

GOLDCRESTS ON LUNDY: ANALYSIS OF RINGING DATA, 1990 TO 2018

by

TONY TAYLOR

26 High Street, Spetisbury, Blandford, DT11 9DJ

e-mail: ammataylor@yahoo.co.uk

ABSTRACT

The ringing and biometrics of Goldcrests (*Regulus regulus*) on Lundy between 1990 and 2018 are analysed. The Goldcrests visiting the island in spring and autumn mainly originate in the southwestern quarter of the British Isles. More males than females visit in autumn, perhaps because the females are more reluctant to make sea crossings. Males move earlier in spring and later in autumn, compared with females. Most Goldcrests do not stay on the island for more than one or two days, but their weights suggest that they generally feed well while on the island.

Keywords: *Goldcrest, ringing, biometrics, Lundy, migration*

INTRODUCTION

The Goldcrest (*Regulus regulus*) is Britain's smallest bird, with individuals normally weighing between five and six grams – roughly the weight of a credit card. Their preferred habitat is coniferous woodland, where they feed on small insects and other invertebrates. They reproduce prolifically, with 7-10 eggs per clutch and two broods per year, but most of these die young. Only about 15% of breeding adults survive to breed the following year, and the oldest known bird was ringed in its first autumn and recaptured five years later (Robinson 2005).

Goldcrests are found in northern Europe including the whole of Britain, and in much of northern Asia, wherever there is suitable habitat. There are outlying populations further south in Eurasia, in areas where mountain ranges hold suitable woodland. There are estimated to be about 520,000 breeding territories in Great Britain (Musgrove *et al.*, 2013), but Goldcrests' small size makes them very vulnerable in severe weather, so numbers fluctuate considerably from year to year



Plate 1: Goldcrest on Lundy © Richard Campey

according to winter temperatures. Fine weather in the breeding season can lead to very large numbers of birds dispersing away from breeding areas in autumn.

Goldcrests from some northern populations migrate south, west or southwest, to winter in milder conditions. Over a hundred birds ringed in Britain outside the breeding season have been found abroad, in areas ranging from northern France and Germany, north into Scandinavia, and east to Finland and western Russia. The great majority of these were ringed on the east coast of England or Scotland. (Wernham *et al.*, 2002).

On Lundy, since 1947, Goldcrests have been confirmed as breeding in four years, with records in two other years suggesting possible breeding. Most Lundy records are of birds arriving on the island in autumn. These are individuals that are either dispersing away from their natal areas or on migration. Very small numbers then overwinter in some years, before a few migrants pass through in spring (Davis & Jones, 2007).

As throughout the UK, bird ringing on Lundy is carried out by trained individuals who are licensed by the British Trust for Ornithology (BTO) under the Wildlife and Countryside Act 1981. Between 1947 and 2018, a total of 11,017 Goldcrests has been ringed on Lundy. All records of newly ringed and recaptured birds from 1990 onwards have been digitised, and analysis of these 6590 records forms the basis of this paper.

DATA ANALYSED

The standard information recorded for each individual bird captured consists of the following:

- **Whether newly ringed or recaptured:** birds may be newly ringed (N), recaptured at the original ringing location (R), or controlled, i.e. recaptured after being ringed elsewhere (C).
- **Ring number:** Goldcrests are ringed using the smallest available size (AA). Each ring is engraved with a different alphanumeric code, and the address of the BTO, so that birds can be identified individually and reported if re-found.
- **Date and time of capture.**
- **Sex:** male and female Goldcrests can be distinguished by looking at the colour of the central crown feathers: yellow in females, and yellow, with orange showing in the centre when raised, in males.
- **Age:** examination of a bird's plumage can give clues about its age, distinguishing autumn birds hatched in the same calendar year (EURING age code 3) from those that have bred (code 4). The same criteria can be used in spring, separating birds that are nearly one year old (code 5) from older ones (code 6).
- **Wing length:** the standard measurement is from the leading edge of the carpal joint to the tip of the longest primary feather, with the wing in its resting position against the body and the primaries straightened and flattened to their full extent.
- **Weight:** measured in grams, to the nearest 0.1g.
- **Capture location and method:** almost all birds were caught in Millcombe or St John's Valleys, using mist-nets. Four were caught in the Terrace Heligoland trap.
- **Whether a playback lure has been used:** recordings of Goldcrest songs are sometimes played in autumn, to attract birds to the netting area and increase the number caught. The use of recordings is limited in time, so dispersing or migrating birds are not held in the area for too long. Recordings are not used in spring, to avoid disrupting any natural territorial behaviour.
- **Initials of ringer:** the person responsible for the record is noted.

