BIRDS IN WALES

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EDITORIAL

This issue is larger than usual but I make no apology for this as it contains some important and interesting papers. If there is a theme it is the changing fortunes of birds in Wales, the declines and the increases.

Firstly, Andrew Dixon and colleagues from the South Wales Peregrine Monitoring Group suggest that the changes in the way that pigeon racing now occurs in Wales with fewer racing pigeons passing through mid Wales, has led to a reduction in numbers of breeding Peregrines in this area and a decline in their breeding success.

Ian Johnstone and John Dyda then describe the changes in the populations of Golden Plovers and Dunlin in the Elenydd in mid Wales over recent decades and relate this to changes in vegetation and sheep stocking density. A trial of appropriate upland management is suggested to see if these waders would respond.

The paper on status of birds in Wales by Ian Johnstone, Andy Young and Reg Thorpe of RSPB gives much food for thought. It updates the 2002 Red, Amber and Green lists for birds in the Principality. Worryingly, an increased number of species have been placed on the Red and Amber lists. The new lists will provide direction for future conservation actions.

Ian Johnstone again co-authors the next paper, with Debbie Scott and Lizzie Webster. This spells out the demise of Turtle Doves and Corn Buntings in Wales, both sadly all but extinct as breeding birds in the country. Concerted action in Wales and in adjacent counties in England are urgently needed to reverse these trends.

Last but not least of the papers, John Lawton Roberts provides a fascinating and detailed account of populations of moorland birds in the autumn and winter months on Mynydd Rhiwabon (Ruabon Mountain) SSSI in north-east Wales between 1978 and 2005. He recorded some 61 species with Red Grouse, then Meadow Pipits being by far the most numerous. He describes changes between years and emphasises the rapid declines of larger upland-specialists, notably Red Grouse, Golden Plover, Lapwing and Curlew and their replacement with generalist species. Reasons for the changes are discussed.

Julian Driver has written on an unusual nest site of a Tawny Owl high in Snowdonia and Derek Moore has reviewed the recently published Birds of Ceredigion. I thank all contributors and look forward to receiving more offerings for 2011.

I thank too Colin Richards and Derek Moore for their excellent illustrations, and Adam Pearce and especially Rhion Pritchard for translating summaries into Welsh.

Steph Tyler

Population decline of Peregrines *Falco peregrinus* in central Wales associated with a reduction in racing pigeon availability

Andrew Dixon, Colin Richards, Paul Haffield, Mike Thomas, Mark Lawrence and Glyn Roberts

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SUMMARY

Many pigeon fanciers in South Wales have switched their racing routes from northern to southern liberation points. This switch, together with a general decline in the popularity of pigeon racing, has lead to a reduction in the availability of racing pigeons in Central Wales during the pigeon race season (April-September). As racing pigeons have become scarcer Peregrine breeding success has declined with fewer pairs attempting to breed. Since 2005 the level of territory occupancy has also declined, from 13 (+/- 1) annually occupied in 1993-2004 to just seven in 2009. The abandonment of breeding territories is most likely due to fewer recruits replacing losses of existing territory occupants. We suggest that the reduced food supply, principally as a result of fewer racing pigeons passing through Central Wales, has reached a threshold level at abandoned territories making them unsuitable for breeding Peregrines.

CRYNODEB

Mae llawer o'r bobl sy'n cadw colomennod yn Ne Cymru wedi newid eu llwybrau rasio o fannau rhyddhau yn y gogledd i fannau rhyddau yn y de. Mae'r newid yma, ynghyd a lleihad cyffredinol ym mhoblogrwydd rasio colomennod, wedi lleihau'r cyflenwad o golomennod rasio yng Nghanolbarth Cymru yn ystod y tymor rasio colomennod (Ebrill - Medi). Fel mae'r nifer o golomennod rasio wedi lleihau, mae llwyddiant magu yr Hebog Tramor wedi lleihau, gyda llai o barau yn ceisio magu. Ers 2005, mae'r nifer o diriogaethau sy'n cael eu defnyddio hefyd wedi lleihau, o 13 (+/- 1) yn flynyddol yn 1993-2004 i ddim ond saith yn 2009. Mae'n debygol fod hyd oherwydd bod llai o adar newydd yn dod i mewn i gymeryd lle deiliaid tiriogaethau a gollir. Awgrymwn fod y lleihad yn y cyflenwad bwyd, yn bennaf oherwydd bod llai o golomennod rasio yn dod trwy Ganolbarth Cymru, wedi cyrraedd lefel yn y tiriogaethau y rhoddwyd y gorau iddynt sy'n eu gwneud yn anaddas i'r Hebog Tramor fagu cywion.

INTRODUCTION

The South Wales Peregrine Monitoring Group (SWPMG) maintains a database on the Peregrine population in south-central Wales. Our analysis of population trends and breeding success in this study area up to 2004 suggested that reduced levels of breeding success might be an indicator of an incipient population decline (Dixon *et al*., 2005). Our subsequent annual monitoring has recorded a population decline in Central Wales but not in South Wales (SWPMG, 2009).

Since the 1990's many pigeon fanciers in South Wales began to change their traditional racing routes from northerly liberation points to southerly ones. Prior to the 1990's, 'north road' racing was the predominant race direction for pigeon fanciers in South Wales, with pigeons being released at incrementally increasing distances at liberation points to the north. Examples of liberation points for 'north road' races include Hereford, Shrewsbury, Nantwich, Carnforth, Tebay, Carlisle, Perth, Elgin, Thurso and Lerwick. Now only a small number of fanciers persist with 'north road' racing in South Wales and instead race from south-easterly liberation points e.g., Chepstow, Marlborough, Basingstoke, Littlehampton, Hastings and continental liberation points across the English channel. A consequence of this shift in race routes is that far fewer racing pigeons from lofts in South Wales would be expected to pass through Peregrine territories in Central Wales during the racing season. This switch in race routes would not result in a reduction in the availability of racing pigeons for Peregrines nesting in South Wales.

In this study we examined the home origin of racing pigeons killed by Peregrines to obtain evidence to support our contention that a switch in race routes has resulted in a decline in the availability of racing pigeons in Central Wales. We examined the response shown by Peregrines to this reduction in food supply in terms of territory occupancy, breeding success and diet.

METHODS

The SWPMG south-central Wales study area can be divided into three sub-regions: Central Wales, Brecon Beacons and South Wales. The Central Wales study area covers *ca.* 1,165 km^2, encompassing parts of the vice-counties of Breconshire, Carmarthenshire and Cardiganshire (Fig.1). Within this region we have identified 19 different territories that have been occupied by Peregrines in at least one year over the period 1975-2009.

We collected racing pigeon rings from 19 Peregrine breeding territories in Central Wales over the period 1997-2009. Rings were collected during licensed nest visits and outside the breeding season using metal detectors. We used ring distribution lists issued by pigeon racing unions to trace the home origin of 1580 rings that were issued from 1990-2007 (with the exception of rings issued in 2003 because we did not have the ring distribution lists from all pigeon unions in that year). For GB-prefix rings issued by the Royal Pigeon Racing Association (RPRA) to individuals and non-regional clubs such as the National Flying Club and Midlands National Flying Club, we submitted the ring details to the RPRA to determine the home origin. Each ring was assigned to one of 15 regional categories based on the home regions defined by the RPRA (Appendix 1).

Data on territory occupancy and breeding success for the period 1990-2009 was collated by the SWPMG based on information provided by several recorders over this time period. Where no records were available for a particular year, occupancy was inferred from the registration dates on racing pigeon rings recovered at the sites (see Dixon *et al.* 2006). We have not distinguished sites that were occupied by pairs and single birds because of the difficulty in proving that only one bird was occupying a territory. Successful breeding was defined as a nesting attempt that fledged at least one chick, and we have only included occupied territories with a known outcome in our measure of breeding success in each year over the period 1990-2009. Consequently our sample will include occupied territories where there were no breeding attempts.

We collected 523 prey remains from 17 different Peregrine territories in Central Wales over the period 1999-2008. Only prey remains that could be assigned to one of two time periods were included in our analysis. These two time periods coincide with the pigeon race season, which runs from April-September inclusive, and the non-race season from October-March.

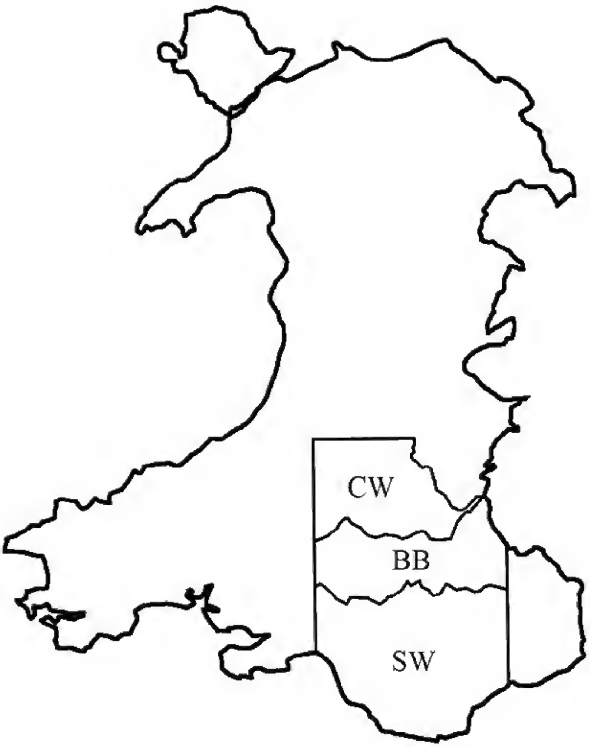

Figure 1. Map showing location of the South Wales Peregrine Monitoring Group's south-central Wales study area. CW is the Central Wales region covered in this study.

RESULTS

Reduction in racing pigeon availability

Racing pigeons killed by Peregrines in Central Wales come from many areas of Britain, Ireland and the European continent (Appendix 1). On average, we found that 34% of racing pigeons killed came from lofts in South Wales. Pigeons from western parts of England (West Midlands north to Cumbria) made up an average of 25% of pigeons killed, 13% came from Ireland and a further 12% came from lofts in NE England and Scotland. However, the proportion of racing pigeons from South Wales declined over the period 1990-2009, indicating that there has been a steady decline in the availability of racing pigeons from lofts in South Wales (Fig. 2).

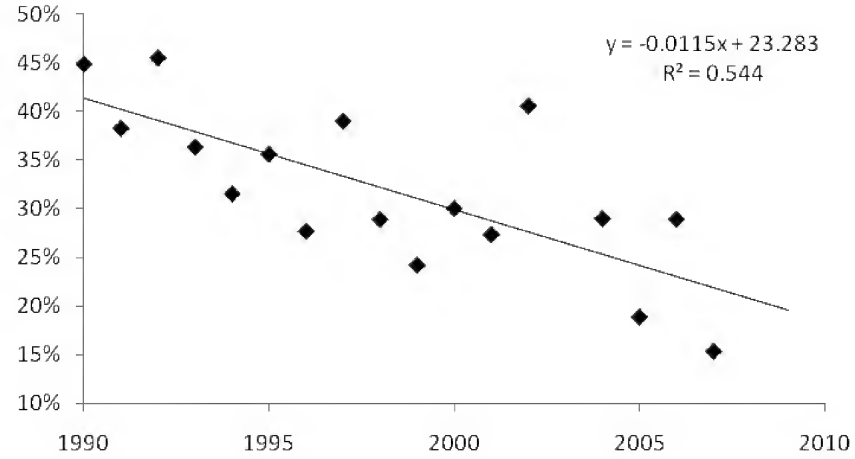

Figure 2. Proportion of racing pigeons killed by Peregrines in Central Wales that came from lofts in South Wales over the period 1990-2007.

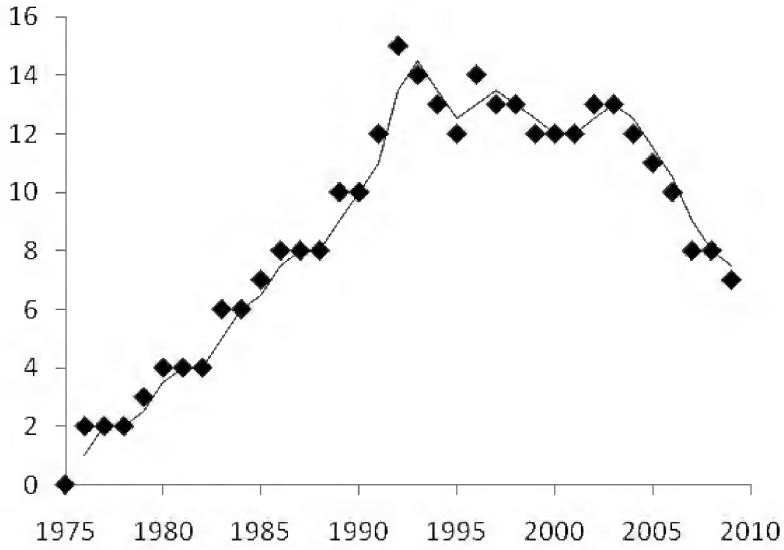

Figure 3. Territory occupancy in Central Wales over the period 1975-2009. Fitted line is a 2-year moving average.

Peregrine population decline

From the mid 1970s to early 1990s the breeding Peregrine population in our study area increased to a maximum of 15 occupied territories in 1992. Over the following 12-years the population fluctuated around an average of 13 (+/- 1) occupied territories per annum, but since 2005 the population has declined at a rate mirroring the rate of increase prior to the 1990s (Fig. 3). The breeding success of this population also exhibited a significant decline over the period 1990-2009 (Fig. 4).

Diet of Peregrines

The majority (92%) of racing pigeons were killed during their race season from April to September (Table 1). Apart from racing pigeons thrushes and corvids were the most important prey taken during the race season. Outside the race season, thrushes were the most important prey (43%, especially Redwings *Turdus iliacus* and Fieldfares *T. pilaris*), together with Starlings *Sturnus vulgaris*, corvids and small passerine species. Our analysis of the race season diet over the period 1999-2008 did not reveal any significant decline in the proportion of racing pigeons killed (Fig. 5).

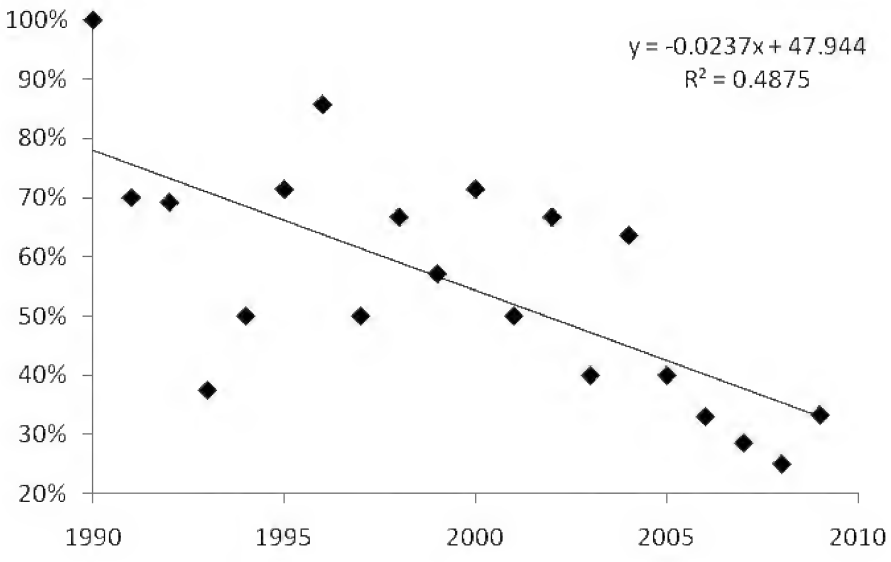

Figure 4. Annual breeding success in Central Wales, expressed as the proportion of occupied territories that fledged at least one chick, for the period 1990-2009.

DISCUSSION

A reduction in the Peregrine breeding population in our Central Wales study area has become apparent since 2005, with the number of occupied territories declining by 38% from 13 to just seven in 2009. In addition to fewer birds occupying territories we found that their breeding success had also declined since 1990. This reduced nesting success was due both to the complete failure of nesting attempts and a failure to breed at all. We believe that Peregrines failed to breed at nearly a quarter of all occupied territories in the period 2005-09. Given that there is no history, or evidence of, significant levels of persecution and nest robbery in our study area, we investigated the possibility that the failure of many birds to breed and the reduced productivity of breeding pairs was the result of a diminishing food supply.

Table 1. Diet of Peregrines in Central Wales during and outside the pigeon race season (April-September) for the period 1999-2008.
No data available for 2001 and for October-March 2005.
(Dom. Pigeon=Domestic Pigeon)

	No. of prey items taken during the pigeon race season (April-September)									
	1999	**2000**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**Total**
Dom. Pigeon	7	29	9	10	11	18	16	18	6	124
Thrushes	2	12	7	9	7	11	8	13	6	75
Starling	0	5	2	3	2	7	3	4	3	29
Corvids	1	10	5	5	2	7	12	12	7	61
Waders	2	5	3	0	4	2	3	3	1	23
Passerines	1	11	5	4	15	2	1	1	0	40
Wood Pigeon	1	3	1	2	1	1	1	1	1	12
Other Species	5	3	4	5	5	3	4	0	2	31
Totals	**19**	**78**	**36**	**38**	**47**	**51**	**48**	**52**	**26**	**395**

	No. of prey items taken outside the pigeon race season (October-March)									
	1999	**2000**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**Total**
Dom. Pigeon	6	1	0	0	0	ND	0	0	0	7
Thrushes	6	3	4	5	22	ND	8	5	2	55
Starling	0	1	0	0	11	ND	2	1	0	15
Corvids	1	0	0	2	3	ND	4	1	2	13
Waders	0	3	1	0	2	ND	2	1	1	10
Passerines	5	5	3	2	1	ND	0	0	0	16
Wood Pigeon	0	0	0	1	2	ND	1	0	0	4
Other Species	1	2	0	1	1	ND	2	0	1	8
Totals	**19**	**15**	**8**	**11**	**42**	**ND**	**19**	**8**	**6**	**128**

In the Central Wales study area racing pigeons were an important component of the diet during the pigeon racing season, comprising 31% of prey remains recorded. By examining the loft-origin of racing pigeons killed at Peregrine territories in Central Wales, we found that the proportion of pigeons from lofts in South Wales declined over the period 1990-2008; providing supporting evidence for a decrease in their availability associated with a switch in race routes. Whilst we cannot discount the possibility that the number of racing pigeons from lofts outside of South Wales has increased over this period, we think that this is unlikely given the general decline in the popularity of pigeon racing in the last twenty years. In Central Wales it is likely that the overall number of racing pigeons has declined.

The decline in breeding success mirrored the linear decline in racing pigeon availability since 1990, though the population has only declined since 2005. Peregrines are highly faithful to their breeding territories (Mearns & Newton, 1984), and individual breeding birds are unlikely to abandon their territories in Central Wales to breed elsewhere. Instead, they might be expected to respond to a reduction in food supply by either not breeding or by being less successful in their nesting attempts. In an environment with a diminished food supply fewer territories will meet the requirements of breeding Peregrines and consequently it is less likely that new recruits will replace any losses of existing territory holders. Clearly, since 2005 the recruitment of new breeding birds has not matched losses of established breeders, possibly because food supply dropped below some critical threshold in the abandoned territories.

Our previous work has also shown that the proportion of racing pigeons in the diet also varies in line with their availability, providing evidence for a functional as well as a numerical response to racing pigeon availability. In regions where racing pigeons are more abundant Peregrines eat a greater proportion of racing pigeons than in regions where their availability is lower (Dixon *et al*., 2003). However, our data for Central Wales does not indicate a significant decline in the proportion of racing pigeons killed over a 10-year period from 1999 to 2008, despite evidence of a reduction in their overall availability.

We know that every year Peregrines in Central Wales do show a response to a reduction in racing pigeon availability at the end of each pigeon race season; the proportion of pigeons in the diet drops dramatically from 31% to 6% of prey remains recorded. So why do we not see a similar switch to alternative prey when racing pigeon availability declines within the race season over time? Outside the pigeon race season Peregrines in Central Wales can switch to alternative prey, primarily winter migrants especially thrushes and Starlings that arrive in the region from October. Such a switch is not possible within the pigeon race season as most of these migrants have left Central Wales by May. Assuming that the availability of wild prey species has remained constant for the 10-year period studied, Peregrines have not responded to a diminishing racing pigeon supply by switching to preying on other resident species, indicating that Peregrines during the pigeon race season behave like specialist predators, exhibiting a strong affinity for racing pigeons.

ACKNOWLEDGEMENTS

We thank Mike Shrubb, Andrew King, Martin Peers, Tony Cross, Graham Williams, Iolo Williams, Hywel Roderick, Reg Thorpe (RSPB) and Humphrey Crick (BTO) for providing additional information on breeding Peregrines in our study area and Jerry Lewis and an anonymous referee who helped improve the paper.

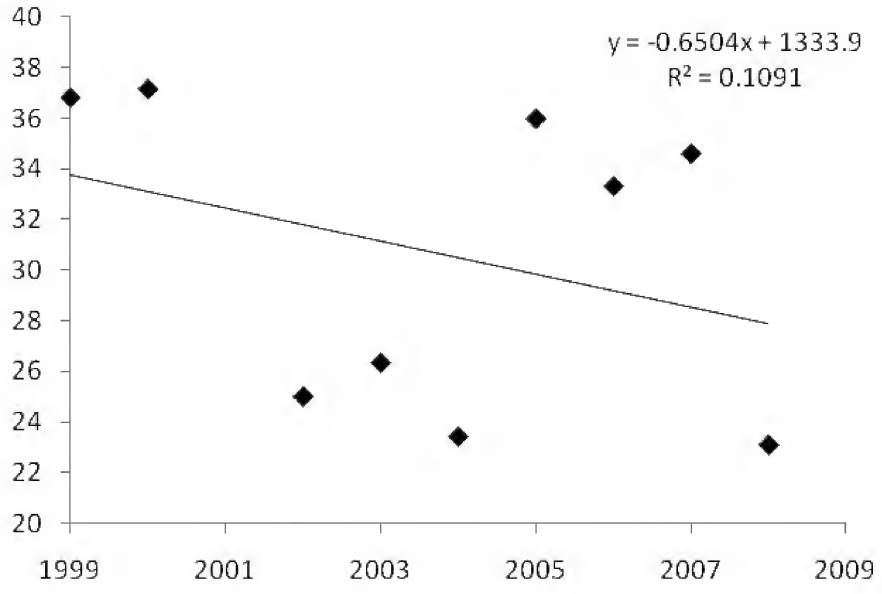

Figure 5. Percentage of racing pigeons in the summer (April-September) diet of Peregrines in Central Wales over the period 1999-2008.

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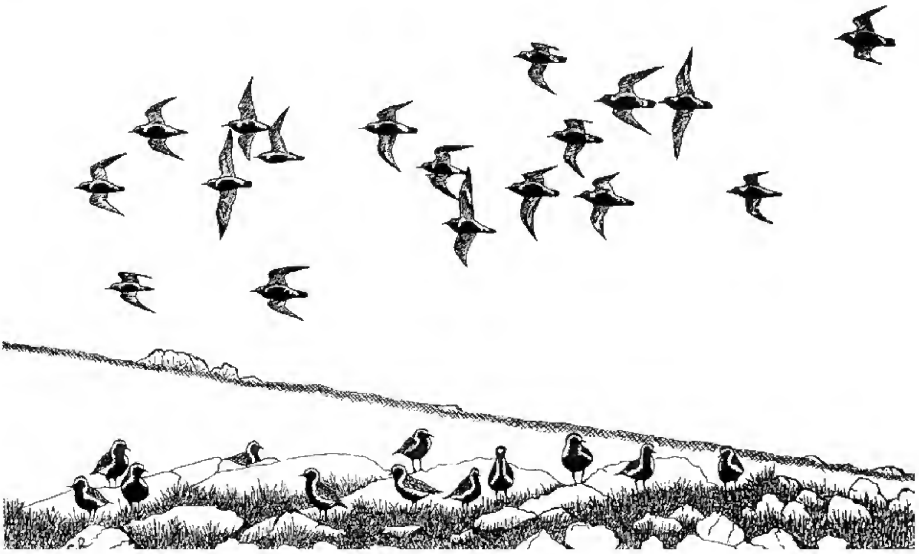
Appendix 1. Origin of racing pigeons killed by Peregrines breeding in Central Wales.
The year represents the year the pigeon was ringed not the year it was killed, but 69% of pigeons killed were less than one year old and 98% were less than four years old (SWPMG data).
No data available for the home origin of racing pigeons registered in 2003.

Home Origin	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	2005	2006	2007	Total	%
Continental Europe	3	0	1	2	2	3	1	3	3	3	8	1	0	0	0	1	0	31	3
Cumbria	4	2	0	0	3	3	4	3	4	5	2	3	2	1	4	2	0	43	4
Devon & Cornwall	1	0	1	1	0	1	1	0	0	2	1	0	2	0	1	0	0	11	1
Derbyshire	2	3	3	2	5	3	4	6	3	5	4	0	0	0	2	2	1	45	2
E Midlands	3	1	3	1	4	3	0	5	4	2	3	1	1	0	0	0	0	32	3
London	2	2	3	3	2	2	4	4	1	2	5	5	0	1	3	1	1	41	2
NE England	8	14	12	13	8	6	16	8	10	16	5	8	1	1	3	2	0	131	8
NW England	6	3	2	13	4	4	1	4	13	10	9	4	5	2	4	4	2	90	6
S England	3	2	0	1	3	1	1	2	4	2	8	1	0	0	1	0	0	29	3
SW England	1	6	3	2	2	2	3	3	8	3	4	3	1	2	3	1	0	47	1
W England & N Wales	4	10	5	3	2	9	10	13	16	11	7	14	8	5	0	4	1	127	4
W. Midlands	4	3	9	3	16	10	2	10	10	20	6	6	4	3	6	4	2	120	4
Ireland	20	7	13	11	17	19	18	18	18	13	14	14	10	3	2	4	2	203	20
Scotland	4	5	6	8	10	8	8	10	14	6	3	1	4	4	1	2	2	96	4
S. Wales	53	36	51	36	36	41	28	57	44	32	34	23	26	9	7	11	2	534	53
Total	**118**	**94**	**112**	**99**	**114**	**115**	**101**	**146**	**152**	**132**	**113**	**84**	**64**	**31**	**37**	**38**	**13**	**1580**	**118**

Patterns in Golden Plover and Dunlin abundance over 25 years in relation to management of the Elenydd, mid-Wales

Ian Johnstone & John Dyda

RSPB North Wales Office, Maes y Ffynnon, Penrhosgarnedd, Bangor, LL60 6NJ



SUMMARY

Golden Plovers are Red-listed in Wales and the Elenydd SSSI supports the largest breeding population of this Principal Biodiversity Species. Dunlin also breed in similar habitats and are Amber-listed, due in part to being largely restricted to this site.

Lack of demographic data for these birds in Wales limits options for determining a cause of decline. However, management of the Elenydd has varied spatially and temporally. Therefore, the aim of this study was to a) describe changes in breeding Golden Plover, Dunlin and candidate covariates at the site-scale, and b) seek correlations between those with data at the within-site scale to evaluate hypothesised causes of decline.

Sheep densities were highest 1900-1915 and in the 1970s, and lowest since 1989. Densities fell rapidly when agri-environment schemes (AESs) began, and are now half the 1893 to 1983 average. August temperature, a key predictor of change in Golden Plover numbers, was stable before 1995, but warmer after.

Golden Plovers were initially more abundant but declined significantly more rapidly than Dunlins between the first census in 1982 and 2007 and their range has become increasingly restricted to places that also hold Dunlins. Furthermore, the decline was underway before most AES grazing reductions took place and before a run of warm summers but not before the post-war peak sheep densities had been reached.

At the holding and km-square scales in 1982, densities of both birds were only correlated with the proportion of suitable habitat that was mire, highlighting a preference for this habitat. There was no evidence at the holding-scale that rate of change in bird density between 1982 and 2007 was correlated with changes in grazing or initial habitat composition. Similarly, there was no evidence that rate of change in bird density was correlated with initial habitat composition at the 1km square-scale. However, small sample sizes may have prevented all real effects from being detected.

Recent data on vegetation characteristics in places with current or former territories were compared with an existing model of Golden Plover preferences. This showed that the low observed breeding densities match that expected from the high vegetation density in these places, and that past higher bird densities were consistent with low vegetation densities, supported by descriptions of nest sites at the time.

Of the hypotheses considered, there was most support for management change as a cause of decline. To test this further the best course of action is to carry out a large-scale monitored trial of managements that improve habitat characteristics in places recently occupied by Golden Plovers.

CRYNODEB

Mae'r Cwtiad Aur ar y rhestr goch yng Nghymru, ac mae SDdGA Elenydd yn cynnal y boblogaeth fagu fwyaf o'r Brif Rywogaeth Bioamrywiaeth yma. Mae Pibydd y Mawn hefyd yn nythu mewn cynefinoedd tebyg, ac ar y rhestr oren, yn rhannol oherwydd eu bod i raddau helaeth yn gyfyngedig i'r safle yma.

Cyfyngir ar y dewis o ddulliau i ddarganfod achos eu lleihad gan ddiffyg data demograffig ar gyfer yr adar yma yng Nghymru. Fodd bynnag, mae rheoli tir ar yr Elenydd wedi amrywio yn ôl lle ac amser. Felly, amcan yr astudiaeth yma oedd a) disgrifio'r newidiadau yn llwyddiant magu Cwtiad Aur a Phibydd y Mawn a chydamrywiadau posibl ar lefel safle, a b) chwilio am gysylltiadau rhwng y rhai lle mae data o fewn y safle i bwyso a mesur achosion damcaniaethol y lleihad.

Roedd y nifer o ddefaid ar ei uchaf 1900-1915 ac yn y 1970au, ac ar ei isaf ers 1989. Bu gostyngiad sydyn yn eu dwysder pan ddechreuodd y cynlluniau amaeth-amgylchyleddol (CAA), ac maent yn awr yn hanner y cyfartaledd yn 1893-1983. Roedd tymheredd ym mis Awst, sy'n allweddol ar gyfer rhagweld newidiadau yn niferoedd y Cwtiad Aur, yn gyson cyn 1995, ond yn gynhesach wedyn.

Ar y dechrau roedd y Cwtiad Aur yn fwy niferus, ond bu lleihad cyflymach yn ei nifer nag yn nifer Pibydd y Mawn rhwng y cyfrifiad cyntaf yn 1982, a 2007, ac yn gynyddol maent i'w cael yn unig mewn lleoedd lle ceir Pibydd y Mawn hefyd. Hefyd, roedd y lleihad wedi dechrau cyn y rhan fwyaf o'r gostyngiad mewn pori oherwydd cynlluniau CAA, a chyn cyfres o hafau cynnes,

ond nid cyn cyrraedd uchafbwynt dwysder defaid yn y cyfnod wedi'r rhyfel.

Ar raddfa daliad tir a cilomedr sgwar yn 1982, y gyfran o gynefin addas oedd yn gors oedd yr unig ffactor oedd yn dangos effaith ar ddwyster poblogaeth y ddau aderyn, yn dangos fod y cynefin yma yn cael ei ffafrio. Nid oedd tystiolaeth ar raddfa daliad tir fod newidiadau yn nwysder poblogaeth yr adar rhwng 1982 a 2007 yn gysylltiedig a newidiadau mewn pori na chyfansoddiad gwreiddiol y cynefin.. Yn yr un modd, nid oedd tystiolaeth fod graddfa'r newid yn nwyster poblogaeth yr adar yn gysylltiedig a chyfansoddiad gwreiddiol y cynefin ar y raddfa sgwar 1km. Er hynny, gall fod samplau bychain wedi atal datgeliad effeithiau gwirioneddol.

Cymharwyd data diweddar ar nodweddion llystyfiant mewn lleoedd lle'r oedd tiriogaethau presennol neu flaenorol gyda model oedd eisoes ar gael o'r hyn yr oedd y Cwtiad Aur yn ei ffafrio. Dangosodd hyn fod y dwysder isel o adar yn nythu yn cyd-fynd a'r hyn a ddisgwylid o'r dwysder llystyfiant uchel yn y lleoedd hyn, a bod y dwysder uwch o adar yn y gorffennol yn cyd-fynd a dwysder llystyfiant isel, rhywbeth a ategir gan ddisgrifiadau o safleoedd nythu ar y pryd.

O'r damcaniaethau a ystyriwyd, roedd y gefnogaeth gryfaf i newidiadau rheoli tir fel achos y gostyngiad. I brofi hyn ymhellach, y dull gorau fyddai arbrawf ar raddfa fawr o ddulliau rheoli fyddai'n gwella nodweddion y cynefin mewn lleoedd a ddefnyddiwyd gan y Cwtiad Aur yn ddiweddar.

INTRODUCTION

Ecology and population status

In Wales Golden Plovers breed in mire, heath and acid grass communities on unenclosed moor, where their nests are placed in short tussocky vegetation. Once hatched, broods feed on invertebrates, such as emerging *tipulids*, in the nesting area. In contrast, adults may feed much further away. For example, birds fly up to 7km to feed on *tipulids* and earthworms on or close to the soil surface in the south Pennines, where they often use favoured unimproved and semi-improved enclosed pasture, and are sensitive to their management (Pearce-Higgins & Yalden 2003). Golden Plovers in Wales favour lower lying farmland outside the breeding season, using a range of habitats to feed on earthworms and other invertebrate prey (Lovegrove *et al.* 1994). Birds that breed in Britain also winter within NW Europe, sometimes within 100km of breeding areas (Wernham *et al.* 2002), although there are no data on the movements of birds breeding in Wales.

Golden Plover was upgraded from Green to Amber listing in the UK (Eaton *et al.* 2009). In Wales, it remains Red-listed due to a >50% decline in breeding population over the last 25 years (Johnstone *et al.* 2010). The Welsh Assembly Government also listed Golden Plover as a species of Principal Biodiversity Importance. The first target in the Welsh Biodiversity Action Plan (BAP) is to increase the population to 80 pairs by 2015, with 40 of these on the Elenydd.

In Wales Dunlin breed in wetter places within mire vegetation communities, usually close to standing water. The race breeding in Britain (*schinzii*) winters on the shores of Mauritania with very few remaining in NW Europe (Wernham *et al.* 2002). There are no movement data specifically from Elenydd breeding birds. Dunlin has been Amber-listed in both the UK and Wales (Gregory *et al.* 2002, Thorpe & Young 2002), in part due to its' restricted breeding distribution. Other amber listing criteria met by Dunlin apply to wintering populations of a race that breeds elsewhere.

The study site

The Elenydd upland block in mid Wales is largely grass moor. Paleoecological studies using soil cores suggest the site had extensive blanket mire, but has been *Molinia* dominated since the mid 1800s (Chambers *et al* .2007), with change coincident with the industrial revolution. However, there had been little drainage improvement. The site was designated as a Site of Special Scientific Interest (SSSI) in 1992, and management aims to restore heather cover. Golden Plover and Dunlin are part of the breeding birds assemblage of upland moor and grass with water bodies, which is a feature of the SSSI. However, they are not features of the sites' SPA designation. Numbers of breeding Golden Plovers on the site as a whole declined by 88% between 1982 and 2007, whilst Dunlins have shown a more moderate 36% decline in the area surveyed (Johnstone & Dyda 2008). The term 'common survey area' is that area common to all surveys: 108.8km^2.

Approaches to diagnosing population decline

Conservation management recommendations are persuasive if the factors that most limit population size have been identified. Where population increase is sought, prescribed changes to these can be implemented, such as increasing the extent of a preferred habitat where its' limited availability is thought to be preventing population increase.

