The Chough in Britain and Ireland

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The Chough Pyrrhocorax pyrrhocorax has a global range that extends from the Atlantic seaboard of Europe to the Himalayas. Vaurie (1959) mentioned seven subspecies and gave the range of P. p. pyrrhocorax as Britain and Ireland only. He considered the Brittany population to be the race found in the Alps, Italy and Iberia, P. p. erythroramphus, whereas Witherby et al. (1940) regarded it as the nominate race.

Despite its status as a Schedule I species, and general agreement that it was formerly much more widespread, the Chough has never been adequately surveyed. Apart from isolated regional surveys (e.g. Harrop 1970, Donovan 1972), there has been only one comprehensive census, undertaken by enthusiastic volunteers in 1963 (Rolfe 1966). Although often quoted, the accuracy of the 1963 survey has remained in question, and whether the population was increasing, stable or in decline has remained a mystery.

In 1982, the RSPB organised an international survey in conjunction with the IWC and the BTO, to determine the current breeding numbers and distribution in Britain and Ireland and to collect data on habitat types within the main breeding areas. A survey of the Brittany population was organised simultaneously by members of La Société pour l'Etude et la Protection de la Nature en Bretagne (SEPNB). The complete survey results are presented here, together with an analysis of the Chough's breeding biology based on collected data and BTO records, along with a discussion of the ecological factors affecting Choughs. Regional totals and local patterns of breeding and feeding biology are discussed in more detail in a series of regional papers for Ireland, the Isle of Man, Wales and Scotland (Bullock et al. 1983a, b, c; Warnes 1983).

Methods
Coverage in Scotland, the Isle of Man and Wales was planned by local organisers who ensured a minimum of two visits to each area within the breeding season. Coverage in Ireland was less thorough owing to scarcity of observers, but all areas (with the exception of a few offshore islands) were
visited at least once. All previous known sites were visited, and coverage was extended to include other potentially suitable coastlines or likely inland areas.

Observers were provided with instruction sheets and survey cards on which they recorded Choughs seen, non-breeding flocks, any evidence of breeding, grid references of nest sites and also estimated proportions of habitat types on a 1-km square basis. Within these habitats, livestock types and any Chough feeding incidents were also noted.

The Chough is predominantly social, and only between April and late June are breeding pairs reliably distinct from flocks. At this time, non-breeders tend to wander farther inland than do breeding pairs, which remain close to their nest sites on the coast (though, occasionally, breeding birds may join non-breeding flocks to feed). Young Choughs probably pair in their first year, though they may not breed until their third or even fourth year (P. Roberts in litt.). Until then, they may prospect likely sites or even build nests. With experience, the lack of purpose in these non-breeding pairs can be distinguished from the urgency of breeding birds.

The following indications were taken as evidence of definite breeding: wool-carrying in early April (to line the nest); single birds visiting nest sites in late April and early May (when males feed the incubating females); pairs visiting sites between early May and end of June (to feed nestlings); and the noise of the nestlings themselves in late June. Probable breeding was recorded for birds seen feeding and then flying directly towards likely nesting terrain, but where no breeding site was confirmed. Lone pairs seen only briefly in likely breeding areas were recorded as possible breeders. To help resolve these categories, it was recommended that observers make two visits to each area, in mid May and again in mid June.
Accuracy of counts

The survey was helped greatly by the extrovert nature of the Chough, whose flamboyant character and distinctive cry often helped the location of birds from some distance. Previous experience, however, of the bird and of its behaviour, helped greatly. Wherever possible, therefore, all areas covered by inexperienced counters were surveyed independently by one of the three full-time survey workers. Observer-accuracy could then be estimated by dividing the first count by the final estimate for that area (based on all observer results). There is no doubt that, with inexperienced observers, there can be considerable errors. Comparison of the performance of experienced individuals on the same section shows, however, that observers should find 85-100% of all Choughs on their first walk in May or June (but only 76% in April).

