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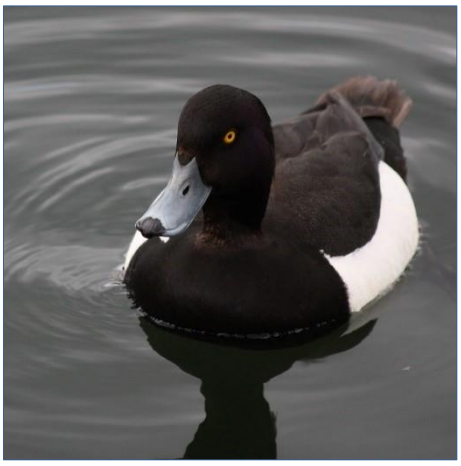
IDENTIFICATION OF BREEDING WATERBIRD HOTSPOTS IN IRELAND

Alan Lauder & Claire Lauder



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Front cover, small photographs from top row:

Limestone pavement, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott; **Garden Tiger** *Arctia caja*, Brian Nelson; **Fulmar** *Fulmarus glacialis*, David Tierney; **Common Newt** *Lissotriton vulgaris*, Brian Nelson; **Scots Pine** *Pinus sylvestris*, Jenni Roche; **Raised bog pool**, Derrinea Bog, Co. Roscommon, Fernando Fernandez Valverde; **Coastal heath**, Howth Head, Co. Dublin, Maurice Eakin; **A deep water fly trap anemone** *Phelliactis* sp., Yvonne Leahy; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson

Main photograph:

Tufted Duck *Aythya fuligula*, Alan Lauder

Identification of breeding waterbird hotspots in Ireland

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Contents

Executive Summary

This study aimed to create a hotspot map of breeding waterbird sites in Ireland. It utilises distribution data for breeding waterbirds collated as part of Ireland's 2019 reporting obligations under Article 12 of the EU Birds Directive.

A scoring system was developed which comprises waterbird species diversity and a range of scoring parameters derived from conservation status, ecology and social value on a species-by-species basis. The sum of the scores of all breeding waterbird species present within each 10 km square was then applied to a 10 km square grid.

Hotspots were then identified using a stepwise exclusion process, including removing 10 km squares with a hotspot score that fell below one standard deviation less than the mean score. Squares were also excluded if examination revealed they did not contain wetland habitats or where the hotspot score was derived predominantly from instances in which species bred within non-wetland habitats. A total of 43 squares were retained in the final hotspot map, each of which was classified into one of three score categories.

To identify individual wetland sites of importance for breeding waterbird within the 43 hotspot squares, the habitats within each square were critically examined using aerial imagery and available literature. This derived a total of 25 sites, a number of which cover more than one 10 km square, and which are ranked below in accordance with their total score:

1. Lough Ree
2. Lady's Island Lake
3. Tacumshin Lake
4. Roonagh & Cross Lough
5. Lough Corrib
6. Inishkea Islands
7. Inch Lake
8. Connemara Bogs Carrowroe
9. Dunfanaghy New Lake/Magheroarty
10. Annagh Marsh & Termoncarragh
11. Tory Island
12. Lough Conn
13. Lough Derg
14. Loughs Carra & Mask
15. Trawbreaga/Malin
16. Connemara Bogs & Slyne Head
17. Clew Bay inner
18. Shannon Callows
19. The Murrough
20. Lough Derravaragh
21. Lough Ourna
22. Limerick wetlands
23. Burren Lakes
24. Boora
25. Blanket Nook

In consideration of the likely challenges for the monitoring, protection and management of these sites in the future, this report provides three primary recommendations for the short term. Firstly, a breeding waterbird sites register should be compiled, including site priority categorisation and clear delineation of site boundaries. Secondly, standardised survey and data collation protocols should be developed for surveying breeding waterbirds at sites. Utilising the products of the previous two recommendations, a breeding waterbird monitoring programme should be implemented, starting with a baseline survey and initially focussing on high priority sites. Given the significant national declines in many breeding waterbird populations, this monitoring programme should also include periodic evaluations of site condition with respect to the ecological requirements of breeding waterbirds, thus assisting with the timely identification of appropriate conservation measures where required.

Acknowledgements

The authors are grateful to the following individuals and groups: data and analyses presented in this Irish Wildlife Manual were efficiently supplied in the appropriate format by Paul Duffy and Edwin Wymer in the ecological data unit of NPWS. Data from Article 12 analyses, used here, were supplied by a wide range of field staff including NPWS Wildlife Rangers and other NPWS Regional and Scientific Unit staff. Thanks are due to the many volunteer ornithologists and professional staff contributing records to the Irish Rare Breeding Birds Panel, Countryside Bird Survey, Irish Wetland Birds Survey, British Trust for Ornithology/Scottish Ornithologists' Club/BirdWatch Ireland Bird Atlas 2007–11 and the Irish National Seabird Monitoring Programme, all of which contributed towards Article 12 reporting.

1 Introduction

The populations of breeding waterbirds in Ireland have in almost all cases suffered significant declines. This is particularly significant amongst ground-nesting species. Waders in particular have suffered large scale declines. Species such as Lapwing *Vanellus vanellus*, Redshank *Tringa totanus* and particularly, Curlew *Numenius arquata*, have seen their numbers and range contract over a long period, but particularly rapid declines have been observed since the 1980s (Balmer *et al*., 2013; Lauder & Donaghy, 2008, O'Donoghue *et al*., 2019, Suddaby *et al*., 2020). The Birds of Conservation Concern in Ireland (BoCCI; Colhoun & Cummins, 2013) also documented a wide range of waterbird species moving onto the red and amber lists from formerly more favourable conservation status, including such ubiquitous species as Black-headed Gull *Chroicocephalus ridibundus*, Snipe *Gallinago gallinago* and Mute Swan *Cygnus olor*. Formerly scarce or rarer breeders are also becoming increasingly vulnerable including Common Scoter *Melanitta nigra* and Dunlin *Calidris alpina* (Crowe, 2019). These species illustrate the widespread declines in wetland species across the country.

For the purposes of this study, waterbirds are those defined, by sources including Wetlands International and The Ramsar Convention (see Wetlands International, 2020), as species of birds that are "ecologically dependent upon wetlands" and "are synonymous with waterfowl". These can be taken to include all species of the families; Gaviidae, Podicipedidae, Pelecanidae, Phalacrocoracidae, Anhingidae, Ardeidae, Balaenicipitidae, Scopidae, Ciconiidae, Threskiornithidae, Phoenicopteridae, Anhimidae, Anatidae, Pedionomidae, Gruidae, Aramidae, Rallidae, Heliornithidae, Eurypygidae, Jacanidae, Rostratulidae, Dromadidae, Haematopodidae, Ibidorhynchidae, Recurvirostridae, Burhinidae, Glareolidae, Charadriidae, Scolopacidae, Thinocoridae, Laridae, Sternidae and Rynchopidae.

Wetlands are defined here, broadly along the lines of the Ramsar Convention's definition (Ramsar, 2020a) to include "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is flowing or static, fresh, brackish or salty…" but exclude those sites where the bird populations are wholly or most significantly reliant on open shore or offshore marine habitats. This includes offshore islands where no wetland habitats are present, sea cliffs and rocky islets. Where islands are larger, there can be significant areas of wetland habitat which support waterbirds and these are included in this study (*e.g.* Tory Island). It is recognised that there is some degree of flexibility in this definition and the authors have used their best judgement as to when hotspots are not derived from wetland habitats.

There are currently no widely applied, frequent and targeted monitoring schemes for breeding waterbirds in Ireland and current trend information is derived from a wide range of monitoring approaches that rely rather heavily on either intensive site-based studies (*e.g.* wader surveys in the Shannon Callows), periodic species-specific national surveys (*e.g.* O'Donoghue *et al*., 2019), large-scale national schemes such as the Bird Atlas 2007-11 (Balmer *et al.*, 2013), or *ad hoc* rare breeding bird monitoring (Crowe, 2019).

This study aims to identify breeding waterbird hotspots using species distribution data combined with scoring criteria based on aspects of each species' ecology, conservation status and social value. This provides an initial spatial framework with which to identify the most important sites for breeding waterbirds. In turn, this provides a key tool for planning and prioritising the measures needed to address conservation management challenges associated with restoring favourable conservation status to these species. In particular, the targeted management of wetland sites which provide key refugia from which to conserve and potentially restore populations can be well directed by using this framework.