Consequently, the most powerful approach to diagnosing the causes of bird population declines is to use mathematical models to explain population trends in terms of the external factors that influence their component demographic rates such as breeding success and survival (Green 1995). However, to create such models requires long-term data, often from populations of marked birds. When addressing priority conservation issues, quicker and simpler alternatives are often required. Examples of these approaches include comparisons between time-periods, geographical areas or similar species with different population trends. For example, Green (1995) used regional corncrake trends and the timing of mechanisation of mowing to implicate this change in the species' decline. A similar approach has strongly implicated intensification and specialisation of agriculture as key factors in the decline of some farmland birds (Chamberlain *et al.* 2000, Robinson *et al.* 2001).

One option would be to simply look for correlations between variables for the whole Elenydd site (e.g. Golden Plovers and sheep decline over the same period). However, because correlation does not imply causation e.g. Golden Plover decline caused by something other than vegetation change through sheep grazing, such as over winter survival away from the Elenydd, with the two happening over the same time by coincidence), such results are unconvincing. A better approach is to look for correlation at the within-site level. In this approach, we ask if changes in Golden Plovers and Dunlins in particular parts of the site were coincident with changes in candidate explanatory variables for the same parts. Correlations detected using this approach are much less likely to happen by chance across a sample of sites, and would more convincingly (but still not conclusively) link changes in Golden Plover and Dunlin populations to changes in their local environment.

Consequently, the aim of this study was to a) characterise the temporal and spatial changes in Golden Plover, Dunlin and candidate covariates at the site-scale over the periods with data, and b) seek correlations between bird data and these covariates at a range of within-site scales in an attempt to better understand the cause of decline.

METHODS

Bird abundance

The populations of breeding Golden Plovers and Dunlins within the Elenydd SSSI were surveyed in 2007 as part of a Wales-wide Golden Plover survey (Johnstone *et al.* 2008). These data added to existing data on their abundance and distribution (Table 1). Unlike some waders (e.g. Curlew: Grant *et al.* 2000), there is no validated method for measuring breeding performance during wide-scale bird surveys. Such data remain lacking for these species in Wales.

Table 1. Previous Golden Plover and Dunlin surveys of the Elenydd and the number of territories recorded in the common survey area

Years	Reference	Method	Golden Plover		Dunlin	
			Total	Common area	Total	Common area
1975 & 76	Davies *et al.* (1978)	2 visits, no specific method, incomplete coverage in each year	>100	>100	37	>30
1982	NCC (1982)	2 visits, transects	112	102	41	29
1990[1]	Leversley *et al.* 1990	3 visits, transects combined with "look see"	46	42	28	23
1995	Young *et al.* (1996)	2 visits Brown & Shepherd	39	37	30	24
2007	Johnstone *et al.* (2008)	2 visits Brown & Shepherd	11	11	17	17

[1] The "look see" method was also used in 1991 (Hack 1991, Jennings 1991), who reported 44 and 37-40 pairs of Golden Plover and Dunlin respectively.

Trends in abundance and range over time are only accurate if the methods and areas surveyed are comparable. In this case, bird surveys methods did vary (Table 1). Davies *et al.* (1978) used an approach that subsequently developed into the method of Brown & Shepherd (1993). Young *et al.* (1996) compared the Brown & Shepherd and transect methods, and found no significant differences in their results. Laversley *et al,* (1990) used a combination of transects and unspecified "look see" searches. When comparing between surveys, differences in methods were addressed by only using full surveys based on transects or Brown & Shepherd. The areas surveyed also varied. This was addressed by defining a common area that all surveys covered (Fig.1). Changes in the number of Golden Plover territories or occupied 1km squares (including those overlapping the boundary where coverage of suitable habitat was complete) were taken as comparable estimates of population size and distribution.

Selection of covariates

A number of previous studies have suggested hypotheses to explain the decline in Golden Plovers on the Elenydd (Green *et al.* 1994b, Buckton *et al.* 1997) and more widely in Wales (Lovegrove *et al.* 1994), which can also be categorised as operating at large or small spatial-scales (Table 2). Data were sought to test these, although this was limited by data availability.

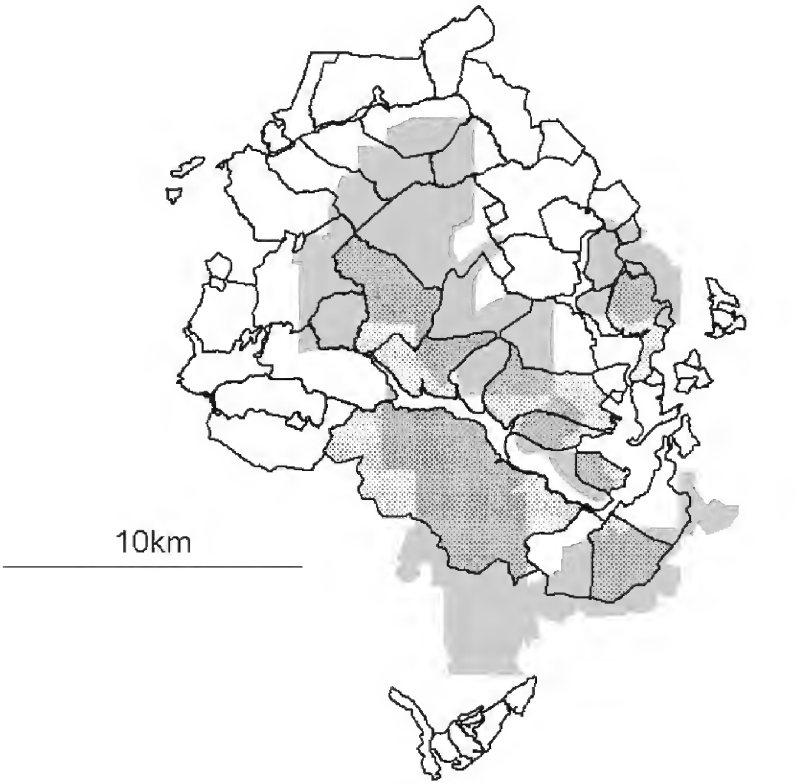


Fig.1. Farm holdings on the Elenydd with sheep data (black line) and the common survey area (grey shading). The eight holdings used in the analysis of change in grazing are stippled.

Two sources of habitat composition data were used. Data were available from the Sinclair Habitat Survey of the Elenydd. Produced in 1970, this predates the first bird surveys and is assumed to represent extent of habitats before the recent periods of agricultural intensification and AESs in Wales. Using the paper 1970 Sinclair map provided by CCW, suitable habitat for Golden Plover and Dunlin territories was defined as that containing *Eriophorum* and/or *Molinia* (categories eV: *Eriophorum vaginatum* dominant, eVM: *E. vaginatum* with *Molinia* sub-dominant, eVC: *E. vaginatum* with *Calluna* sub-dominant, CeV: Calluna with *E. vaginatum* sub-dominant and M: *Molinia* dominant). Just one Golden Plover territory (<1%) was outside these habitats in 1982, the first year with full bird survey data. Using the digitised Countryside Survey of Wales data collected during the 1980s, suitable habitat for Golden Plover and Dunlin territories was defined

as categories of mire (E.1.6.1., E1.6.2., E.2.1., E.2.2, E.3, E.3.1), heath (D.1.1, D.2) and grass (B.1, B.5) communities. Again, just one (<1%) was outside these categories in 1982. In addition, the Countryside Survey of Wales data were used to measure the area of improved grass (B.4) within 7km (Pearce-Higgins & Yalden 2003) of the edge of each holding. These data represent the extent of improved grass accessible by Golden Plovers towards the end of a period of rapid agricultural intensification, which may have affected prey abundance (only three of 142 1km squares within the common survey area contained improved grass, while a further nine contained semi-improved grass). In unimproved habitats, the boundaries of vegetation communities change much more slowly than their physical characteristics (e.g. Norris *et al.* 1997). Therefore, habitat composition was assumed to have remained constant, although physical characteristics may have changed. Data extracted from the Sinclair and Countryside Survey of Wales were not directly comparable as different classifications were used.

Grazing data were available for historic and more recent periods. Historic data on annual flock sizes by holding for 1893-1983 were from parish records collated by CCW. Each annual flock size was converted to a density by dividing by the holding area (digitised historic holding boundaries provided by CCW). These were then averaged across holdings to generate a record of mean and variance in sheep density over the historic period. For 20% of holdings, there were periods when data for adjacent pairs of holdings had been merged. Values for each holding were calculated based on the mean percentage of the total sheep in each for the years when they were listed separately.

Recent data on sheep numbers for 1986 onwards are from agri-environment scheme (AES) records provided by CCW (all holdings in the SSSI are now in AESs), and were converted to densities. In many cases, these data also contained immediate pre-agreement sheep numbers. Grazing levels were assumed constant for the duration of individual agreements, and were extrapolated to 2007. Flock sizes traditionally represent the number of breeding ewes on a holding in spring. Therefore, number of ewes in summer in the recent data were assumed equivalent to flock sizes given in the historic data. Historic grazing data provided no information on winter grazing practices, although this was available from the recent data.

Table 2. Hypotheses to explain variation in breeding Golden Plover and Dunlin abundance and distribution. Also shown are data available for testing each. Hypotheses for which sufficient data exist for analyses are highlighted in bold.

	Hypothesis	Scale [1]	Variable	Data availability
1	**Mire habitats are preferred and determine distribution**	**Small**	**Proportion of suitable habitat with *Eriophorum***	**Sinclair 1970 vegetation map**
2	**Tall dense vegetation unsuitable for breeding has increased**	**Small**	**Physical vegetation characteristics**	**Defra upland grazing project (Pearce-Higgins & Grant 2006)**
3	**Grazing reductions have created unsuitable breeding habitat**	**Small**	**Breeding ewe density and winter sheep days as a percentage of summer**	**Flock sizes from parish records (2893-1983) and CCW management agreements (1989-2007)**
4	Burnt areas good for nesting and chick feeding are no longer created	**Small**	Location & frequency of burning	Anecdotal
5	**Intensive grass management impacts on adult food supplies before and during breeding**	**Small**	**Area of improved grass within 7 km of holdings**	**Countryside Survey of Wales**
6	High crow and fox abundance has reduced breeding success	**Small**	Predator abundance	1994 baseline only which does not cover all holdings/1 km squares
7	Disturbance displaces birds from breeding habitat	Small	Disturbance levels	No data
8	Afforestation has destroyed breeding habitat	Small	Change in forest cover	No change since SSSI designation in 1992
9	**Changing climate has reduced *tipulid* abundance during breeding**	**Large/ small**	**Augest temperature (Pearce-Higgins *et al* 2009)**	**Met Office**
10	Acid deposition has reduced earthworm abundance during breeding	Large/ small	Unknown	Unknown

Although a few holding names and boundaries differed between the historic and recent periods because of neighbouring holdings merging, the areas of historic (after merging) and recent holdings were not significantly different (paired test $t_{26}=1.39$, $P=0.18$). Moreover, because data were expressed as densities for both periods, they could be directly compared. However, because sheep show preferences for grazing different vegetation communities (e.g. Green *et al.* 1994a),

and their shepherding/management may vary across years, mean values do not reflect true sheep grazing intensity on Golden Plover and Dunlin habitat. Nevertheless, they do reflect overall differences in grazing intensity between holdings and across years.

As part of fieldwork for a Defra project encompassing sites in Wales, the Pennines and southern Scotland, data on physical habitat characteristics were collected at 100m points within a sample of 1x2 km plots on the Elenydd in 2002. These data were too recent and coverage too incomplete to include as covariates in the analyses. However, some points overlapped with recent or historic Golden Plover territories and therefore with places with suitable topography. This was determined by overlaying vegetation sample points with notional circular territory of 240m radius based on the five territories in 90ha reported by Thomas *et al.* (1983). This provided the opportunity to compare recent vegetation characteristics with Golden Plover's preferences, established using the same data for other parts of the UK (Pearce-Higgins & Grant 2006).

Mean daily maximum temperature in August two years previous is the best predictor of change in population size through its effects on *tipulid* abundance and Golden Plover breeding success (Pearce-Higgins *et al.* 2009). Long-term surface data from individual weather stations are incomplete for the Elenydd. Therefore, August temperature data were extracted from the UK Climate Impacts Program, for which data are extrapolated to all 5 km squares in the UK. Data were obtained for a centrally placed square on the Elenydd (SN8565) for the period 1914-2005. Data were divided into three periods, taking into account the two-year lag in the temperature effect. Period 1 was 1914 to 1979, representing the period before bird survey data. Period 2 was 1980 to 1992: the period between the first two surveys. Period 3 was 1993 to 2005: the period between the second two bird surveys. Differences in temperature between these periods will assess any changes in climate that might play a role in the Golden Plover decline.

Analyses

At the within-site level, bird data could be expressed at three spatial scales: agricultural holdings (mean 3.95km^2, range 0.2-14.24, n=36, of which 21 could be matched with bird data and eight could be matched with both bird and grazing data), 1km square (n=142, of which 75 were occupied by Golden Plovers in 1982) and individual bird territories (treated as points, n$\geq$11). The advantages and disadvantages of each differ. For example, holding boundaries often run along ridge tops artificially dividing aggregations of birds. They also vary in size by two orders of magnitude. Although 1km squares avoid this and provide a finer spatial-scale for habitat composition, no agricultural variables are available at this level. Data at the level of individual territories only provide information on their distribution across habitats.

Generalized linear models (GzLMs) with Poisson error distributions were appropriate because data were counts, and these were fitted using SAS v9.1. For each model, the significance of both linear and quadratic terms and first order interactions between terms were reported at $P<0.1$. Where present, over-dispersion was accounted for using the d-scale option.

RESULTS

Site-level patterns

Grazing history

Sheep densities on the Elenydd ranged from 1.7 to 4.5 ewes ha^{-1} over the 114 years with data (Fig. 2). Moreover, densities in 1983 (end of historic) and 1989 (start of recent) did not differ, consistent with the two different data sources being comparable.

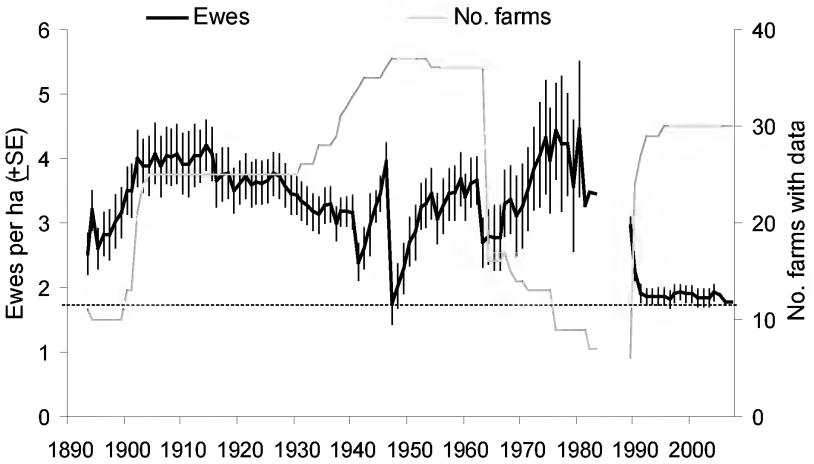
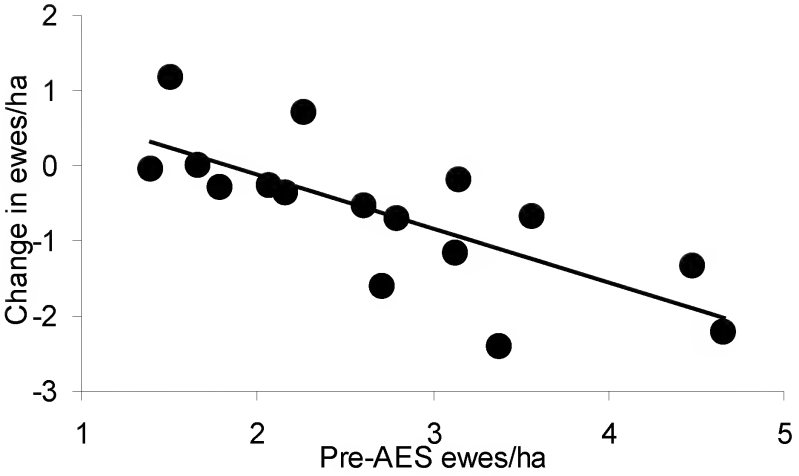


Figure 2. Site-level variation in sheep density on the Elenydd over 114 years (see text for details). *The sample size for each year is shown on the second y-axis. The dashed line indicates the minimum sheep density for the whole period. Data include parts of holdings that fall outside the common survey area.*

Mean sheep densities were highest during the 1970s and 1900-1915, but showed most variation between holdings during the 1970s. The long-term pattern in sheep density is punctuated by sudden falls (e.g. 1946-47 and 1962-63), which coincide with winters with heavy snowfall. There is also a marked reduction in sheep densities with the onset of AESs around 1990, densities falling to 1.9 sheep ha^{-1}, almost half that of 1893-1983 mean of 3.4 sheep ha^{-1}. Current grazing densities are the lowest for 114 years, only equalled by the severe winter of 1946-47 following mass sheep mortality.

Data for the recent period suggest that reductions in sheep stocking were greatest on holdings that had the highest initial sheep densities (Fig. 3). This could explain why variation in sheep density between holdings was greatest in the 1970s and least in the 1990s, with grazing intensities being reduced to generic target levels across the Elenydd on a holding-by-holding basis. However, pre-AES sheep density and change in sheep density were not correlated with the proportion of suitable habitat within holdings that was mire (F_{14} <1.068 P>0.320), showing that holdings with more wetter areas were not initially stocked any different nor did they experience greater stock reductions to those that were drier.

a)



b)

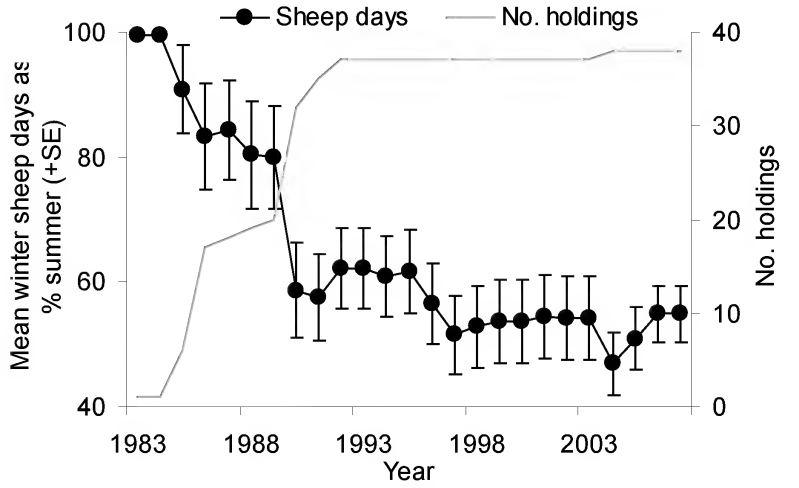


Figure 3. A negative relationship between change in ewes ha^{-1} as part of ESA agreements over the recent period and the initial ewes/ha before agreement (F_{14}=17.2 P=0.0010) was evidence that the largest grazing reductions took place on holdings with the highest initial sheep densities (a). There was also evidence that winter sheep days (number of sheep x number of days present) averaged across interpolated holding data had declined more than summer (b).

Finally, there was evidence over the recent period for a decline in winter sheep-days (number of sheep multiplied by the number of days they were on the hill) as a percentage of summer sheep-days (Fig.3). This suggests that AES grazing reductions were most pronounced during winter.

Environmental conditions for prey

The mean temperature for the 1914 to 2005 period was 16.63^{0}C, with a mean anomaly (annual difference from the mean) of 0.3^{0}C (Fig.4). There was a significant difference between time-periods (ANOVA $F_{89,2}$=6.0 P=0.0036). However, Tukey individual comparisons identified the most recent period (1993-2005) as being warmer (>1.69^{o}C) than both 1914-1979 and 1980-192 (which differed by 0.05^{o}C).

Bird population trends

Data for 1976-78 were not included in analyses because this survey a) predated formal upland bird survey methods and b) had incomplete coverage in any one year. Data for 1990 were also excluded because a combination of transects and unspecified 'look-see' methods was used. In 1982, the Elenydd SSSI held the largest population of breeding Golden Plovers in Wales. The results of the 2007 all Wales Golden Plover survey showed that this was still the case (Johnstone *et al.* 2008), but abundance within the common survey area had declined by 89% and that this rate of decline was similar at each resurvey (Fig.5). Dunlin abundance has also declined at a constant rate over the period, but the extent of this decline was much less (41%). Although the 1990 survey methods differed from other surveys, data were consistent with this pattern for both species, suggesting that decline was underway before most AESs agreements were implemented in the 1990s but not before peak sheep densities had been reached in the 1970s.

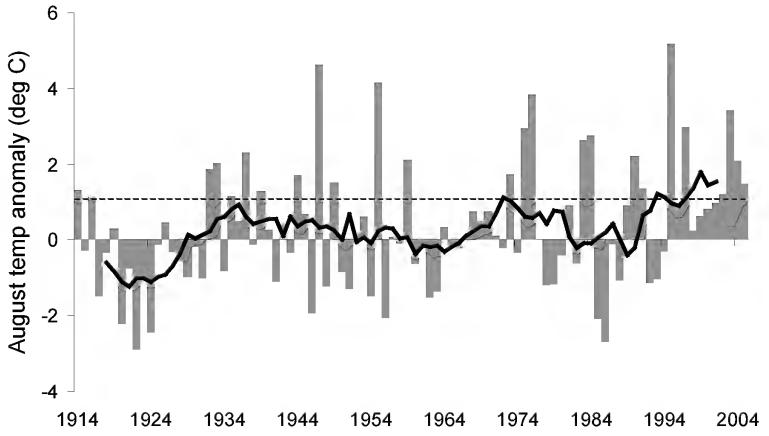


Figure 4. Variation in August maximum temperature on the Elenydd for the period with data, expressed as the annual difference from the mean (bars).

The significance of these trends was assessed using a GzLM. The effect of year on counts of Golden Plover and Dunlin territories on 21 agricultural holdings in 1982, 1995 and 2007 was modelled using a Poisson error distribution, a log link function and with log holding-area specified as an offset variable. Year was treated as a continuous variable. The decline in Dunlin density was much less significant (χ^2_1=4.17 P=0.0435), than the decline in the density of Golden Plover territories (χ^2_1=68.51 P<0.0001). A strongly significant interaction between year and species confirms that these trends were different (χ^2_1=15.92 P<0.0001).

Measured at the km square level, the range of Golden Plovers declined by 88% compared with just 36% for Dunlin between 1982 and 2007. Over the same period, Golden Plover territories have become increasingly restricted to the 1km squares that also contained Dunlin territories in any one year (Fig.5). The pattern of loss, retention and gain of occupied 1km squares varied between species when data for 1982 and 2007 were compared using contingency tables (χ^2_2=22.68 P<0.0001). For Dunlin, 86% of 1km squares occupied in 2007 were not occupied in 1982, in contrast to just 13% of squares for Golden Plovers. Thus, the range of Dunlin on the Elenydd has not only declined by less than half that of Golden Plovers, it has also varied much more between surveys.

Within-site patterns

Correlates of initial abundance

Site-level bird surveys showed that Golden Plovers were significantly more abundant and occupied a much larger range than Dunlins in 1982. A GzLM was used to assess the role of habitat composition, contemporary summer and winter sheep densities and extent of improved grass adjacent to holdings in explaining variation in bird abundance between agricultural holdings at this time. The response variable was the count of territories in 1982 in each of the 21 holdings with bird data, with a factor determining species (Golden Plover or Dunlin), the proportion of suitable habitat that contained *Eriophorum* (from 1970 Sinclair map, arcsin square root transformed), summer and winter sheep density immediately before AESs began (from recent CCW grazing data), and extent of improved grass within 7km of each holding as explanatory variables. The model used a Poisson error distribution and a log link function. Log holding-area was an offset variable.

Table 3. Models to explain variation in bird abundance between agricultural holdings.
In (a) data were for 1982 only (n=21).
In (b), data for all years are used (Golden Plover only n=8).

a)

Term	Direction	Df	F	P
Species	GP>DN	1	10.15	0.0029
Proportion with mire	+ve	1	11.14	0.0017

b)

Term	Direction	Df	F	P
Holding		7	1.88	0.0678
Year	-ve	1	31.86	<0.0001

The minimal adequate model contained species and the proportion of suitable habitat containing *Eriophorum* (Table 3). Variables describing improved grass and grazing were not significant. Golden Plovers were more abundant than Dunlin, and both species were at higher densities on holdings where a greater proportion of suitable habitat contained *Eriophorum*. However, there was no evidence that habitat preferences differed between species (Table 3, Fig. 6). Although excluding the outlying point (Glanhirin) reduced *P* values, both terms remained significant ($P<0.007$).

Table 4. The minimal adequate GzLM of Golden Plover territories in km squares in the common survey area.
In (a) data were for 1982 only (n=142), while in (b) data for all years were used (n=75).

a)

Term	Direction	Df	F	P
Proportion with mire	+ve	1	15.15	0.0001
DN_pres_abs	Pres>abs	1	21.17	<0.0001

b)

Term	Direction	Df	F	P
Year	-ve	1	3.60	0.0576

Because habitat composition varied within individual holdings, it is possible that some information about within-site abundance and distribution in relation to habitat composition is lost in analyses at the holding-scale. Therefore, a second analysis was carried out. In this, count of Golden Plover territories was the response variable, and proportion of suitable habitat that was mire (Countryside Survey of Wales sum of category E, arcsin square root transformed) and the presence or absence of Dunlin territories as explanatory variables (there was no data on sheep density at this scale). The analysis used the 75 1km squares within or overlapping the common survey area that contained Golden Plovers in 1982, with a Poisson error distribution, and with km square specified as a random factor. The results show that, as suggested by the previous analyses, Golden Plovers were more abundant in areas with more mire habitat (Table 4) (also true for Dunlin at this scale: $F_1=36.49$ $P<0.0001$) and were more abundant in squares that also held Dunlin territories.

Finally, an analysis was carried out of the frequency with which individual territories occurred in different habitats using data for 1982. Both species were significantly more likely to settle in areas of mire communities than heath/grass (Golden Plover $\chi^2_{1Yates}=12.57$ $P<0.001$, Dunlin $\chi^2_{1Yates}=6.13$ $P<0.025$).

Correlates of change

The above results show that although when both Golden Plover and Dunlin were more numerous they preferred places with more mire habitat, their trends since then have differed. This may have come about through management change that impacted, either directly or indirectly, on one species more than the other. That Golden Plovers have become restricted to places with Dunlin may be indirect evidence of this.

This was first investigated at the holding-scale by estimating the average annual rate of change in Golden Plover territories for each holding with data by fitting a GzLM in which Golden Plover count depended on a factor describing holding plus a series of year x covariate interactions. The

covariates were: initial habitat composition; extent of improved grass within 7km; initial summer and winter sheep density; and change in summer sheep density and winter sheep density as a percentage of summer density (both 2003-2007 mean level minus pre-AES level). None of the management terms were retained at the P<0.1 level, suggesting that birds were not preferentially lost from holdings with initially less mire or sheep, or greater summer or winter grazing reductions over the period (Fig. 7). The only consistently significant predictor of bird density at the holding level was year (Table 3).

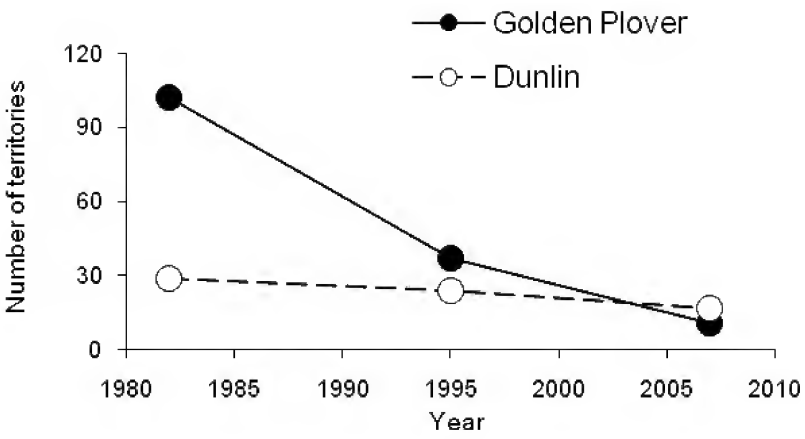
The same approach was adopted with the 1km square data. The minimal adequate model only contained the grid-reference and year terms, similarly suggesting that birds were not preferentially lost from holdings with initially less mire (Table 4).

Data on the frequency with which Countryside Survey of Wales habitat categories were occupied on successive surveys (heath/grass or mire) were used to test for an association between settlement pattern and year. There was no trend in the probability of heath/grass habitats being settled and no difference between species, based on a logistic model (odds ratio=1.02, P=0.43) (Table 5). Thus, heath/grass was not preferentially abandoned as the population decline progressed.

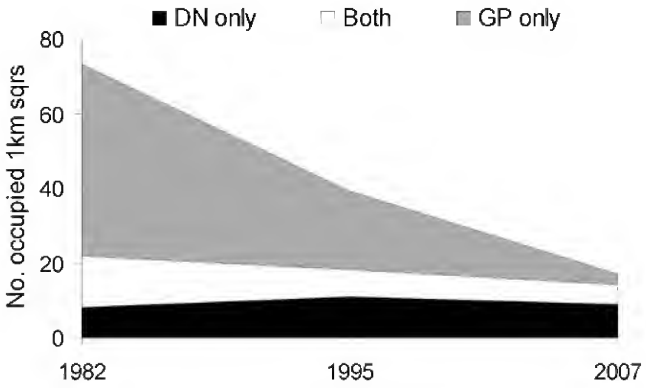
Table 5. The frequency with which territories were located in different Countryside Survey of Wales habitat categories within the common survey area of the Elenydd SSSI.

Species	Year	Blanket mire	Other mire	Grass & dry heath
Golden Plover	1982	29	52	21
	1995	9	21	7
	2007	3	7	1
Dunlin	1982	8	14	7
	1995	14	7	3
	2007	7	8	2

a)


Golden Plover
Dunlin
Number of territories
120
90
60
30
0
1980
1985
1990
1995
2000
2005
2010
Year

b)


DN only
Both
GP only
No. occupied 1km sqrs
80
60
40
20
0
1982
1995
2007

c)

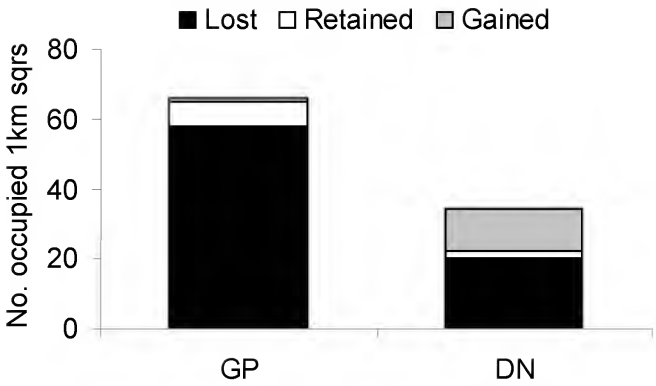


Figure 5. Site-level changes in breeding Golden Plovers and Dunlins on the Elenydd. *Evidence for significant decline in abundance was strong for Golden Plover but weak Dunlin, and these trends were significantly different (a). Golden Plovers became increasingly restricted to 1km squares that also held Dunlin, although the number of squares with Dunlin alone has remained stable (b). Golden Plovers showed marked range contraction between 1982 and 2007 with few new squares being occupied, in contrast to Dunlin which were often found in 1km squares with no previous records.*

Habitat characteristics

The frequency distribution of vegetation density values from within notional Golden Plover territories was compared with Golden Plover habitat preferences determined as part of the Defra project that covered the Pennines and Scotland (Pearce-Higgins & Grant 2006) (Fig.8). Notional territories were created from 1982 survey data in addition to 2007 to increase the sample size of vegetation measurements. Density of Golden Plover territories in the common survey area in 2007 was 0.10prs/km^2: matching expected values given observed vegetation density. In contrast, the territory density in the common survey area in 1982, soon after the peak sheep densities and before AES grazing reductions began, was 0.94prs/km^2, indicative of low vegetation density from the Pearce-Higgins & Grant (2006) model.

Vegetation density was also strongly correlated with vegetation height ($r = 0.76$ for 1982 territories, $n = 116$). Furthermore, the modal maximum sward height category was 20-29cm in 2002, while Thomas *et al.* (1983) reported that Golden Plover nests on the Elenydd were found in areas with vegetation height <20cm in 1982.

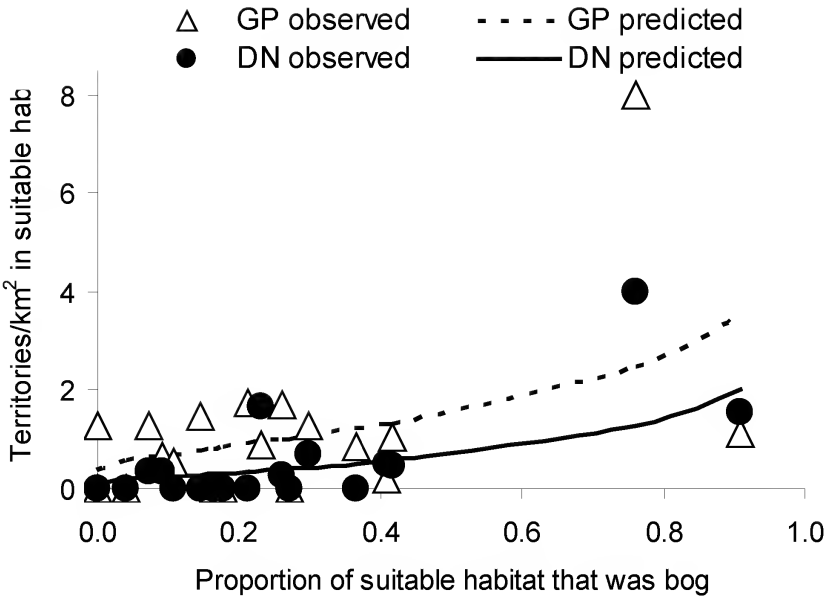


Fig.6. The relationship between the number of territories of Golden Plover (GP) and Dunlin (DN) and the proportion of bog in suitable habitat.

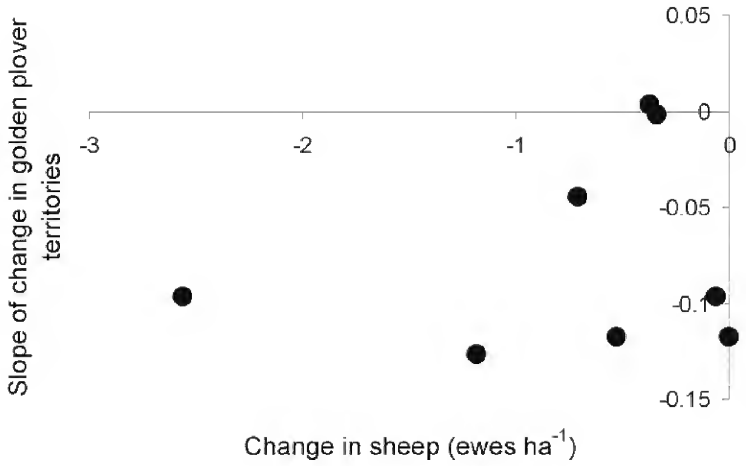


Fig. 7. The relationship between the slope of change in Golden Plover territories and change in sheep density on each holding between 1982 and 2007.

DISCUSSION

Site-level patterns

Although the Sinclair and Countryside Survey of Wales categories were not directly comparable, it was clear from visual inspection that no marked changes in the extent of vegetation communities had taken place surveys over the 15yrs or so between surveys. Furthermore, Norris *et al.* (1997) showed there was remarkably little change in the extent of vegetation communities over a 50 year period, based on analysis of aerial photographs of three upland site in Wales (Carneddau, Pumlumon, and Mynydd Du). It seems unlikely therefore that the decline in Golden Plovers is linked simply to a complete loss of preferred vegetation communities.

