

Birds of Conservation Concern Wales 4: the population status of birds in Wales

Ian G. Johnstone¹, Julian Hughes², Dawn E. Balmer³, Anne Brenchley⁴, Richard J. Facey⁵
Patrick J. Lindley⁵, David G. Noble³, Rachel C. Taylor⁶

¹ RSPB Centre for Conservation Science, Unit 14 Llys Castan, Parc Menai, Bangor, LL67 4FH.

² RSPB Cymru, Unit 14 Llys Castan, Parc Menai, Bangor, LL67 4FH.

³ British Trust for Ornithology. The Nunnery, Thetford Norfolk, IP24 2PU.

⁴ Welsh Ornithological Society, web@birdsin.wales

⁵ Natural Resources Wales, Maes y Ffynnon, Penrhosgarnedd, Bangor LL57 2DW.

⁶ BTO Cymru, Thoday Building, Deiniol Road, Bangor, Gwynedd, LL57 2UW.

*Corresponding author: ian.johnstone@rspb.org.uk

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Abstract

This, the fourth review of the population status of birds in Wales, complements Birds of Conservation Concern 5 in the UK. Birds that breed, winter, or regularly migrate through Wales were assessed against standardised criteria, using data from monitoring and surveillance schemes and citizen science initiatives. Each was assigned to Green, Amber, or Red lists, indicating increasing levels of conservation concern. Levels of concern use data for Wales, so far as possible, and are based on abundance and distribution change, as well as current population size, localised distribution, and international importance (extinction risk was not a criterion). The UK, European and global conservation status of each was also considered. A total of 220 species was assessed, 10 more than in the 2016 review. Fourteen species qualified for review for the first time, typically because formerly scarce species have become more frequent visitors to or breeders in Wales. There are now 60 species (27%) on the Red list, 91 (41%) on the Amber list and 69 (31%) on the Green list. The Red list has grown by five species since last reviewed: three have moved from Green to Red, 10 from Amber to Red, while one newly assessed species was Red listed. Seven previously Red species have been moved to Amber, and 14 moved from Amber to Green. Two formerly regular breeding species are now considered extinct in Wales. We used draft data from the recent Seabirds Count, and publication of this fourth UK seabird census in 2023 may lead to revised listings. Our results show overall levels of conservation concern have increased and remain high, with no sign of improvement for species explicitly linked to conservation delivery mechanisms. Levels of conservation concern are rising fastest among species not already explicitly linked to such mechanisms.

Crynodeb

Mae'r arolwg hwn, y pedwerydd arolwg o statws poblogaeth adar yng Nghymru, yn ategu arolwg 'Adar o Bryder Cadwraethol 5' yn y DU. Aseswyd adar sy'n bridio yng Nghymru, sy'n treulio'r gaeaf yng Nghymru, neu sy'n mudo'n rheolaidd trwy Gymru, a hynny yn erbyn meini prawf safonedig, gan ddefnyddio data o gynlluniau monitro a mentrau gwyddoniaeth dinasyddion. Rhoddwyd yr adar ar restrau Gwyrdd, Oren, neu Goch, sy'n nodi lefelau'r pryder cadwraethol. Defnyddir data Cymru - i'r graddau y bo modd - ar gyfer y lefelau pryder, ac maent yn seiliedig ar amllder a newid o ran dosbarthiad, yn ogystal â maint cyfredol y boblogaeth, dosbarthiad lleol, a phwysigrwydd rhyngwladol (nid oedd y risg o ddifodiant yn faen prawf). Ystyriwyd statws cadwraeth yr adar yn y Deyrnas Unedig, yn Ewrop, ac yn fyd-eang hefyd. Aseswyd 220 o rywogaethau, sydd 10 yn fwy nag yn adolygiad 2016. Roedd 14 o rywogaethau yn gymwys ar gyfer yr arolwg am y tro cyntaf, a hynny, ar y cyfan, gan fod rhywogaethau oedd gynt yn brin wedi dechrau ymweld â Chymru, neu fridio yma, yn amlach. Mae 60 o rywogaethau (27%) bellach ar y rhestr Goch, 91 (41%) ar y rhestr Oren a 69 (31%) ar y rhestr Werdd. Mae'r rhestr Goch bump rhywogaeth yn fwy ers yr arolwg diwethaf: gyda thri wedi symud o Wyrdd i Goch, 10 o Oren i Goch, ac mae un rhywogaeth sydd newydd ei hasesu wedi'i restru'n Goch. Mae saith rhywogaeth oedd yn Goch gynt wedi'u symud i Oren, ac mae 14 wedi symud o oren i Wyrdd. Mae dwy rywogaeth oedd gynt yn bridio'n rheolaidd yng Nghymru bellach yn cael eu hystyried yn ddiflanedig. Defnyddiwyd data drafft o'r Cyfrifiad Adar Môr diweddar, felly gallai cyhoeddi'r pedwerydd Cyfrifiad Adar Môr hwn yn y Deyrnas Unedig yn 2023 arwain at restrau diwygiedig. Mae ein canlyniadau'n dangos bod lefelau pryder cadwraethol wedi codi'n gyffredinol a'u bod yn parhau i fod yn uchel, heb unrhyw arwydd o welliant i rywogaethau sy'n benodol gysylltiedig â mecanweithiau cyflawni cadwraeth. Fodd bynnag, mae lefelau pryder cadwraethol yn codi gyflymaf mewn cysylltiad â rhywogaethau nad ydynt eisoes yn benodol gysylltiedig â mecanweithiau o'r fath.

Introduction

This paper presents the fourth 'Birds of Conservation Concern in Wales' (BoCCW4) review, previous reviews having been produced in 2002 (Thorpe and Young 2002), 2010 (Johnstone *et al.*, 2010) and 2016 (Johnstone and Bladwell 2016). Birds are placed on 'Red', 'Amber' or 'Green' lists using a well-established approach, based on quantitative review against standardised criteria (Stanbury *et al.* 2021), to indicate the level of concern we have for their future. By applying a transparent and standardised approach, based on the best available evidence and conducted collaboratively by a multi-partner group of both statutory and non-government sectors, BoCCW4 is a robust assessment of the status of all birds in Wales. The status of species at small geographic scales should include consideration of their status at larger scales (i.e., Wales < UK < Europe < international < global). On this basis, whilst data on bird populations in Wales are at the core of the review, the migratory nature of many species means it also reflects the pressures on bird populations from the Arctic to southern Africa.

In the first review (BoCCW1) it was proposed that such reviews should be revised on an approximately six-year cycle, to inform conservation action and that they should also take a hierarchical approach to geographic scale (Thorpe and Young 2002). This six-year cycle fits into an emerging cycle of reporting on the status of birds in Wales influenced by the requirements of post Brexit Article 12 reporting (Conservation of Habitats and Species Regulations 2017). BoCCW1 used the same criteria as at UK-level, but as part of the review process, changes have also been made to the criteria at both UK- (BoCCUK5: Stanbury *et al.* 2021) and Wales-levels. As the time period with good data has grown, for example, a longer-term change criteria was introduced in BoCCW2 (Johnstone *et al.* 2010) to complement the existing 25-year change. Furthermore, because Wales has a particular responsibility for UK species with populations concentrated in Wales, additional criteria were added in BoCCW2 that show when Wales supports 50% or more of the UK population size of a species, and when 10% or more of UK rare breeding or non-breeding population sizes (excluding those not established as breeding species in Wales; Johnstone *et al.*, 2010).

In each review we also consider which species qualify based on the periodically reviewed Welsh

Bird List. This has led to both additions and removals but an overall increase in the number of species assessed from 210 in BoCCW1 to 212 in BoCCW3 (Johnstone and Bladwell 2016). However, unlike at the UK-level (Stanbury *et al.* 2021), we have chosen not to carry out an IUCN Red-list assessment in parallel with our BoCC review. Attempting such an assessment needs careful consideration of the impact of both the geographic scale of Wales relative to other countries that have used this approach, and the contiguous nature and capacity for dispersal of bird populations among the rest of Britain and Ireland. A race-level BoCC review was carried out as part of BoCCW2 but was not repeated here due to the substantial challenges in distinguishing between races in the field.

Introduction

BoCC review process

The BoCCW4 review process, as established by three previous Wales-level reviews (Johnstone and Bladwell 2016), and four UK-level reviews (Stanbury *et al.* 2021), assessed bird populations against a series of standardised criteria relating to population status which have remained unchanged since BoCCW3 (see below). 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-listed criterion will be placed on the Red list regardless of qualification against an Amber-listed criterion). Any species that met none of the criteria because of, for example, population increase or stability, along with any that have continued to recover from historic decline were placed on the Green list. Lack of data for review against one or more criteria would result in Green-listing, unless other criteria with data were Amber or Red qualifying.

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. The principal data sources used for this review were the same as in previous reviews and are summarised in table 1. They cover schemes ranging from the BTO/JNCC/RSPB Breeding Bird Survey (BBS, Harris *et al.* 2022), whose results are of well understood precision, to unstructured records that provide the only information on some rare breeding, passage, and wintering birds but which need to be interpreted more cautiously

Table 1. The data sources used in the BoCCW4 review grouped by complexity of design and periodicity. Criteria abbreviations are given in table 1.

Type	Source	Time Period	Status in BoCCw4	Criteria informed
Structured UK annual surveys	1. Smoothed Breeding Bird Survey (BBS) abundance change: BBS-Wales, and with supporting evidence: Small-sample BBS-Wales, BBS-UK, BBS+CBC-UK	1995–2020	Updated	BDp1, BDp2
	2. Waterways Bird Survey/Waterways Breeding Birds Survey (WBS/WBBS)	1975–2018	Updated	BDp1, BDp2
	3. Smoothed Wetland Bird Survey (WeBS) for relative abundance change & recent five-year mean population size	1967/68–2019/20	Updated	WDp1, WDp2, WR, WL, WI
	4. Heronries Census	1969–2019	Updated	BDp1, BDp2, BR, BR _{UK} , UK ₅₀ , BL
Structured UK periodic surveys	5. Bird Atlases 1–3	1968–72, 1988–91, 2007–11	Upchanged	BDr1, BDr2, WDr1
	6. Non-Estuarine Waterbird Survey (NEWS)	1997/98, 2006/07, 2015/16	Updated	WDp1, WDp2, WR, WL, WI
	7. Seabird census (Operation Seafarer, Seabird 2000, Seabird Count)	1969–70, 1998–2002, 2015–21	Seabird Count new	BDp1, BDp2, BR, BR _{UK} , UK ₅₀ , BL
	8. Winter Gull Roost Survey (WinGS)	1992, 2003/04–05/06	Unchanged	WDp2
	9. Species specific Scarce and Rare Annual Breeding Birds Surveys (SCARABBS)	Various	Some updated	BDp1, BDp2, BR, BR _{UK} , UK ₅₀ , BL
Unstructured UK & Welsh surveys	10. Rare Breeding Birds Panel (RBBP)	From 1973, species-specific	Updated	BDp1, BDp2, BR, BR _{UK} , UK ₅₀ , BL
	11. Welsh Ornithological Society (WOS) classified records	2001–05 – 2016–20	Updated	WDp1, WR, WR _{UK}
Derived from other schemes	12. Sizes of breeding populations of Birds in Wales (Hughes et al. 2020)	2007–11	New	BDp1, BDp2, BR, BR _{UK} , UK ₅₀ , BL
	13. UK Avian Population Estimates Panel (Woodward et al. 2021)	To 2017	Updated	BR _{UK} , UK ₅₀
	14. International flyway population estimates	To 2018	Updated	BI, WI

Table 2. Ranked priority for use of data sources for assessment under the breeding population decline criteria (BDp1, BDp2).