Not all of these data were recorded in every case, for a variety of reasons: results might be unclear to the observer, as in the case of some birds' ages when tail feather shape was intermediate; birds may be deliberately released without measuring and/or weighing, if unexpectedly large numbers are caught and the ringers' priority is to minimise the time for which birds are kept; and occasionally birds are released or escape during the ringing process before the completion of data recording. So each analysis has been carried out using only those records with relevant data, and this explains the variation in size of the samples analysed.

RESULTS AND DISCUSSION

Annual catch size

The number of Goldcrests ringed each year varies greatly. Annual spring and autumn totals are shown in Table 1. The mean number is 210, with extremes of 623 in 1990 and 4 in 2007. Ringers have visited Lundy at a variety of times within the migration periods and their catches have been influenced by weather conditions, which can affect whether mist-nets can be set and also whether birds choose to move to or from the island. So the correlation between catch sizes and UK Goldcrest population size is low; a constant level of catching effort throughout every year's migration seasons would be needed in order to provide a consistent numerical indicator. So the analyses below have been carried out on combined data from all years of this study.

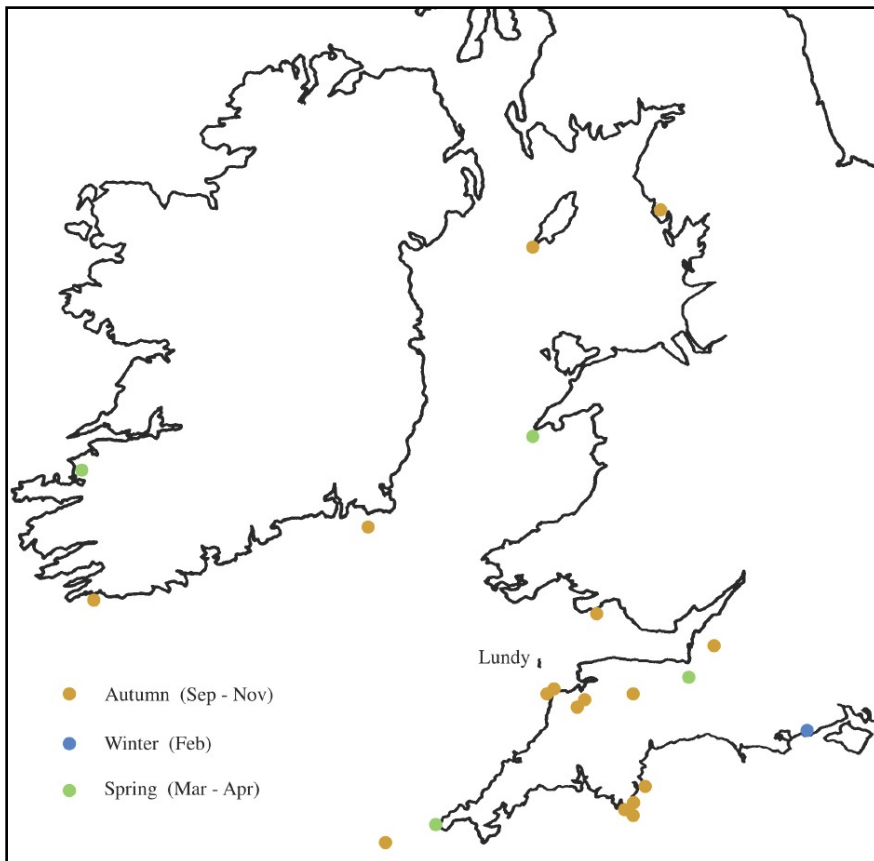
Table 1: Annual catches of Goldcrests on Lundy, 1990-2018