However, sheep densities on the Elenydd have varied considerably over the last century, broadly consistent with Fig.8 of Green *et al.* (1994a) and Fig.2 in Green *et al.* (1994b). Large between-year declines match known severe weather events, suggesting the data reflect true fluctuations in sheep farming over the last century. A quarter of the UKs national flock died during the winter of 1946-47, and the data for the Elenydd suggest even greater losses, with half the sheep dying. An increase in sheep densities in Wales through the period 1950-1996 was highlighted by Fuller & Gough (1999), and this is regularly cited in support of the view that sheep numbers in Wales have increased post-war. When seen in the context of the long-term historic data and severe 1946-47 winter however, the impression of only post-war increase on the Elenydd is misleading, with current sheep densities on the Elenydd being the lowest for over a century. Nevertheless, that the grazing data may contain bias that has changed over time should not be overlooked. For example, numbers may have gone under-reported in the first half of the 20th century when rent was linked to flock size, but over-reported when subsidy payments were linked to flock size. However, such bias is likely to be small and not unduly influence the long-term pattern.

Whilst evidence for recent decline in Golden Plovers on the Elenydd is overwhelming, there were no systematic data from before 1982. It is possible that a decline was already underway by then, or that numbers may have increased from lower levels to peak around 1982. Numbers in the north Wales strongholds were reported as stable during the first half of the last century followed by decline (Holloway 1996), while in reviewing the evidence for change in numbers and range in Wales, Lovegrove *et al.* (1994) concluded that decline was underway by the 1940s. It therefore seems unlikely that the first formal surveys coincided with a short-lived peak in numbers. However, because surveys from the 1970s were not comparable with later surveys, it remains unclear whether the decline began or was already underway in 1982.

Missing data

Management data were incomplete for the Elenydd. Spring burning of *Molinia* was regarded as a time-honoured tool for agricultural management but data on this were incomplete and reports of its frequency and impacts contradictory. Davies *et al.* (1978) reported no planned rotational burning, rather, fires being large and accidental in nature and not having a major influence on the site at a time when the population exceeded 100 pairs. Conversely Green *et al.* (1994a) suggest some areas were burnt annually to remove the previous year's growth and litter and make new growth readily accessible to sheep. However, there are no data on the location and frequency of burning, a practice, which on heather moor has previously been linked to benefits for Golden Plovers (Parr 1980). For example, of eight management units for which management history was described in detail in Green *et al.* (1994a), regular *Molinia* burning was only explicitly mentioned for one (a combined report for Lluest Abercaethon, Nantybeddai and Troed Rhiw Draen). Furthermore, Green *et al.* (1994b) stated that all holdings surveyed showed signs of recent burning, often on mire, at a time when the population had already declined by half. Blanket mire was considered by Green *et al.* (1994a) to have been damaged by past burning, which ceased with the introduction of AESs. Whilst it is clear that burning has declined across the site, lack of data prevented it from being included in analyses, so its' role in the Golden Plover decline cannot be assessed.

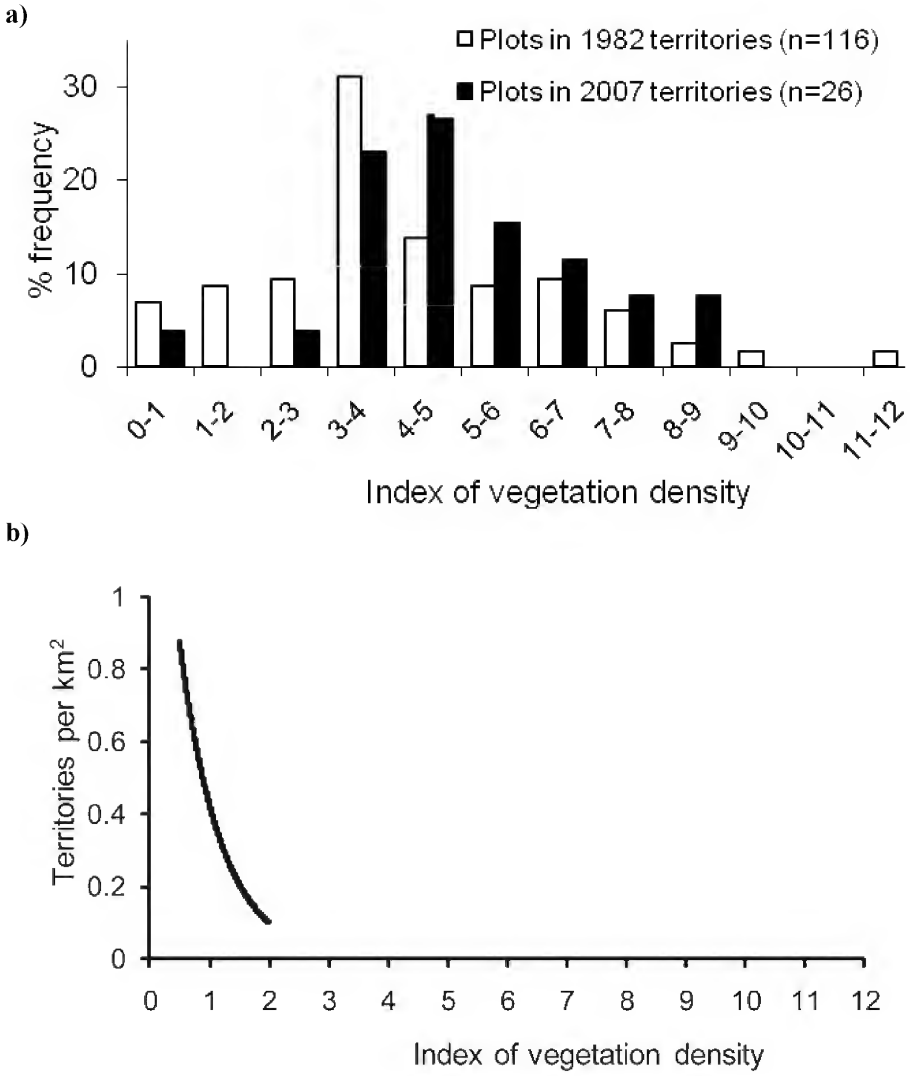


Figure 8. The distribution of vegetation density measurements from sample points that fell within notional Golden Plover territories from the 2007 and 1982 surveys (a) suggested that only low densities of Golden Plovers could now be expected (b). The function in (b) is taken from Pearce Higgins & Grant 2006).

The importance of enclosed pasture as feeding sites for adults during breeding has also been highlighted in the Peak District (Pearce-Higgins & Yalden 2003). Furthermore, deterioration of adult feeding areas would explain why Golden Plovers have declined faster than Dunlin. However, whilst there is evidence that off-duty adults fed away from the nest area in the past, there are few records of habitual adult feeding sites, on which management might have changed (Thomas *et al* 1983). For example, lowland wet grass in the Irfon valley some 7km south east of the SSSI was reported being used in the 1970s by Ray Woods (Ken Perry, *pers. comm.*), and a marginally improved ridge-top in Botallogh (=Botalog), also outside the SSSI (Thomas & Hack 1984). These data are insufficient to draw conclusions about the importance of and changes in adult feeding sites.

Although there are limited data on Golden Plover hatching success and egg losses to unnamed predators on the Elenydd (Thomas *et al.* 1983, Thomas & Hack 1984), there are no data on overall breeding success (chicks fledged per female). This means calculations to assess population stability, such as those carried out by Thomas *et al.* (1983), are heavily dependent on demographic values from elsewhere (e.g. chick survival) which are likely to vary between sites, and should be treated with caution. That losses of eggs to predators were noted in the 1980s indicates that predation may have or still limits breeding success. However, whilst some baseline data on corvid abundance exist (Green *et al.* 1994b), there are no data on site-level trends, and informal observations during 2007 suggest Carrions Crows *Corvus corone* are very scarce on the higher areas.

Data on afforestation were not included in analyses because there has been no change in forest cover within the SSSI and common survey area since 1992, with Golden Plovers continuing to decline well away from the forest edge. Whilst it is possible that such plantations provide refuges for carrion crows and foxes, the decline was underway before the plantings took place. Furthermore, only baseline data on predator abundance are available (Green *et al.* 1994b), and this post-dates both the first phase of Golden Plover decline and conifer plantings.

Within-site patterns.

There were patterns in the bird declines, with Golden Plovers initially three times as abundant as Dunlin, declining faster, and becoming increasingly restricted to places that also held Dunlin between 1982 and 2007. Golden Plovers and Dunlins select different habitats: Dunlins nest close to standing water in the wetter parts of mire habitats, while nesting Golden Plovers are more tolerant of drier areas. One explanation for the different trends in numbers and distribution is that increases in vegetation height and density through reduced grazing and/or burning impacts the drier areas more rapidly, such that Golden Plovers become increasingly restricted to the remaining wet areas, where vegetation characteristics remain most suitable for both species.

Data on sheep numbers were only available at the holding level. However, Green *et al.* (1994b) showed that sheep numbers in 1km squares was negatively correlated with the proportion of habitat that was heath and mire. This suggests that AES reductions in grazing to levels that benefit heath and mire could bring about disproportionate change in the physical characteristics of adjacent grass communities and there is some evidence that Golden Plover declines elsewhere have occurred faster on grass than mire (Crick 1992). However, there was limited evidence for habitat composition related to preferential abandonment. This suggests that either the decline is unrelated to habitat composition, or that changes in vegetation characteristics have occurred similarly in different communities. Alternatively, small sample size may have prevented all real effects on Golden Plovers from being detected (a Type II error).

Initial sheep density or change in density was not a predictor of change in Golden Plover abundance. Sheep numbers may be a poor proxy measure of habitat characteristics. For example, sheep densities may vary considerably across individual holdings due to shepherding and supplementary feeding, such that grazing intensity in the areas used by breeding Golden Plovers is not related to mean sheep density, so a simple association would not be expected.

Can we diagnose the cause of decline?

Because data are incomplete, not all causes of decline, expressed as hypotheses in Table 2, could be formally evaluated, which makes an unambiguous cause impossible to identify. However, the hypotheses that were tested can be ranked based on (1) the degree of support from this and previous studies and (2) the extent to which each cause is, in turn, limited by others. For example, introducing predator removal to reduce nest failures would be of no benefit if the habitat condition were unsuitable for nests to be initiated.

The highest ranked cause of decline was a decrease in nesting habitat suitability (hypotheses 1-3, Table 2). Although there was no evidence for a direct link with sheep densities, there was evidence that vegetation density and height is now unsuitable for nesting Golden Plovers, where past bird densities and descriptions of nest sites suggest that it was, when sheep densities were higher. Furthermore, numerous previous studies of habitat characteristics preferred by Golden Plover support this conclusion (Avery 1989, Pearce-Higgins & Grant 2006, Parr 1992, Stroud *et al.* 1990 and Finney *et al.* 2005).

Although there was very little evidence for the habitual use of adult feeding sites away from territories, it is possible they have gone unrecorded or at least undocumented when Golden Plovers were more abundant (hypothesis 5, Table 2). However, if they are on unenclosed land, then changes in grazing are also likely to have reduced their suitability for foraging so this cause has an intermediate rank.

Climate data show that the Golden Plover decline was underway before the recent period of warmer temperatures (hypothesis 9, Table 2). Therefore, climate change cannot explain the initial decline and is ranked lowest.

Next steps

Focus must now shift away from trying to diagnose the decline using incomplete data, towards pragmatic actions to benefit Golden Plovers and meet BAP targets. The use of habitat management trials to test the conclusions of research into population declines is well established. A trial of Golden Plover management on the Elenydd should be based on large (10ha) replicated plots targeted to areas with a history of occupation by Golden Plovers, following a before-after control-impact design. Management prescriptions to consider include mowing, burning (to fire breaks) and grazing, which could be applied in combination and/or successively over a number of years. The expected response will be preferential settlement or use of managed areas. Although the small population may make significant effects hard to demonstrate at the bird-level, change in characteristics pre/post management would provide evidence for improved and continuing suitability at the habitat level. Nevertheless, Golden Plovers occur on the Elenydd during spring passage (e.g. Thomas *et al.* 1983), and provision of suitable conditions for breeding may attract recruits from other more northerly populations to supplement the Welsh population.

There is a precedent to such trials. Golden Plovers have also declined in Northern Ireland and

the population there is now critically small. Anecdotal evidence suggested grazing reductions through the single farm payment have resulted in deteriorating breeding habitat characteristics (vegetation too tall). In response to this, and as a precedent to the situation on the Elenydd, trial habitat management has begun. Starting in 2008, a small scale RSPB five year project is cutting several one and two hectare patches annually on Cuilcagh Mountain Special Area of Conservation to provide habitat suitable for nesting. The resource requirements and practical experience from this could inform a larger-scale trial on the Elenydd.

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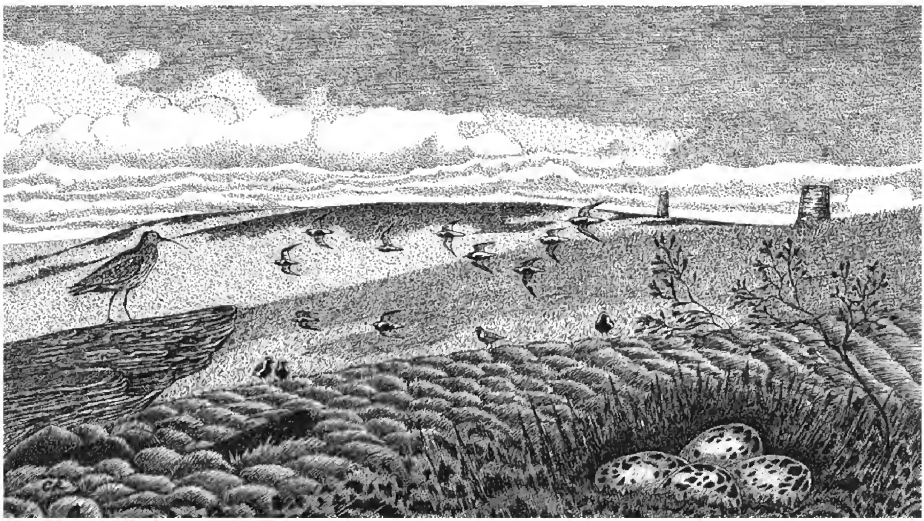

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The revised population status of birds in Wales

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SUMMARY

- The leading bird conservation organisations in Wales have revised the population status of the bird species that are regularly found here, updating the review published in 2002 and using the same method as the UK review published in 2009.
- A total of 213 species were assessed and each placed on one of three lists. The 'highest' Red list is for those that are globally threatened, or have historically or recently shown severe decline. The 'intermediate' Amber list is for those showing recovery from historic decline, moderate decline, or are localised, rare or internationally important. The 'lowest' Green list is for other species, including those showing further recovery. Revisions were made to some criteria, and include those made as part of the UK review.
- Forty-five species (21%) were placed on the Red list, an increase of 18. One hundred (47%) were on the Amber list, an increase of 31, and 68 (32%) on the Green list, a fall of 57.
- Nine have been moved to lower lists, while 63 have been moved to higher lists – with seven moving straight from Green to Red. Seven were assessed for the first time, one being placed on the Red list. In total, 149 species (70%) were on the same list as the UK assessment.
- Revised international assessments, the revised Wales criteria and new data from both new and previously used sources, acting both individually and in combination, caused these 63 previously assessed species to move to a higher list. Seventeen such changes (27%) depended on revised international listings; five changes (8%) depended on UK red listing; 35 changes (56%) depended on the revised criteria; four changes (6%) depended on new data sources while 23 changes (37%) depended on data from sources updated since the first assessment.
- Thus, although 30% of species have been moved to a higher list, less than half of these changes are attributable to deteriorating populations in Wales.
- Reasons for moving to a lower list included more favourable population trends, improved status in Europe and no longer being rare. Nevertheless, two species moved to a higher list for positive reasons (successful colonisation and reaching international importance), while one species moved to a lower list for negative reasons (its breeding population had become extinct).
- These revised lists, along with information on other factors (e.g. threats faced now and in the future, feasibility of action and likelihood of success) should be used in the identification of priority species for conservation effort.

CRYNODEB

- Mae'r prif sefydliadau cadwraeth adar yng Nghymru wedi adolygu statws poblogaeth y rhywogaethau o adar a geir yma'n rheolaidd, gan ddiweddaru'r adolygiad a gyhoeddwyd yn 2002 a defnyddio'r un dull â'r adolygiad i'r DU a gyhoeddwyd yn 2009.
- Aseswyd cyfanswm o 213 rhywogaeth, a gosodwyd pob un ar un o dair rhestr. Yr 'uchaf' yw'r Rhestr Goch, i'r rhai sydd mewn perygl byd-eang neu sydd a'u niferoedd wedi gostwng yn sylweddol yn hanesyddol neu'n ddiweddar. Ar y Rhestr Oren 'ganol' mae'r rhai sy'n adfer eu niferoedd wedi gostyngiad hanesyddol, sydd wedi gostwng yn gymhedrol neu sy'n lleol,yn brin neu o bwysigrwydd rhyngwladol. Mae'r rhywogaethau eraill ar y Rhestr Werdd 'isaf', yn cynnwys rhai sy'n adfer eu niferoedd. Newidiwyd rhai o'r meini prawf, yn cynnwys newidiadau oedd yn rhan o adolygiad y DU.
- Rhoddwyd 45 o rywogaethau (21%) ar y Rhestr Goch, cynnydd o 18. Roedd cant (47%) ar y Rhestr Oren, cynnydd o 31, a 68 (32%) ar y Rhestr Werdd, gostyngiad o 57.
- Symudwyd naw i restr is a 63 i restr uwch – gyda saith yn symud yn syth o Wyrdd i Goch. Aseswyd saith am y tro cyntaf, gydag un yn cael ei rhoi ar y Rhestr Goch. Roedd cyfanswm o 149 rhywogaeth (70%) ar yr un rhestr a'r asesiad DU.
- Symudwyd y 63 rhywogaeth yma a aseswyd o'r blaen i restr uwch oherwydd asesiadau rhyngwladol newydd, y meini prawf newydd i Gymru, a data newydd o ffynonellau newydd neu flaenorol, ar wahan neu gyda'i gilydd. Roedd 17 o'r newidiadau (27%) yn dibynnu ar asesiadau rhyngwladol newydd, pump newid (8%) yn dibynnu ar y Rhestr Goch i'r D.U.; 35 newid (56%) yn dibynnu ar y meini prawf newydd; pedwar newid (6%) yn dibynnu ar ffynonellau data newydd a 23 newid (37%) yn dibynnu ar ddata o ffynonellau a ddiweddarwyd ers yr asesiad cyntaf.
- Felly, er fod 30% o'r rhywogaethau wedi eu symud i restr uwch, mae llai na hanner y newidiadau yma wedi eu hachosi gan leihad yn y boblogaeth yng Nghymru.
- Ymhlith y rhesymau dros symud i restr is ceir tueddiadau poblogaeth mwy ffafriol, gwell statws yn Ewrop a'r ffaith nad yw'r rhywogaeth yn brin bellach. Er hynny, symudwyd dau rywogaeth i restr uwch am resymau positif (gwladychu llwyddiannus a chyrraedd pwysigrwydd rhyngwladol), tra symudodd un rhywogaeth i restr is am reswm negyddol (y boblogaeth nythu wedi diflannu).
- Dylid defnyddio'r rhestri newydd yma, gyda gwybodaeth am ffactorau eraill (e.e. bygythiadau presennol a dyfodol, ymarferoldeb gweithredu a'r siawns o lwyddiant) i ddewis rhywogaethau i gael blaenoriaeth ar gyfer ymdrechion cadwraeth.

INTRODUCTION

Various data can be used to describe the status of a bird population in a specified area, such as a political region. For example, its size, range (geographic distribution), trends in these over time, and the status of populations of the same species elsewhere. It is useful to summarise these data in a simple way so that information on population status can be easily communicated and used. For example, along with threats faced, feasibility of action and likelihood of success, population status is used in identifying priority species for conservation efforts. The Welsh Assembly Government has identified 51 Species of Principal Biodiversity Importance using this approach, and these are the biodiversity action plan (BAP) species in Wales.

Thorpe & Young (2002) first assessed the population status of birds in Wales and envisaged periodic revision. They also acknowledged that such assessments should take a hierarchical approach to geographic scale because of increasing knowledge of geographic variation in the fortunes of different bird species within the UK (e.g. Starlings *Sturnus vulgaris*: Robinson *et al.* 2005). Essentially, the European or UK population status lists are too blunt a tool to be useful in Wales, but do supply a wider context to a Welsh list. Thus, the status of species in Wales takes into account their status at larger scales (i.e. Wales < UK < Europe < international < global). Furthermore, UK BAP targets now represent the sum of the country targets (UK Biodiversity Partnership Standing Committee 2003), which for Wales, are in part based their population status here.

At the centre of this reassessment are the same eight broad criteria used in the first assessment. Whilst it would be preferable to keep the assessment method the same in successive reviews to ensure consistency, some changes have been made since 2002 and include those made at the UK level (see Eaton *et al.* 2009). A longer-term period over which to assess recent population change has been introduced, in addition to the 25year period (1981-2006). This runs from 1969 to 2006 and was to prevent species that have made no recovery from declines since 1969 but have been stable in the last 25yrs, from moving to lower lists (in their previous assessment, Thorpe & Young (2002) used only the 25-year period running from 1977-2002). A new rare non-breeding criterion has been introduced to mirror that for breeding.

Wales has a particular responsibility for the populations of UK species with populations centred in Wales. Consequently, there are new criteria to 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.

Species assessed

Native species

This assessment included all those species on the Welsh list (Prater & Thorpe 2006), excluding those that occur solely as vagrants (considered so by the 'British Birds' Rarities Committee (BBRC): www.bbrc.org.uk); along with rare and scarce migrants (considered so by the Welsh Records Panel, Fraser & Rogers 2006a & b, and www.scarce-migrants.org.uk). However, we have also included the only globally threatened species that has occurred in Wales in each of the 20 years prior to 2006 (Balearic Shearwater *Puffinus mauretanicus*, but not Aquatic Warbler *Acrocephalus paludicola*). This criterion is to justify taking conservation action for the species in the world that are most threatened (for example for small numbers of migrants on passage through Wales), whilst excluding those species that, even if they occur occasionally as migrants or vagrants, do not warrant conservation action in their main geographical distribution.

Colonisations and extinctions

Some species native to Europe have colonised Wales in recent decades. The threshold year for colonisation was that in which the population first met a mean of one pair per year over the previous five years (Johnstone *et al.* 2005). This approach allowed us to assess newly established breeders, such as Osprey *Pandion haliaetus* and Avocet *Recurvirostra avosetta.*

Thorpe & Young (2002) identified extinct species as those that had been regular breeders since 1800, and had not successfully bred in Wales in the 20 years before their assessment year (i.e. 1982), even though in some years they showed behaviours associated with breeding in suitable habitat. This resulted in the inclusion of species on the edges of their range that may go through periods of not breeding in Wales, but should not be considered extinct. Thus although two species are classified by the Welsh Records Panel as rare or scarce migrants (spotted crake and bearded tit), because they have continued to breed sporadically within any 20 year window, they have been assessed as established species. One species (Eurasian Bittern *Botaurus stellaris*) met the definition of extinction (last confirmed breeding in 1984, more than 20 years before the end of the assessment period for this review (i.e. 1986), although it still occurs annually and continues to be assessed on other criteria.

Non-breeding birds were considered established when removed from the lists of vagrants and rare or scarce migrants.

Non-native species

Also excluded were all non-native species, whether or not they have established self-sustaining breeding populations. These species could not have arrived in Wales naturally, and are not considered of conservation interest: indeed, introduced birds can be harmful to the natural environment, and are thought to have detrimental effects on 51% of all globally threatened bird species (BirdLife International 2008a). None of the non-native species in Wales are considered threatened within their native ranges (although Little Owl *Athene noctua* shows moderate decline), which, also with the exception of Little Owl, are outside of Europe.

Goshawk *Accipiter gentilis* was considered a reintroduced native, and was assessed because the deliberate release of Goshawks in Wales probably used birds of European origin. Goshawk did not qualify as a historic decliner because it became extinct before 1800. Goshawk was also assessed as part of the UK revision of population status.

METHODS

The approach

The approach, as established by one previous Wales review (Thorpe & Young 2002), two previous and one current UK reviews (Gibbons *et al.* 1996, Gregory *et al.* 2002, Eaton *et al.* 2009), assesses birds against a series of quantitative criteria relating to important aspects of population status. Meeting one or more criteria qualifies a species for the relevant list; with species being placed on the highest 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 no criteria, along with any that only qualify under continued recovery from historic decline, are placed on the Green list.

As in the last Wales assessment, eight broad criteria have been used. The same seven criteria used in the UK assessment determine the population status of birds in Wales based on: global importance, historical population decline, recent population decline, European importance, breeding rarity, localised distribution, and international importance. The eighth criterion uses UK importance to complete the hierarchical approach to geographical context.

Whilst the seven criteria do not differ from those used at UK-level, the qualifying thresholds for breeding rarity, localised distribution, and international importance do continue to differ to reflect the size of Wales. The thresholds for breeding rarity, localised distribution and international importance have been reduced by 90% because Wales accounts for 10% of the UKs' land surface.

The criteria

The eight main criteria and their sub-criteria are summarised in (Table 1), where differences between the criteria used in this assessment, those used in the previous Wales assessment and those used in the current UK assessment are indicated. Further information justifying these criteria is below.

1. GLOBAL POPULATION STATUS. This criterion considers the population status of each species in a global context. Species that meet this criterion are those of highest concern, and hence should be so in Wales regardless of national status (i.e. should be Red-listed even if they only occur briefly but in each of the past 20 years). In assessing species against this criterion, we have used the most up-to-date assessment of globally threatened species (Birdlife International 2008b).

2. 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. 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 in recent decades.

In line with the approach for Ireland (Newton *et al.* 1999), Thorpe & Young (2002) used information from Birds in Wales (Lovegrove *et al.* 1994), and comparisons between the Historical Atlas (Holloway 1996) and the 1988-1991 Breeding Bird Atlas (Gibbons *et al.* 1993) to establish historical trends for the period 1800-1994, and that assessment was also used here.

Populations of species that have declined will recover if conditions become more suitable through, for example, a more favourable climate or successful conservation action. We used the following sub-criteria so that species that have shown recovery from historic decline can move sequentially

from Red to Amber to Green lists, and this is designed to recognize recovery in numbers, while not downplaying the status of small populations or ranges, or ignoring UK European and international status. Therefore, historic decliners qualify as Amber if their populations have at least doubled in the last 25yrs (1981-2006), provided they also exceed 10prs (90% lower than the UK threshold reflecting the extent of Wales in relation to the UK). If their population has continued to recover (≥20%) between assessments, and they do not meet other Red or Amber list criteria, historic decliners then qualify as Green. However, a historical decliner is moved back onto the Amber or Red list if its' recovery in numbers falters (numbers decrease by ≥20%).

3. RECENT BREEDING AND NON-BREEDING POPULATION DECLINE. This criterion is used to assess the extent of decline for birds that spend different times of the year 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. Change in abundance outside the breeding season is used to assess non-breeding populations that breed elsewhere. Some species 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 and Fieldfare *Turdus pilaris*).

Previously, recent decline was assessed using data spanning a period of up to 25 years. However, this is problematic in that as it is 'rolled forward' in successive assessments, some species may no longer qualify for Red or even Amber lists because, while still relatively recent, the period of decline that would qualify is before the beginning of the 25-year recent assessment period. Without any change in the method, such species would be moved to the Amber or even Green list without having shown any recovery, or in some cases may have undergone further decline but at a slower rate. To prevent this, data from an additional longer-term period were used, starting at the beginning of the 25-year period used for the first UK assessment (i.e. 1969-2006). This period also ties in well with the advent of formal monitoring schemes in Wales and the UK.

In the previous assessment, change in range was the difference in number of 10km squares with probable or confirmed breeding between the two breeding bird atlases (Sharrock 1976, Gibbons *et al.* 1993). Species that occurred in 20 or fewer squares in both periods were excluded because small changes in occupied squares cause disproportionally large percentage changes in range (Thorpe & Young 2002). However, the most recent data (from the 1988-91 atlas) are now at least 18 years old, and no longer represent recent trends, while data from the ongoing BTO/BirdWatch Ireland/SOC 2007-11 bird atlas are not yet available. Therefore, only a limited number of species with recent range data from other sources were assessed against this criterion. For example, those for which recent single-species surveys have recorded range completely (e.g. Golden Plover *Pluvialis apricaria* and Hen Harrier *Circus cyaneus*), and seabirds, which were mapped comprehensively by the Seabird 2000 census (Mitchell *et al.* 2004) for which distribution data in 10-km squares are available from the National Biodiversity Network (www.nbn.org.uk). Recent range estimates from these sources were compared with atlas range estimates from the 1968-72 (for the longer-term period) and the 1988-91 (for the 25-year period) atlases. On this occasion, we included seabirds that occupied 10 or fewer 10km squares, as this approximates to number of colonies, changes in which are important components of population status even if they are few in number. Similar assessments were not made for non-breeding ranges, as no such data are available.

For each sub criteria (time-period and abundance/range), we distinguish between two levels of change: rapid (at least 50% decline) and moderate (at least 25% but less than 50% decline) to identify Red and Amber-listed species respectively.

4. EUROPEAN IMPORTANCE. This criterion considers the population status of each species in a European context (BirdLife International 2004), spanning the period 1970-2000 and replacing the first such assessment in 1994. SPEC 1 are of global conservation concern (including those classified as IUCN Near Threatened so not Red-listed under criterion 1). SPEC 2 are those of unfavourable conservation status within Europe and concentrated in Europe (more than 50% of the world population or range in Europe), whilst SPEC 3 are those of unfavourable conservation status but not concentrated in Europe.

5. BREEDING AND NON-BREEDING RARITY. Species were categorised as rare breeders in Wales if they had a breeding population of less than 30 pairs, and for the first time as rare non-breeders if the non-breeding population was less than 90 individuals (small non-breeding populations are as important as breeding populations). We also included a new sub-criterion, by Amber-listing, species for which Wales supports $\geq$10% of the UK's population of rare breeding or wintering birds. This reflects the importance of those populations in Wales to the UK.

Breeding rarity was assessed from recent single-species surveys (e.g. Dartford Warbler *Sylvia undata*), from informal data sources, such as County Bird Reports (CBRs), Bird Track and the Rare Breeding Birds Panel (RBBP) reports (expressed as a mean maximum number of pairs 2002-2006). Non-breeding rarity was assessed from County Bird Reports (expressed as a mean maximum number of individuals in the same period). However, County Bird Reports were considered to underestimate population size for some species, such as breeding Water Rail *Rallus aquaticus* and non-breeding Dotterel *Charadrius morinellus*. In these cases, population size was based on expert opinion.

6. LOCALISED POPULATIONS. 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 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, rather than the best 10 in the UK-level assessment, to reflect the proportion of the UK made up by Wales. 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 sizes for the same period, based on data from single-species surveys, CBRs, RBBP, and simple Wetland Bird Survey (WeBS) head counts.

The previous Wales assessment used a geographic definition of sites. In this assessment, however we moved closer to the UK approach of basing sites on the SPA and IBA network. Thus seabird SPAs made up of several constituent sites, were treated as single sites. However, because of issues of data availability, 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. In practice, some waterbirds were placed on the Amber list based on expert opinion when data alone suggested the Red list. 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 shores and adjacent agricultural land in England (Robinson *et al* 2004, Hearn 2004). Therefore, these species were assessed using non-WeBS data for Wales only.

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, there are new sub-criteria to show when Wales has 50% or more of the UK population of any species.

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. Breeding population estimates for Europe were taken from *Birds in Europe: population estimates, trends and conservation status* (BirdLife International 2004). For non-breeding waterbirds we followed the approach used in previous assessments by using estimates for the regional populations that winter in Wales, (usually north west Europe for wildfowl and most gulls, and East Atlantic flyway for waders) taken from *Waterbird Population Estimates – fourth edition* (Wetlands International 2006), summing populations listed separately where appropriate.

Although there is considerable variation between species, the European estimates are often of uncertain quality and expressed as a large range owing to poor knowledge in many countries. For example, the European population estimate for Twite *Carduelis flavirostris* is 170,000 to 760,000 pairs. Following Eaton *et al.* (2009), we required the Wales population estimate to exceed 2% of the upper limit of international population estimates for a species to qualify under this criterion.

Data sources

The monitoring of bird populations in Wales is relatively good, and has improved in recent years thanks largely to many skilled and enthusiastic volunteer birdwatchers. Nevertheless, there remain gaps in our knowledge for some species. Data from the following monitoring activities were used in this assessment.

BREEDING BIRD SURVEY (BBS). This BTO/JNCC/RSPB annual surveillance scheme is based on a random sample of 1km squares. Abundance is expressed as annual indices, with species reported on when they meet threshold sample sizes (mean of at least 30 squares with records). In the UK, long-term trends in widespread breeding bird abundance from the BBS have in many cases been combined with the earlier Common Birds Census (CBC) to cover the period 1970 to present. CBC/BBS indices are also statistically smoothed. This smoothing reduces the effect of unusual years, and so gives a clearer picture of underlying population trend. However, there were too few CBC plots in Wales for comparable long-term Welsh trends to be generated.

Smoothed BBS trends have been produced for the first time for the period 1995-2007 (Risely 2009). Although they end one year later than assessment period (1981-2006), using smoothed trends outweighed this disadvantage. Nevertheless, even with this extra year, the Wales BBS trends do not span the full 25year period. This is also the case at the UK level, with several species qualifying for the UK Amber list on the sole basis of decline in BBS index over this shorter period (Swift *Apus apus*, Whinchat *Saxicola rubetra* and Pied Flycatcher *Ficedula hypoleuca*: Eaton *et al.* 2009).

BBS sample size for some species indices failed to meet that for publishing separate indices, but were sufficiently reliable for their inclusion in the Welsh Assembly Governments composite wild bird indicator. 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). Species only qualified as Red or Amber under the recent population change criterion if there was other independent supporting evidence in Wales (qualifying BBS population change based on small samples was also not reported in the results).

WETLAND BIRD SURVEY (WeBS). Annual BTO/RSPB/JNCC WeBS core counts take place at around 200 wetland sites in Wales, in association with the WWT, with estuaries and large still waters predominating. Most species counted are wintering waders and wildfowl. More details on the scheme and the latest results can be found in Holt *et al* (2009). Reliable trends can be generated for most wildfowl species from 1966/67, and from 1974/75 for waders. A few other waterbird species are covered from later years (e.g. Coot *Fulica atra* and Great Crested Grebe *Podiceps cristatus* from 1983/84. For each species, percentage change in smoothed index values were calculated using the longest period that data were available within both 25yr and longer-term time-periods. WeBS data for species that occur sporadically and/or in small numbers (e.g. Slavonian Grebe *Podiceps auritus*) and on habitats not well covered by core counts (e.g. Snipe *Gallinago gallinago*) were not used. For some of these, more representative trends from the periodic Non-Estuarine Waterbird Surveys (e.g. Purple Sandpiper *Calidris maritima*: Rehfisch *et al.* 2003) and Winter Gull Roost Surveys (Banks *et al.* 2009) were available.

BTO total head counts for wintering water birds in Wales were less reliable than UK population estimates, and a conservative approach was taken to their use.

WATERWAYS BIRD SURVEY (WBS). Monitoring of some widespread breeding birds of streams and rivers in the UK is poor because such sites are outside of WeBS coverage and such linear features are poorly represented in the 1km square sample unit used by the BBS. The Waterways Bird Survey and newer Waterways Breeding Bird Survey scheme began in 1975. Coverage in Wales is low for both schemes, and no Wales-level results are produced at present. Furthermore, no UK data from this scheme were used in this assessment.

