RESULTS OF RINGING GUILLEMOTS AND RAZORBILLS ON LUNDY, 1947-56

By H. J. Boyd

The capture of auks for ringing has been one of the more exciting mid-summer pastimes of visitors and wardens since the Society began operations. The completion of ten seasons' work provides an opportunity for reviewing the results of all this strenuousness.

The first aim of ringing was to learn about the geographical distribution at all seasons of birds breeding and bred in any particular place. A second use of ringing, which has recently been found capable of yielding results of considerable importance, is to provide information on mortality which, when combined with data on breeding success, can tell us how bird populations work as dynamic systems. The ringing of auks on Lundy has produced interesting results in both these fields.

The Distribution of Recoveries of Ringed Guillemots

In Table I the sixty-six Guillemot recoveries whose dates are known with sufficient certainty are grouped by month of recovery and by the area in which the birds were found. The categories used are those described by Thomson (1953) in his paper on the results of British auk ringing as a whole. 'Home waters' in his sense comprise the Irish Sea and the English Channel east to the Straits of Dover (including the French shore) : 'North Sea' covers recoveries east of Dover : 'Biscay' comprises the west coast of France south from Finisterre, and the north coast of Spain : 'Peninsula' comprises the coast of Spain and Portugal south from Cap Ortegal : and the 'Mediterranean' includes both the African and European shores of that sea. Table I distinguishes between birds ringed as nestlings and recovered in the first year of life and those recovered later, or ringed as adults.

TABLE I

Distribution of Guillemot recoveries by regions and months of recovery. When there are two figures in any cell of the table that in italic type indicates the number of birds ringed as nestlings and recovered in their first year. The regions used are described in the text.

	Month of Recovery										
Region	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*April-June*	*Total*
Home Waters	*2*, 3	*5*, 8	*11*, 16	*4*, 5	*1*, 4	*1*, 3	1	3	3	*1*, 5	51
North Sea	–	–	*1*, 1	*1*, 1	–	–	–	–	*1*, 1	–	3
Biscay	–	*1*, 2	*3*, 3	–	*1*, 2	–	–	*2*, 2	*1*, 2	–	11
Peninsula	–	–	–	–	–	–	–	–	–	–	–
Mediterranean	–	–	–	–	–	–	*1*, 1	–	–	–	1
Total	3	10	20	6	6	3	2	5	6	5	66

For his study Thomson made use of all recoveries reported by August 1952. These included thirty of Lundy-ringed birds. In his analysis he grouped them with thirty-one recoveries of Guillemots ringed in Wales, nearly all on Skokholm or Skomer, since it appeared that birds from Lundy occurred in much the same localities as those from S.W. Wales. Thomson concluded that of Guillemots ringed in the south-west some remain throughout the winter in home waters, some move south along the French coast of the Bay of Biscay, occasionally as far as Portugal, and some penetrate the North Sea, reaching the east coast of Great Britain and the south of Norway. He further concluded that the southward movement into or beyond the Bay of Biscay is probably more pronounced during the first year of life than later. The recoveries of Lundy-ringed birds notified since the completion of Thomson's report do not seem to require substantial alterations to these conclusions. There is some indication that Guillemots from Lundy occur relatively more often (11/62) in the Biscay region than birds from S.W. Wales (3/28), that is, they may tend to move rather further south, but the evidence is insufficient for confidence.

It appears too that a higher proportion of the recoveries of Lundy-ringed birds occur in the months July-September than is the case for Welsh-ringed birds (32/65 of Lundy birds being recovered in those months, but only 8/31 of Welsh birds). This might reflect a heavier mortality, particularly affecting young birds, during that period, but is more probably related to the chance of casualties being reported. As the map shows, many Lundy-ringed birds occur on the coasts of Devon and Cornwall, which have a high human population in those months. Birds from the Welsh islands, mostly rather further north at this time, are perhaps less likely to be picked up.