Year	Spring	Autumn	Total
1990	20	603	623
1991	2	26	28
1992	0	100	100
1993	1	305	306
1994	8	44	52
1995	3	520	523
1996	22	115	137
1997	2	335	337
1998	8	32	40
1999	7	266	273
2000	21	131	152
2001	1	51	52
2002	0	136	136
2003	0	179	179
2004	1	93	94
2005	1	306	307
2006	9	75	84
2007	1	3	4
2008	8	520	528
2009	4	7	11
2010	0	51	51
2011	1	175	176
2012	7	296	303
2013	48	409	457
2014	2	59	61
2015	10	223	233
2016	24	241	265
2017	5	474	479
2018	28	68	96
Total	244	5843	6087
Mean	8.4	201.5	209.9

Movements to and from Lundy

Figure 1 shows the ringing or finding locations of the 21 ringed Goldcrests that have moved to or from Lundy. The seasons when they were located away from Lundy are also indicated. All relevant captures on Lundy were in September or October. The locations suggest that birds reaching Lundy originate from a limited area involving southern Ireland (three records), the Isle of Man (one record), Wales (two records) and the western half of England. The general trend has been for birds to move north in spring and south in autumn, the exceptions being one that went to South Wales in October 1988 and one from the Isles of Scilly that was on Lundy the next day, in October 1989.

Figure 1: Recoveries and controls of Goldcrests caught on Lundy



As the map shows, most of the birds involved, when caught by other ringers away from Lundy, were at coastal sites rather than in breeding habitat inland. This comes about because Goldcrests are much easier to catch in mist-nets when they are in low scrub on coasts and islands; in their typical breeding habitat they tend to be high in trees. So the data are biased in favour of migration stop-off points, and of dispersing or migrating individuals rather than the unknown proportion of birds that remain sedentary.

It is possible that birds which moved to the south Devon coast went further south into France, that birds moving east reached the continent and that those from the Isle of Man and Cumbria originated in Scotland. However, it is interesting to note that Lundy

Goldcrest movements contrast strongly with those of the closely related Firecrest *Regulus ignicapillus*. Four ringed Firecrests have moved to or from Lundy. One was found at Penzance, Cornwall, but the other three are beyond the furthest spread of Goldcrest records: one arrived from Beachy Head on the Sussex coast and two went to the Netherlands. This suggests that the Firecrests reaching Lundy move over much larger distances than the Goldcrests. If significant numbers of Goldcrests reached Lundy from the continent, for instance, one would expect even stronger evidence than there is for Firecrests, since the number of Goldcrests caught on the island is twenty times higher, yet there has been none.

Sex ratio

Of the birds for which sex was recorded, 2641 (43.6%) were female and 3412 (56.4%) were male. The percentages varied greatly according to the time of year, with 75.4% females among spring-caught birds and 42.3% females in autumn. A more detailed breakdown of these figures is given in Table 2, which shows that males tended to be caught earlier in spring than females. The difference between catches up to 21 April and those from 22 April onwards is statistically significant (Chi squared test: $p < 0.01$).

Table 2: Sex ratios in Goldcrests caught on Lundy

Dates	Female	Male	% Female
Spring:			
25 Mar-21 Apr	73	36	67
22 Apr-17 May	93	20	82
Autumn:			
15-Aug	11	1	92
01-Sep	38	34	53
15-Sep	741	933	44
01-Oct	897	1269	41
15-Oct	693	1032	40
31 Oct-17 Nov	47	68	41

In autumn, females predominated until mid-September, after which males made up 56 to 60% of the catches. Comparison of data obtained between 15 August and 15 September with 16-30 September shows a decrease in females that is statistically significant (Chi squared test: $p < 0.001$).

Wernham *et al.* (2002) looked at movements of ringed Goldcrests to, from and within Britain and Ireland. They found that about 60% of the birds involved were males, which is similar to the figure for the overall numbers ringed on Lundy. In mainland Europe, males predominate at migration and wintering sites in the Baltic, Belgium and France (Hildén, 1982, Cramp, 1992, Vercauteren, 1991). Grenmyr (1997, 2000) suggested that such a bias at Swedish bird observatories in autumn came about because the two sexes followed different routes. The males may be more prepared to cross open water while females tend to follow coastlines.