Rank	Source	Data specific to:
1	Species-specific population size	Wales
2	Wales smoothed BBS and WeBS indices	Wales
3	Wales small sample smoothed BBS, with supporting evidence	Wales
4	UK CBC/BBS and UK WBS/WBBS, with supporting evidence	UK

owing to their lack of rigour. Trend data were used up to summer 2020, winter 2020/21, or the most recently available year before then. Furthermore, some species lack population monitoring in Wales because they are too infrequently detected to be reported by annual schemes such as the BBS, but still too widespread for unstructured records to be useful. Previous *BoCC_w* reviews took a precautionary approach for such species; where there was evidence for Wales that UK-level population change was similar, the same value was used.

In addition, we took a precautionary approach to using trends for species reported on by BBS with sample sizes below those met for species trends to be published, with species only qualifying based on such data if there was other supporting evidence from Wales. Furthermore, in this analysis we relaxed the mean number of squares with records from $n > 20$ to $n > 10$. This resulted in 25-year change values for two additional species which would otherwise be data deficient (Oystercatcher *Haematopus ostralegus*, $n = 13$. Lapwing *Vanellus vanellus*, $n = 14$) as their breeding population change from Wales BBS was similar to UK change and consistent with species accounts in Pritchard *et al.* (2021) over the same period.

However, there is a trade-off between using Wales-specific sources that may be based on specific habitats or may not have been repeated recently, and robust UK sources, such as the longer-term UK Common Birds Census (CBC)/BBS trend. As with *BoCC_{w3}*, we prioritised data sources according to Table 2. In some cases, measures of change were approved by expert opinion, taking into account under-reporting (i.e., not sufficiently detectable or notable for all occurrences to be documented,

for example Quail *Coturnix coturnix* and Water Rail *Rallus aquaticus*), or where coverage may be patchy or inconsistent (e.g. observers will not have covered all suitable habitat with similar effort, for example wintering marine waterbirds). In a small number of cases more recent data were selected that may have a lower ranking in table 2 (e.g. using recent RBBP 2015-19 in place of a 2006 sample survey for Dartford Warbler *Curruca undata*).

In separating range data between Wales and England, Welsh 10km squares were those along the border that were at least 50% in Wales by land area. There were a few squares that were not covered in all three Atlases (two during breeding and three during winter), and these were excluded from assessments of percentage change in occupied squares between Atlas periods. We used Atlas data to inform 25 year and longer-term breeding range change, and 25 year winter range change (longer-term range change were unavailable) noting the 2007-2011 Atlas remains sufficiently current for use in our review (< 15 years before our most recent data).

Changing data sources and data gaps

Reviewing *BoCC_w* provides an opportunity to review available data sources, and this sometimes results in changes in changes to the sources used. For example, the Wales-specific Repeat Woodland Bird Survey used for *BoCC_{w2}* and *BoCC_{w3}*, last repeated in 2004, now predates our 2005 limit on current data. We replaced the abundance change data generated by this survey with UK data where there was evidence that change was similar using species accounts in Pritchard *et al.* (2021). We made a similar decision for Dipper *Cinclus cinclus*, replacing a Welsh-specific repeat survey by UK annual data (Waterways Bird Survey

(WBS)/Waterways Breeding Bird Survey (WBBS), Woodward *et al.* 2020).

For the first time we used classified records collated by WOS to inform 25 year population change for breeding species not reported by the Rare Breeding Birds Panel (RBBP, Eaton *et al.* 2021), but primarily for species during the non-breeding period and considered these data sufficiently systematic from 2001. This is made possible by records submitted to County Bird Recorders being collated annually into the Welsh Bird Report (most recently in Hughes 2022).

The nature of the *BoCC* method means that species with no data qualify for the Green list alongside species for which extensive data show stability or increase (although, importantly, they may qualify for the Red-list if any one data source meets the criteria). Although not formally compared, data limitations are likely more pronounced at Wales than at UK levels because of limits on monitoring confidence due to reduced sample size at smaller scales (in simple terms, with smaller sample sizes we may be unsure if any population change is real). In this review, we highlight those Green-listed species where monitoring could be improved to minimise the presence of species on the Green list that should be Amber or even Red-listed.

For the first time we assessed the number of criteria with data available for each species (i.e., criteria for which we had a value or category), with the maximum possible being 31 (table 3).

The criteria

The criteria reflect a hierarchical approach to geographical scale, determining population status based on: global importance, historical population decline, recent population decline, European importance, breeding rarity, localised distribution, UK importance and international importance. The eight main criteria and their sub-criteria remain unchanged from those used in *BoCCw3* (table 3).

1. IUCN: Global Population Status. 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, hence should be thus 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 2021 assessment of globally threatened

species (www.iucnredlist.org).

2. HD, HDrec HDrec2: Historical decline in breeding population. The period over which population trends are assessed is recent, reflecting the period that formal monitoring schemes have been in place (earliest year = 1967). It would thus be possible for a species to have undergone a large population decline over the previous two centuries, but for its population to have remained stable during the last half century. In line with the approach for Ireland (Colhoun and Cummins 2013), the Wales review used information from reliable historical sources (Lovegrove *et al.* 1994, Holloway 1996, Sharrock 1976, Pritchard *et al.* 2021) and Bird Atlas 2007–11 (Balmer *et al.* 2013) to establish historical population change for the period 1800–1994. In *BoCCw4* we used the same review as compiled for *BoCCw1* (Thorpe and 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 (Ausden *et al.* 2019, Jeffs *et al.* 2018). We used the criteria for recovery from historical decline to allow species that have shown recovery from historic decline to move sequentially from Red to Amber to Green lists. This recognises 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 *BoCCw5* (Stanbury *et al.* 2021). Thus, any HD species doubling its population size or more within the recent 25-year period and exceeding 10 breeding pairs (10% of the UK value of 100 pairs, reflecting Wales as a proportion of the UK rounded to 10%) 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 a review of trend over the *BoCC* longer-term period (since 1967, as the earliest data used by *BoCC* Wales). Therefore, here 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

Table 3. The 31 assessment criteria used in BoCCw4.

List	Criteria	Name	Definition	Abbrev	First use ¹
Red	1	Global importance	IUCN globally endangered, critically threatened, endangered or vulnerable, excluding near-threatened	IUCN	1
Red	2	Historic decline	Severe historical decline in breeding population 1800-1995	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 ²
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
Red	3	Recent population decline	At least 50% decline in wintering range (longer term)	WDr1	3
Amber	4	European importance	Included in the European Red List of Birds (ERLOB) as critically endangered, endangered and vulnerable	ERLOB	1 ³
Amber	2	Historic decline - recovery	Was Red but population increase of greater than 100% in last 25 yrs.	HD rec	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 wintering population (25yrs)	WDMp1	1
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding population (longer term)	BDMp2	2
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 ²
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	3	Recent population decline	At least 25% but less than 50% decline in wintering range (longer term)	WDMr2	-
Amber	5	Breeding or non-breeding rarity	Mean of less than 30 breeding prs in the most recent 5yr period with data.	BR	1
Amber	6	Breeding or non-breeding rarity	Mean of less than 90 non-breeding 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 ⁴
Amber	7	UK	At least 50% of the UK breeding or non-breeding population occurs in Wales	UK50	2 ⁴
Amber	7	UK	At least 10% of the population of a UK rare breeding species	BRuk	2 ⁴
Amber	7	UK	At least 10% of the population of a UK rare wintering species	WRuk	2 ⁴
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

¹ BoCCw version of first use. 2 Only assessed if range greater than 20 10km squares in both years. This requirement relaxed for seabirds from BoCCw2 owing to colonial nature. 3 ERLOB replaced SPEC for BoCCw3. 4 Used for Wales assessment only.

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. A further increase of at least 167% from its HD_{REC} level is required to move to the Green list (HD_{REC2}, Stanbury *et al.* 2021). 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 remain at more than double its HD_{REC} numbers.

3. **BD/WD:** Recent AND LONGER-TERM BREEDING AND NON-BREEDING population decline. 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 are used to assess resident and migrant breeding species (Harris *et al.* 2022, Frost *et al.* 2021, Balmer *et al.* 2013). 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 formally monitored annually during the non-breeding season, many species could not be assessed against the non-breeding criterion (e.g., Fieldfare *Turdus pilaris* and Starling *Sturnus vulgaris*).

Change in range is important evidence for change in population status. However, this may be misleading where within-Wales ranges are small and when numerically small and biologically non-significant range change may result in a percentage change sufficient for Red-list qualification. As in previous reviews 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 exceptions to this were highly aggregated breeding seabirds, as range approximates to number of colonies (viewing urban gulls on multiple nearby rooftops as single colonies), each of which may be numerically large. Change in the distribution of colonies is an important component of population status even if they are few in number. Although we were able to assess change in wintering range over the 25 year period, change over the longer-term period is not

currently possible until the Atlas is repeated.

For each sub criteria (time-period and abundance/range), we distinguish between three levels of change: rapid (at least 50% decline) and moderate (at least 25% but less than 50% decline) and stability (less than 25% decline) to distinguish between qualification for Red, Amber or Green lists. Data from 25 year and longer-term periods were used to reflect species whose decline lies between historical and recent, and from which there has been no recovery.

4. **ERLOB**: European IMPORTANCE. The first two *BoCC_w* reviews used Species of European Conservation Concern (SPEC) assessments as an indication of wider regional concern (Thorpe and Young 2002, Johnstone *et al.*, 2010. This was replaced by the European Red List of Birds (ERLOB), i.e., species that are threatened (Critically Endangered, Endangered, Vulnerable and Near Threatened) in *BoCC_w3*, with any species meeting this criterion qualifying as Amber-listed (the impact of this change has been discussed previously, Johnstone *et al.* 2016). We used the updated ERLOB (European Red List of Birds, BirdLife International 2021) and for consistency with Stanbury *et al.* (2021) excluded any Near Threatened species.

5. **BR/WR**: Breeding and non-breeding rarity. Species were categorised as rare breeders in Wales if they had a breeding population of fewer than 30 pairs, and as rare non-breeders if the non-breeding population was fewer than 90 individuals (small non-breeding populations are as important as breeding populations), the factor of three multiplication representing adult and sub-adult birds following the method of previous reviews (Johnstone & Bladwell 2016, Stanbury *et al.* 2021). We continued 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 wintering birds (i.e., <30 breeding pairs or <90 winter individuals in UK). This reflects the importance of those populations in Wales to the wider UK populations.

