Birds in Wales

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Edited by Rhion Pritchard

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Welsh translations by Rhion Pritchard

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EDITORIAL

This issue includes the new version of Birds of Conservation Concern Wales, the third listing to be published. Compared to previous lists, some species are moving in the right direction, but the number of Red listed species has increased by eight since the last listing in 2010. The photographs on the front and back covers of this issue show two species which have moved directly to the Red list from being Green listed in 2010. The Kittiwake is still a fairly common breeding species along suitable parts of the Welsh coast, but numbers at most of the major colonies have been in gradual decline since the mid-1990s, and productivity figures have generally been poor. The next issue of the *Welsh Bird Report* will show that there was a welcome increase in both numbers and productivity at some of the main colonies in 2015, but it remains to be seen whether or not this heralds a period of better fortunes for this attractive gull. The Whinchat has moved from Green listing to Red largely as a result of more information on long-term trends in Wales being available. Though still found in quite good numbers in some areas of Wales, the species has vanished from other areas and overall is much harder to find than it was fifteen or twenty years ago.

The paper on changes in bird abundance in the Elenydd SSSI between 1982 and 2012 by Heather Crump and Mick Green shows that there have been worrying declines in this area over that thirty year period. Breeding Snipe have vanished from the study area, and there have been notable declines in the numbers of Golden Plover and Dunlin. These are just some of the species which need to be closely monitored in Wales. The next BTO Atlas is still many years away, but it is never too early to start preparing. The paper by Ian Spence in this issue considers the advantages and the feasibility of surveying all of Wales at tetrad level during field work for the next BTO Atlas, building on the results of surveys at tetrad level in some parts of Wales in recent years.

The paper by Compton *et al* is based on an analysis of the pellets of Little Owls and Short-eared Owls on Skomer Island, Pembrokeshire. The pellets of the Short-eared Owls here contained the remains of several species of mammal not found on the island, indicating that the birds travel to the mainland and to the neighbouring island of Skokholm to hunt. The final paper is a review by Julian Hughes of the first twenty years of the RSPB Conwy reserve. Those of us who saw the site twenty years ago, when it was an almost desert landscape made up of rubble from construction work, would never have thought it would have developed to be a major attraction, not only for enthusiastic birdwatchers but for many others with only a passing interest in birds.

Stephanie Tyler stepped down as Editor of *Birds in Wales* last year, and I would like to thank her not only for her work as Editor but for information and advice. She also acted as a referee this year, as did Mick Green and Steve Sutcliffe; I am grateful to all of them for their help. I thank Ian Spence for his help with the layout of this and previous issues of our journal. Thanks also to Kelvin Jones for taking responsibility for the photographs, and to photographers Phil Woolen and Bob Garrett for permission to use their work.

Rhion Pritchard

Birds of Conservation Concern in Wales 3: the population status of birds in Wales

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Crynodeb

- Mae'r prif sefydliadau cadwraeth yng Nghymru wedi adolygu statws poblogaeth y rhywogaethau adar a geir yma'n rheolaidd, gan ddiweddaru'r asesiad a gyhoeddwyd yn 2010 ar sail dull arolwg 2015 y DU.

- Adolygwyd cyfanswm o 213 o rywogaethau, a rhoddwyd pob un ar un o dair rhestr. Rhoddwyd 54 o rywogaethau ar y rhestr Goch (cynnydd o wyth), sydd ar gyfer y rhywogaethau sydd mewn perygl yn fyd-eang neu sydd wedi lleihau'n sylweddol yn hanesyddol neu'n ddiweddar. Gosodwyd 90 ar y rhestr Ambr (gostyngiad o naw), sydd ar gyfer rhywogaethau sy'n cynyddu yn dilyn lleihad hanesyddol neu gymhedrol, neu sy'n lleol, prin neu o bwysigrwydd rhyngwladol. Rhoddwyd y 69 sy'n weddill ar y rhestr Werdd (cynnydd o un).

- Roedd y rhan fwyaf o symudiadau rhwng y rhestri Coch ac Ambr (naw i fyny, tri i lawr), ond symudodd dau rywogaeth (Gwylan Goesddu *Rissa tridactyla* a Chrec yr Eithin *Saxicola rubetra*) o Wyrdd i Goch. Y prif reswm dros symud oedd newidiadau mewn data poblogaeth, er i newid yn y meini prawf fod yn gyfrifol am rai.

- Roedd y gyfran o rywogaethau adar nythu yn amrywio yn ôl cynefin, gyda mwy o rywogaethau sy'n nythu mewn cynefinoedd ar y glannau, tir amaethyddol a'r ucheldir ar y rhestri Coch ac Ambr na grwpiau eraill. Hefyd, bu mwy o ychwanegiadau i'r rhestr Goch ymhlith adar sy'n nythu ar y glannau a'r ucheldiroedd nag ymhlith adar sy'n nythu mewn cynefinoedd eraill. Grŵp arall sy'n fwy niferus ar y rhestri Coch ac Ambr yw adar sy'n gaeafu neu'n mudo trwy Gymru ond nad ydynt yn nythu yma.

- Tra bod lefel pryder cadwraeth rhai rhywogaethau wedi newid ers yr asesiadau blaenorol, mae'n anodd gweld cysylltiadau clir ar gyfer rhywogaethau unigol rhwng hyn a ffactorau fel rheolaeth tir, newid hinsawdd a gweithgareddau cadwraeth. Er hynny, mae'r ail-asesiad yma yn tanlinellu fod adar y glannau yn grŵp newydd sydd angen sylw, yn ogystal â'r grwpiau pwysig eraill, adar tir amaethyddol ac adar yr ucheldir.

Summary

- The leading bird conservation organisations in Wales have revised the population status of the bird species that are regularly found here, updating the assessment published in 2010 and based on the method of the 2015 UK review.

- A total of 213 bird species were assessed and each placed on one of three lists. Fifty four species were placed on the Red list (an increase of eight), which is for those that are globally threatened, or have historically or recently shown severe decline. Ninety were placed on the Amber list (a fall of nine), which is for those showing recovery from historic decline, moderate decline, or are localised, rare or internationally important. The remaining 69 were placed on the Green list (an increase of one).

- Most movements were between Red and Amber lists (nine upward, three downward), but two species, Kittiwake *Rissa tridactyla* and Whinchat *Saxicola rubetra* moved from Green to Red. Movements could be accounted for primarily by changes in population data, although changes to criteria did account for some.

- For breeding birds, the proportion of species on each list varied by habitat, with more breeding birds of coastal, farmland and upland habitats being Red and Amber listed than other groups. Furthermore, there were more additions to the Red list among coastal and upland breeding birds than among breeding birds in other habitats. Wintering and passage migrants that do not breed in Wales represent a fourth group of birds over-represented among Red and Amber lists.

- Whilst the level of conservation concern of some species has changed since the previous assessment, clear links with drivers such as land management, climate change and conservation action are difficult to make for individual species. Nevertheless, this reassessment highlights that coastal breeding birds is a new group to watch, in addition to the already important farmland and upland bird groups.

Introduction

This paper presents the third 'Birds of Conservation Concern in Wales' (BoCC W) assessment, previous assessments having been made in 2002 (Thorpe & Young 2002) and 2010 (Johnstone *et al* 2010). Using a well established approach, based on quantitative assessments against standardised criteria, birds are placed on 'Red', 'Amber' or 'Green' lists to indicate the level of 'conservation concern' we have for them. In the first assessment (BoCC W1) we acknowledged that such assessments should be revised periodically to inform conservation action and that they should also take a hierarchical approach to geographic scale. Thus, the status of species at smaller geographic scales must take into account their status at larger scales (i.e. Wales < UK < Europe < international < global).

At the centre of this assessment are the same eight broad criteria used in the first assessment ensuring consistency between successive reviews. However, some changes have been made to the methods used due to changes in data availability (Table 1) as well as to reflect our growing understanding and experience, mirroring those made at the UK level (BoCC4: Eaton *et al* 2015). Though the process for individual species assessments is consistent with those undertaken in the UK assessment (BoCC4), Wales has a particular responsibility for the populations of UK species with populations concentrated in Wales. Consequently, we continue to make use of criteria that show when Wales has 50% or more

of the UK population of a species, and 10% or more of UK rare breeding or non-breeding species (excluding those not established as breeding species in Wales).

If we are to track our progress towards environmental goals we need regular, quantitative measures of the state of our environment and the means to ensure effective use of resources. With the ongoing decline of nature in Wales (Burns *et al* 2013) and the resultant threat to the health and resilience of our ecosystems, this need has never been more pressing. BoCCW3 provides up to date knowledge, enabling us to identify the threatened bird species that require urgent conservation action and helping to prioritise where resources should be directed.

Methods

Species assessed

Thorpe & Young identified extinct species as those that had been regular breeders since 1800 but had not successfully bred in Wales in the 20 years before the assessment year (1994 for this assessment). As with the two previous assessments we included all those species on the Welsh list, excluding those that occur solely as vagrants and rare and scarce migrants, but have included the only globally threatened species that has occurred in Wales in each of the 20 years prior to 2014 (Balearic Shearwater *Puffinus mauretanicus*). The year of colonisation (or re-colonisation) was that in which the population first met a mean of one pair per year over the previous five years.

Non-breeding birds were considered established when removed from the lists of vagrants and rare or scarce migrants. Also excluded were non-native species that have established self-sustaining breeding populations. These species could not have arrived in Wales naturally, and are not considered of conservation interest: None of the non-native species in Wales are considered threatened within their native ranges, which, with the exception of Little Owl, *Athene noctua* are outside of Europe.

The approach

The approach, as established by two previous Wales-level assessments (Thorpe & Young 2002, Johnstone *et al* 2010), and four UK-level reviews (Gibbons *et al* 1996, Gregory *et al* 2002, Eaton *et al* 2009, Eaton *et al* 2015), assesses bird populations against a series of quantitative criteria relating to aspects of population status. Meeting one or more criteria qualifies a species for the relevant list; with species being placed on the highest priority list for which they qualify (i.e. those qualifying against a Red criterion will be placed on the Red list regardless of qualification against Amber criteria). Those species that meet none of the criteria along with any that have continued to recover from historic decline are placed on the Green list.

The criteria

The criteria determine population status based on: global importance, historical population decline, recent population decline, European importance, breeding rarity, localised distribution, UK importance and international importance, reflecting a hierarchical approach to geographical scale. The eight main criteria and their sub-criteria are summarised in Table

1, where differences between the criteria used in this assessment, the previous Wales assessments and the current UK assessment are identified, and expanded upon below.

1. GLOBAL POPULATION STATUS (IUCN). This criterion considers the population status of each species in a global context. Species that meet this criterion are those of the highest priority for action, and hence should be so in Wales regardless of national status (i.e. should be Red-listed even if they only occur briefly and in low numbers). In assessing species against this criterion, we have used the latest 2015 assessment of globally threatened species (www.iucnredlist.org).

2. HISTORICAL DECLINE IN BREEDING POPULATION (HD). The period over which population trends are assessed is recent, reflecting the period that formal monitoring schemes have been in place. It would thus be possible for a species to have undergone a large population decline over the last two centuries, but for its population to have remained stable during the last few decades.

In line with the approach for Ireland (Colhoun & Cummins 2013), the Wales assessment uses information from reliable historical sources (Lovegrove *et al* 1994, Holloway 1996) and the 1988-1991 Breeding Bird Atlas (Gibbons *et al* 1993) to establish historical trends for the period 1800-1994. We used the same assessment as compiled for BoCC W1 (Thorpe & Young 2002).

Populations of species that have declined will recover if conditions become more suitable through, for example, successful conservation action or more favourable climate. We used the sub-criteria to allow species that have shown recovery from historic decline to move sequentially from Red to Amber to Green lists. This recognizes recovery in numbers, while not ignoring small populations or UK, European and international status. The process by which species were considered to have shown partial recovery from historical decline (hence move to the Amber list), or complete recovery (move to the Green list), or subsequently faltered from those recoveries, follows that used by BoCC4. Thus any HD species doubling its population size or more within the 25-year period, and exceeding 10 breeding pairs (10% of the UK value of 100 pairs) moves to the Amber list (provided it did not qualify as Red under other criteria). One change was made to this step to be consistent with other criteria, and introduced an assessment of trend over the BoCC longer-term period (since 1969 as the earliest data used by BoCC Wales). Therefore, in BoCC W3 we used the following rationale: a species should be moved to the Green list (if not qualifying against other Red or Amber criteria) if it shows continued and substantial recovery from historical decline beyond the level that qualified the species for the Amber list. When it moves to Green, the species should be considered as having recovered permanently and would no longer be assessed against the HD criterion, i.e. any subsequent decline would be assessed only against the relevant decline criteria such as BDp (Breeding population decline). A further increase of at least 167% from its HDrec (Historical Declne recorded) level is required to move to the Green list. This higher threshold ensured that if a species subsequently declines by anything less than 25% (thus does not trigger a return to the Amber list under the moderate decline criterion), it will still remain at more than double its HDrec numbers.

3. RECENT BREEDING AND NON-BREEDING POPULATION DECLINE (BD / WD). This criterion is used to assess the extent of decline for birds that spend different life-stages in Wales, and consists of several sub-criteria and thresholds. Data on change in breeding

abundance (numbers) and range (geographic distribution) are used to assess resident and migrant breeding species. Change in abundance outside the breeding season was used to assess non-breeding populations that breed elsewhere. Some non-breeding migrants occur in greater numbers than during breeding (sometimes involving different races or geographic populations), and where possible both breeding and non-breeding populations were assessed. As only waterbirds are regularly monitored during the non-breeding season, many species could not be assessed against the non-breeding criterion (e.g. Starling *Sturnus vulgaris* and Fieldfare *Turdus pilaris*).

Change in geographical distribution is important evidence for change in population status. However this can be misleading where ranges are consistently small, when small and biologically insignificant numerical change may result in percentage change sufficient for red-list qualification. As in previous assessments therefore, range change assessments were not carried out for species occupying <20 10 km squares in both time periods (such as Spotted Crake *Porzana porzana* and Hooded Crow *Corvus cornix*). The exception to this was seabirds, as range approximates to number of colonies (each of which may be large). Change in the distribution of these is an important component of population status even if they are few in number. For the first time in this series of assessments we were able to assess trends in wintering range following completion of the 2007-2011 Atlas.

For each of the sub criteria (time-period and abundance/range), we distinguish between three levels of change: rapid (at least 50% decline), moderate (at least 25% but less than 50% decline) and none (less than 25% decline) to distinguish between qualification for Red, Amber or Green lists. As in BoCC W2, data from 25 year and longer-term periods were used (1967-2013). This takes account of species whose decline lies between historical and recent, and from which there has been no recovery.

4. EUROPEAN IMPORTANCE (ERLOB). Previous assessments have used Species of European Conservation Concern assessments (SPECs; see Tucker & Heath 1994 and BirdLife International 2004) as an indication of wider regional concern (species on the SPEC list were Amber listed in Wales). Although a new European assessment, the European Red List of Birds (ERLOB; BirdLife International 2015), is newly available, this assessed against IUCN Red List criteria (IUCN 2012) with no consideration of the wider measures (species rarity, localisation, moderate decline and depletion) included in SPEC assessments. Because it is unclear when or if SPECs will be revised, therefore, following BoCC4, we chose to Amber-list any species on the ERLOB, recognising that this has had an impact on the BoCC W3 lists.

5. BREEDING AND NON-BREEDING RARITY (BR / WR). Species were categorised as rare breeders in Wales if they had a breeding population of fewer than 30 pairs, and, for the first time, as rare non-breeders if the non-breeding population was fewer than 90 individuals (small non-breeding populations are as important as breeding populations). We continue to include a sub-criterion to highlight, by Amber-listing, species for which Wales supports ≥10% of the UK's population of rare breeding or (for the first time) wintering birds (i.e. ≤30 breeding pairs or ≤90 winter individuals in UK). This reflects the importance of those populations in Wales to the overall UK populations.

Breeding rarity was assessed from recent formal single-species surveys (e.g. Hen Harrier *Circus cyaneus*), and two informal sources published annually (the UK Rare Breeding Birds

Panel reports published in *British Birds* and the Welsh Ornithological Society classified records for the period 2008-2013 published in *Birds in Wales*). Non-breeding rarity was assessed from mean maximum number of individuals per winter between 2007-08 and 2012-13. Assessments from such informal data were reviewed by experts and in cases where they were considered to underestimate population size for some species, such as breeding Water Rail *Rallus aquaticus* and non-breeding Dotterel *Charadrius morinellus* qualification under this criterion was informed by expert opinion.

6. LOCALISED POPULATIONS (BL / WL). This criterion was used because populations that are geographically concentrated face greater threats from chance events than those that are more dispersed. Rare breeders or non-breeders (species qualifying under criteria 5 (Table 1)) were not assessed against this criterion as their small numbers and range make them more likely to be localised. Amber listing under the localised criterion is intended to signal a species' vulnerability as relatively local pressures (e.g. pollution or development) could adversely impact a large proportion of the population.

The criterion was based on the single best site (SPA and/or IBA), rather than the best 10 in the UK-level assessment, to reflect the extent of Wales within the UK. Species with 50% or more of their population in a site qualified for the Amber list. If the Wales population estimate was presented as a range, we took a conservative approach by requiring that the site held at least 50% of the upper range limit. Data for the most populous site in the breeding and non-breeding seasons were compared with Wales' population estimates for the same period, using site-level data (often using single-species breeding surveys and the Wetland Bird Survey for wintering populations).

However, because of issues of data availability, as previously, we treated the entire Dee and Severn estuaries including parts that were outside of designated areas as single sites. Because of this, and the simple head-count method used to calculate waterbird population estimates, we took a precautionary approach to assessing non-breeding waterbirds. Two waterbirds (Bewick's Swan *Cygnus columbianus* and White-fronted Goose *Anser albifrons*) were treated differently. In both cases, there was evidence that populations on the Dee and Severn estuaries were almost exclusively limited in their distribution to the eastern shore and adjacent agricultural land in England (Robinson *et al* 2004). Therefore, these species were assessed using non-WeBS data for Wales.

7. UK IMPORTANCE. This criterion is used to assess the population status of each species in a UK context: Red list qualification at the UK-level is used as an Amber list qualification in Wales. This ensures that UK priorities are fully considered at the Wales-level in the same way that European priorities are considered in both the UK and Welsh assessments.

Wales may have a particular responsibility for the populations of some UK species with a western distribution. Consequently, sub-criteria show when Wales has 50% or more of the UK population of a species, and 10% or more of a UK rare breeding or non-breeding species, excluding any not established as breeding species in Wales.

8. INTERNATIONAL IMPORTANCE. Species for which Wales holds at least 2% of the European population in either the breeding or non-breeding season were considered present in internationally important numbers. Again this was less than the 20% used for the UK criterion, to reflect the extent of Wales within the UK. We use the same international

population estimates as the UK assessment (Eaton *et al* 2015). The UK assessment used Musgrove *et al* 2013 as their source of data on the population sizes of widespread breeding species. However, these are not available for Wales, so as in previous assessments we were unable to assess some species against these criteria.

European estimates are often of uncertain quality and expressed as a large range owing to poor knowledge in many countries. We required the Wales population estimate to exceed 2% of the upper range limit of the European or flyway population for a species to qualify under this criterion.

Data sources

The monitoring of bird populations in Wales is good, thanks largely to the many skilled and enthusiastic volunteer bird watchers that take part. Data sources used for this assessment are summarised in Table 2. They cover schemes ranging from the formal Breeding Bird Survey (BBS), whose results are of known precision, to the informal classified records, which provide the only information on some rare breeding, passage and wintering birds but which need to be interpreted more cautiously owing to their lack of rigorous method. Furthermore, some species lack population monitoring in Wales because they are too scarce to be reported on by annual schemes such as the BBS, but still too widespread for informal records to be useful. BoCC W1 and BoCC W2 took a precautionary approach for such species: where there was no evidence in Wales to contradict UK-level population change, the same listing was adopted (and UK values are reported in results tables and labelled as such).

This approach was continued in this third assessment. UK data for individual species were only used if they were considered representative of national populations based on expert opinion. In addition, we took a precautionary approach to using trends for species reported on by BBS with marginal sample sizes (mean squares with records n=20-29), with species only qualifying based on such data if there was other supporting evidence from Wales.

However, there is a trade off between using Wales-specific sources that may be based on specific habitats or be relatively out of date, and robust UK sources, such as the longer-term CBC/BBS trend, that may mask within-UK variation. Indeed, it is known that trends vary across the UK for some species, and we cannot rule this out for other species that lack formal data in Wales. We took the decision to prioritise data sources according to Table 3, but anticipate that some sources will be too out of date to be used in future assessments.

In separating data from the UK, Welsh 10km squares were taken as those along the border that were at least 50% in Wales by land area. There were a few squares which were not covered in all three Atlases (2 during breeding and three during winter), and these were excluded from assessments of percentage change in occupied squares between Atlas periods.

Results

Species assessed

The breeding populations of nine former regularly breeding species became extinct between 1800 and 1984 (Table 3), three of which continue to be assessed as winter migrants. No species has become extinct since BoCC W2, although given a lack of records in recent years, the Corncrake *Crex crex,* Turtle Dove *Streptopelia turtur* and Corn Bunting *Emberiza calandra* are close to meeting the definition. Since 1800 a few species have established small temporary breeding populations once (the Common Gull *Larus canus* currently assessed as a winter migrant) or more than once (Bearded Tit *Panurus biarmicus* currently established), while other species have established as breeders within the last decade or so (Little Egret *Egretta garzetta,* Osprey *Pandion haliaetus*), while still others are likely to do so in the future (Mediterranean Gull *Larus melanocephalus*). Three species, Bittern *Botaurus stellaris* Woodlark *Lullula arborea* and Red-backed Shrike *Lanius collurio* have bred or showed signs of breeding in single locations in some recent years, but have not yet met the definition for being considered established (or re-established) breeders.

The new Red, Amber and Green lists

Of the 213 species assessed, 54 species (25%) were placed on the Red list, an increase of eight (Table 5), while 90 (42%) were placed on the Amber list (Table 6), a decline of nine. The remaining 69 species (33%) were placed on the Green list, a decline of two (Table 7). Twenty five species moved to higher lists while 20 species moved to lower lists between BoCC W2 and BoCC W3 (Table 8). Thirty nine species were on a higher UK list while 38 were on a lower UK list. Two species were Red-listed in Wales but Green-listed at UK level (European Golden Plover *Pluvialis apricaria,* Whitethroat *Sylvia communis*) (Table 8). The number of species on the Welsh Red and Amber lists has steadily increased over time, but the proportions of species assessed on each list is very similar to that for the same species at UK-level (Figure 1).

Reasons for changes between BoCCW2 and BoCCW3

The majority of moves between lists could be explained by changes in underlying population data, with 15 upward moves and nine downward moves solely accounted for by this. Furthermore, among Red list species, the majority of qualifications were due to decline in abundance (Figure 2), suggesting that placement on the lists is most sensitive to population data. The remainder of the 45 moves between lists were solely (nine species) or partly (12 species) due to changes to the criteria used in this assessment (Table 9). In particular the use of the ERLOB list in place of the SPEC list resulted in seven species dropping to the Green list (Table 9).

BoCC Wales and breeding habitats

There were patterns among breeding habitats for the proportions of species placed on each

list, based on the breeding habitat associations used by Gibbons *et al* (1993). Coastal, farmland and upland birds had the greatest proportions of species on the Red and Amber lists (70-93%), while upland and coastal groups had the greatest number of additions to the Red list (three each, Figure 3). The level of conservation concern of breeding birds associated with lowland wetland, woodland and urban habitats is more reassuring, with half or more of species in these groups being placed on the Green list (50-52%, Figure 3).

Winter and passage migrants without breeding populations in Wales, with the exception of Redwing *Turdus iliacus,* Snow Bunting *Plectrophenax nivalis,* Waxwing *Bombycilla garrulus* and Fieldfare, inhabit coastal and lowland wetland habitats, with a high proportion of this group (59%) being Amber listed but one of the lowest proportions (16%) on the Red list (Fig.3). Knot *Calidris canutus,* Long-tailed Duck *Clangula hyemalis* and Bewick's Swan joined the Red list for this group.

Discussion

Red list increases in length again

Our assessment shows that length of the Red list has increased by a further eight species since BoCC W2 in 2010, and by 17 species since BoCC W1 in 2002. This increase is accounted for by population data showing worsened and now severe decline.

A feature of the successive assessments since BoCC W1 has been the incremental 'fine tuning' of the criteria and the incorporation of new data as they become available. These changes are essential to adapting successive assessment to increased knowledge and improving and changing datasets over time. Thus a species' movement to the Red list can be as a result of the same data source showing successively worsening declines, and/or the inclusion of criteria which incorporate previously unused data. For example, previously data deficient, the Whinchat has moved from the Green to Red list on account of new Wales data on longer term trends becoming available for use with an existing criterion. In contrast, the Bewick's Swan has moved from Amber to Red on account of the new winter range criterion.

This assessment at a Wales level highlighted key differences between the status of some species in Wales when compared to the UK. European Golden Plover and Chough *Pyrrhocorax pyrrhocorax* both moved onto the Green list in the latest UK assessment (BoCC4) though they remain Red and Amber respectively in Wales and of key conservation concern. Golden Plover have shown catastrophic declines in Wales, where they are on the south west edge of their UK and European breeding range and remain on the Red list. Chough is on the UK Green list in BoCC4, due partly to the change in this latest assessment of the treatment of conservation concern at the European level. However, they remain relatively rare and range restricted in the UK and with more than 50% of the UK breeding population in Wales they remain on the Amber list in this assessment and continue to merit conservation concern.