Davis and Jones (2007) state that spring migration of Goldcrests through Lundy is mainly from mid-March to late April. Ringing is rarely carried out on the island before early April, and only nine birds in this study were caught before 3 April. Of those, seven were males. That sample is too small to provide firm evidence, but it is possible that the apparently anomalous Lundy data, with a high percentage of birds caught in spring being female, comes about because males tend to move through Lundy in March, before ringing has started there. In most species of birds, males migrate earlier than females in spring.

Dates of ringing

As indicated in the paragraph above, and as with comparisons between years, ringing on Lundy does not provide a very good indication of the timing of migration, since ringers are not present throughout each season. The earliest and latest capture dates in spring and autumn are included in Table 2, which also shows that the main autumn catching period for Goldcrests is from mid-September to the end of October. Given the limitations of the data, further discussion of migration timing would be of little value.

Recaptures on Lundy

Records from the study period include 484 that involve birds previously ringed on Lundy being recaptured there. Almost all are relatively short-term, with birds recaptured within the same spring or autumn migration season. Two birds were exceptions to this: a male ringed on 6 May 1994 was recaptured on 13 July 1994, and a female ringed on 28 April 2000 was recaptured on 6 and 24 October 2000. It is likely that both birds spent the breeding season on Lundy, with the male having little time to leave, attempt breeding elsewhere and return, and the female being ringed in a year when breeding was proved to have occurred on the island (Davis & Jones, 2007).

All other recaptures are summarised in Table 3. The figures suggest that the majority of Goldcrests arriving on Lundy in spring and autumn move on again quickly. In both seasons the median time between ringing and recapture was two days, with means of 3.6 days in spring and 4.3 days in autumn.

Age

A summary of the ages of all Goldcrests in this study is given in Table 4. Most birds in autumn are aged as being in their first year (96% of those for which a definite age is given), and those aged in spring as in their second calendar year (94% of birds with age given). Goldcrest reproductive rates are high and survival rates low, so a high proportion of young birds is to be expected. In addition, young birds are more likely to disperse away from breeding areas than territory-holding adults, some of which remain sedentary all year (Wernham *et al.*, 2002). This would further increase the proportion of young reaching Lundy.

In the clearest cases, determining a Goldcrest's age by the shape of its tail feathers is straightforward: Plate 2 shows the tail of a first-autumn bird, with pointed juvenile feathers originally grown when the bird was a nestling, and one rounded, adult-type feather. This has not yet reached full length, and is growing to replace one that must have been lost accidentally. However, there can be uncertainty over some individuals with intermediate feather shapes: 2% of Lundy autumn records and 36% in spring are

Table 3: Summary of recaptures of Goldcrests on Lundy

Days after initial capture	Spring retraps	Autumn retraps
1	8	159
2	8	85
3	2	48
4	2	37
5	2	31
6	2	11
7	1	14
8	1	18
9	2	5
10	1	4
11-20		22
21-30		12
31-40		2
41-50		1
51-60		1
Total	29	450

Table 4: Ages of Goldcrests on Lundy

	Age code	Number of birds			% of total	% of known-age birds
		Female	Male	Total		
Spring						
	4	67	21	88	36	
	5	109	37	146	60	94
	6	28	2	10	4	6
Autumn						
	2	47	68	115	2	
	3	2301	3162	5463	94	96
	4	105	122	227	4	4