The ability of observers to locate non-breeding flocks was more variable (66-100%), and the ability to determine the status of pairs on a single visit varied between 50% and 78%. With a second visit, resolution was much improved, and accuracy rose to over 90% in most cases. Inland sites were checked on the basis of past or likely use (e.g. all old quarries were checked). Here, 92% accuracy was achieved in a single visit. In Ireland, where Choughs use mainly natural inland crags, the accuracy was probably lower.

Historical perspective

The decline in the 18th and early 19th centuries was summarised by Rolfe (1966). Fig. 1 gives an idea of the disappearance of Choughs from English counties and the western isles of Scotland. Ussher & Warren (1900) recounted its disappearance from the eastern Irish counties in the mid 1800s, and described it as a ‘diminishing species’. The disappearance from Irish inland sites continued into the early 1900s, though there were some local increases after 1925 (Kennedy et al., 1954). Data for the intervening years until 1963 is scant. The most dramatic event in this period was the demise of the ‘Cornish’ Chough: the last proved breeding of native English birds was in 1947, though a pair lingered until 1967 (Penhallurick 1978).

The 1963 survey found 700-800 breeding pairs in Britain and Ireland (Rolfe 1966) a figure largely underpinned by the Irish total of 567-682 pairs. There is no doubt that the 1963 Irish survey achieved only partial coverage, despite heroic efforts by the few volunteers who undertook it (Cabot 1965). At that time, little was known about the part played by non-breeders in the population, and in some cases figures based on post-breeding flocks almost certainly overestimated breeding pairs. In these cases, the original results (kindly provided by Dr David Cabot) have been re-analysed: this brings the 1963 total down to 400-477 breeding pairs (Bullock et al. 1983a). The shortfall between this and the 1982 Irish total (650-677 pairs) represents those areas not covered in 1963 (most inland areas, plus some coastal sections, especially in Co. Kerry). Ironically, overestimation has eclipsed the effect of incomplete coverage, and the published figure (Cabot 1965) is very similar to that for 1982.
The 1963 Welsh total is considered to be reasonably accurate, but the Manx and Scottish figures for 1963 were almost certainly underestimates (Bullock et al. 1983b, c; Warnes 1983).

Population in 1982
The results of the 1982 survey are given in table 1. A total of 905 breeding pairs was counted in Britain and Ireland. This is a minimum figure, which represents probable plus definite breeding pairs. A further 54 pairs possibly bred. If we allow for pairs that may have been missed (as in those many Irish areas visited only once), we arrive at a figure of around 1,000 pairs, representing an upper limit for the British and Irish population.

In addition to breeding pairs, 825-858 non-breeding Choughs were encountered. The proportion of non-breeders (31-32%) is strikingly similar to the figure of 30% suggested by Rolfe (1966).

It is gratifying to note that the distribution of the Chough in 1982 (fig. 2) is almost exactly as shown in The Atlas of Breeding Birds in Britain and Ireland (Sharrock 1976), which was based on fieldwork during 1968-72. The Atlas recorded Choughs in 244 10-km squares (181 ‘confirmed’, 25 ‘probable’ and 38 ‘possible’ breeding); the 1982 tally is remarkably similar: the 243 10-km squares comprised 200 ‘confirmed’, 20 ‘probable’ and 23 ‘possible’ breeding. The four months’ fieldwork in 1982 seems to have matched the distribution shown by the five years’ fieldwork for The Atlas. Over the last 10
years, the range of the Chough has hardly changed.

The declines that may have occurred in the 19th century (fig. 1) seem to have been arrested and even reversed in a few areas. There remain a few areas with evidence of a decline in the last 20 years (notably Northern Ireland), but in many others (e.g. the south coast of Ireland, Anglesey, Snowdonia and possibly Islay) there is some evidence of slight increases.

For those areas in Ireland where good detail is available from 1963, it is clear that numbers recorded in 1982 were almost unchanged. Furthermore, records kept by R. J. Ussher in Ireland for the 1890s and 1900s give Chough sites and flock sizes virtually unchanged to this day. Even at isolated inland sites first found by Ussher in 1891 and 1905 (some up to 17 km from the sea) pairs were still breeding in 1982, some 90 years on (Bullock et al. 1983a).