Breeding rarity was assessed from recent formal single-species surveys (e.g., for Hen Harrier *Circus cyaneus*), and two annually published unstructured data sources: the UK Rare Breeding Birds Panel (RBBP) reports published in British Birds and the Welsh Ornithological Society (WOS) classified records for the period 2001–2020 published in

Birds in Wales (succeeded by *Milvus* in 2022).

As the nature of such records vary, we used species-specific methods to generate metrics of abundance and for the first time, change (Appendix 1). Assessments from such informal data were reviewed by experts and in cases where they were considered to poorly estimate population size or, such as breeding Little Ringed Plover (*Charadrius dubius*) and non-breeding Black Tern (*Chlidonias niger*), qualification under this criterion, were considered data deficient.

6. **(BL/WL)**: Localised populations. This criterion was used because populations that are geographically concentrated are assumed to face greater threats from chance events than those that are more dispersed. Rare breeders or non-breeders 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 local pressures (e.g., agricultural change or urbanisation) could adversely impact a large proportion of the population.

The criterion was based on the single best site, either Special Protection Areas (SPAs) and/or Important Bird Areas (IBAs), rather than the best 10 in the UK-level review, 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's population estimates for the same period, using site-level data (often using single-species breeding surveys and the BTO/RSPB/JNCC Wetland Bird Survey (WeBS, Frost *et al.* 2021) for wintering populations). As in previous *BoCC* Wales reviews we treated cross-border SPAs such as the Dee SPA and Severn SPA, 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 European White-fronted Goose *Anser albifrons 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. uk50/ukrb/ukrw: 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 (Stanbury *et al.* 2021) 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 reviews.

Wales may support substantial proportions of the populations of some UK species with a western distribution, for example Red-billed Cough (*Pyrhacorax pyrrhacorax*). 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. These values of these threshold were pragmatic, but consistently applied across successive reviews.

8. BI/WI: 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 review (CSR8; Wetlands International 2021). For the first time we had access to Wales population estimates of population size for widespread breeding species (Hughes *et al.* 2020; Woodward *et al.*, 2020), comparable with UK APEP estimates (Woodward *et al.* 2020).

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.

Species assessed

Thorpe and Young (2002) 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 review year (2022 for BoCCw4). All

452 native species on the Wales list (WOS 2022) were considered, with 220 selected for review based on the following three criteria. First, we excluded those species that occur solely as very-rare, rare and scarce migrants. Second, the Wales list is revised annually, it has resulted in some differences in the species assessed by BoCCw3. Although assessed previously as a winter migrant, the Barnacle Goose (*Branta leucopsis*) was not assessed by BoCCw4 as, unlike elsewhere in the UK, the Welsh population, likely founded by escapes from wildfowl collections, is now known to exhibit non-natural ecology (i.e., not migrating to natural Arctic breeding areas, [Dodd 2017]). In contrast, the Goshawk (*Accipiter gentilis*) was introduced through falconry activities but continues to be assessed because the population behaves naturally and is self-sustaining (Pritchard *et al.* 2021). A third species, the Woodlark (*Lullula arborea*), is a historic regular breeder and remains categorised as a winter migrant. However, since the number of records greatly exceeds the number of localities, we chose to continue to treat this as a scarce species and did not assess it. Consequently, we have updated the list of former breeders to include this and other species (table 4). Corncrake (*Crex crex*) and Corn Bunting (*Emberiza calandra*) have been added as they now meet our definition of extinct in Wales (no breeding for 20 years) and do not overwinter. We have also added both Golden Eagle (*Aquila chrysaetos*) and White-tailed Eagle (*Haliaeetus albicilla*) based on a recent review of historic records (Williams *et al.* 2020) (table 4).

Non-breeding birds were considered established when removed from the lists of very-rare and rare or scarce migrants, while breeding populations were considered established once a mean of five pairs had been recorded over a five year period from the year of (re-)colonisation. Also excluded were non-native species that have established self-sustaining breeding populations, such as Ring-necked Pheasant (*Phasianus colchicus*) and Red-legged Partridge (*Alectoris rufa*). 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, except for Little Owl (*Athene noctua*) and Red-legged Partridge, are outside of Europe.

Fourteen species were added while seven species were removed (appendix 2). There were 44

Table 4. Birds that bred regularly in Wales in 1800 but whose breeding populations have since become and remain extinct, with current status and most recent year with confirmed breeding.

Species	Current status	Last breeding
Black-necked Grebe Podiceps nigricollis ¹	Winter migrant	1957
Cirl Bunting <i>Emberiza cirlus</i>	Rare migrant	1968
Corn Bunting <i>Emberiza calandra</i>	Scarce migrant	2007
Corncrake <i>Crex crex</i>	Scarce migrant	1996
Golden Eagle <i>Aquila crysaetos</i>	Extinct breeder	1850s
Marsh Harrier <i>Circus aeruginosus</i>	Winter migrant	1992
Montagu’s Harrier <i>Circus pygargus</i>	Rare migrant	1964
Nightingale <i>Luscinia megarhynchos</i>	Rare migrant	1981
Red-backed Shrike <i>Lanius collurio</i>	Rare migrant	2007
White-tailed Eagle <i>Haliaeetus albicilla</i>	Extinct breeder	Early 1800s
Woodlark <i>Lullula arborea</i>	Rare migrant	2011
Wryneck <i>Jynx torquilla</i> ¹	Scarce migrant	1906

¹ Amber listed on non-breeding population

species assessed at UK level but not in Wales, while five were assessed in Wales but not UK due to differences in the occurrence and distribution of these species that influenced respective status (appendix 3).

Review period

The review period for recent population decline over a 25 year period was 1995–2020 for breeding and 1994/95–2019/20 for wintering, or the longest period with data before these. The longer-term decline period was determined by the earliest available data, being 1967 for breeding and 1967/68 for wintering.

Changes between reviews

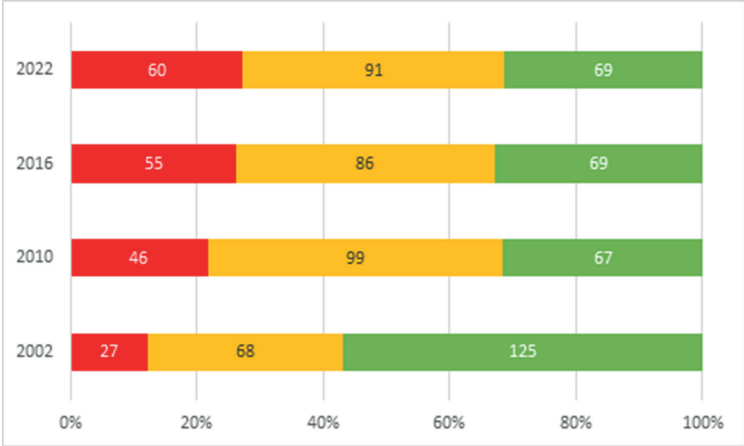
We summarised change in the percentage of species in each level of conservation concern across the four *BoCC_W* assessments for three groups. First, species that could benefit from protected sites. Second, species that could benefit from tailored Glastir options (of which six were also feature species of protected sites). Third, species that are not explicitly targeted by such tailored conservation delivery mechanisms.

Results

The revised lists and change between reviews

Our *BoCC_W4* review placed 60 species on the Red

Figure 1. The percentage of assessed species qualifying for each list for successive iterations of BoCCW annotated with the number of species on each list.



list, 91 on the Amber list and 69 on the Green list (table 5, fig.1). The percentage of species on each list has changed and is consistent with change between previous assessments with both Red- and Amber lists lengthening while, in this review, the Green list has remained unchanged (fig.1). Given our assessment process removes species that decline to extinction (Corncrake *Crex crex* and Corn Bunting *Emberiza calandra* in BoCCw4) whilst including species in the process of colonising (appendix 1), the consistent increase in level of conservation concern for species across reviews is a recurring theme of our results.

There has also been movement of species between lists. Of the 220 species assessed by BoCCw4, 13 (11%) were moved to a higher level of conservation concern, while 21 species (10%) were moved to a lower level, the remaining 161 (73%) species did not change status between the two reviews, while a further 6% were assessed for the first time (table 6). Perhaps most alarming is the rapid decline in abundance of Rook (*Corvus frugilegus*) which inhabit farmland, and of coastal wintering Purple Sandpiper (*Calidris maritima*) in Wales in the last 25 years, while the deteriorating global status of Leach’s Petrel (*Hydrobates leucorhous*), a passage seabird, means that they have all jumped from the Green- to the Red-list since the 2016 review.

The status of many birds of farmed habitats, both arable and grassland has not improved. Starling (*Sturnus vulgaris*), Tree Sparrow (*Passer montanus*), Yellow Wagtail (*Motacilla flava*) and Yellowhammer (*Emberiza citrinella*) remain Red-listed and are now absent as breeding birds from large parts of Wales. Also part of the wider farmed landscape, many upland species remain on the Red list, including Black Grouse (*Lyrurus tetrix*), Merlin (*Falco*

columbarius), Hen Harrier, Ring Ouzel (*Turdus torquatus*) and Whinchat (*Saxicola rubetra*). The status of several widespread upland songbirds has deteriorated: Meadow Pipit (*Anthus pratensis*) has moved from Amber to Red and Wheatear (*Oenanthe oenanthe*) from Green to Amber.

Almost all breeding waders in Wales remain either Red-listed (Curlew *Numenius arquata*, Golden Plover *Pluvialis apricaria*, Redshank *Tringa totanus*, Lapwing *Vanellus vanellus* and Ringed Plover *Charadrius hiaticula*) or Amber-listed (Oystercatcher, Snipe *Gallinago gallinago* and Common Sandpiper *Actitis hypoleucos*). Only the wetland-living Avocet (*Recurvirostra avosetta*) is placed on the Green list because its’ numbers are increasing. With the exception of coastal breeding Oystercatcher (European and international importance) and Ringed Plover (winter decline), all breed in or adjacent to farmed habitats.

Declines in several breeding seabirds have continued. Staying firmly Red listed are Kittiwake (*Rissa tridactyla*), Black-headed Gull (*Chroicocephalus ridibundus*), and Roseate Tern (*Sterna dougallii*). Puffin (*Fratercula arctica*) have increased in abundance in Wales but remain Red listed due to concerns over their global population. Similarly, Arctic Tern (*Sterna paradisaea*) and Little Tern (*Sterna albifrons*) remain Red listed, despite growth in numbers, due to the localised nature of these populations. However, Mediterranean Gull (*Ichthyaetus melanocephalus*) has now established a rare breeding population justifying its move from Green to Amber.