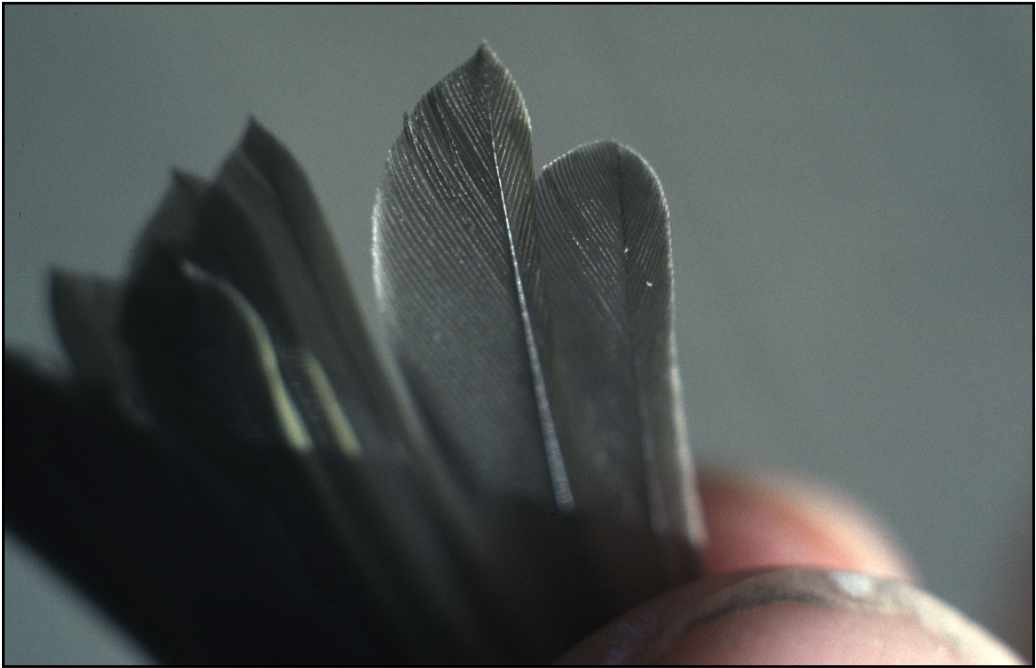


Plate 2: Goldcrest tail with one adult feather growing. © Tony Taylor

recorded as indeterminate. Grenmyr (2000) found that in Sweden up to a third of all Goldcrests were wrongly aged using tail shape, so ringers have become more cautious about using this feature in recent years.

Wing length

The wing lengths of Goldcrests caught on Lundy in spring and autumn are shown in Table 5. Mean wing lengths for females are 51.6mm in autumn and 51.1mm in spring. For males they are 53.7mm in autumn and 53.4mm in spring. As in most Passerine species, males are slightly larger than females. All feathers become worn over time and so the marginal loss in length between autumn and spring is to be expected. Adult birds carry out a full moult at the end of the breeding season, so they have new feathers in autumn (Svensson, 1999).

As discussed above, movements of ringed Goldcrests provide no evidence of birds from continental Europe reaching Lundy. Those from the northern parts of the species' European range tend to be a little larger than British birds, with wing lengths around 2mm longer on average. During autumn of 2005, Rob Duncan ringed Goldcrests on Lundy, and also on the Suffolk coast at a time when easterly winds were bringing continental birds across the North Sea. His data gave a direct comparison between the two locations and is shown in Table 6 (R.A. Duncan, pers. comm.). There is a clear difference in wing lengths, with the Suffolk values about 2mm longer. His Lundy data are very close to the overall Lundy figures for autumn, given in Table 5, with differences in mean lengths of just 0.3mm for females and 0.1mm for males. If significant numbers of continental Goldcrests reached Lundy, wing lengths in Table 5 would be expected to show a greater spread into the higher fifties.

Table 5: Wing lengths of Goldcrests on Lundy

Wing length (mm)	Number of birds			
	Spring		Autumn	
	Female	Male	Female	Male
45			1	
46				
47			1	
48			7	1
49	12		34	4
50	33		320	19
51	63	5	738	84
52	41	8	792	344
53	14	9	333	891
54		25	73	1032
55		7	27	598
56		1	2	171
57	1		1	21
58				5
59				1
Total	164	55	2329	3171
Mean wing length (mm)	51.1	53.4	51.6	53.7
Standard deviation	1.14	1.21	1.14	1.23

Table 6: Comparison of Goldcrest wing lengths on Lundy and the Suffolk coast, autumn 2005

Wing length (mm)	Number of birds			
	Females		Males	
	Lundy	Suffolk	Lundy	Suffolk
48	1			
49	3			
50	20		2	
51	37	2	7	
52	30	11	19	
53	12	17	61	1
54	1	10	50	3
55		7	33	34
56			6	19
57			1	11
58				2
Sample size	104	47	179	70
Mean wing length (mm)	51.3	53.2	53.6	55.6
Standard deviation	1.08	1.10	1.21	0.95

Weight

Mean weights for all Goldcrests captured on Lundy for the first time are 5.26g for females and 5.44g for males. Table 7 shows the wide range of weights recorded, and compares the weights of birds captured in spring and autumn. Females are 0.15g lighter in spring than autumn, but this difference is small compared with the range of values, and the small sample size in spring should be considered.