2 Methods and approach

2.1 Developing a species scoring matrix

The identification of important or priority sites for birds and other wildlife has underpinned nature conservation through most of the modern era and particularly since the establishment of wide-ranging legislation that enables site protection. In Ireland, notable legislation includes the Wildlife Acts of 1975 and its later iterations, and more widely in Europe through the establishment of the Birds (2009/147/EC) and Habitats (1992/43/EEC) Directives.

Within Ireland the site designation process has employed a range of approaches since the 1970s, entailing compilation of information on the population size and rarity of species to assess the need for protection (National Parks and Wildlife Service, 2020).

At a global level, Myers (2000) developed an approach to identify global biodiversity hotspots and this involved focussing primarily on species rarity and endemism; thereby identifying sites where rich biodiversity is linked to unique and restricted habitats.

BirdLife International (2020a) use the Important Bird Areas (IBA) system to identify priority bird and biodiversity areas around the world. These employ key criteria including the presence of globally threatened, range- and biome-restricted species, and species congregations. Within Europe this is further refined (BirdLife International, 2020b) and these criteria apply both Europe-wide and to sites specifically within the EU.

The criteria for IBAs rely largely on population size and rarity to define the listing of a site, thus with designated Natura 2000 sites (under the Birds and Habitats Directives) often mirroring this listing. As a result of the dependency on large congregations of birds, small sites of local or regional importance usually fall out of the listing under these criteria, as do sites which support species which nest at low density.

This dependency on congregations of birds for site identification is also reflected in the criteria used by the Ramsar Convention (Ramsar, 2020a) for the designation of “Ramsar Sites” where a wetland is considered to be internationally important for birds if it meets two of the nine criteria (Ramsar, 2020b), namely:

Criterion 5: "it regularly supports 20,000 or more waterbirds."

Criterion 6: "it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird."

The main issues surrounding the application of these criteria to hotspot identification for breeding waterbirds include:

- Breeding waterbirds typically occur at lower density than during the non-breeding season
- There is high inter-specific variance in species density
- Breeding waterbirds do not always use a discrete or easily defined site for their breeding requirements
- Species rarity in an Irish context is not always reflected in conservation status or rarity definition at international level
- Ireland has no endemic breeding bird species.

2.2 Criteria for hotspot identification

There are few sites in Ireland which have been designated for their breeding waterbird interest. For example, a small number of sites, designated primarily for their cliff-nesting seabirds or wintering waterbird congregations, also contain significant populations of ground nesting seabirds (*e.g.* gulls, terns and Eider *Somateria mollissima*) but these may not have been the primary reason for designation.

As noted by the aims of this study, the primary driver for identifying hotspots for breeding waterbirds is to provide a framework for addressing the conservation management needed to restore favourable conservation status to waterbird populations in decline.

Breeding waterbird species in Ireland may include more widely dispersed species whereby existing designation criteria do not apply effectively, species which fall out with the criteria for coverage by the Natura network, species whose ecology may stretch beyond the boundaries of traditional wetland sites, and those species which may be of regional or local importance.

To achieve accurate hotspot identification, the examination of key factors which provide a means of effective priority scoring is required. Hotspots can be identified by the summing of scores for species present in a given area (in this case, the 10 km square and/or delineated sites within these squares, subject to data being available), thereby creating a priority score which is a function of both species diversity and the scoring categories which include aspects of rarity, ecology, conservation and social value (see Section 2.3).

The use of the 10 km square as the basic unit of distribution was determined based on the resolution of existing available spatial data on the distribution of breeding waterbird species in Ireland, relying primarily on the data compiled as part of Ireland's reporting under Article 12 of the Birds Directive (EIONET, 2020).

The proposed priority scoring criteria are described in Table 1.

Table 1 Priority scoring criteria. Within each scoring area there can be multiple score categories, with a specified scoring parameter and associated score range. The description of and rationale for each scoring range is also included.

Scoring area	Score category.	Scoring parameter	Score range	Description	Rationale
Species diversity	Cat. 1	Presence	0 or 1	Score 1 point for each species present	Provides a score for total species diversity in a given recording area (*i.e.* 10 km square).
Species status	Cat. 2	EU Annex 1	0 or 2	Score 2 points for each Annex 1 species	Two points assigned to species listed on Annex I of the Birds Directive, providing clear weighting for those species of high EU importance. Maintaining and restoring favourable conservation status of Annex 1 species is a clear policy driver for EU member states.
Species status	Cat. 3	IUCN Red List category	0 – 7	Score up to 7 points for each species' relevant IUCN criterion (0 = not categorised/least concern, 2 = near threatened, 3 = vulnerable, 5 = endangered, 7 = critically endangered)	IUCN criteria (BirdLife International, 2015) are an international standard and recognised as a driver for the identification of *e.g.* IBAs and other sites at global level. The existence of a species within the "threatened" range of criteria (a score of 3 or more) within Ireland would bring with it high global conservation priority and urgency; thus the scores and increments within this range have been weighted to reflect this. While there are no Irish breeding species which exceed a score level of 3, this may change in future. The criteria that apply within the EU 27 are particularly relevant (as noted above) and are applied in this case. While IUCN criteria are included within the BoCCI criteria (see below), the criteria are applied separately here given the international significance and conservation concern for of species of threatened status.
Species status	Cat. 4	BoCCI Red list	0 or 2	Score 2 points for each Red-listed species	The Birds of Conservation Concern in Ireland 2014-2019 (BoCCI; Colhoun and Cummins, 2013) is the definitive Red List for Ireland. It takes account of a range of key factors including IUCN criteria (see above), short- and long-term population trends, range trends, and breeding rarity. Utilising the Red and Amber lists provides a good proxy for those more detailed criteria. Scores are awarded only if a species if Red- or Amber-listed for its breeding populations. The scoring range provided reflects the relative seriousness and urgency of Red-listing over Amber-listing and excludes those requiring no immediate action (*i.e.* green-listed).
Species status	Cat 5.	BoCCI Amber list	0 or 1	Score 1 point for each Amber-listed species	

Scoring area	Score category.	Scoring parameter	Score range	Description	Rationale
Site dependency	Cat. 6	Irish extinction risk/rare breeder	0 – 2	Score 2 points if the breeding population has a recognised extinction risk or is below 100 pairs; or score 1 point if a "scarce breeder"	The high dependency on a few sites is particularly clear for species which are rare or are facing rapid declines in population size and range and thereby suffer significant extinction risk. Two points are assigned in this case to reflect rarity and urgency (rare breeders), and one point is awarded to those species classed as scarce breeders. This follows the criteria and categorisation used by the Irish Rare Breeding Birds Panel (IRBBP, 2020).
Site dependency	Cat. 7	High natal site philopatry (fidelity)	0 or 1	Score 1 point if species exhibits recognised high natal site philopatry (fidelity)	High natal site philopatry (or fidelity) can be a key factor in population declines as the offspring of species with this attribute will return to breeding sites regardless of its condition. This site dependency reduces dispersal potential and puts the species at higher risk of negative impacts upon these sites (for example, as a results of unsuitable land management). High natal site philopatry is dependent upon available information from research and some species are data deficient. References are provided where evidence of high natal philopatry exists (*i.e.* where it exceeds 70% return rate to within 20 km); see Table A1.
Social value	Cat. 8	Socio-economic or intrinsic cultural significance	0 or 1	Score 1 point where a species has a recognised social or economic value	The social value of a species is rarely recognised within conservation assessments but the value of these species as a driver for conservation policy or management can be significant and can be critical in determining public buy-in to conservation projects and site protections (Barbier *et al.*, 1997; Lauder & O'Donoghue, 2019). This can be due to their aesthetic appeal, references to religion or tradition, recreational and/or economic value (*e.g.* for sporting shooting or for wildlife tourism).

2.3 Developing hotspot mapping

Two metrics for hotspot mapping were applied; species diversity scoring and species priority scoring.

Species diversity scores (score category 1 only; see Table 1) were derived from calculating the sum of the presence (1) or absence (0) of each waterbird species within each 10 km square.

Species priority scores were calculated for each species using each of the criteria outlined in Table 1. The calculated values for each species are shown in Table A1.

A total score for each squares, termed a 'hotspot score', was calculated by summing the species priority scores for each square (which includes a diversity score). Resulting total (or hotspot) scores ranged from zero to 93 in 881 possible 10 km squares.