A suite of woodland species, including Marsh Tit (*Poecile palustris*), Willow Tit (*Poecile montanus*) Spotted Flycatcher (*Muscicapa striatastriata*),

Table 5. Previous and current species BoCCw assessments, the criteria under which species currently qualify along with the number of criteria with data. Criteria abbreviations are given in table 1.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
Arctic Skua	<i>Stercorarius parasiticus</i>	G	A	A	Amber	ERLOB, UKRed	15
Arctic Tern	<i>Sterna paradisaea</i>	A	R	R	Red	BDr2, BL, HDrec2	15
Avocet	<i>Recurvirostra avosetta</i>	G	A	A	Green		18
Balearic Shearwater	<i>Puffinus mauretanicus</i>	NL	R	R	Red	IUCN, ERLOB, WR, UKRed	11
Barn Owl	<i>Tyto alba</i>	A	A	G	Green		12
Bar-tailed Godwit	<i>Limosa lapponica</i>	R	R	R	Red	WDp1, WDp2	15
Bearded Tit	<i>Panurus biarmicus</i>	NL	A	A	Amber	BR, WR	20
Bewick's Swan	<i>Cygnus columbianus</i>	A	A	R	Red	WDp1, WDr1, ERLOB, WR, WL, UKRed	13
Bittern	<i>Botaurus stellaris</i>	R	A	A	Red	HD, WDMp1, BR, WR	20
Black Grouse	<i>Lyrurus tetrix</i>	R	R	R	Red	HD, BDr2, BDMr1, WDMr1, UKRed	15
Black Guillemot	<i>Cephus grylle</i>	A	A	A	Amber	BDMp1, BR	15
Black Redstart	<i>Phoenicurus ochruros</i>	G	A	A	Amber	BR	12
Black Tern	<i>Chlidonias niger</i>	G	A	G	Green		11
Blackbird	<i>Turdus merula</i>	G	G	G	Green		14
Blackcap	<i>Sylvia atricapilla</i>	G	G	G	Green		15
Black-headed Gull	<i>Chroicocephalus ridibundus</i>	A	R	R	Red	BDp1, BDp2, BDMr2, WI	20
Black-necked Grebe	<i>Podiceps nigricollis</i>	G	A	A	Amber	ERLOB, WDMp1, WR	13
Black-tailed Godwit	<i>Limosa limosa</i>	A	A	A	Amber	UKRed, WI	15
Black-throated Diver	<i>Gavia arctica</i>	G	A	A	Amber	WR	13
Blue Tit	<i>Cyanistes caeruleus</i>	G	G	G	Green		15
Brambling	<i>Fringilla montifringilla</i>	G	G	G	Green		7
Brent Goose	<i>Branta bernicla</i>	A	A	G	Green		15
Bullfinch	<i>Pyrrhula pyrrhula</i>	R	R	R	Amber	BDMp2	14
Buzzard	<i>Buteo buteo</i>	G	G	G	Green		10
Carrion Crow	<i>Corvus corone</i>	G	G	G	Green		12
Cattle Egret	<i>Bubulcus ibis</i>	NL	NL	NL	Amber	WR	13
Cetti's Warbler	<i>Cettia cetti</i>	G	G	G	Green		15
Chaffinch	<i>Fringilla coelebs</i>	G	G	G	Amber	BDMp1	14
Chiffchaff	<i>Phylloscopus collybita</i>	G	G	G	Green		16

Table 5 continued.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
Chough	<i>Pyrrhocorax pyrrhocorax</i>	A	A	A	Amber	UK50	15
Coal Tit	<i>Periparus ater</i>	G	A	G	Amber	BDMp1	15
Collared Dove	<i>Streptopelia decaocto</i>	G	G	G	Green		13
Common Crossbill	<i>Loxia curvirostra</i>	G	G	G	Green		7
Common Gull	<i>Larus canus</i>	G	R	R	Amber	WDMp1, WDMp2	15
Common Sandpiper	<i>Actitis hypoleucos</i>	G	A	R	Amber	BDMp1, BDMp2	17
Common Scoter	<i>Melanitta nigra</i>	A	A	A	Amber	WL, UKRed, WI	11
Common Tern	<i>Sterna hirundo</i>	A	R	A	Amber	BDMr2, BL	15
Coot	<i>Fulica atra</i>	G	G	A	Amber	BDMp2	16
Cormorant	<i>Phalacrocorax carbo</i>	A	A	A	Green		22
Cuckoo	<i>Cuculus canorus</i>	G	R	R	Red	BDp2, UKRed	16
Curlew	<i>Numenius arquata</i>	R	R	R	Red	BDp1, WDMp1, BDMp2, BDMr1, BDMr2, UKRed	22
Curlew Sandpiper	<i>Calidris ferruginea</i>	G	G	A	Amber	ERLOB, WR	13
Dartford Warbler	<i>Curruca undata</i>	A	A	A	Amber	BR	15
Dipper	<i>Cinclus cinclus</i>	G	A	A	Green		12
Dotterel	<i>Charadrius morinellus</i>	G	G	A	Amber	UKRed	9
Dunlin	<i>Calidris alpina</i>	A	R	R	Red	WDp1, WDp2, BDMp1, BDMp2, BR, UKRed, WI	22
Dunnoch	<i>Prunella modularis</i>	G	G	G	Amber	BDMp2	14
Eider	<i>Somateria mollissima</i>	A	A	A	Amber	ERLOB, WDMp1, BR	18
Fieldfare	<i>Turdus pilaris</i>	G	A	A	Amber	UKRed	7
Firecrest	<i>Regulus ignicapilla</i>	A	A	A	Amber	BR	14
Fulmar	<i>Fulmarus glacialis</i>	G	G	A	Amber	ERLOB, BDMp1	16
Gadwall	<i>Mareca strepera</i>	A	A	G	Green		20
Gannet	<i>Morus bassanus</i>	A	A	A	Amber	BL, BI	16
Garden Warbler	<i>Sylvia borin</i>	G	A	G	Amber	BDMp1, BDMp2	16
Garganey	<i>Spatula querquedula</i>	A	A	A	Amber	BR	13
Glaucous Gull	<i>Larus hyperboreus</i>	NL	NL	NL	Amber	WR, WRUK	13
Goldcrest	<i>Regulus regulus</i>	G	A	A	Red	BDp1	14
Golden Plover	<i>Pluvialis apricaria</i>	R	R	R	Red	WDp1, BDp2, WDMp2, BDMr2	20

Table 5 continued.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
Goldeneye	<i>Bucephala clangula</i>	G	G	G	Amber	WDMp1, UKRed	15
Goldfinch	<i>Carduelis carduelis</i>	G	G	G	Green		12
Goosander	<i>Mergus merganser</i>	G	G	G	Green		18
Goshawk	<i>Accipiter gentilis</i>	G	G	G	Amber	UK50	13
Grasshopper Warbler	<i>Locustella naevia</i>	R	R	R	Red	BDp2, UKRed	14
Great Black-backed Gull	<i>Larus marinus</i>	A	R	R	Amber	BDMp2	19
Great Crested Grebe	<i>Podiceps cristatus</i>	G	G	G	Green		23
Great Grey Shrike	<i>Lanius excubitor</i>	NL	NL	NL	Amber	ERLOB, WR	13
Great Northern Diver	<i>Gavia immer</i>	G	A	A	Green		13
Great Skua	<i>Stercorarius skua</i>	G	G	G	Green		13
Great Spotted Woodpecker	<i>Dendrocopos major</i>	G	G	G	Green		15
Great Tit	<i>Parus major</i>	G	G	G	Green		15
Great White Egret	<i>Ardea alba</i>	NL	NL	NL	Amber	WR	13
Green Sandpiper	<i>Tringa ochropus</i>	G	G	A	Amber	WR, WRUK	11
Green Woodpecker	<i>Picus viridis</i>	A	A	A	Amber	BDMp1, BDMr2	13
Greenfinch	<i>Chloris chloris</i>	G	G	A	Red	BDp1, UKRed	12
Greenshank	<i>Tringa nebularia</i>	G	G	G	Green		15
Grey Heron	<i>Ardea cinerea</i>	G	G	A	Amber	BDMr1	18
Grey Partridge	<i>Perdix perdix</i>	R	R	R	Red	HD, BDp1, BDp2, BDr1, BDr2, WDr1, UKRed	12
Grey Phalarope	<i>Phalaropus fulicarius</i>	NL	NL	NL	Amber	WR	12
Grey Plover	<i>Pluvialis squatarola</i>	A	R	R	Red	WDp1, WDp2, WL	15
Grey Wagtail	<i>Motacilla cinerea</i>	G	G	A	Amber	BDMp1	12
Guillemot	<i>Uria aalge</i>	G	A	A	Amber	BI	15
Hawfinch	<i>Coccothraustes coccothraustes</i>	G	A	A	Amber	BDMp1, UKRed, UK50	11
Hen Harrier	<i>Circus cyaneus</i>	R	R	R	Red	HD, BDMp1, WR, BL, UKRed	20
Herring Gull	<i>Larus argentatus</i>	A	R	R	Red	BDp2, BDMp1, UKRed, WI	21
Hobby	<i>Falco subbuteo</i>	A	A	G	Green		14
Honey-buzzard	<i>Pernis apivorus</i>	A	A	A	Red	BDp1, BR	13
Hooded Crow	<i>Corvus cornix</i>	NL	A	A	Amber	WR	12
Hoopoe	<i>Upupa epops</i>	NL	NL	NL	Amber	WR	12

Table 5 continued.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
House Martin	<i>Delichon urbicum</i>	G	A	G	Amber	BDMp1, UKRed	12
House Sparrow	<i>Passer domesticus</i>	A	A	A	Amber	UKRed	12
Iceland Gull	<i>Larus glaucoides</i>	NL	NL	NL	Amber	WR	13
Jack Snipe	<i>Lymnocyrtus minimus</i>	G	A	A	Amber	WR	14
Jackdaw	<i>Coloeus monedula</i>	G	G	G	Green		12
Jay	<i>Garrulus glandarius</i>	G	G	G	Green		15
Kestrel	<i>Falco tinnunculus</i>	A	R	R	Red	BDp1	12
Kingfisher	<i>Alcedo atthis</i>	A	A	A	Green		11
Kittiwake	<i>Rissa tridactyla</i>	A	G	R	Red	IUCN, ERLOB, BDMp1, BDMp2, UKRed	15
Knot	<i>Calidris canutus</i>	R	A	R	Amber	WL, WI	15
Lapland Bunting	<i>Calcarius lapponicus</i>	G	A	A	Amber	WR	12
Lapwing	<i>Vanellus vanellus</i>	R	R	R	Red	BDp1, BDp2, ERLOB, WDMp1, BDMr1, BDMr2, UKRed	22
Leach's-petrel	<i>Hydrobates leucorhous</i>	G	A	G	Red	IUCN, UKRed	11
Lesser Black-backed Gull	<i>Larus fuscus</i>	A	A	A	Red	BDp1	20
Lesser Spotted Woodpecker	<i>Dryobates minor</i>	R	R	R	Red	BDp1, BDp2, BDMr1, BDMr2, WDMr1, UKRed	15
Lesser Whitethroat	<i>Curruca curruca</i>	G	G	G	Green		15
Linnet	<i>Linaria cannabina</i>	A	R	R	Red	BDp2, BDMp1, UKRed	15
Little Auk	<i>Alle alle</i>	NL	NL	NL	Red	WDp1, WR	13
Little Egret	<i>Egretta garzetta</i>	A	G	G	Green		18
Little Grebe	<i>Tachybaptus ruficollis</i>	G	G	G	Green		23
Little Gull	<i>Hydrocoloeus minutus</i>	NL	A	A	Amber	WR	14
Little Ringed Plover	<i>Charadrius dubius</i>	G	G	G	Green		14
Little Stint	<i>Calidris minuta</i>	G	G	G	Green		9
Little Tern	<i>Sternula albifrons</i>	R	R	R	Red	BDr1, BDr2, BL, HDrec2	16
Long-eared Owl	<i>Asio otus</i>	A	A	A	Amber	BR	13
Long-tailed Duck	<i>Clangula hyemalis</i>	G	A	R	Red	IUCN, WDMr1, WR, UKRed	14