When such historical accounts are compared in detail with 1982 figures and the regional totals are set against those for the 1963 survey, the present Chough population appears quite healthy. Ireland remains its great stronghold, with 72% of the total population; Wales holds 16%, and Islay and the

<table>
<thead>
<tr>
<th>Region</th>
<th>1963 (pairs)</th>
<th>Breeding 1982 (pairs)</th>
<th>Non-breeding 1982 (individuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Islay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mull of Kintyre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jura</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colonsay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scotland total</strong></td>
<td>11</td>
<td>61-72</td>
<td>46-64</td>
</tr>
<tr>
<td><strong>Isle of Man</strong></td>
<td></td>
<td>49-60</td>
<td>61-65</td>
</tr>
<tr>
<td>Anglesey</td>
<td>2</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Caernarvonshire</td>
<td>42</td>
<td>51</td>
<td>24-25</td>
</tr>
<tr>
<td>Denbighshire</td>
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<td>1</td>
<td>0</td>
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<tr>
<td>Merionethshire</td>
<td>7</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Montgomeryshire</td>
<td>5-7</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Cardiganshire</td>
<td>9</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Pembrokeshire</td>
<td>33-36</td>
<td>49-52</td>
<td>38-40</td>
</tr>
<tr>
<td><strong>Wales total</strong></td>
<td>99-104</td>
<td>139-142</td>
<td>103-106</td>
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<tr>
<td>Northern Ireland</td>
<td>31-33</td>
<td>9-10</td>
<td>3</td>
</tr>
<tr>
<td>Donegal</td>
<td>120-131</td>
<td>109-112</td>
<td>103</td>
</tr>
<tr>
<td>Sligo</td>
<td>15</td>
<td>5-6</td>
<td>6</td>
</tr>
<tr>
<td>Mayo</td>
<td>81-100</td>
<td>73-75</td>
<td>72</td>
</tr>
<tr>
<td>Galway</td>
<td>79-93</td>
<td>38-39</td>
<td>33</td>
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<tr>
<td>Clare</td>
<td>15</td>
<td>31-34</td>
<td>35-37</td>
</tr>
<tr>
<td>Kerry</td>
<td>152-171</td>
<td>205-209</td>
<td>131</td>
</tr>
<tr>
<td>Cork</td>
<td>73-98</td>
<td>148-153</td>
<td>171</td>
</tr>
<tr>
<td>Waterford</td>
<td>21-26</td>
<td>37-46</td>
<td>59-65</td>
</tr>
<tr>
<td>Wexford</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Ireland total</strong></td>
<td>567-682</td>
<td>656-685</td>
<td>615-623</td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td>700-800</td>
<td>905-959</td>
<td>825-858</td>
</tr>
</tbody>
</table>
Isle of Man hold the remainder in equal parts.

The Brittany Chough census located 25 breeding pairs in 1982, with a further ten pairs of uncertain status (which may include non-breeding pairs). This figure of 25-35 pairs is an all-time low, having declined from the '30-40 pairs' recorded in 1973 (A. Thomas in litt.).

**Productivity and mortality**

There is very little known about the population dynamics of the Chough. Data gathered from the 1982 survey, unpublished field notes and past oologist diaries, BTO nest record cards and BTO ringing recoveries have all been used here to review its productivity and mortality. Only data for the number of successful fledged young were collected during the survey. No attempt was made to examine the contents of individual nests. Chough is a Schedule 1 species, and as such is protected at all times by law.
The Chough lays one to six eggs (fig. 3); in its British and Irish range, the average clutch is 3.88 eggs ± 0.99 (n = 236). Scottish birds lay most eggs on average (4.38 ± 0.77) (table 2). Though not significantly more than in Wales, this is significantly higher than clutch sizes in the Isle of Man (t = 4.30, p < 0.001) and in Ireland (t = 3.26, p < 0.01). It has been shown for a number of other species that island populations lay smaller clutches (Lack 1968). Isle of Man Choughs lay least eggs (3.39), which is signifi-
significantly lower than Irish clutches (3.76 eggs, t = 1.95, p < 0.05) and Welsh clutches (4.18 eggs, t = 4.16, p < 0.001). Though inland pairs laid slightly fewer eggs (table 2), the difference between inland and coastal clutch sizes is not significant.