Body weight can be influenced by a range of factors in addition to the size and sex of the individual. Birds need to build up enough energy stores to support their needs through the night, when they cannot feed, so weight may vary with time of day. They may also accumulate extra fat stores to provide energy during migration or dispersal flights. Weather conditions influence birds' rates of feeding and heat loss, and hence their weight, particularly in a small, insect-eating species such as the Goldcrest. Time of year can be relevant, with a wide range of species accumulating extra fat stores in late autumn, as insurance against the challenges of difficult conditions in winter.

Analysis of Lundy data suggests that date is not a significant factor influencing Goldcrest weights in autumn. The mean weight for females is 5.26g up to 30 September, and identical at 5.26g from 1 October onwards. The equivalent values for males are 5.42g and 5.45g. This rise in mean weight of males is minimal, at less than 1%.

Some passerines are known to adjust their weights according to the level of threat from predators: fat storage, as insurance against poor weather conditions, needs to be balanced against the resulting loss of acceleration and manoeuvrability in flight. On Lundy the threat from raptors is usually high. Merlins (*Falco columbarius*), Kestrels (*Falco tinnunculus*) and Sparrowhawks (*Accipiter nisus*) are regular visitors in autumn and often more than one of each is present. Though Merlins and Kestrels typically hunt in open habitats, both hunt among the trees in Millcombe when migrant Passerines are concentrated there. Even the local Peregrines (*Falco peregrinus*) will do this, despite their large size, and male Peregrines will intercept very small migrants such as *Phylloscopus* warblers approaching the island over the sea and consume them in flight (pers. obs.).

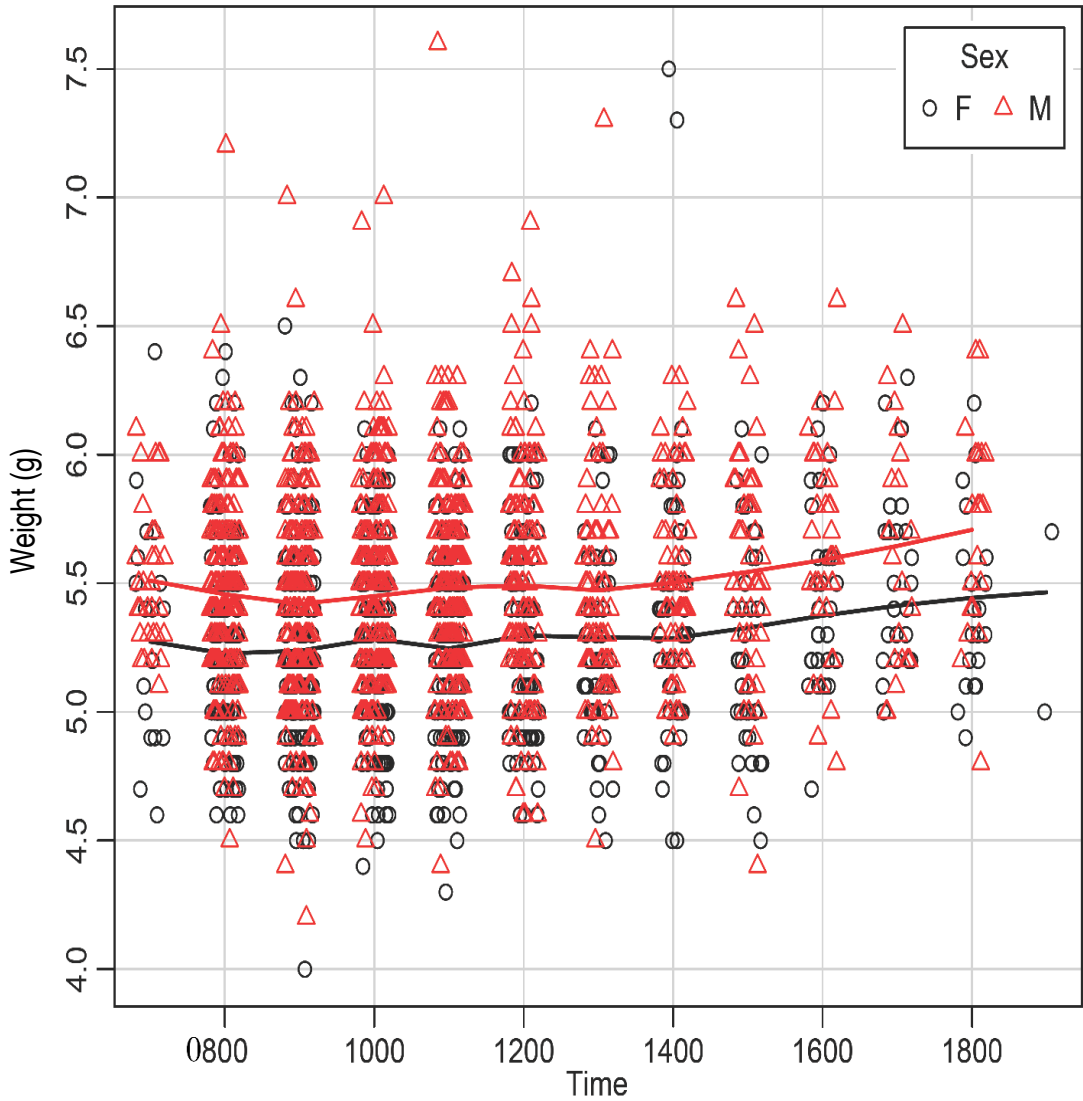
With so many factors influencing birds' weights, conditions are not sufficiently well controlled in the Lundy Goldcrest dataset to allow each factor to be analysed reliably. In the case of time of day, data from a limited range of dates, 1-15 October, were selected, in an attempt to minimise seasonal variations while still giving a reasonable sample size. The results are shown in Figure 2. While the data suggest an increase of about 0.25g through the day for both females and males, the average sample sizes between 08:00 and 12:00 are more than three times greater per hour than outside that period. So the reliability of the data decreases as the afternoon progresses.