The lists and breeding habitats

Among the habitats compared for breeding birds, birds of coastal habitats, which include

many of our well known seabirds, are faring particularly poorly, with 93% of the 29 breeding species on the Red or Amber lists, and three joining the Red list at this review. Moving from Green to Amber are the cliff nesting Shag *Phalacrocorax aristotelis* (now of European importance and on the UK Red list), Fulmar *Fulmarus glacialis* and Razorbill *Alca torda* (both now of European importance). Kittiwake has moved straight from Green to Red on account of population decline. Although conservation efforts directed at seabirds have been greatest in the other UK countries, the high and increased proportion of Red and Amber listed coastal birds in Wales may suggest an increasing need for such measures in Wales also. There are, however, some improvements in status, such as the Common Tern *Sterna hirundo* whose range decline has improved from severe to moderate.

Farmland and upland birds are two other habitat groups which are over-represented on the Red and Amber lists, with three species joining the Red list. Characteristic of fast flowing streams, the Grey Wagtail *Motacilla cinerea* is of greater concern following breeding decline and joining the UK Red list. Another bird of upland streams, the Common Sandpiper *Actitis hypoleucos* has also joined the red list because of population decline. The moorland nesting Merlin *Falco columbarius* has re-qualified for the Red list under historic decline, as it has also done at UK-level. Finally, with new data available for the long-term period, the Whinchat has joined the Red list, mirroring its status at UK level. Among lowland farmland birds, the Greenfinch *Chloris chloris* has moved from Green to Amber on account of a moderate 25 year breeding decline. This change likely provides an example of the impact of disease on the lists, with populations affected by *Trichomonosis* in recent years (Lawson *et al* 2012).

Birds breeding in lowland wetland, woodland and urban habitats were among those that are particularly well represented on the Green list, and there were few movements between lists. Grey Heron *Ardea cinerea* and Coot *Fulica atra* move from Green to Amber due to moderate range decline and European importance respectively. Just one woodland bird, the Woodcock *Scolopax rusticola* moved from Amber to Red on account of breeding population decline, and this species selects farmland in early spring for foraging (Hoodless & Hirons 2007). Finally among urban birds, there were no movements to higher lists.

Note that assessments were made at the species level and that there are no separate lists for breeding and wintering populations. For example, there is no separate assessment for the two races of White-fronted Geese that overwinter in Wales, though it is recognised that Wales supports the most southerly wintering flocks of the critically endangered Greenland race (*Anser albifrons flavirostris*). Indeed, many species with important wintering populations also breed in Wales in widely varying numbers (e.g. Robin *Erithacus rubecula* and European Golden Plover). Therefore whilst comparing between breeding habitats provides a useful way to contrast important groups of birds, in some cases the listing of individual species will be the result of wintering rather than breeding criteria. Of the winter and passage migrants which do not breed in Wales, three quarters were Red or Amber listed, making them a fourth important group of birds in terms of their levels of conservation concern, particularly for Amber listed species.

Drivers of movement between lists

Although there are some methodological influences on the revised lists, movement of bird

species between lists is primarily influenced by responses to environmental change, and key drivers of this change are land management, and climate change (Burns *et al* 2016). Furthermore, differing magnitudes of impacts of land management and climate might be expected to explain the variation in listings between preferred breeding habitats. For example, coastal breeding birds might be impacted more by climate change than farmland birds, where land use change may be most important.

It is tempting to link listings and movements between lists to specific drivers. In many cases, however, this is difficult without detailed diagnostic research and may in fact be the result of multiple drivers. For example, whilst the move of Mediterranean Gull from Amber to Green and Kittiwake from Green to Red might be examples of likely climate change effects on marine food resources, the move of Whinchat from Green to Red or Merlin from Amber to Red are at this stage hard to explain. In both cases land use such as inappropriately high or low management intensity or climate change may be influencing populations.

Nevertheless, some themes are reinforced by this reassessment while other themes have emerged. First, farmland and upland birds continue to be over-represented on Red and Amber lists. Second, coastal birds have emerged as a new important group within the Red and Amber lists. Climate change and land management remain likely important drivers of membership of and movements between the lists, but allocating their impact at the level of individual species will remain a challenge for most species.

The future

Birds are being added to the Red list faster than our collective ability to deliver conservation actions to improve their status. For example, whilst the Glastir agri-environment scheme has objectives for priority bird species, there is currently no evidence to link it to change in their conservation status, and this may be because the correct combination of critical resources is not provided and/or that scheme extent has not been sufficient. Funding to progress conservation research and delivery has been limited by the climate of austerity within governments in recent years, and this may continue for the UK and Wales as we leave the EU. It is vital therefore that the monitoring programmes upon which BoCC Wales and BoCC UK depends are continued to inform future reassessments of BoCC Wales, and this will only be possible thanks to the army of dedicated volunteers that take part.

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List	Criteria	Name	Definition	Abbrev	First use
Red	1	Global importance	IUCN globally endangered, critically threatened, endangered or vulnerable, ecluding	IUCN	1
Red	2	Historic decline	Severe historical decline 1800-1994	HD	1
Red	3	Recent population decline	At least 50% decline in breeding population (25yrs)	BDp1	1
Red	3	Recent population decline	At least 50% decline in wintering population (25yrs)	WDp1	1
Red	3	Recent population decline	At least 50% decline in breeding population (longer-term)	BDp2	2
Red	3	Recent population decline	At least 50% decline in wintering population (longer-term)	WDp2	2
Red	3	Recent population decline	At least 50% decline in breeding range (25yrs)	BDr1	1 [1]
Red	3	Recent population decline	At least 50% decline in breeding range (longer term)	BDr2	2
Red	3	Recent population decline	At least 50% decline in wintering range (25yrs)	WDr1	3
Amber	4	European importance	Included in the European Red List of Birds (ERLOB)	ERLOB	1 [2]
Amber	2	Historic decline - recovery	Was Red but population increase of greater than 100% in last 25 yrs.	HDrec	1
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding population (25yrs)	BDMp1	1
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding population (longer term)	BGMp2	2
Amber	3	Recent population decline	At least 25% but less than 50% decline in wintering population (25yrs)	WDMp1	1
Amber	3	Recent population decline	At least 25% but less than 50% decline in wintering population (longer term)	WDMp2	2
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding range (25yrs)	BDMr1	1 [1]
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding range (longer term)	BDMr2	2
Amber	3	Recent population decline	At least 25% but less than 50% decline in wintering range (25yrs)	WDMR1	3
Amber	5	Breeding or non-breeding rarity	Mean of less than 30prs or 90 individuals in the most recent 5yr period with data.	BR	1
		Breeding or non-breeding rarity	Mean of less than 30prs or 90 individuals in the most recent 5yr period with data.	WR	1
Amber	6	Localised breeding or non-breeding	At least 50% of population occurs at one site, but not a rare breeder	BL	1
Amber	7	Localised breeding or non-breeding	At least 50% of population occurs at one site, but not a rare breeder	WL	1

Amber	7	UK	Red listed at UK-level	UKRed	1 [3]
Amber	7	UK	At least 50% of the UK population occurs in Wales	UK50	2 [3]
Amber	7	UK	At least 10% of the population of a UK rare breeding or wintering species	Bruk	2 [3]
		UK	At least 10% of the population of a UK rare breeding or wintering species	WRuk	2 [3]
Amber	8	International importance	At least 2% of the European or East Atlantic flyway population	BI	1
Amber	8	International importance	At least 2% of the European or East Atlantic flyway population	WI	1
Green	2	Historic decline	Further recovery: was Amber and at least 167% increase since first HDrec qualification	HDrec2	1

Table 1. The criteria used for the BoCC W3 assessments, along with differences between this and other assessments. Also shown is the original BoCC Wales assessment in which each sub-criteria was first used.

1. Only assessed if range greater than 20 10km squares in both years. This requirement relaxed for seabirds from BoCCw2 owing to colonial nature.
2. ERLOB replaced SPEC for BoCCw3
3. Used for Wales assessment only

Source	Life-stage	Metric	Key organisa-	Time-period	Description
BBS	Breeding	Annual abundance index	BTO/JNCC/RSPB	BBS 1995-2013	Random sample of 1km sqrs surveyed annually using a standard method to generate an abundance index. Sp inclusion depends on number of sqrs with records and has increased over time
SCARABBS	Breeding	Periodic abundance	RSPB/BTO/NRW	Typically 6 or 12 year repeats	Full or sample surveys to estimate population size using species-specific field methods
Seabird censuses	Breeding	Periodic absolute	JNCC/NRW	1969-70, 1985-88, 2000	Full census of all breeding seabirds using species-specific methods
SMP	Breeding	Annual abundance index	JNCC/RSPB	1986-2013	Sample census using species-specific methods
Atlas	Breeding	Periodic, range	BTO	1968-72, 1988-91, 2007-11	Species geographical distribution at the 10 km sqr scale. Range change was the % change in occupied sqrs between Atlas periods where at least 50% of each square was within Wales (and its coastal waters), including only squares surveyed in each time period of interest.
RBBP	Breeding	Annual abundance	RBBP	1970s-2013	County-level reports of numbers of breeding pairs using informal coverage
Classified records	Breeding and wintering	Annual abundance	WOS/RBBP	Up to 2013	County-level breeding, passage and wintering species numbers not included in RBBP reports
WeBS	Wintering	Annual abundance	BTO/RSPB/JNCC	1969-2013	Systematic counts of roosting waterbirds birds on estuaries and inland water bodies expressed as an abundance index
NEWS	Wintering	Periodic abundance	BTO	1997/98 - 2006/07	Non-estuarine waterbird survey. The objective of this is to cover coastline outside of established webs sites
WinGS	Wintering	Periodic abundance	BTO	1983-2004	Wintering gull survey. Repeat roost counts at known sites
Atlas	Wintering	Periodic, range	BTO	198182-83/84, 2007/08-10/11	Species geographical distribution at the 10 km sqr scale (see also breeding Atlas above)

Table 2. The main data sources providing data on Welsh bird populations and used in the BoCCw3 assessment.

Rank	Source	Earlies/latest years for trend	Data specific to:
1	SCARABBS and other national single species surveys	1982/2014 (both Chough)	Wales
2	Wales smoothed BBS	1995-2013	Wales
3	Wales small sample smoothed BBS, with supporting evidence	1995-2013	Wales
4	Habitat surveys, with supporting evidence	1968-2003/04 RWBS)[1] 1982-2002 (WWM)[2] 1983-2002 (RUBS)[3]	Wales
5	UK CBC/BBS, with supporting eveidence	1967-2013[4]	UK

Table 3. Ranked priority for use of data sources for assessment under the Recent Population Decline criteria.

1. Repeat woodland bird survey (Amar et al 2006)
2. Waders of wet meadows (Wilson et al 2005)
3. Repeat upland birds survey (Sim et al 2005)
4. From BTO Bird Trends www.bto.org/about-birds/birdtrends

Species	Scientific name	Current status	Most recent breediing
Black-necked Grebe	*Podiceps nigricollis*	Winter migrant	1957
Bittern	*Botaurus stellaris*	Winter migrant	1984
Marsh Harrier	*Circus aeruginosus*	Winter migrant	1992
Montagu's Harrier	*Cicus pygargus*	Rare migrant	1964
Wryneck	*Jynx torquilla*	Scarce migrant	1904
Woodlark	*Lullua arborea*	Rare migrant	2006
Nightingale	*Luscinia megarhynchos*	Rare migrant	1981
Red-backed Shrike	*Lanius collurio*	Rare migrant	2006
Cirl Bunting	*Emberiza cirlus*	Rare migrant	1960

Table 4. Birds that bred regularly in Wales in 1800 but whose breeding populations have since become extinct, with current status and most recent year with breeding (to year of this assessment).

English name	BoCC W2	IUCN	HD	BDp1 & BDMp1	BDp2 & BDMp2	BDr1 & BDMr1	BDr2 & BDMr2	WDp1 & WDMp1	WDp2 & WDMp2	WDr1 & WDMr1	HDrec1	ERLOB	UK Red	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Bewick's Swan	A									-55		EN											
White-fronted Goose	R							>50	>50						61							70-80^{Both}	
Pochard	R	VU						-64	-73	*-28*		VU	*										
Long-tailed Duck	R	VU								*-37*		VU			21								
Red Grouse	R		*				*-44*					VU											
Black Grouse	R		*			*-48*	-67			*-46*			*										
Grey Partridge	R		*	-75^{uk}	-91^{uk}	-58	-78			-67			*										
Balearic Shearwater	R	CR										CR	*										
Slavonian Grebe	A	VU													45								
Hen Harrier	R		*									NT	*		55								
Corncrake	R		*	-100	-100		-98						*	*0*									
European Golden Plover	R			-89	-83		*-27*																
Grey Plover	R							-63	-44													10-20^{SPA}	
Lapwing	R			-77	-99	*-35*	*-46*					VU	*										
Ringed Plover	A							-62	-52				*								*4*		
Curlew	R			-57	*-39uk*	*-30*	*-39*					VU	*								*2*		
Bar-tailed Godwit	R							*-28*	-58														
Knot	A							*-31*	-56												*4*		
Dunlin	R			*-41*	*-45*			*-26*	-51					*17*							*3*	40-50^{Both}	
Common Sandpiper	A			-51^{uk}	-50^{uk}							LC											
Redshank	A				*-38*	-62	-67					LC									*4*	70-80^{Both}	
Woodcock	A			*-48*		-58	-77						*										

English name	BoCC W2	IUCN	HD	BDp1 & BDMp1	BDp2 & BDMp2	BDr1 & BDMr1	BDr2 & BDMr2	WDp1 & WDMp1	WDp2 & WDMp2	WDr1 & WDMr1	HDrec1	ERLOB	UK Red	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Puffin	R	VU										EN	*						*90-100*^{SPA}				*
Little Tern	R					-50													*90-100*^{Both}				
Roseate Tern	R			-100	-100	-25								*1*									
Arctic Tern	R						-60												*90-100*^{Both}				*
Kittiwake	G			-51								VU	*										
Black-headed Gull	R			-34	-75		*-46*	*-39*													*2*		
Common Gull	R							-70															
Herring Gull	R				-68			-57				NT	*								*4*		
Great Black-backed Gull	R				-53																		
Turtle Dove	R	VU		-94^{uk}	-97^{uk}	-82	-96					VU	*										
Cuckoo	R			-29	-75^{uk}								*										
Short-eared Owl	R			-69		-51	-62							*5*	*70*				*70-80*^{Both}				
Lesser Spotted Woodpecker	R			-73^{uk}	-60^{uk}	-26	-32			-26			*										
Kestrel	R			-77																			
Merlin	A		*	*-38*		*-28*	*-36*												*60-70*^{Both}				
Willow Tit	R				-92^{uk}	*-43*	*-41*			-43		LC	*										
Marsh Tit	R			-39	-68								*										
Wood Warbler	R			-72									*										
Willow Warbler	R				-68																		
Whitethroat	A				-57^{uk}																		
Grasshopper Warbler	R			-68^{uk}	-93^{uk}								*										

English name	BoCC W2	IUCN	HD	BDp1 & BDMp1	BDp2 & BDMp2	BDr1 & BDMr1	BDr2 & BDMr2	WDp1 & WDMp1	WDp2 & WDMp2	WDr1 & WDMr1	HDrec1	ERLOB	UK Red	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Starling	R			-70	-89[uk]								*										
Ring Ouzel	R						-50						*										
Spotted Flycatcher	R			*-48*	-63								*										
Pied Flycatcher	R			-55									*										
Whinchat	G			-54uk	-67	-29	-34						*										
Tree Sparrow	R			*-49uk*	-95[uk]	-53	-66						*										
Yellow Wagtail	R			-61uk	-71[uk]		-75			*-45*			*										
Bullfinch	R				-52																		
Linnet	R			-26	-74								*										
Yellowhammer	R			-56	-56[uk]	*-25*	*-35*			*-32*			*										
Corn Bunting	R		*	-100	-88[uk]								*										

Table 5. Species on the BoCC W3 Red list, the criteria under which they qualify for both Red and Amber lists, and their supporting data. Red-list criteria are: IUCN: Globally Threatened (CR = Critically Endangered, EN = Endangered, VU = Vulnerable). HD: historical decline in the breeding population (* = qualifies). BDp1/2: severe breeding population decline over 25 years/longer term. WDp1/2: severe non-breeding population decline over 25 years/longer term. BDr1/2: severe breeding range decline over 25 years/longer term. WDr1: severe non-breeding range decline over 25 years. Amber-list criteria are: ERLOB: Threatened in Europe (CR = Critically Endangered, EN = Endangered, VU = Vulnerable). HDrec1/2: historical decline – recovery/further recovery since BoCCW2. BDMp1/2: moderate breeding population decline over 25 years/longer term. WDMp1/2: moderate non-breeding population decline over 25 years/longer term. BDMr1/2: moderate breeding range decline over 25 years/longer term. WDMr1: moderate non-breeding range decline over 25 years. Superscript 'uk' indicates cases where UK data are used. BR/WR: breeding/non-breeding rarity. BL/WL: breeding/non-breeding localisation. Superscript text indicates whether species qualified as localised in IBAs, SPAs, or both. BI/WI: breeding/non-breeding international importance. Figures are given in bands for species exceeding the qualifying thresholds for the localisation and international importance criteria. Red and Amber criteria for population and range trends are given as % change, and are combined in the same columns (BDp1 = normal text, BDMp1 = italic). When a species has changed list since BoCCW2, shading indicates the criteria responsible for that change.

English name	BoCCw2	HDrec1	BDMp1	BDMp2	BDMr1	BDMr2	WDMp1	WDMp2	WDMr1	ERLOB	UKred	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Shelduck	A						-33											2	7	90-100^{Both}	
Wigeon	A									LC		2							3		
Teal	A					-30													4		
Mallard	A						-40														
Pintail	A									LC		0							12	90-100^{Both}	
Garganey	A									LC		2			*						
Shoveler	A											10							4		
Scaup	A										*		64								
Eider	A									VU		3									
Common Scoter	A																		4	90-100^{Both}	
Velvet Scoter	A									VU	*		34								
Smew	A												5								
Red-breasted Merganser	A				-29		-32			NT											
Quail	A											28									
Red-throated Diver	A																			70-80^{SPA}	
Black-throated Diver	A												9								
Great Northern Diver	A									VU			89								
Fulmar	G									EN											
Sooty Shearwater	A												70								
Manx Shearwater	A					-40								57			90-100^{Both}	43			
Storm Petrel	A																90-100^{Both}				

English name	BoCCw2	HDrec1	BDMp1	BDMp2	BDMr1	BDMr2	WDMp1	WDMp2	WDMr1	ERLOB	UKred	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Leach's Petrel	A									LC											
Gannet	A																80-90[SPA]	13			
Cormorant	A																		2		
Shag	G									LC	*										
Bittern	A											1	24								
Grey Heron	G				-25																
Spoonbill	A												8			*					
Red-necked Grebe	A										*		2								
Black-necked Grebe	A												6								
Honey-buzzard	A											10			*						
Red Kite	A									NT								2			*
Marsh Harrier	A												5								
Osprey	A											3									
Coot	G									NT											
Avocet	A											16									
Oystercatcher	A									VU									7	60-70[Both]	
Dotterel	G										*										
Whimbrel	A										*										
Black-tailed Godwit	A									VU									3	50-60[Both]	
Turnstone	A						-26			LC											
Ruff	A									LC			26								

English name	BoCCw2	HDrec1	BDMp1	BDMp2	BDMr1	BDMr2	WDMp1	WDMp2	WDMr1	ERLOB	UKred	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Curlew Sandpiper	G									VU			63								
Sanderling	A																		3		
Purple Sandpiper	G									LC											
Green Sandpiper	G												36								
Spotted Redshank	A									LC			42			*					
Jack Snipe	A												69								
Snipe	G					-45															
Pomarine Skua	A												84								
Arctic Skua	A										*										
Long-tailed Skua	A												31								
Black Guillemot	G									LC		28									
Razorbill	A									NT							50-60^{Both}				
Guillemot	A									NT								2			
Sandwich Tern	A																80-90^{Both}				
Common Tern	R					-46											90-100^{Both}				
Little Gull	A									NT			30								
Lesser Black-backed Gull	A																60-70^{Both}	6			
Long-eared Owl	A													10							
Nightjar	A	*																			
Swift	A		-49																		
Kingfisher	A									VU											

Full English name	BoCCw2	HDrec1	BDMp1	BDMp2	BDMr1	BDMr2	WDMp1	WDMp2	WDMr1	ERLOB	UKred	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Green Woodpecker	A		-35			-31								55							
Chough	A												6								
Hooded Crow	A																				
Goldcrest	A		-32							LC											
Firecrest	A											6									
Bearded Tit	A											2	13								
Skylark	A										*										
Long-tailed Tit	A			-41																	
Dartford Warbler	A									NT											
Dipper	A		-35																		
Fieldfare	A									LC											
Song Thrush	A										*										
Redwing	A									NT	*										
Mistle Thush	G										*										
Black Redstart	A												<90								
House Sparrow	A										*										
Grey Wagtail	G		-28								*										
Tree Pipit	A			-25							*										
Meadow Pipit	A			-46[uk]						NT											
Brambling	G									LC											
Hawfinch	A		-26								*										

English name	BoCCw2	HDrec1	BDMp1	BDMp2	BDMr1	BDMr2	WDMp1	WDMp2	WDMr1	ERLOB	UKred	BR	WR	UK50%	BRuk	WRuk	BL50%	BI	WI	WL50%	HDrec2
Greenfinch	G		-38																		
Twite	R		-38							LC	*	16	65								
Lesser Redpoll	R										*										
Snow Bunting	A												29								
Lapland Bunting	A												61								
Reed Bunting	A			-25^{uk}																	

Table 6. Species on the BoCC W3 Amber list, the criteria under which they qualify, and the supporting values. Amber-list criteria are ERLOB: Threatened in Europe (CR = Critically Endangered, EN = Endangered, VU = Vulnerable). HDrec1/2: historical decline – recovery/further recovery since BoCCW2. BDMp1/2: moderate breeding population decline over 25 years/longer term. WDMp1/2: moderate non-breeding population decline over 25 years/longer term. BDMr1/2: moderate breeding range decline over 25 years/longer term. WDMr1: moderate non-breeding range decline over 25 years. BR/WR: breeding/non-breeding rarity. BL/WL: breeding/non-breeding localisation. Superscript 'uk' indicates cases where UK data are used.Superscript text indicates whether species qualified as localised in IBAs, SPAs, or both. BI/WI: breeding/non-breeding international importance. Figures are given in bands for species exceeding the qualifying thresholds for the localisation and international importance criteria. Amber criteria for population and range trends are given as % change, and are combined in the same columns (BDp1 = normal text, BDMp1 = italic). When a species has changed list since BoCCW2, shading indicates the criteria responsible for that change.

Name	BoCCW2	Name	BoCCW2
Mute Swan	A [f]	Jackdaw	G
Whooper Swan	G	Rook	G
Pink-footed Goose	G	Carrion Crow	G
Barnacle Goose	A [cg]	Raven	G
Brent Goose	A [cfg]	Blue Tit	G
Gadwall	A [cg]	Great Tit	G
Tufted Duck	A [c]	Coal Tit	A [a]
Goldeneye	G	Sand Martin	A [c]
Goosander	G	Swallow	A [c]
Little Egret	G	House Martin	A [c]
Little Grebe	G	Cetti's Warbler	G
Great Crested Grebe	G	Chiffchaff	G
Goshawk	G	Blackcap	G
Sparrowhawk	G	Garden Warbler	A [b]
Buzzard	G	Lesser Whitethroat	G
Water Rail	G	Sedge Warbler	G
Spotted Crake	A	Reed Warbler	G
Moorhen	G	Waxwing	G
Little Ringed Plover	G	Nuthatch	G
Little Stint	G	Treecreeper	G
Greenshank	G	Wren	G
Great Skua	G	Blackbird	G
Black Tern	A [c]	Robin	G
Mediterranean Gull	A [e]	Redstart	A [c]
Rock Dove	G	Stonechat	G
Stock Dove	G	Wheatear	A [c]
Woodpigeon	G	Dunnock	G
Collared Dove	G	White / Pied Wagtail	G
Barn Owl	A [c]	Rock Pipit	G
Tawny Owl	G	Water Pipit	G
Great Spotted Woodpecker	G	Chaffinch	G
Hobby	A [d]	Common Crossbill	G
Peregrine	G	Goldfinch	G
Magpie	G	Siskin	G
Jay	G		

Table 7. The BoCC W3 Green list. Superscripts indicate which criteria are no longer qualified for. [a] No longer BDMp1, [b] No longer BDMp2, [c] Not on ERLOB but was on SPEC, [d] No longer BR, [e] No longer WR, [f] No longer WI, [g] No longer LW50%.