Table 5 continued.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
Long-tailed Skua	<i>Stercorarius longicaudus</i>	G	A	A	Amber	WR	13
Long-tailed Tit	<i>Aegithalos caudatus</i>	G	A	A	Green		14
Magpie	<i>Pica pica</i>	G	G	G	Amber	BDMp1	12
Mallard	<i>Anas platyrhynchos</i>	A	A	A	Green		17
Manx Shearwater	<i>Puffinus puffinus</i>	A	A	A	Amber	BDMr2, UK50, BI	14
Marsh Harrier	<i>Circus aeruginosus</i>	G	A	A	Amber	BR, WR	20
Marsh Tit	<i>Poecile palustris</i>	R	R	R	Red	BDp2, BDMp1, UKRed	15
Meadow Pipit	<i>Anthus pratensis</i>	G	A	A	Red	BDp2	14
Mediterranean Gull	<i>Ichthyaetus melanocephalus</i>	G	A	G	Amber	BR	21
Merlin	<i>Falco columbarius</i>	A	A	R	Red	HD, ERLOB, BDMp1, BDMr1, BDMr2, UKRed	13
Mistle Thrush	<i>Turdus viscivorus</i>	G	G	A	Amber	UKRed	14
Moorhen	<i>Gallinula chloropus</i>	G	G	G	Green		13
Mute Swan	<i>Cygnus olor</i>	G	A	G	Green		19
Nightjar	<i>Caprimulgus europaeus</i>	A	A	A	Green		13
Nuthatch	<i>Sitta europaea</i>	G	G	G	Green		14
Osprey	<i>Pandion haliaetus</i>	G	A	A	Amber	BR	15
Oystercatcher	<i>Haematopus ostralegus</i>	A	A	A	Amber	ERLOB, WI	18
Peregrine	<i>Falco peregrinus</i>	A	G	G	Green		14
Pied Flycatcher	<i>Ficedula hypoleuca</i>	G	R	R	Amber	BDMp1, BDMp2, UK50	13
Pied Wagtail	<i>Motacilla alba</i>	G	G	G	Green		12
Pink-footed Goose	<i>Anser brachyrhynchus</i>	G	G	G	Green		14
Pintail	<i>Anas acuta</i>	A	A	A	Amber	ERLOB, WL, WI	17
Pochard	<i>Aythya ferina</i>	G	R	R	Red	IUCN, WDP1, WDp2, ERLOB, WDMr1, UKRed	22
Pomarine Skua	<i>Stercorarius pomarinus</i>	G	G	A	Amber	WDMp1, WR	13
Puffin	<i>Fratercula arctica</i>	R	R	R	Red	IUCN, ERLOB, UKRed, HDrec2	15
Purple Sandpiper	<i>Calidris maritima</i>	G	G	G	Red	WDp1, WDp2, WR, UKRed	15
Quail	<i>Coturnix coturnix</i>	A	A	A	Amber	BDMp1, BDMp2, BR	15

Table 5 continued.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
Raven	<i>Corvus corax</i>	G	G	G	Green		13
Razorbill	<i>Alca torda</i>	G	G	A	Amber	BI	15
Red Grouse	<i>Lagopus lagopus</i>	R	R	R	Red	HD, BDMr2	15
Red Kite	<i>Milvus milvus</i>	A	A	A	Green	HDrec2	15
Red-breasted Merganser	<i>Mergus serrator</i>	G	A	A	Red	WDp1, BDMr1	18
Redpoll	<i>Acanthis cabaret</i>	G	R	A	Amber	UKRed	10
Redshank	<i>Tringa totanus</i>	A	A	R	Red	BDr1, BDr2, ERLOB, BDMp2, WI	18
Redstart	<i>Phoenicurus phoenicurus</i>	A	A	G	Green		11
Red-throated Diver	<i>Gavia stellata</i>	A	A	A	Amber	WL	11
Redwing	<i>Turdus iliacus</i>	G	A	A	Green		7
Reed Bunting	<i>Emberiza schoeniclus</i>	A	A	A	Green		17
Reed Warbler	<i>Acrocephalus scirpaceus</i>	G	G	G	Green		13
Richard's Pipit	<i>Anthus richardi</i>	NL	NL	NL	Amber	WDMp1, WR	12
Ring Ouzel	<i>Turdus torquatus</i>	R	R	R	Red	BDr2, UKRed	14
Ringed Plover	<i>Charadrius hiaticula</i>	R	A	R	Red	WDp2, WDMp1, UKRed, WI	22
Robin	<i>Erithacus rubecula</i>	G	G	G	Green		14
Rock Pipit	<i>Anthus petrosus</i>	G	G	G	Green		7
Rook	<i>Corvus frugilegus</i>	G	G	G	Red	BDp1, ERLOB BDp2,	15
Roseate Tern	<i>Sterna dougallii</i>	R	R	R	Red	BDMr1, BR, UKRed	15
Ruff	<i>Calidris pugnax</i>	G	A	A	Amber	WR, UKRed	13
Sabine's Gull	<i>Xema sabini</i>	NL	NL	NL	Amber	WR	12
Sand Martin	<i>Riparia riparia</i>	A	A	G	Green		12
Sanderling	<i>Calidris alba</i>	G	A	A	Green		15
Sandwich Tern	<i>Thalasseus sandvicensis</i>	A	A	A	Amber	BDMr2, BL	18
Scaup	<i>Aythya marila</i>	A	A	A	Amber	WR, UKRed	15
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	G	G	G	Green		14
Shag	<i>Phalacrocorax aristotelis</i>	G	G	A	Amber	BDMp1, UKRed	17
Shelduck	<i>Tadorna tadorna</i>	A	A	A	Red	BDp2, WI	22
Short-eared Owl	<i>Asio flammeus</i>	A	R	R	Amber	BR, WR	18
Shoveler	<i>Spatula clypeata</i>	A	A	A	Amber	WI	20
Siskin	<i>Spinus spinus</i>	G	G	G	Green		13

Table 5 continued.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
Skylark	<i>Alauda arvensis</i>	A	A	A	Amber	UKRed	13
Slavonian Grebe	<i>Podiceps auritus</i>	G	R	R	Red	IUCN, WDMp1, WR, UKRed	13
Snipe	<i>Gallinago gallinago</i>	A	A	A	Amber	ERLOB, BDMr2	14
Snow Bunting	<i>Plectrophenax citrinella</i>	G	A	A	Amber	WDMp1, WR	12
Song Thrush	<i>Turdus philomelos</i>	A	A	A	Green		14
Sooty Shearwater	<i>Ardenna grisea</i>	G	A	A	Green		8
Sparrowhawk	<i>Accipiter nisus</i>	G	G	G	Green		13
Spoonbill	<i>Platalea leucorodia</i>	NL	A	A	Amber	WR, WRUK	13
Spotted Flycatcher	<i>Muscicapa striatastriata</i>	A	R	R	Red	BDp1, BDp2, UKRed	14
Spotted Redshank	<i>Tringa erythropus</i>	G	A	A	Amber	WDMp1, WR, UK50, WRUK	14
Starling	<i>Sturnus vulgaris</i>	R	R	R	Red	BDp1, BDp2, UKRed	14
Stock Dove	<i>Columba oenas</i>	A	G	G	Green		13
Stonechat	<i>Saxicola rubicola</i>	A	G	G	Green		9
Storm-petrel	<i>Hydrobates pelagicus</i>	A	A	A	Amber	BL	12
Swallow	<i>Hirundo rustica</i>	A	A	G	Green		12
Swift	<i>Apus apus</i>	G	A	A	Red	BDp1, UKRed	13
Tawny Owl	<i>Strix aluco</i>	G	G	G	Green		11
Teal	<i>Anas crecca</i>	A	A	A	Amber	BDMr2, WI	16
Tree Pipit	<i>Anthus trivialis</i>	G	A	A	Red	BDp2, BDMp1, UKRed	14
Tree Sparrow	<i>Passer montanus</i>	R	R	R	Red	BDp2, BDr1, BDr2, WDMr1, UKRed	11
Treecreeper	<i>Certhia familiaris</i>	G	G	G	Green		14
Tufted Duck	<i>Aythya fuligula</i>	G	A	G	Green		18
Turnstone	<i>Arenaria interpres</i>	A	A	A	Amber	WDMp2	15
Turtle Dove	<i>Streptopelia turtur</i>	R	R	R	Red	IUCN, BDp1, BDp2, BDr1, BDr2, ERLOB, BR, UKRed	15
Twite	<i>Linaria flavirostris</i>	A	R	A	Amber	BDMp1, BR, UKRed	17
Velvet Scoter	<i>Melanitta fusca</i>	G	A	R	Red	IUCN, ERLOB, WDMp1, WR, UKRed	13
Water Pipit	<i>Anthus spinoletta</i>	G	G	G	Green		7
Water Rail	<i>Rallus aquaticus</i>	A	G	G	Amber	BDMp1	14

Table 5 continued.