To identify the hotspots at 10 km square resolution, a four–step process of exclusion of non-priority squares was followed using the total scores.

Figure 1 shows the distribution of the waterbird species diversity scores across all 881 10 km squares. Twenty 10 km squares held zero (0) species, whereas two squares held 25 breeding waterbird species. The mean number of breeding waterbird species per 10 km squares was 6.8. The normal distribution curve in this instance only acts as an indication of the relative spread of the data distribution, the actual distribution in this case being Poisson.

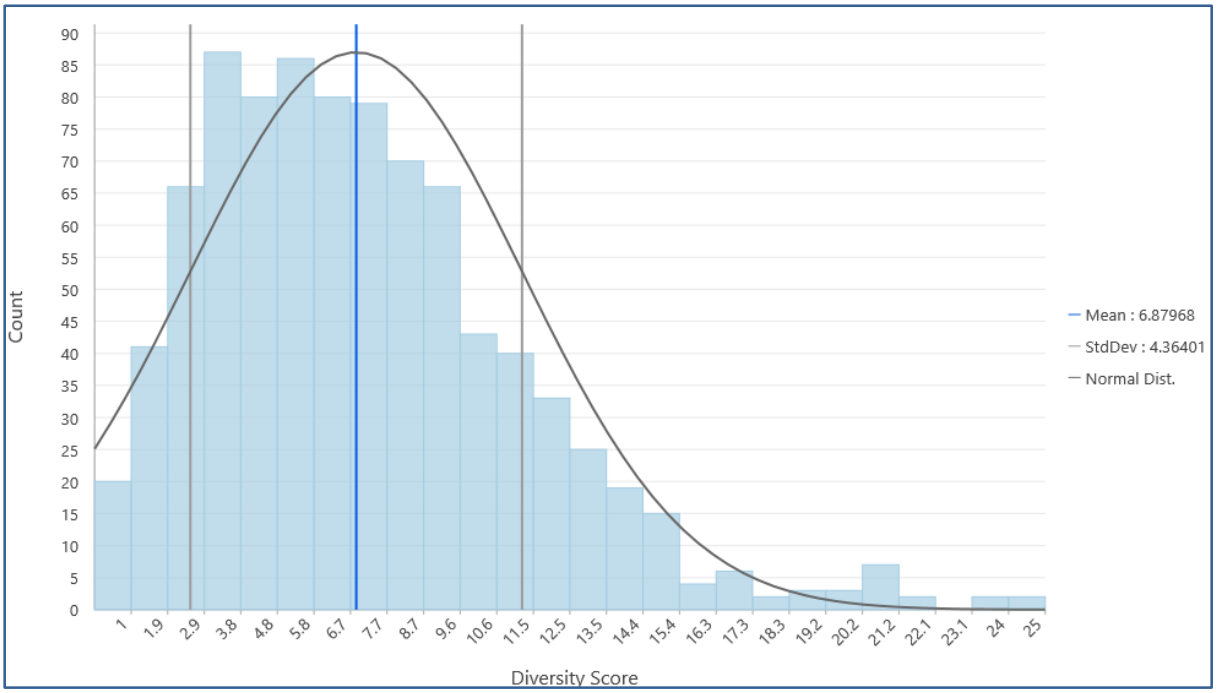

Figure 1 Distribution of breeding waterbird species diversity score across all 881 10 km squares in the Republic of Ireland.

Figure 2 shows the spatial distribution of 10 km squares according to their species diversity score. Five classifications of equal interval are illustrated in Figure 2.

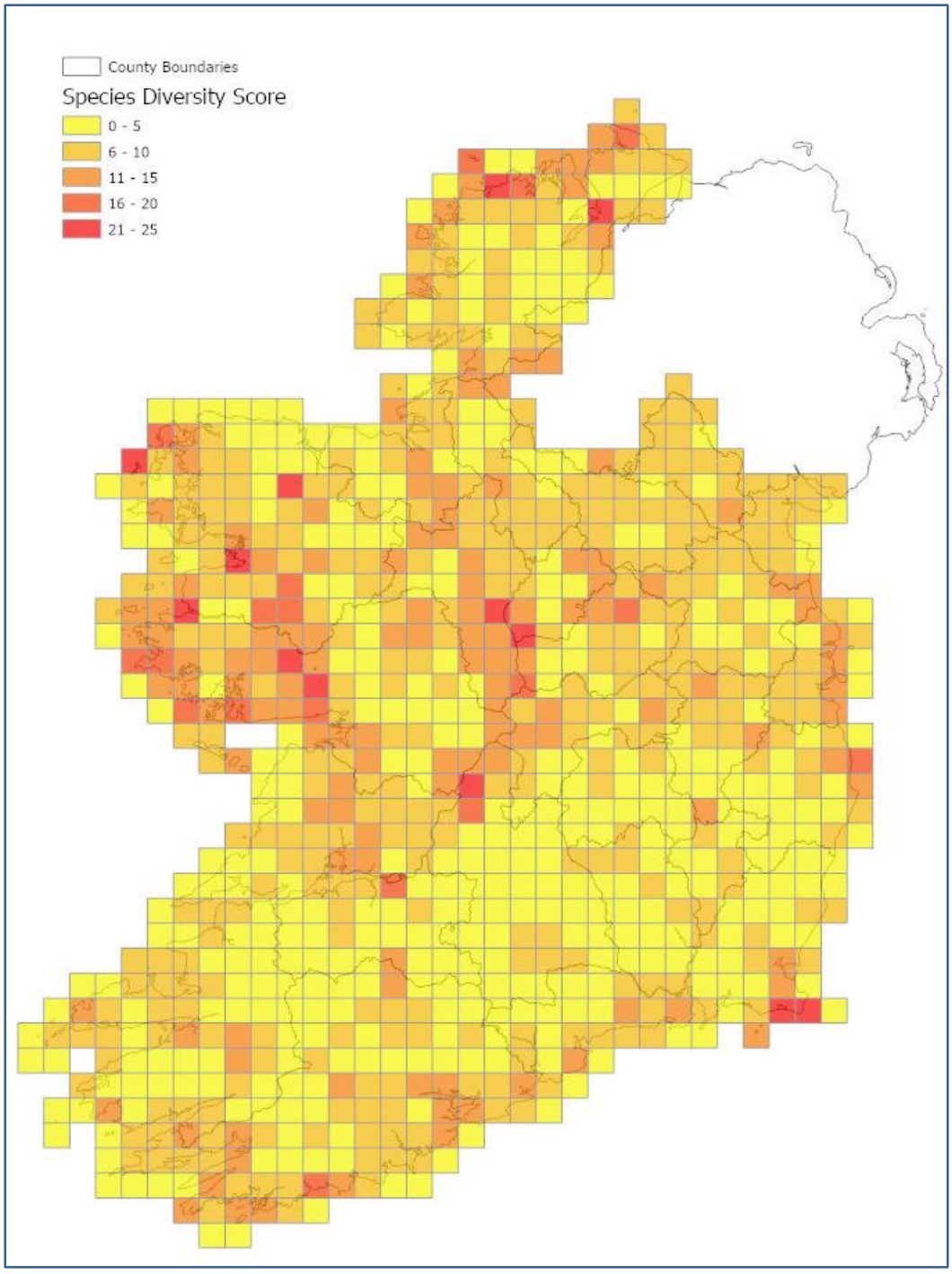

Figure 2 Distribution of 10 km squares according to their species diversity score.

Figure 3 shows the distribution of the hotspot scores across all 881 10 km squares. The hotspot scores ranged from 0 (20 10 km squares with no waterbird species present) to 93 (one square), with a mean score of 20.9. Sixty-one 10 km squares held scores of less than three. Scores of 37–93 were found in 120 10 km squares. Figure 4 shows the spatial distribution of squares according to their species priority score, with five classifications of (Jenks) natural breaks illustrated.