(A)	Rw3	Aw3	Gw3	Total
Rw2	43	3 Twite Lesser Redpoll Common Tern	0	46
Aw2	9 Woodcock Ringed Plover Knot Pintail Merlin Long-tailed Duck Long-eared Owl Common Sandpiper Bewick's Swan Redshank	73	17	99
Gw2	2 Whinchat Kittiwake	14	52	68
Total	54	90	69	213

(B)	Ruk4	Auk4	Guk4	Total
Rw3	35	17	2 European Golden Plover Whitethroat	55
Aw3	22	47	21	90
Gw3	0	17	52	69
Total	57	81	75	213

Table 8. Numbers of birds moving between lists from BoCCw2 to BoCCw3, with species named for movements between Red and Amber and Red and Green **(A)**, and comparison of number of species in each list between BoCC W3 and BoCC UK4, with species named for differences between Red and Green (**B**). Notation: first letter = list (Red Amber or Green), second letter = country (Wales or UK), number = assessment (first to fourth).

Change	Effect (BoCCW2 > BoCCW3)	Species affected
HDrec modified	Amber > Red	Merlin
ERLOB instead of SPEC	Amber > Green	Barn Owl, Black Tern, Redstart, House Martin, Wheatear, Swallow, Tufted Duck
New Winter Distribution (WDR) criteria	Red	Bewick's Swan

Table 9. Impact of new and changed criteria on the BoCC W3 lists. Species listed are those that change list solely because of the named change.

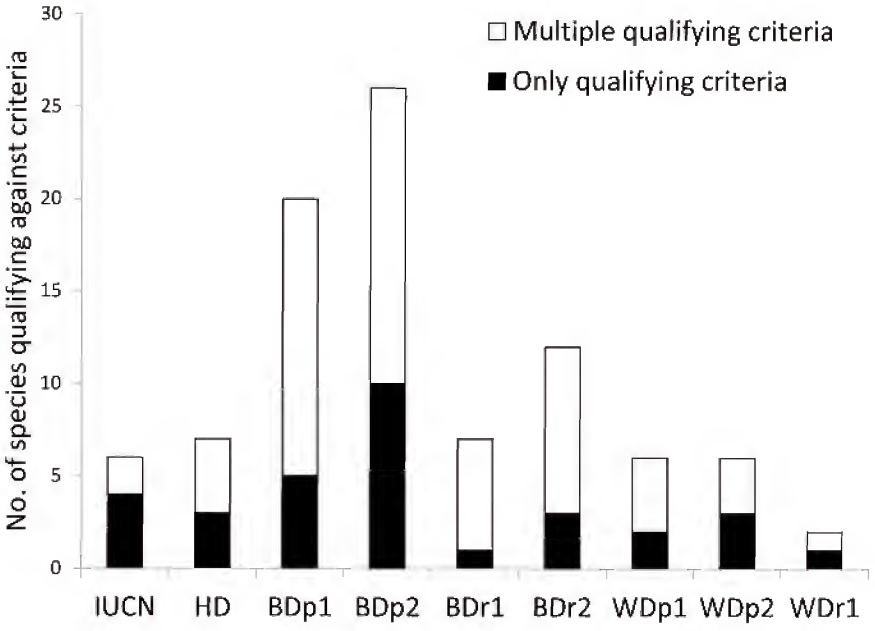

Figure 2. Frequency of species qualifying under the different BoCC W3 Red list criteria. The black parts of bars show those species qualifying Red on only a single criterion.

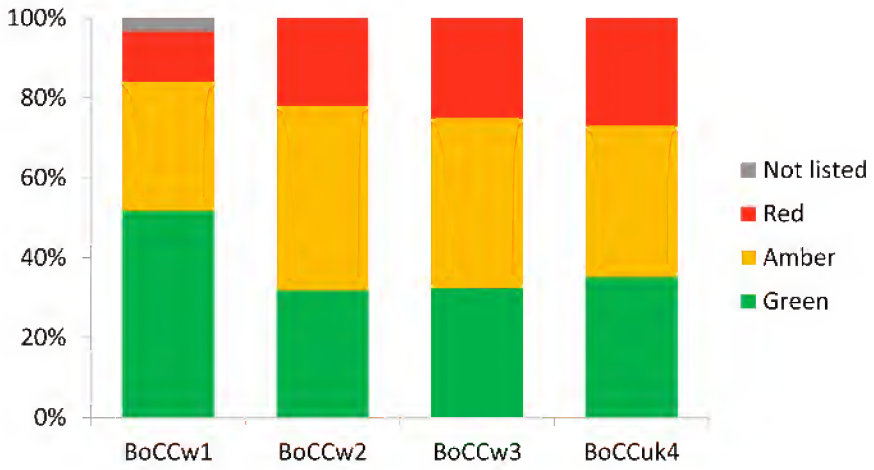

Figure 1. The number of species on each list for successive BoCC Wales assessments, and the numbers of those species placed on each list by BoCC UK4.

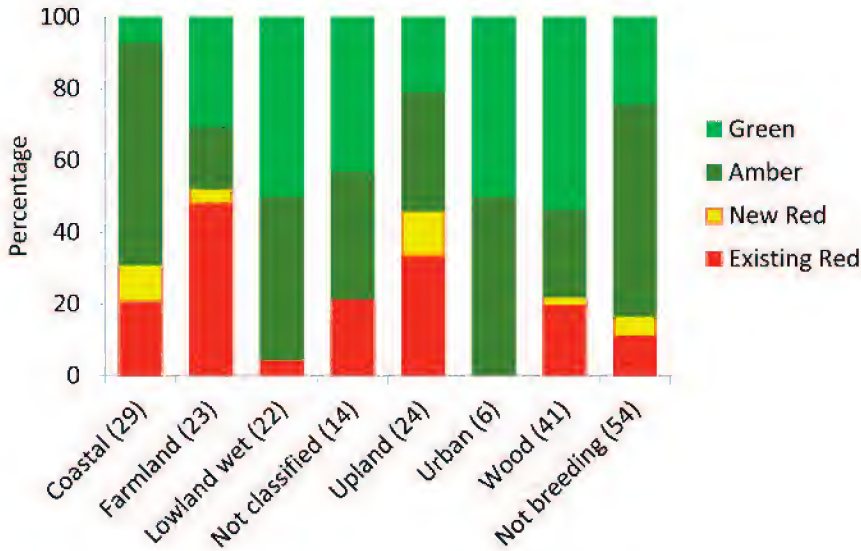

Figure 3. Proportion of breeding birds associated with major habitat types (following Gibbons et al 1993) that have been placed on each list (distinguishing between those already on the Red list in BoCC W2 and those added to the Red list for BoCC W3). Also shown are those species which occur only as wintering or passage populations in Wales (largely in coastal and lowland wetland habitats), along with the number of species in each group.

Changes in breeding bird abundances in the Elenydd SSSI between 1982 and 2012

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Crynodeb

Gwnaed arolwg o rannau o SDdGA Elenydd yng nghanolbarth Cymru fel rhan o arolwg adar rhostiroedd yr NCC yn 1982. Yn 2012, gwnaed arolwg arall, yn defnyddio'r un trawsluniau llinell ag yn 1982, ar ddwy ardal fawr o'r SDdGA ; Trumau ac Esgair Garthen. Collwyd y Gïach *Gallinago gallinago* yn gyfangwbl o'r ardaloedd a arolygwyd, tra bu lleihad o dros 80% yn niferoedd y Cwtiad Aur *Pluvialis apricaria* a Phibydd y Mawn *Calidris alpina*. Er bod maint y sampl o rai rhywogaethau yn rhy fychan ar gyfer casgliadau pendant, yn sicr bu lleihad mawr ym mhoblogaeth adar y safle.

Summary

Areas of Elenydd SSSI in Mid Wales were surveyed as part of the Nature Conservancy Council (NCC) moorland bird survey in 1982. A repeat survey, using the same line transects from the 1982 survey was undertaken in 2012 for two large areas of the SSSI; Trumau and Esgair Garthen. Snipe *Gallinago gallinago* have been completely lost from the survey areas, while Golden Plover *Pluvialis apricaria* and Dunlin *Calidris alpina* declined by over 80%. Whilst the sample size for some species is too small to draw conclusions there has undoubtedly been a drastic reduction in the bird population of the site.

Introduction

The Elenydd uplands in central Wales are a large expanse of upland moorland, bogs and adjacent coniferous forestry plantations. It was originally designated as a SSSI for upland habitats and the associated bird assemblage and subsequently as a Special Protection Area (SPA) for Peregrine *Falco peregrinus*, Merlin *Falco columbarius* and Red Kite *Milvus milvus*. The area has always been known as a stronghold for Golden Plover and, to a lesser extent, Dunlin.

Over the last thirty years, many upland bird species have been declining in abundance, distribution or both (Eaton *et al*. 2009). Baseline surveys of sections of the Elenydd uplands were undertaken in 1982 by the NCC as part of a Wales-wide scheme of surveys. In order to look at changes since 1982, a re-survey of the Trumau and Esgair Garthen sections took place between May and June 2012.

Methodology

The method described in Stroud *et al*. (1988) was used for direct comparison between the 1982 and the 2012 survey. Transects were 200m apart and all species within 100m either side of the transect were recorded onto maps. Recordings used the accepted British Trust for Ornithology (BTO) species abbreviations and behavioral notations to indicate breeding status (singing bird, alarming etc.). Maps denoting the original transects were used so as to stay as close to the original design as possible. The transects varied in length due to the terrain; some areas were inaccessible owing to cliffs or extremely steep angles.

Effort to access all of the transects was comparable to the 1982 survey. The survey used two of the areas surveyed in 1982, and two visits were made over several days, one in May and one in June. The results from both visits were combined. Surveys were undertaken between 08.00 and 18.00 hours in order to avoid peak times of bird activity at dawn and dusk.

The boundaries of the survey areas are shown in Figure 1.

Figure 1. Transects on Trumau (left) and Esgair Garthen (right) (Basemap courtesy of Ordnance Survey © Crown Copyright and Database Right [2016]. Ordnance Survey (Digimap Licence)).

Results

Five key species records in 1982 and 2013 within the boundaries of the study area were compared. These species were:

- Golden Plover
- Red Grouse *Lagopus lagopus*

• Dunlin
• Redshank *Tringa totanus*
• Snipe

A direct comparison can be made of the abundance of the five species in 1982 and in the most recent survey in 2012. A summary of the comparison between the results from 1982 and 2012 can be seen in Table 1.

Species	Latin Name	BTO Code	1982 Count	2012 Count	% Change
Red Grouse	*Lagopus lagopus*	RG	2	2	0
Golden Plover	*Pluvialis apricaria*	GP	19	3 (+ 2 possible)	-84
Dunlin	*Calidris alpina*	DN	6	2	-88
Redshank	*Tringa totanus*	RK	2	2	0
Snipe	*Gallinago gallinago*	SN	6	0	-100

Table 1. Survey results for key species from 1982 and 2012 for Trumau and Esgair Garthen combined.

Golden Plover have declined by over 80% since the baseline surveys and Snipe have disappeared from the site; Dunlin have also declined in abundance by over 80%. Red Grouse appear constant since the 1980s. Although Snipe may be under-recorded using the transect method of survey the same method was used in 1982 and 2012 so the decline is probably genuine.

Discussion

There has been a reduction in the number of Golden Plover pairs to the east of Trumau and to the north-west of Esgair Garthen (Figure 2). Pairs on Trumau, though fewer than in 1982, still appear to cluster in neighbouring areas, indicating that the habitat here is of prime quality and/or other reasons such as the relative lack of disturbance in this area or that the allee effect (population exponentially supported by more pairs) of pair interaction is causing this pattern (Stephens & Sutherland 1999; Courchamp *et al*. 1999). Whilst some population changes involve few individuals that could just be within annual fluctuations, in general the results show a real and serious decline in the overall bird population of these areas of Elenydd, in line with, or more serious than, Wales-wide population trends (Johnstone *et al*. 2010).

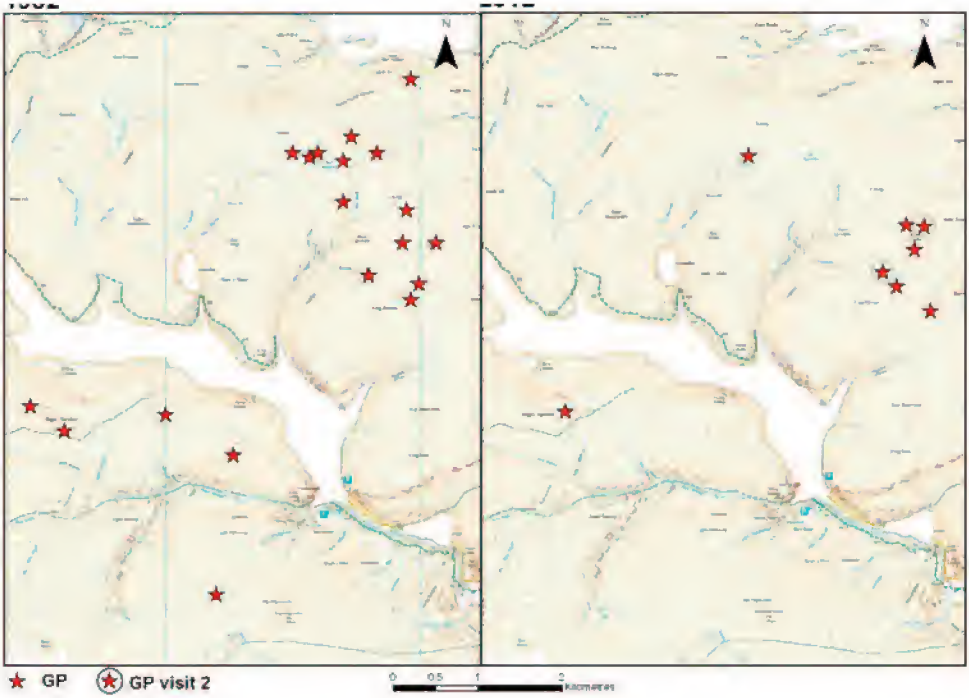

Figure 2. Change in Golden Plover abundance on both Elenydd sites, 1982 – 2012. Star indicates a Golden Plover pair (Base map courtesy of Ordnance Survey © Crown Copyright and Database Right [2016]. Ordnance Survey (Digimap Licence)).

Golden Plover are in a period of widespread decline over the whole of Wales, with an 83% decrease between 1982 and 2007. This correlates to the 94% decline witnessed for Elenydd between 1982 and 2011. The reasons for the declines are in most cases unclear. A survey on Plynlimon, West Wales, in 2011 (Crump & Green 2012) showed similar declines. A PhD study, of which these surveys are a part, suggests that the cause of Golden Plover declines in the Welsh uplands could possibly be due to a mixture of external influences relating to the availability and amount of prey available (Crump 2014).

In order to better understand the declines of upland birds, a comprehensive survey series should be initiated, with adjoining vegetation, climate, and predator and prey data. This should be compared to other areas throughout the UK where species such as Golden Plover have thrived over the past decades. It would also be particularly beneficial to conduct a study of feeding and wintering area conditions to ensure a complete lifecycle perspective is applied to any further research.

Acknowledgements

With thanks to all those who helped to complete this survey: Karen Heppingstall, Richard Lucas, Karen Lucas, George Lucas, Ben Lucas, Josh Brown, Jonathon Brownett, Chris Draper, Sarah Perry and Alberto Di Dio. Thanks also to Siân Whitehead, Natural Resources Wales, for supplying the 1984 data.

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The distribution of birds breeding in Wales at tetrad level: what we know now and future prospects

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Crynodeb

Casglwyd gwybodaeth am ddosbarthiad adar ar lefel tetrad ar gyfer y blynyddoedd 1998-2012 i ystyried a allai fod yn bosibl trefnu prosiect atlas ar gyfer Cymru oll yn ystod cyfnod yr Atlas cenedlaethol nesaf. Cynhwysir mapiau dosbarthiad ar gyfer nifer o rywogaethau sy'n bwysig o safbwynt cadwraeth.

Summary

Tetrad level distribution data for the years 1998-2012 have been brought together to examine if it is likely to be feasible to conduct an all-Wales tetrad atlassing project at the time of the next national Atlas. Example distribution maps of several species of conservation concern are included.

Introduction

As yet, there has not been an all-Wales study of the distribution of breeding birds at tetrad level. There have been aspirations for one for at least 20 years but the goal has not been reached. There have been tetrad level atlases of areas of South Wales in the relatively recent past, e.g. Thomas (1992), Donovan & Rees (1994), Venables *et al* .(2008) and Rees et al (2009), with the first two being from fieldwork up to the early 1990s, which is a long time ago in terms of how bird distributions seem to be changing (Balmer *et al.* 2013). During the last national Atlas period there was a project undertaken in North Wales to map the distribution of breeding birds at tetrad level, using the excellent facilities provided by the BTO for acquiring and validating records using internet based processes. During the preparation of the results of this project, which covered approximately one third of the land area of Wales, a question arose about how much information is available, now, about the distribution of breeding birds across all of Wales at the tetrad level and how feasible is the notion of completing an all-Wales tetrad atlas in the future.

The national atlases to date (Sharrock 1976, Gibbons *et al.*1993, Balmer *et al.* 2013) have all presented their results at the level of the 10km square. For present purposes, I wanted to know what we could say about breeding bird distribution from fieldwork undertaken for the more recent atlassing projects in Wales, covering the years 1998 – 2012. The aims were to find (a) how much of Wales has been fairly well covered at tetrad level, (b) what we can

tell about the distribution of breeding birds in Wales from these combined projects and (c) what we could learn about the likelihood of being able to achieve complete coverage of Wales at tetrad level when the next national atlas is being undertaken (possibly 2027-31).

Why bother with a tetrad atlas?

Increasingly, birdwatchers are using methods of recording their observations that are available electronically to Recorders and others. This makes the compilation of records within an area much easier than ever before. However, the records that are gathered in this way are not systematic or coordinated at a large spatial scale. From a British perspective, the ideal level at which to gather data would be the 1km square, but the huge number of these squares (c 22,000 in Wales) makes the task virtually impossible. The tetrad, a square of 2km x 2km, is a useful compromise between fine level of detail and the possibility of achieving a complete result. Data gathered for a tetrad atlas are automatically available for use at the 10km level and provide much greater detail (25 times more). Tetrad distributions and 10km distributions will look broadly the same as they use the same records, but for conservation planning, to know that the one record that occurred within a 10km square was in a particular tetrad is of much more value and easier to relate to habitat.

An atlas gives a view of distribution at a given time scale. Again, for conservation purposes, an atlas would be more useful if the data gathered were at the greatest detail possible within the time scale determined for data gathering. This could be a period of four or five years, which if repeated with national atlases every 20 years or so would show changes in distribution in a more useful way. Similarly, estimation of abundance would be very useful if available for two or more time periods. However, the methods needed to be able to make such estimations place a considerable burden on observers as, ideally, two visits are needed. It is, of course, possible to gather breeding evidence at the same time as counting birds during Timed Tetrad Visits.

The scale of the task

The land area of Wales is enclosed in 279 10km squares, of which 173 have all 25 tetrads within them in Wales and the other 106 have fewer than 25 tetrads with some of their land in Wales (some tetrads either being in the sea or in England). In total there are 5,534 tetrads to be covered. Within the period 1998 – 2012 there were 394 tetrads covered by Venables et al (2008), 490 by Rees *et al.* (2009) and 1,796 by Brenchley *et al.* (2013), totalling 2,680 tetrads, or just under a half of Wales. Data for the remaining tetrads came mainly from the BTO from the latest national Atlas project though some records were provided for the Glamorgan area.

Record collection

The main aim of this paper was to be a feasibility study to attempt to assess if it might be possible to conduct a tetrad level Atlas of all of Wales at the time of the next national Atlas. To investigate this possibility I wished to clarify what is already known from the Atlas style

surveys that have already been done and to identify the areas of Wales where more targeted effort would be needed in the future. I sent an initial email to all County Bird Recorders and BTO regional representatives whom I thought might be able to assist with gathering tetrad level data across all of Wales. I received the requested data from: Gwent (contact Al Venables), Pembrokeshire (Bob Haycock), Glamorgan (Wayne Morris) and copies of the latest Atlas data for Brecon and Carmarthenshire (John Lloyd). I requested tetrad level data for the other areas of Wales from the BTO and was sent a full set of data for all of Wales (Dawn Balmer, Simon Gillings).

The data for Gwent were sent in two files, one for common species and one for sensitive species. The distribution data (without species names) were combined for the bulk of the maps relating to coverage. There are no data for any species on the Natural Resources Wales 'sensitive species list shown here, so no confidentiality has been broken.

The three areas in South Wales that are included in this analysis are shown in Figure 1. It shows records collected in the years shown in Table 1.

Area	Years of fieldwork
Gwent	1998-2003
Pembrokeshire	2003-2007
East Glamorgan	2003-2007

Table 1. The years of tetrad atlassing fieldwork achieved in South Wales.

The data for the rest of Wales was gathered as part of the 2007-11 BTO Atlas project, with the first summer for gathering records of breeding attempts being in 2008. The final such year was 2011 but in Pembrokeshire and North Wales, record gathering continued into 2012 although the very wet summer curtailed the targeted action that had been planned in the latter area.

Compiling the results of these different studies provides an overall coverage map for Wales at the tetrad level.

Figure 3 shows that there was a lack of records from mainly high ground across Carmarthen, Ceredigion, Radnor and Montgomery. This is shown more clearly in Figure 4 where the numbers of records gathered in each tetrad are shown by a different sized dot. The small dots in the areas just mentioned indicate the lack of survey time spent in those counties. The highest ground would have possibly seemed less appealing to volunteer observers because of the difficulty of access and the relative lack of species that could be expected there.

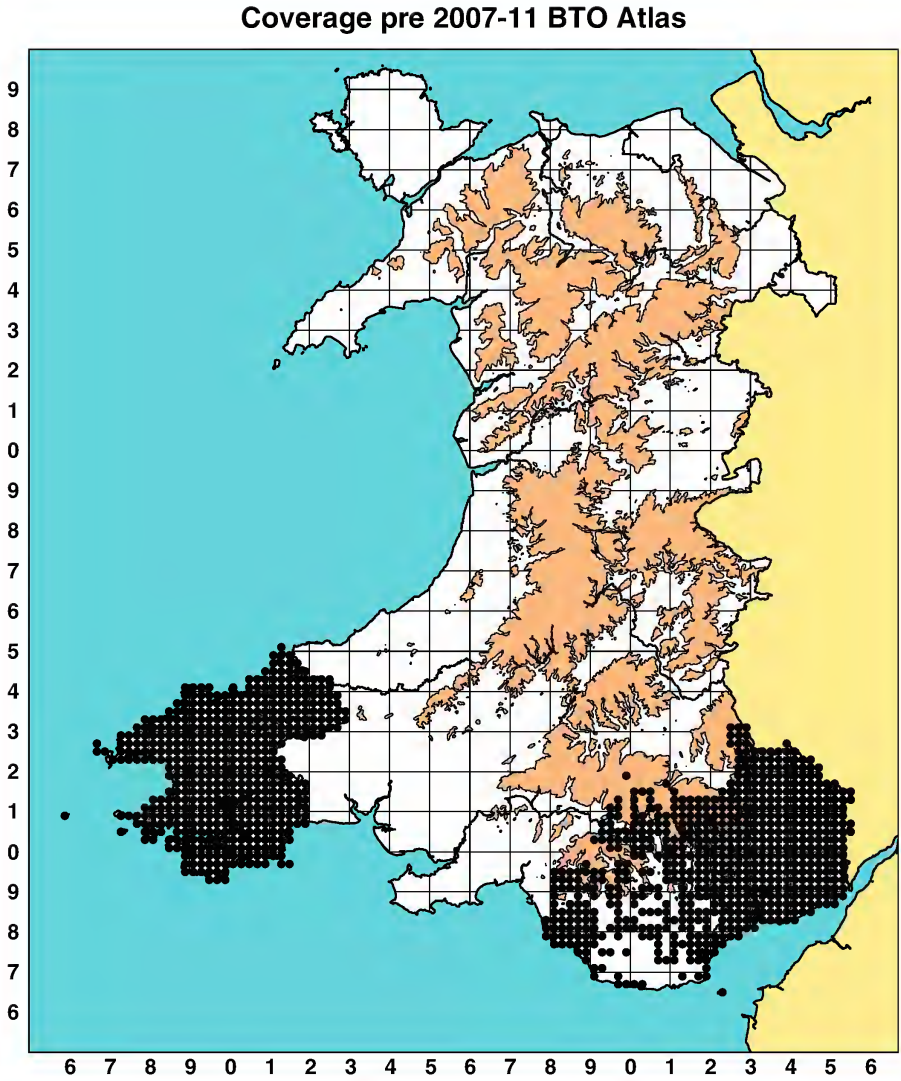


Figure 1. A map of Wales showing the areas that had some tetrad coverage prior to the 2008-11 breeding seasons of the national atlas project run by the BTO. The grids show the 10km squares. The irregular shading within Wales shows the land above the 300m contour.