Species		BoCCw1 (2002)	BoCCw2 (2010)	BoCCw3 (2016)	BoCCw4 (2022)	Red- and Amber-list qualifying criteria	Number of assessed criteria
Waxwing	<i>Bombycilla garrulus</i>	G	G	G	Green		7
Wheatear	<i>Oenanthe oenanthe</i>	G	A	G	Amber	BDMp1	12
Whimbrel	<i>Numenius phaeopus</i>	A	A	A	Amber	UKRed	11
Whinchat	<i>Saxicola rubetra</i>	G	G	R	Red	BDp1, BDp2, BDMr1, BDMr2, UKRed	14
White-fronted Goose	<i>Anser albifrons</i>	R	R	R	Red	WDp1, WL, UKRed	16
Whitethroat	<i>Curruca communis</i>	G	A	R	Red	BDp2	12
Whooper swan	<i>Cygnus cygnus</i>	G	G	G	Green		14
Wigeon	<i>Mareca penelope</i>	A	A	A	Amber	BR, WI	20
Willow Tit	<i>Poecile montanus</i>	R	R	R	Red	BDp1, BDp2, BDMr1, BDMr2, WDMr1, UKRed	11
Willow Warbler	<i>Phylloscopus trochilus</i>	G	R	R	Red	BDp2	15
Wood Sandpiper	<i>Tringa glareola</i>	NL	NL	NL	Amber	WR	13
Wood Warbler	<i>Phylloscopus sibilatrix</i>	G	R	R	Red	BDp1, BDp2, UKRed	14
Woodcock	<i>Scolopax rusticola</i>	A	A	R	Red	BDr1, BDr2, BDMp1, UKRed	14
Woodpigeon	<i>Columba palumbus</i>	G	G	G	Green		14
Wren	<i>Troglodytes troglodytes</i>	G	G	G	Green		14
Wryneck	<i>Jynx torquilla</i>	NL	NL	NL	Amber	WR	13
Yellow-browed Warbler	<i>Phylloscopus inornatus</i>	NL	NL	NL	Amber	WR	13
Yellowhammer	<i>Emberiza citrinella</i>	R	R	R	Red	BDp1, BDp2, BDMr1, BDMr2, WDMr1, UKRed	16
Yellow-legged Gull	<i>Larus michahellis</i>	NL	NL	NL	Amber	WR	13
(Western) Yellow Wagtail	<i>Motacilla flava</i>	A	R	R	Red	BDp2, BDr1, BDr2, BDMp1, BR, UKRed	13

Willow Warbler (*Phylloscopus trochilus*), Wood Warbler (*Phylloscopus sibilatrix*), and Lesser Spotted Woodpecker (*Dryobates minor*) remain Red-listed, with the last two at real risk of being lost from Wales. Goldcrest (*Regulus regulus*) has joined the Red list following a decline in abundance since 1995, and Garden Warbler (*Sylvia borin*) moves from Green to Amber. Close to our homes, Swifts (*Apus apus*) are placed on the Red list and House Martin (*Delichon urbicum*) on Amber for the first time. Familiar at our bird tables, Greenfinch (*Chloris chloris*) moves to Red and Chaffinch (*Fringilla coelebs*) to Amber.

Two species, Corncrake and Corn Bunting, were previously Red-listed but have been removed from the list of species assessed as they have ceased being regular breeding birds in or visitors to Wales. In contrast, Marsh Harrier (*Circus aeruginosus*) and Bittern (*Botaurus stellaris*) have returned as breeding birds. The Green-listing of Red Kite represents a demonstration of the capacity for

species to recover their numbers. There is hope for some species that feed on farmland and nest in damp, marginal habitats. Song Thrush (*Turdus philomelos*) and Reed Bunting (*Emberiza schoeniclus*) have moved from Amber to Green for the first time, reflecting the partial recovery of their populations both in Wales and across the UK. Other species moving to the Green list include Mallard (*Anas platyrhynchos*), Long-tailed Tit (*Aegithalos caudatus*), Redwing (*Turdus iliacus*) and Kingfisher (*Alcedo atthis*). Several, such as Cattle Egret (*Bubulcus ibis*) and Great White Egret (*Ardea alba*), are increasing in number and were assessed for the first time. Both are now regular visitors to Wales.

The number of species for which Wales has a particular responsibility has increased. Six are now Amber-listed because Wales holds more than 50% of the UK breeding population. We have 79% of the UK's breeding Chough population, so recent declines in populations in north and mid Wales are a concern. Wales also holds more than half of the

Table 6. Numbers of birds moving between lists from BoCCw3 to BoCCw4, with species listed for movements on and off the Red list. Rw = Wales Red list; Aw = Wales Amber list; Gw = Wales Green list; 3 = third review; 4 = fourth review (this document).

	Rw4	Aw4	Gw4	Total
Rw3	46	7	0	53
Aw3	10 Shelduck Red-breasted Mer- ganser Swift Lesser Black-backed Gull Bittern Honey-buzzard Goldcrest Meadow Pipit Tree Pipit Greenfinch	60	14	84
Gw3	3 Purple Sandpiper Leach's Petrel Rook	11	55	69
Not previously assessed	1 Little Auk	13	0	14
Total	60	91	69	220

Table 7. The percentage of species on each list by membership, or no membership, of two current conservation delivery mechanism across BoCCW assessments 1-4. A) by percentage of species in each conservation concern level, and B) by breeding atlas habitat preference for percentage Red-listed.

A)

Mechanism	Assessment	Red	Amber	Green
Protected sites (n=59)	1	20	54	25
	2	27	54	19
	3	36	46	19
	4	36	37	27
	Mean	30	48	23
Glastir (n=9)	1	72	28	0
	2	89	11	0
	3	78	22	0
	4	78	22	0
	Mean	81	19	0
Outside mechanisms (n=158)	1	8	25	67
	2	17	44	39
	3	21	39	40
	4	23	39	38
	Mean	17	28	46

UK’s breeding Manx Shearwater (*Puffinus puffinus*), Pied Flycatcher (*Ficedula hypoleuca*), Goshawk and Hawfinch (*Coccothraustes coccothraustes*), and based on winter WeBS counts, more than half visiting Spotted Redshanks (*Tringa erythropus*).

Levels of conservation concern in relation to conservation delivery

Sixty-one of the species assessed for BoCCw4 (28%) are ‘features’ of one or more protected sites in Wales represented by Sites of Special Scientific Interest (SSSIs) and Special Protection Areas (SPAs). Nine species may benefit from specific options available within the Glastir Agri-environment Scheme (AES) that are designed to

provide suitable conditions for them (Glastir began in 2012, replacing Tir Gofal, a previous scheme with similar options [Glastir Advanced Rules Booklet 2017]), and there is evidence that some elements of the scheme are effective for birds (MacDonald *et al.* 2018, Dadam and Siriwardena 2019). The results showed a considerably higher percentage of species were Red-listed for the two groups that benefit from delivery mechanisms compared with the group that does not (Glastir=78%, Protected sites=30%, Other=17%) suggesting successful targeting of such mechanisms to species identified as being of conservation concern (Table 7a). However, the Red-list for the species group outside these mechanisms tripled in length across the four

Table 7 continued.

B)

Mechanism	Assess- ment	Costal	Farm- land	Lowland Wetland	Upland	Urban	Wood- land	Winter- ing only	Not as- signed
Protected sites	1	24	100	0	22			43	0
	2	24	100	9	33			43	20
	3	35	100	9	39			71	20
	4	41	100	9	39			57	20
	Mean	31	100	7	33			54	15
	n	17	1	11	18	0	0	7	5
Glastir	1	0	100		83			100	
	2	0	100		83			100	
	3	0	100		83			100	
	4	0	100		83			100	
	Mean	0	100		83			100	
	n	1	1	0	6	0	0	1	0
Other	1	0	21	7	7	0	10	0	8
	2	18	35	6	7	0	21	5	31
	3	18	40	6	21	0	21	14	33
	4	31	50	12	27	20	23	11	23
	Mean	17	37	8	16	5	19	8	24
	n	13	20	17	15	5	43	28	17

assessments (8% to 23%), while the percentage on the Green-list nearly halved (67% to 38%, table 7a). In contrast, the length of the Red-list for the Protected sites group less than doubled (20% to 36%) while the Green-list varied little. Whilst there are few bird species with tailored Glastir options (n=8), making patterns across assessments hard to interpret, the length of the Red-list for this group also showed little change. There is evidence of variation between habitats, however. Protected site Red-listed species are dominated by coastal, upland and wintering species, while in contrast, those not explicitly targeted by either delivery mechanism are dominated by farmland and woodland species (table 7b).

Data gaps

Values ranged from a minimum of seven (e.g. Rock Pipit *Anthus petrosus* and Fieldfare) to a maximum of 22 (e.g. Curlew and Dunlin). Species that were assessed against a greater number of criteria qualified for higher levels of conservation concern. However, this difference was consistent among non-breeding and breeding species (means: non-breeding Green=11.2, Amber=12.8, Red=13.5 vs. breeding Green=14.3, Amber=15.2, Red=15.8) and its' magnitude was small. The seven species with lowest data availability (seven criteria assessed) were, among non-breeding species, Fieldfare, Brambling (*Fringilla montifringilla*), Water Pipit (*Anthus spinoletta*), Redwing and Waxwing (*Bombicilla garrulus*) and, among breeding species: Common Crossbill (*Loxia curvirostra*) and Rock Pipit, with all on the Green list except Fieldfare (Amber).

Discussion

The revised lists

The consistent pattern of increasing lengths of both Red- and Amber-lists provides a clear message that our bird populations are changing. Some southerly distributed species are expanding their ranges northward, first as non-breeding species such as Cattle Egret (*Bubulcus ibis*) and Spoonbill (*Platalea leucorodia*), and then as breeding species such as Little Egret and Mediterranean Gull Easton *et al.* 2022). Across our *BoCCw* reviews, such species are typically initially added to the Amber-list as rare wintering or rare breeding because of their small numbers. Such new additions to the the Amber-list will likely be joined by others in the future such, as Common Crane (*Grus grus*). Its' tiny breeding population on the Gwent Levels. which

originated from a reintroduction in Somerset, just failed to qualify for assessment in *BoCCw4*. If their populations grow they will likely be moved to the Green-list (e.g. as has occurred for Avocet, listed across the four assessments: G,A,A,G). Indeed, the Amber-list serves well to highlight such moderate levels of concern and is sensitive to change as species move from Green to Amber and back as species colonise, but also as populations show natural fluctuations (e.g. Tufted Duck *Aythya fuligula*: G,A,A,G, and Garden Warbler: G,A,G,A). When using the lists it is important to understand the reasons for a species' listing by examining the criteria under which they have qualified.

Qualification for the Red-list depends on international threat and severe decline, and because of this includes some species at real risk being lost from Wales such as the consistently Red-listed Curlew and Willow Tit. The lengthening of the Red-list across all four Wales *BoCC* reviews and across the five UK *BoCC* reviews (Stanbury *et al.* 2021) is of considerable concern. Indeed given its current length, perhaps thought should be given to the development of an objective method of identifying those species that are of highest conservation concern within this list. For example, this might be based on species with high extinction risk. The IUCN Red-list approach may be advantageous here as it includes elements of population dynamics among its criteria, such as generation length, extinction risk and rescue effects from adjacent populations that influence the feasibility of population recovery.

Interpreting the moves between lists

Three species moved from Green to Red in *BoCCw4* and two of these did so because of population decline (Rook, and Purple Sandpiper). Importantly, these declines may have come about for very different reasons, that touch on changes underway in Wales that have profound effects on biodiversity (Hayhow *et al.* 2019). Rook, in particular is such a familiar farmland bird that it is hard to comprehend that half of them have been lost since 1994 (BBS data; Harris *et al.* 2022). Indeed, one striking feature of the *BoCCw4* Red-list is the growing number species previously considered 'too common to worry about' that have been added since *BoCCw1*. Examples being Herring Gull (*Larus argentatus*, A,R,R,R) and Whinchat (G,G,R,R) in previous assessments, and Swift (G,A,A,R), Meadow Pipit (G,A,A,R) and Rook (G,G,G,R) in

this assessment. This is a stark illustration, adding to existing evidence (e.g. Robinson *et al.* 2005), that once very common birds cannot be taken for granted. Importantly, such declines may continue whilst drivers of change are diagnosed. Even then, and if such drivers act within Wales such as via land-use change, developing, testing and rolling out of interventions typically takes many years. Further challenges are posed if drivers of decline act on the routes to or wintering ranges of migrants where international research and action may be needed.