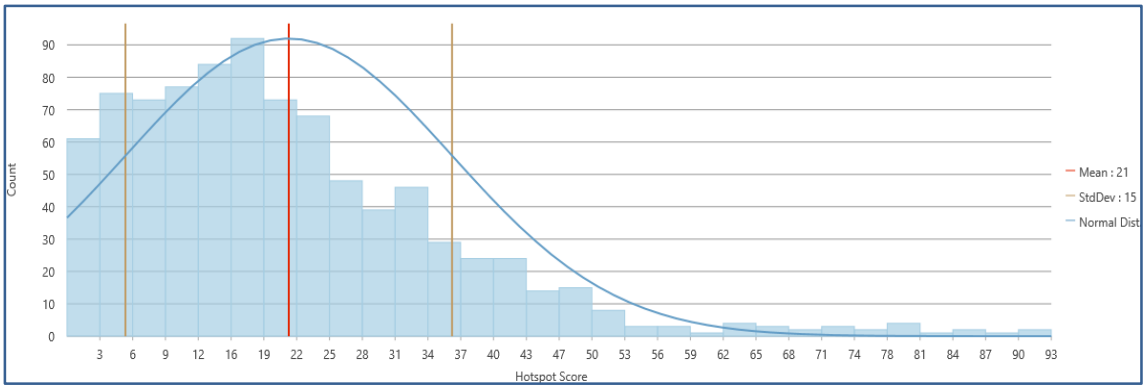

Figure 3 Distribution of hotspot scores across all 881 10 km squares.

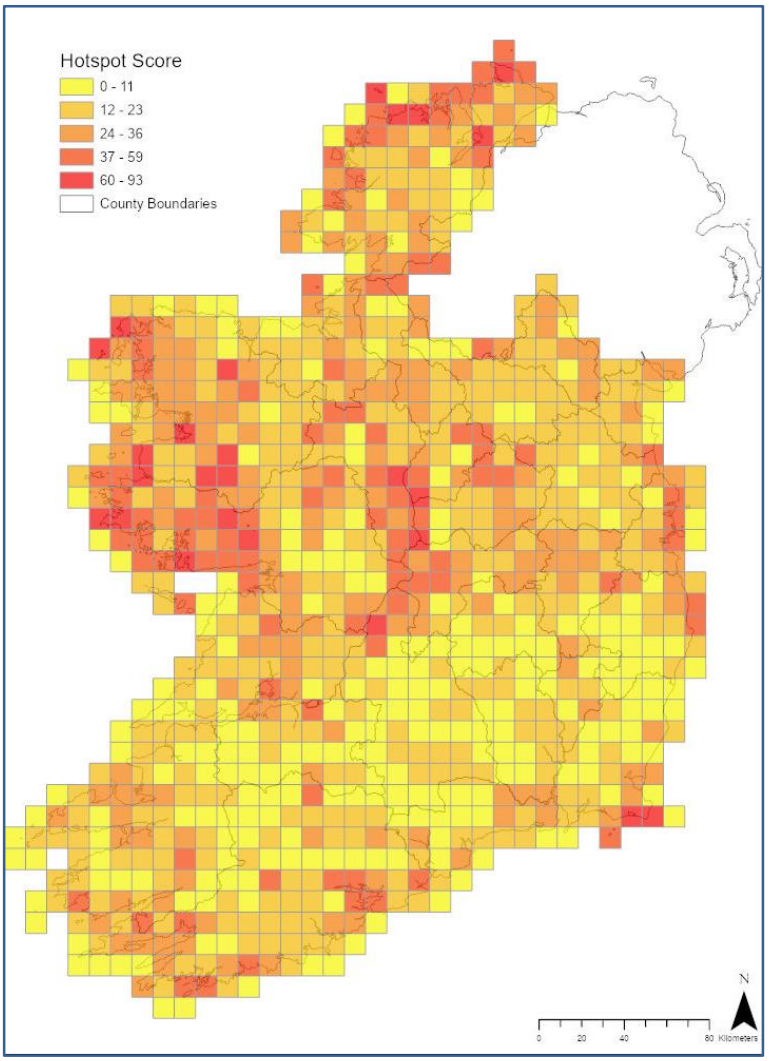

Figure 4 Distribution of 10 km squares according to their hotspot score (all squares).

Step 1: All 10 km squares below the lower standard deviation threshold (a score of 6 or less) were dropped from further analysis. This resulted in 136 10 km squares being removed from the analysis. Figure 5 shows the distribution of the hotspot scores across all remaining 745 10 km squares. The remaining scores ranged from 7 to 93.

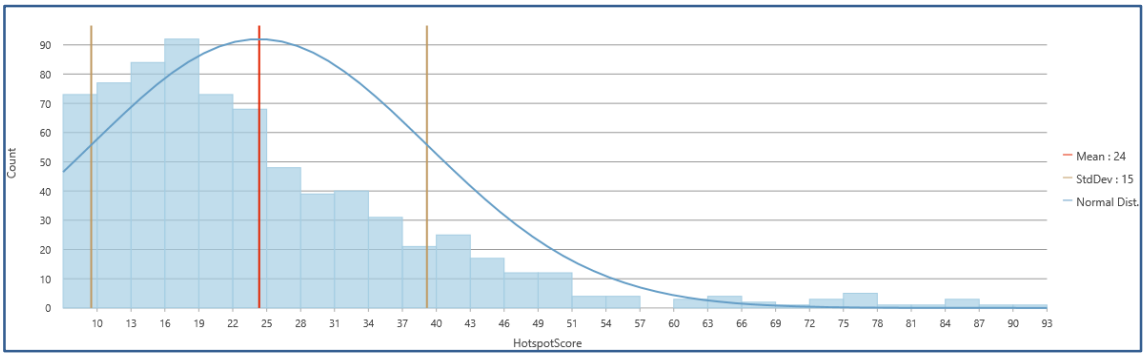

Figure 5 Distribution of hotspot scores across remaining 745 10 km squares after Step 1 site exclusion.

Figure 6 shows the spatial distribution of 10 km squares according to their hotspot score. Five classifications of equal interval are illustrated in Figure 6.

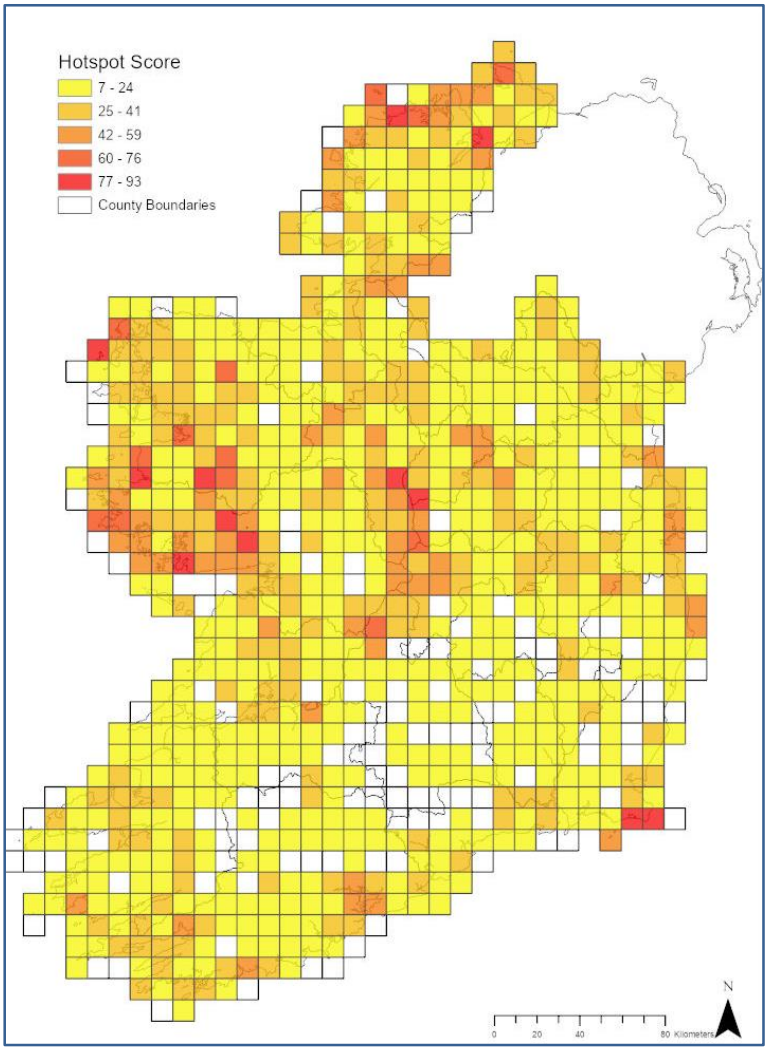

Figure 6 Distribution of hotspot scores across remaining 745 10 km squares after Step 1 site exclusion.

Step 2: All 10 km squares with a hotspot score of 25 or less (see Figure 5) were dropped from the analysis. This resulted in 478 10 km grid cells being removed from the analysis. Figure 7 shows the distribution of the hotspot scores across all remaining 267 10 km squares; scores ranged from 26 to 93.