All breeding data were grouped into 'bad' years, which were breeding seasons following severe winters (1948, 1963, 1979 and 1982), and 'good' years (the rest), to test for effects of winter weather on subsequent breeding performance. No significant differences were found for clutch size, for number of nestlings hatched, nor for number of young fledged.

Nestling success
Coastal pairs in Wales (and probably also Ireland) manage to hatch most young, with an average of 3.11 nestlings per pair. Despite their low clutch sizes, the Isle of Man Choughs have the lowest egg to nestling mortality (23%). Greatest losses at the egg stage occur on Islay (40% mortality) and in inland Wales (40%) (table 2). It is impossible to say what causes these losses. Some are certainly a result of predation; others are probably due to natural infertility. Young birds in particular are more likely to lay infertile eggs or even desert clutches as a result of breeding inexperience. (The higher proportion of inexperienced birds in an expanding population may partly explain the greater losses in Islay and in Snowdonia for example.)

Fledging success
It is a striking fact that Ireland (with the second smallest clutches) has the
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The greatest fledging success (2.85 young per pair), while Islay, with the largest clutch size, has the poorest (1.82 young fledged). The high success in Ireland may be slightly biased due to lack of data on breeding failures. Despite this, clutch and fledgling differences in the British Isles reflect the biological trend for larger clutches farther north. Certainly, fledging success is greater in the southern parts of the Chough's range: success ranges from 1.82 young in Scotland to 2.85 in Ireland to 3.7 in Abruzzo, Italy (Lovari, 1976). Success rates between Scotland, Ireland and Wales are all significantly different (p < 0.05) (table 2).

It is noteworthy that in Pembrokeshire fledging success is slightly higher than in the rest of Wales (p < 0.05); this may also reflect the better coastal climate in the south of Wales. Unfortunately, there are no data for clutch sizes from this country.

Inland pairs are less successful than their coastal counterparts in Wales, where inland and coastal clutch sizes are not significantly different (table 2): inland pairs raise fewer young (2.05) than on the coast (2.68, p < 0.001).

When data for all areas are combined (table 2), the mortality in the egg stage is 30% and that at the nestling stage 12%. This means that out of 100 eggs laid there should be on average 61 fledged young. Farner & King (1971) quoted 57% breeding success in open nests and 76% success by hole-nesters. This freedom from predation is apparently not conferred on the Chough, which enjoys only 61% breeding success overall.

Post-fledging mortality

Since the BTO ringing scheme began, there have been only 48 returns for the Chough, of which 39 were ringed as nestlings, and 38 recovered dead. Four of these died in the nest (and are thus excluded from analysis), and one was shot. The remaining 33 have been used to analyse post-fledging mortality. Not surprisingly, 40% of all young birds died in their first two months out of the nest; a further 40% of all young birds died in their first winter (October to March); thus, the total first-year mortality is 85%. Similarly, in the second year, most died in winter months, with an equally high annual mortality of 80%. The sample size (33) is too small for these figures to be trustworthy; it also gives us no idea of mortality rate in older birds. The only other available data come from the Chough colour-ringing scheme carried out on Bardsey Island, Gwynedd, by Peter Roberts. Of 52 fledglings ringed between 1978 and 1981, eight were found dead in their first year, and at least 13 were seen still alive after their first year. For these, first-year mortality is at minimum 25%, at maximum 75%. From 32 ringed fledglings (1978-80), at least seven survived their second year, which gives maximum second-year mortality of 78%. These figures suggest that mortality of immatures at Bardsey may not be quite so severe as the BTO ringing returns imply.

The main periods of mortality can be gauged by using all the ringing recoveries (fig. 4). Here, the winter losses show up with February clearly the worst month. Post-fledging losses in July and August also stand out; mortality in April and June may reflect stress in the adults during the breeding season, though this is not nearly so marked as in the cases of other
crow species, where, in April (Magpie Pica pica, Raven Corvus corax, Rook C. frugilegus and Carrion Crow C. corone) and May (Jackdaw C. monedula), adult mortality reaches a very dramatic peak (Busse 1969; Holyoak 1971). Recovery of Chough corpses is made difficult both by their scarcity and the terrain in which the species lives.