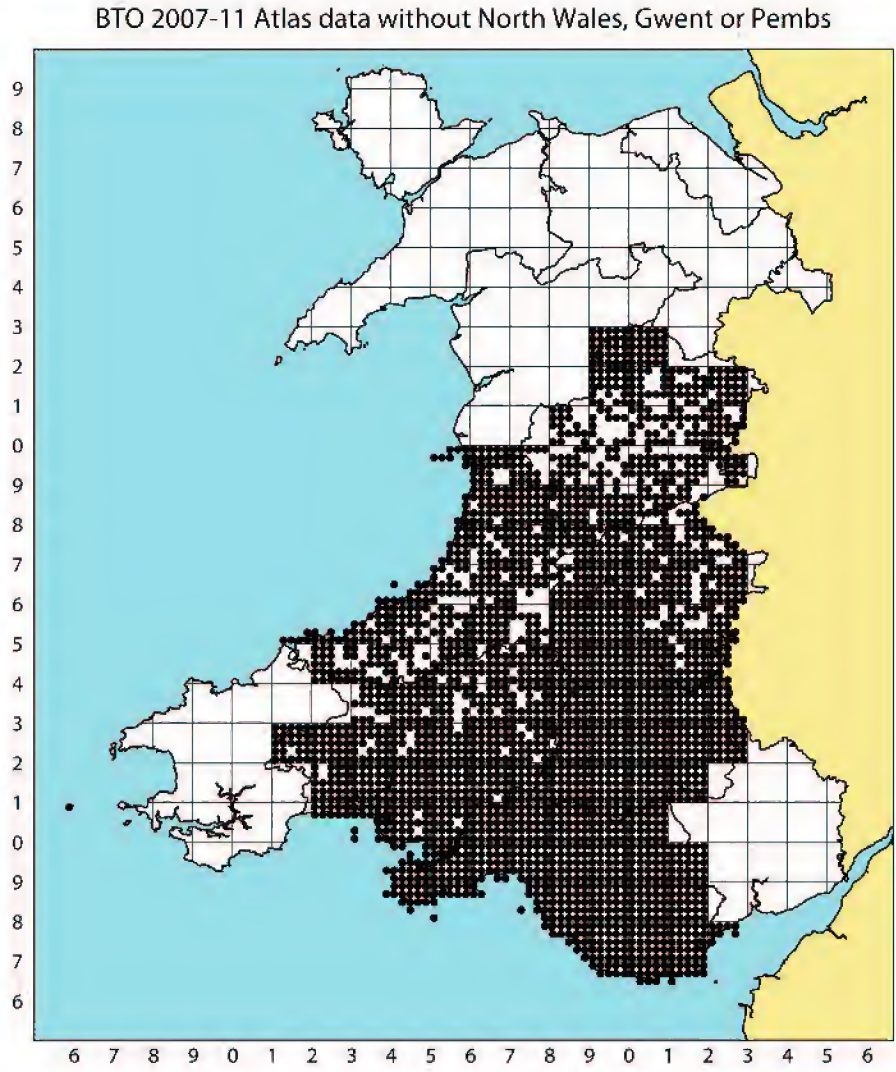


Figure 2. This map shows the distribution of tetrads with at least one record surveyed as part of the national Atlas project during the years 2008-11. Pembrokeshire and North Wales were covered during the summers 2008-12. Each dot represents at least one record. For further information about coverage, see Figure 4.

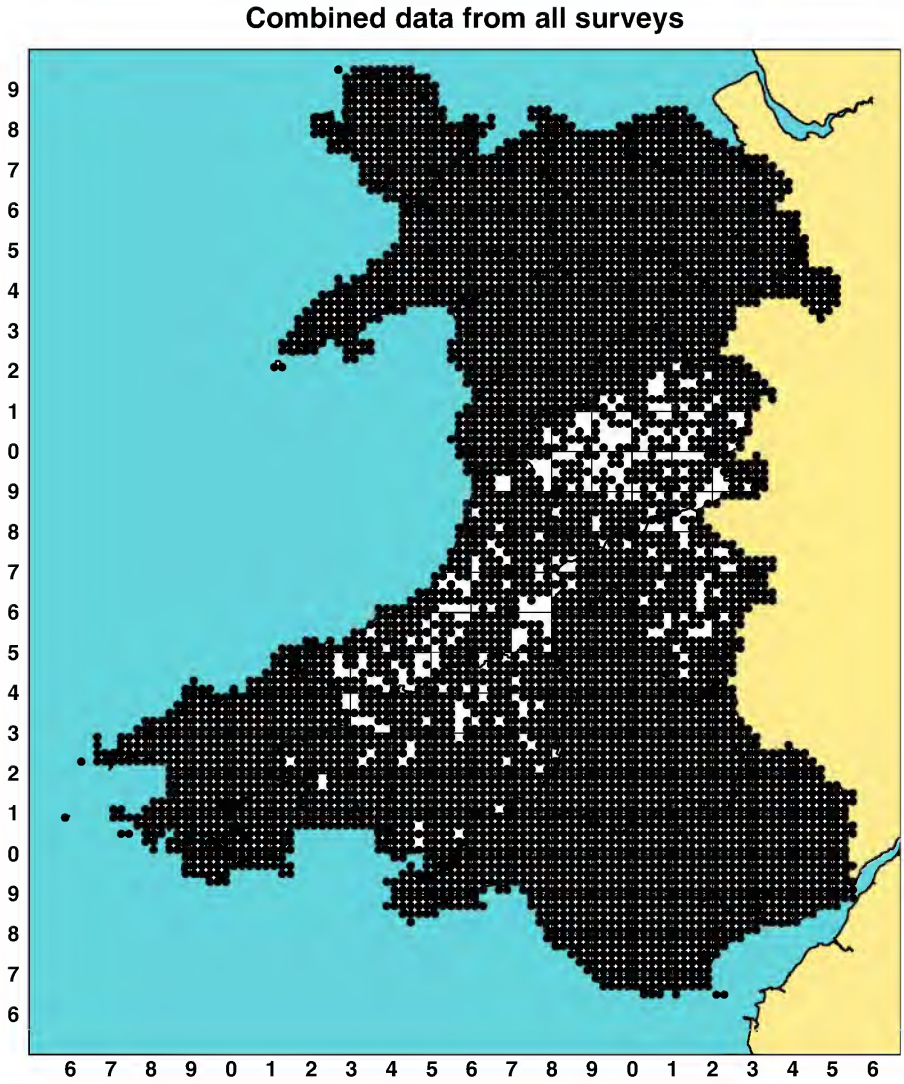


Figure 3. This shows the coverage from all the surveys combined. Each dot represents at least one record.

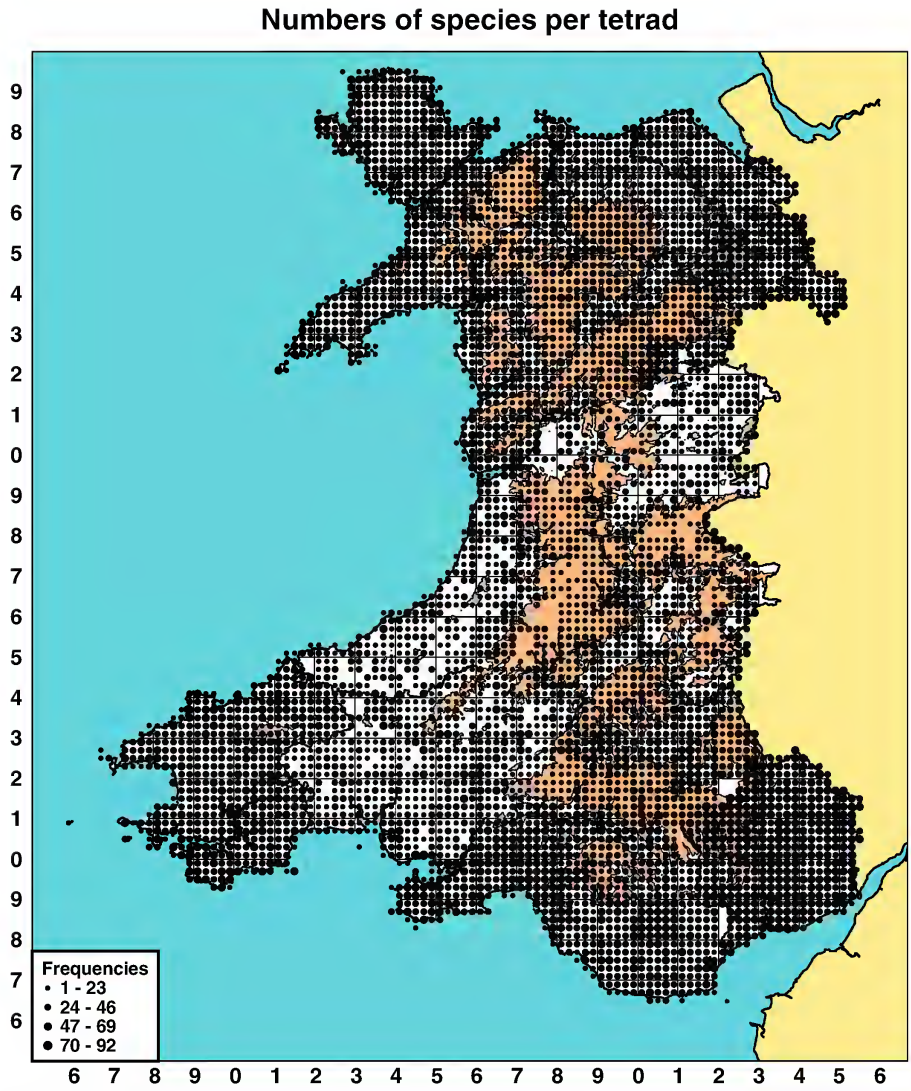


Figure 4. Here the four sizes of dot represent different numbers of records in each tetrad. The pale areas through Carmarthen, Ceredigion, Radnor and Montgomery are likely to represent less effort. That area contains a large amount of high ground.

Results by species

As a feasibility study it may seem there is no need to show any maps of particular species. The data gathered here allow the preparation of the most detailed all-Wales tetrad distribution maps available to date. Therefore, it seemed appropriate to show some examples as an encouragement for observers to engage further, coordinated effort, in the future, to produce still more detailed data about the distribution of breeding birds in Wales. For this publication, only maps of non-sensitive species are included. The sensitive species are listed in Letheren (2016).

The following maps show tetrad level distributions for five species with three sizes of dot for the three levels of breeding evidence – possible, probable and confirmed breeding. The first, Carrion Crow *Corvus corone*, provides a base that is likely to be the most widespread species (based on the data from North Wales in Brenchley *et al.* 2013). The other four are species that are of conservation concern and show the comparison of 10km level and tetrad distributions, showing the greater detail, and sadly, how the 10km results 'overstate' the presence of these species. The pale areas in the middle of Wales reflect the numbers of observers that were active there. Tetrad level maps for all species will be made available for conservation purposes, to the RSPB and Natural Resources Wales and to the contributors.

Wiith the scale at which these maps can be shown in this publication, the difference between distribution maps can be more clearly seen by zooming into a small area, in this case, broadly Caernarfon and Anglesey.

Discussion

Initially there were concerns about combining data from such an extended period (1998-2012), a total of 14 years. These concerns would have been about the distribution of species changing within that time frame, though any changes would only be possible to see for Pembrokeshire and SE Wales, especially Gwent. Most of the rest of the maps were based on data gathered between 2008 and 2012. Clearly, large numbers of people were motivated to gather data in a systematic way to cover Gwent, Pembrokeshire and North Wales. The resulting species maps are, to the best of my knowledge, the most detailed distribution maps of bird species breeding in Wales to date. A caveat that has to be made for the species maps included here is that the data were gathered over a period of 13 years (Gwent) and 8 years (Pembrokeshire), so for some of the less common species, e.g. Willow Tit *Poecile montana*, the maps may over-represent their current, real distribution. The maps are tantalising in the questions they raise about the area of central Wales that has not been as well covered. These questions can only be answered by ensuring as near as possible equal effort across the whole of Wales. This would seem to be a task to be undertaken at the time of the next national Atlas.

There would need to be a considerable amount of organisation and persuasion to ensure that inhabitants of, and visitors to, Wales visit central Wales to achieve the highest possible total of breeding species for each tetrad. I suspect that it would still be an insurmountable

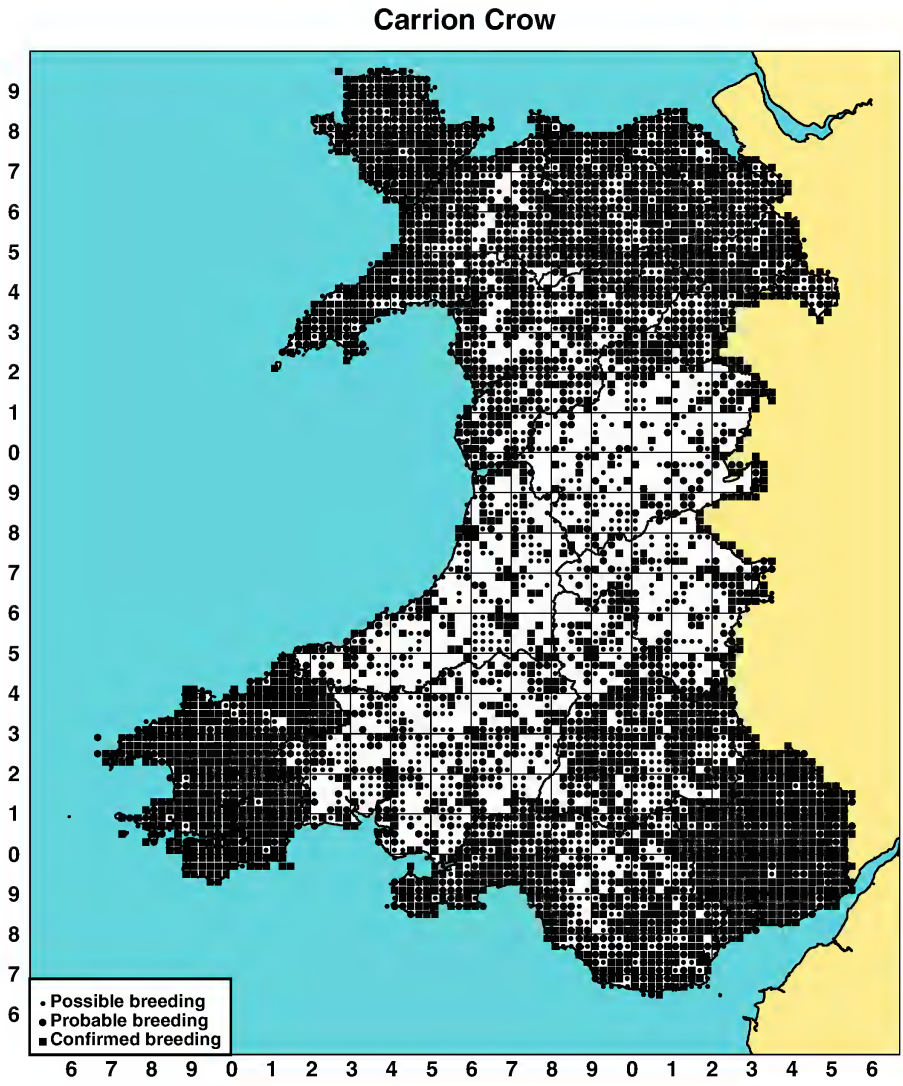


Figure 5. Carrion Crow distribution at tetrad level.

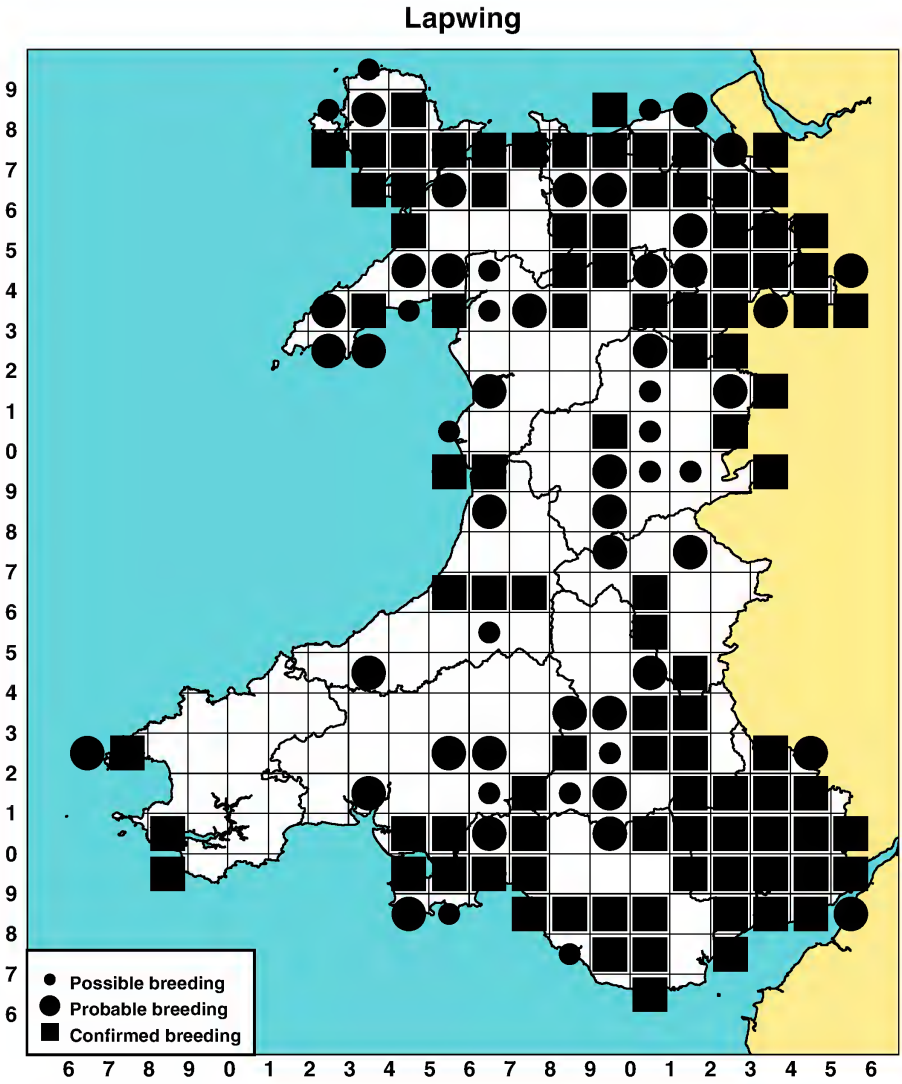


Figure 6. Lapwing *Vanellus vanellus* distribution at 10 km level.

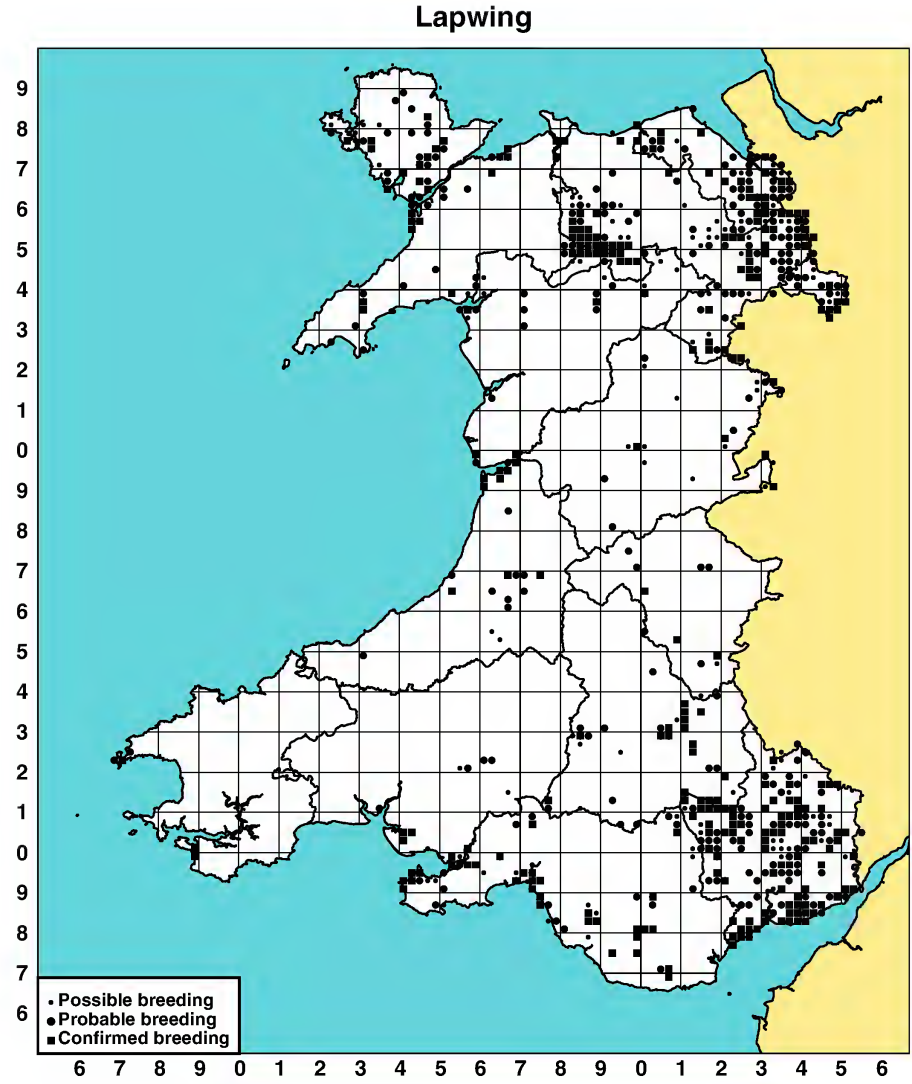


Figure 7. Lapwing distribution at tetrad level.

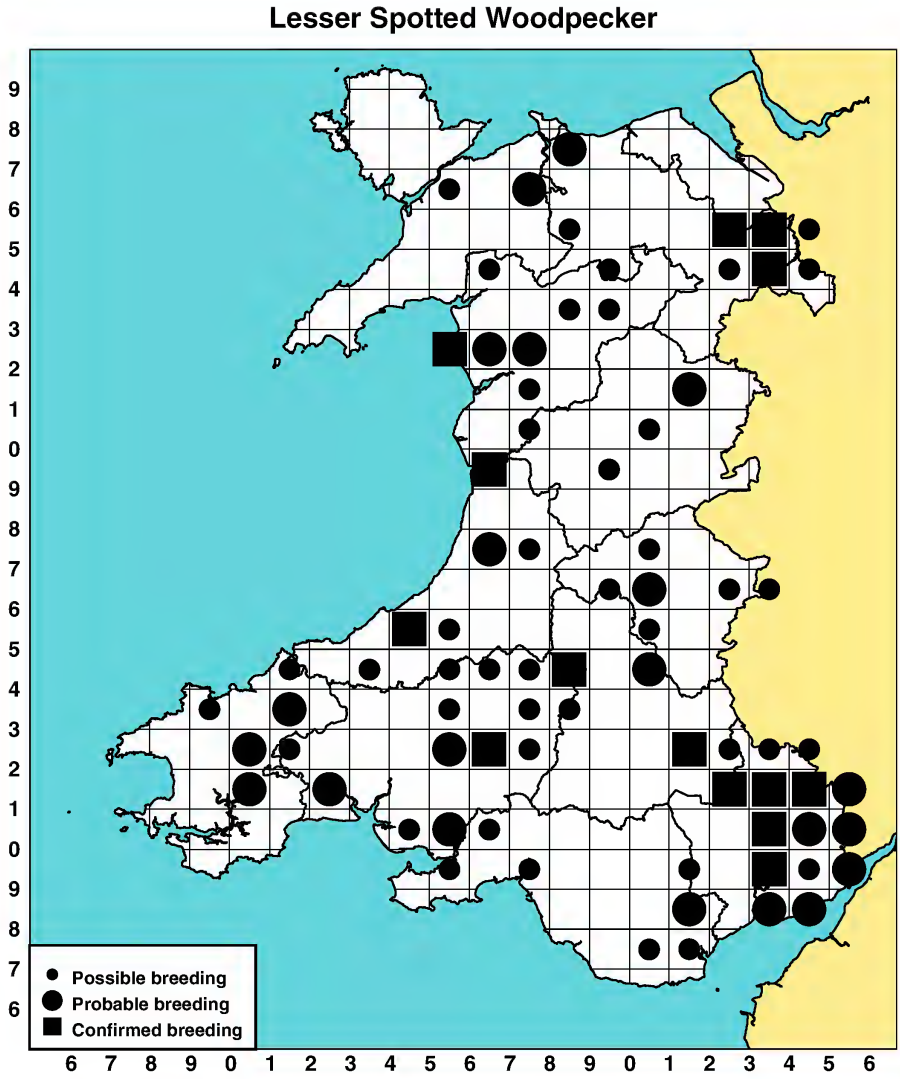


Figure 8. Lesser Spotted Woodpecker *Dryobates minor* at 10 km level.