Whilst the >50% decline in Rook abundance in Wales reported by the BTO/JNCC/RSPB Breeding Bird Survey is the greatest across UK countries and regions, there is evidence from BBS for declines of >20% in Scotland and the north and southwest of England. Although not all these changes are statistically significant, it does highlight that the problems faced by Rooks in Wales are not unique. Indeed, there is evidence for national declines elsewhere in Europe that have been linked to persecution (Keller *et al.* 2020). The ongoing WOS-led repeat Rook Survey will be extremely valuable in providing longer-term population change estimates for Wales. Analyses of trends of farmland birds in Wales and elsewhere have identified a number of pressures associated with agricultural intensification (Hayhow *et al.* 2019) but the reason for declines in Rook remain uncertain. As a farmland bird, changes in agriculture could be included in further analyses based on these data to inform such questions. Indeed, based on UK data, whilst there is no change in breeding productivity since the 1960s there is evidence for a significant decline in brood size (Woodward *et al.* 2020), which may be linked to invertebrate food supplies for chicks.

Purple Sandpiper populations have been estimated four times since winter 1984/85 but only show severe abundance decline (-68%) since the third survey in winter 1996/97, a pattern also seen in other UK countries (Austin *et al.* 2017). Birds may be wintering farther north, closer to Arctic breeding areas as UK winters have become milder, so called 'short-stopping' (Burton *et al.* 2020), although it remains possible that poor performance in Arctic breeding areas has resulted in global population decline (also possibly linked to climate, Summers *et al.* 2012). Warmer winters may also explain the marked decline in Little Auk records since 2001. It was assessed for the first time in *BoCCw4*, having

previously been considered a scarce migrant (Prater and Thorpe 2006).

Meadow Pipits are characteristic of upland landscapes in Wales and their move to the Red-list suggests negative changes to their upland environment are taking place, such as more polarised grazing regimes. For example, further intensification of enclosed grassland to support high livestock densities (through a combination of grazing and increased silage production) and reduced grazing intensity or even abandonment of less economically viable moorland and mountain pasture. Interestingly, as with Rook (which also depends heavily on invertebrate food), declines in Meadow Pipit are more severe in Wales than other parts of the UK (Harris *et al.* 2022). Research is needed to explore the environmental correlates of changes in Meadow Pipit abundance across the UK. This is all the more important because Meadow Pipits are a key food species for a number of already Red-listed birds of prey, such as Hen Harrier and Merlin.

Almost all of Wales' breeding waders are Red- or Amber-listed, and in most cases this is because of population decline. Among Red-listed waders, prospects for one has improved locally, with Lapwings benefiting from habitat restoration and anti-predator measures on nature reserves (Ausden *et al.* 2014). However, this has been insufficient to address severe national decline in numbers and range and, hence, their level of conservation concern. Saltmarsh-nesting Redshanks have declined because inappropriate grazing by sheep prevents successful nesting (Pritchard *et al.* 2021), while Curlews risk extinction in Wales possibly as soon as the next decade if their breeding success remains insufficient (Taylor *et al.* 2020). Moving these species from Red to Amber will require targeted landscape management that includes the benefits of lower intensity livestock farming.

Wales is important for a number of woodland birds, supporting more than half of the UK's Pied Flycatcher, Hawfinch and Goshawk populations. One woodland species that perhaps unexpectedly moved from Green to Red across *BoCCw* reviews is Goldcrest (G,A,A,R). Often described as vulnerable to winter cold snaps, the insectivorous Goldcrest may also be sensitive to fluctuations in the abundance of small insects. For example, aphid abundance has fallen in recent decades (Finch *et*

al. 2022). Although small population change can ‘nudge’ a species across a qualifying threshold also without undue biological significance, with a decline of 54%, the fortunes of the Goldcrest should nevertheless be watched closely.

On a cautionary note, we have based our analysis on provisional results from the latest UK seabird census (Seabird Count, Pritchard *et al.* 2021), and it remains possible that seabird listings may change. For example, should the -57% Lesser Black-backed Gull 25 year population change be revised to less than -50%, the species would move to the Amber-list.

Bird populations are currently being impacted by a range of diseases, which has focused attention on this relatively poorly monitored issue. Among the better known of these is Trichomonosis (a protozoan parasite), which has impacted Greenfinch (*Chloris chloris*) particularly severely (G,G,A,R) (Lawson *et al.* 2012), with additional population-level impacts emerging for Chaffinch (*Fringilla coelebs*: G,G,G,A) (Hanmer *et al.* 2022), and worrying recent cases in Welsh Hawfinch populations that have UK importance (G,A,A,A) (Hughes *et al.* 2020). Highly Pathogenic Avian Influenza (HPAI) virus has been confirmed in over 65 wild bird species in the UK (Avian influenza in wild birds - GOV.UK ([www.gov.uk](https://www.gov.uk/government/publications/avian-influenza-in-wild-birds)) <https://www.gov.uk/government/publications/avian-influenza-in-wild-birds>) and has already caused mortality in breeding seabirds and wintering waterbirds in Wales (<https://www.gov.uk/government/publications/avian-influenza-in-wild-birds>). It may take several years for the current epidemic to take its course and for impacts on breeding and wintering abundance to become apparent in our wild bird populations. Biological resilience, i.e., the ability to bounce back from negative impacts on the population, will vary between species with different life history traits and is also influenced by pressure from other limiting factors such as habitat quality. Seabirds typify species with low resilience (naturally low breeding success means more time is needed to replace adult deaths), making HPAI of particular concern for Welsh seabird populations. We should also remain vigilant for other emerging avian diseases with the potential to impact bird abundance, such as avian pox (Lawson *et al.* 2012).

Birds of conservation concern and conservation delivery

There are some conservation successes among the species we have reviewed. Notable examples being among birds of wetland habitats, which, after considerable losses to agriculture, have been the target of over two decades of restoration projects often on nature reserves (e.g. Ausden *et al.* 2014). Mediterranean Gull and Avocet have likely both benefited from wetland restoration (likely in combination with a warmer climate) and have been moved to the Green-list. Bittern and Marsh Harrier have returned as a breeding species, the former also returning to the Red-list because of the considerable historical breeding decline which must be recovered.

For other species that have benefited from such projects on a local scale, such as Lapwings, the prospects of being moved to Amber due to population recovery in the wider countryside still seem slim. This is because at a wider scale Wales has experienced profound changes in the way land is managed over recent decades, with much past drainage and intensification of grassland management, and afforestation with non-native conifers. For example, increasing monocultures of ryegrass now account for over 50% of landcover in Wales (Blackstock 2010). This is being countered in part by new iterations of AES in Wales, with objectives to benefit biodiversity, store carbon and manage seasonal water runoff being developed. This wider countryside scheme sits alongside a network of protected areas with important habitat and bird populations. Protected sites have management plans with objectives to maintain favourable condition for feature species (NRW 2020). In some cases, they collectively support a large proportion of a species' population in Wales (e.g. Common Scoter) but are often insufficiently monitored (NRW 2020). While some AES options are to explicitly address the conservation needs of priority birds such as Lapwing and Black Grouse.

Our summary of list length by delivery mechanisms across the four BoCC reviews suggests firstly that species with high levels of conservation concern have been successfully targeted by conservation delivery mechanisms. However, that there is almost no improvement in levels of conservation concern (i.e. downlisting) for those species is worrying, and in some cases this may be linked to the unfavourable status of many sites. For example, 70% of grassland habitat on SSSIs is in poor condition, with under-management being the

principal cause (NRW 2020). The abandonment or relaxation of management activities such as grazing or cutting leading to natural succession, represents the greatest single threat to semi-natural grasslands in Britain and Ireland (Stroh *et al.* 2019). Protected sites for birds have proved effective elsewhere (Donald *et al.* 2007) but adequate resources to deliver favourable conservation status of these sites are essential for this mechanism to be effective. Secondly, levels of conservation concern are rising faster among species not explicitly targeted by such mechanisms, particularly birds of farmland and woodland. Some AES options are designed to benefit specific species, whilst others are intended to be generic and could benefit those species not otherwise targeted. Assessments of bird responses to the Tir Gofal AES by comparing treatment and control locations have shown some benefits for hedgerow and woodland birds, including for Welsh Government priority species (a list based on *BoCCw3*), but less so for grassland and arable birds, particularly breeding waders (MacDonald *et al.* 2018, Dadim and Siriwardena 2019). Reasons for increasing levels of conservation concern nationally, often driven by declining abundance and range, might include inadequate and/or insufficient delivery of suitable habitat through AES options on scheme farms. Current woodland restoration projects may contribute to reduced levels of concern in the future by, for example, removing invasive plant species and reintroducing appropriate woodland grazing. More widely, the lack of recovery of Red-list species may indicate that such mechanisms only deliver benefits to a limited proportion of the Welsh populations of target bird species because protected area provision is insufficient (Williams *et al.* 2016) or uptake of AES options most beneficial to target species is too low even though scheme uptake may be high. Glastir's replacement, the Sustainable Farming Scheme has potential to benefit birds of highest conservation concern in woodland and other habitats if effective packages of options can be delivered in quantity in places where these birds still occur. Such options often also have water quality and carbon storage benefits. However, we cannot rule out the possibility that some species may also be impacted by other factors, such as land use change in the wintering ranges of migrants, that may make AES provision for them less effective. For example through impacts on invertebrate prey or through phenological mismatches (Burgess *et al.* 2018).

Data gaps and future developments

Data availability in Wales is lower than for the wider UK. For example, smaller sample sizes lead to reduced confidence in abundance change which may result in data for some species falling below acceptable thresholds for use. We can address this, in part, by building participation in structured schemes such as BBS and WeBS as well as encouraging more reporting of rare birds to schemes such as the Rare Breeding Bird Panel, the County Bird Recorder network and BirdTrack. This is ongoing, with most schemes, including BBS (Harris *et al.* 2022), showing increased participation following low coverage in 2020 due to Covid restrictions. Our analysis has highlighted those species with lowest data availability, which identifies knowledge gaps that could be addressed with the appropriate application of effort. BirdTrack data in particular, represent an as yet unused resource in *BoCC* reviews. Species such as breeding Rock Pipit, and wintering Fieldfare may be candidates with which to explore the use of such data for estimating abundance change at both the UK and Wales levels.

BoCCw5 is some years away. The long-running structured and informal bird monitoring schemes in Wales will continue to generate invaluable data on the status of the country's birds in that time. The schemes will continue to be developed and, we hope even better supported by birdwatchers. Where we can, we should all contribute to more and better data that can be used to review levels of conservation concern in the future.

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We thank the huge number of birdwatchers contributing to the many citizen science monitoring schemes operating in Wales that range from highly structured data collection to informal but valuable recording of rare birds. This assessment would not be possible without your fieldwork. This review was funded by Natural Resources Wales.

Ethical statement

This report is based on data were collected by citizen scientists, who as experienced bird watchers, were careful not cause disturbance to the birds they were monitoring.

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Image: Ben Andrew

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Appendix 1

Table A1.1. Species-specific method for estimating non-breeding population size and recent change from Welsh Ornithological Society classified records using means of two 5-year periods.