Difficulties of interpretation of that kind become acute as soon as any attempt is made to deduce from recoveries the distribution of the living population at any particular time. Guillemots being maritime (though not oceanic), birds found on the shore are strays rather than normal individuals and it seems unlikely that we shall learn very much more from ringing about the true distribution of the population other than at times of stress (e.g. blown ashore by gales, or 'oiled'). Thomson has suggested that there may be important differences in winter distribution from one season to another. This could only be confirmed by marking on a large scale for several years, to provide sufficiently large annual recovery samples for reliable comparisons.

The Distribution of Ringed Razorbills

Table II shows that Razorbills from Lundy occur more often in the Peninsula and Mediterranean areas than do Guillemots. Thomson (loc. cit.), lumping seventeen recoveries of Lundy-ringed Razorbills with one hundred and ten of Welsh-ringed ones, concluded

TABLE II

Distribution of Razorbill recoveries by regions and months of recovery. For description of regions see text. First-year recoveries of birds ringed as nestlings shown in italics.

Region	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*April June*	*Total*
Home Waters	*1*, 1	*5*, 5	*2*, 2	1	*1*, 2	1	1	–	1	*1*,2	16
North Sea	–	–	–	–	–	–	*1*, 1	–	1	–	2
Biscay	–	–	–	*1*, 1	*1*, 1	1	*1*, 1	–	*2*, 2	–	6
Peninsula	–	–	–	–	*1*, 1	*1*, 1	–	–	–	–	2
Mediterranean	–	–	–	–	*2*, 2	–	–	*1*, 2	*2*, 2	–	6
Total	1	5	2	2	6	3	3	2	6	2	32

that some birds from these breeding stations remain throughout the winter in home waters, notably in the English Channel, but also extending in a minority of cases as far north as the Firth of Clyde and the west of Ireland; some move further south into the Bay of Biscay and along the western seaboard of the Iberian Peninsula; some continue along the southern shore of Spain into the Mediterranean, east to the Gulf of Genoa on the north side and Algeria on the south; while others penetrate the North Sea, probably by way of the Straits of Dover, and may reach S.W. Norway and the Danish coast.

Again there seems no occasion to modify Thomson's findings in the light of subsequent information, summarized in Table II, although it seems that relatively few Lundy birds enter the North Sea (only 2 of 33 recoveries from its shores, compared with twelve of one hundred and ten Welsh-ringed birds). Also, as with the Guillemot, Lundy contributes a relatively high proportion of southern recoveries (6/33 from the Mediterranean compared with 12/110 Welsh birds).

Statistics of the Lundy Guillemot Population

Although there is a sad lack of accurate information on the number of auks breeding on Lundy, the available evidence suggests, first, that the Guillemot population is now very much smaller than it was in 1939 and second, that relatively little change in numbers has occurred in the last few years. Counts in 1955 and 1956 both showed the presence of about three thousand nine hundred birds in June. As an essential preliminary to any attempt at restoring the population to its former status, it is necessary to discover as much as possible about the statistics of the colony—in particular the mortality rates affecting different age-groups, and there productive capacity of the mature females.

The mathematical basis for this kind of inquiry has been provided in an admirably concise form by Capildeo and Haldane (1954). They show how the rate of decrease, or increase, of a population can be calculated, given knowledge of (1) the age at which females become sexually mature, (2) the fraction of adults

surviving from one year to the next, after the first, and (3) the mean number of female progeny produced by a mature female which survive to the time of laying in the next year. If the age of sexual maturity is a years, the surviving fraction of the adult population is s and the net fertility, just defined, is $f \times s$, it can be shown that the population will be in equilibrium, i.e. its size at the time of laying in successive years will be nearly constant, if $f = \frac{1 - s}{s^a}$

Recoveries and recapture of Guillemots ringed as adults on Lundy provide two estimates of the adult survival s. There have been seventeen recoveries: six within one year of marking, five in the second year after marking, four in the third, one in the fourth and one in the sixth. From this series s can be calculated by a method devised by Haldane (1955), which is applicable even to recovery series which are not yet completed (in the sense that a number of the ringed birds are probably still alive). This yields the results $s = 0.76$. The twenty-four recaptures on Lundy of adults ringed there in previous years can also be used to estimate s. Applying the procedure described as 'Method A' by Leslie and Chitty (1951) to the numbers of captures and recaptures of adults in the years 1952-56 $s = 0.79$. Neither of these estimates is precise, because of the very small numbers of individuals on which they are based, but they provide a first approximation which is at least useful in establishing the pattern of mortality and replacement.