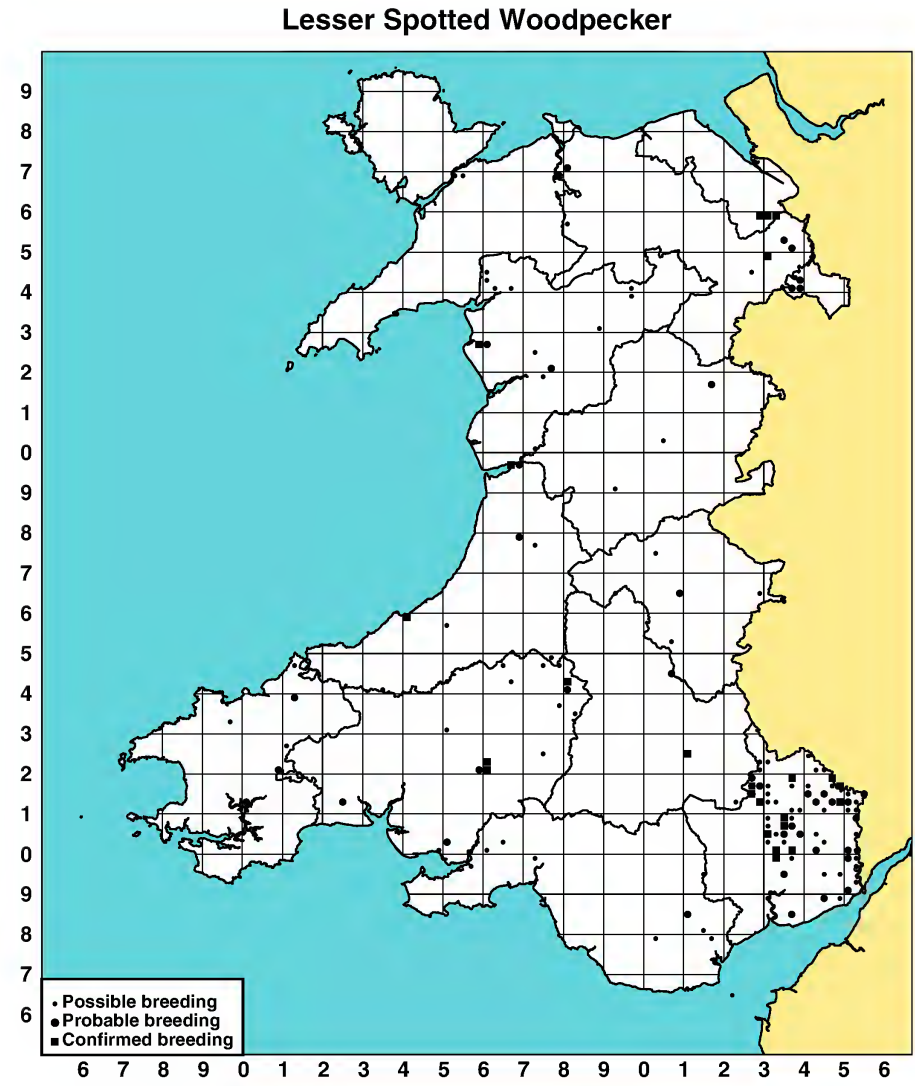


Figure 9. Lesser Spotted Woodpecker at tetrad level.

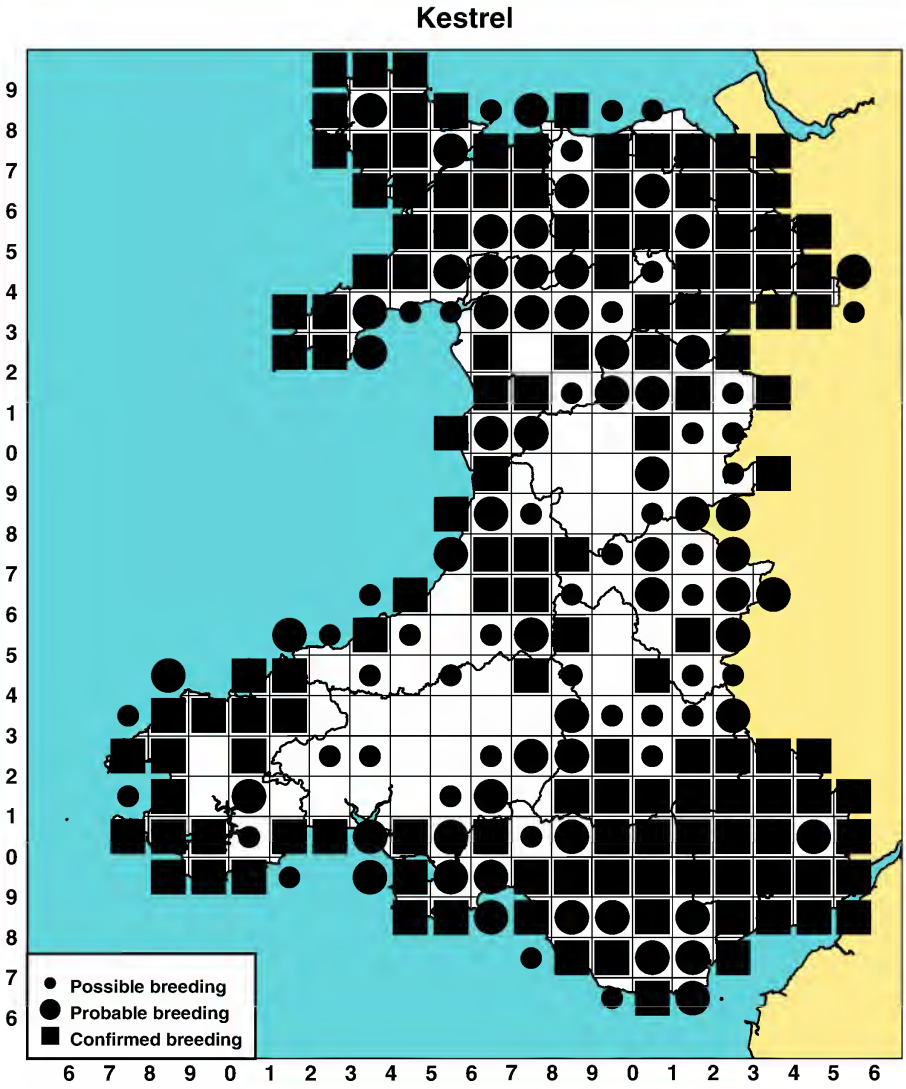


Figure 10. Kestrel *Falco tinnunculus* distribution at 10km level.

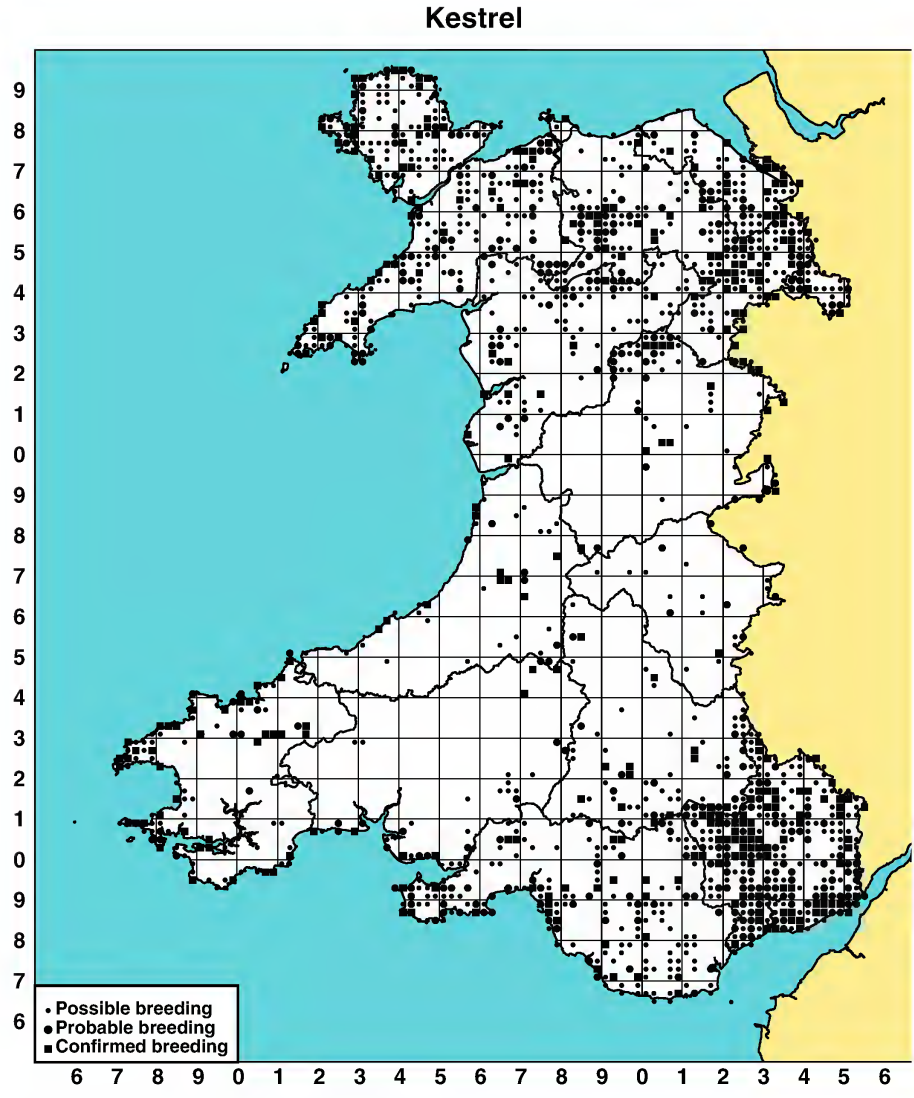


Figure 11. Kestrel distribution at tetrad level.

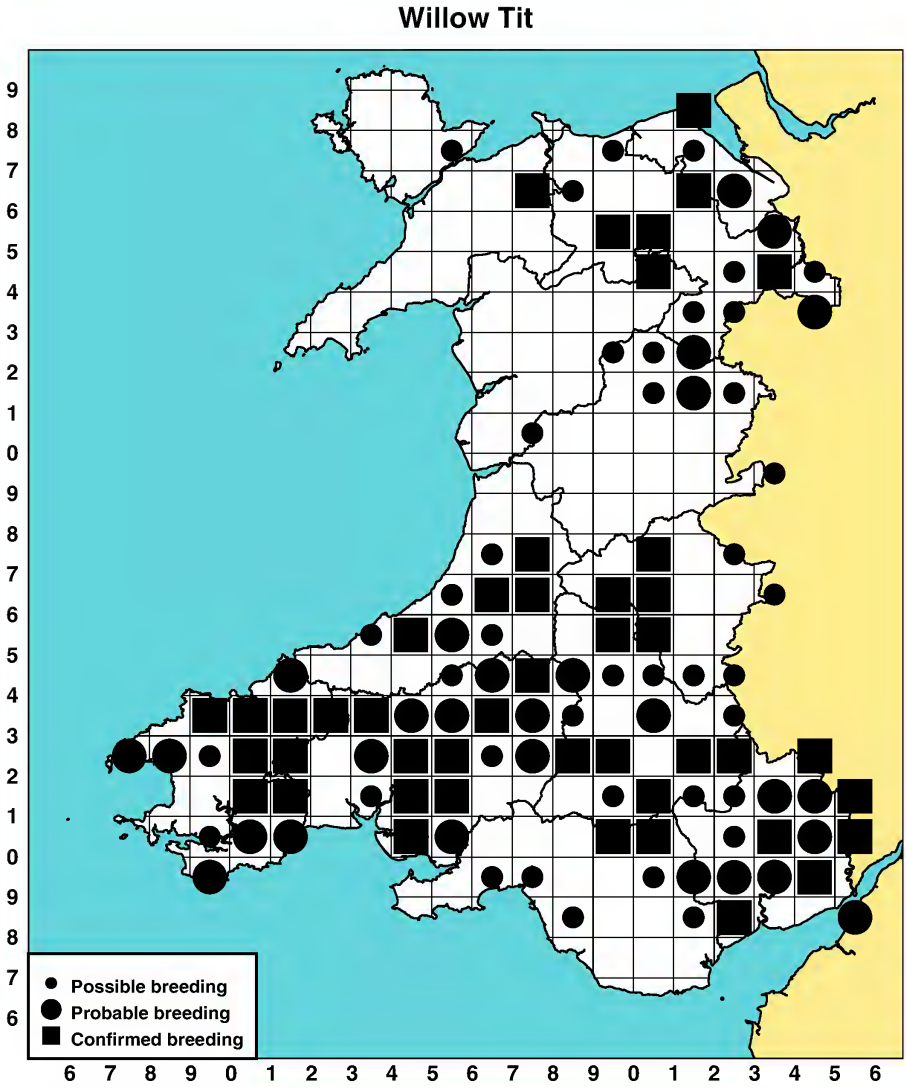


Figure 12. Willow Tit *Poecile montana* distribution at 10 km level.

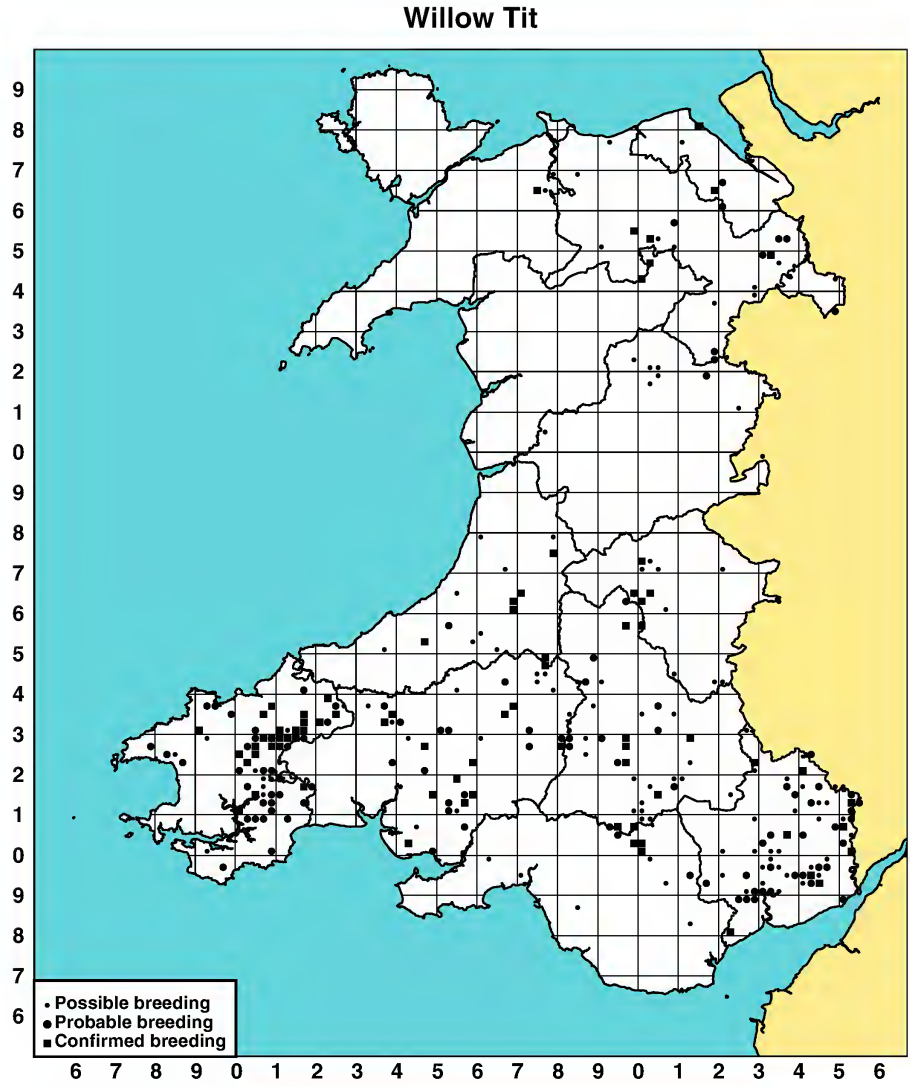
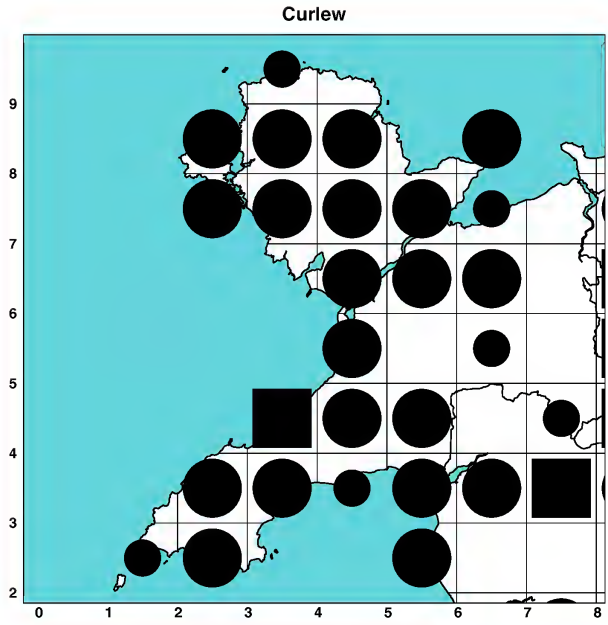


Figure 13. Willow Tit distribution at tetrad level.

a.



b.

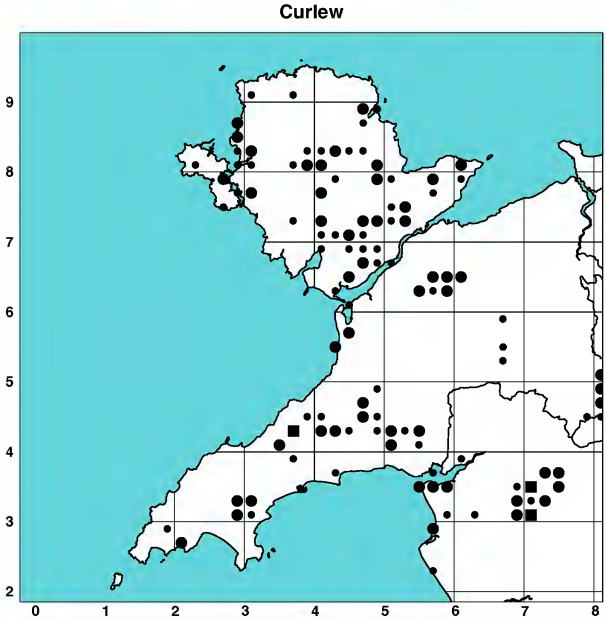


Figure 14. Using the north west of Wales as an example, (a) shows the distribution of breeding Curlew *Numenius arquata* at the 10 km level and (b) shows the distribution at the tetrad level. At the 10 km level it could be assumed that Curlew breed all over Anglesey and Caernarfon, whereas the tetrad map shows this is far from the case.

task to achieve more than the BTO's recommended 8/25 tetrads coverage by Timed Tetrad Visits to enable calculation of relative abundance.

Prospects for the future

Given the results of the last national Atlas I think it would be possible to organise an all-Wales tetrad level Atlas of the breeding birds of Wales. It would need to be highly organised and the Welsh Ornithological Society is the ideal organisation to undertake the overall responsibility for this organisation and coordination. From the experiences of the North Wales project during 2008-12 I think there would need to be a structure as follows.

Recommendations

In order to achieve such an Atlas, the following appear to me to be essential recommendations for the organisation of the project:

- A single overall coordinator or a small coordinating committee of not more than five people.

- Coordinators for areas, probably at Vice-county level. These people would need to be computer literate and able to use the internet and spreadsheets with ease. Several are likely to be BTO Regional Representatives.

- Within each county, 10km stewards would be helpful.

- Planning of visits by 'booking' tetrads should start at least one year before the survey begins. This would enable the county and overall coordinators to see the areas where people need to be directed. For some of the tetrads, mainly at high altitude, that are likely to be tougher to cover, it may be necessary to seek grant funding in order to pay surveyors to visit those tetrads.

- During and after each breeding season the data would need to be compiled to compare: the number of tetrads actually visited with those booked; the numbers of species per tetrad; the number of species recorded in each tetrad compared with the number of species recorded in the 10km square for the last national Atlas and the recording of as many species as possible as confirmed breeding.

- The targeting of vacant, or poorly covered, tetrads will need to be tackled from the start of Year 2 of the project as there may be other factors, like the weather, that would mean it could be risky to leave targeting until the later years of the project.

- There would be a need for training of volunteers as this would be a huge opportunity for mass engagement in citizen science within Wales. Approaches to WOS Affiliate Members, the Local Voluntary Councils, other bird clubs and Wildlife Trusts may prove helpful and would need to start at least one year before the start of the project.

- At the end of the project the results would need to be written up and presented in whichever way is the most suitable means of publication at that time.

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Diet, ecology, and biosecurity: analysis of owl pellets from Skomer Island

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Crynodeb

Mae tylluanod yn chwydu rhannau o'u bwyd na allant eu treulio fel pelenni, sy'n gallu rhoi gwybodaeth werthfawr am eu dulliau bwydo ac am boblogaeth eu hysglyfaethau. Archwiliwyd gweddillion ysglyfaethau ym mhelenni Tylluanod Bach *Athene noctua* a Thylluanod Clustiog *Asio flammeus* ar Ynys Skomer yn 2014, a chymharwyd ein canlyniadau ag astudiaethau blaenorol i chwilio am newidiadau ym mwyd y tylluanod o gyfnod cyn gynhared â 1970. Y prif grwpiau a ysglyfaethwyd oedd mamaliaid bychain; yn enwedig Llygoden Gota Skomer *Myodes glareolus skomerensis* (35.7% o fwyd y Dylluan Fach yn 2014; 36.7% o fwyd y Dylluan Glustiog) ac adar (29.8% o fwyd y Dylluan Glustiog yn 2014). Bwytawyd Llygoden y Maes *Apodemus sylvaticus*, Chwistlen *Sorex araneus*, Chwistlen Leiaf *Sorex minutus*, a'r Llyffant Cyffredin *Rana temporaria* gan y ddwy rywogaeth o ddylluan, a bwytawyd Llygoden Fach *Mus domesticus* a Chwningen *Oryctolagus cuniculus* gan Ddylluanod Clustiog. Gall archwilio pelenni fethu darganfod gweddillion ysglyfaethau bychain, megis anifeiliaid di-asgwrn-cefn. Yn fwyaf nodedig, cafwyd fod Tylluanod Clustiog yn teithio i'r tir mawr ac i ynys Skokholm i hela: cafwyd hyd i rywogaethau sy'n absennol o Skomer yn y pelenni, yn cynnwys y Llygoden Fach, Twrch Daear *Talpa europaea*, Llygoden Ffrengig *Rattus norvegicus* a hyd yn oed flew Mochyn Daear *Meles meles*. Gall hyn beryglu diogelwch biolegol yr ynys rhag mamaliaid bychain mewnlifol: rydym yn argymell archwilio pelenni tylluanod yn rheolaidd i gael rhybudd cynnar o'r posibilrwydd o rywogaethau mewnlifol, a chyfle i astudio deinameg ecolegol poblogaethau mamaliaid bychain.

Summary

Owls regurgitate indigestible components of their diet as pellets, which can provide valuable information on predator feeding behaviour and prey populations. We examined the prey remains in the pellets of Little Owls *Athene noctua* and Short-eared Owls *Asio flammeus* on Skomer Island in 2014, and compared our results to previous studies to investigate changes in owl diet from as early as 1970. The dominant prey groups were small mammals; particularly Skomer Voles *Myodes glareolus skomerensis* (35.7% of Little Owl diet in 2014; 36.7% of Short-eared Owl diet) and birds (29.8% of Short-eared Owl diet in 2014). Wood Mouse *Apodemus sylvaticus*, Common Shrew *Sorex araneus*, Pygmy Shrew *Sorex*

minutus, and Common Frog *Rana temporaria* were also consumed by both owl species, and House Mouse *Mus domesticus* and European Rabbit *Oryctolagus cuniculus* by Short-eared Owls. Pellet analysis may not be effective in detecting the predation of smaller prey items of owls, such as invertebrates. Most notably, we found that Short-eared Owls travel to the mainland and Skokholm Island to hunt: species not found on Skomer were found in pellets, including House Mouse, European Mole *Talpa europaea*, Brown Rat *Rattus norvegicus* and even hair from European Badger *Meles meles*; none of which are present on Skomer Island. This presents a potential risk to island biosecurity from invasive small mammals: we recommend regular monitoring of owl pellet remains as an early-warning indicator of the potential introduction of invasive species, and an opportunity to study ecological dynamics of small mammal populations.

Introduction

Pellet analysis is a non-invasive and inexpensive method of studying the feeding ecology of owls (Williams *et al.*, 2012); as they regurgitate hair, feathers, bones and bone fragments to provide data on the diet of particular owl species and populations. The careful dissection and examination of pellets gives a true and full representation of all the vertebrate prey an owl has ingested, and no important part of their diet is overlooked (Southern, 1954). Studying pellets provides an accurate assessment of diet and the consumption of small mammals that is difficult to record solely through direct observation (Simmons *et al.*, 1991). The biomass of each species is taken into account by multiplying the biomass of each species by the number of each prey present, giving an estimate of the total biomass of each species in owl diets, and thus the relative importance of each prey species. Assessing the presence of small mammals can be achieved by live-trapping and spotlighting, but these methods are labour-intensive and often incapable of detecting rare, trap-shy or elusive species (Laurance, 1992). Owl pellet analysis avoids these and other logistical problems including bait selection, and logistically challenging trapping schedules to maintain ethical standards (McDonald *et al.*, 2013). Pellet analysis can also offer insights on a number of ecological questions; revealing predator-prey relationships and prey selection biases (Votier *et al.*, 2001), as a source of DNA to gain further insight into conservation biology and behavioural ecology (Taberlet *et al.*, 1999), and to monitor island biosecurity and the introduction of non-native species (Russell et al., 2008).