SEABIRD CENSUSES. Three censuses have produced complete estimates of both numbers and range for most species at 15-year intervals: Operation Seafarer (1969-70), Seabird Colony Register (1985-88) and Seabird 2000 (1998-2001) (Mitchell *et al.* 2004). However, not all species were included in earlier censuses (e.g. European Storm-petrel *Hydrobates pelagicus*).

SEABIRD MONITORING PROGRAM (SMP). Established in 1986 following the 1984 Seabird Colony Register, the JNCC/RSPB/SOTEAG SMP is an annual scheme that generates indices of breeding seabird abundance and success based on numbers at selected colonies (Mavor *et al.* 2008). SMP data were used for assessing tern populations.

THE STATUTORY CONSERVATION AGENCY AND RSPB ANNUAL BREEDING BIRD SURVEY (SCARABBS). This scheme for scarcer breeding birds consists of periodic census based on full or sample coverage using species-specific methods. The scheme typically operates a 12 year cycle of repeats, although some species are surveyed every six years (e.g. Hen Harrier).

The SCARABBS program has been supplemented by additional surveys in Wales in recent years (e.g. Black Grouse *Tetrao tetrix*: Lindley *et al.* 2003). Because of the importance of including recent data for species surveyed infrequently, some periodic surveys since 2006 have been used (e.g. Golden Plover in 2007 and Twite in 2008).

INFORMAL RECORDS. Much data on birds in Wales are also collected annually but informally (not following a formal design or recording method), including records submitted to CBR, BirdTrack, and the RBBP. Because observer effort may vary, between-year variation in number of breeding pairs from informal records was smoothed by calculating the mean number of pairs (using the maximum number of displaying or territorial individuals or breeding pairs), or non-breeding individuals, over five-year periods following Eaton *et al.* (2009). The periods used were 1973-77 for the longer period, and 1977-81 for the 25-year period, to 2002-2006. Population change was the percentage difference in mean number of pairs between these periods. For a few species (e.g. Kingfisher *Alcedo atthis* and Barn Owl *Tyto alba*), RBBP data for Wales was considered unreliable due to a known insufficient recording effort, or a known increase in reporting effort over time through activities such as bird ringing. Expert opinion of trends was used in these cases.

BIRD ATLASES. The first BTO Atlas took place between 1968 and 1972 (Sharrock 1976). It was repeated in 1988-1991(Gibbons *et al.* 1993). A second repeat is currently underway (2007-2011). Data for the ongoing Atlas are incomplete, while changes in range between the first two Atlases is now too far in the past to inform recent changes. However, where available, we have used more recent complete census data on geographical range size to calculate change in range as the percentage change in the number of occupied 10-km squares in Wales between atlases and recent census.

Prioritising data sources

Some species lack formal population monitoring in Wales because they are too scarce to be reported on by annual or periodic surveys such as the BBS, but still too widespread for informal records to be useful. The first assessment for Wales took a precautionary approach for such species: in that where there was no evidence in Wales to contradict UK population changes, the UK qualification for that criterion was adopted.

A similar approach was taken in this reassessment. However, other data sources have become available in recent years that provide Wales-specific population change for species that were previously only assessed by UK data and the precautionary principle, albeit in particular parts of Wales (e.g Dipper *Cinclus cinclus*: Tyler 2004), and habitats (e.g. Waders of Wet Meadows: Wilson *et al.* 2005, Repeat Upland Bird Survey: Sim *et al.* 2005 and Repeat Woodland Bird Survey: Amar *et al.* 2006). Data from these sources were only used if they were considered representative of national populations.

There is a need to balance the use of Wales-specific sources (that may be based on certain habitats

or localities rather than national schemes), and the use of robust UK sources (that may mask within-UK variation). Indeed, it is known that trends differ across the UK for some species (e.g. Common Starling; Robinson *et al* 2005), and we cannot rule this out for other species that lack formal data in Wales. Therefore, data sources were prioritised according to how robustly they measured population trends in Wales (Table 2). This ensured that the most use was made of Wales-specific data without compromising on data quality. This prioritising was particularly relevant for widespread breeding birds.

Race-level assessment

An assessment at race level was undertaken for the UK following the same species-level approach and using the same criteria and data sources. However, in many cases the information available for races was considerably poorer than for species. Bird monitoring is rarely targeted at bird races, with a few exceptions such as races of geese (e.g. White-fronted Goose), which have been long treated as separate entities for monitoring and conservation purposes. In other cases, different races occur at different times of year (e.g. Dunlin *Calidris alpina*), so can be assessed separately even though they are not routinely distinguished in the field. Nevertheless, the UK race listings may be less robust than that for species (Eaton *et al.* 2009), and this will also be the case for Wales.

A list of the races listed by the UK assessment that occur in Wales was compiled, acknowledging a lack of clarity on the existence of some endemic races. For example, the BOU list used in this assessment includes a western race of Yellowhammer *Emberiza citrinella caliginosa*, but recent genetic work suggests strongly that the breeding birds in Western Scotland, Ireland and possibly Wales are simply at the end of a cline and, as here, should be treated as the nominate race *E. c. citrinella*. Therefore, it is important that the races listed here should not be taken as a judgement on their provenance.

With few exceptions, there were too few data to assess the population status at race-level based on recent population change. This was because formal data on the range and numbers of many races in Wales is lacking. However, race-level assessments could be made for those considered important outside of the UK (qualify under pseudo-IUCN and SPEC listings based on Eaton *et al.* 2009), or important because the majority of their populations were in the UK (with Wales assumed to contain 10% of such endemic or near-endemic races which qualify under BI).

RESULTS

Species assessed and data availability

Eight former regularly breeding species had become extinct between 1800 and 1986 (Table 3) and were not assessed under breeding criteria (and under no criteria if now considered rare or scarce migrants). This is an increase of one since the first review (Eurasian Bittern), which continues to be assessed under other criteria.

Data on recent populations trends were in many cases not available for the full 25-year or longer-term periods (Table 4), and this was particularly so for widespread breeding birds. However, because many monitoring schemes collect data annually, the periods for trends used by this review were at least six years longer than used in the first review, and consequently more robust. The shortest trend period was for the Twite (six years), because despite breeding records since 1905, its' population has only been formerly surveyed in the last decade.

The new Red, Amber and Green lists

Of the 213 species assessed, 45 (21%) were placed on the Red list, an increase of 18, while 100 (47%) were placed on the Amber list, an increase of 31. The species on the Red or Amber lists, and the criteria under which they qualify are given in Tables 5 & 6. The remaining 68 species (32%) were placed on the Green list, a fall of 57 (Table 7). Sixty-three species moved to higher lists and nine species moved to lower lists between previous and current assessments in Wales. These are listed in Table 8, along with the reasons for change. Seven species were assessed for the first time; including two (Rock Dove/Feral Pigeon *Columba livia* and Chaffinch *Fringilla coelebs*) that were listed as not previously assessed for clarity here, but would have been Green-listed by Thorpe & Young (2002).

The data that qualify species for Red and Amber lists are summarised in a series of tables. Recent breeding and non-breeding declines of a magnitude that qualify species for the Red and Amber lists are presented in Table 9, while Table 10 gives estimates of population size for rare breeding and non-breeding species, along with localised species during the breeding and non-breeding periods. Table 11 presents species occurring in internationally important numbers during the breeding and non-breeding season.

The influence of the new criteria alone on population status was investigated. Some 26 species would have been placed on different lists had the revised international status and new data been available, but had the criteria remained unchanged (Table 12). Five species would have moved to a lower list, including one (the Bullfinch *Pyrrhula pyrrhula*), which would have been Green instead of Red. The population status of 64 species (30%) differed between Wales and the UK, with 31 (15%) on a higher list in Wales than in the UK (Table 13).

Race-level assessment

Sixteen species are polytypic in Wales (involving 33 races), with two or more races occurring here (Table 14). Of these, population size is considered unclear for 14 (42%). Many other species have been subdivided into different races across their global ranges, but with only one of these races occurring in Wales. Races that occur in Wales but have a different population status to their species are listed in (Table 15), of which 13 (72%) had a higher population status than their species.

DISCUSSION

Are the data reliable enough?

The Red, Amber and Green lists are only of value if they are based on reliable information. Accordingly, this review used the most up to date data available. The status of species from other assessments (IUCN, SPEC, UK) was assumed reliable. However, two sources of error in data on bird numbers and change in numbers may have reduced the reliability of the revised Wales lists.

First, data used for assessment under the recent population decline criterion do not always span the full 25-year or longer-term periods. It is possible that population sizes may fluctuate over relatively short periods (e.g. Bullfinch), and that without a sufficiently long period with data, the true underlying trend cannot not be detected, potentially leading to species qualifying for the wrong list. However, given the current time-periods with data (e.g. BBS=13 years), this risk was considered low relative to the advantages of using Wales-specific data. This issue was particularly relevant to widespread terrestrial breeding species (Table 4). To a lesser extent, this source of error was present in the UK assessment also. Nevertheless, trends from annual monitoring schemes in Wales are now based on six more years of data than when the assessment was first carried out, so the qualification of species based in these schemes is more reliable than then. In addition, cyclical fluctuations in numbers over the period of a few years may result in an inappropriate listing as for example, if the start and end years for population change assessment fall in years of maximum and minimum numbers respectively. This may have been the case for the Grey Plover *Pluvialis squatorola*, which moved from Amber to Red because of a marginally severe recent non-breeding decline.

Second, data sources that are not from national monitoring schemes may not be representative of national populations. To minimise the impact of this, sources were only used for the assessment if there was evidence that they were representative (e.g. Amar *et al.* 2006), or they were considered so by expert opinion. The lack of recent range data for the majority of breeding species meant that fewer species were assessed against the range criteria than during the previous assessment, and this limitation is shared with the UK assessment. It is possible that some species could have qualified for higher lists if those data had been available.

Data sources were prioritised for species with more than one reliable source; with national schemes considered most relevant and UK data least relevant to Wales (Table 2). Overall, the availability of population data for Wales was good, with the listing of only eight species (4%) under the recent population decline criterion depending solely on their UK status over 25 yr and/or longer-term periods (Red: Lesser Spotted Woodpecker *Dendrocopos minor*, Yellow Wagtail *Motacilla flava*, Grasshopper Warbler *Locustella naevia*, Willow Tit *Poecile montanus*, Linnet *Carduelis cannabina* and Yellowhammer, Amber: Meadow Pipit *Anthus pratensis* and Common Whitethroat *Sylvia communis*).

Estimates of population size and change were available for relatively few non-breeding visitors. In a few cases, expert opinion was used to assess whether species qualified under the rare non-breeding criterion (Water Rail, Dotterel, Little Stint *Calidris minutus*, Pomarine Skua *Stercorarius pomarinus*, Water Pipit *Anthus spinoletta*, Waxwing *Bombycilla garrulous* and Black Redstart *Phoenicurus ochrurus*). This will have been less reliable than formal survey data, but of more value than no assessment under this criterion.

The influence of information changes

Changes in the listing of individual species have been influenced by changes in four sources

of information: 1) revised international status, 2) revised UK status, 3) revised criteria and 4) updated or new population data.

Change in the listing of 17 species depended solely or in part on revised international status (IUCN and SPEC), with the majority being from Green to Amber. Five species moving from Green to Amber were dependent on their UK Red listing.

Changes for 35 species (56%) depended partly or in full on revisions to the criteria. An important such change was the use of an additional longer-term time window for assessing population change, and eight species were Red-listed because of this new criterion (Pochard *Athya ferina*, Great Black-backed Gull *Larus marinus*, Common Cuckoo *Cuculus canorus*, Willow Warbler *Phylloscopus trochilus*, Marsh Tit *Poecile palustris*, Linnet, Bullfinch and Yellowhammer). The Red listings of Common Cuckoo, Willow Warbler, Linnet and Yellowhammer were based on the UK longer-term listing supported by other evidence from Wales. A further five species were Amber-listed for the same reason (Great Cormorant *Phalacrocorax carbo*, Meadow Pipit, Common Whitethroat, Long-tailed Tit *Aegithalos caudatus* and Reed Bunting *Emberiza schoeniclus*).

Another change in criteria was to achieve parity in the treatment of breeding and non-breeding populations by adding a non-breeding rarity criterion and considering non-breeding species for Amber listing under the SPEC criterion. This has introduced an element of non-comparability between this and the previous Wales assessment. Indeed, 17 species are Amber-listed on these criteria (eight of these on WR alone: Long-tailed Duck *Clangula hyemalis*, Great Northern Diver *Gavia immer*, Red-necked Grebe *Podiceps grisegina*, Black-necked Grebe *P. nigricollis*, Marsh Harrier *Circus aeruginosus*, Long-tailed Skua *Stercorarius longicaudus*, Mediterranean Gull *Larus melanocephalus* and Black Redstart). Many of these species are on the edges of their ranges, so such non-breeding rarity in Wales is to be expected. However, Wales' importance as a home for non-breeding bird populations sometimes exceeds its importance for breeding bird populations, and so it is appropriate that the method reflects this even-handedly.

Three species qualified Amber under a new criterion for assessing the importance of Welsh populations in the UK (UK_{50}: Manx Shearwater *Puffinus puffinus* and Red-billed Chough *Pyrrhocorax pyrrhocorax*, BR_{UK}: Honey Buzzard *Pernis apivorus*), while no species qualified as WR_{UK}. Although their Amber listing was not solely dependent on these (nor were any on the UK Red list), it highlights the significant contribution Welsh populations make to the status of these species in the wider UK. Reviewing and adapting the method to changing circumstances at each review is an important part of making maximum the use of available data, and maximising the robustness of the resulting lists.

Many data sources used in the previous assessment have been updated since then and have been used for assessment under the recent population change criteria in this assessment. The data sources solely or partly accounted for change in the listing of 23 species (37%). Other data sources not available to the previous assessment, such as the Repeat Woodland Birds Survey (Amar *et al.* 2006) only influence list changes for four species (6%).

Thus, although overall 30% of the 213 species assessed have been moved to a higher list, less than half of these changes are attributable to deterioration of their populations in Wales.

Conservation themes in Wales and the new lists

The revised and lengthened Red list contains species of varying habitats and ecology. Some have been Red-listed for reasons outside of Wales (Balearic Shearwater), and it is difficult to influence the status of this species through action in Wales. The same is likely to be true for some rare migrant species for which the availability of favourable habitat seems unlikely to be limiting Welsh populations (e.g. Spotted Crake *Porzana porzana*). Despite this, the new lists do highlight some themes in bird conservation in Wales. These themes include changes within particular habitats, the affects of climate change and the success of conservation efforts.

Birds of farmed habitats

The first Population Status recognised the decline of some birds of farmed habitats in Wales and the new lists provide no good news. None of the birds of farmed habitats Red-listed in 2002 have moved to lower lists, while a further four have been added (Common Kestrel *Falco tinnunculus*, Yellow Wagtail, Linnet and Twite). Birds of farmed habitats have received much research to find species-specific causes of decline and remedial actions to enable population recovery (e.g. Vickery *et al.* 2004). Despite this, the delivery of action through Government-funded agri-environment schemes, such as Tir Gofal, seems inadequate bring about national population recoveries (Morris *et al.* 2008). The new scheme, Glastir, must fully embrace the findings of this and other ongoing Government funded research on Tir Gofal if the status of these species is to be improved.

Woodland birds

The 2002 Population Status raised the profile of declines in woodland birds, with three woodland species Red-listed and a further six Amber-listed. In this 2009 review, none of these have been removed, Spotted Flycatcher *Muscicapa striata* moves from Amber to Red and is joined by a further four moving from Green to Red (Wood Warbler *Phylloscopus sibilitrix*, Willow Warbler, Pied Flycatcher and Lesser Redpoll *Carduelis cabaret*). Knowledge of the causes of declines in woodland birds is less complete than for birds of farmed habitats. However, this is being addressed by ongoing research in Wales and elsewhere.

Seabirds

Seabirds show mixed fortunes. Kittiwake *Rissa tridactyla* has moved from Amber to Green because recent change is now slightly less than -25%, but the fortunes of this species should be watched closely given the problems it is facing elsewhere in the UK. Guillemot *Uria aalge* has moved from Green to Amber because numbers are now internationally important due to a real increase in Wales. However, four species moved to the Red list: Herring Gull *Larus argentatus argentatus* and Great Black-backed Gull because of declines in breeding and non-breeding numbers respectively, and the Common Tern *Sterna hirundo* and Arctic Tern *S. paradisea* because of longer-term decline in breeding range, assessed for the first time through a criteria change.

Waterbirds

Breeding and non-breeding wading birds featured strongly in the Red and Amber lists (21 species). Two wildfowl (White-fronted Goose and Pochard) qualified for the Red list because of severe decline in their wintering numbers. However, most qualifying wildfowl (12) were placed on the Amber list because of their European status. Just three species were Amber-listed because of moderate recent population declines: Shelduck *Tadorna tadorna* (breeding), and Mallard *Anas platyrhynchos* and Red-breasted Merganser *Mergus serrator* (non-breeding). A few other species such as Common Eider *Somateria mollissima* and Long-tailed Duck were on the Amber list because of rarity (breeding and non-breeding respectively).

Some waders are on the Red list because of declines in breeding numbers (Northern Lapwing *Vanellus vanellus*, Golden Plover and Eurasian Curlew *Numenius arquata*). Others are Red-listed because of declines on their estuarine wintering sites (Grey Plover, Dunlin and Bar-tailed Godwit *Limosa lapponica*). Red Knot *Calidris canutus* and Ringed Plover *Charadrius hiaticula* (now marginally qualifying as moderate recent population change) have moved off the Red list, along with the Eurasian Bittern (extinct breeder, qualified Amber on SPEC, WR and UK_{red}).

Whilst list changes that have come about through change in international status and non-breeding recent population change are difficult to address through management in Wales (with the exception of maintaining estuarine wintering sites through the designated sites network), effort to halt declines in the formerly ubiquitous breeding Northern Lapwings and Curlews have yet to be successful.

Migrants

Wales hosts breeding migrants that winter south of the Sahara, along with winter migrants that breed further north in the Arctic. A complication of declines for some birds is the influence of factors acting away from breeding or wintering areas.

The Afro-Palearctic migrants listed by Sanderson *et al (* 2006) contains six (32%) of the 19 newly Red-listed songbirds (Spotted Flycatcher, Yellow Wagtail, Pied Flycatcher, Common Cuckoo, Willow Warbler and Wood Warbler), who found that across Europe, inter-continental migrants showed significantly worse trends between 1970-1990 than short-distance migrants or resident species. However, the causes of decline might include the degradation or loss of habitat on breeding grounds, sub-Saharan wintering grounds, or loss of staging areas on route between these. Furthermore, hunting pressure in southern Europe and North Africa, and climate change might have a role (Ewing 2008). However, exactly where and when during the annual cycle these hypothesised causes of decline might act has yet to be identified.

Down listing is not always good news

The down listing of three species from Red to Amber (Eurasian Bittern, Ringed Plover and Red Knot) and six species from Amber to Green (Little Egret *Egretta garzetta*, Peregrine Falcon *Falco peregrinus*, Water Rail, Kittiwake, Stock Dove *Columba oenas*, Common Stonechat *Saxicola torquatus*), might give cause for optimism. Some down listings are the result improved population status. For example, improved status in Europe has resulted in Common Stonechat moving to the Green list. The previously severe declines of the Ringed Plover and Red Knot have now become moderate following some increase in numbers (the latter marginally). The Little Egret *Egretta garzetta* is no longer rare following successful colonisation, the Peregrine Falcon is no longer internationally important because of increases elsewhere.

However, down-listing can occur for other reasons. For example, because the Eurasian Bittern is now an extinct breeding bird, it can no longer qualify Red on historic decline of breeding population. Instead it qualifies as Amber on its status in Europe, its UK Red-list status and as a rare non-breeder in Wales. There are parallels to this with the status of the UK Black Tern *Chlidonias niger* population (although never qualifying for the UK Red list). Its numbers declined during the 19th century and was last recorded breeding in 1979. It currently qualifies Amber in the UK because of its' status in Europe (Eaton *et al.* 2009), occurring in the hundreds on passage. Furthermore, the Water Rail and the Stock Dove were previously assessed using Atlas data now considered too old, which could result in down-listing though lack of data. However, although

there are no recent trend data for Water Rail (Green in UK), for Stock Dove; small sample BBS results support the conclusion of Lovegrove *et al.* (1994) that it has increased in number.

With the exception of the Peregrine Falcon which has benefited from legal protection in places and the withdrawal of certain pesticides, there is no evidence that these down-listings have been achieved though successful conservation management. However, a closer look at the criteria under which species qualify does highlight some signs of success even though species have remained on the same list or even moved to a higher list. For example, the Red Kite *Milvus milvus* has recovered in numbers sufficiently to qualify for the Green list thanks to former nest protection and changes in attitudes to these birds of prey, although it remains Amber-listed due to its now internationally important numbers (aided by declines elsewhere in Europe). The Arctic Tern has benefited from protection from disturbance at its remaining colonies in North Wales and also meets the further recovery criteria for Green listing. However, its longer-term serious decline in range has resulted in it being Red-listed. Breeding birds are sensitive to disturbance, and the abandonment of colonies on Anglesey has been attributed to its colonisation by foxes (Hope-Jones & Whalley 2004).

Differences between Wales and the UK

Only the White-fronted Goose was Red-listed in Wales and Green-listed in the UK on the same non-breeding criterion (although when assessed separately, both races are Red in the UK). Two species were rare breeders in Wales but not the UK (Hobby *Falco subbuteo* and Long-eared Owl *Asio otus*). Several species have more severe recent population declines in Wales than the UK (e.g. Black-headed Gull *Larus ridibundus*, Golden Plover and Eurasian Curlew), while the declines of others are less severe (e.g. Greater Scaup *Aythya marila* and Skylark *Alauda arvensis*) or their populations have increased here (Nightjar *Caprimulgus europaeus*, Song Thrush *Turdus philomelos*, House Sparrow *Passer domesticus*). Reasons for differences probably include differences in climate, landscape and agriculture.

The race-level assessments

The status of individual races of the same species may differ widely. For example, having different ranges (e.g. endemic and near-endemic races to the UK versus the wider ranges of races of the same species elsewhere) and undergoing different abundance changes. Drawing these distinctions can only serve to help target action more precisely and efficiently. For example at species level in Wales, Dunlin is on the Red-list for severe non-breeding population decline, although it also qualifies Amber under moderate breeding population decline and breeding rarity. However, on assessing this at the race-level, the wintering population is predominately *Calidris alpina alpina* and therefore this race would be Red-listed, while the rare breeding population is of a second race, *C.a. schinzii,* which would qualify Amber. A third race, *C.a. arctica*, occurs in such small numbers on passage that it would not be assessed. This advantage was recognised by the review of the Principal Biodiversity Species at race level in 2008 (**http://www.biodiversitywales.org.uk/species-35.aspx**). Presenting information on population status for races for Wales, however limited such an assessment can be at this time, may encourage work to fill knowledge gaps and refine the role of bird races in setting conservation priorities.

Although a revised species list for Wales will include the races recorded here (Thorpe & Stratford *in prep*), there remain gaps in knowledge of the distribution, numbers and population trends of birds at race level, which is why so few Wales race-level assessments include qualification under recent population decline. Indeed, the very validity of some races is uncertain. However, nature conservationists are interested in preventing biodiversity loss and this should include genetic

diversity at all scales, enshrined in the Convention on Biological Diversity (http://www.cbd.int/). Nevertheless, there are considerable practical difficulties in conserving races, not least in their identification in the field. A focus at race level has two important consequences. Firstly, it highlights the fact that the UK is home to a number of endemic races (although none are restricted to Wales) and holds internationally important populations of many others, of which some are declining.

How to use the new Wales lists

The Red, Amber and Green lists are a three-level summary of data on the size and geographical distribution of populations, and how these change over time in Wales and in relation to elsewhere. Species on the Red list are those with declines of greatest severity and of highest international importance. However, this does not mean they are automatically the species of highest priority for conservation action.

This is because other factors need to be considered when selecting species to invest conservation effort in. First, feasibility: can lost habitat be recreated and would this conflict with other priorities? Second, biological constraints: how likely is success given the starting population size and would success benefit other biodiversity or enhance ecosystem function? Third, benefit to society: is the species of cultural importance, does it represent a flagship for wider ecosystem benefits? Fourth, economics: is the required action affordable?

For some Red list species, it may be appropriate that no action is taken beyond monitoring, and this is the case for the Puffin *Fratercula arctica*. This species qualifies under historic decline because huge numbers of their burrows on their 200,000 strong Grassholm colony on caused the soil to erode, the site to become uninhabitable, and the birds to move elsewhere (Lovegrove *et al.* 1994). Although numbers have increased greatly over the longer-term (146%), stability over the last 25 years (-7%) prevents it qualifying Amber under the HD_{rec} criterion, and it continues to be Red-listed. It would not be a high priority for urgent conservation action at present because breeding habitat on Grassholm cannot be recreated without impacting on the internationally important Gannet *Morus bassanus* colony that has replaced the Puffins

The future

In conjunction with other information, these new lists should provide a valuable basis for the Welsh Assembly Government, Countryside Council for Wales and the Biodiversity Framework to revise conservation priorities in Wales. Reviews of population status should be revised at regular intervals to allow conservation priorities to be updated and remain relevant. To do this, support for the excellent monitoring programmes that underpin such reviews needs to be continued. However, there remain gaps in bird population data in Wales. These need to be addressed so that the reliability of the next review can be improved further.

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Table 1. The criteria used to assess the population status of birds in Wales, along with differences between those used in the new UK-level assessment, and those used in the previous Wales-level assessment. The 25yr period within which trend data were sought is 1981-2006, the longer-term period is 1969-2006, while the historic decline period is 1800-1994.
Further recovery from historic decline since last assessment is for the period 2000-2006.

List	Criteria		Definition	Abbreviation	Different to UK	Different to previous
Red	1	Global importance	IUCN globally endangered, critically threatened, endangered or vulnerable, excluding near-threatened	IUCN	No	No
Red	2	Historic decline	Severe historical decline 1800-1994	HD	No	No
Red	3	Recent population decline	At least 50% decline in breeding population (25yrs)	BDp1	No	No
Red	3	Recent population decline	At least 50% decline in wintering population (25yrs)	WDp1	No	No
Red	3	Recent population decline	At least 50% decline in wintering population (longer term)	WDp2	No	Yes
Red	3	Recent population decline	At least 50% decline in breeding population (longer-term)	BDp2	No	Yes
Red	3	Recent population decline	At least 50% decline in breeding range (25yrs)	BDr1	No	No[1]
Red	3	Recent population decline	At least 50% decline in breeding range (longer term)	BDr2	No	Yes
Amber	4	European importance	SPEC1=global conservation concern (includes IUCN near-threatened), SPEC2=unfavourable status and ≥50% of global population or range in Europe. SPEC3=unfavourable status but <50% in Europe	SPEC	No	No
Amber	2	Historic decline	Recovery: was Red but population increase of greater than 100% in last 25 yrs.	HDrec1	No	No
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding population (25yrs)	BDMp1	No	No
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding population (longer term)	BDMp2	No	Yes

Amber	3	Recent population decline	At least 25% but less than 50% decline in wintering population (25yrs)	WDMp1	No	No
Amber	3	Recent population decline	At least 25% but less than 50% decline in wintering population (longer term)	WDMp2	No	Yes
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding range (25yrs)	BDMr1	No	No[1]
Amber	3	Recent population decline	At least 25% but less than 50% decline in breeding range (longer term)	BDMr2	No	Yes
Amber	5	Breeding or non-breeding rarity	Mean of less than 30prs or 90 individuals in the most recent 5yr period with data.	BR, WR	Yes	No
Amber	6	Localised breeding or non-breeding	At least 50% of population occurs at one site, but not a rare breeder	BL WL	Yes	No
Amber	7	UK	Red-listed at UK-level	UKRed	Wales only	No
Amber	7	UK	At least 50% of the UK population occurs in Wales	UK50	Wales only	Yes
Amber	7	UK	At least 10% of the population of a UK rare breeding or wintering species	BRuk, WRuk	Wales only	Yes
Amber	8	International importance	At least 2% of the European or East Atlantic flyway population	BI, WI	Yes	No
Green	5	Historic decline	Further recovery: was Amber and at least 20% increase since last assessment	HDrec2	No	No

[1] All seabirds assessed. Previously only assessed if range greater than 20 10km square

Table 2. How data sources were prioritised for use with the recent population decline criteria for widespread breeding birds.

Priority for use	Source	Start years for trend	Data specific to:
1st	SCARABBS and other national single species surveys	Earliest 1982 (Chough) Latest 2002 (Twite)	Wales
2nd	Wales BBS	1994	Wales
3rd	Regional/habitat surveys	1968 [1] 1982 [2] 1983 [3]	Wales
4th	Wales small sample BBS with independent supporting evidence	1994	Wales
5th	UK CBC/BBS	1969	UK

[1] Repeat Woodland Birds Survey (Amar *et al.* 2006); [2] Waders of Wet Meadows (Wilson *et al* 2005). [3] Repeat Upland Birds Survey (Sim *et al.* 2005).

Table 3. Status and most recent breeding records of former regularly breeding birds whose breeding populations met the definition of extinct in 2006. More recent breeding season records have been insufficient meet the definition of recolonisation. NA = not assessed.

Species	Breeding status		Recent breeding records	Current occurrence
	2002	2006		
Black-necked Grebe	NA	Extinct	1957	Non-breeding migrant
Bittern	Red	Extinct	1984	Non-breeding migrant
Montagu's Harrier	Extinct	Extinct	1964	Rare migrant
Wryneck	Extinct	Extinct	1904	Scarce migrant
Woodlark	Extinct	Extinct	1981, 2006	Rare migrant
Nightingale	Extinct	Extinct	1981	Rare migrant
Red-backed Shrike	Extinct	Extinct	1952, 2005, 2006	Rare migrant
Cirl Bunting	Extinct	Extinct	1960	Rare migrant

Table 4. Frequency of species with recent population change data spanning different time-periods. Not all species assessed had data for assessment under the recent population change criterion, and some species are represented in more than one type of data.

Recent population change period	Time period (years)	Breeding population	Breeding range	Winter population	Total	% total
25yrs	≤5	0	0	0	0	0
	6-10	10	0	0	10	4.8
	11-15	91	20	5	116	56.0
	16-20	13	6	4	23	11.1
	21-25	26	1	31	58	28.0
	Total	142	27	40	207	100.0
Longer term	26-30	2	19	13	34	25.4
	31-35	41	2	12	55	41.0
	36-40	26	6	13	45	33.6
	Total	69	27	38	134	100.0

Table 5. Red-listed birds in Wales and the criteria under which they qualify, along with the Amber and Green list criteria under which they qualify. Definitions of the criteria are given in table 1. R=Red, A=Amber, G=Green, NA=not assessed.

Species	Previous population status	IUCN	HD	BDp1	BDp2	WDp1	WDp2	BDr1	BDr2	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
White-fronted Goose	R					●	●														●							
Pochard	G						●			●				●				●			●							
Red Grouse	R		●									●	●															
Black Grouse	R		●						●	●												●						
Grey Partridge	R		●	●	●					●												●						
Balearic Shearwater	NA	●								●												●						
Hen Harrier	R		●							●									●			●						
Common Kestrel	A			●						●																		
Corn Crake	R	●	●	●	●					●												●						
European Golden Plover	R			●	●				●							●												
Grey Plover	A					●									●						●							
Northern Lapwing	R			●	●					●												●						
Dunlin	A					●	●			●		●	●					●			●	●					●	
Bar-tailed Godwit	R					●	●			●											●							
Eurasian Curlew	R			●						●			●								●							

Species	Previous population status	IUCN	HD	BDp1	BDp2	WDp1	WDp2	BDr1	BDr2	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Black-headed Gull	A				●	●		●	●			●															●	
Common Gull	G					●				●																		
Herring Gull	A				●	●																●					●	
Great Black-backed Gull	A				●												●											
Roseate Tern	R			●	●			●		●							●	●		●		●						
Common Tern	A								●							●				●								
Arctic Tern	A								●											●								●
Little Tern	R							●	●	●	●									●								
Puffin	R																											
Turtle Dove	R			●	●			●	●	●												●						
Common cuckoo	G				●							●										●						
Short-eared Owl	A			●						●								●	●									
Lesser Spotted Woodpecker	R			●	●																	●						
Yellow Wagtail	A			●	●																	●						
Ring Ouzel	R			●	●																	●						
Grasshopper Warbler	R			●	●																	●						
Wood Warbler	G			●						●												●						
Willow Warbler	G				●																							
Spotted Flycatcher	A			●	●					●												●						

Species	Previous population status	IUCN	HD	BDp1	BDp2	WDp1	WDp2	BDr1	BDr2	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Pied Flycatcher	G			●																								
Marsh Tit	R				●					●		●										●						
Willow Tit	R			●	●					●												●						
Common Starling	R			●	●					●												●						
Tree Sparrow	R			●	●					●												●						
Linnet	A				●					●												●						
Twite	A							●				●						●	●	●		●						
Lesser Redpoll	G			●	●																	●						
Bullfinch	R				●																							
Yellowhammer	R				●							●										●						
Corn Bunting	R		●	●	●			●	●	●												●						

Table 6. Amber-listed birds in Wales and the criteria under which they qualify, along with the Green list criterion under which they qualify.
Definitions of the criteria are given in table 1. R=Red, A=Amber, G=Green, NA=not assessed.

Species	Previous population status	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Mute Swan	G																		●	
Bewick's Swan	A	●									●									
Barnacle Goose	A	●											●							
Brent Goose	A	●											●						●	
Shelduck	A			●									●					●		
Eurasian Wigeon	A									●										
Gadwall	A	●											●							
Eurasian Teal	A												●							
Mallard	A					●	●						●							
Pintail	A	●											●						●	
Garganey	A	●								●										
Shoveler	A	●																	●	
Tufted Duck	G	●																		

Species	Previous population status	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Greater Scaup	A	●									●			●						
Common Eider	A									●										
Long-tailed Duck	G										●									
Common Scoter	A												●						●	
Velvet Scoter	G	●									●									
Smew	G	●									●									
Red-breasted Merganser	G					●														
Common Quail	A	●		●						●										
Red-throated Diver	A	●																		
Black-throated Diver	G	●									●									
Great Northern Diver	G										●									
Red-necked Grebe	G										●									
Slavonian Grebe	G	●									●									
Black-necked Grebe	G										●									
Sooty Shearwater	G	●									●									

Species	Previous population status	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Manx Shearwater	A	●							●			●			●			●		
European Storm Petrel	A											●								
Leach's Petrel	G	·																		
Northern Gannet	A											●						●		
Great Cormorant	A								●											
Eurasian Bittern	R	●									●			●						
Eurasian Spoonbill	NA	●									●									
Honey Buzzard	A									●						●				
Red Kite	A	●																●		●
Marsh Harrier	G										●									
Osprey	G	●								●										
Merlin	A		●																	
Hobby	A									●										
Spotted Crake	A									●										
Oystercatcher	A												●						●	
Avocet	G									●	●									

Species	Previous population status	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Ringed Plover	R					●	●													
Red Knot	R	●					●						●						●	
Sanderling	G												●							
Ruff	G	●									●			●						
Jack Snipe	G	●									●									
Common Snipe	A	●																		
Woodcock	A	●																		
Black-tailed Godwit	A	●											●						●	
Whimbrel	A					●							●							
Spotted Redshank	G	●									●									
Common Redshank	A	●		●	●								●						●	
Common Sandpiper	G	●		●																
Turnstone	A					●														
Arctic Skua	G													●						
Long-tailed Skua	G										●									
Mediterranean Gull	G										●									
Little Gull	NA	●																		

Species	Previous population status	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Lesser Black-backed Gull	A											●	●					●		
Sandwich Tern	A	●										●								
Black Tern	G	●																		
Common Guillemot	G																	●		
Black Guillemot	A	●								●										
Barn Owl	A	●																		
Long-eaRed Owl	A									●										
European Nightjar	A	●	●						●					●						
Common Swift	G			●																
Common Kingfisher	A	●																		
Green Woodpecker	A	●																		
Skylark	A	●												●						
Sand Martin	A	●																		
Swallow	A	●																		
House Martin	G	●																		
Tree Pipit	G													●						

Species	Previous population status	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Meadow Pipit	G				●															
Dipper	G			●																
Black Redstart	G										●									
Common Redstart	A	●																		
Northern Wheatear	G	●																		
Fieldfare	G													●						
Song Thrush	A													●						
Redwing	G													●						
Garden Warbler	G			●																
Common Whitethroat	G				●															
Dartford Warbler	A	●																		
Goldcrest	G			●																
Firecrest	A									●										
Bearded Tit	NA	●								●										
Long-tailed Tit	G				●															
Coal Tit	G																			

Species	Previous population status	SPEC	Hdrec1	BDMp1	BDMp2	WDMp1	WDMp2	BDMr1	BDMr2	BR	WR	BL	WL	UkRed	UK50%	BRuk	WRuk	BI	WI	HDrec2
Red-billed Chough	A	●													●					
Hooded Crow	NA																			
House Sparrow	A	●												●						
Hawfinch	G			●										●						
Lapland Bunting	G										●									
Snow Bunting	G										●									
Reed Bunting	A				●															

Table 7. Species placed on the Green list in Wales.
A=Amber, G=Green, NA=not assessed.