Productivity

From 100 Chough eggs laid (equivalent to 26 clutches) an average of 61 young fledge. Using the post-fledging mortality figures above, these 61 young dwindle to only two individuals of first potential breeding age (table 3). Thus, 26 clutches are required to guarantee two breeding adults, equivalent to a bird gained every 13 years. Assuming a stable population, this suggests a breeding lifespan of 13 years, and an actual lifespan of 15 years for breeding adults. The oldest known Chough was ‘Eric’, a bird at least 17 years old, ringed as an adult in 1965 on Bardsey and recovered in the winter of 1981/82. (P. Roberts in litt.).

Table 3. Life table for Chough Pyrrhocorax pyrrhocorax

<table>
<thead>
<tr>
<th>Month</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Month</td>
<td>No.</td>
</tr>
<tr>
<td>1</td>
<td>100 eggs</td>
<td>1</td>
<td>11 immatures</td>
</tr>
<tr>
<td>2</td>
<td>70 nestlings</td>
<td>2</td>
<td>9 immatures</td>
</tr>
<tr>
<td>3</td>
<td>61 fledglings</td>
<td>3</td>
<td>9 immatures</td>
</tr>
<tr>
<td>4</td>
<td>52 juveniles</td>
<td>4</td>
<td>9 immatures</td>
</tr>
<tr>
<td>5</td>
<td>43 juveniles</td>
<td>5</td>
<td>9 immatures</td>
</tr>
<tr>
<td>6</td>
<td>43 juveniles</td>
<td>6</td>
<td>9 immatures</td>
</tr>
<tr>
<td>7</td>
<td>39 juveniles</td>
<td>7</td>
<td>9 immatures</td>
</tr>
<tr>
<td>8</td>
<td>37 juveniles</td>
<td>8</td>
<td>9 immatures</td>
</tr>
<tr>
<td>9</td>
<td>31 juveniles</td>
<td>9</td>
<td>7 immatures</td>
</tr>
<tr>
<td>10</td>
<td>26 immatures</td>
<td>10</td>
<td>7 immatures</td>
</tr>
<tr>
<td>11</td>
<td>17 immatures</td>
<td>11</td>
<td>3 immatures</td>
</tr>
<tr>
<td>12</td>
<td>15 immatures</td>
<td>12</td>
<td>2 immatures</td>
</tr>
</tbody>
</table>
Nest sites
Table 4 summarises the sites throughout Britain and Ireland. Of all pairs located, 86% were on the coast. Wales is a striking exception to this, with 32% of the pairs found nesting inland, mostly at disused quarries and mineshafts in North Wales. In Ireland, only Co. Kerry showed a similar pattern (17% of its 200 pairs inland), with some nesting in natural crags up to 19km from the sea. On Islay, over 30% of the breeding pairs nest inland, using mainly old buildings, though the use of rafters in new farm barns is a recent innovation.

Choughs will nest at altitudes of up to 600m, and up to 27km inland. Many of these inland pairs are successful, despite extreme isolation. One Welsh site 27km from the sea has been in use since at least 1957, and remains 40km from its next nearest neighbour. A current Irish site is 28km from the open sea, and 13km from its nearest neighbour, and was occupied as long ago as 1890. The survival of such isolated pairs away from coastal areas reinforces the impression that the Chough population is healthy.

Coastal Choughs nest in crevices in sheer rocky cliffs or on ledges in coastal caves (table 4). Taking the population as a whole, only 10% of all the known pairs nested in man-made features, which included ruined buildings, lighthouses, bridges, mines, quarries, castles and, in one case, an abandoned hotel.