The diet of Little Owls has been studied extensively across Europe (Goutner & Alivizatos, 2003; Angelici *et al.*, 1997), and more recently in Britain after reintroduction in the late 19th century (Hounsome *et al.*, 2004). Although now widespread across England and Wales, breeding bird survey data suggest that Little Owl numbers are declining, with the UK population estimated to be down by 24 % between 1995 and 2008 (Balmer *et al.*, 2013). A declining population emphasises the value of understanding their diet. Previous studies on Skomer Island examine Little Owl pellets between 1998 and 2004 (Hayden, 2004; Green *et al.*, 2005), with particular interest being paid to their detrimental effect on local populations of European Storm Petrels *Hydrobates pelagicus*. In 1954, Little Owls were removed from neighbouring Skokholm Island and have since been blamed for Storm Petrel population declines on Skomer (Lockley, 1983), specifically for predation of breeding colonies at two sites, The Mew Stone and Tom's House, in the 1980s (S. Sutcliffe, pers. comm.). The diet

of Short-eared Owls is less well studied (Glue, 1977; Roberts & Bowman, 1986) perhaps due to a more limited breeding range and attraction to remote areas. Skomer Island is one of the most important breeding sites for the Short-eared Owl in southern Britain, with up to five pairs usually nesting each year (and as many as 13 pairs in 1993).

In this study, we aimed to examine the diet of Little Owls and Short-eared Owls on Skomer Island in 2014, and compare data to those in previous years between 1970 and 2014. We assessed the potential for biosecurity threats from invasive small mammals.

Methods

Study site and owl pellet collection

Skomer Island, Wales (51°40′N, 05°15′W) is a National Nature Reserve managed by the Wildlife Trust of South and West Wales under a lease from Natural Resources Wales. Pellets were collected systematically in April 2014 by LFD; island wardens, researchers and volunteers also collected further pellets between March and April from both species at scattered sites across the island. As the island is only inhabited from March to end of November, it can be expected these pellets were regurgitated between December 2013 and April 2014. Pellets were collected again in August 2014 (by EC) in a similar way. Potential old nest sites (no nests of schedule 1 species i.e Barn Owl *Tyto alba* were approached during this study) and current roosting sites were identified with advice on sightings from island staff, in addition to maps of pellet collection in April). By careful searching, pellets were collected particularly from rocks and on walls around the island. Pellets were placed into separate air-tight bags or paper envelopes labelled with the date and location, and stored at 4ºC in a refrigerator until dissection in the laboratory.

Pellet Analysis

54 pellets in total (22 Little Owl, 32 Short-eared Owl) were collected across 2014 in April and August and were analysed using the methods in Yalden (2009). Pellets were individually soaked for 48 hours in 200ml of 5% saline solution to ease dissection and act as a disinfectant prior to dissection. The matrix (basic material) of each pellet was noted to provide information on the species that may be present. Pellets were teased apart using tweezers, enabling species identification by examining jaw bones (Thomas, 2008; Yalden, 2009) – a hand lens was used where necessary. The matrix was retained and frozen for any later analysis, and bones were stored for further observation and reference. The total number of prey items from each species was recorded. The relative abundance of each species was first assessed to indicate whether identified species were as expected, and that no errors were made. The total biomass was calculated by multiplying the biomass of each individual species by the number of each prey type found (Hayden, 2004). This was converted to a percentage to show the importance of each prey species in the diet of both owls. Determining the contribution of invertebrates to total biomass is difficult, therefore the contribution of invertebrates in Little Owl diet is analysed in terms of percentage occurrence only (Romanowski *et al.*, 2013). Bone remains were counted as the same individual if a pellet contained the remains of the skull and the right and left lower jaw bones of the same species (Dupal & Chernyshov, 2013). Similarly, if only a fraction of a species was found

within a pellet, it was assumed only a fraction of that species was consumed. As in Hayden (2004), the biomass of each species consumed was calculated by multiplying by the number of each prey species present by the known biomass of an individual of that species, to estimate the total biomass contributed by all species in both owls' diet. Converting the individual species' biomass into a percentage shows the relative importance of each prey type in overall diet as opposed to the abundance alone (Yalden & Morris, 1990) so that diet is assessed more accurately. Some masses have been applied from previous research (Hayden, 1999; cited in Hayden, 2004). A jawbone identified from a Brown Rat was present in a Little Owl pellet in 2012. The percentage biomass of this species has been omitted from the results as it causes a unique skew in 2012 data that cannot be compared to other research years where Brown Rat was not a component of the diet. Biomass for *Aves* was calculated using the mean biomass for both Storm Petrel and Manx Shearwater *Puffinus puffinus* carcasses. Although a Little Owl is unlikely to kill and eat a whole shearwater, both seabird species have been recorded in the diets of both Little Owls and Short-eared Owls on Skomer, and we retain this method for comparison with Hayden (2004). Biomass values for stones and fish otoliths that were found in any pellets were individually weighed, used to calculate percentage biomass. Otoliths were identified according to Härkönen (1986). 'Total other' includes invertebrates, otoliths, stones and marine snails. We must bear in mind that individual specialisation in particular prey items and seasonal variation in the availability and choice of prey may influence diet studies.

Statistical analysis

Owl pellet biomass data from 2014 were not normally distributed, and so were subjected to non-parametric analyses for testing differences between groups, and Spearman's rank order correlation for testing relationships between Little Owl and Short-eared Owl diets. Changes in diet over time were tested using Chi-square tests using proportion of biomass. Statistical significance was set to $P<0.05$ and all analyses were carried out using SPSS 20.0 (IBM, New York, USA).

Results

In April 2014, a total of 28 pellets were collected: 16 Short-eared Owl pellets and 12 Little Owl pellets. In August 2014, a total of 26 pellets were collected: 16 Short-eared Owl and 10 Little Owl pellets. In all years, the diet of both owl species is comprised predominantly of Common Shrew, Pygmy Shrew, Wood Mouse and Skomer Vole (Tables 1a & b). European Rabbit also made a surprisingly large contribution to Short-eared Owl diet in 1973 and 2012. House Mouse remains were also present in Short-eared Owl diet in 2014, while in 2012 an Oystercatcher *Haematopus ostralegus* foot (most probably from a chick) and a single Brown Rat jawbone were found in Little Owl pellets. Badger hair was found in a Short-eared Owl pellet in 2012.

Table 2 shows the estimates of biomass for each species present in the pellets analysed. The most abundant species in the diets of both owl species was the Skomer Vole, accounting for 35.7% of the diet of Little Owls (Figure 1a) and 36.7% of the diet of Short-eared Owls (Figure 1b). The percentage biomass of small mammals and birds present in Little Owl diet did not differ significantly between 1973, 2003 and 2014 (Kruskal-Wallis test:

χ^2=0.764, df=4, P=0.943; Figure 2), groups of species that accounted for between 81% and 98% of the total Little Owl diet in these years. There was a large decrease in the biomass of birds in the Short-eared Owl diet in 2014 (10.3%) in comparison with 1970-71 (41.0%). The particularly low biomass in 2014 may be due to the particularly low levels recorded in August 2014 (4.7%). Despite the variability, the percentage biomass of Skomer Vole and European Rabbit did not differ significantly between 1970-71, 2012 and April and August 2014 (Kruskal-Wallis test: χ^2=2.833, df=3, P=0.418; Figure 3). Figure 3 shows a change in both owl diets between 2012 and 2014. However, the changes in both owl diets are not significant. Little Owl diet (Mann-Whitney U test: U=24, n_1=7, n_2=7, P=0.951), Short-eared Owl diet (Mann-Whitney U test: U=18, n_1=7, n_2=7, P=0.455) between 2012 and 2014. Little Owl diet did not vary seasonally (Wilcoxon signed rank test: T=3, n=2, N=2, P=0.180; Figure 4). The biomass of species present in Little Owl and Short-eared Owl diets across 2014 differed significantly between owl species (χ^2=121.47, df=7, P<0.001).

Other prey species

Fish otoliths (Figure 5) were present in both Little Owl pellets and Short-eared Owl pellets, but occurred more frequently with higher biomass in Little Owl diet (+1.46% compared with Short-eared Owl pellets). All otoliths present were approximately the same size and seemed to be from the same few species. The otoliths present in the owl pellets (Figure 5) were identified as Haddock *Melanogrammus aeglefinus* (5A) and Round Herring *Etrumeus teres* (5B) (Härkönen, 1986).

Discussion

We found that the diets of Little Owls and Short-eared Owls were markedly different, but that diets did not vary between Spring and Summer, or between studies in different years: small mammals including Skomer Vole, Wood Mouse, Common Shrew, Pygmy Shrew and European Rabbit and birds have consistently dominated the diets of both owls diets on Skomer Island since the 1970s, and invertebrates were also an important prey species in Little Owl diets. Prey items of marine origin were consumed by both owl species in 2014: otoliths from Round Herring and Haddock were found in owl pellets. We also found evidence that Short-eared and Little Owls hunt on the mainland or neighbouring islands; with the remains of House Mice, Brown Rat and even Badger being found in pellets, even though none of these species are found on Skomer. The number of pellets collected is large enough that diet should be accurately represented in this study (Hayden, 2004).

Patterns in owl diets

Although both owl species preyed predominantly on small mammals, there was a highly significant difference in the biomass of prey consumed by each owl species. This apparent lack of dietary overlap may indicate that there is relatively little competition between both species, which are able to coexist largely due to their different habitat preferences, nesting requirements, hunting styles and movements to the mainland (Lynch, 2007).

Little Owl diet showed greater seasonal variation (April to August) than Short-eared Owl diet, although the differences were not statistically significant. This was similar to previous

work on Skomer (Hayden, 2004) and may reflect Little Owls' opportunistic ability to exploit changing food resources (Hibbert-Ware, 1938; Heaver, 1987, Cramp 1985; Mikkola, 1983; Goutner & Alivizatos, 2003). Invertebrates were an important prey for Little Owls, present in over 90% of pellets (Romanowski *et al.*, 2013; Mikkola, 1983), however, in terms of biomass this accounted for very little of the diet. Several previous studies have also shown insect prey, including *Coleoptera* to be an important food source for the Little Owl (Hibbert-Ware, 1938; Collinge, 1922). Whereas insect remains were present in 19 Little Owl pellets, they were only present in three Short-eared Owl pellets. Small mammals were the staple food of Little Owls (as in Gotta & Pigozzi, 1997), primarily Skomer Voles. Birds were also common in the diet, comprising (as in Hayden, 2004) nearly 50% of prey biomass.

Previous concerns about the predation of breeding Storm Petrels by Little Owls (Green *et al.*, 2005) is unclear, as this study found no pellets consisting of Storm Petrel remains. However, Storm Petrels have been regularly found in recent years around Little Owl nest sites on the Island (D. Boyle, per comm.), and pellets were collected from these nest sites. Pellet analysis alone may not be effective in monitoring the numbers of Storm Petrels predated by Little Owls, and individual predators may specialise in certain prey items for distinct periods of time: Storm Petrels remains have certainly been recovered from owl pellets on Skomer in the past, and around Little Owl nest sites during pellet collection for this study in 2012-13 (MJW, pers. obs.). As might be expected for a larger owl, the total biomass of prey consumed by Short-eared Owls is much higher than that of the Little Owl over the whole year. Again, Skomer Voles were the most common prey species although birds made up more than a third of Short-eared Owl diet in August. Yalden (1985) also found that voles were the predominant prey item of this owl species, with birds being of secondary importance. In 1970-71, Short-eared Owl diet mainly consisted of Skomer Voles and European Rabbits (Figure 4), with Wood Mice and birds being of secondary importance (Glue, 1977).

The presence of otoliths in both species' pellets is interesting in apparently terrestrial predators, and previously unrecorded to our knowledge. Van Damme (2005) suggests owls may feed on fish when more common prey such as voles are less accessible. Otolith presence may provide details on the birds they are preying on and their diet, as opposed to the owl's preying on fish themselves. For example, the owls are known to prey on Manx Shearwaters, which have a diet of fish including clupeids, sandeels and squid (Brooke, 2010). The owls may be feeding on the stomach contents of seabirds through predation, or scavenging regurgitated remains e.g. from gulls. This seems more likely than kleptoparasitism of seabirds by owls causing regurgitation of fish, and we presume that the hunting of fish by owls at sea is even less likely. Unfortunately, otoliths recovered from pellets are not a reliable indication on of the size of the original fish, as they can be reduced in length, becoming fragile in the digestive tract (Duffy & Laurenson, 1983; Votier e*t al.*, 2001), so we cannot speculate on the size of fish consumed, which may indicate the species of seabird that captured the fish.

Off-island prey items and biosecurity

This and previous studies have shown that both island species hunt away from Skomer Island, because prey items not found on the island have been found in owl pellets collected

on Skomer. Remains of House Mice (found on the mainland and nearby Skokholm Island) were identified in Short-eared Owl pellets. Pellets collected from Skomer in winter 2014-15 have been found to contain Field Vole *Microtus agrestis* remains (Jason Moss, pers. obs.), another small mammal species not native to the island (Davis & Saunders, 1965). This comes as no surprise, as Short-eared Owls travel from Skomer to hunt Storm Petrels on Skokholm Island, where neither owl species breeds, and where the remains of Storm Petrels have been found in Short-eared Owl pellets (MJW pers. obs; R. Brown & G. Eagle, pers. comm.): this owl species clearly has the capacity to hunt across a wide range. A surprising mammal remain came in the form of a Badger hair, found in a Short-eared Owl pellet in 2012. This raises questions about the foraging behaviour of Short-eared Owls, which are assumed to be exclusively predatory and not carrion eaters (Cramp, 1985).

The presence of Brown Rat in Little Owl pellets may appear, at first glance, to be of concern. A single Brown Rat jaw was found amongst a number of Little Owl pellets in a small cave in 2012, in close proximity to a Little Owl roosting site, and Glue (1977) found Brown Rat remains in Short-eared Owl pellets on Skomer between 1964 and 1973. Rats are commonly recorded as prey of Little Owls on the mainland (Hounsome *et al.*, 2004). The movement of owls to the mainland to hunt is notable, and perhaps unsurprising (in 1973 on Skomer this included European Mole). The transportation of Brown Rats by owls from the mainland to Skomer presents a theoretical biosecurity risk for a currently rat-free seabird island (requiring the transport of multiple live or a pregnant female rat), but we consider this to be highly unlikely. It is possible that gulls brought the rat jaw to the island, which was subsequently moved by a scavenger. The introduction of rats to Skomer Island by owls is highly improbable compared to the risk of introduction of ground predators through human activities, for example in the transport of luggage, food and materials to the island. To safeguard Skomer against natural or anthropogenic introduction of rats a robust system of hazard alerts and quarantine procedures is in place and implemented fully. Skomer holds an emergency rodent kit comprising chew-sticks and break-back traps. Of the 'non-native' prey species discovered in pellets, the introduction of House Mouse, although known to be a problem on seabird islands elsewhere in the world (Wanless *et al.*, 2007), is thought to be of low risk, as competition from the already present Wood Mouse and evidence from Skokholm Island on the diet of House Mice suggest that an introduced population of this species would be unlikely to persist to the levels where eating seabirds would become problematic (Berry 1968).

Continued monitoring of owl diets by pellet analysis might be considered on Skomer, to build up a long-term data set that could be used to study predator-prey interactions. For example the associations between the size of small mammal and Short-eared Owl populations may be of interest, with long-term data available in island bird records and from small mammal monitoring data dating back to the 1970s (Healing et al. 1983). As a biosecurity measure, systematic pellet analyses (Russell et al., 2008) to complement the rat-eradication plan described above may be useful, as the early detection of an invasion would be crucial to enable an effective response. Conservation management and the ecological study of island wildlife are clearly closely intertwined.

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	% Total Biomass			
Prey species	**2003**	**2012**	**2014 April**	**2014 August**
European Rabbit	0.0	37.3	0.0	0.0
Common Shrew	0.0	1.1	1.6	5.6
Pygmy Shrew	0.0	1.1	1.7	0.0
Wood Mouse	20.0	15.5	31.5	12.5
Skomer Vole	21.7	13.6	37.5	29.7
Total mammals	41.7	68.6	72.3	47.8
Total birds	43.5	29.8	4.7	47.2
Total herptiles	2.9	0.3	22.2	4.1
Total other	11.9	1.3	0.8	0.9

Table 1a. Little Owl diet on Skomer Island in 2003, 2012 and 2014.

	% Total Biomass			
Prey species	**1973**	**2012**	**2014 April**	**2014 August**
European Rabbit	78.9	70.4	14.7	4.7
Common Shrew	2.1	0.0	2.0	0.3
Pygmy Shrew	0.0	0.0	0.6	0.6
Wood Mouse	2.3	8.7	9.6	3.7
House Mouse	0.0	0.0	3.3	17.3
Skomer Vole	6.4	8.6	37.1	36.1
Total mammals	89.7	87.7	67.3	62.7
Total birds	9.0	12.2	24.5	36.8
Total herptiles	1.3	0.1	8.1	0.4
Total other	0.0	0.0	0.1	0.1

Table 1b. Short-Eared Owl diet on Skomer Island in 1973, 2012 and 2014.

Species	Biomass (g)	Reference
Skomer Vole *Myodes glareolus*	25	Fullager *et al.* (1963)
Wood Mouse *Apodemus sylvaticus*	18	Yalden (2009)
House Mouse *Mus domesticus*	12	Yalden (2009)
Common Shrew *Sorex araneus*	8	Yalden (2009)
Pygmy Shrew *Sorex minutus*	4	Yalden (2009)
European Rabbit *Oryctolagus cuniculus*	50-1100	Graham (2012)
Birds *Aves*	226	
Storm Petrel *Hydrobates pelagicus*	28	Cramp and Simmons (1977)
Manx Shearwater *Puffinus puffinus*	350-535	Cramp and Simmons (1977)
Common Frog *Rana temporaria*	30	Graham,(2012)
Brown Rat *Rattus norvegicus**	100	Morris (1979)
Ground Beetles *Carabidae*	0.2	Yalden & Warburton (1979)
Dor Beetles *Geotrupes*	1	Yalden & Warburton (1979)
Leaf Beetle *Chrysomelidae*	0.1	Hayden (1999)
Ants *Formicidae*	0.1	Hayden (1999)
Woodlice *Oniscidea*	0.3	Hayden (1999)

Table 2. Individual biomass estimates of prey species present in pellets collected from Little Owls and Short-Eared Owls on Skomer Island 2012-2014. * Brown Rat was present in one pellet in 2012 but is omitted from biomass calculations (along with other sporadic prey items such as Oystercatcher) to avoid skew of diet composition

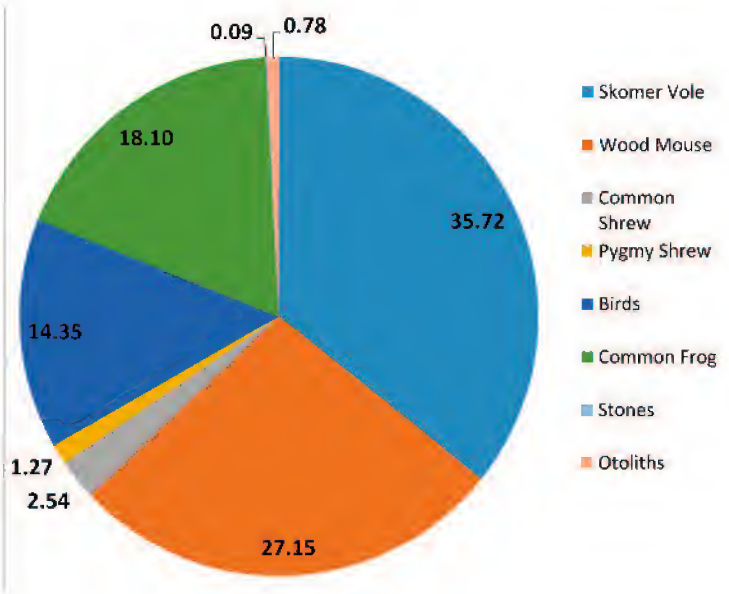

Figure 1a. The relative biomass of prey species in the diet of Little Owls on Skomer Island in 2014.

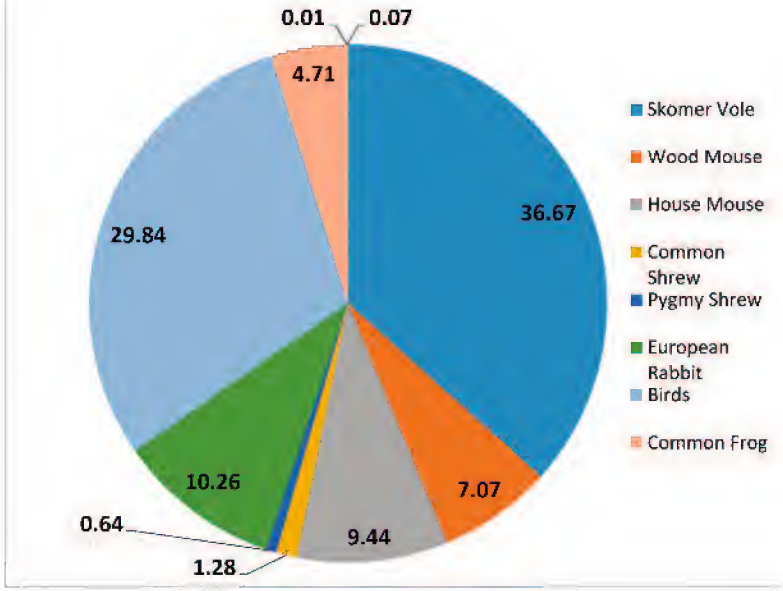

Figure 1b. The relative biomass of each prey species in the diet of Short-Eared Owls on Skomer Island in 2014.

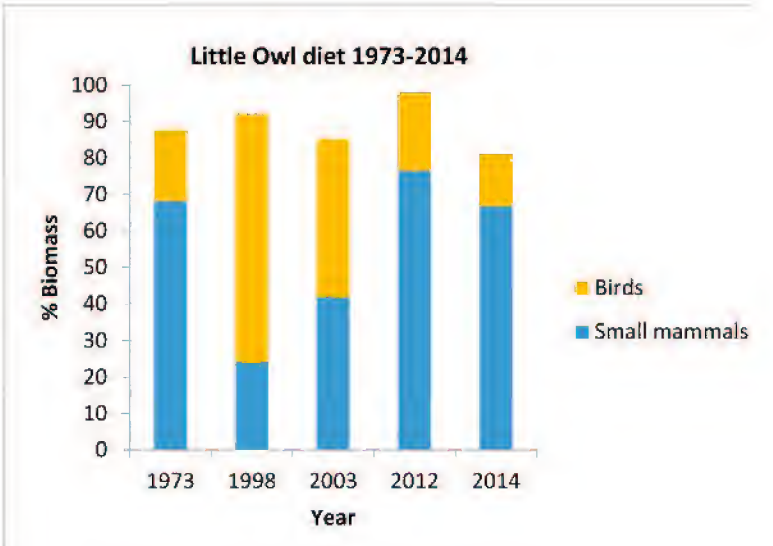

Figure 2a. The percentage biomass of small mammals and birds found in Little Owl pellets between 1973-2014 (Hayden, 1999; Daley, 2012). Brown Rat *Rattus norvegicus* omitted.

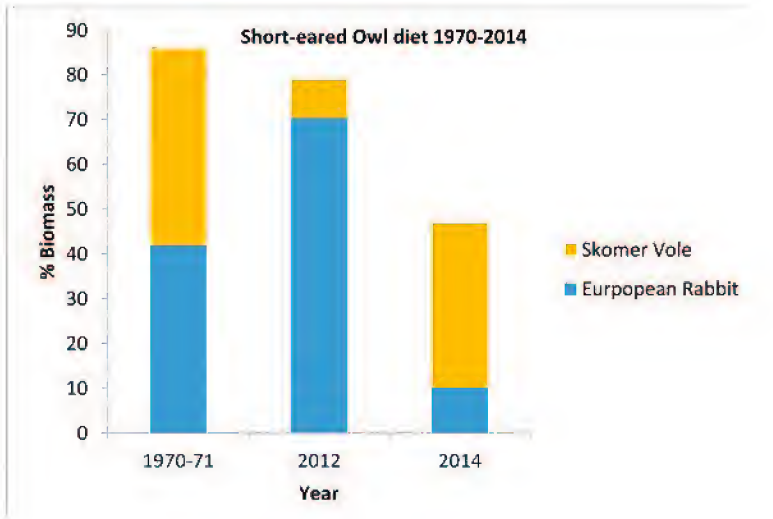

Figure 2b. Percentage biomass of Skomer Voles and European Rabbit found in Short-Eared Owl pellets 1970-71 (5 pairs: Glue, 1977), 2012 (2 pairs: Daley, 2012) and 2014 (3-4 pairs).

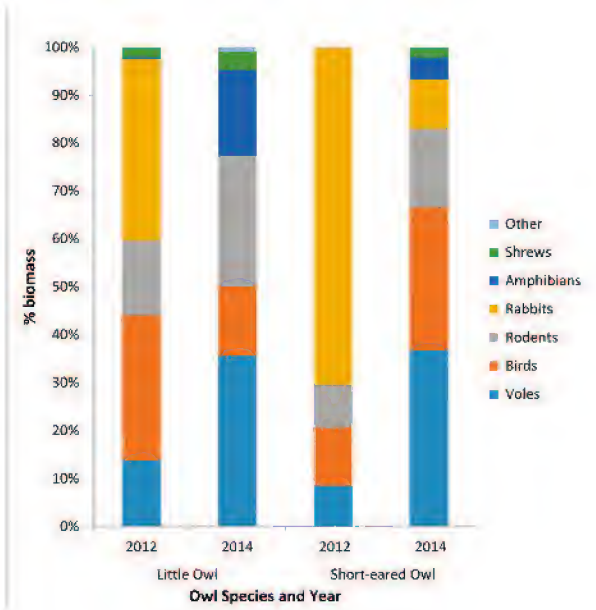

Figure 3. Variation of Little Owl and Short-Eared Owl diets by % biomass of prey in 2012 and 2014.