Species	Previous population status	Species	Previous population status
Whooper Swan	**G**	Water Pipit	**G**
Pink-footed Goose	**G**	Grey Wagtail	**G**
Common Goldeneye	**G**	Pied Wagtail	**G**
Goosander	**G**	Waxwing	**G**
Little Grebe	**G**	Wren	**G**
Great Crested Grebe	**G**	Dunnock	**G**
Fulmar	**G**	Robin	**G**
Shag	**G**	Whinchat	**G**
Little Egret	**A**	Common Stonechat	**A**
Grey Heron	**G**	Blackbird	**G**
Goshawk	**G**	Mistle thrush	**G**
Sparrowhawk	**G**	Cetti's Warbler	**G**
Common Buzzard	**G**	Sedge Warbler	**G**
Peregrine Falcon	**A**	Reed Warbler	**G**
Water Rail	**A**	Blackcap	**G**
Moorhen	**G**	Lesser Whitethroat	**G**
Coot	**G**	Chiffchaff	**G**
Little Ringed Plover	**G**	Coal Tit	**G**
Dotterel	**G**	Blue Tit	**G**
Little Stint	**G**	Great Tit	**G**
Curlew Sandpiper	**G**	Eurasian Nuthatch	**G**
Purple Sandpiper	**G**	Treecreeper	**G**
Greenshank	**G**	Eurasian Jay	**G**
Green Sandpiper	**G**	Magpie	**G**
Pomarine Skua	**G**	Western Jackdaw	**G**
Great Skua	**G**	Rook	**G**

Species	Previous population status		Species	Previous population status
Kittiwake	**A**		Carrion Crow	**G**
Razorbill	**G**		Raven	**G**
Rock Dove/Feral pigeon	**NA** [1]		Chaffinch	**NA** [1]
Stock Dove	**A**		Brambling	**G**
Woodpigeon	**G**		Greenfinch	**G**
Collared Dove	**G**		Goldfinch	**G**
Tawny Owl	**G**		Siskin	**G**
Great Spotted Woodpecker	**G**		Common Crossbill	**G**
Rock Pipit	**G**			

[1] Previous assessment would have been Green.

Table 8. Previously assessed species that have changed status. In (a), an upward change refers to Green to Amber or Amber to Red, while downward means Red to Amber or Amber to Green. Change dependent on: INT = depends on revised IUCN and SPEC lists that apply internationally; UK = depends on new UK Red-listing; CRI = depends on new longer-term population change and winter rarity criteria; DAT1 and DAT2 = depends on previously used and newly available data sources respectively and assessed under previously used criteria. New qualifications are bold for Red, plain for Amber and italic for Green. In (b) the number of species that changed list for different reasons are summarised.

a)

Change direction	Species	Previous → new status	Change dependent on:					New qualifications
Upward	Mute Swan	G-A				DAT1		WI
Upward	Pochard	G-R			CRI	DAT1		**WDp2**
Upward	Tufted Duck	G-A	INT					SPEC
Upward	Long-tailed Duck	G-A			CRI			WR
Upward	Velvet Scoter	G-A	INT		CRI			SPEC, WR
Upward	Smew	G-A	INT		CRI			SPEC, WR
Upward	Red-breasted Merganser	G-A				DAT1		WDMp1
Upward	Black-throated Diver	G-A	INT		CRI			SPEC, WR
Upward	Great Northern Diver	G-A			CRI			WR
Upward	Red-necked grebe	G-A			CRI			WR
Upward	Slavonian Grebe	G-A	INT		CRI			SPEC, WR
Upward	Black-necked Grebe	G-A			CRI			WR
Upward	Sooty Shearwater	G-A	INT		CRI			SPEC, WR
Upward	Leach's Petrel	G-A	INT					SPEC
Downward	Eurasian Bittern	R-A				DAT1		Extinct breeder, so no longer historic or recent decline, WR
Downward	Little Egret	A-G				DAT1		*No longer BR*
Upward	Marsh Harrier	G-A			CRI			WR
Upward	Osprey	G-A	INT			DAT1		SPEC, BR
Upward	Common Kestrel	A-R				DAT1		**BDp1**
Downward	Peregrine Falcon	A-G	INT			DAT1		*No longer SPEC or BI*
Downward	Water Rail	A-G				DAT1		*No data to reassess BDMr*
Upward	Avocet	G-A			CRI	DAT1		BR, WR
Downward	Ringed Plover	R-A			CRI	DAT1		WDp1 & WDp2 to Amber
Upward	Grey Plover	A-R				DAT1		**WDp1**

Downward	Red Knot	R-A				DAT1		WDp1 to Green, WDp2 to Amber
Upward	Sanderling	G-A				DAT1		WL
Upward	Dunlin	A-R			CRI	DAT1		**WDp1, WDp2**
Upward	Ruff	G-A			CRI			WR
Upward	Jack Snipe	G-A	INT		CRI			SPEC, WR
Upward	Spotted Redshank	G-A	INT		CRI			SPEC, WR
Upward	Common Sandpiper	G-A	INT			DAT1		SPEC, BDMp1
Upward	Arctic Skua	G-A		UK				UKRed
Upward	Long-tailed Skua	G-A			CRI			WR
Upward	Mediterranean Gull	G-A			CRI			WR
Upward	Black-headed Gull	A-R			CRI	DAT1		**BDp2, WDp2, BDr1, BDr2**
Upward	Common Gull	G-R	INT				DAT2	**WDp1**
Upward	Herring Gull	A-R			CRI		DAT2	**BDp2, WDp1**
Upward	Great Black-backed Gull	A-R			CRI			**BDp2**
Downward	Kittiwake	A-G				DAT1		*No longer BDMp1*
Upward	Common tern	A-R			CRI			**BDr2**
Upward	Arctic Tern	A-R			CRI			**BDr2**
Upward	Black Tern	G-A	INT					SPEC
Upward	Common Guillemot	G-A				DAT1		BI
Downward	Stock Dove	A-G				DAT1		*No data to reassess BI based on range*
Upward	Common Cuckoo	G-R			CRI			**DBp2**
Upward	Short-eaRed Owl	A-R	INT			DAT1		**BDp1**
Upward	Common Swift	G-A				DAT1		BDMp1
Upward	House Martin	G-A	INT					SPEC
Upward	Tree Pipit	G-A		UK				UKRed
Upward	Meadow Pipit	G-A			CRI			BDMp2
Upward	Yellow Wagtail	A-R			CRI	DAT1		**BDp1, BDp2**
Upward	Dipper	G-A				DAT1		BDMp1
Upward	Black Redstart	G-A			CRI			WR
Downward	Common Stonechat	A-G	INT					*No longer SPEC*
Upward	Northern Wheatear	G-A	INT					SPEC
Upward	Fieldfare	G-A		UK				UKRed
Upward	Redwing	G-A		UK				UKRed
Upward	Garden Warbler	G-A				DAT1		BDMp1

Upward	Common Whitethroat	G-A			CRI			BDMp2
Upward	Wood Warbler	G-R	INT			DAT1		**BDp1**
Upward	Willow Warbler	G-R			CRI			**BDp2**
Upward	Goldcrest	G-A				DAT1		BDMp1
Upward	Spotted Flycatcher	A-R			CRI		DAT2	**BDp1, BDp2**
Upward	Pied Flycatcher	G-R				DAT1		**BDp1**
Upward	Long-tailed Tit	G-A			CRI			BDMp2
Upward	Coal Tit	G-A				DAT1		BDMp1
Upward	Linnet	A-R			CRI			**BDp2**
Upward	Twite	A-R				DAT1		**BDp1**
Upward	Lesser Redpoll	G-R			CRI	DAT1		**BDp1, BDp2**
Upward	Hawfinch	G-A		UK			DAT2	BDMp1, UKRed
Upward	Lapland Bunting	G-A			CRI			WR
Upward	Snow Bunting	G-A			CRI			WR

b)

Change dependent on:	Upward					Downward			
	G-R	G-A	A-R	Tot		R-G	R-A	A-G	Tot
INT	0	5	0	5		0	0	1	1
INT, CRI	0	7	0	7		0	0	0	0
INT, DAT1	1	2	1	4		0	0	1	1
INT, DAT2	1	0	0	1		0	0	0	0
CRI	2	14	4	20		0	0	0	0
CRI, DAT1	2	1	3	6		0	1	0	1
CRI, DAT2	0	0	2	2		0	0	0	0
UK	0	4	0	4		0	0	0	0
UK, DAT2	0	1	0	1		0	0	0	0
DAT1	1	9	3	13		0	2	4	6
Sum of species changing status	7	43	13	63		0	3	6	9
Sum of changes dependent on DAT1	3	13	7	23		0	3	5	8

Table 9. Recent population changes that qualifies species for the Red (bold) and Amber lists. Qualification based on information other than Wales surveys are indicated by <-25 for Amber qualification and <-50 for Red qualification, with supporting evidence given under source (CBR = County Bird Reports, RBBP = Rare Breeding Bird Panel). Species are grouped by data for each season (B=breeding, NB=non-br.).

		Numbers trends					
Species	Season	*Source*	25yr numbers change	Longer-term numbers change	Range trends	25yr range change	Longer-term range change
Shelduck	B	BBS UK, supported by Birds in Wales	-27		Source		
Red Grouse	B	GWCT Game bag census, Birds in Wales: decline since 1930s	-33	-44			
Black Grouse	B					**-50**	**-54**
Grey Partridge	B	UK listing supported by Birds in Wales (declining throughout 20th century)	**-78**	**-88**	Atlas/ 2005 survey		
Common Quail	B	RBBP	-48				
Manx Shearwater	B	Seabird censuses					
Great Cormorant	B						-40
Common Kestrel	B	BBS small sample, supported by N. Breconshire decline of -64% 1987-2002)	**<-50**		Atlas/ Seabird 2000		
Corn crake	B	CBRs 1969-2006	**-100**	**-100**		**-100**	**-100**
European Golden Plover	B	Birds in Wales/2007 survey	**-89**	**-83**	CBRs 1969-2006	-29	**-54**
Northern Lapwing	B	1987 survey/1998 survey. Expert opinion: longer-term decline started earlier and is more severe than UK -45%	**-77**	**<-50**	Atlas/ 2007 survey		
Dunlin	B	Elenydd surveys 1975-2007	-41	-45			
Eurasian Curlew	B	1993/2006 survey. Longer-term: UK listing supported by Birds in Wales (decline in range and probably numbers 1964-1994)	**-81**	<-25			
Common Redshank	B	1985 survey/1996 survey. Longer-term :UK WBS supported by Birds in Wales (decline since 1960s)	-38				
Common Sandpiper	B	UK listing supported by Birds in Wales (geberal decline in the 20th century)	-28				
Black-headed Gull	B	1976 survey and Seabird censuses	-34	**-75**		**-53**	**-72**
Herring Gull	B	Seabird censuses & SMP		**-68**	Atlas/ Seabird 2000		
Great Black-backed Gull	B	Seabird 2000		**-53**			-46

		Numbers trends					
Species	Season	*Source*	25yr numbers change	Longer-term numbers change	Range trends	25yr range change	Longer-term range change
Roseate Tern	B	Seabird censuses & SMP	**-100**	**-100**		**-100**	**-100**
Common tern	B				Atlas/ Seabird 2000	-29	**-62**
Arctic Tern	B				Atlas/ Seabird 2000		**-60**
Little Tern	B				Atlas/ Seabird 2000	**-75**	**-90**
Turtle Dove	B	CBRs 1981-2005. Longer-term: UK listing supported by Birds in Wales (decline since 1920s)	**-88**	**<-50**	Atlas/ Seabird 2000	**-100**	**-100**
Cuckoo	B	BBS smoothed. Longer-term: UK listing supported by Birds in Wales (general decline from 1950)	-32	**<-50**	Atlas/ 2008 survey		
Short-eared Owl	B	CBRs 1988-2006	**-82**				
European Nightjar	B						-43
Common Swift	B	BBS smoothed	-43		Atlas/ 2004 survey		
Lesser Spotted Woodpecker	B	UK listing based on precautionary principle	**<-50**	**<-50**			
Meadow Pipit	B	UK listing supported by Birds in Wales (much less numerous than earlier decades)		<-25			
Yellow Wagtail	B	UK listing supported by Birds in Wales (decline accelerated in 2nd half of 20th century)	**<-50**	**<-50**			
Dipper	B	Tyler (2004), change at 100 territories on Wye & Usk 1983-2003	-35				
Ring Ouzel	B	1999 survey/2006 survey. Longer-term 1972 estimate in Birds in Wales/2006 survey	**-69**	**-51**			
Grasshopper Warbler	B	UK listing based on precautionary principle	**-80**	**-91**			
Garden Warbler	B	BBS smoothed	-26				
Common Whitethroat	B	UK listing supported by Birds in Wales (pre 1969 levels not achieved by early 1990s)		<-25			
Wood Warbler	B	BBS small sample, support from UK BBS+most of UK pop in Wales	**<-50**				
Willow Warbler	B	Repeat woodland bird survey		**-68**			
Goldcrest	B	BBS smoothed	-30				

		Numbers trends					
Species	Season	*Source*	25yr numbers change	Longer-term numbers change	Range trends	25yr range change	Longer-term range change
Spotted Flycatcher	B	Repeat woodland bird survey	**-58**	**-63**			
Pied Flycatcher	B	BBS small sample supported by RSPB reserve data	**<-50**				
Long-tailed Tit	B	Repeat woodland bird survey		-41			
Marsh Tit	B	Repeat woodland bird survey	-39	**-68**			
Willow Tit	B	UK listing based on precutionary principle	**-82**	**<-50**			
Coal Tit	B	Repeat woodland bird survey	-25				
Common Starling	B	BBS smoothed. Longer-term: UK listing supported by Birds in Wales (decline 1970s-1990s)	**-51**	**<-50**			
Tree Sparrow	B	UK listing supported by Birds in Wales (period of strong decline after 1976)	**-87**	**<-50**			
Linnet	B	UK listing supported by Birds in Wales (pop said to be at lowest levels ever in 1994)		**<-50**			
Twite	B	2002 survey/2008 survey	-46			**-83**	**-50**
Lesser Redpoll	B	UK listing supported by Birds in Wales (population dropped sharply from around 1977)	**-87**	**<-50**	Atlas/ 2008 survey		
Bullfinch	B	Repeat woodland bird survey		**-52**			
Hawfinch	B	Gwent index from Langston et al 2002	-26				
Yellowhammer	B	BBS smoothed. UK listing supported by Birds in Wales (substantial decline 1974-1994)	-39	**<-50**			
Reed Bunting	B	UK listing supported by Birds in Wales (decline from land-use induced high in 1950s)		**<-50**			
Corn Bunting	B	1993 survey/2008 survey. UK listing supported by Birds in Wales (decline since 1900)	**-100**	**<-50**	Atlas/ 2008 survey	**-100**	**-100**
Whitefronted Goose	NB	CBRs 1979-2006	**-57**	**-85**			
Mallard	NB	WeBS smoothed index	-34	-33			
Pochard	NB	WeBS smoothed index	-44	**-56**			
Red-breasted Merganser	NB	WeBS smoothed index	-28				
Ringed Plover	NB	WeBS smoothed index	-47	-48			
Grey Plover	NB	WeBS smoothed index	**-53**	-27			
Red Knot	NB			-36			
Dunlin	NB	WeBS smoothed index	**-53**	**-70**			
Bar-tailed Godwit	NB	WeBS smoothed index	**-85**	**-85**			

		Numbers trends					
Species	Season	*Source*	25yr numbers change	Longer-term numbers change	Range trends	25yr range change	Longer-term range change
Whimbrel	NB	WeBS smoothed index	-28				
Turnstone	NB	Non-estuarine surveys 84/85-06/07	-26				
Black-headed Gull	NB	Wintering gull surveys 1992-2004/05	**-73**				
Common Gull	NB	Wintering gull surveys 1992-2004/05	**-70**				
Herring Gull	NB	Wintering gull surveys 1992-2004/05	**-57**				

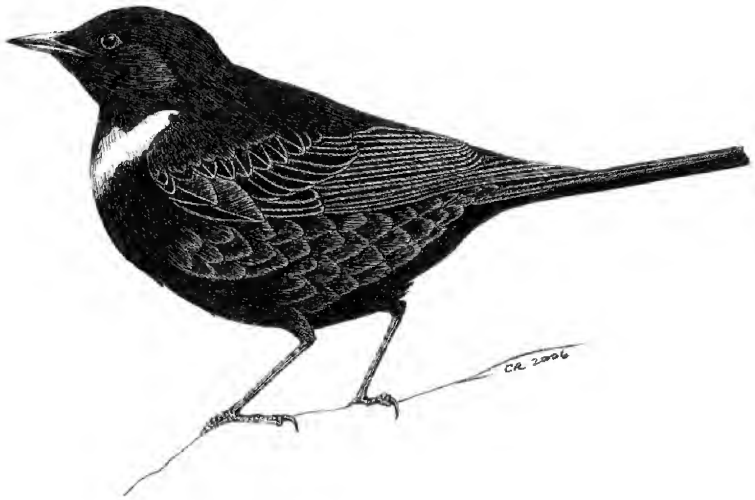


Table 10. Rare breeding and non-breeding species and localised species in Wales. Qualification based wholly or partly on expert opinion is indicated by ≥50. Entries for species with at least 95% of their Welsh population in one site are shown in bold. CBR = County Bird Reports and RBBP=Rare Breeding Birds Panel. With 14% of the UK population in Wales, only honey buzzard qualified under BR_{UK}, and no species qualified under WR_{UK}. Two species qualified under UK_{50}: Manx shearwater (57%) and Red-billed chough (53%).

	Rare breeders		Rare non-breeders		Localised breeding		Localised non-breeding	
Species	**Source**	**No**	**Source**	**No**	**Site Name**	**% pop**	**Site name**	**% pop**
Bewick's Swan			CBR 2002-2006	36				
Whitefronted Goose							Dyfi Estuary	99
Barnacle Goose							Dyfi Estuary	100
Brent Goose							Burry Inlet	≥50
Shelduck							Dee Estuary	≥50
Eurasian Wigeon	RBBP 2002-2006	2						
Gadwall							Severn Estuary	≥50
Eurasian Teal							Dee Estuary	52
Mallard							Severn Estuary	58
Pintail							Dee Estuary	77
Garganey	RBBP 2002-2006	2						
Pochard	RBBP 2002-2006	26					Severn Estuary	93
Greater Scaup			CBR 2002-2006	66				
Common Eider	CBR 2002-2006	2						
Long-tailed Duck			CBR 2002-2006	13				
Common Scoter							Carmarthen Bay	54
Velvet Scoter			CBR 2002-2006	<90				
Smew			CBR 2002-2006	<90				
Common Quail	RBBP 2002-2006	13						

Black-throated Diver			CBR 2002-2006	<90				
Great Northern Diver			CBR 2002-2006	58				
Red-necked Grebe			CBR 2002-2006	1				
Slavonian Grebe			CBR 2002-2006	30				
Black-necked Grebe			CBR 2002-2006	5				
Sooty Shearwater			CBR 2002-2006	54				
Manx Shearwater					Skomer/Skokholm SPA	88		
European Storm Petrel					Skomer/Skokholm SPA	91		
Northern Gannet					Grassholm SPA	**100**		
Eurasian Bittern			CBR 2002-2006	18				
Eurasian Spoonbill			CBR	6				
Honey Buzzard	2003 survey	10						
Marsh Harrier			CBR 2002-2006	8				
			CBR 2002-2006	28				
Osprey	RSPB 2002-2006	1						
Hobby	RBBP 2002-2006	20						
Spotted Crake	CBR 2002-2006	1						
Oystercatcher							Dee Estuary	63
Avocet	CBR 2002-2006	3	WeBS 07/08	<90				
Grey Plover							Dee Estuary	≥50
Red Knot							Dee Estuary	≥50
Sanderling								
Dunlin	2007 survey	≤30						
Ruff			CBR 2002-2006	38				
Jack Snipe			CBR 2002-2006	44				

Black-tailed Godwit							Dee Estuary	≥50
Bar-tailed Godwit							Dee Estuary	≥50
Whimbrel							Severn Estuary	≥50
Eurasian Curlew							Dee Estuary	64
Spotted Redshank			CBR 2002-2006	20				
Common Redshank							Dee Estuary	≥50
Long-tailed Skua			CBR 2002-2006	3				
Mediterranean Gull			CBR 2002-2006	90				
Lesser Black-backed Gull					Skomer/Skokholm SPA	75	Severn Estuary	≥50
Sandwich Tern					Anglesey SPA	**100**		
Roseate Tern		2			Anglesey SPA	**100**		
Common Tern					Shotton steel works	63		
Arctic Tern					Anglesey SPA	**100**		
Little Tern					Point of Ayr	**100**		
Black Guillemot	Seabird 2000	28						
Puffin					Skomer/Skokholm SPA	88		
Long-eared Owl	CBR 2002-2006	7						
Short-eared Owl	CBR 2002-2006	3	CBR 2002-2006	14				
Black Redstart			Expert opinion	<90				
Firecrest	RBBP 2002-2006	2						
Bearded Tit	CBR 2002-2006	1	CBR 2002-2006	<90				
Hooded Crow			CBR 2002-2006	<90				
Twite	2008 survey	14-17	CBR 2002-2006	78	Nant Francon	57		
Lapland Bunting			CBR 2002-2006	4				
Snow Bunting			CBR 2002-2006	10				

Table 11. Birds in Wales with internationally important breeding or non-breeding populations. Data are for the regional populations that individuals breeding and/or wintering in Wales belong to, in many case the western European (wildfowl and most gulls) and eastern Atlantic (wader) populations.

Species	% breeding population	% non-breeding population
Mute Swan		2.9
Brent Goose		2.6
Shelduck	2.0	1.5
Pintail		12.6
Shoveler		3.6
Common Scoter		2.3
Manx Shearwater	43.1	
Northern Gannet	10.4	
Red Kite	2.3	
Oystercatcher		3.5
Red Knot		2.7
Dunlin		2.0
Black-tailed Godwit		6.3
Common Redshank		2.3
Black-headed Gull		2.1
Lesser Black-backed Gull	6.0	
Herring Gull		2.2
Common Guillemot	2.1	

Table 12. Species that changed in population status solely because of the changes in the criteria between the previous and the current assessments. Species in bold are those which would have moved to a lower list if the criteria had not been revised.

	Pop Status I	Pop Status II	
Species	**List**	**Difference in status (previous → revised)**	**Reason for change**
Pochard	G	A-R	WDp2
Long-tailed Duck	G	G-A	WR
Great Northern Diver	G	G-A	WR
Red-necked Grebe	G	G-A	WR
Black-necked Grebe	G	G-A	WR
Great Cormorant	**A**	**G-A**	**BDMr2 only**
Marsh Harrier	G	G-A	WR
Sanderling	G	G-A	WL
Long-tailed Skua	G	G-A	WR
Mediterranean Gull	G	G-A	WR
Great Black-backed Gull	A	A-R	BDp2, BDMr2
Common Tern	A	A-R	BDr2
Arctic Tern	A	A-R	BDr2
Common Cuckoo	G	A-R	BDp2
Meadow Pipit	G	G-A	BDMp2
Black Redstart	G	G-A	WR
Common Whitethroat	G	G-A	BDMp2
Willow Warbler	G	G-R	BDp2
Long-tailed Tit	G	G-A	BDMp2
Marsh Tit	**R**	**A-R**	**BDp2**
Linnet	A	A-R	BDp2
Bullfinch	**R**	**G-R**	**BDp2 only**
Lapland Bunting	G	G-A	WR
Snow Bunting	G	G-A	WR
Yellowhammer	**R**	**A-R**	**BDp2 only**
Reed Bunting	**A**	**G-A**	**BDMp2 only**

Table 13. Birds whose status differs between Welsh and UK populations, grouped by whether they are on higher or lower lists than for the UK as a whole.

Species	Status relative to UK	Wales-UK comparison	Reason why Wales different to UK
Mute Swan	Higher	A-G	WI
Whitefronted Goose	Higher	R-G	WDp1, WDp2
Pochard	Higher	R-A	WDp2
Long-tailed Duck	Higher	A-G	RW
Red-breasted Merganser	Higher	A-G	WDMp1
Red Grouse	Higher	R-A	HD
Great Cormorant	Higher	A-G	BDMr2
Common Kestrel	Higher	R-A	BDp1
Hobby	Higher	A-G	BR
European Golden Plover	Higher	R-A	BDp1, BDp2, BDr2
Grey Plover	Higher	R-A	WDp1
Sanderling	Higher	A-G	WL
Bar-tailed Godwit	Higher	R-A	WDp1, WDp2
Eurasian Curlew	Higher	R-A	BDp1
Long-tailed Skua	Higher	A-G	WR
Black-headed Gull	Higher	R-A	BDp2, WDp1, BDrp1, BDrp2
Common Gull	Higher	R-A	WDp1
Great Black-backed Gull	Higher	R-A	BDp2
Common tern	Higher	R-A	BDr2
Arctic Tern	Higher	R-A	BDr2
Little Tern	Higher	R-A	BDr1, BDr2
Puffin	Higher	R-A	HD
Long-eared Owl	Higher	A-G	BR
Short-eared Owl	Higher	R-A	BDp1
Dipper	Higher	A-G	BDMp1
Garden Warbler	Higher	A-G	BDMp1
Willow Warbler	Higher	R-A	BDp2
Goldcrest	Higher	A-G	BDMp1
Pied Flycatcher	Higher	R-A	BDp1
Long-tailed Tit	Higher	A-G	BDMp2
Coal Tit	Higher	A-G	BDMp1
Hooded Crow	Higher	A-G	WR
Bullfinch	Higher	R-A	BDp2
Whooper swan	Lower	G-A	Not established breeder or WL
Greater Scaup	Lower	A-R	Not WDp2
Common Scoter	Lower	A-R	Not established breeder

Species	Status relative to UK	Wales-UK comparison	Reason why Wales different to UK
Common Goldeneye	Lower	G-A	Not established breeder
Little Grebe	Lower	G-A	Not BDMp1 or BDMp2
Fulmar	Lower	G-A	Not BDMp1 or BL
Shag	Lower	G-A	Not BDMp1, BDMp2, BL or BI
Eurasian Bittern	Lower	A-R	Extinct breeder so does qualify on breeding criteria
Little Egret	Lower	G-A	Not BL
Dotterel	Lower	G-A	Not established breeder
Purple Sandpiper	Lower	G-A	Not WDMp1 or established breeder
Ruff	Lower	A-R	Not established breeder
Green Sandpiper	Lower	G-A	Not established breeder
Arctic Skua	Lower	A-R	Not establisged breeder
Great Skua	Lower	G-A	Not established breeder
Kittiwake	Lower	G-A	Not BDMp1, not BL
Razorbill	Lower	G-A	Not BL
Stock Dove	Lower	G-A	Not BI
European Nightjar	Lower	A-R	Not BDr2
Skylark	Lower	A-R	Not BDp2
Tree Pipit	Lower	A-R	Not BDp1 or BDp2
Water Pipit	Lower	G-A	Not WR
Grey Wagtail	Lower	G-A	Not BDMp2
Dunnock	Lower	G-A	Not BDMp2
Whinchat	Lower	G-A	Not BDMp1
Fieldfare	Lower	A-R	Not established breeder
Song Thrush	Lower	A-R	Not BDp2
Redwing	Lower	A-R	Not established breeder
Mistle thrush	Lower	G-A	Not BDMp1 and BDMp2
House Sparrow	Lower	A-R	Not BDp1 or BDp2
Hawfinch	Lower	A-R	Not BDp1

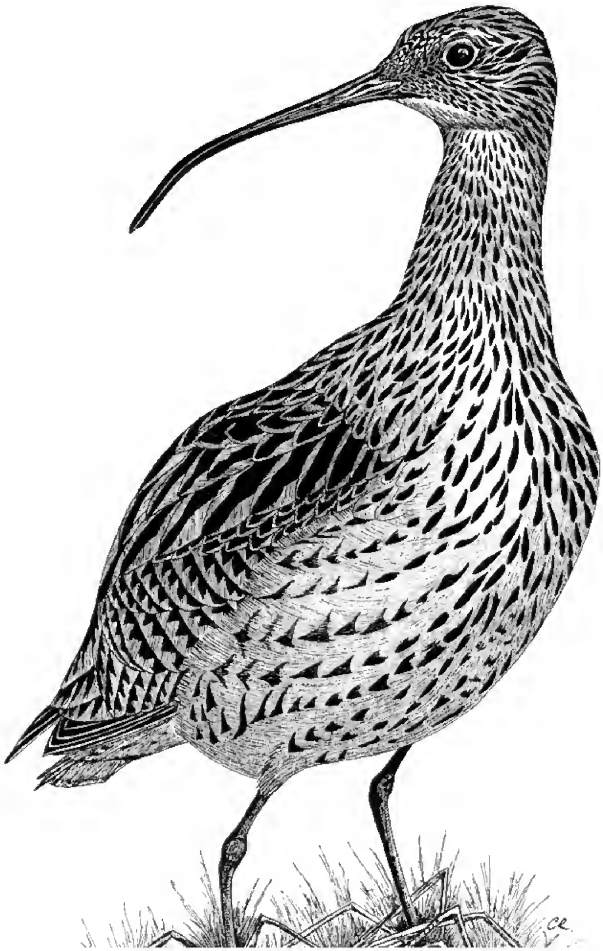
Table 14. Birds whose populations in Wales were assessed, are polytypic, and are considered to have more than one race occurring here in sufficient numbers to qualify for assessment.

Species	Race	Notes on occurrence in Wales
Brent Goose (dark-bellied)	*bernicla*	Winter visitor, predominantly south Wales
Brent Goose (light-bellied)	*hrota*	Winter visitor predominantly north Wales
Northern Wheatear	*leucorhoa*	Regular passage migrant – numbers unclear
Northern Wheatear	*oenanthe*	All Wales breeding population are of this race
Great Cormorant	*carbo*	All Wales breeding population are of this race
Great Cormorant	*sinensis*	Winter visitor, population probably increasing, but numbers uncertain
Knot	*Canutus*	Majority of winter population
Knot	*islandica*	Winter visitor – numbers unclear
Dunlin	*alpina*	Majority of wintering population of this race
Dunlin	*arctica*	Regular passage migrant – numbers unclear
Dunlin	*schinzii*	All Wales breeding population are of this race
Redshank	*totanus*	All Wales breeding population are of this race
Redshank	*robusta*	Winter visitor – numbers unclear
Greater White-fronted Goose (European)	*albifrons*	Only occasional winter records – formerly regular winter visitor to South Wales
Greater White-fronted Goose (Greenland)	*flavirostris*	Single wintering flock on Dyfi Estuary
Guillemot	*aalge*	Winter visitor – numbers unclear
Guillemot	*albionis*	All Wales breeding population are of this race
Herring Gull	*argentatus*	Winter visitor – numbers unclear
Herring Gull	*argenteus*	All Wales breeding population are of this race
Lesser Black-backed Gull	*graellsii*	All Wales breeding population are of this race
Lesser Black-backed Gull	*intermedius*	Regular passage migrant and winter visitor – numbers unclear
Pied Wagtail (White)	*alba*	Regular passage migrant – numbers unknown
Pied Wagtail	*yarrellii*	All Wales breeding population are of this race
Ringed Plover	*hiaticula*	All Wales breeding population are of this race
Ringed Plover	*tundrae*	Regular passage migrant – numbers unclear
Rock Pipit	*littoralis*	Regular passage migrant and winter visitor – numbers unclear
Rock Pipit	*petrosus*	All Wales breeding population are of this race
Yellow Wagtail (Blue-headed)	*flava*	Regular passage migrant – numbers unclear
Yellow Wagtail	*flavissima*	All Wales breeding population are of this race

Table 15. Races with different population status to the species in Wales based on available information.

Species	Race	Species status	Race status	Change in criteria	Reason
Race of higher status than species					
Brent Goose (Dark-bellied)	*bernicla*	A	R	+IUCN	Race globally threatened due to recent population decline
Common Eider	*mollissima*	A	R	+IUCN	Race globally threatened due to recent population decline
Peregrine Falcon	*peregrinus*	G	A	+SPEC	Race (pseudo-) SPEC listed
Great-spotted Woodpecker	*anglicus*	G	A	+BI	Race internationally important (endemic)
Pied Wagtail	*yarrellii*	G	A	+BI	Race internationally important (near-endemic)
Wren	*indigenus*	G	A	+BI	Race internationally important (endemic)
Blue Tit	*obscurus*	G	A	+BI	Race internationally important (near-endemic)
Great Tit	*newtoni*	G	A	+BI	Race internationally important (near-endemic)
Eurasian Treecreeper	*britannica*	G	A	+BI	Race internationally important (endemic)
Eurasian Jay	*rufitergum*	G	A	+BI	Race internationally important (near-endemic)
Chaffinch	*gengleri*	G	A	+BI	Race internationally important (endemic)
Greenfinch	*harrisoni*	G	A	+BI	Race internationally important (endemic)
Goldfinch	*britannica*	G	A	+BI	Race internationally important (endemic)
Race of lower status than species					
Dunlin	*schinzii*	R	A	-WDp1 -WDp2	Species Red on winter population decline. This race Amber on breeding criteria
Dunlin	*arctica*	R	G	No qualifications	Species Red on winter population decline. No evidence for any qualifications by this passage migrant
Herring Gull	*argentatus*	R	G	No qualifications	Species Red on breeding and non-breeding decline. No evidence for any qualification by this passage migrant

Species	Race	Species status	Race status	Change in criteria	Reason
Northern wheatear (Greenland)	*leucorhoa*	A	G	No qualifications	Species Amber on SPEC. No evidence for any qualifications by this passage migrant
Song Thrush	*philomelos*	A	G	No qualifications	Species Amber on UK status. No evidence for qualifications by this passage migrant



On the brink: the breeding population status of Turtle Doves and Corn Buntings in Wales

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SUMMARY

- Two Principal Biodiversity Species: Turtle Dove and Corn Bunting, continue to be Red-listed due to population declines, and have critically small breeding populations and ranges in Wales. This report presents the results of recent formal surveys of these species, and the implication of these for their futures in Wales.
- Systematic surveys of Turtle Doves in 2005 and 2006 in their Monmouthshire stronghold reported four to seven and zero breeding pairs respectively. Since then, there have been no records of singing males from this area. However, a single pair has been reported as breeding successfully at a different site in northeast Wales in 2007 and in 2009.
- A systematic regional survey of Corn Buntings in 2008 in their key-area and adjacent places with previous records in northeast Wales reported zero birds, but records continue over the border. A record of three non-breeding birds was reported in this area in 2009.