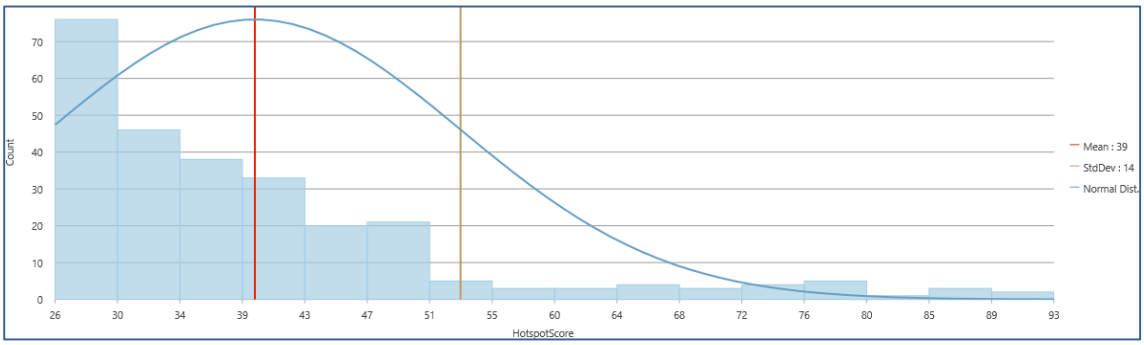

Figure 7 Distribution of hotspot scores across remaining 267 10 km squares after Step 2 site exclusion.

Figure 8 shows the spatial distribution of 10 km squares according to their hotspot score. Five classifications of equal interval are illustrated in Figure 8.

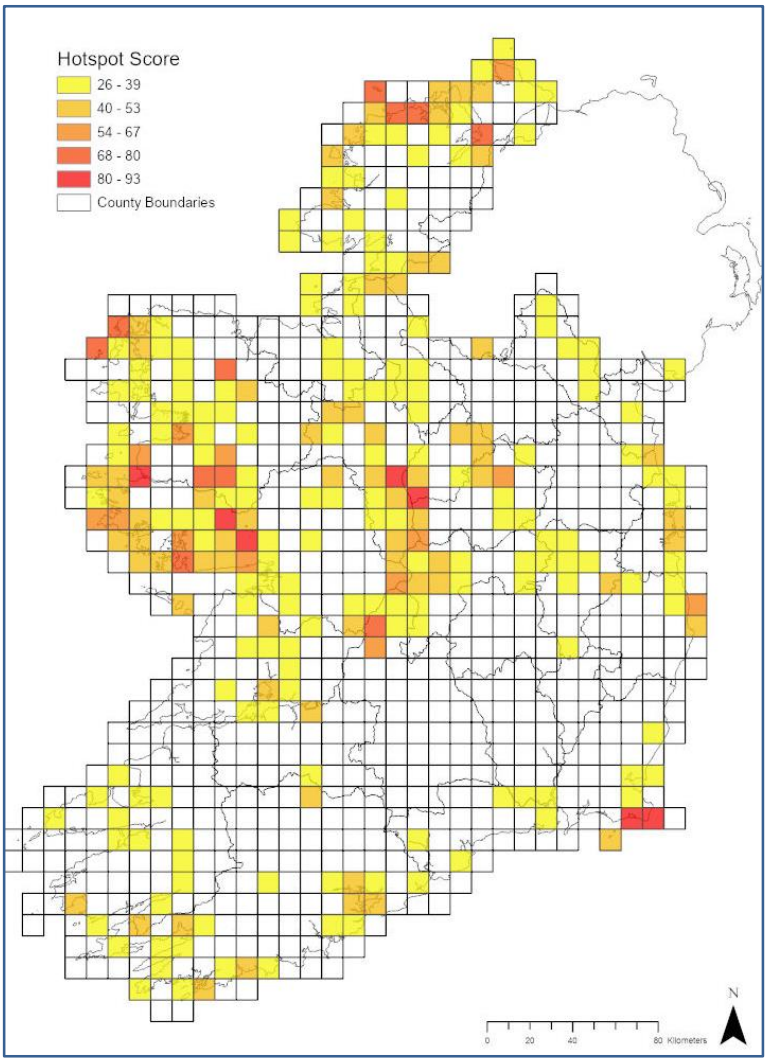

Figure 8 Distribution of hotspot scores across remaining 267 10 km squares after Step 2 site exclusion.

Step 3: All 10 km squares with a score of 35 (the mean rounded down to nearest 5) or less (see Figure 7) were dropped from the analysis. This resulted in a further 134 10 km squares being removed from the analysis. Figure 9 shows the distribution of the hotspot scores across all remaining 133 10 km squares. The remaining scores ranged from 36 to 93.

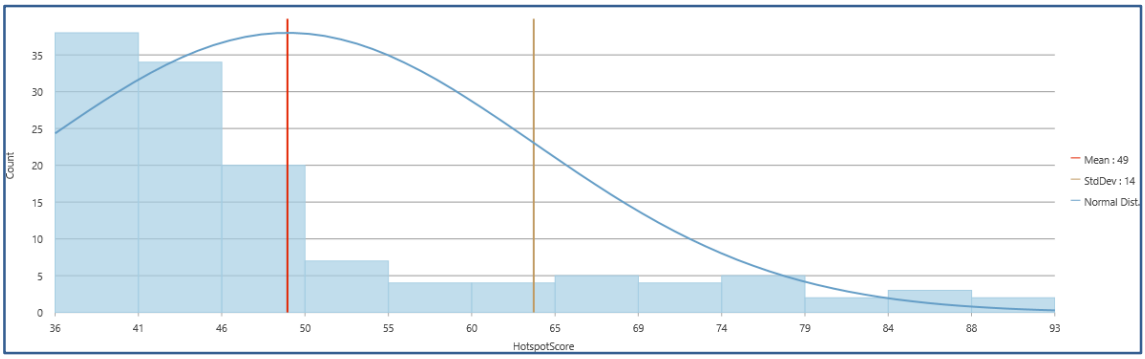

Figure 9 Distribution of total species priority (or hotspot) scores across remaining 133 10 km squares after Step 3 site exclusion.

Figure 10 shows the spatial distribution of 10 km squares according to their hotspot score. Five classifications of equal interval are illustrated.

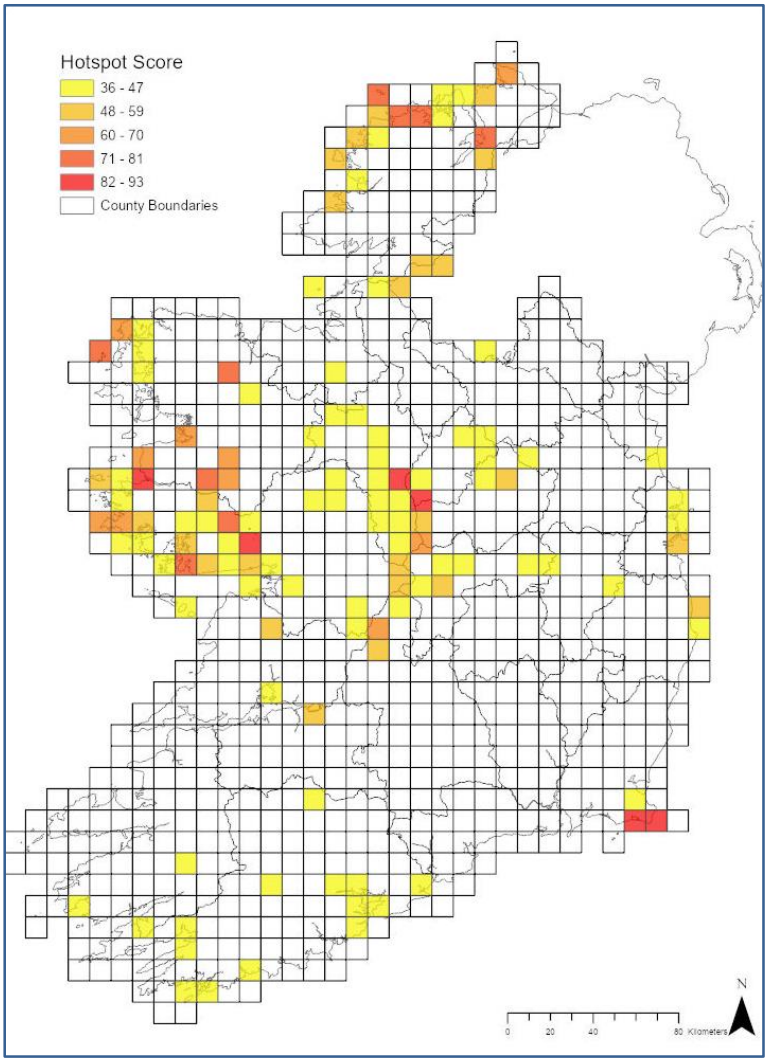

Figure 10 Distribution of hotspot scores across remaining 133 10 km squares after Step 3 site exclusion.