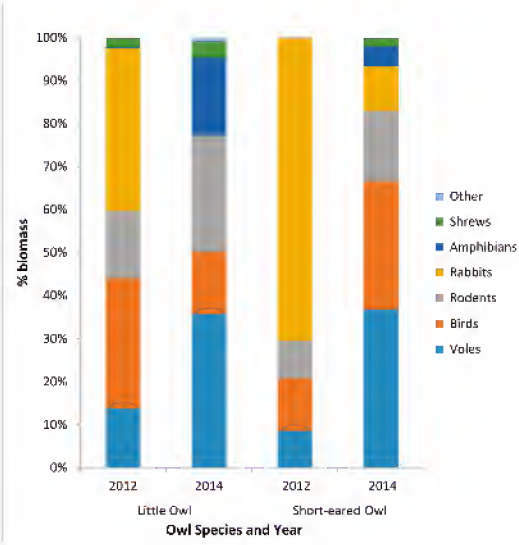

Figure 4. Seasonal variation of the diets of Little Owl and Short-Eared Owl diets in 2014 by % biomass of prey.

Figure 5. Examples of fish otoliths found in Little Owl and Short-Eared Owl pellets in 2014. A: Haddock *Melanogrammus aeglefinus* and B: Round Herring *Etrumeus teres*.

RSPB Conwy Nature Reserve: a review of the first 20 years

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Crynodeb

Daeth gwarchodfa Conwy yn un o'r gwarchodfeydd natur sy'n cael fwyaf o ymwelwyr yng Nghymru, yn rhannol oherwydd y mynediad hawdd o'r briffordd A55. Rydym yn adolygu'r modd y cytrefwyd y safle gan fywyd gwyllt, yn enwedig adar, yn ystyried rhai o heriadau rheoli'r warchodfa ac yn edrych ymlaen i'r ugain mlynedd nesaf.

Summary

Conwy reserve has become one of the most frequently visited nature reserves in Wales, partly thanks to its easy access next to the A55 trunk road. We review the colonisation by wildlife, particularly birds, of the site, consider some of the management challenges faced by the reserve, and look forward to the next 20 years.

Introduction

RSPB Cymru's nature reserve at Conwy is a 50 hectare (125 acre) wetland site located between the A55 trunk road and the Conwy estuary, North Wales. The habitats have been created in the 22 years since the RSPB took on the lease from the Crown Estate in 1994. It is a major visitor attraction, with more than 70,000 visits annually, providing many people – especially families and schoolchildren – with their first opportunity to discover nature. This review focuses on the wildlife, particularly the birds, that have made the reserve their home during the first 20 years, and sets out some of the challenges that the site faces.

A potted history

The reserve was created from three million tonnes of silt, sand and mud removed from the bed of the adjacent Conwy estuary during construction of the A55 road tunnel during 1988-91. These materials were pumped onto a 50 hectare area of saltmarsh and intertidal habitat that had been impounded from the tide, using thousands of tonnes of limestone to create a new sea wall. The loss of the intertidal habitat was opposed by conservation groups, including the Nature Conservancy Council and the RSPB, but with no formal protection (the Afon Conwy SSSI was not notified until 2003), there was no legal means to prevent the loss.

The intention was for the settling lagoons to be in-filled, capped with topsoil and the area

grazed. During the planning stages, however, The RSPB was invited to collaborate with the Crown Estate and Aberconwy Borough Council to create a nature reserve on the site, and then formally to manage it. Dick Squires, site manager at RSPB Ynys-hir; John Andrews, the RSPB's chief advisory officer, and Graham Williams, head of reserves at RSPB Cymru, drew up plans to change the settling lagoons into a wetland habitat and install visitor infrastructure. Costain Tarmac – contractors for the tunnel construction – undertook some landscaping work to the RSPB's design in 1991. Dave Elliott was seconded from Ynys-hir in 1991, and with a team of locally-recruited volunteers prepared the site for its public opening on 14th April 1995.

Habitats, species and management

Having been created from inert silt and mud buried at the bottom of the estuary since the last Ice Age, the site did not look promising for anyone anticipating a wealth of wildlife. Dave Elliott described it as "looking like the moon", with minimal vegetation except for roadside "weeds".

In the following two decades, the area has matured, and the site now comprises the habitat types shown in Table 1.

Habitat type	Area (ha)	Comments
Scrub	8.1	Predominantly bramble
Neutral grassland	7.9	Grazed by mountain ponies
Reedbed	2.7	Rhizomes imported from a nearby site to create reedbed
Open water	12.9	Two large freshwater lagoons, and a number of smaller ponds
Saltmarsh and intertidal mud	14.7	Forms part of Afon Conwy SSSI
Bare ground	4.4	Footpaths, car park and bare rocks
TOTAL	**50.7**	

Table 1. Phase 1 habitats at Conwy (as of 2011).

Freshwater pools

The waterbodies provide the main focus for the reserve. The settling lagoon created during tunnel construction was split into two small freshwater lakes, which sit three metres above the high water mark. Causeways, that had been designed to slow the water as it deposited silt into the lagoons during tunnel construction, were broken into a series of islands and a pump was installed to enable water from a nearby stream (the Afon Ganol) to be transferred into the lagoons. Along with precipitation, this is the only source of water for the lagoons; there is no tidal exchange, and the height of the lagoons above sea level means that this will never be possible.

The main water bodies vary in depth, from just a few centimetres to three metres, a result of their origins as settling lagoons, dropping heavier silt and clay sediment at the north end, leaving mainly sand to remain at the south end. The shallow areas host non-breeding waterbirds such as Teal *Anas crecca*, Shoveler *A. clypeata* and Gadwall *A. strepera*, while Pochard *Aythya ferina*, Red-breasted Merganser *Mergus serrator* and Goldeneye *Bucephala clangula* winter in the deeper water.

Although there are limits to hydrological control on the site, the aim is to raise the water levels to their maximum during the winter, providing foraging opportunities for a range of diving and dabbling water birds and giving the islands greater protection from mammalian predators. Water levels are then allowed to fall during the spring and summer; evaporation and transpiration results in an average natural loss of 10mm each day during May to September without additional rainfall. By July and August, this creates marginal muddy feeding habitat for southbound wader species.

Reedbed

Rhizomes of Common Reed *Phragmites australis* were transplanted from a nearby site, which had itself been created in 1990 for flood alleviation from the A55 trunk road. These rooted successfully to create reed fringes in the shallow parts of the lagoons, holding small populations of breeding Sedge Warbler *Acrocephalus schoenobaenus,* Reed Warbler *A. scirpaceus* and Reed Bunting *Emberiza schoeniclus*, plus wintering Water Rails *Rallus aquaticus* and, occasionally, Bittern *Botaurus stellaris*.

To date, there has been minimal intervention in the reedbeds, save for cutting small areas close to trails and boardwalks to maximise viewing opportunities for visitors. Invasion by Willow *Salix* scrub has not been an issue so far at Conwy except in one small area. However, 15 years after the reeds established, a periodic cutting regime will be instituted during the next five-year management plan.

Scrub, grassland and bare ground

At the outset, the whole reserve was bare ground, and the poor quality of the soil (initially with soil salt levels of almost 40%) meant that it took some years for grass and other plants to become established. Lapwings *Vanellus vanellus* quickly occupied the bare ground, as did Skylarks *Alauda arvensis* and Little Ringed Plover *Charadrius dubius*. Grazing, initially by sheep but latterly by ponies, was introduced in order to maintain open habitats for these birds. Six animals (usually Carneddau mountain ponies) graze an 11-hectare block of grassland and scrub at the south end of the reserve throughout the year. These animals manage the scrub, rush and reed and create a varied sward of grass. The weight of the ponies create depressions that, once filled with rainwater, provide ideal conditions for invertebrates, as does the manure of the ponies, which are not routinely treated with avermectin drugs.

Around 4,000 small trees, mainly Alder *Alnus glutinosa,* Silver Birch *Betula pendula* and

Ash *Fraxinus excelsior,* were planted in the mid 1990s, and low scrub (primarily Bramble *Rubus fruticosus*) has become established, creating thickets for passerines such as Bullfinch *Pyrrhula pyrrhula*, Whitethroat *Sylvia communis* and Dunnock *Prunella modularis*. Small areas of scrub are cut mechanically each year to create micro-climates for invertebrates, especially on south-facing banks.

Estuarine habitats

The reserve includes 15 hectares of intertidal mud and saltmarsh, formed of a strip of approximately 100 metres below the high water mark. This area is monitored, but no management is undertaken, and bird counts include the whole Wetland Bird Survey (WeBS) unit, across the width of the estuary, from the Conwy embankment (Cob) to the bend in the river at Glan Conwy.

The habitat provides a foraging area for Oystercatcher *Haematopus ostralegus*, Curlew *Numenius arquata* and Redshank *Tringa totanus*, and smaller numbers of passage birds such as Whimbrel *N. phaeopus*, Dunlin *Calidris alpina* and Ringed Plover *Charadrius hiaticula*. At high tide, some of these birds roost on the islands within the lagoons, but others – particularly Curlews – switch to feeding on grasslands in Llandudno and Penrhyn Bay, around 5 km distant. The saltmarsh proves especially attractive to White Wagtails *Motacilla alba alba* in April, stopping off *en route* to Iceland, and Wheatears *Oenanthe oenanthe* are common on migration along the sea wall.

Major changes in the first 20 years

Creating a nature reserve (and, indeed, the landform) from scratch has provided a rare opportunity to monitor its colonisation, although for some species, presence is only temporary. It is important to remember that there is very little 'natural' about RSPB Conwy, but aside from the trees and reeds that were transplanted to kick-start the vegetation, everything else has found its own way to the reserve. The management philosophy has been "build it, and they will come", and in that time, more than 1,000 species have been recorded. Not surprisingly, most are fairly widespread and abundant species, but a small number have proved to be nationally scarce, or the first record for the vice-county or even the region. 65 species recorded at RSPB Conwy are priority species in Wales; these were formerly known as 'Section 42' species, but are now listed under Section 7 of the new Environment (Wales) Act 2016 (Wales Biodiversity Partnership 2015).

Aside from birds, which are well monitored, recording of other taxonomic groups is patchy, reliant on specialist knowledge and enthusiasm, though boosted by periodic 'Bioblitz' events. In recent years, transects for butterflies, dragonflies and bumblebees have been established and regular moth-trapping is helping to increase our knowledge. As on all nature reserves, records from visitors are greatly appreciated – do not assume that site staff already know about the presence of a species.

Taxa	Number of species
Flowering plant	325
Bird	234
Moth	226
Spider	49
Butterfly	26
Dragonfly	15
Mammals	25
Others	169
TOTAL	**1069**

Table 2. Number of species recorded at RSPB Conwy for selected taxonomic groups

Water birds: increasing numbers and diversity

Wetland Bird Surveys (WeBS) have been undertaken on the Conwy estuary, with some gaps in coverage, since winter 1962/63. One WeBS sector (Upper Sector 1) contains the whole RSPB landholding as well as an adjacent area of intertidal habitat between Conwy Cob and Glan Conwy. This sector has been counted by RSPB wardens and/or volunteers since 1993-94, except in 2000-01. Note that species that occurred on fewer than five occasions have been excluded from the analysis below.

The numbers of water birds (Figure1) and their diversity (Figure 2) has increased since Conwy reserve was created. In the early years (1993-2000), the range of species and their numbers were fairly low: Oystercatchers and Curlews were present in good numbers on the estuary and roosted on the lagoons at high tide, but with minimal vegetative cover, and perhaps little food in the (brackish, but not intertidal) lagoons, few birds were attracted to the pools. From the reserve's second decade, however, higher numbers and diversity have been consistently maintained. The only wetland bird to have ceased occurrence is Ruddy Duck *Oxyura jamaicensis*, which bred for a number of years in the 1990s. The species has been largely removed by the UK Government Ruddy Duck Eradication Programme (GB Non-Native Species Secretariat), though no control was carried out at Conwy.

WeBS counts for the Conwy estuary held on the BTO database were not recorded by sector prior to 1992-93, so it is not possible to compare the impact of the creation of the nature reserve. However, few of the duck species (except Red-breasted Merganser and Wigeon *Anas penelope*) and none of the rails or grebes were regular on the estuary, and the wader species were limited to Curlew, Dunlin, Lapwing, Oystercatcher and Redshank.

Long-term trends for the whole estuary show marked changes for some species. For example, Black-tailed Godwits *Limosa limosa* (Figure 3) were rare on the Afon Conwy prior to the construction of the RSPB reserve, since when flocks of 20-50 birds are regular on passage, and a small number winter. Sightings of colour-ringed birds show that these are

islandica birds *en route* to and from their nesting grounds in Iceland.

Dunlins were formerly much more abundant on the Conwy estuary. Figure 4 shows how Dunlin counts fell dramatically, from 3-5,000 in the 1970s to 1-2,000 in the 1980s, before the tunnel construction and have continued to decline subsequently. This is likely to be a product of "range-shift", as Dunlin is one of several species shown to be declining on estuaries in western Britain and in Ireland (Austin and Rehfisch 2005). There is an amber long-term alert for Dunlins in Wales, owing to a 43% decline since 1984-85 (Cook *et al*. 2013).

Redshank counts had been falling on the Afon Conwy in the last 30 years of the 20th century. However, they have made something of a recovery in recent years, returning to their mid-1980s levels at a time when their GB and Wales winter populations have fallen (Cook *et al*. 2013). The WeBS counts show that the RSPB reserve and the south wall of Conwy Cob provide a roost refuge for Redshanks at high tide, holding almost all of the estuary's total (Figure 5).

Non-breeding birds

Other non-breeding birds are not routinely surveyed, but ad hoc sightings from visitors and staff are recorded. Just a few of the highlights are featured below:

Water Rail. This species has featured on WeBS counts at Conwy since 2002, but this is recognised as a poor way to monitor the presence of this secretive bird. In winter 2012/13, the reserve was one of six sites that participated in a pilot study to compare WeBS counts with a tape-playback method that is already used to monitor breeding numbers. The pilot study, undertaken over three months in winter 2012/13 showed a much higher detection rate when using tape-playback (Calbrade 2014). Subsequently, staff have undertaken one tape-response survey in January each year to provide a more accurate estimate of numbers than WeBS.

January survey	2013	2014	2015	2016
Responding Water Rails	18	15	16	20

Table 3. Water Rails found during tape-response surveys in January 2013-16.

Bittern. The modest area of reedbed (2.7 ha) at Conwy mostly forms a narrow fringe around the lagoons, with a small area in the old Afon Ganol. Bitterns were recorded during five of the seven winters between 2006/07 and 2012/13, though not subsequently. Although birds were recorded for a week or less in two of those winters, their presence in other years lasted between 20 and 60 days, and in 2012/13, two birds were present. Bittern is unlikely to breed at Conwy, but its occurrence in winter may provide a 'stepping stone' on the North Wales coast to the larger areas of reedbed that have been created and restored by RSPB Cymru and others on Anglesey, where booming males were heard in 2015 and 2016.

Starling. The structure of the reedbeds also provides a winter roost for Starlings, which is often preceded each Winter afternoon by a spectacular murmuration. The numbers vary each Winter, and in some years no roost occurs, but in a good year upwards of 50,000

individuals will roost each night for up to two months. Each area of reedbed is used for around 10 days, by which time it is squashed almost flat (50,000 Starlings weigh 3.9 tonnes!), and the flock moves to another area of reedbed within the site.

Scarce and rare birds

The combination of good geography, good habitat and a reasonable density of experienced birdwatchers has ensured that Conwy has recorded some unusual birds since its creation. Not surprisingly, waders dominate the list: 39 species have been recorded here, including two firsts for Wales. Some species are now rare in a Welsh context and are unlikely ever to occur again. Perhaps Black Grouse *Tetrao tetrix,* one of which was found standing on a sandbank in the estuary during a guided walk in May 2007, is the candidate for the most unlikely record at the reserve!

Species	Date	Occurrence in Wales
Stilt Sandpiper *Calidris himantopus*	11th-13th July 2006	First record
Terek Sandpiper *Xenus cinereus*	29th April-3rd May 1999	First record
Citrine wagtail *Motacilla citreola*	30th April 2008	Second record (also May 2011 and August 2013)
Broad-billed Sandpiper *Calidris falcinellus*	14th May 1999	Fifth record
Marsh Sandpiper *Tringa stagnatilis*	14th June 1996	Fifth record

Table 4. Top five rarest birds recorded at RSPB Conwy

Breeding waterbirds

Lapwing. The sparsely vegetated habitat that was created after the tunnel spoil was pumped to the site quickly attracted Lapwings. With little human presence and the site effectively an island (its three sides bordered by a busy road, the Conwy estuary and a railway line), there were regularly 10 breeding pairs during the first decade. Most nested on the islands formed within the lagoon, though the rocky substrate here often resulted in broods swimming to the shore at one or two days old, presumably because of limited feeding opportunities. Figure 6 shows that only in two years (1999 and 2001) did Lapwings fledge >0.6 chicks/territorial pair, the minimum productivity necessary to achieve a self-sustaining population (MacDonald and Bolton 2008).

Efforts were made to boost productivity by creating scrapes and pools for feeding chicks and re-profiling the edges of the lagoons to ease movement of chicks. However, the contours of the reserve and the unnatural soil horizons result in the soil surface drying out by early spring, and few areas remain reliably damp throughout the chick-rearing weeks. Annual surveys of benthic invertebrates in the lagoons show *chironomid* (non-biting midge)

larvae to vary between 0 and 5g/m^2, but it is unclear why and unknown how important *chironomids* are to wader diet at Conwy. The substrate of the lagoons is unnatural, the sides are steep and the island edges are very rocky, limiting the amount of change that can be achieved.

As the site matured, aerial predators (Herring Gull *Larus argentatus,* Lesser Black-backed Gull *Larus fuscus*, Carrion Crow *Corvus corone* and Grey Heron *Ardea cinerea)* moved onto the reserve, and individuals of all four species have been witnessed taking eggs and/or chicks. Ground predators may also have taken eggs and chicks, especially when broods swam onto the 'mainland', though American Mink *Neovison vison*, Stoat *Mustela erminea* and Fox *Vulpes vulpes* may also have swum onto the islands. American Mink are controlled on the site, and during 2006-09 nests of Herring and Lesser Black-backed Gulls were raked out to prevent breeding. However, this did not result in an increase in Lapwing productivity (see below).

Other breeding waders

Oystercatcher has bred at the reserve from the outset, with four or five pairs annually in recent years (Figure7). Productivity is higher than Lapwing, perhaps because adults feed their young rather than leave them to fend for themselves. Common Sandpiper *Actitis hypoleucos* bred in 2007 and has bred annually since 2010, with two pairs in some years. Productivity has been good, with one or two chicks fledging per pair each year.

In the early years, Redshank bred annually, one or two pairs fledging young in 1993-98. After this, productivity fell as the site matured, and breeding failed at the nest or chick stage in 2002, 2003 and 2007; one of the nests failed when a Moorhen *Gallinula chloropo*s predated the eggs.

Little Ringed Plover nested annually in the early years (1993-98), two or three pairs fledging young each season. One or two pairs have nested periodically in subsequent years, with variable degrees of success: young fledged once in four years during 2002-05 and once in three years during 2011-13. In these latter years, their propensity to nest is determined entirely by water levels, generally attempting only when low rainfall has prevented the levels being raised on the lagoons over the previous Winter.

Ringed Plovers also adopted the bare ground rapidly prior to the public opening of the reserve, with young reared annually during 1994-97, but the sole nesting attempt since – in 2003 – failed at the nest stage.

Waterfowl, rails and gulls

Canada Goose *Branta canadensis*, Mallard *Anas platrhynchos* and Tufted Duck *Aythya fuligula* breed annually. There are typically 8-17 pairs of Mallard and 8-14 pairs of Tufted Duck, with productivity averaging 1.2 and 1.0 fledged chicks per pair respectively. Canada Geese started to breed in 1998, and in the last 10 years have numbered between 20 and 35 pairs. The loss of eggs to large gull sp. is high, and the mortality of chicks is also typically high. Productivity averages 1.0 chick/pair.

Other duck species regularly remain into the breeding season in small numbers, but few breed. Two pairs of Gadwall nested in 2014, though no young fledged, and Teal bred successfully in 2003. Ruddy Ducks bred annually from 1997 with a peak of six pairs; the last pair fledged two young in 2006. Shelduck *Tadorna tadorna* have over-summered, but breeding was proven only once, in 2003, when one chick fledged.

Water Rails are monitored by a call-response method in early April. One or two pairs respond each year, although proving breeding of this shy reedbed species is notoriously difficult. Kingfisher *Alcedo atthis* is a regular winter visitor to the reserve, but breeding has been suspected only once, in 2008.

Between five and 10 pairs each of Coot *Fulica atra* and Moorhen nest in the reedbeds each year, with productivity averaging 1.3 and 1.0 fledged chicks/pair. This compares favourably with other long-term studies with an average of 1.01 Coot chicks fledged per pair (Sage 1969) and 0.85 Moorhen chicks fledged per pair (Wood 1975).

Up to seven pairs of Herring Gulls nested on the lagoon islands during 2004-15 (and probably prior to that), but productivity was low, with birds fledging only in 2006. Similarly, Lesser Black-backed Gulls nested in all but one year during 2004-13, but fledged young only in 2006. During 2006-10, nest raking was undertaken owing to concerns that predation by large gulls was responsible for the loss of wader chicks, especially Lapwings. Upon review, this was discontinued since it made no material difference to wader productivity; the presence of large numbers of non-breeding gulls, equally capable of predating eggs and chicks, was unaffected by the nest-raking; and the red-listing of Herring Gull and amber-listing of Lesser Black-backed Gull in Wales altered the priority afforded to both species.

Black-headed Gulls *Chroicocephalus ridibundus* bred in 2003, fledging two young, but have not done so since, although in recent years birds have stayed well into May, and it is hoped that the de-vegetation of three islands in Autumn 2015 will make this area more attractive to this species in future. To encourage nesting, a fence will be installed in Autumn 2016 to prevent mammals getting onto these islands.

Other breeding birds

Presence of territorial non-waterbird species is recorded, with full surveys undertaken in 2007 and 2012 (and another planned for 2017), using a mapping method based on BTO Common Birds Census. These show the numbers of all species were stable or increasing over this period except for Reed Bunting. Figure 8 illustrates that relatively few passerines nested during the first 10 years after the site was created, in contrast to nesting by waders. Skylark was a regular breeder until 2005, by which time the grasslands had started to become more scrub-dominated, as reflected in the colonisation by a range of warbler species. Skylark has become far scarcer in the adjacent countryside too (pers.obs.).

Since 2003, the range of species nesting at Conwy has become more diverse, with 20-30 passerine species typically nesting. Skylark is the only species to have been lost from the reserve, although a few species, notably Stonechat *Saxicola rubicola* (2002-04), Wheatear (2002-04), Bearded Tit *Panurus biarmicus* (2010) and Pheasant *Phasianus colchicus* have come and gone. Sand Martin *Riparia riparia* inspected sand faces around the lagoon edges

in 1999 and 2002, and it is believed that two clutches hatched in 2005, but no young fledged. The Bearded Tits, which hatched three young and fledged two, was the first occurrence of the species at Conwy and the first (and still sole) nest known in North Wales since the 1960s. Unfortunately, although the family remained on the reserve until October 2010, freezing weather put paid to hopes of colonisation. Nonetheless, their appearance showed that Bearded Tits can make it to North Wales, even though the nearest breeding site is 150km from Conwy at RSPB Leighton Moss in north Lancashire.

In addition, several species nesting in the locality use the reserve as part of their breeding cycle, including House Martins *Delichon urbicum* that collect mud from the estuary to build their nests, and Starlings that bring fledged juveniles to feed on the reserve in late Summer. Grey Herons and Little Egrets *Egretta garzetta* nest in a colony on the west bank of the estuary and feed in the lagoons.

Colonisation by non-avian species

Over 1,000 species have been recorded at RSPB Conwy since its creation, of which more than 75% are species other than birds. Other groups are, doubtless, under-recorded, although we do now believe we have a good handle on mammals, butterflies, dragonflies, moths and flowering plants thanks to surveys by expert volunteers. We would urge all visitors with wildlife expertise to provide their more interesting records to nature reserve staff; the RSPB has a GIS database on which to record such sightings, helping to inform future habitat and visitor management.

Twelve European Protected Species (listed on Annex IV of the Habitats Directive) have occurred on the reserve. Three of these (including Polecat *Mustela putrorius*) are occasional visitors, but the others – European Otter *Lutra lutra* and eight bat species – are regular. Otters are monitored using trailcams, and are present throughout the year. Bats have been surveyed periodically, in recent years using passive detectors, which has provided more detail of the frequency of occurrence. In 2015, Nathusius' Pipistrelle *Pipistrellus nathusii* was recorded for the first time, and on each subsequent survey into 2016, suggesting that this former migrant has become established in the area. Of the bat species recorded at Conwy, the rarest is Lesser Horseshoe *Rhinolophus hipposiderus,* also recorded for the first time in 2015.