- While extinction in Wales is a very real possibility for these species, it is unlikely to be a sudden event, as borne out by the sporadic records of recent years. This is reflected in the time-window used in the definition of extinction in Wales, which means there is until at least 2029 before they should formally be considered extinct.
- Therefore, despite such critically small populations, there remains time for conservation action e.g. to encourage natural reinforcement of the Welsh populations from over the border through sympathetic agricultural management in Wales. However, conservation action is also required in England to maximise the numbers of potential immigrants of both species.

CRYNODEB

- Mae dau Brif Rywogaeth Bioamrywiaeth, y Durtur a Bras yr Yd, yn parhau i fod ar y Rhestr Goch oherwydd lleihad yn y boblogaeth, ac mae eu poblogaeth a'u dosbarthiad yng Nghymru yn beryglus o fychan. Cyflwynir yma ganlyniadau ymchwiliadau ffurfiol diweddar i'r rhywogaethau yma, a'r casgliadau am eu dyfodol yng Nghymru.
- Canlyniadau archwiliad systematig o'r Durtur yn 2005 a 2006 yn ei chadarnle yn Sir Fynwy oedd 4-7 par yn nythu yn 2005 a dim yn 2006. Ers hynny, nid oes cofnod o geiliogod yn canu yn yr ardal yma. Fodd bynnag, adroddwyd i un par nythu'n llwyddiannus mewn safle wahanol yng ngogledd-ddwyrain Cymru yn 2007 a 2009.
- Canlyniad archwiliad systematig ranbarthol o Fras yr Yd yn 2008 yn eu prif ardal a safleoedd cyfagos yng ngogledd-ddwyrain Cymru oedd dim adar, ond ceir cofnodion dros y ffîn. Cofnodwyd tri aderyn heb fod yn nythu yn yr ardal yma yn 2009.
- Er fod diflaniad y rhywogaethau yma yng Nghymru yn bosibilrwydd gwirioneddol, mae'n annhebygol y bydd hyn yn digwydd yn sydyn, fel y gwelir o'r cofnodion amrywiol dros y blynyddoedd diwethaf. Adlewyrchir hyn yn y cyfnod amser a ddefnyddir i ddiffinio diflaniad yng Nghymru, sy'n golygu fod hyd at o leiaf 2029 cyn y gellir ystyried yn ffurfiol eu bod wedi diflannu.
- Felly, er bod y boblogaeth yn beryglus o isel, mae o hyd amser i weithrediad cadwraeth, e.e. i hybu ychwanegiad naturiol i'r boblogaeth Gymreig o ochr arall y ffîn trwy reolaeth amaethyddol addas yng Nghymru. Er hynny, bydd angen gweithrediad cadwraeth yn Lloegr hefyd, i gynyddu'r nifer o fewnfudwyr posibl o'r ddau rywogaeth.

INTRODUCTION

Accounts of declining populations for some bird species have become familiar in recent decades (e.g. http://www.rspb.org.uk/ourwork/science/sotukb/sobiw.asp). Inevitably, without effective conservation measures, such declines lead to national extinctions of breeding populations. However, the extinction process is seldom clear-cut, such that the populations of individual species dwindle to the point that breeding is not reported every year before breeding completely ceases. Because of this, it is never too late to apply conservation measures to regional population declines, particularly when these populations are contiguous with wider bio-geographic (cross-border) populations. If such adjacent populations are managed to produce a population increase, surplus birds represent potential future immigrants to Wales. Two bird species in Wales that are currently dwindling towards extinction are the Turtle Dove *Streptopelia turtur* and Corn Bunting *Emberiza calandra*.

By the 1988-91 Breeding Bird Atlas (Gibbons *et al.* 1993) Turtle Doves had become restricted to a handful of 10km squares in the northeast and southeast of Wales, most notably in Monmouthshire where in 2004 an estimated six pairs remained (Scott 2007) (Fig.1). This decline has led to their Red list status being renewed, and their selection as a Principal Biodiversity Species (PBS) in Wales. They are also UK Biodiversity Action Plan (BAP) species.

The Turtle Dove is a summer visitor to the UK, arriving in late April and leaving at the end of August. In Wales, Turtle Doves are primarily found nesting in tall hedgerows, scrub and woodland edges, that support a dense shrub layer often with climbers. Turtle Doves feed themselves and their young on cereal, grass and weed seeds that need to be available throughout the breeding season.

Also Red-listed, the Corn Bunting formerly bred in all counties of Wales. However, it is now a PBS and a UK BAP species because of population decline, and so is a priority for conservation action in both Wales and England. Prior to the 2008 survey, the last record of a singing male was in 2006, with another singing male nearby but over the border in England (Green *et al.* 2008). Although their range in Wales was restricted to northeast Wales at the time of the last Breeding Bird Atlas, it is continuous with a larger population in England (Fig. 2) that, if its status is good, represents a potential source of recruits for population recovery in Wales. Corn Buntings, resident breeding birds, are also seed-eaters, but nest on the ground. Traditionally, nest sites are in spring-sown barley, but they will also nest in autumn-sown cereals and grassland. They feed their young on insects found in such places. In winter, seed food is found in cereal stubbles and wild bird cover crops.

The aim of this paper is to document the status of these species in Wales, and comment on their futures in relation to conservation action.

Turtle Dove

Sixteen and 20 1km squares were surveyed in Monmouthshire in 2005 and 2006 respectively. In 2005 there were eight squares previously occupied between 1994 and 2004 and eight squares near to these with suitable habitat: all within the Turtle Dove key-area (Lamacraft *et al.* 2008). Eight of the same squares were surveyed in 2006, plus an additional 12 squares with previous occupancy (1994-2004).

Figure 1. The 16 1km squares surveyed in 2005 (left-hatched) and 20 squares surveyed in 2006 (right-hatched), along with the Turtle Dove records in 2005 (black dots), the Turtle Dove key-area (grey shading) and 1km grid.

Visits were made to each square in the following three periods: 1-8 May, 1-8 June and 1-8 July, such that successive visits to the same square were at least three weeks apart, following Browne & Aebischer (2001). Each square was surveyed by walking along paths and woodland rides, passing within 200m of all suitable habitats. The direction walked was reversed between successive visits. The locations of Turtle Doves and their behaviour were marked on a map using Common Bird Census codes (Bibby *et al.* 1992). The locations of all singing (=territorial) males from the survey and other informal reports were plotted onto a map of the study area. Circles were drawn round clusters of records of territorial birds following Bibby *et al.* (1992). The population size was the sum of territorial clusters.

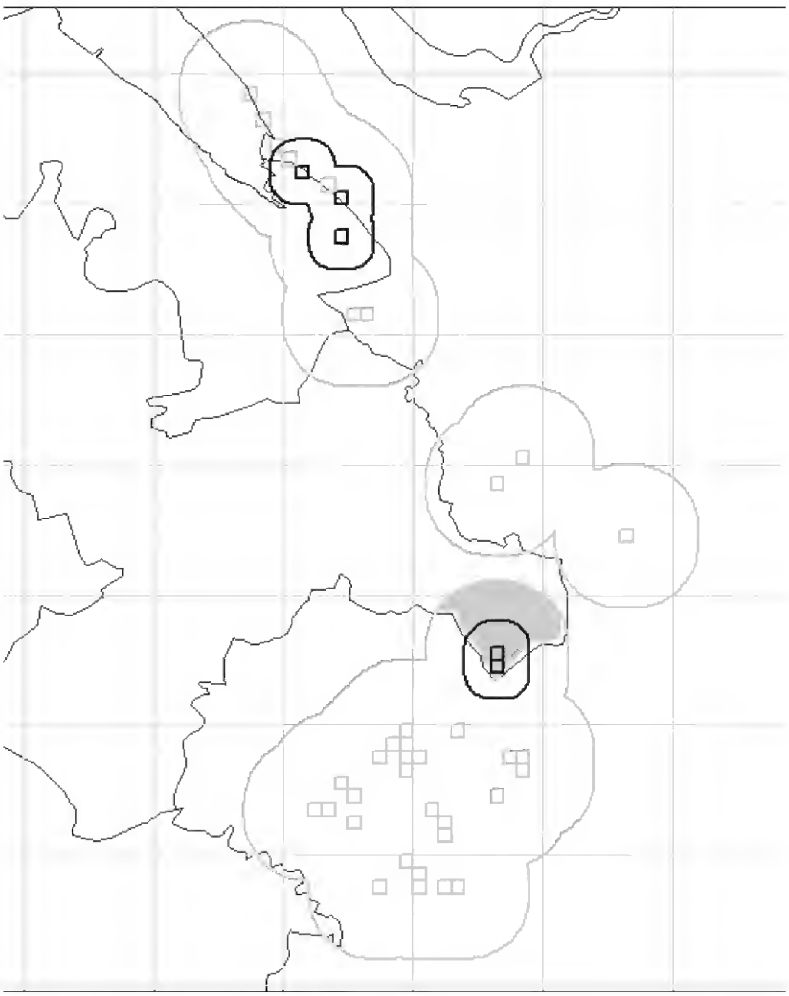

Figure 2. Squares with Records of Corn Bunting in Wales with a 2km buffer (black) and squares with records from 2002 to 2007 in England within 5km of the border (shown with a 5km buffer: grey). Systematic survey took place within the black buffers in 2008. The key-area is shown by grey shading; the grid is 10km.

Corn Bunting

A full survey took place in 1km squares with records in Wales since 2000 and the area within a 2km buffer of these (Fig.2). A 2km buffer was used to achieve full coverage up to this distance given available resources. The full survey was based on three morning visits: one in each of May, June and July at least two weeks apart following Gilbert *et al.* (1998). The population size was the maximum number of singing (=territorial) males on any one visit. In addition, informal records were encouraged from the Shropshire Ornithological Society within a 5km buffer around 1km squares in England with records between 2002 and 2007 (=the generic buffer size used by the RSPB Bird Conservation Targeting Project in England), and most likely to contain remaining birds.

RESULTS

Turtle Doves

Analysis of survey records following Bibby *et al.* 1992 indicated seven territories in 2005. However, the surveyors suspected individual singing Turtle Doves of ranging widely and they suggested a minimum of four occupied territories in 2005. No singing males were found in 2006. However, between 2007 and 2009, a single site in northeast Wales has been occupied, with young being produced successfully (J. Lawton Roberts *pers. comm.*).

Corn Buntings

No singing males were found in the areas studied in 2008. However, records continue for the area just over the border in England. In 2009, an informal visit to the key-area (Lamacraft *et al.* 2008) found three birds in August.

DISCUSSION

Turtle Doves

Clearly, the Welsh Turtle Dove population is critically small. Furthermore, there has been a similar decline in the Turtle Dove population over the border in the Forest of Dean.

Why is the population declining? In both places, Turtle Doves seem to be associated with heathland and forestry habitats as much as farmland, where dense scrub e.g. thicket stage conifers and areas of dense coniferous scrub provides nesting habitat, and disturbed ground e.g. forest tracks which are seed-rich feeding habitat, although formal data on this are lacking. Two notable changes in their former Monmouthshire breeding areas are the maturation of conifer plantations and the removal of conifers for heathland restoration projects. Both of these events could impact on the availability of nest sites. There is however, an abundance of suitable nesting habitat in the area. Unlike many farmland birds Turtle Doves have a wholly seed and grain diet, so are dependent upon habitats such as weed-rich arable crops, field margins and other open, disturbed ground e.g. forest tracks. However, recent evidence from Monmouthshire suggested Turtle Doves often visited seed feeders in gardens (Scott 2007). This may also indicate a lack of seed food during the breeding season, perhaps through loss of seeds from cereals, arable weeds and non-farmed habitats (e.g. heathland). Supplementary food was however, provided in two areas during the surveys although Turtle Doves rarely came to this food source.

Although there are habitat management options to address these issues (including incentives such as agri-environment schemes) as Turtle Doves are trans-Saharan migrants, their needs in wintering areas (tropical savannas) and during migration (where they continue to be shot in southern Europe) are outside the influence of conservation in Wales.

Nevertheless, slowing or halting population decline remains a possibility if breeding success alone can be increased sufficiently. To do this requires food and nest site provision at a scale only possible through agri-environment schemes. For example, Brown & Aebischer (2002) concluded that despite being 200 ha, their experimental food provision plots were too small to detect a population-level effect because individuals were travelling so far to feeding sites. They suggest increasing food availability at the scale of 1000 ha.

Corn Bunting

At the turn of the 20th century Corn Buntings were common wherever cereals were grown in the UK and they formerly bred in all counties of Wales. Recent research in southern England, northeast Scotland and the Western Isles shows that there are several agricultural causes of decline: lack of seed food in winter, food for nestlings, nest loss to harvesting and lack of re-nesting opportunities, and their importance varies regionally (Wilson *et al. 2007).* It is unclear how many of these are important for Corn Buntings in Wales. Although current agri-environment schemes offer several management options likely to benefit Corn Buntings, geographical targeting is essential for successful population recovery.

In 1993, at least 22 birds were recorded in a small part of the survey area. However, the full coverage in 2008 resulted in no birds being seen during the breeding season, although there were informal records outside the survey area in England, indicating the potential source population still exists. Corn Buntings are largely sedentary residents. This aspect of their ecology provides a considerable advantage in improving their population status. This is because introducing favourable agricultural practices in their key areas should increase both winter survival (through the provision of seed-rich stubbles and wild bird cover) and breeding success (through delayed harvesting/mowing for safe nest sites, re-nesting opportunities and insect food for chicks), with the impact on numbers being greater than if only breeding success was improved. Thus, the future of the population is very much under the influence of farming in Wales and over the border in England. An additional advantage is the continued presence of a potential source population within known dispersal distance along some 50km of the Welsh border (Fig. 1). However, successful conservation management is also required there to maximise the numbers of potential immigrants to occupy favourable conditions provided in Wales.

How imminent is their extinction?

If no Turtle Doves or Corn Buntings breed in Wales in 2010, then it will not be until at least 2029 before they can be considered extinct as breeding birds in Wales, following the definition of Johnstone *et al.* (2010). Even if this definition is met, they are still likely to occur on passage (Turtle Dove) or in winter (Corn Bunting).

With prescriptions packages for these species targeted to the most recently occupied sites being included in the new Glastir agri-environment scheme to be launched in 2012, and other tools being developed to target sympathetic agriculture in the right places (e.g. RSPB's BirdMap), the future of these species are very much in our hands.

ACKNOWLEDGEMENTS

The Turtle Dove project was a partnership between RSPB, Forestry Commission Wales (who contributed staff time) and the Wye Valley Area of Outstanding Natural Beauty (who funded the project and field staff). The project was managed by Debbie Scott. Ray Armstrong, Lindsay Tyler, Stephanie J. Tyler, Adrian Thomas and Jerry Lewis carried out the fieldwork. CCWs Species Challenge Fund supported Lizzie Webster during the Corn Bunting survey. We thank all those other volunteer surveyors who helped provide records of these species and to Ian Spence and Jerry Lewis for comments on this paper.

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Bird numbers from September to March on a grouse moor in north-east Wales, 1978-2005

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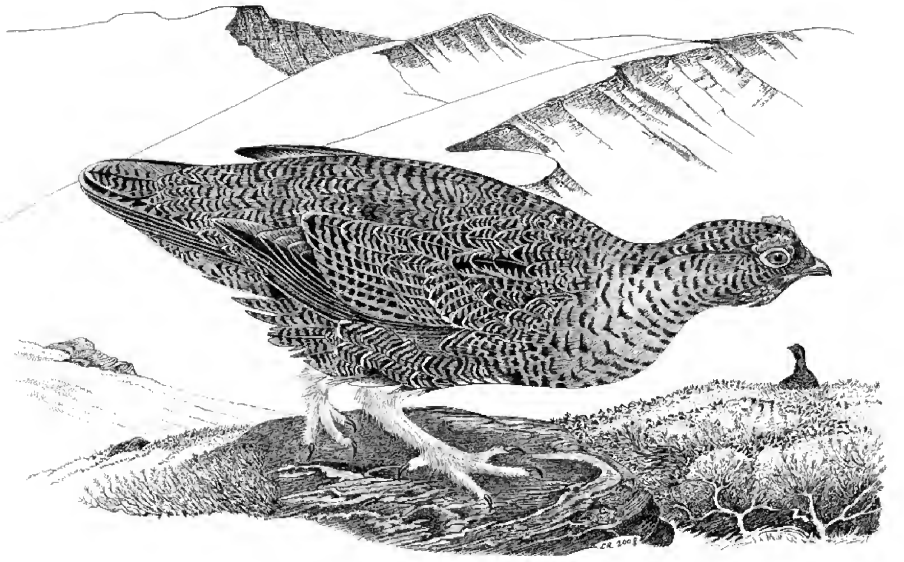


SUMMARY

Multiple annual transect counts of birds were made on a Welsh grouse moor from September to March in 1978-2005. All told, 44,586 birds of 61 species were recorded, Red Grouse, then Meadow Pipits being by far the most numerous. Mean all-species totals were highest in 1980-81, falling four-fifths by 1993-1994, then recovering to two-thirds of the original level by 2004-05. Monthly means fell from September to February, then rose in March.

Within the study period, larger upland-specialist species were mostly replaced with generalists. Red Grouse, Golden Plover, Lapwing and Curlew declined sharply and in synchrony between 1980 and 1993. Increases in Wrens, Stonechats and Reed Buntings showed strong correlation with rising winter temperatures. Hen Harriers declined in tandem with falling numbers of Red Grouse, then increased, along with generalist raptors and corvids, following introduction of Red-legged Partridges for shooting. Merlin presence on the moor was regular throughout the winter in the period 1979-1991, even in severe weather.

Possible causes of wader and Red Grouse declines are discussed.

CRYNODEB

Gwnaethpwyd nifer o gyfrifau trawslun blynyddol ar rostir grugiar Cymraeg o fis Medi i Mawrth yn ystod y cyfnod 1978-2005. Cofnodwyd 44,586 o adar o 61 o rywogaethau gwahanol, Grugiar a Phibyddion y Ddôl oedd y mwyaf niferus o bell ffordd. Roedd cyfanswm cymedrol pob rhywogaethau yn uchaf yn 1980-1981, cyn cwympo gan pedair rhan o bump erbyn 1993-1994, yna adennill hyd at ddwy ran o dair o'r lefel wreiddiol erbyn 2004-05. Cwympodd cymedrau misol o fis Medi i fis Chwefror, yna codi ym mis Mawrth.

O fewn y cyfnod astudio, disodlwyd rhywogaethau ucheldir mwy gan gyffredinolwyr yn bennaf. Gostyngodd niferodd y Grugiar, Cornicyll y Mynydd, Cornchwiglen a Gylfinir yn serth rhwng 1980 a 1993. Cynyddwyd nifer y Dryw, Clochdar y Cerrig a Bras y Gors gyda chydberthynas amlwg gyda tymhereddau cynyddol yn ystod y gaeaf. Gostyngodd niferodd Boday Glas ar y cyd â gostyngiad yn niferoedd y Grugiar Goch, cyn cynyddu, ynghyd ag adar ysglyfaethus cyffredinol a brain, yn dilyn cyflwyniad Petris y Graig ar gyfer saethu. Ni welyd newid sylweddol ym mhresenoldeb Gweilch Bach ar y rhostir drwy'r gaeaf yn y cyfnod 1979-1991, hyd yn oed mewn tywydd garw.

Trafodir achosion posib ar gyfer dirywiadau Adar Hirgoes a Gruigar Goch.

INTRODUCTION

In Wales, 'grouse moor' is near the southern limit of its world range. The status of its birds is thus of high conservation interest (see Ratcliffe & Thompson 1988). As elsewhere in Britain and Ireland, breeding numbers of certain characteristic moorland species have declined sharply since the 1970s in Wales (Lovegrove *et al.* 1994, Tyler 1991, Shrubb *et al.* 1997, O'Brien *et al.*1998, Sim *et al.* 2005, Johnstone *et al.* 2007, 2008). However, nothing seems to have been published on overall bird numbers on Welsh grouse moor outside the breeding season.

From 1978 to 2005, I made transect counts of all birds on a moor in north-east Wales between September and March. My aim was to determine species presence and abundance, seasonal fluctuations in numbers and any longer-term changes in status. Initial material on wintering Hen Harriers *Circus cyaneus* and their association with Red Grouse *Lagopus lagopus scoticus*, was reported in Roberts (1998). I now present the results of the study for all species.

METHODS

Position, physical features and vegetation

The 33 km sq. study area, Mynydd Rhiwabon (Ruabon Mountain) SSSI, lies at the eastern edge of the north Wales uplands, overlooking the Cheshire Plain (see Fig. 1). Altitude ranges from *ca* 300m to *ca* 565m asl, with most land at 350-490m asl. Rainfall averages 980mm at 280 m asl (Meteorological Office Data) and 1084 mm at 390m asl (Dee Valley Water). The moor is relatively well-drained, overlying millstone grits and Ordovician shales, limestone and boulder clay in roughly equal proportion. Deeper peat overlay is scattered and small in area. Vegetation is predominantly of dwarf shrub, mainly Heather *Calluna vulgaris* in association with Bilberry *Vaccinium myrtillus*, the latter increasingly dominant at lower altitudes. Locally, wetter-ground vegetation occurs in flushes along watercourses and as Heather/Hare's Tail Cotton-grass *Eriophorum vaginatum* blanket bog. Since 1980, when fire destroyed the surface cover of around half the moor, encroachment by
Bracken *Pteridium aquilinum* has advanced considerably on deeper soils.

Simultaneously, the ratio of old Heather to young increased progressively as a result of reduced burning, a situation mitigated to some extent since the late 1990s by burning and cutting performed by gamekeepers and the RSPB Black Grouse Recovery Project. Especially since the late 1980s, encroachment by conifers, birch *Betula* sp. and Rowan *Sorbus aucuparia* has been considerable.

Land use; history of game shooting and management

The moor is grazed by sheep between March and October, but numbers have been strictly limited throughout and have even fallen in recent years. Over-grazing is mainly confined to the fringes, mostly on limestone areas.

Historically, Ruabon Mountain was Wales's most productive grouse moor in terms of its Red Grouse 'bag' (*i.e.* numbers of birds shot). Records dating from 1885 show that over 4,000 Red Grouse were shot in each of 11 of the 14 years prior to World War 1 (Wynnstay Estate Archives). Maximum bags per day of over 1000 birds occurred in nine of these years. The Welsh record year bag (7142) and day bag (1774) date from 1912. Numbers then fell, as over much of Britain (Watson & Moss 2008), more than halving between the World Wars (Table 1).

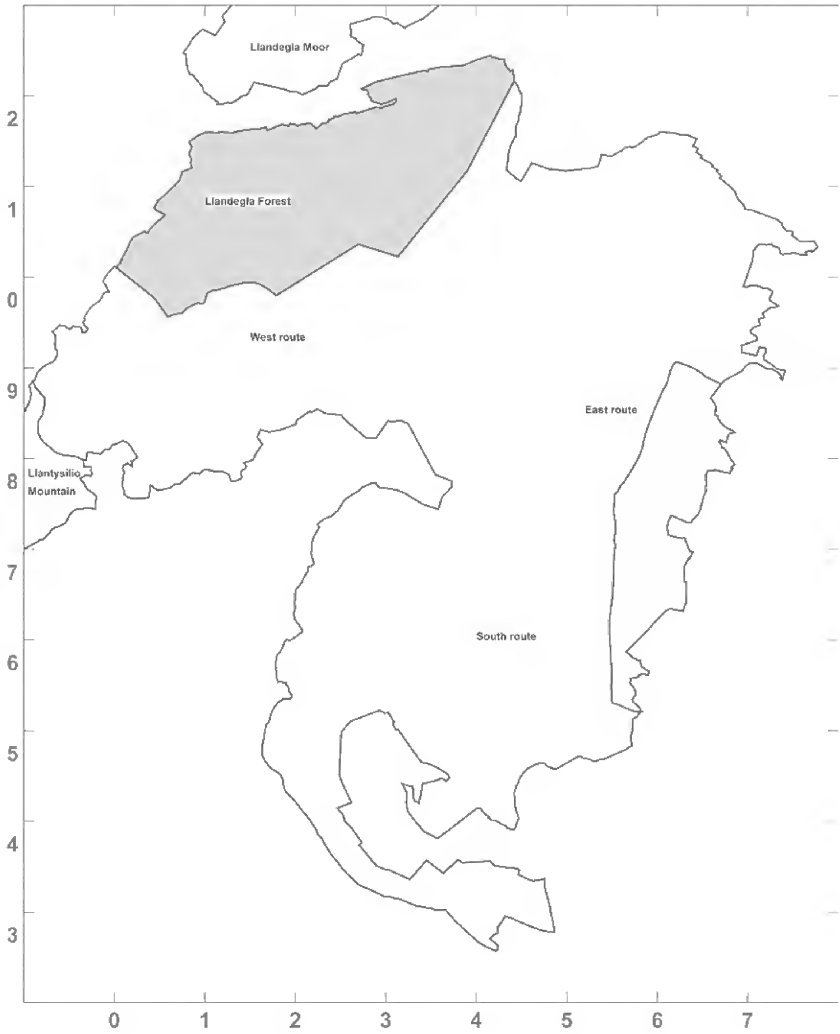


Figure 1. Map of Ruabon Mountain (ca 33 km sq.)
The moor is centred at ca. 2 deg. 8. 07' W, 50 deg. 01' N, in grid square SJ24. Altitude ranges ca 300-565m asl, with most land at 350-490m asl.

Notes: 100m intervals are marked on the margins; the vertical axis is due north; the lightly shaded section shows where Red-legged Partridges were released and shot from summer 1997.

Table 1. Average Red Grouse shooting bags on Ruabon Mountain, 1885-1974
'Bag' is total number of birds shot

	1885-99	1900-14	1915-39	1955-64	1965-74
Average annual bag	1775	4599	2039	617	821

Shooting was suspended in 1940, when use of the moor as a decoy to enemy bombers resulted in conflagration. Regular keepering resumed in 1952 and bags rose to a new peak in 1966, albeit less than half the inter-Wars maximum. The overall decline then continued until 1993, when grouse shooting ceased to conserve stocks. Unlike on certain moors in northern England and in Scotland, occurrence of peaks and troughs in numbers is irregular, showing no cyclicity (A.Watson *in litt.*).

From summer 1997, Red-legged Partridges *Alectoris rufa* were released annually, for shooting, on one flank of the moor. In 1999 numbers involved rose to many hundreds, but stayed fairly constant thereafter. Most shooting took place from September to December, while from February a proportion of surviving birds was caught and removed from the moor.

Throughout, pest control and heather management were performed by gamekeepers, their numbers ranging between one and 3 since the 1950s. From before the 1990s keeper effort diminished markedly on the western third of the moor. Late in the decade, a still-running programme of small-strip heather mowing by the RSPB Black Grouse *Tetrao tetrix* Recovery Project improved the habitat for both grouse species, in that area and in the central band of the moor. By the time of writing, this has resulted in a patch-work of short and long vegetation.

Land use on surrounding ground
In 1972, 7 km^2 of moor at the NW edge of the site, under different ownership and now known as Llandegla Forest, was planted with exotic conifers. Other conifer plantings, mostly post-war, are much smaller. Altogether, of the 48 km moor boundary, 13 km abuts conifer forest, the rest mainly fenced, intensively grazed sheep pasture, interspersed with wooded gullies. Mostly by the 1960s, a 1.5km sq. swathe of the south end of the moor was ploughed and converted to grass and forest, seriously fragmenting the remainder.

Llantysilio Mountain, joined to Ruabon Mountain by a 1 km-wide neck of moorland, was probably no longer managed by a full-time moor keeper by the 1950s (R. Greenwell, pers. comm.). Subsequently, large-scale burning by graziers, sometimes uncontrolled, became standard practice. In a survey of Welsh Heather moors in 1990-1991, Williams *et al.* (1991) placed its remaining 6 km^2 of Heather moor in their 'poor cover' category (<80% cover and patchy), with only small patches of rank growth and several areas dominated by Bilberry.

The 3000 ha Llandegla Moor formed a northern extension of Ruabon Mountain until the planting of Llandegla Forest in 1972. It was managed for grouse shooting by gamekeepers, probably until the early 1980s. After this, reduced burning, coupled with under-grazing, led to degradation of heather and spread of trees. In 1990, Williams *et al.* (1991) found 'rank Heather, even-aged and without evidence of regeneration, much of it dead at the base', covering 75% of its area. By 2000,

there was widespread encroachment of broad-leaved saplings.

Study methods

Period 1(1978-2003)

In the first season of study, 1978-1979, I walked a standard route of 10.7 'map km' 12 times from September to 1 April (referred to in this paper as the 'count season'). In autumn 1979 the route was extended to 13.7 km and up to 1993-94 was walked an average of 14.5 times annually. My aim was to count every fortnight and weekly in March, but constraints of time and weather led to a more flexible schedule, including two counts in early April (Appendix 1). The route was designed to cross most altitude bands and micro-habitats, and included stream courses, a damper flat and the exposed central ridge. I walked at brisk pace and transects took 4-5 hours, depending on numbers of stops for writing purposes, state of Bracken and energy of counter. Counts were made in relatively calm and dry weather, began at sunrise, and involved recording all birds flushed, seen flying or heard within ca.150m. Binoculars were used only to help counting or identification, not for distant scanning. The route was divided into topographically separate sections and records grouped accordingly.

Weather conditions were noted and maximum and minimum temperatures recorded - until autumn 1983 at 130m asl and thereafter at 105m asl (Appendix 2).

Period 2, 1994-2005

From autumn 1994, Period 2 of the study, I added two new routes, of 9.7 and 12.5 'map km', thus extending coverage to most parts of the moor. Of these routes, the original, renamed East Route (ER), and the South and the West Routes (SR, WR), respectively covered the majority, a little and none of the subsequent partridge release and shooting area. My plan, initially, was to walk each route four times annually, in September/October, November, February and March but there was considerable overlap into other months, including four April counts (Appendix 1).

Treatment of data

The following categories are excluded from this report: birds migrating over the moor; Black Grouse on the lek; and Red-legged Partridges recorded since autumn 1997. Possible migrants using the moor as a resting or refuelling place were included.

As numbers of counts varied between years, annual bird totals are given as the mathematical mean per count for the count season. Where appropriate mean counts from September/October or from March were used in analyses. Most analysis began from 1979-80. In the few cases where1978-79 means were used, these were adjusted to compensate for the shorter count route covered in that season. This involved applying the formula $X = A*(B+1)$, where X is the adjusted mean for 1978-79, A the unadjusted mean for that year and B is the proportion of the 1979-80 mean taken up by the section of count route added in that season.

In 1986-87 only one March count was made, and in 1995-96 and 2000-01 none, in the last case because of access restrictions due to foot-and-mouth disease. In calculations of annual and monthly trends from Period 2, usually only data from ER were used in analyses, though where there was strong similarity between numerical trends from that route and from all three routes combined (AR), the latter may be quoted to enlarge the sample. In those cases, totals from SR and WR were multiplied by 1.412 and 1.096 respectively, to allow for the different lengths of these routes.

An index of winter severity was calculated as the annual sum of minimum and maximum daily

temperatures below 1° C in December-March, with daytime values multiplied by a factor of 2 (Appendix 2). Temperature in 1978-79 and December 1981 was not recorded locally, but for the purpose of rank test analysis, the former is allocated a nominal value higher than that of 1981-1982. This accorded with temperatures recorded at the Hadley Centre in Central England (Meteorological Office data). All tests for correlation are 2-tailed, made using the programme SPSS (Version 17).

RESULTS

Overall abundance and species composition

Altogether 44,586 birds of 61 species were encountered in 4389 km of transects. The Period 1 (1979-93) bird total was 32,923 of 52 species c.f. 11,727 birds of 51 species seen on all three routes (AR) in Period 2 (1994-2004) and 5083 birds of 41 species on ER only in that period.

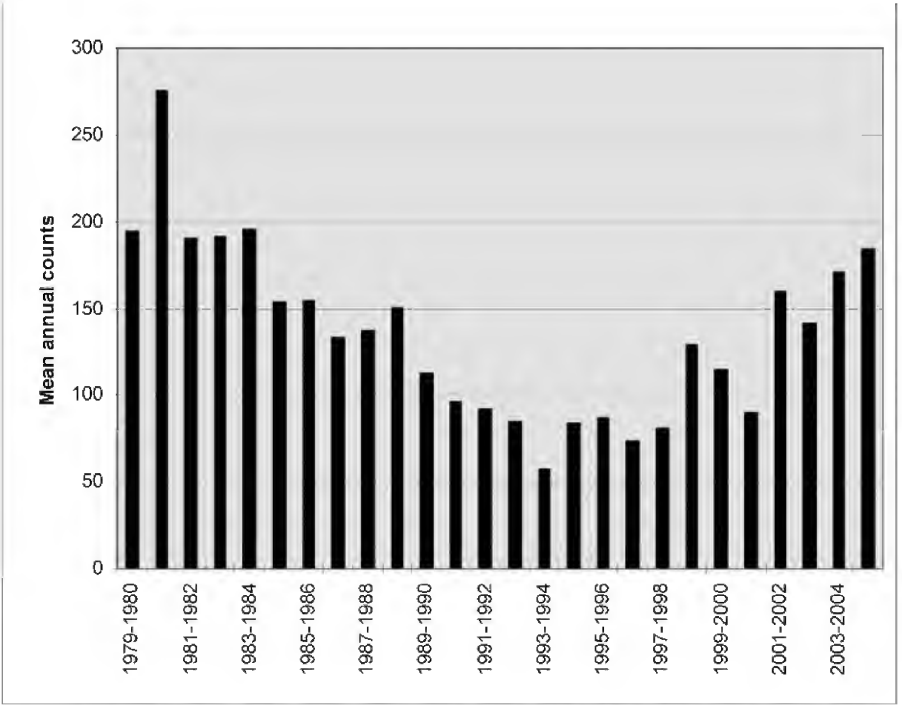


Figure 2. Mean annual counts, East Route, 1979-2005

Figure 2 shows the mean total per count, thus allowing for variation in numbers of counts between years. From a maximum in the first five years of counting, numbers declined to a low point in 1993-94. This was followed by gradual recovery in Period 2, reaching a level close to that at the start of the study by 2004-05.

Annual totals of species ranged between 33 and 22 where data from AR are used for Period 2 (Fig. 3). The much lower number of counts on ER in Period 2 is reflected in lower species totals there: 20 on average, as against 27 in Period 1. Predictably, given AR's wider coverage, more

species were seen there than on ER alone, though the average difference between them fell from 10.2 species in the first six years to only four in the last five years. Lowest species counts were in 1986-87 and 1995-96, years with one and no March counts respectively.

Some 22 species were encountered sufficiently often to be considered regular. These were Mallard *Anas platyrhynchus*, five raptors, three gamebirds, four waders and 10 passerines (including two corvids). For these, overall count totals along with means, range and SE for Periods 1 and 2 are given in Appendix 3. Species seen more rarely are listed in Appendix 4, with totals of individuals and number of counts involved.