Of the 133 10 km squares that remained after Step 3, many overlapped with coastal areas. In order to select only squares of relevance to wetland breeding waterbirds, each square that overlapped the coast was reviewed, with Ordnance Survey Ireland (OSI) 1:50,000 raster data used to identify coastal squares. Each coastal square was then reviewed in detail using OSI raster data (1:50,000 and 1:5,000). The habitat of each of these squares was reviewed to identify whether the squares included areas of recognised wetland habitat. Many of these squares held high cliffs, farmland, moorland or similar habitats. Those squares which did not hold any wetland habitats (e.g. bodies of standing water, areas of marsh vegetation, wet grassland, saltmarsh or similar wetland habitats) were excluded. Thus, four coastal 10 km squares with no wetlands were dropped from further analysis, leaving 129 10 km squares.

Step 4: All sites with a hotspot of 48 or less (*i.e*. below the mean value of remaining squares) were then excluded, leaving 50 squares. Of the 50 squares remaining, three squares overlapped the border, with the waterbird interests within the jurisdiction of Northern Ireland; thus these squares were excluded. Additionally, four of the remaining 50 squares were excluded as they derived a significant element of their hotspot score from species occurring only within non-wetland habitats (coastal cliff or offshore island breeding sites). The final hotspot map is shown in Figure 11, with three score categories of equal interval.

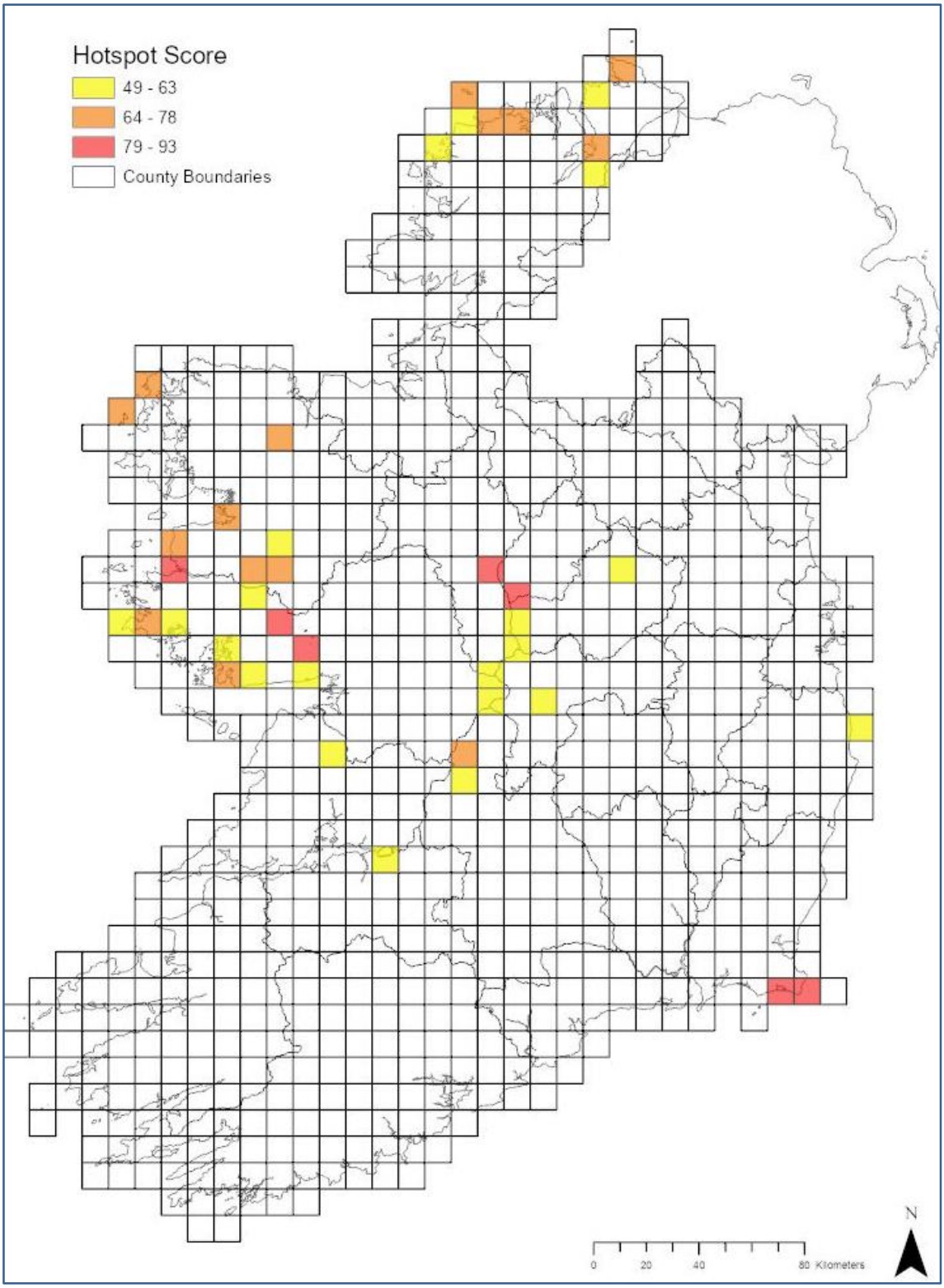

Figure 11 Distribution of breeding waterbird hotspots within 43 10 km squares after Step 4.

3 Identification of breeding waterbird site hotspots

The above methods for hotspot mapping identified 43 10 km squares which have high waterbird priority scores and which form identifiable breeding waterbird hotspots. In general, these also match squares with high species diversity, albeit with some minor variation due to the presence of high scoring, high priority species.

Using the 43 10 km hotspot squares, each square was examined to identify the individual sites of importance within each square. All hotspot squares were examined by looking at aerial imagery, from searching published information, and from the authors' own knowledge to discern discrete wetland sites within the squares. These wetland sites were considered as supporting the species assemblages which form the basis of the waterbird hotspot scores. As 10 km squares are arbitrary boundaries and not linked to discrete wetland sites, individual wetland sites may overlap multiple 10 km squares. Each square may contain more than one discrete site, which may or may not vary in wetland habitat type and bird species may not be equally distributed across sites within a given square.

Difficulties in achieving a definitive site list include:

1. Sites which extend into more than one 10 km square may be under-represented by a hotspot map where a suite of species may be unevenly distributed across squares, thereby reducing the apparent scoring for the site as a whole.
2. Coastal squares may contain both wetland sites and cliff or marine island sites which provide greater habitat diversity within a square and may encompass species which score highly but are not breeding within a wetland unit. Typically, this could include terns, Eider or gulls and may cause a square to be identified as a hotspot without the score being attributable to a single site.
3. Bird distribution data are largely derived from the Bird Atlas 2007–11 as provided in Article 12 reporting in 2019 (EIONET, 2020). The records used were only those of "probable" or "confirmed" breeding and there is a chance of records having been missed due to a lack of high-level breeding evidence, observers error (*e.g.* where a species was incorrectly assigned a higher or lower level breeding evidence) and poor observer coverage (where observers may only have visited a subset or parts of wetland sites in any 10 km square or for only short visits).
4. Hotspot squares may lie cross-border, with the wetland of interest lying predominantly outside the jurisdiction of the Republic of Ireland. All three of the squares identified as such were removed.
5. Squares could score highly where there is more than one wetland unit present. This is relatively rare. In all such cases identified, the multiple wetland units are considered to be interlinked and to thus comprise a single wetland complex. Waterbirds utilising part of this wetland complex are likely to be dependent on the functioning of the complex as a whole

The top 25 breeding waterbird sites, linked to the 10 km square hotspots, are listed in Table 2. The designation status and corresponding NPWS Regional Management Division for each site is outlined in Table A2.