A further note of caution is needed because about three quarters of the records before 08:00 and two thirds of those after 17:00 were obtained on dates up to 7th October. Those at other times of day were split more evenly between the first and second quarters of the month. At a season when day length shortens rapidly, this probably reflects the changing times at which Goldcrests are active. It could be that longer days allow the birds to maintain weight more easily, and this would bias the average weights near dawn and dusk.

Table 7: Weights of Goldcrests on Lundy in spring and autumn

Weight (g)	Spring		Autumn	
	Females	Males	Females	Males
4.0			2	
4.1	1		2	1
4.2				1
4.3	2		3	
4.4	3		8	4
4.5	7		19	9
4.6	9	2	52	19
4.7	13		69	41
4.8	15	3	138	83
4.9	14	1	139	111
5.0	14	4	261	206
5.1	19	3	212	185
5.2	16	6	266	333
5.3	9	4	225	270
5.4	12	5	201	340
5.5	11	7	216	372
5.6	4	2	113	273
5.7	2	1	99	246
5.8	3	6	80	162
5.9	2	4	49	143
6.0	1	2	50	117
6.1	1		22	50
6.2	1	2	14	41
6.3		1	7	28
6.4			2	12
6.5	1	1	1	13
6.6				5
6.7		1		2
6.8			1	3
6.9				3
7.0				2
7.1	1			
7.2				2
7.3				1
7.4				
7.5	1		1	
7.8				1
Sample size	162	55	2252	3079
Mean weight (g)	5.099	5.471	5.258	5.440

Figure 2: Effect of time of day on Goldcrest weights, 1-15 October



Another line of enquiry involves the weights of birds recaptured a day or more after their original ringing date. Weight comparisons are available for 357 birds. Their mean weight when ringed was 5.34g and on recapture was 5.31g. The mean capture and recapture times were similar, and the sex ratio of the birds involved was the same as for the complete dataset. So these birds appear to be able to maintain weight on Lundy, even though the sample may be biased against the fittest birds: the sooner a bird continues its migration, the smaller its chances of recapture.

The overall impression given by these results is that weight changes through the day and on longer time-scales are slight. Most of the Goldcrests visiting Lundy appear to be able to regulate their weight very effectively, and are not subjected to major stresses in their energy budgets as a result of the local conditions, even though there is very little of their preferred habitat available on the island.

Playback lures

The use of playback lures can increase catching rates greatly. Some ringing groups operating on Lundy have played recordings of Goldcrest songs in autumn and birds respond strongly to them. Several questions arise from this. To what extent does the use of recordings increase catching rates? Do they influence the sex ratio of the catch by attracting females more than males, or vice versa? Do they have different effects on first-year birds and adults?