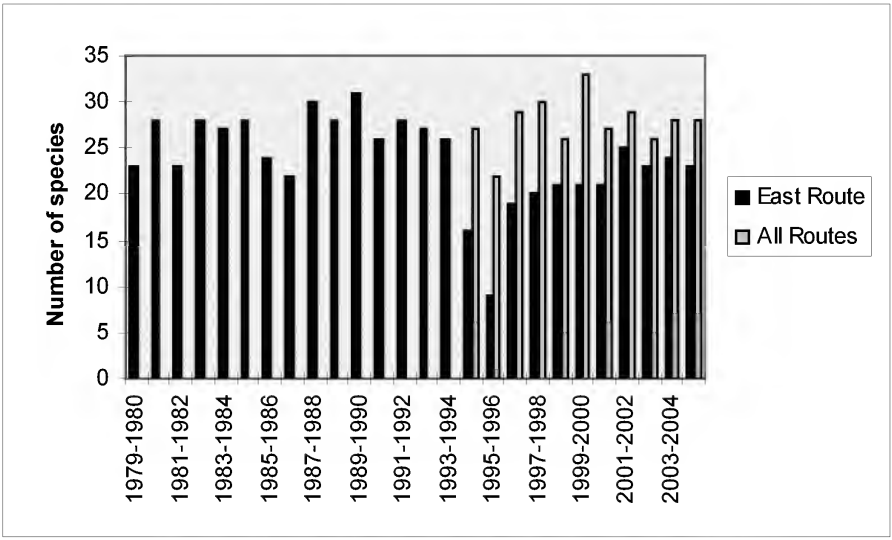


Figure 3. Annual totals of species recorded, East Route and All Routes, 1979-2005

Trends in monthly means within and between count seasons

Predictably for moorland, overall means of birds encountered varied greatly between months, falling sharply after September and rising again in March (Fig. 4). In Period 2, samples from September, December and January were too small to merit inclusion. In contrast with Period 1, March values exceeded those from October due to the much greater proportional contribution of Meadow Pipits *Anthus pratensis* to overall totals in this period (see Appendices 3 and 5).

Monthly mean counts of 16 species where values approach or exceed 1.0 are given in Appendix 5. These fall into often overlapping categories of resident and migrant breeders, autumn passage birds and species breeding primarily outside the moor but using it for foraging. Only the Fieldfare *Turdus pilaris* is present exclusively in winter. Months of occurrence of species seen rarely are included in Appendix 4.

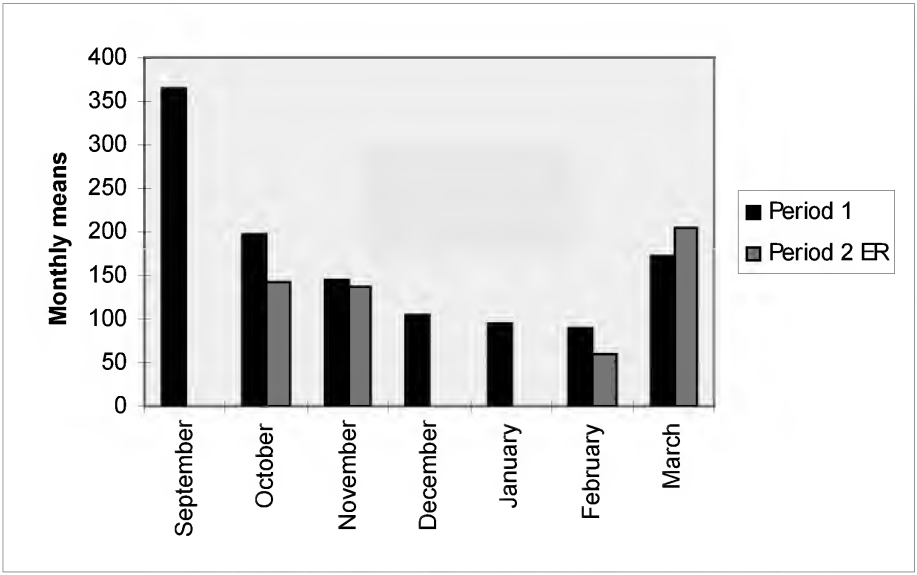


Figure 4. Monthly mean counts of all birds on the East Route, 1979-2005

Resident species

Red Grouse, all but restricted to moorland by their diet, declined steadily in numbers between September and March. Five experimental counts from July/August, not included in annual averages, were on average lower than September/October counts from the same year. The late July total from 1987 was one-third of its successor in late September. The rate of annual decline between September/October counts and those in March showed significant positive correlation with summed degrees of frost: $r_s = 0.764$, n= 15, $P<0.001$. Neither May nor June temperature influenced proportional increase in count means between March and October of the same year, nor were they related to the autumn shooting bag.

In contrast with Red Grouse, numbers of Wrens *Troglodytes troglodytes*, whose diet permits movement to and from non-moorland ground, stayed fairly stable through to November, dipping thereafter and recovering slightly in spring.

Hen Harriers and Merlins *Falco columbarius* occurred throughout the winter. Based on very small numbers, as with all raptors in this study, Hen Harriers were most numerous in November-December and, again, in March. Merlins were recorded most often in October and January of the pre-spring months and most often of all in March, when pairs display conspicuously in their breeding areas (pers. obs.). Some 76 supplementary records from September-February 1979-1991 confirm all-winter presence of Merlins on or close to the moor, even in a period of severe winters (Table 2). Of these records, 33 were in December-February, 14 of them from 1979-1982, when only six Meadow Pipits were recorded on transects in those months.

Table 2 All records of Merlins on and near moorland, September-February, 1979-1991 Non-transect count values are totals, while transect counts are means (* sightings within 1 km of moor edge; values in parenthesis are numbers of transect counts)

	Sept	Oct	Nov	Dec	Jan	Feb
Non-transect (on moor)	5	14	4	9	12	15
Non-transect (off moor*)		3	1	4	8	1
Total non-transect	**5**	**17**	**5**	**13**	**20**	**16**
Transect	1 (10)	8 (27)	6 (25)	5 (28)	7 (25)	6 (23)
All records	**6**	**25**	**11**	**18**	**27**	**22**

Spring migrant breeders
Mallard, Curlew *Numenius arquata*, Golden Plover *Pluvialis apricarius* and Lapwing *Vanellus vanellus* returned in spring to breed on the moor, occurring mainly in March within the present study, Curlews exclusively so. The other three species appeared in warm spells in February, rarely even in January. All four left soon after breeding, usually before August (pers. obs.). Autumn records were few, those of Golden Plovers being more frequent than those of Lapwings, with 17 records and three respectively. In the last six years of study there were eight autumn records of Golden Plovers c.f. only 10 in the first 20 years. The former figure included five birds seen on SR or WR, on ground covered in only five of the first 20 years.

Spring migrant breeders with limited presence in autumn/winter
Skylarks *Alauda arvensis*, Meadow Pipits and Reed Buntings *Emberiza schoeniclus* were numerous at both ends of the count season, especially in September. Numbers fell sharply through to late winter, rising in February for Skylark and in March for the pipit and bunting. Skylarks were most numerous in spring, Meadow Pipits and Reed Buntings in September.

For Meadow Pipit, experimental counts in July and August of four years point to an increase in numbers from July to September. Altogether in the study, there were 8 months with nil totals for this species, all prior to autumn 1986 and thus within the period of coldest winters. These were December (1), January (3) and February (4). In Period 2, Meadow Pipit March means were almost double those from October, whereas in Period 1 they were greater by only a fifth. Neither annual, March nor September-October means show correlation with degrees of frost in the current or previous winter.

Raptors and scavengers resident near the moor and foraging on it
Generalist predators and scavengers - Ravens *Corvus corax*, Carrion Crows *Corvus corone corone*, Buzzards *Buteo buteo*, Peregrines *Falco peregrinus* and Kestrels *Falco tinnunculus* - were present throughout the count season. The corvids increased to October, fluctuating thereafter, with Raven counts falling by March but Carrion Crow numbers rising then. Kestrels declined sharply after October, while Peregrines peaked in November and dwindled into March. Again, however, the smallness of monthly totals of raptors should be noted.

Changes in numbers over time

Overall trends in numbers

Of species regularly encountered in the study, my counts show that six increased, six decreased, one decreased then increased, and nine showed little overall change in status. For these, Table 3 gives status and correlates of change against years and, where relevant, against December-March temperature.

Proportions of certain groups of species changed greatly between the early and later years of the study (Figure 5). In the first 5 years, Red Grouse and waders were almost three-quarters of all birds counted, with Meadow Pipits and Skylarks as the majority of the remainder. From 1999 (excluding 2000-01 because no March counts were made that season), small passerines comprised over half the count total; the remainder were largely corvids and generalist raptors. Red Grouse and waders made up <5% of the total.

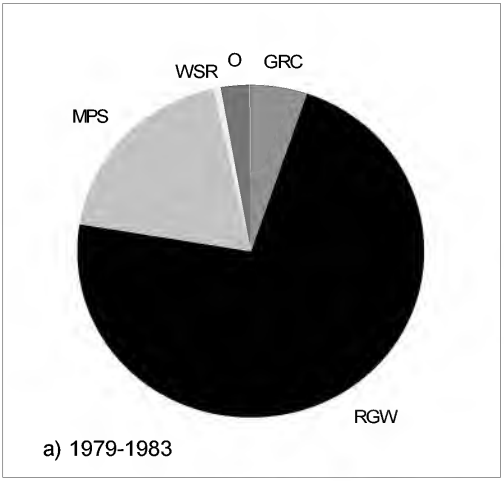
Table 3 Correlates of more frequently occurring species on Ruabon Mountain, September-March 1978-2005

Population status: + - increase, minus sign - decrease, = unchanged; 3 - March mean, 9 - September/October mean. * Sample size in parenthesis; [i] Hen Harrier and Black Grouse - upper row - 1979-95, lower row - 1995-2004.

	Year			Degrees of frost in current year		Degrees of frost in previous year	
	Status	**r_s value***	**P<**	**r_s value***	**P<**	**r_s value***	**P<**
Mallard	3 =	-.05 (24)	0.815	-.527(26)	0.006	-.545 (26)	-.004
Hen Harrier[i]	- +	-.910 (17) 0.875 (10)	0.0001 0.002				
Buzzard	+	0.759 (26)	0.0001				
Kestrel	=	0.26 (26)	0.199				
Merlin	=	-.391 (26)	0.048				
Peregrine	+	0.641 (26)	0.018				
Red Grouse	-	-.976 (26)	0.0001	0.527(26)	0.006	0.583(26)	0.002
Black Grouse[i]	= =	-.35 (17) 0.506 (10)	0.164 0.136				
Pheasant	+	0.415 (26)	0.035				
Golden Plover	3 -	-.872 (24)	0.0001	0.481 (24)	0.017	0.395(24)	0.058
Lapwing	3 -	-.715 (24)	0.002	0.781 (24)	0.0001	0.433(24)	0.035
Snipe	=	-.293 (26)	0.146				
Curlew	3 -	-.748 (24)	0.0001	0.438 (24)	0.017	0.463(24)	0.023
Skylark	3 =	-.073 (24)	0.734				
Meadow Pipit	3 = 9 =	-0.28 (24) -.455 (26)	0.185 0.02				
Wren	+ 3 +	0.893 (26) 0.710 (26)	0.0001 0.0001	-.425(26) -.646 (26)	0.03 0.0000	-.621 (26) -.492 (26)	0.001 0.011
Stonechat	-	0.736 (26)	0.0001	-.527 (26)	0.006	-.545 (26)	0.004
Fieldfare	-	-.520 (26)	0.006				
Goldcrest	=	0.244 (26)	0.231				
Raven	=	0.218 (26)	0.285				
Carrion Crow	=	0.367 (26)	0.065				
Reed Bunting	+	0.736 (26)	0.0001	-.545 (26)	0.004	-.218 (26)	0.285

Raptors and corvids

Contrasting trends are apparent in the two moorland 'specialist' raptors, Merlin and Hen Harrier (Table 3). Numbers of Merlins fell sharply from 1979, staying consistently low thereafter. Hen Harriers declined to nil by 1994, in strong correlation with numbers of Red Grouse (Fig. 6). Wintering resumed on ER in 1997, the year when Red-legged Partridges were released for shooting, and numbers rose significantly, returning to their 1979 level by the end of the study.



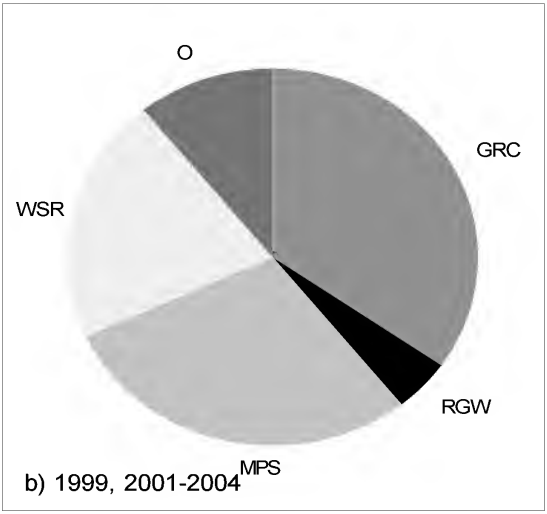


Figure 5. Changes in proportions of certain categories of species *(Codes: GRC - Generalists raptors and corvids; RGW - Red Grouse and waders; MPS - Meadow Pipit and Skylark; WSR - Wren, Stonechat and Reed Bunting; O - other species.*

Wintering birds were almost exclusively 'ring-tails', probably females, with only one 'grey' male in 197 observations on AR or in 182 on ER (see Roberts 1998). Since 2005, 'grey' males have been reported during winter months (S. Hart, H. Nash, pers. comm.).

Numbers of Peregrines, Buzzards and Kestrels - 'generalist' raptors - showed little change until the late 1990s, when the first two increased significantly, the last apparently. Peregrines are known to prey frequently on Red Grouse (Thirgood *et al*. 2000) but their numbers showed no correlation with this species' decline. Buzzards were encountered rarely before 1998, with only 18 sightings in 19 years of study. In the following seven years, there were 46 encounters.

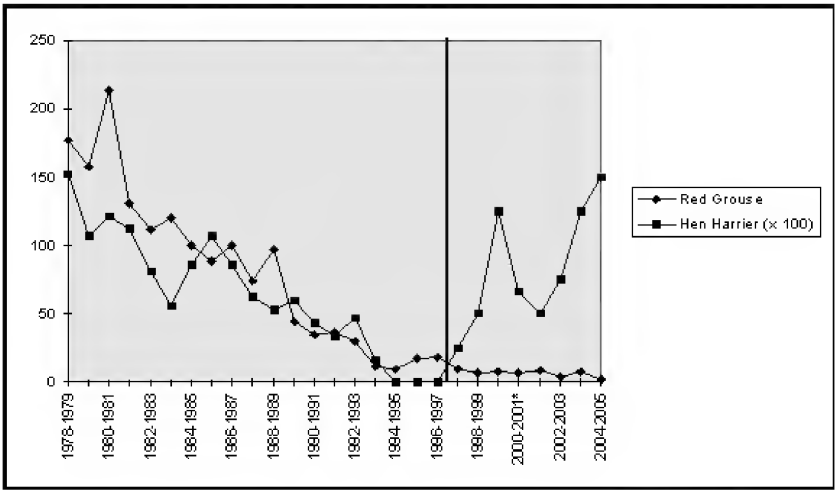


Figure 6. Hen Harrier (x 100) and Red Grouse annual means, East Route, 1978-2004
(Correlation up to 1996-97: r_s 0.872, n = 17, P<0.0001; The vertical line shows when Red-legged Partridges were introduced en masse for shooting)

Carrion Crow and Raven numbers showed no significant overall change in time, though means were larger late in the study (Fig. 7). Numbers of the two species were well correlated (*ibidem)*. Carrion Crow means fluctuated strongly between years due to chance encounters with flocks of non-breeding birds: there were 12 count days with 25 or more birds seen and 120 days with none recorded. From 1991 to 1997, lower means accompanied a concerted crow removal campaign by the gamekeeper. Numbers then increased sharply, annual means in all remaining years of study far exceeding any recorded to date. Raven numbers were lower, fluctuated less in the earlier years and rose later, from 2001, when a flock of non-breeders began foraging at the partridge feeders and returned in two of the next three years.

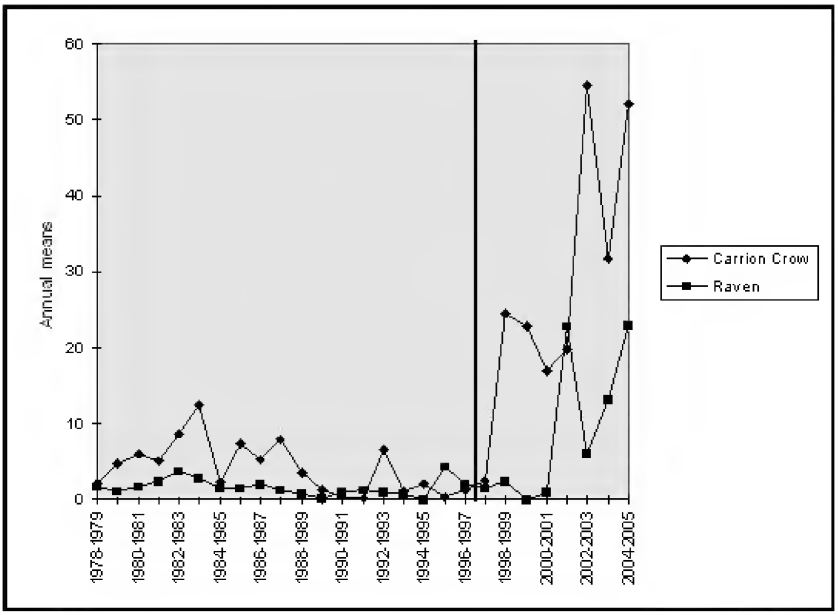


Figure 7. Carrion Crow and Raven mean counts, E Route, 1979-2004.
Correlation: $r_s = 0.470$, $n = 26$, $P<0.015$;

Red Grouse

Over 21,000 Red Grouse were counted, by far the largest number for any species in the study. Means and maxima for September/October, for March and for the whole count season showed close correlation ($P<0.0001$ in all cases). Values declined from a peak in 1980-81 - sharply until 1982-83, more gradually in the next 3 years, a sharp decline returning between 1987 and 1994 (Fig. 6). That this decline was part of a long-term pattern is confirmed by shooting bag records (Table 1). These showed significant declines between 1970 and 1979, though numbers peaked in 1981 (Fig. 8). However, bags are the product of all shooting days in a year. These days vary in number between years and in the total of 'drives' taking place on each day. (Drives involve lines of 'beaters' flushing grouse towards stationary, concealed shooters.) A more precise measure of numbers of grouse present is the annual mean bag per drive. This was available from 1975 onwards. Between 1979 and 1993, when shooting ceased, these means were strongly correlated with my counts (Fig. 9).

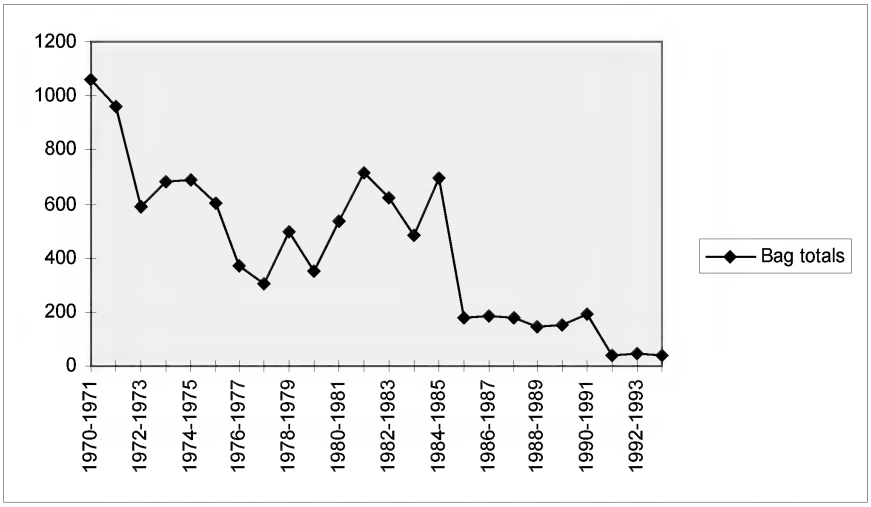


Figure 8. Red Grouse shooting bag totals, 1970-1993 *(Declines were significant: 1970-1979 r_s=-0.855, n=10, P<0.002; 1979-1993 - r_s = -0.752, n=19, P<0.0001*

Annual Red Grouse means showed positive correlation with summed degrees of frost between December and March of the previous winter, only marginally weaker with the same parameter in the current winter (Table 3). However, degrees of frost were well correlated with year, winters declining in severity with time: r_s = -0.527, n= 26, P<0.006. Finer-scale testing, over the periods up to and after 1993, shows much weaker correlation with cold, with probability of only <0.051 for 1979-1993 and <0.5 for 1994-2004, for both current and previous winters.

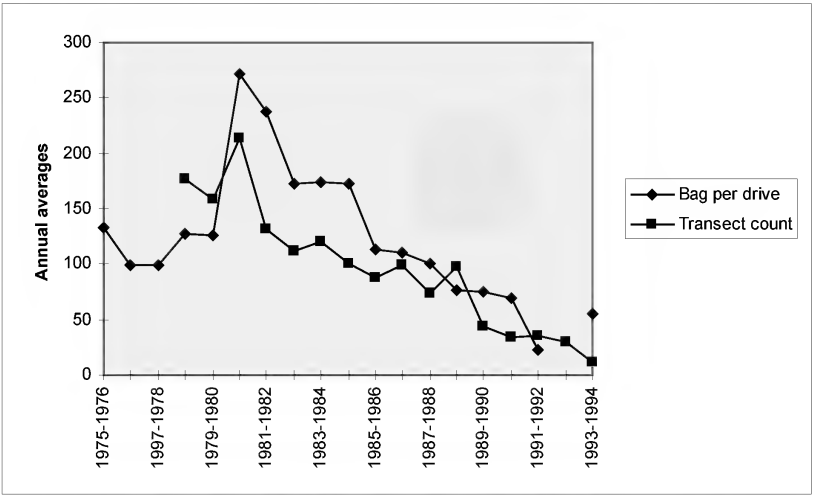


Figure 9. Mean counts of Red Grouse versus mean shooting bag per drive, 1978-1993. *The 1978-79 autumn count has been adjusted to allow for the omission of a section of moor included from 1979-1980 (see Methods, treatment of data). No driven shooting took place in 1992-93. Correlation, 1979-1993: r_s = 0.913, n = 14, P<0.0001.*

Black Grouse and Pheasants

Black Grouse numbers apparently declined from 1979-80 to the mid-1990s and rose thereafter (Table 3). On ER, count means more than trebled between 1993-2000 and 2001-2004, from 0.37 to 1.25: $\chi^2 = 7.356$, 1df, $P<0.01$. On AR, which traversed the area containing most leks on the mountain, count means rose from 1994 to 2002, remaining lower in the next three springs.

The increase in Pheasants *Phasianus colchicus*, which appear to use the moor mainly for roosting, accompanied the release of larger numbers for shooting in woods < 1km from the moor edge.

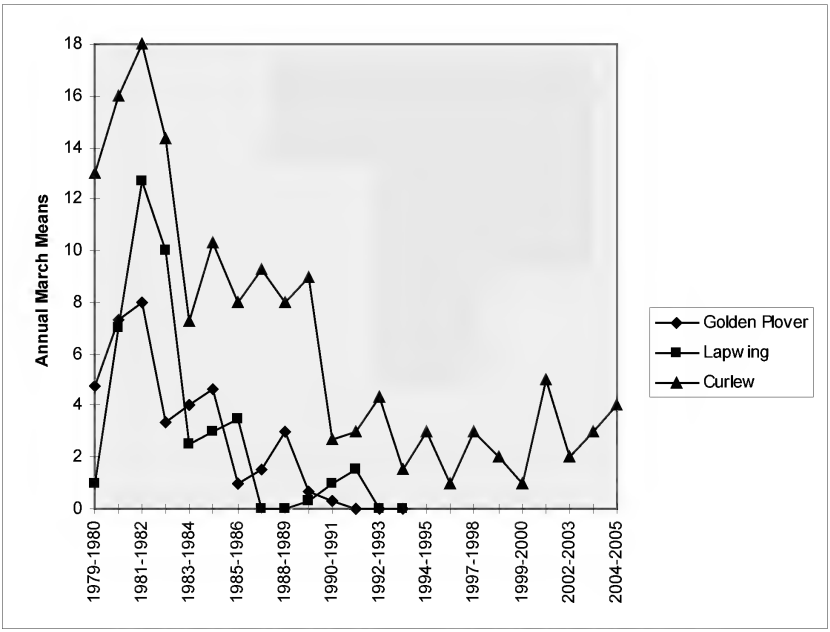


Figure 10. Annual March means of waders, 1979-2005 *(Count seasons omitted: 1986-87, 1995-96 and 2000-01. Curlew means after 1994 are for All Routes.Correlations (n = 24 in all cases): Curlew with Golden Plover - $r_s = 0.844$, $P<0.0001$; Curlew with Lapwing - $r_s = 0.599$, $P<0.002$; Golden Plover with Lapwing - $r_s = 0.650$, $P<0.001$).*

Mallard and waders

Means and maxima from March counts of Curlew, Golden Plover and Lapwings were strongly correlated, within and between species (Table 3, Fig. 10). All three peaked in 1981, in the spring following the big fire of April 1980. They then declined significantly, in strong synchrony with numbers of Red Grouse (*ibidem*, Fig. 11). In Period 2, there were only two spring records of Lapwings, involving seven birds (two on ER), while seven Golden Plovers were seen in nine years on SR and WR combined. Snipe *Gallinago gallinago* numbers were very small and showed no overall change.

As with Red Grouse, over the duration of the study numbers of Golden Plovers, Lapwings and

Curlews were positively correlated with summed degrees of frost in the same and previous winters (Table 3). Here, though, the strength of correlation was reversed, being weaker for the previous winter. To refine the test it was then limited to Period 1 data, where six of the 15 winters involved were relatively mild. No correlation was apparent for Golden Plover and Curlew, but it remained strong for Lapwing: $r_s = 0.827$, n = 15, $P<0.0001$. However, count totals of Lapwings were particularly small, containing four zero values and eight tied ranks, thus weakening the test.

For Mallard, the correlation with cold was strongly negative and was slightly weaker for the current than for the previous winter (Table 3).

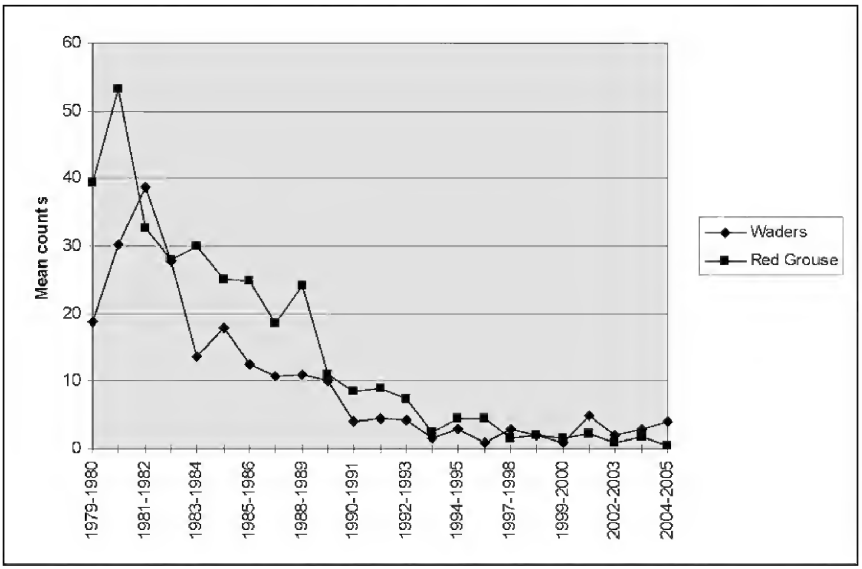


Figure 11 Red Grouse annual means (x 0.25) versus combined wader March means, 1979-2005. *Count seasons omitted: 1986-87, 1995-96 and 2000-01. Curlew means after 1994 are for All Routes.Correlations 1979-80 to 1993-94 (n = 15 in all cases): Curlew with Red Grouse - $r_s = 0.780$, $P<0.001$; Golden Plover with Red Grouse - $r_s = 0.876$, $P<0.0001$; Lapwing with Red Grouse - $r_s = 0.670$, $P<0.006$.*

Small passerines

Skylark and Meadow Pipit March means showed no trend in time, but varied much between years (Table 3). Because Meadow Pipits usually arrive suddenly and *en masse* in March, these means were drawn only from counts on or following the species' main arrival date. There was no correlation between these spring means and those from the previous autumn or the whole count season. However, the means involved are subject to bias.

Firstly, years without September counts have lower autumn and annual means. In Period 1, all 12 counts in this month numbered >100, as against only two in October, both of these very early in the month. Next, many Meadow Pipits migrate over the moor in the autumn, sometimes landing to spend the night, re-fuel or avoid adverse weather (unpubl. data). The varying scale

and irregularity in occurrence of these events, and the difficulty of distinguishing birds actively migrating, affect means. Finally, even March totals based on counts after the main arrival are sometimes small. Within this period, later counts are larger on average than early ones, probably a result of staggered arrival during prolonged cold weather coupled with the species' tendency to leave the moors temporarily even in brief cold spells (pers. obs.).

Numbers of Wrens, Stonechats *Saxicola torquata* and Reed Buntings increased during the study period. All three show negative correlation with summed degrees of frost in the same winter, the first two with the same parameter in the previous winter (Table 3). On a finer scale, too, Wren numbers reflect severity of weather. Five times, in the period of coldest winters (1978-87), numbers fell to zero following heavy snowfalls and freezes in December/January. They recovered little in between. Comparable 'dips' happened after the freezes of 1995-96 and 2000-01, but recovery was more rapid.

Changes within areas between years

Effects of the 1980 fire on Red Grouse and waders

The 1980 fire occurred on the 19th April, when Red Grouse territories would be well established, with many hens already laying eggs (Watson & Moss 2008). Opportunistic recording and the gamekeeper's observations (pers. comm.) suggest that several pairs continued to hold territory on the burnt ground, the hens re-laying in strips of vegetation that survived the fire. There was evidence, however, of movement away from this ground. The proportion of grouse counted on the unburnt section of my route rose by 6% in the 1980-1981 count season in comparison with the previous year. In the following season, this process was reversed, with a 15% proportional increase on the burnt section, the increase continuing more slowly till 1984-85, after which no trend was evident. However, means on both sections of the route declined overall from 1981-82.

Contrasting patterns were apparent amongst waders. Curlews were proportionally only half as numerous on the burnt section in the March following the fire, this figure halving again in 1982 but proportions rising thereafter. For Golden Plover and Lapwing, proportions on the burnt section were higher than before the fire for two and five years respectively, though numbers involved were small, particularly for Lapwing.

Table 4 Differences in numbers of raptors and corvids between Period 2 count routes after 1996. ER - East Route; SR - South Route; WR - West Route; ** - significant at P<0.01

	n/ratio ER:SR:WR	χ^2
Hen Harrier	26:10:9	12.495**
Buzzard	46:11:15	29.743**
Peregrine	55:12:40	26.629**
Carrion Crow	882:302:235	535.681**
Raven	279:171:177	35.254**

Differences between count routes after 1996

Ratios of Red Grouse, corvids and certain raptors on the three Period 2 count routes showed change following the introduction of Red-legged Partridge in the summer of 1997. Red Grouse count means on ER had exceeded those on WR and SR combined in 1994-1997 but fell significantly below them thereafter: $\chi^2 = 22.75$, 1df, P<0.01. Hen Harriers, Buzzards and Peregrines were seen

more frequently on ER than on SR or WR in the period from 1997 (Table 4). Numbers from SR and WR prior to 1997 were too small to admit comparison, as counting on these routes began only three years earlier.

Distances of Blackgame from leks
Overall, Blackcocks - excluding actively lekking birds - were seen more often close to, than distant from, leks: $\chi^2 = 5.14$, $P<0.05$. At two leks, numbers of Greyhens counted were higher than those of Blackcock where the count route passed 300m from and out of sight of the lek They were lower than for males where the route passed within 50 m and in view of the lek. In Period 2, overall numbers of Black Grouse on ER (33) were significantly lower than those on SR (88) and WR (126): $\chi^2 = 5.14$, 2df, $P<0.01$. At that time, two of the largest leks were close to WR and birds from the next largest lek, on the fringe of ER, spent most of the day on ground covered by SR.

Associations of small passerines with habitat
In Period 2 more Skylarks were recorded on ER (127) than on SR (31) and WR (54): $\chi^2 = 5.14$, $P<0.01$. The ratio roughly reflects the proportion of shorter vegetation, the species' preferred habitat, on these routes.

Wrens were recorded much more frequently on broken, especially boulder-strewn ground in stream courses and other hollows, including stone shooting butts built into the ground, bomb craters from WW2 and disused mine shafts and buildings. In and after cold seasons the species was restricted to 3 locations: the deepest, most steep-sided gulley, a gorsy fringe and the garden of the keeper's lodge. Later, in seasons of high numbers, Wrens were also found on high altitude, gently sloping banks of tall Heather.

In freezing conditions, the few Meadow Pipits seen were almost invariably in sheep-tracks or footpaths cut by hooves and boots into the surface of the ground and attracting run-off rain water. Flushed birds moved ahead, keeping to the track, eventually returning to it behind me. This suggested a degree of territoriality in these birds.

DISCUSSION

Advantages and limitations of the study
This study is probably unique in Wales in using multiple annual counts over a 26 year period outside the breeding season. Together with the standardised methods used, this should provide a robust index of extent, timing and rapidity of changes in numbers. In addition, the study coincided with a period of major change in upland land-use in Wales and spanned two periods of climatic contrast, typified by severe and mild winters.

Only three or four species are fully resident on the study moor, the remainder using the ground primarily for breeding or as part of larger foraging ranges. This resulted in small count totals for many species, with 58 showing annual means of less than 1.0 in both study periods or, like Teal *Anas crecca*, occurring rarely but in sizeable flocks. This problem is compounded by the small number of counts on ER in Period 2: 4 and 3, in each of nine and two years respectively. March counts, important for spring migrant breeders, were absent in two years, while the absence of September counts in seven of 26 years affects the annual means of the seven species most numerous in that month.

Except on grouse species, published data from other Welsh moors are exclusively from the

breeding season. A report on breeding birds on Ruabon Mountain is being compiled and detailed comparison of its results with those from elsewhere in Wales will be presented there. In the following section, only summary reference is made to work from that season.

Status of raptors and corvids

Of the two specialist moorland raptors, the decline then rise in Hen Harrier means showed no correlation with breeding numbers on this moor, or in the species' Berwyn stronghold (in Thorpe *et al.* 2004). Similarly, the pattern of decline in winter Merlin sightings did not reflect the rapid fall in breeding numbers after 1981, followed by modest, short-lived, recovery in the late 1990s (Roberts & Green 1983, Roberts & Jones 1999a, unpublished data). Elsewhere in Wales breeding numbers may have risen since the early 1980s and were thought to have remained fairly stable to the early 2000s (Williams & Parr 1995, Thorpe *et al.* 2004).

Given the general dearth of suitable prey in winter, and the severity of the winters themselves, the overall numbers of Merlins recorded in mid-winter in the 1980s were surprisingly high. This contradicts Green (2002), who describes Merlins as wintering on Welsh inland farmland "in mild winters". Birds involved may have been guarding or, from 1981, checking prime nest areas. Competition for the best sites should have been strong, given the unusually high breeding density in the period 1975-1980 (Roberts & Green 1983).

For Peregrines, Buzzards and Ravens - generalist hunters and scavengers - the rather late increase did not reflect the pattern of gradual but substantial increase in numbers breeding locally (Roberts & Jones 1999b, 2004, 2009). Carrion Crow breeding numbers, though not monitored locally, in Wales generally were believed to be already very high by the 1970s, increasing only gradually thereafter (Lovegrove *et al.* 1994). Kestrel breeding numbers probably remained stable or decreased slightly, around Ruabon Mountain (unpubl. data).