Table 2 A ranked list of high priority breeding waterbird sites, including whether they are designated as Special Protection Areas (SPAs; wholly or in part), their maximum final score, and the Irish Grid 10 km squares (sq.) associated with each site. Sites are ranked according to their score.

Site name	SPA	Max score	Sq. #1	Sq. #2	Sq. #3	Sq. #4	Comments
Lough Ree	✓	93	M96	N05	N04		
Lady's Island Lake	✓	90	T10	T00			Roseate Tern not included on score
Tacumshin Lake	✓	90	T00				Terns noted but linked to Lady's Island, co-dependence of the two sites
Roonagh & Cross Lough	✓	86	L76	L77			Golden Plover in squares but not on site
Lough Corrib	✓	83	M23	M14	M17	M22	
Inishkea Islands	✓	78	F52				
Inch Lake	✓	78	C32				
Connemara Bogs Carrowroe	✓	78	L92	L93	M02		
Dunfanaghy New Lake/Magheroarty	✓	77	B93	C03			Red-throated Diver noted in square but not on site
Annagh Marsh & Termoncarragh	✓	76	F63				Eider and Arctic Tern scored but not on site
Tory Island	✓	73	B84	B83			
Lough Conn	✓	73	G11				Hotspot overlaps northern part of lough
Lough Derg	✓	70	R89	R88			
Loughs Carra & Mask	✓	77	M06	M16	M17		
Trawbreaga/Malin	✓	66	C45	C34			
Connemara Bogs and Slyne Head	✓	65	L64	L54	L74		Eider in square but not on site
Clew Bay inner		64	L98				Composite site–mixed coastal habitats
Shannon Callows	✓	62	N03	M91	M92		
The Murrough	✓	57	O30				Little Tern not included on score
Lough Derravaragh	✓	57	N46				
Lough Ourna		55	R88				Co-dependent/overlap with Lough Derg. Likely to qualify on its own in some years at least
Limerick wetlands	✓	51	R55				
Burren Lakes	✓	49	R39				
Boora		49	N11				
Blanket Nook	✓	49	C31				Potential co-dependence with Inch Lake

4 Discussion

This if the first formal identification of breeding waterbird hotspots in Ireland. The approach taken here should be regarded as preliminary, in that it uses a composite, non-targeted dataset and looks at species diversity and qualitative scoring without any measure of absolute or relative population sizes. While further information is required for future steps, the current results are of immediate value for the compilation of a breeding waterbird site register which encompasses all sites with significant breeding waterbird populations or potential. This could be carried out initially by central collation of information gleaned by consultation with NPWS Regional Management staff, with limited additional field surveys as required, and thereafter consolidated and built upon by an established monitoring programme.

While many of the most important wetland sites in Ireland are designated as Special Protection Areas, this is primarily for the wintering waterbird populations they support. Due to the lower densities of waterbirds during the breeding season, the chance of a site meeting designation criteria based on breeding species is low. While breeding waterbirds are often mentioned within designated site synopses, the level of data or information on the populations is usually poor. Traditionally, there has been a dependence that site protections and management for those species present in winter will also support conditions for breeding birds. While this may well be true in some cases, many species likely require fine-scale, species-specific conservation management. Compared to the wintering period, breeding waterbirds usually depend on a much wider range of habitat types and ecological conditions associated with wetland units. They often require subtly different habitats and locations for various aspects of the breeding cycle, *e.g.* display, nesting, chick rearing, adult feeding and post breeding.

In order to properly assess the value of individual wetlands for breeding waterbirds and inform any associated requirements for conservation management, robust, specific and targeted survey work is required. This needs to address the survey methodologies required for the likely species present: colony surveys for cormorants, gulls and terns; breeding surveys for ducks, grebes and rallids; heronry surveys; breeding wader surveys in upland and lowland contexts; and other species-specific survey approaches. In addition, the species list considered here focussed entirely on waterbirds and did not include other (non-waterbird) wetland dependent bird groups such as wetland raptors (*e.g.* Marsh Harrier *Circus aeruginosus* and Osprey *Pandion haliaetus*) or specialist wetland passerines such as Reed Warbler *Acrocephalus scirpaceus* or Bearded Reedling *Panurus biarmicus*. These species all require wetland habitats for a significant part of their breeding cycle and could add significant conservation value to any site evaluation (albeit not all currently breed in Ireland but are arguably likely to in future).

There have been rapid and large-scale declines experienced by many species of breeding waterbird, particularly waders like Curlew and Redshank, and Black-headed Gull. This is alongside a widely acknowledged range of land use pressures on wetlands and ground nesting birds such as agricultural intensification, drainage, water quality, recreational pressure, scrub and forest encroachment, invasive species, and predator (native and non-native) impacts. The urgency of identifying sites that hold appropriate levels of importance and then applying appropriate protections and, more importantly management interventions to support and maintain the sites and associated species is critical to prevent further loss. Losses of waders in particular continue at pace (*e.g.* Suddaby *et al*., 2020) and without rapid conservation interventions, loss of species diversity and overall population declines will continue.

The loss of species from sites where they were formerly present is likely to have been significant. In this study, no effort was made to examine the former value of sites and their restoration potential. This should form an important aspect of further identification of important breeding waterbird sites. Species re-introductions, translocations or similar species management tools may play a role in this regard.

The development of new wetlands (e.g. for water supply, energy generation, coastal realignment) and the restoration of former wetlands (e.g. post-industrial peat and gravel extraction) will require careful consideration to ensure these sites are managed with consideration for waterbird conservation, where relevant.

5 Recommendations

The following recommendations are made for consideration in the short term (1–3 years):

1. **Develop a breeding waterbird sites register**

This should include the high priority sites listed in Table 2 as well as those other sites which can form a lower tier where restoration or enhancement may provide for higher value in future. This should include an identification of a boundary for each site/wetland unit and any sub-units; this will assist with targeted monitoring and management.

2. **Develop survey/monitoring and data collation protocols for breeding waterbird sites**

Defining the scope, general approach and frequency of survey and monitoring, including data management protocols, required to survey high priority and lower priority sites is essential.

3. **Develop and implement a site survey programme to include condition assessment and restoration potential**

The delivery of a phased site survey programme based on recommendation number 2, starting with a baseline survey of the highest priority sites and followed by a baseline survey of sites falling into a second tier (to be defined).

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Appendix 1 Species priority scores

Table A1 Species priority scoring: results from Table 1 for each species. *Conservation status score below includes a score of 1 for Species Diversity.

	Conservation status					Site dependency			Social value			
Species	Annex 1	IUCN	BoCCI Red	BoCCI Amber	**Conservation Status Score***	Irish extinction risk/rare breeder	Natal philopatry	**Site Dependency Score**	Socio-economic, ecosystem services, cultural	**Social Value Score**	**Total score**	**Comments and References**
Common Sandpiper		2		1	**4**			**0**		**0**	**4**	
Common Scoter			2		**3**	2		**2**		**0**	**5**	
Coot				1	**2**			**0**		**0**	**2**	
Curlew		3	2		**6**	2	1	**3**	1	**1**	**10**	Natal philopatry not clear but likely high (Oring & Lank 1984)
Dunlin	2		2		**5**	2		**2**		**0**	**7**	Ssp. *C. a. schinzii. Nominate:* Natal philopatry (BWP) 50% <2 km.
Eider		5		1	**7**		1	**1**	1	**1**	**9**	IUCN: VU (Eur)/ EN (EU27)
Gadwall				1	**2**	1		**1**	1	**1**	**4**	Quarry species
Golden Plover	2		2		**5**	2		**2**	1	**1**	**8**	Quarry species, moorland "sentinel"
Goosander				1	**2**	2		**2**		**0**	**4**	
Great-crested Grebe				1	**2**			**0**		**0**	**2**	
Grey Heron					**1**			**0**	1	**1**	**2**	Top predator & highly familiar in Irish literature
Lapwing		3	2		**6**	1		**1**	1	**1**	**8**	Very familiar species to public, literature & folklore, natal philopatry ~61% (Coulson, 2016)
Little Egret	2				**3**	1		**1**		**0**	**4**	
Little Grebe				1	**2**			**0**		**0**	**2**	
Mallard					**1**		1	**1**	1	**1**	**3**	Quarry species
Moorhen					**1**			**0**		**0**	**1**	
Mute Swan				1	**2**		1	**1**	1	**1**	**4**	Very familiar species to public, literature & folklore

