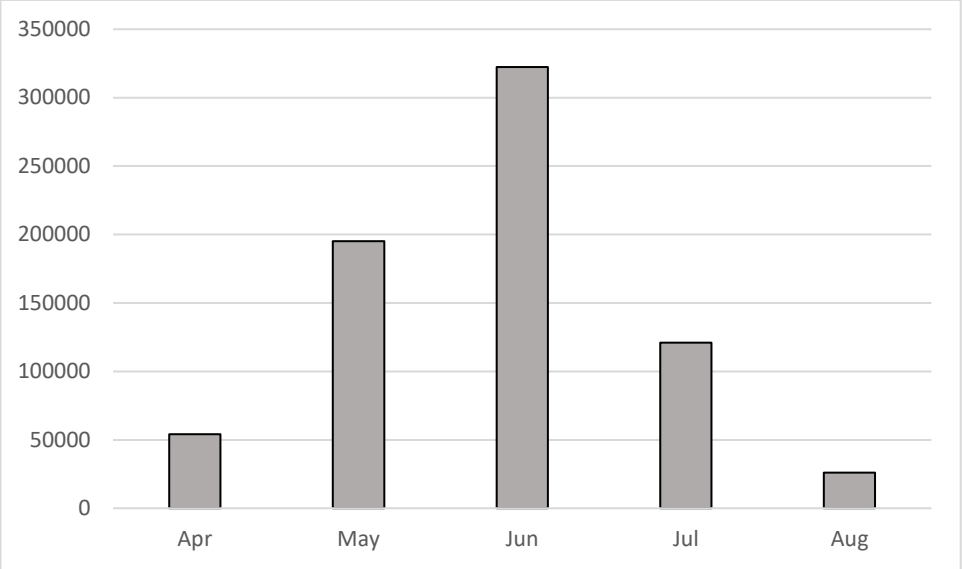

Figure 15. Number of monthly views of the Barn Owl nest livestream

During the breeding season, Donncha Ó Teangana who heads up the East Cork Barn Owl nest box project, recorded a video highlighting the successes of the project to date (https://youtu.be/6XoQbL8jDuw?si=GPra_YqQjMhp3oD4). The video provided an overview of Barn Owl nest boxes and the project's aims and followed Donncha and Alan McCarthy during a morning of surveying the nest boxes, including the ringing of two broods.

Image 7. The East Cork Nest Box Project video is available to watch on YouTube