The age at which Guillemots first breed is not known with certainty. This is a point which can only be established by large-scale ringing of nestlings. So far, despite the fact that one thousand, one hundred and ten nestlings have been ringed on Lundy alone, no recaptures of Guillemots known to be breeding for the first time have been reported. A Razorbill ringed in 1952 as a nestling has been found breeding in 1956 and by analogy it may be supposed that for the Guillemot $a = 4$ years. It is, however, quite possible that some females, perhaps most, will breed at three years, and the firm establishment of the facts is a most important task for future research.

If $s = 0.79$ and $a = 4$, $\frac{1 - s}{s^a} = 0.54$. This means that for the population to be in equilibrium the net fertility f must be equal, or very close, to the same value. It will be remembered that fs is a measure of survival to one year after hatching. Thus $fs = \frac{c}{2} \times s^1 \times s$ where $\frac{c}{2}$ is half the mean number of eggs laid (assuming the sex ratio to be close to 1:1), s^1 is the fraction of young birds reaching independence and s, is the fraction surviving for the rest of the first year. The clutch size of the Guillemot is one. Lost eggs are readily replaced (Fisher and Lockley, 1954, p. 102 and p. 281),

so that $\frac{c}{2}$ may be assumed to be 0.50 or little less. There is no direct measure of s^1. Young Guillemots leave the nesting ledge only about fourteen to sixteen days after hatching, when less than half grown, and remain dependent on feeding and protection by one or both parents for some time. Recoveries of ringed nestlings and adults provide a rough guide to the value of s^1. Only thirty-eight of one thousand one hundred and ten nestlings ringed from 1947 to 1955 had been recovered by the end of 1956, as compared with nineteen of three hundred and seventy-nine adults (omitting live recaptures, and records of rings and remains found on Lundy). It may be supposed that the smaller recovery rate of nestlings is the consequence of losses suffered by them before reaching independence, for only when they are nearly full grown are they found away from Lundy, like recovered adults. It may be assumed therefore that only $\frac{38}{1110} \div \frac{19}{379}$ or 0.67 of ringed nestlings survived to independence. This value may be used as a measure of s^1 and is probably not far from the true value even though it takes no account of losses suffered between hatching and ringing. Losses in the first ten days of life are unlikely to be negligible, but on the other hand those who have ringed young Guillemots will concede that, even where great care is exercised, ringing tends to increase losses by causing the newly-ringed nestlings to jump into the sea or leave their own ledges and so make them more vulnerable to attack by gulls.

Losses during the rest of the first year can be estimated, for ringed nestlings, in relation to adult losses. Thirty-one nestlings were recovered in this interval, as compared with $\frac{6}{379}$ adults. Allowing for earlier nestling casualties by multiplying the total ringed (1,110), by s^1 (0.67), $d = \left(\frac{31}{1110 \times 0.67} \div \frac{6}{379}\right) \times d$ or 2.62 d where $d = (1 - s)$ and $d_1 = (1 - s_1)$. If $s = 0.79$, $d = 0.55$ and $s_1 = 0.45$. The fact that the fraction of young birds surviving is much less than the adult survival is not unexpected. In almost all species for which similar statistics are available first year losses are substantially greater than those in later years.