Of the 65 'Section 42' species (Wales Biodiversity Partnership 2015), 39 are not birds. The wetland habitats are particularly attractive to wainscot moths including two S42 species: Shoulder-striped Wainscot *Leucania comma* and Large Wainscot *Rhizedra lutosa*. As with the birds, some species were typical early colonisers when the habitats were bare and the soils nutrient-poor. Dingy Skipper butterfly *Erynnis tage*, for example, has not been recorded since 1998, even though the site has plentiful Bird's Foot Trefoil *Lotus corniculatus* (its larval food plant) and there are colonies in the adjacent 10km square.

Periodic Bioblitz events, bringing species experts to a site for an intensive search, pays off. The 2011 Bioblitz, for example, recorded the fungus *Bisporella scolochloae* on a dry area of reedbed, which remains the only record from Wales. Evidence that the reserve is still being colonised comes with the recording every year of species, particularly invertebrates,

not previously found at RSPB Conwy. The first record of Common Lizard *Zootoca vivipara* came only in 2015, thanks to a visitor with a camera. In recent years, orchid species have flourished, with over 2,500 Southern Marsh Orchid *Dactylorhiza praetermissa* spikes and 400 Bee Orchids *Ophrys apifera* recorded in 2016. Intriguingly a record of Fragrant Orchid *Gymnadenia conopsia* in 2001 has not been repeated. At a site such as Conwy, there is still more to discover, and everyone can help!

Connecting people with nature

A primary aim of creating and managing RSPB Conwy was to enable large numbers of people to have contact with wildlife, so from the outset, the network of trails and viewing hides and screens was designed with this in mind. In the early years, the reserve appealed to birders in particular, especially as the temporal nature of the habitats attracted a variety of rarities. As the site has matured, and become a more interesting place for other visitors, particularly walkers, families and photographers, visitor numbers have increased, and so has habitat and infrastructure management, designed to minimise disturbance to wildlife and maximise enjoyment of visitors.

The examples below vary from the very simple to more resource-intensive, but are used to illustrate how thinking has evolved during the lifetime of the reserve.

- Strategically-placed branches (and stones) around the edge of pools provide perching posts for Kingfishers and dragonflies, and when positioned close to a hide or footpath, provide excellent photographic opportunities.
- A Sand Martin nesting bank was built early in 2007, following the collapse of a 'natural' sand bank during a nesting attempt the previous year, but birds have not used it.
- Viewing hides are expensive both to build and maintain, so in the last 10 years, opportunities to open up views across the lagoons have used viewing screens with a variety of heights of aperture. This has enabled two new areas to be opened up, including one where the screen was sunk low into the bank of the lagoon to allow eye-level views of waders roosting on the islands. To one of these a new footpath was created that enables visitors to enjoy the spectacle of the Marsh Orchids each June.
- Being close to a centre of human population does, inevitably, result in a level of vandalism, so all the infrastructure has to be resilient to damage. One hide was burned to the ground in 2005 and replaced by a simple wooden viewing screen. Now, perhaps, is the time to consider whether a more interesting viewing structure could be built, as extolled by birder and architect Tormod Amundsen (biotope.no).
- Water Rails are a particularly difficult bird to see, but always a popular one. Selective cutting to allow small 'islands' of reeds to remain at popular viewpoints (such as in front of the Coffee Shop), provides Water Rails with sufficient cover to feel safe and opportunities for visitors to see one running between the 'islands'.
- Three of the islands in the Deep Lagoon were de-vegetated and re-profiled in Autumn 2015, to 'reset the clock' for roosting and breeding waders and to enhance visitor interest. Each island now has a longer shoreline viewable from the hide, and each is a different height to maximise viewing opportunities, allowing the lowest to be submerged when winter water levels are high.
- In 2015, new habitat features were created within the lagoons that provide more feeding opportunities closer to the hides. Lengthening the shoreline, by creating gently shelving

channels and pools, should increase its use by feeding waders within a few metres of one of the hides.
- The Deep Lagoon is up to three metres deep in places, thus limiting the bird interest. In Autumn 2016, floating islands will be installed to provide additional loafing and nesting opportunities for water birds where currently there is a limited amount of birdlife to view in front of the hide that is most popular with families and most frequently used by school visits.

Constraints and challenges

RSPB Conwy was always going to be a 'different' kind of nature reserve, yet from its inauspicious birth that involved the destruction of intertidal habitat for a major engineering scheme, it has often led the way in bringing people close to nature and delivering good habitats for a diverse range of wildlife. Nonetheless, some constraints temper our ability to deliver even more.

Size. The site is one of the smallest mainland RSPB nature reserves in the UK, set within an urban landscape of roads, railways, high-density housing and light industry, and intensively-managed grassland for sheep. There is little opportunity to expand the reserve, and the wider landscape is fairly inhospitable, save for a small wetland to the east and the Afon Conwy SSSI.

Hydrology. Reflecting its industrial origin as a settling lagoon, the whole site is artificial, the soil horizons unnatural and the lagoons sit several metres above the Afon Ganol and Afon Conwy. Typical annual rainfall is insufficient to replace the amount that is lost from the lagoons to evaporation and transpiration (1cm per day in the summer); while there is some ability to pump water from a nearby freshwater stream between September and March, this relies on sufficient rain in the hills to allow the submersible pump to operate. There is no means to remove water from the lagoons, but we have now installed a pipe dam that will allow water to be drawn off the shallow lagoon in wet Summer weather, creating soft muddy margins for migrant waders.

Substrate and water chemistry. There are relatively low levels of nutrients and benthic invertebrate biomass in the water and mud, and unusual water chemistry that results in low levels of nitrogen. Pumping salt water into the Shallow Lagoon in 2012 to tackle New Zealand Pigmyweed *Crassula helmsii* (see below) may have boosted the nutrients temporarily, but the soft mud prevents extra nutrients being added in the usual way, using machinery to spread 'green manure' or to plough in surface vegetation at the end of each summer since it is inaccessible using machinery.

Invasive non-native species. Regular inspections are undertaken, especially of water bodies, to ensure early detection of non-native invasive species. New Zealand Pigmyweed was found on the reserve in 2003, and despite attempts to contain it within one pond, this aquatic plant subsequently spread to both lagoons. The only control method so far found to eliminate *Crassula* is to submerge it in saline water for a year (at RSPB Old Hall Marshes, Essex, unpubl.). If left untreated, *Crassula helmsii* can form a thick 'mat', deoxygenating the mud and preventing access by waders to invertebrate food. Pumping, under licence, 11 million gallons of water from the tidal estuary into the Shallow Lagoon in 2012 did hamper

its growth, but the lagoon remained salty for only a few months (in contrast to expectation). Currently, herbicide is sprayed on the plant in Summer while it is growing, but periods of wet or windy weather can leave only short time windows to do this, and for environmental reasons, only *Crassula* growing on dry areas above the water level can be treated. Ultimately, we hope that further research will provide a permanent solution without recourse to chemicals.

Natural succession. In the early years, the nutrient-poor (and initially saline) soil meant that the challenge was to get anything to grow at RSPB Conwy. After 20 years, that is no longer a problem, and the next management plan is likely to involve a greater amount of removal of scrub, to prevent encroachment of bare ground, grassland and reedbed. This will be done sensitively, managed on a long-term rotation in order to maintain populations of invertebrates.

Two native plant species are monitored as they have the potential to be invasive. Ragwort *Jacobaea vulgaris* grows across the reserve, including in the area grazed by ponies. Ragwort can be toxic if it is fed to livestock in hay or silage, but ponies will avoid it when growing and if left to wither naturally in the fields. More than 100 species of invertebrates live on Ragwort, including the caterpillars of Cinnabar Moth *Tyria jacobaeae*. Its extent is assessed each August to ensure that it will not cause a problem for neighbouring graziers or risks out-competing other native grassland species on the reserve.

Common Cordgrass Spartina anglica is an allotetraploid species derived from a native European cordgrass and an introduced species from North America, originally bred and planted to counter coastal erosion. It grows in small pockets on the RSPB-leased area of saltmarsh, but is far more extensive on the mudflats adjacent to Glan Conwy. Were it to dominate the saltmarsh, it could reduce the other floristic interest and the suitability of the habitat for waders and passerines. We monitor the extent through biennial fixed-point photography, reporting the results to Natural Resources Wales, which has responsibility for the condition of the SSSI.

Ground-nesting birds. Conwy has only ever had low numbers of nesting waders and productivity was never high. Predation - particularly by birds - appears to be a major factor, in line with research showing that predation of Lapwing nests is lower on sites with 10 or more pairs of Lapwings, thanks to the beneficial effects of sustained mobbing behaviour by adults (Laidlaw *et al*. 2015). This mobbing behaviour may also benefit other ground-nesting birds in the vicinity.

Electrified anti-predator fences have been successfully deployed at some other RSPB nature reserves where predation by mammals is an issue. However, at Conwy, even if predation by mammals ceased, the presence of large numbers of non-breeding Herring and Lesser Black-backed Gulls (now Red and Amber listed respectively) and a colony of Grey Herons adjacent to the reserve mean that predation would not necessarily be reduced. It would also be difficult to maintain an effective electric fence on a site so accessible to the public.

Efforts have been made to increase the suitability of ground conditions for invertebrates on

which Lapwing chicks feed, but this has proved difficult on a sandy, free-draining, substrate. The relatively small area of habitat, which is more than likely suboptimal in quality for breeding waders, means that the Conwy reserve has always had very limited potential compared to larger, more open sites. No other lowland sites in the Conwy Valley have retained breeding waders. RSPB Cymru has prioritised where it can focus effort for the greatest return, and by doing so has achieved positive results at some of its other reserves in North and Mid Wales, notably Malltraeth Marsh, Morfa Dinlle and Ynys-hir, where the scale and quality of the habitat is more suitable for Lapwings.

Conclusion

The reserve at Conwy can be considered a success on several levels, from the large number of people who have the opportunity to discover nature, to the number of species that have colonised the site or stop to feed during migration. Although there is no baseline data for the area prior to the building of the A55, we can be certain that a far greater number and diversity of species occupy the land now than previously, although it does nothing to replace those species that were lost during the construction. Certainly, managing it as a nature reserve is likely to have been better for biodiversity than alternative after-uses, such as intensive agriculture or industry.

Some pioneering species, such as Dingy Skipper and ground-nesting birds of open landscapes, have come and gone, and the constraints of the reserve's size, substrate and hydrology make it unlikely that intensive management can bring these back. Surveys show that a greater number and range of water birds than ever utilise the nature reserve, and since much of the rest of the lower Conwy estuary has been developed in the last 25 years, the site provides a refuge without which the whole area would be poorer. Invasive species are perhaps the most significant threat to the site, especially aquatic non-native species, and until research provides innovative solutions, keeping these in check through intensive management is the only response available.

Increasing our knowledge of the distribution and management for non-avian species is a priority, but wetland birds will continue to be the core objective of the site. In another 20 years, the reserve will doubtless have changed again, and continued management will be required to ensure that it maintains its value for many of the current species, and provides a suitable home for those moving in response to climatic change. And it would be nice to think that the reserve would be managed by staff and volunteers whose passion for wildlife was inspired by Conwy reserve, or somewhere like it, where space for nature was created by people with ambition and vision.

Acknowledgements

Thanks to the staff, volunteers and visitors to RSPB Conwy who have recorded and reported their sightings to the reserve, enabling us to track the fortunes of the birds as the reserve has developed. In particular, thanks to the previous Site Managers (Dave Elliott, Ian Higginson and Alan Davies) and Wardens (Stephen Dixon and Mike Duckham). Our thanks also to Gareth Fisher for his advice on the production of this paper, to the photographers

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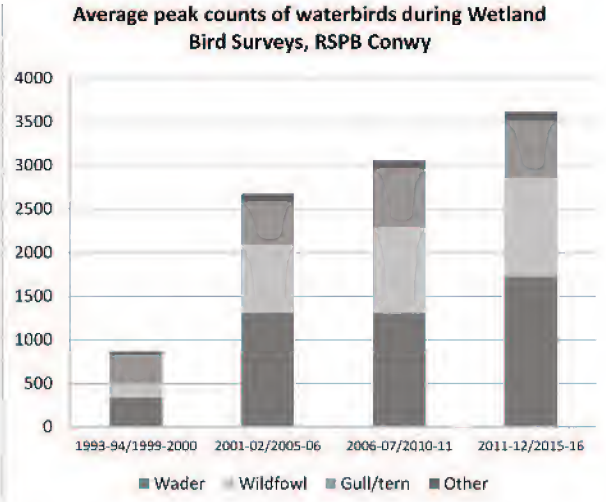

Figure1. Average peak count of waterbirds by species group in five-year* periods. 'Other' species are herons, rails, grebes, cormorant and kingfisher.*for convenience, the first period (1993-94/1999-2000) includes seven years; during this period, counts were not undertaken in every month.

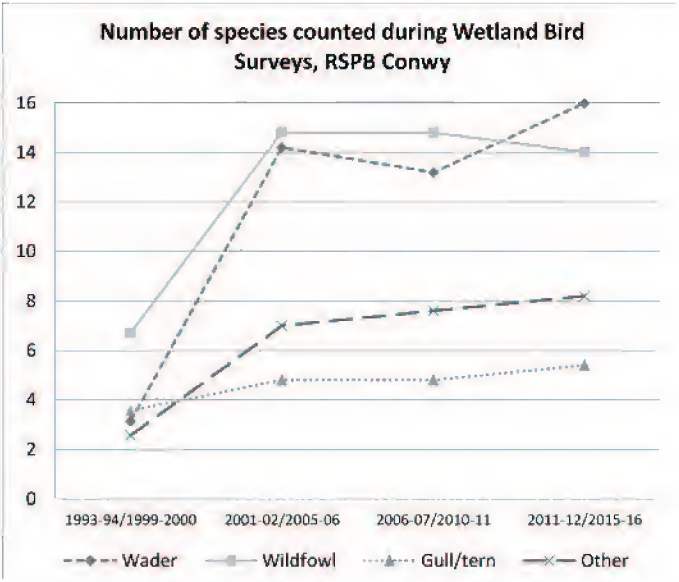

Figure 2. Average peak number of waterbird species in five-year* periods. 'Other' species are herons, rails, grebes, cormorant and kingfisher. *for convenience, the first period (1993-94/1999-2000) includes seven years; during this period, counts were not undertaken in every month.

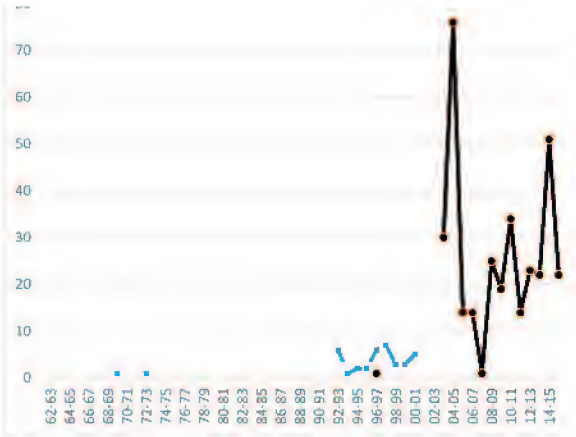

Figure 3. Black-tailed Godwit peak counts: whole Conwy estuary (dotted) and sector U1 (solid black).

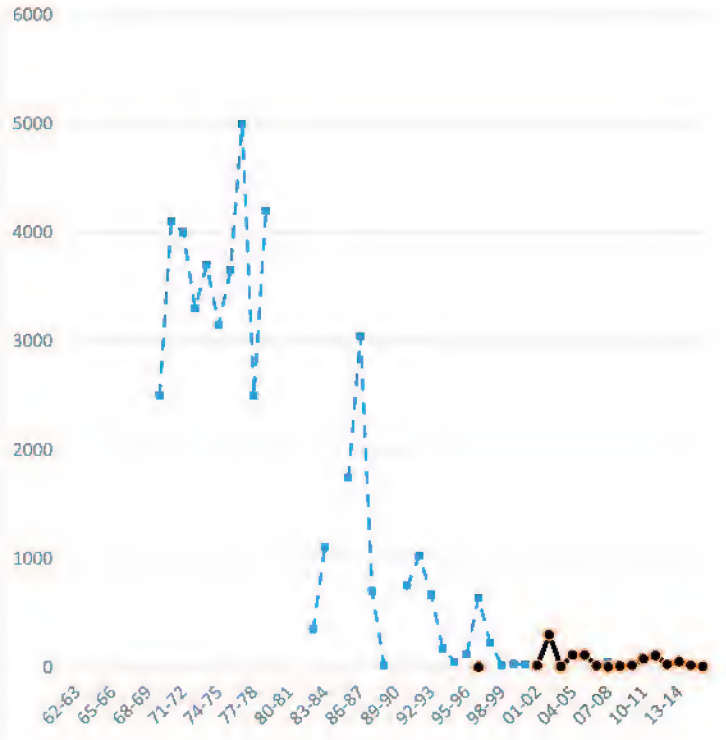

Figure 4. Dunlin peak counts: whole Conwy estuary (dotted) and sector U1 (solid).

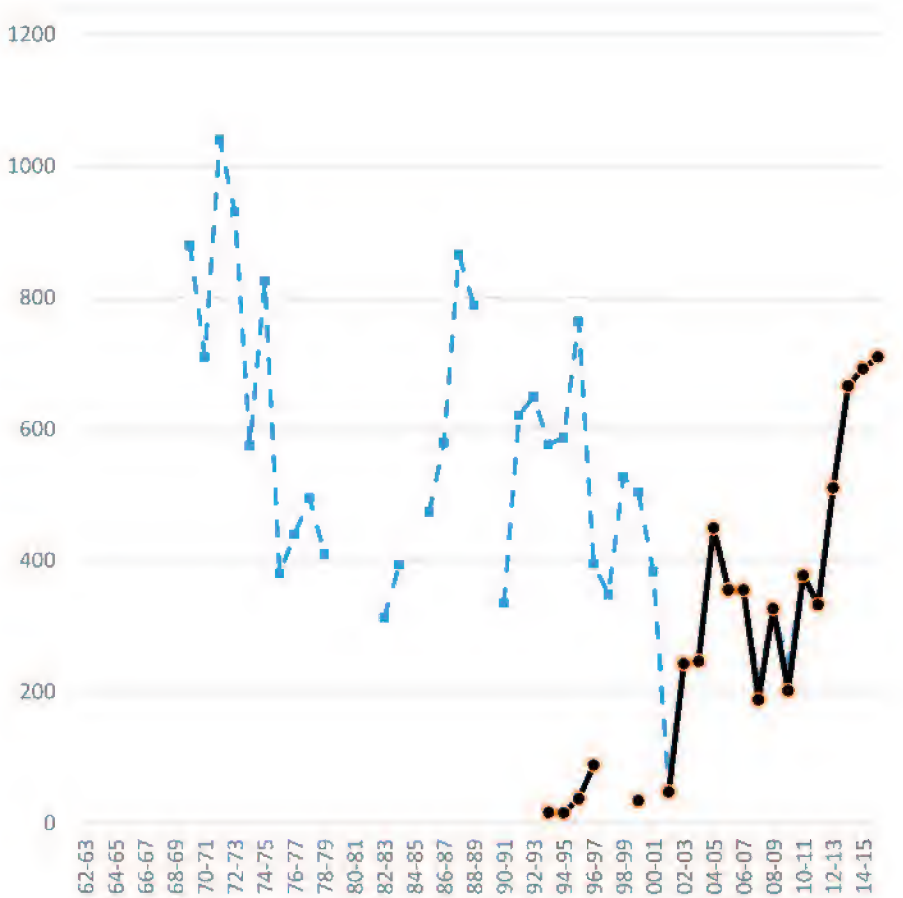

Figure 5. Redshank peak counts: whole Conwy estuary (dotted) and sector U1 (solid).

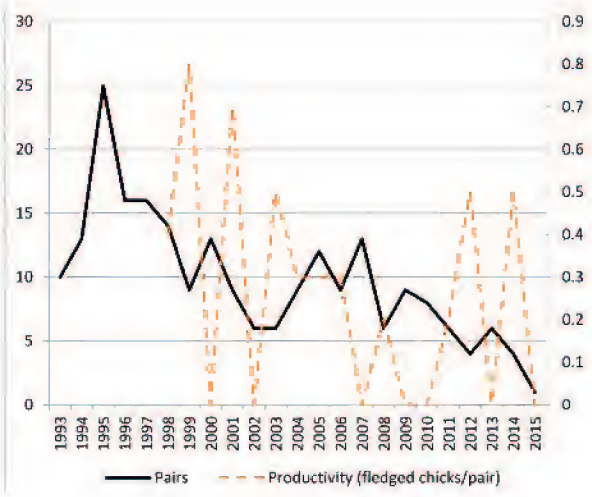

Figure 6. Lapwing population and productivity at RSPB Conwy.

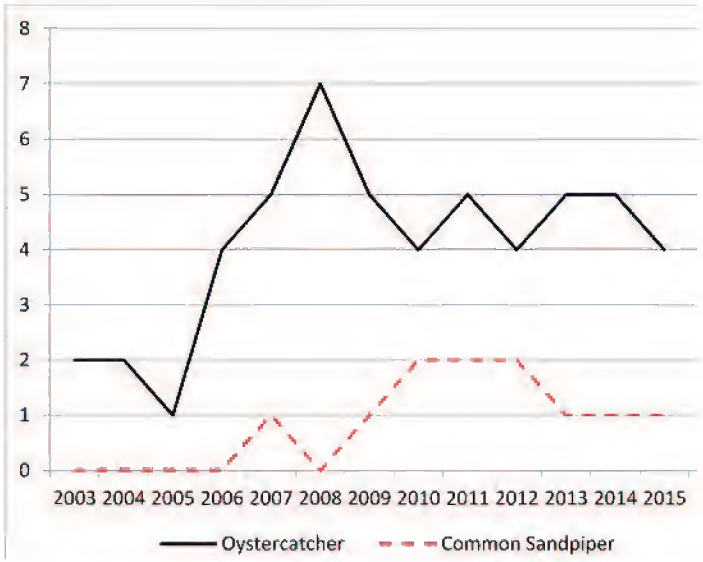

Figure 7. Pairs of Oystercatcher (solid line) and Common Sandpiper (dashed line) at RSPB Conwy

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bearded Tit																			●					
Blackbird									●		●	●	●	●	●	4	●	●	●	●	13	●	●	●
Blackcap												●		●		2	●	●	●	●	8	●	●	●
Blue Tit												●		●	●	1	●	●	●	●	3	●	●	●
Bullfinch												●		●					●			●	●	●
Carrion Crow												●					●	●	●	●	1			●
Chaffinch												●		●	●	4	●				3	●	●	●
Chiffchaff												●		●	●	1	●	●	●	●	4	●	●	●
Dunnock					●			●	●		●	●	●	●	●	5	●	●	●	●	21	●	●	●
Garden Warbler												●		●		1	●	●	●				●	●
Goldcrest																								●
Goldfinch												●		●			●	●	●	●	3	●	●	●
Grasshopper Warbler								●				●		●			●	●	●	●		●	●	●
Great Tit												●					●	●	●	●	2	●	●	●
Greemfinch												●		●	●	3	●	●	●	●	6	●	●	●
Grey Wagtail												●		●										
House Sparrow														●			●	●	●	●	4	●	●	●
Kingfisher																	●							
:esser Redpoll																				●				●
Lesser Whitethroat												●		●		1	●	●	●		4	●	●	●
Linnet	●	●		●								●		●				●						
Long-tailed Tit												●						●	●			●	●	●
Magpie												●			●		●	●	●	●			●	●
Pheasant																								●
Pied Wagtail												●		●	●		●	●	●	●				
Reed Bunting	●			●	●		●	●	●		●	●	●	●	●	8	●	●	●	●	5	●	●	●
Reed Warbler												●		●	●	18	●	●	●	●	15	●	●	●
Robin												●		●	●	4	●	●	●	●	9	●	●	●
Sand Martin								●			●			2										
Sedge Warbler												●		●	●	14	●	●	●	●	32	●	●	●
Skylark	●		●	●	●	●	●	●	●		●	●	●	●										
Song Thrush									●			●	●	●	●	4	●	●	●	●	5	●	●	●
Stonechat												●	●	●										
Wheatear			●								●	●	●											
Whitethroat		●										●		●	●	8	●	●	●	●	7	●	●	●
Willow Warbler												●		●	●	1	●	●	●	●	4	●	●	●
Woodpigeion												●		●				●	●	●	1		●	●
Wren												●		●	●	6	●	●	●	●	5	●	●	●
Number of species	**3**	**2**	**2**	**3**	**3**	**1**	**2**	**5**	**5**		**7**	**31**	**7**	**27**	**16**	**17**	**25**	**26**	**27**	**23**	**21**	**22**	**25**	**29**

Figure 8. Breeding by non-waterbirds at RSPB Conwy. $\frac{4}{5}$ denotes proven breeding or territory held. Numbers denote territorial pairs, from adapted Common Bird Census in 2007 and 2012.