Species	Method	2001/02– 2005/06	2015/16– 2019/20	% change
Arctic Skua	Sum of all records, autumn=Jul–Nov winter=Dec–June	459	669	46
Balearic Shearwater	Sum of all passage records	280	88	-69
Bearded tit	Individuals in Jul–Mar period	1	15	957
Bewick's Swan	Summed peak county counts	108	21	-80
Black-throated Diver	Summed peak county counts	14	12	-15
Cattle Egret	Summed peak county counts in winter (Dec–June) and autumn (Jul–Nov)	0	17	9999
Curlew Sandpiper	Sum of all passage records	111	36	-67
Eider duck	Summed peak county counts	305	228	-25
Eurasian Bittern	Summed peak count from each site	17	11	-34
Eurasian Spoonbill	Summed peak county counts	14	15	7
Glaucous Gull	Summed county totals but some duplication likely	9	18	102
Great Grey Shrike	Sum of county totals, winter=Dec–June, autumn=Jul–Nov	13	23	74
Great Northern Diver	Apparent county winter peak summed across counties	81	100	22
Great Skua	Sum of all passage records	328	416	27
Great White Egret	Summed peak county counts, autumn=Jul– Nov winter=Dec–June (deduplication increasingly hard)	2	63	3389
Greater Scaup	Summed county winter peak	103	71	-31
Grey Phalarope	Sum of all records, autumn=Jul–Nov winter=Dec–Jun	33	28	-14
Hen Harrier	Peak County count, summed between sites	53	53	-1
Hooded Crow	Summed peak county counts	6	17	196
Hoopoe	Sum of all records for autumn and spring passage	8	10	25
Iceland Gull	Summed county totals but some duplication likely	8	23	190
Jack Snipe	Peak winter count (Nov–Mar) summed across counties	59	69	17
Lapland Bunting	Summed peak county counts	11	23	111
Little Gull	Summed peak county counts, winter=Nov– Mar	13	16	25
Long-tailed Duck	Sum of county totals	27	55	105
Long-tailed Skua	Sum of all passage records	24	23	-4
Marsh Harrier	Summed peak county counts	4	18	333

Table A1.1 continued.

Species	Method	2001/02– 2005/06	2015/16– 2019/20	% change
Mediterranean Gull	Summed peak county counts	156	1399	798
Pink-footed Goose	Summed peak county counts	821	1787	118
Pomarine Skua	Sum of all passage records	123	84	-31
Richard's Pipit	Sum of county totals, autumn=Jul-Nov, winter=Dec-Jun. Some duplication possible	12	7	-36
Ruff	Sum of county totals, autumn=Sep-Oct	34	73	114
Sabine's Gull	Sum of day counts, autumn=Jul-Nov winter=Dec-June	39	41	4
Short-eared Owl	Summed peak county counts	29	68	134
Slavonian Grebe	Summed peak county counts	46	27	-40
Snow Bunting	Summed peak county counts	37	23	-38
Spotted Redshank	Summed peak county counts, Nov-Mar	41	25	-38
Twite	Summed peak county counts	106	119	12
Velvet Scoter	Peak county count, no summing.	34	21	-37
Whooper Swan	Summed peak county counts	212	329	55
Wood Sandpiper	Sum of all records	17	18	10
Wryneck	Sum of county totals, winter=Dec-June, autumn=Jul-Nov, some duplication possible	17	20	16
Yellow-browed Warbler	Sum of county totals, winter=Dec=June autumn=Jul-Nov	16	88	448
Yellow-legged Gull	Summed peak county counts, autumn=Jul- Nov, winter=Dec-June	13	26	94

Appendix 2

Table A2.1. Differences in the species assessed by BoCCW3 and BoCCW4. Categories: A = recorded in a natural state at least once since 1st January 1950; B = recorded in a natural state at least once 1st January 1800 - 31st December 1949, but not been recorded since; C4 = naturalised domestic species; E = introductions with breeding populations not thought as self-sustaining. Status: Passage migrant = present during Autumn and/or Spring; scarce migrant = >35 records total but <5 records per year; vagrant = 3-9 birds in last 30 years.

Species		BOU category or WOS status change between <i>BoCCW3</i> and <i>BoCCW4</i>		Comments
Added	Dropped	<i>BoCCW3</i>	<i>BoCCW4</i>	
Cattle Egret		Vagrant	Resident but not breeding	
Glaucous Gull		Scarce migrant	Winter migrant	
Great Grey Shrike		Winter migrant	Winter migrant	Not previously assessed
Great White Egret		Vagrant	Resident but not breeding	
Grey Phalarope		Passage migrant	Passage migrant	Not previously assessed in error
Hoopoe		Scarce migrant	Occasional breeder after 1950	
Iceland Gull		Scarce migrant	Winter migrant	
Little Auk		Scarce migrant	Passage migrant	
Richard's Pipit		Scarce migrant	Passage migrant	
Sabine's Gull		Passage migrant	Passage migrant	Not previously assessed in error
Wood Sandpiper		Scarce migrant	Passage migrant	
Wryneck		Scarce migrant	Occasional breeder after 1950	
Yellow-browed Warbler		Scarce migrant	Passage migrant	
Yellow-legged Gull		Scarce migrant	Winter migrant	
	Barnacle Goose	A	C5, E, not self-sustaining, un-natural ecology	
	Corn Bunting	Resident breeder	Scarce (extinct)	Historically widespread
	Corncrake	Migrant breeder, not formally extinct	Scarce (extinct)	Historically widespread
	Red-necked Grebe	Winter migrant	Scarce	
	Rock Dove/Feral pigeon	B, C4, E	B, C4	Assessed by BoCC and 3 but not 1
	Smew	Winter migrant	Scarce	
	Spotted Crake	Casual breeder, not formally extinct	Scarce	
Total 14	Total 7			

Appendix 3

Table A3.1. Differences in the species assessed by BoCCW4 and BoCCUK5. Passage migrant = present during Autumn and/or Spring. Scarce = more than 35 records, but < 5 records per year (in past “few” years). Rare = total number of birds 10-35 in the last 30 years. Very rare - 3-9 birds in the last 30 years. Introduced = escapes from captive populations or released for sporting or conservation reasons, including re-introductions outside of Wales.

Assessed in UK but not in Wales	Status in Wales (WOS 2022)
Aquatic Warbler	Scarce
Barnacle Goose	Introduced
Bean Goose	Very rare
Black-winged Stilt	Very rare
Bluethroat	Rare
Capercaillie	Absent
Caspian Gull	Very rare
Cirl Bunting	Extinct historic breeder
Common Crane	Rare
Corn Bunting	Scarce
Corncrake	Scarce, extinct recent breeder
Crested Tit	Absent
Golden Eagle	Extinct, historic occurrence
Golden Oriole	Scarce
Great Auk	Globally extinct, historic occurrence
Great Bustard	Extremely rare, extinct historic occurrence
Great Shearwater	Scarce
Greylag Goose	Introduced
Icterine Warbler	Scarce
Kentish Plover	Rare
Little Bittern	Very rare
Marsh Warbler	Rare
Montagu's Harrier	Rare
Nightingale	Scarce
Parrot Crossbill	Absent
Ptarmigan	Absent
Red-backed Shrike	Scarce
Red-necked Grebe	Scarce
Red-necked Phalarope	Rare
Rock Dove/Feral Pigeon	Historic breeder, replaced by domestic form

Table A3.1 continued.

Assessed in UK but not in Wales	Status in Wales (WOS 2022)
Savi's Warbler	Very rare
Scarlet Rosefinch	Scarce
Scottish Crossbill	Absent
Serin	Rare
Shorelark	Scarce
Short-toed Treecreeper	Absent
Smew	Scarce
Snow Goose	Absent
Snowy Owl	Very rare
Spotted Crake	Scarce
Stone-curlew	Rare
Temminck's Stint	Scarce
White-tailed Eagle	Very rare
Woodlark	Winter migrant but number of records greatly exceeds number of localities
Total 44	
Assessed in Wales but not in UK	Status in Wales
Great Grey Shrike	Winter migrant
Grey Phalarope	Passage migrant
Richard's Pipit	Passage migrant
Sabine's Gull	Passage migrant
Hooded Crow	Winter and passage migrant, hybrid breeding, not recognised in BoCC _{UK} 5
Total 5	

Appendix 4

Estimating effort-controlled 25yr Chough breeding population change in Wales

Choughs have been periodically censused in Wales as part of the UK scarce and rare breeding bird survey program. Although the headline results from this identify successive national increases in breeding abundance, it has been acknowledged in associated reports that this was at least in part accounted for by increased knowledge of the distribution of Chough territories (Hayhow 2019). In recent years separate collaborations have taken place between two long-term Chough monitoring projects (Mid and North Wales, and Pembrokeshire), that monitor the majority of Welsh Choughs annually (98 % in 2014), and RSPB to analyse data (Cross *et al.* 2020, Haycock *et al.* 2021). We used these results to estimate effort-controlled breeding population change for Choughs as follows.

First, annual territory occupancy probability was estimated from a binomial generalised linear mixed model that treated calendar year as a factor and accounted for different territories being monitored in different years by specifying territory identify as a random factor. Models were fitted separately for each study. Second, the maximum number of territories monitored in any one year in each study taken as the maximum population size over the monitoring period (data analysed for both over 1994-2019). Third, annual population size was taken as the maximum population size multiplied by the proportion of territories occupied in each year for each study, with the Wales total annual population size was the sum of annual sizes in each study. Percentage change in the 25yr period prior to 2020 (BDp1) was the % change in Wales population size between 1995 and 2019 (=24yrs).

The result was an estimated effort-controlled breeding abundance change value of -18.9% between 1995 and 2019, compared with the 2 % increase in abundance between 2002 and 2014 from census results.

Appendix 5

Black Grouse population size in Wales

Adapted from *BoCCuk5* Appendix Appendix 2: Evaluation of Black Grouse trend in abundance 2005–2019, and over three generations - N. J. Aebischer 15/7/2021. The number of Black Grouse in Wales were monitored annually until 2017, with counts of 195 (estimated from graph) in 2005 and 336 in 2017 (Anon. 2017). No total was available for 2019, but counts at Lake Vyrnwy were taken from Boyes (2020), and were carried out at Ruabon by keepers assisted by GWCT (D. Baines, unpublished). Between them, these two sites held 65% of Black Grouse in Wales in 2017. I applied the change from 2017 to 2019 at Ruabon and Lake Vyrnwy to the Welsh total for 2017 to obtain a Welsh total for 2019.

Location	Males in 2017	Ruabon+ Vyrnwy 2017	Ruabon+ Vyrnwy 2019	Ratio 2019/2017	Estimate of males in 2019
Wales	336	219	146	0.667	224

The 2005 count of 195 compares with the 2005 estimate of 213 from Sim *et al.* (2008), so for comparability I increased the estimated 2019 count of 224 pro rata to 245.

Location	Males in 2005	2005 survey	Ratio	Estimate of males in 2019	Projected males in 2019
Wales	195	213	1.092	224	245