It appears that for ringed nestlings $fs = 0.50 \times 0.67 \times 0.45 = 0.15$, little more than a quarter of the value required for equilibrium if $s = 0.79$ and $a = 4$. If this discrepancy obtained in the population as a whole its numbers would be decreasing at the rate of 12.6% (about 1/8) a year. A steady rate of decline as high as this might have obtained in the period 1939-49 but has fairly certainly not done so since. It seems probable that some, if not all, the estimated statistics are at fault. In particular, if s is as small as 0.79 it is certain that the population cannot regain equilibrium, for the

requirement that f be equal to 0.54 cannot be met by a bird hatching only one egg a year : it is impossible that f should exceed $\frac{c}{2} = 0.50$. The highest feasible value of f for a species laying a single egg is only about 0.30. For equilibrium this requires that $s = 0.845$, which falls well within the range of possible values indicated by the recovery data (the standard error of both estimates of s being large). The conclusion must be that the results so far obtained are not precise enough to show reliably what changes may be taking place.

But a second conclusion from this playing about with figures is of some practical importance. It appears that the rate of change of population size is much more readily affected by alterations in adult survival than by alterations in effective fertility. In addition, the scope for increasing effective fertility by reducing losses of nestlings is not very great. A massive assault on the gulls and rats of Lundy might increase the breeding success of the Guillemots, but such an increase would affect the size of the breeding population only very slowly and perhaps not at all, since gains at the nestling stage could so easily offset by losses later on. Against this, it appears that quite a small reduction in adult losses would greatly assist the capacity of the species to build up its numbers again. Even if the net fertility remained as low as 0.19, a reduction in adult losses from 11% to a little less than 10% annually would bring about equilibrium, and if $f = 0.25$ a reduction of adult losses to 8% would produce an annual increase in the breeding population of 6.7%.

The possibility of a reduction in adult mortality suggests an inquiry into the causes of death amongst adult Guillemots. It is possible that in the nesting season a few fall victim to Great Black-backed Gulls. Away from the breeding place no animal predator of importance can be envisaged. The rôle of disease and parasites in causing deaths is not known, but if either produced massive losses the fact would probably be known by now. Bad weather in winter probably constitutes a real danger. Sea-birds blown on to a lee shore by winds of higher velocity than their own flight-speed have only a limited capacity for resistance. But storm-driven Guillemots are not very commonly encountered. Examination of the recovery records of ringed birds leaves little doubt that human activities are responsible for much of the adult mortality. In the sample of sixty-one recoveries of Lundy-ringed birds (records of 'rings only' and of nestling casualties on the island being omitted), thirty-eight were described as found dead, or dying, without further details, fifteen were 'oiled' and eight had been killed by man, mostly by shooting. Six of the eight 'kills' occurred abroad : (two-fifths of the number of foreign recoveries) : shore shooters in England either refrain from firing at auks or get fewer opportunities than those on the Continent. Fourteen of the fifteen casualties due to oil were reported from British coasts. It may be that people reporting ringed birds

in this country are more liable to remark on the apparent cause of death than reporters overseas, but it is an alarming fact that at least 14/46, nearly a third, of the dead Guillemots found in Britain were killed by waste oil. The menace of oil is well known and may now begin to decrease as the legislative measures following the signing of the International Convention of 1954 take effect. If a substantial reduction in the discharge of waste oil at sea is effected there is little doubt that losses of adult Guillemots will be reduced enough to enable the population not merely to hold its own but to return towards its former abundance.

Recoveries of Razorbills on Lundy have been so few that statistics derived from them do not attain even the low level of accuracy of the Guillemot data and the figures are not worth quoting, but they suggest an essentially similar picture, with the possibilities of lower mortality both among adults and in the pre-flying stage. This in turn suggests that the Lundy Razorbill population may be more nearly stable than that of the Guillemot. Unfortunately there is no useful numerical information on the status of the population in recent years, although subjective estimates by successive wardens indicate that the numbers have fluctuated from year to year and have not decreased continually.

Reviewing the results so far obtained it may be concluded that future ringing of Guillemots and Razorbills on Lundy is unlikely to yield important new results on the distribution of the populations when away from the island, but can supply very useful data for the investigation of population dynamics. Specifically, it may be suggested that the ringing effort should be combined with detailed census work on a suitable part of the island. The region of St James' Stone might well be selected because of the comparative accessibility of many of the breeding ledges. This area has already contributed a large proportion of adult recaptures.

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