	Conservation status					Site dependency			Social value			
Species	Annex 1	IUCN	BoCCI Red	BoCCI Amber	**Conservation Status Score***	Irish extinction risk/rare breeder	Natal philopatry	**Site Dependency Score**	Socio-economic, ecosystem services, cultural	**Social Value Score**	**Total score**	**Comments and References**
Oystercatcher		3		1	**5**		1	**1**		**0**	**6**	Natal philopatry ~71% (Coulson, 2016)
Red-breasted Merganser		3			**4**			**0**		**0**	**4**	
Redshank		3	2		**6**	1	1	**2**		**0**	**8**	
Red-throated Diver	2			1	**4**	2		**2**	1	**1**	**7**	Natal philopatry per Okill (1992)
Ringed Plover					**1**		1	**1**		**0**	**2**	Natal philopatry per Coulson (2016)
Shelduck				1	**2**			**0**		**0**	**2**	
Shoveler					**1**	2		**2**	1	**1**	**4**	Quarry species
Snipe				1	**2**			**0**	1	**1**	**3**	Quarry species
Teal				1	**2**	1		**1**	1	**1**	**4**	Quarry species
Tufted Duck					**1**			**0**	1	**1**	**2**	Quarry species
Water Rail					**1**	1		**1**		**0**	**2**	
Garganey		3		1	**5**	2		**2**		**0**	**7**	
Pochard		3			**4**	2		**2**	1	**1**	**7**	Quarry species
Red-necked Phalarope	2		2		**5**	2		**2**	1	**1**	**8**	Natal philopatry per Schamel & Tracy (1991)
Black-tailed Godwit					**1**	2	1	**3**		**0**	**4**	Natal philopatry per Kruk (1998)
Black-necked Grebe			2		**3**	2		**2**		**0**	**5**	
Wigeon		3			**4**	2		**2**	1	**1**	**7**	Quarry species
Pintail		3			**4**	2		**2**	1	**1**	**7**	Quarry species
Greater Scaup		3			**4**			**0**		**0**	**4**	
Goldeneye					**1**			**0**	1	**1**	**2**	Quarry species
Little Ringed plover				1	**2**	2		**2**		**0**	**4**	
Mediterranean Gull	2			1	**4**	2		**2**		**0**	**6**	
Common Gull				1	**2**		1	**1**		**0**	**3**	
Lesser Black-backed Gull				1	**2**			**0**		**0**	**2**	
Greater Black-backed Gull					**1**			**0**		**0**	**1**	

	Conservation status					Site dependency			Social value			
Species	Annex 1	IUCN	BoCCI Red	BoCCI Amber	**Conservation Status Score***	Irish extinction risk/rare breeder	Natal philopatry	**Site Dependency Score**	Socio-economic, ecosystem services, cultural	**Social Value Score**	**Total score**	**Comments and References**
Black-headed Gull			2		**3**			**0**	1	**1**	**4**	Ecosystem services - colonies associated with incr. nest density of ducks & grebes (see: Liordos & Lauder, 2015)
Cormorant				1	**2**		1	**1**		**0**	**3**	
Common Tern	2			1	**4**			**0**		**0**	**4**	
Arctic Tern	2			1	**4**			**0**		**0**	**4**	Moderate natal philopatry at 67% within 20 km (Coulson, 2016)
Sandwich Tern	2			1	**4**			**0**		**0**	**4**	

Appendix 2 Designations status and NPWS Division of high priority sites

Table A2 The SPA and SAC designation status of and corresponding NPWS Regional Management Division for each of the high priority breeding waterbird sites identified. See Appendix 3 for species codes used below.

Site name	SPA code	SAC code	Species of primary interest	NPWS Division
Lough Ree	4064	440	BH, CX, CN, CU, GA, L., ET, OC, RK, RM, T.	W/N
Lady's Island Lake	4009	704	Terns, GA, L., BH	E
Tacumshin Lake	4092	709	GA, GY, L., ET, OC	E
Roonagh & Cross Lough	4212	1529, 484, 1932,	CS, CN, AE, L., OC, RK, RP, RM, T., DN,	W
Lough Corrib	4042	297	CX, CU, GA, L., OC, RK, RM, PO, SV, WN, T.	W
Inishkea Islands	4004	507	CN, AE, E., L.,OC, SV, RP	W
Inch Lake	4075	2287	BH, DN, GA, L.,PT, RK, TE	N
Connemara Bogs Carrowroe	4181	2034	CS, CN, AE, CU, L., OC, RK, RM, T., DN, GP	W
Dunfanaghy New Lake/Magheroarty	4194	147	E., L., OC, RK, DN	N
Loughs Carra & Mask	4051, 4062	1774	CN, BH, OC, L., RK, RM, DN, T.	W
Annagh Marsh & Termoncarragh	4093	470, 808	OC, NK, L., RK, RP, DN	W
Tory Island	4073	2259	E., L., OC, RK, DN	N
Lough Conn	4228	2298	CX, CN, GA, L., BH, OC, RK, RM, T.	W
Lough Derg	4058	2241	CN, L., BH, GA, RM, RK, SV	S/W
Trawbreaga/Malin	4034	2012	CU, E., L., RK, OC, RM,	N
Connemara Bogs and Slyne Head	4181, 4159	2034, 2074	CS, CN, AE, L., OC, RK, RM, T., DN, GP	W
Clew Bay inner		1482	CN, L., BH, OC, DN	W
Shannon Callows	4096, 4086	216	BW, CS, CU, L., RK, GA, GY, SV	W/S/E
The Murrough	4186	2249	ET, L., OC, SV, T.	E
Lough Derravaragh	4043		L., RK, ET, CN, BH	N
Lough Ourna			BH, GA, PO, SV	S
Limerick wetlands	4077	2165	CA, GA, L., SV, T., PO	S
Burren Lakes	4220	1926	CS, L., ET, RK	W
Boora			CS, L., RK, T., WN,	E
Blanket Nook	4075	2287	L., RK, OC, T.	N

Appendix 3 Species names and BTO two-letter species codes

BTO Species code	Species name	Scientific name
AE	Arctic Tern	*Sterna paradisaea*
BH	Black-headed Gull	*Chroicocephalus ridibundus*
BN	Black-necked Grebe	*Podiceps nigricollis*
BW	Black-tailed Godwit	*Limosa limosa*
CA	Cormorant	*Phalacrocorax carbo*
CM	Common Gull	*Larus canus*
CN	Common Tern	*Sterna hirundo*
CO	Coot	*Fulica atra*
CS	Common Sandpiper	*Actitis hypoleucos*
CU	Curlew	*Numenius arquata*
CX	Common Scoter	*Melanitta nigra*
DN	Dunlin	*Calidris alpina*
E.	Eider	*Somateria mollissima*
ET	Little Egret	*Egretta garzetta*
GA	Gadwall	*Mareca strepera*
GB	Greater Black-backed Gull	*Larus marinus*
GD	Goosander	*Mergus merganser*
GE	Goldeneye	*Bucephala clangula*
GG	Great Crested Grebe	*Podiceps cristatus*
GP	Golden Plover	*Pluvialis apricaria*
GY	Garganey	*Anas querquedula*
H.	Grey Heron	*Ardea cinerea*
L.	Lapwing	*Vanellus vanellus*
LB	Lesser Black-backed Gull	*Larus fuscus*
LG	Little Grebe	*Tachybaptus ruficolis*
LP	Little Ringed Plover	*Charadrius dubius*
MA	Mallard	*Anas platyrhynchos*
MH	Moorhen	*Gallinula chloropus*
MS	Mute Swan	*Cygnus olor*
MU	Mediterranean Gull	*Larus melanocephalus*
NK	Red-necked Phalarope	*Phalaropus lobatus*
OC	Oystercatcher	*Haematopus ostralegus*
PI	Pintail	*Anas acuta*
RH	Red-throated Diver	*Gavia stellata*
RK	Redshank	*Tringa totanus*
RM	Red-breasted Merganser	*Mergus serrator*
RP	Ringed Plover	*Charadrius hiaticula*
SN	Snipe	*Gallinago gallinago*
SP	Greater Scaup	*Aythya marila*
SU	Shelduck	*Tadorna tadorna*
SV	Shoveler	*Anas clypeata*
T.	Teal	*Anas crecca*
TD	Tufted Duck	*Aythya fuligula*
TE	Sandwich Tern	*Sterna sandvicensis*
WA	Water Rail	*Rallus aquaticus*
WN	Wigeon	*Anas penelope*