A total of 1235 birds are recorded as having been playback-lured, all in autumn. Among these, 39% are female, compared with a value of 43% for non-lured autumn records. Interestingly, the value for the 67 lured birds aged as adults is 51% female. This might suggest that while lures are attractive to most Goldcrests in autumn, when the majority are first-year birds, they reduce the catch of adult males.

The uncertainties involved in this last analysis are considerable. The sample size is small; as discussed above, the aging method normally used for Goldcrests is not considered to be entirely reliable; and it is also known that some visiting ringers have not kept records of when lures have been used. It seems plausible that adult males might stay away from lures, if they perceive them as territory-holding birds, but more rigorous experimental procedures, and consistent recording, would be needed to establish this point.

CONCLUSIONS

The ringing and recording of biometrics of Goldcrests on Lundy has shown that the birds visiting the island in spring and autumn mainly originate in the southwestern quarter of the British Isles. More males than females visit in autumn, perhaps because the females are more reluctant to make sea crossings. Males move earlier in spring and later in autumn, compared with females. Most Goldcrests do not stay on the island for more than a day or two, but they generally appear to find ample supplies of food while they are present. Given their very small size, they have a remarkable ability to thrive in habitat that is atypical for the species.

While the data give valuable insights into the lives of the Goldcrests visiting Lundy, the analytical work carried out for this study also highlights the data's limitations. These are an inevitable result of reliance on visiting ringers to carry out the work. Ideally, data would be gathered throughout the migration seasons every year, using a standard number of mist-nets over standard times of day, as happens at officially designated Bird Observatories. Some of the uncontrolled variables could then be eliminated, larger samples gathered and further conclusions drawn. The need for consistent high standards of data recording is also clear.

ACKNOWLEDGEMENTS

This work could not have been done without the dedication of the many bird ringers who have visited Lundy, devoting countless hours to catching, ringing, measuring and recording birds there. Special thanks to Rob Duncan for providing data on migrating Goldcrests in Suffolk. The Lundy Field Society has provided vital financial and other support for all bird ringing on Lundy throughout the Society's existence. I am also greatly indebted to the Wardens and other islanders who have facilitated and supported the ringing.

REFERENCES

- Cramp, S. (ed). 1992. *Handbook of the Birds of Europe, the Middle East and North Africa: Birds of the Western Palearctic. Vol VI. Warblers*. Oxford University Press. Oxford
- Davis, T.J. & Jones, T.A. 2007. *The Birds of Lundy*. Devon Bird Watching and Preservation Society and Lundy Field Society, Berryarbor, Devon
- Grenmyr, U. 1997. Sex differences in recovery pattern and migratory direction of Goldcrests *Regulus regulus* ringed in northern Europe during autumn migration. *Ornis Svecica* 7: 81-90
- Grenmyr, U. 2000. Återfynd av kungsfåglar *Regulus regulus* funna i Sverige: tidsmässigt uppträdande samt köns- och åldersfördelning. *Ornis Svecica* 10: 129-139
- Musgrove, A., Aebischer, N., Eaton, M., Hearn, R., Newson, S., Noble, D., Parsons, M., Risely, K. & Stroud, D. (2013). Population estimates of birds in Great Britain and the United Kingdom. *British Birds* 106: 64-100
- Hildén, O. 1982. Winter ecology and partial migration of the Goldcrest *Regulus regulus* in Finland. *Ornis Fennica* 59: 99-122
- Robinson, R.A. 2005. *BirdFacts: profiles of birds occurring in Britain & Ireland*. BTO, Thetford (<http://www.bto.org/birdfacts>, accessed on 21 July 2019)
- Svensson, L. 1992. *Identification guide to European Passerines (Fourth edition)*, 288-289. British Trust for Ornithology
- Vercauteren, P. 1991. Overwinteren van Goudhaantjes *Regulus regulus* in Vlaanderen. *De Giervalk* 81: 35-55.
- Wernham, C.V., Toms, M.P., Marchant, J.H., Clark, J.A., Siriwardena, G.M. & Baillie, S.R. (eds). 2002. *The Migration Atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London