Status of Red Grouse

Outside shooting circles, concern over Red Grouse numbers in Wales developed rather late (Williams 1991). NCC and RSPB surveys between 1976 and the mid-1980s did not count this species systematically. Thus, most records from before 1990 are from estate shooting 'bags'. Those from neighbouring Bodidris Estate (Llandegla Moors) show a decline from an average annual bag of 2111 in 1905-1913 to 211 in 1958-1969 to 11 in 1994 (Shrubb *et al.* 1997). On Ruabon Mountain the corresponding figures were 5378 (1910-1914), 177 (1985-1989) and 17 in 1993 (*ibidem* drawn from Wynnstay Estate Records). My count means confirm that a major decline in Red Grouse numbers on Ruabon Mountain occurred between 1978 and 1993.

The increase in count and bag means following the 1980 fire may have been due to overcrowding on the un-burnt ground, this making the grouse wilder and easier to flush for both counter and beaters. The flushing distance of those birds that stayed on the burnt section might also have increased, given the sparseness of cover. Alternatively, the unusually dry and fine weather in April and May of that year may have led to high production of young, as the reported ratio of young to old grouse shot that autumn was notably higher, at 1.7:1, than in 1979 or 1981-84, where the range was 1:1.4 to 1:1.28 (Gamekeeper's records). However, these figures are based on only 27 out of 47 shoots and may not therefore be representative.

From 1981, the relative lack of cover on the burnt area would probably have drawn fewer breeding pairs to settle there, though the abundance of new, nutritious heather and Bilberry growth could prove attractive to non-breeding birds and broods post-fledging (A.Watson *in litt.*). This might

account for the much increased proportion of grouse counted on the burnt section in 1981-82 and sustained for the next several years.

After 1993 Red Grouse count averages remained very low. This species becomes less detectable at low densities and where predators are numerous, displaying only briefly, at dawn and dusk (Watson & Moss 2008). It is therefore possible that my more recent counts have exaggerated the extent of the decline. However, targeted walks over areas with vegetation mosaics most suited to breeding Red Grouse have revealed few droppings, fresh or older, while birds heard calling at dusk and dawn were very widely scattered (unpublished data).

Status of Blackgame
Black Grouse numbers appeared to show a broad parallel with Welsh national census counts, where numbers of lekking males fell between 1986 and 1997, then rose to near the 1986 level by 2002 (Lindley *et al.* 2003). They correlate strongly with counts of lekking males on Ruabon Mountain - mine in 1995 and 1996, and the RSPB Black Grouse Recovery Project coordinated count data thereafter: $r_s = 0.903$, n= 10, P<0.0001 (personal data, RSPB North Wales Office *in litt.*).

Status of waders
Declines in Golden Plovers, Lapwings and Curlews on Ruabon Mountain broadly match findings from other north Wales moors in the Repeat Upland Breeding Bird Surveys (RUBS), as reported in Sim *et al.* (2005) and by I.M.S.Sim (*in litt.*). Breeding numbers declined sharply on Ruabon Mountain between the early 1980s and 2003 (Roberts 2003).

Numbers of Curlews, Golden Plovers and Lapwings peaked in 1980-81. The increased availability of short sward resulting from the fire will have favoured the two plovers, which breed preferentially on such ground (Pierce-Higgins & Grant 2006, personal data). Curlews prefer more heterogeneous vegetation cover (*ibidem*), of the kind available on the un-burnt section of my route. The observed concentration of birds there may have resulted in more display and thus greater detectability than before.

Status of small passerines
As in this study, Wrens, Stonechats and Reed Buntings showed marked increases in Wales generally (Sim *et al.* 2005, IMS Sim *in litt.*). The strong negative correlation, on Ruabon Mountain, between increase of these species and summed degrees of frost, suggests a response to the long succession of mild winters dating from 1988. This supports the above authors' explanation of RUBS-detected increase in Stonechats (*ibidem*). The BBS survey showed UK-wide increase in all 3 species between 1994 and 2005 (Raven & Noble 2006). As in RUBS (Sim *et al.* 2005) Skylark numbers in March on Ruabon Mountain showed little long-term change. My breeding bird surveys on Ruabon Mountain give comparable results for all the above species (Roberts 2003, Roberts in prep.)

My March counts of Meadow Pipits are heavily influenced by count date relative to date of main influx and may not indicate breeding numbers. That they show no correlation with autumn numbers implies that different populations are involved. This is supported by the observed increase in numbers between July and September-October. According to Lovegrove *et al.* (1994), Meadow Pipits leave the high ground at the end of summer, while the Winter Atlas (Lack 1986) estimates an 80% emigration in autumn, with large scale immigration of northern birds. My March counts show no long-term change, though RUBS surveys in Wales suggest major increase

in breeding numbers between 1981-85 and 2002 (Sim *et al.* 2005). However, those authors (*ibidem*) question the thoroughness of coverage of certain passerines in the earlier surveys, the main focus of which was waders.

Apparent effects of the introduction of Red-legged Partridges
The timing of the increase in corvids and generalist raptors suggests a link with the introduction of Red-legged Partridges for shooting. In corroboration, all species except Kestrel were most numerous from autumn 1997 on ER, where the introduction took place. Flocks of corvids, including Rooks *Corvus frugilegus* and Jackdaws *Coloeus monedula*, gathered at the partridge food hoppers, eating the high-energy feed pellets; the abundance of unwary partridges made easy prey for Peregrines and Buzzards, the latter apparently specialising in weak birds and those injured during the shoots (gamekeepers pers. comm., personal observation). However, while Kestrels were drawn to rodents also taking the partridge food, they were seen in equal numbers on WR. There, the larger proportion of damp, rushy ground no doubt harboured a higher non-anthropogenic population of small rodent prey.

That Hen Harriers resumed wintering on the moor from autumn 1997 is probably also a result of the introduction of partridges. Sightings quickly returned to the level of the early 1980s and, as with Peregrine, Buzzard and the corvids, were significantly more frequent on ER. Interestingly, in contrast with the past, 'grey' males are now reported to winter, regularly hunting the partridges, of which sizeable numbers remain on the moor into the following spring (gamekeeper pers. comm.). This prey is smaller and ca 17% lighter than Red Grouse, probably bringing it within the prey spectrum of the less powerful male raptor (see Roberts 1998).

From autumn 1997, fewer Red Grouse were counted on ER than on SR and WR, a reversal of the situation in 1994-1996. The observed greater frequency of predators on ER - or disturbance by shooting, or both - may have caused the birds to move onto other parts of the moor. SR is closer to the partridge release area than WR and grouse counts were higher here from 1998 to 2002 than previously. On WR they actually declined in the same period, probably in response to an increase in length and uniformity of Heather cover.

Potential causes of decline in Red Grouse and waders
Possible causes of the national decline in Red Grouse and waders have been discussed elsewhere (Williams *et al.* 1991, Shrubb *et al.* 1997, Sim *et al.* 2005). Here, I note factors local to Ruabon Mountain, where the synchrony and severity of decline between 1979 and 1993 suggests response to one or more common, and drastic, factors. Studies in Scotland and northern England have found association between management for (and abundance of) Red Grouse and healthy numbers of waders (Baines *et al.* 2008). At Langholm, in south Scotland, waders declined sharply when such management ceased (Tharme *et al.* 2001).

Over-grazing, important elsewhere in Wales (Williams *et al.* 1991, Shrubb *et al.* 1997), applied in relatively few parts of the moor, as sheep numbers were strictly limited and stock was removed in winter. Red Grouse, Golden Plover and Curlew are northern species, in Wales close to the limit of their breeding range and thus probably susceptible to climatic warming. However, Red Grouse showed only a weak positive relationship with summed degrees of frost in 1979-1994, whilst none was apparent for the two waders. Further, the declines occurred during the period 1978-87, when winters were severe. The same objection might apply to the theory that heavy tick burdens caused the decline: this parasite thrives in damp, mild conditions (Watson & Moss 2008).

Amongst factors specific to Red Grouse, there was no evidence of high intestinal infestation by strongylid worms. Of raptors shown to reduce grouse numbers (Thirgood *et al.* 2000) but not waders (Arjun *et al.* 2008), until 1989 no more than one pair of Hen Harriers bred on the moor, not annually and usually without success. Had winter predation by harriers caused the grouse decline, the raptor's absence in winter between 1994 and 1996 should have led to recovery in its prey. Locally breeding Peregrines reached only 2 pairs by 1986-1988.

Prior to 1978-79, no information is available on wader numbers on Ruabon Mountain. Probably the most plausible explanation of the longer-term decline in Red Grouse is the increasing isolation, and fragmentation of heather habitat, on the moor. Habitat fragmentation can reduce Red Grouse numbers, in part through increased nest losses to generalist predators like Foxes and Carrion Crows (Watson & Moss 2008). Waders, too, are likely to be affected, as their nests are generally more exposed than those of Red Grouse (personal observation).

Ruabon Mountain is all but surrounded by intensively farmed pasture. Higher sheep densities in such habitat are believed to have led to increased numbers of crows and Foxes (Shrubb *et al.* 1997). Other predators - Badgers, Polecats, Ravens and Buzzards - have increased greatly on this ground since the 1970s (personal observation, Roberts & Jones 1999, 2009), alongside decreases in gamekeeping there. The isolation of Ruabon Mountain has been furthered by reductions in keepering and heather cover on the two adjacent moors and by the planting of Llandegla Forest. This, together with the site's heavily indented southern and western boundaries, seriously reduces the extent of the moorland core. The closest large moorland massif, Berwyn Mountain, is 5.5 km distant.

At least two factors might explain the rapid collapse in numbers of Red Grouse and waders on Ruabon Mountain after 1981. One is the louping ill virus, which spread to many moors from around 1980, and can devastate both Red Grouse and wader populations (Watson & Moss 2008, A.Watson pers. comm.). However, evidence for its presence on Ruabon Mountain prior to 1985 is scant (D.Taylor pers. comm., personal observation). Later, in 1995, antibodies to the virus were present in one of three birds tested; in 1996, 20 sheep from each of nine flocks on the mountain were similarly tested, none showing positive (Welsh Grouse Project data via D.Baines *in litt.*).

A more probable cause is the 1980 conflagration, which caused drastic, if temporary, reduction in breeding habitat for Red Grouse on around two-fifths of the moor. The strikingly rapid re-growth of Heather that followed, along with declines in muirburn elsewhere on the moor from around 1985, resulted by the 1990s in uniformly dense, tall vegetation cover ill-suited to breeding Red Grouse and waders. This and the destruction of soil nutrients caused by large, high-temperature fire (Watson & Moss 2008), along with the spread of Bracken and increasing domination of lower areas by Bilberry, would compound the effects of isolation and fragmentation and may explain the timing and rapidity of decline in these birds.

Increase of Black Grouse since the early 1990s

The contrast in Black Grouse fortunes with those of Red Grouse and waders is striking. This species is resistant to louping ill (Watson & Moss 2008). Harvesting and re-planting of sections of 2 of the area's main forest blocks since the 1990s, and sympathetic management of the third, have created areas of pre-thicket scrub of the kind associated with increase of the species in Perthshire (Pierce-Higgins *et al.* 2007). As a forest-moor interface species, breeding in dense vegetation, it may have benefited from the increasing height and density of Heather sward on the adjacent moor, suffering less from egg and chick loss to generalist predators. This could be

reinforced by the 'single parent' factor: males play no part in protecting nests or rearing young (Watson & Moss 2008), thus giving no clues as to their location - or existence. Targeted heather management, by the RSPB Black Grouse Recovery Project, has also probably contributed to the species' increase (see Lindley *et al.* 2003).

Conclusions

My study points to a replacement of larger upland specialist birds, all now red-listed in Wales (Johnstone *et al.* 2010) with more widespread generalists. The severity of Red Grouse and wader declines is especially worrying, because Ruabon Mountain was Wales's prime grouse moor in the past and its wader populations were unusually high for a relatively dry southern moor (P.E. Davis and R. Lovegrove *in litt.*). Conservation measures to aid recovery of these species may be hampered by the current high numbers of generalist predators, probably partly a result of the mass introduction of Red-legged Partridges for shooting. Given the frequency of such introductions, there is arguably a strong need for study of their effects. However, in the case of Ruabon Mountain, the effects of isolation and fragmentation of habitat may already be terminally advanced.

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Appendix 1. Count date averages by month and period, 1979-80 to 2004-05
ER - East Route; SR - South Route; WR - West Route
Values are mean dates of counts within months for the given route and period.

	Period 1		Period 2					
	ER	**N**	**ER**	**n**	**SR**	**n**	**WR**	**n**
September	22.5	*12*	26	*2*	30	*1*	28	*6*
October	15	*34*	12	*12*	9	*11*	17	*8*
November	14	*31*	11.4	*7*	7	*8*	10	*7*
December	16	*34*	9	*1*	14	*2*	23	*1*
January	17	*33*	23	*3*	26	*1*	25	*3*
February	16	*30*	13	*8*	9	*10*	11	*8*
March	16	*44*	16	*7*	20	*8*	20	*8*
April	1	*2*	2	*2*	11	*1*	10	1

Appendix 2 Winter (December-March) temperatures, 1978-79 to 2004-05
Values are sums of degrees of frost (< 1^0 C), with daytime maxima of <1^0 C x 2
* temperature not recorded locally

Year	December	January	February	March	Total
1978-79*					
1979-80	15	8	11	1	35
1980-81	15	11	40	0	66
1981-82	*	180	15	3	198
1982-83	16	2	37	3	58
1983-84	5	6	4	0	15
1984-85	1	39	59	14	113
1985-86	19	5	41	7	72
1986-87	0	60	13	2	75
1987-88	13	0	0	2	15
1988-89	0	0	0	0	0
1989-90	2	0	0	0	2
1990-91	3	7	13	0	33
1991-92	11	18	2	0	31
1992-93	13	4	0	0	17
1993-94	0	1	11	0	12
1994-95	8	4	0	1	13
1995-96	46	5	10	0	61
1996-97	4	4	0	0	8
1997-98	2	0	0	0	2
1998-99	2	4	0	0	6
1999-2000	7	0	0	0	7
2000-01	25	2	3	17	47

Year	December	January	February	March	Total
2001-02	4	16	0	0	20
2002-03	0	10	5	0	15
2003-04	2	0	6	7	15
2004-05	1	0	0	1	2

Appendix 3 Bird numbers on Ruabon Mountain, September-March, 1979-2005
* SE in parenthesis; ** values are for E Route, with summed totals for S and W Routes in parentheses; M: means, SE and ranges are for March

	Period 1			Period 2		
Species	Total	Mean*	Range	Total**	Mean*	Range
Mallard	159	M2.8 *(0.42)*	M5.7-0.5	29(70)	M2.9 *(0.63)*	M6.0
Hen Harrier	156	0.72 *(0.08)*	1.2-0.2	26(15)	0.61*(0.08)*	1.5-0
Buzzard	16	0.07 *(0.02)*	0.3-0	48(24)	1.14 *(0.12)*	2.25-0
Kestrel	69	0.31*(0.05)*	0.63-0	24(33)	0.55*(0.08)*	1.25-0
Merlin	66	0.3*(0.06)*	0.8-0	7(22)	0.16*(0.05)*	0.5-0
Peregrine	137	0.62*(0.05)*	0.9-0.2	60(50)	1.44*(0.14)*	3-0.25
Red Grouse	19924	89.9*(13.6)*	214-12	367(710)	8.9*(0.98)*	18-1.75
Black Grouse	89	0.41*(0.09)*	1.4-0	33(177)	0.77*(0.29)*	1.8-0
Pheasant	32	0.15*(0.04)*	0.7-0	19(66)	0.43*(0.18)*	2.25-0
Golden Plover	166	M2.8*(0.68)*	M8-0	3(12)	M0.0	
Lapwing	143	M3*(0.97)*	M13-0	4(5)	M0.22*(0.22)*	M2-0
Snipe	65	0.3*(0.07)*	1.3-0	7(29)	0.17*(0.05)*	0.5-0
Curlew	421	M9.1*(1.28)*	M18-1.5	24(31)	M2.7*(0.44)*	5-1
Skylark	640	M12*(1.39)*	M14-2.8	128(71)	M12.7*(2.18)*	M26-5
Meadow Pipit	7535	33.5*(2.55)*	52-16	1674(3051)	39.3*(3.27)*	58-14
Wren	1087	5.0*(1.43)*	17-0	946(1168)	22.7*(2.43)*	42-6.3
Stonechat	30	0.14*(0.03)*	0.42-0	26(47)	0.6*(0.14)*	1.25-0
Fieldfare	118	0.52*(0.12)*	1.8-0	5(68)	0.11	0.75-0
Goldcrest	53	0.24*(0.07)*	0.9-0	17(6)	0.41*(0.06)*	1.25-0
Raven	345	1.54*(1.23)*	3.7-0.1	300(335)	6.94*(1.27)*	23-0
Carrion Crow	1096	4.85*(0.88)*	12.5-0.2	896(447)	21*(2.4)*	55-0.3
Reed Bunting	120	0.55*(0.1)*	1.1-0.1	44(52)	1.01*(0.12)*	2.8-0

Appendix 4 Species recorded rarely or irregularly

Notes: * Data are given in the following order: Period 1 bird total; Period 2 bird total; number of counts in which species recorded (in parenthesis); ** Probably involves the same individual; + initial letter of months September-March, with months of most frequent occurrence in bold.

	*P1,P2 (counts)	Months+		*P1,P2 (counts)	Months+
Canada Goose	0,17 (5)	M	Song Thrush	7,6 (8)	**O**,N,F
Teal	7,200 (15)	S,**O**,N,F	Redwing	22,18 (12)	**O**,N,M
Honey-Buzzard	0,1 (1)	S	Chiffchaff	2,0 (2)	S,O
Goshawk	0,1 (1)	O	Long-tailed Tit	0,1 (1)	M
Sparrowhawk	18,10 (28)	S,**O**,N-M	Coal Tit	79,0 (2)	S
Rough-legged Buzzard**	3,0 (3)	D,J	Blue Tit	15,5 (5)	S-N,F-M
Red-legged Partridge	3, 0 (2)	M	Great Tit	6,2 (3)	O
Grey Plover	6,0 (2)	S,J	Tree-creeper	1,0 (1)	S
Jack Snipe	9,1 (10)	O-F,**M**	Magpie	3,24 (10)	S,O,**N**,M
Woodcock	3,5 (8)	**N**,F-M	Jackdaw	107.48 (10)	S-O,**N**,F-M
Wood Pigeon	2,2 (4)	N,M	Rook	111,61 (6)	S,**O**,M
Short-eared Owl	6,0 (5)	N-**J**,**F**,**M**	Starling	0,4 (1)	O
Great Spotted Woodpecker	0,1 (1)	O	Chaffinch	0,2 (1)	O
Grey Wagtail	1,0 (1)	O	Goldfinch	0,10 (3)	N
Dunnock	6,12 (14)	S,**O**,N,M	Linnet	10,12 (13)	S,O,F,**M**
Robin	1,5 (6)	S-N,**M**	Twite	4,0 (1)	N
Whinchat	0,5 (3)	**S**,N	Lesser Redpoll	3,1 (4)	S,**O**,J
Wheatear	12,8 (15)	**S**,O,**M**	Snow Bunting	8,4 (10)	O,**N**-**D**,F-M
Ring Ousel	4,1 (5)	O,**M**	Yellowhammer	2,0 (1)	O,J
Blackbird	23,18 (32)	S-D,**M**			

Appendix 5. Monthly averages, 1979-80 to 2004-05

Standard error in parenthesis; * P1 - Period 1 (1979-80 to 1993-94), P2 - Period 2 (1994-95 to 2004-05)

Species*	Sept	Oct	Nov	Dec	Jan	Feb	March
Mallard	0	0.17 *(0.08)*	0.13	0.02	0.16 *(0.09)*	0.51 *(0.25)*	2.6 *(0.43)*
Hen Harrier	0.5 *(0.23)*	0.54 *(0.12)*	0.86 *(0.21)*	0.88 *(0.20)*	0.63 *(0.13)*	0.49 *(0.17)*	0.86 *(0.19)*
Buzzard P1	1 *(0.13)*	0.08	0	0.06 *(0.04)*	0.03	0.11 *(0.08)*	0.13 *(0.07)*
Buzzard P2		1.12 *(0.26)*	0.82 *(0.27)*			0.43 *(0.1)*	0.33 *(0.17)*
Kestrel P1	1.08 *(0.38)*	0.76 *(0.17)*	0.36 *(0.17)*	0.27 *(0.08)*	0.07 *(0.05)*	0.10 *(0.05)*	0.14 *(0.07)*
Kestrel P2		1.11 *(0.25)*	0.82 *(0.27)*			0.03	0.07 *(0.05)*
Merlin	0.17 *(0.11)*	0.27 *(0.09)*	0.2 *(0.09)*	0.17 *(0.08)*	0.21 *(0.09)*	0.20 *(0.1)*	0.67 *(0.17)*
Peregrine	0.67 *(0.23)*	0.69 *(0.15)*	0.98 *(0.18)*	0.73 *(0.2)*	0.46 *(0.11)*	0.66 *(0.17)*	0.37 *(0.12)*
Red Grouse	134 *(27)*	119 *(18)*	111 *(17)*	91 *(16)*	80 *(15)*	75 *(14)*	60 *(9.5)*
Black Grouse	0.08 *(0.08)*	0.72 *(0.17)*	0.47 *(0.17)*	0.39 *(0.15)*	0.56 *(0.24)*	0.37 *(0.15)*	0.17 *(0.09)*
Pheasant	1 *(0.51)*	0.2 *(0.08)*	0.1 *(0.05)*	0.06 *(0.04)*	0.03	0	0.17 *(0.08)*
Golden Plover	0.03 *(0.19)*	0.17 *(0.07)*	0	0	0.08 *(0.04)*	0.6 *(0.42)*	2.57 *(0.7)*
Lapwing	0	0.03	0	0	0	0.19 *(0.15)*	3.03 *(1.01)*
Snipe	0.58 *(0.34)*	0.48 *(0.16)*	0.59 *(0.37)*	0.37 *(0.13)*	0	0.06 *(0.04)*	0.17 *(0.09)*
Curlew	0	0	0	0	0	0	8.51 *(1.32)*
Skylark	1.55 *(0.42)*	0.28 *(0.09)*	0.27 *(0.15*	0	0.16 *(0.08)*	1.65 *(0.38)*	11.8 *(1.44)*
Meadow Pipit P1	189 *(30)*	50 *(5.32)*	9.8 *(1.95)*	4.6 *(0.90)*	2.8 *(0.82)*	2.7 *(0.79)*	60 *(6.52)*
Meadow Pipit P2		51 *(9.44)*	10.1 *(1.78)*			2.05 *(0.38)*	85 *(9.48)*
Wren P1	6.17 *(1.74)*	6.4 *(1.72)*	6.0 *(1.64)*	4.8 *(1.26)*	3.48 *(1.32)*	4.29 *(1.82)*	5.08 *(1.77*
Wren P2		18.7 *(2.3)*	19.2 *(2.83)*			9.1 (2.42)	20.9 *(3.92)*
Stonechat	0.58 *(0.32)*	0.18 *(0.11)*	0.17 *(0.08)*	0.02	0.03	0.08 *(0.06)*	0.13 *(0.05)*
Fieldfare	0	0.53 *(0.39)*	1.22 *(0.56)*	1.44 *(0.93)*			

Goldcrest	0	0.71 *(0.27)*	0.43 *(0.19)*	0.32 *(0.13)*	0.03	0	0
Raven P1	0.92 *(0.23)*	2.58 *(0.52)*	1.91 *(0.48)*	2.88 *(0.93)*	1.47 *(0.26)*	0.83 *(0.20)*	0.43 *(0.12)*
Raven P2		7.37 *(2.94)*	4.32 *(1.92)*			3.6 *(1.13)*	3.41 *(1.02)*
Carrion Crow P1	7 *(5.7)*	12.7 *(2.91)*	4.47 *(2.11)*	1.68 *(0.75)*	2.08 *(1.1)*	1.93 *(1.15)*	5.08 *(1.57)*
Carrion Crow P2		11.7 *(2.66)*	19.7 *(6.14)*			8.6 *(3.56)*	4.78 *(1.38)*
Reed Bunting	3.25 *(0.77)*	0.69 *(0.19)*	0.11 *(0.06)*	0	0.06 *(0.04)*	0.07	1.11 *(0.29)*

Tawny Owl nesting on a high mountain crag in Snowdonia

Whilst climbing a high crag on the Carneddau mountain range of Snowdonia on 15 June 2006 a fledgling Tawny Owl *Strix aluco* was inadvertently flushed from a grassy ledge. The bird launched into the air and parachuted down the rock face landing clumsily amongst boulder scree at the base of the crag. It appeared to land safely and immediately scrambled in amongst the rock crevices. It was in downy plumage with brown feathering just visible on the wings and was considered to be less than one week out of the nest. A search of the crag successfully located a dirty used nest on a rock ledge shielded by luxuriant amounts of Great Wood Rush *Luzula sylvatica* in a nearby deep vegetated gully. The same ledge was occupied again during 2007 when a sitting bird was flushed off a single egg on 5 May but during a further visit on 9 June the nest was found to be empty though it was possible that a mobile chick could have been overlooked amongst the copious amounts of woodrush and crevices surrounding the ledge. No further visits were made that season and in 2008 the nest was found to be unoccupied though the adults were roosting in the vicinity. Remarkably one of these roosting birds was flushed from a deep crevice fringed by Heather *Calluna vulgaris* less than 3m above an occupied Ring Ouzel *Turdus torquata* nest on which a female was incubating eggs. During 2009 nest ledge was used by a pair of nesting Buzzards *Buteo buteo* and I was unable to find any indications that the Tawny Owls were still in residence.

This was an extraordinary nesting situation, being situated on an exposed rock face on a high mountain ridge overhanging a deep valley totally devoid of any trees and about 4km from the nearest substantial woodlands and 3.5km from the nearest known nesting pair. The surrounding habitat was mountain sheep walk with patches of dense Heather and numerous rock outcrops and subjected to severe weather conditions. At an altitude of 560m (1,837ft) this nest may well be the highest ever recorded in Wales and possibly one of the highest found in the UK. The Birds of the Western Palearctic states that Tawny Owl nests have occasional been found up to 550m in Scotland though there is no mention of the type of nest situations.

It is interesting to note that the observations suggested that this pair of Tawny Owls were breeding much later than is usual for this species, presumably a consequence of the difficult feeding conditions they had to endure in such a hostile location. Examination of pellets at a roost sites indicated a diet mostly of Field Voles *Microtus agrestis* and included some small passerine feathers, possibly Meadow Pipits *Anthus pratensis*.

How this pair became established in such a remote and isolated location is a mystery. One possible explanation is that fluctuations in prey numbers, particularly Field Voles, could lead to periodic increases in the lowland population and extension of ranges into marginal areas well beyond normal limits. A succession of mild winters prior to 2008 could also have been an important factor. On the lower slopes below 350m Tawny Owls do occasionally occupy old Corvid or Buzzard nests in isolated trees and inevitably their territorial ranges will extend into treeless areas at higher levels. This could then result in new pairs establishing territories even higher on the mountains than would be normal when conditions are favourable.

In addition to this pair of Tawny Owls, Snowdonia can also boast other avian altitudinal breeding records. During the early 1980's a pair of Chough *Pyrrhocorax pyrrhocorax* nested at 770m in a high level copper mine on Snowdon which will almost certainly contend the record for the

highest UK nesting pair. Examples of other species found nesting at unusually high altitudes include a pair of Barn Owls *Tyto alba* nesting in a derelict hafod farm building at 360m; a pair of Ring Ouzel that nested at 850m on Esgair Felen, Glyderau; Common Sandpipers *Actitis hypolecus* nesting at 650m above the Ogwen valley; nests of Skylark *Alauda arvensis* on Foel Fras summit at 900m and Meadow Pipit on Carneddau Llewelyn summit at 950m; and perhaps rather more unexpected a pair of Great Black-backed Gulls *Larus marinus* nesting on a mountain tarn at 580m in the Moelwyns region of Snowdonia.

Julian Driver, Hafod y Fedwen, Gwyllt Road, Llanfairfechan, LL33 0EG

Location of the Tawny Owl nest in Snowdonia Photo: ***Julian Driver***

The Birds of Ceredigion *by Hywel Roderick & Peter Davis*

Published by The Wildlife Trust of South & West Wales
Hardback 302pp 50 colour photographs £16.50 inc. postage and packing

More than 40 years after William Condry's *Birds of Cardiganshire*, sterling efforts have seen the publication of the much awaited *Birds of Ceredigion*. The work is a fitting tribute to co-author Hywel Roderick who sadly died in 2009 before he could finish the book. Peter Davis took over the responsibility of finishing the work which ensured that Hywel's dream was achieved.

My own love affair with West Wales began in the early 1970's when I rented various cottages for my annual holiday and to go birding. In those days things were very different. The wilderness of Cors Caron was only experienced with a permit from Peter Davis and a cheery wave as you entered with some trepidation and the risk of losing your welly boots. The hills still contained a few Black Grouse near young plantations and I recall hearing my first Whinchat in full song. Red Kites were a real treat but my lasting memory is the musical chorus of waders around the Teifi Pools. I am therefore delighted to have the opportunity to review this long awaited title.

The first impression of the book is how sumptious it feels. Hard bound and extending to 302 pages with a generous section of 50 colour photographs. There is the usual plethora of species special to the county and what I believe is far more relevant a number of superb habitat shots of Ceredigion. I do however suspect that the image captioned Arctic Tern may well be a Common Tern.

The book begins with an interesting account of recording birds including information of ornithologists who have contributed to Ceredigion. It is heartening to read that some are still alive. A sad omission from this section is no mention of the very significant contribution made by the authors themselves. There is also a description of the climate and topography of the county and changes to the bird populations of the county during the 20th century. A section is also devoted to the conservation of birds in Ceredigion. These sections are now a familiar part of any avifauna as is the systematic list and it is to that part that most will immediately turn. I like the idea of a section on each species entitled Historical Review. This is especially helpful in getting a quick impression of past work before reading of more current events.

The systematic list is full of useful tables dealing with the distribution of many key species but it is the text itself that provides so much information. One could be forgiven for looking at some of "The very Welsh" species first but Red Kite in particular beckons prominently. I can well remember the time when less than 10 nests of this spectacular raptor existed in the UK in Carmarthen/Ceredigion. How different the situation today with Red Kites now a feature of many parts of the UK. Reading the current situation the modesty of one of the authors disguises his and other's enormous conservation efforts locally when more formal organizations sadly often took less interest.

Another species I remember from the 1960's which has probably disappeared is Black Grouse although one can only hope that recent successes elsewhere will bring this superb bird back to the Cambrian Hills. Sadly it is a reflection of modern times that the book catalogues the decline of many species in particular the big reduction in the breeding numbers of waders such as Golden Plover, Lapwing, Curlew, Snipe and Dunlin.

It is not all doom and gloom. In keeping with rest of the UK there have been significant additions

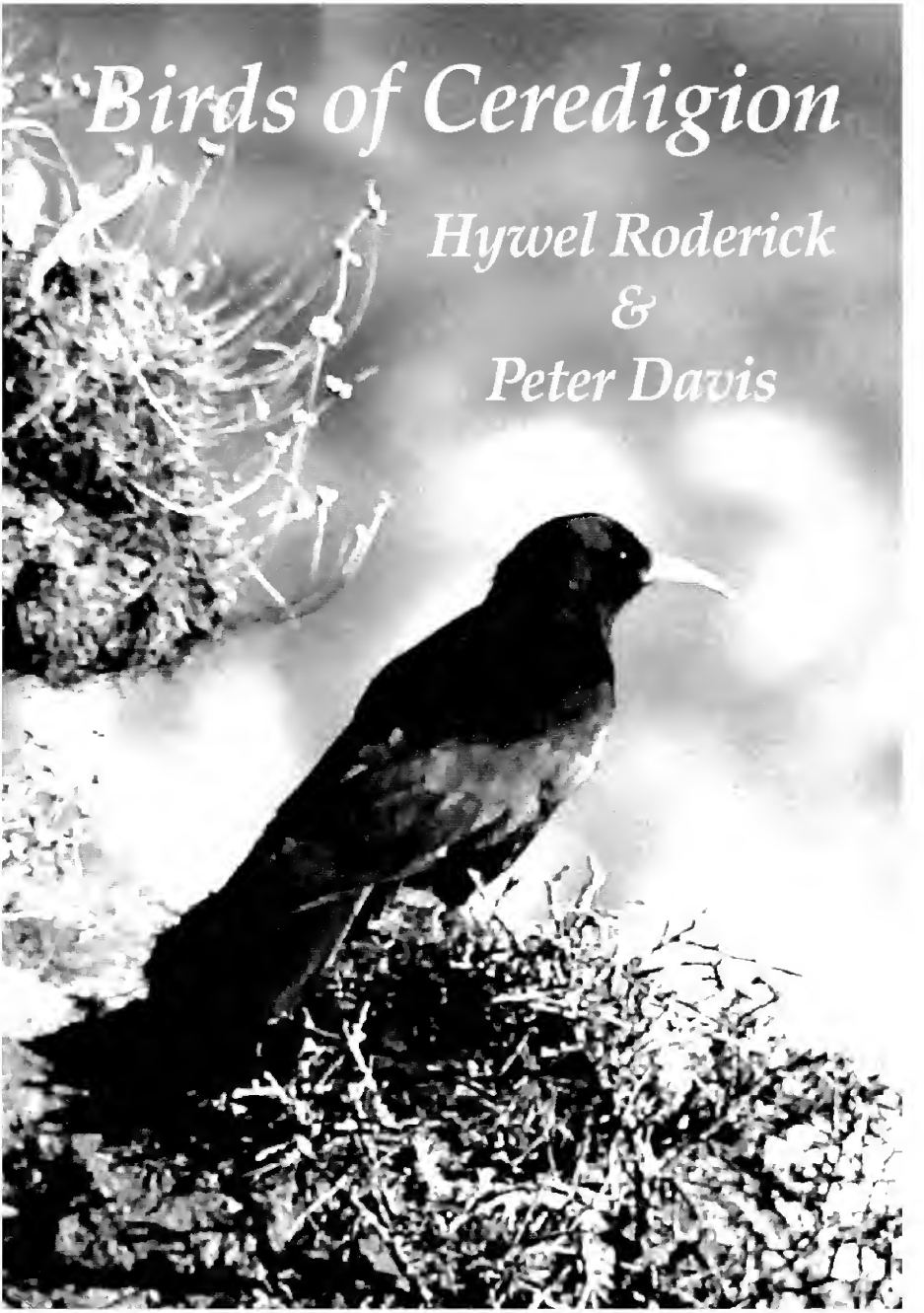
to the County breeding list. Little Egret in 2003 is the latest colonizer and Goshawk has been on the increase very significantly since the 1980's. We must not forget the seabird colonies where Guillemots and Razorbills have also increased their numbers in recent years.

The book also contains a number of Appendices the largest dealing with "escapes from captivity" and others with a series of tables summarizing various species population studies. A gazetteer and references complete a very thorough work.

Many congratulations are due to Peter Davis for finishing the volume and ensuring that the considerable efforts of Hywel Roderick have reached fruition. Special praise goes also to Peter and to Hywel's widow Olga for financing the book and the Wildlife Trust of South & West Wales for publishing it under their imprint. The latter will receive any profits from sales. I would urge all those interested in Birds in Wales to lose no time in getting a copy of this latest addition to our county avifaunas.

Derek Moore

NB – To get a copy of Birds of Ceredigion send a cheque for £16.50 (this amazingly includes postage and packing) to Peter Davis at Felindre, Aberarth, Aberaeron, Ceredigion, SA46 0LP or by Paypal to pedavis@supaman.com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