Table 4. Survey of Choughs Pyrrhocorax pyrrhocorax in Britain and Ireland in 1982: regional nest-site data

<table>
<thead>
<tr>
<th></th>
<th>Ireland</th>
<th>Wales</th>
<th>Scotland (Islay)</th>
<th>Isle of Man</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nesting inland (%)</td>
<td>8</td>
<td>32</td>
<td>30-34</td>
<td>7-8</td>
<td>14</td>
</tr>
<tr>
<td>Using man-made sites (%)</td>
<td>5</td>
<td>28</td>
<td>20-23</td>
<td>3-4</td>
<td>9-10</td>
</tr>
<tr>
<td>Quarry</td>
<td>0</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Mine</td>
<td>1</td>
<td>13</td>
<td>0</td>
<td>1</td>
<td>15</td>
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<tr>
<td>Building</td>
<td>1</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Bridge</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Natural crag</td>
<td>38</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>49</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
<td><strong>45</strong></td>
<td><strong>18</strong></td>
<td><strong>3</strong></td>
<td><strong>109</strong></td>
</tr>
</tbody>
</table>

As Choughs use sites naturally sheltered from the elements, one might infer that aspect would be irrelevant. This appears not to be the case. Nest-site directions recorded at the coastal sites in Wales showed that most faced southwest or west (fig. 5). This may be related to the prevailing coastal bias. A northwesterly aspect occurs commonly at inland Welsh sites and for both the inland and coastal sites in Ireland. Whether this direction provides any shelter from the prevailing southwesterly winds is impossible to say.

At two Welsh nests and one in Northern Ireland, a third bird was regularly noted in the company of the breeding pair. These ‘helpers’ were also noted at at least four nests on Islay; one was seen to help the resident
male feed the incubating female (Warnes 1982), though the exact nature of this intriguing relationship remains a mystery.

**Breeding density**

Choughs do not nest colonially: the average distance between coastal pairs (calculated from 32 Welsh sites in the best Chough areas) was 1.4 km. In the better areas, breeding densities varied between one pair per kilometre to four pairs per kilometre (as in Co. Kerry and certain Irish offshore islands). The Calf of Man holds the record, with six pairs in 1 km$^2$. In Wales the closest nests were found within 300 m of each other. A coastal locality in Co. Kerry has two Chough pairs nesting one vertically above the other in a sloping 180 m cliff, and a ruined castle in Co. Galway contained at least two breeding pairs among a colony of Jackdaws. These, however, are exceptional cases. This coastal spacing contrasts with very low breeding densities of inland pairs, where, for 27 sites in North Wales, the average distance to nearest neighbouring pair was 2.6 km (Bullock et al. 1983c).

Breeding density presumably depends on available nest sites and quality of adjacent feeding areas. Choughs tend to feed very close to their nest sites: the average distance between 58 coastal nest sites and their observed feeding areas was 0.7 km. Of these pairs, 88% fed within 1 km of the nest, though some flew up to 2 km for food. In Snowdonia, where pairs are well over 2 km apart, Choughs fly on average much farther for their food, and pairs are away from the nest longer. Trips of 2 km or even 3 km for food are not unusual (IDB personal observations).
Feeding ecology

A number of studies (Cowdy 1973; Bullock 1980; Roberts 1982; Warnes 1982) have now confirmed the general diet of the Chough. Characteristically, its strong curved bill is used to dig for its food, which consists almost exclusively of insects, particularly (and at all times of year) soil-living invertebrate larvae. Of 33 feeding incidents analysed from Ireland in the 1982 breeding season (April-July), 60% involved leatherjackets (Tipula) as likely prey items, 24% ants (especially Lasius flavus), 12% beetle larvae, and 9% spiders. One notable incident involved Choughs feeding alongside gulls Larus, Rooks and Oystercatchers Haematopus ostralegus on adult chafer beetles Phyllopertha horticola, hatched in large numbers from machair in early June.

Bullock (1980) suggested that mere abundance of soil invertebrates is not enough. Good Chough feeding sites must have either a modicum of bare ground or vegetation short enough to allow access to the soil for digging. Thus, maritime heathland which is periodically burned, maritime turf or short-grazed traditional rough pastures are all ideal. Each has minimal vegetation cover and is rich in invertebrates. To test these ideas further, the proportions of habitat types in all areas visited, and the habitats selected by feeding Choughs, were recorded during the 1982 survey.

The results confirm these findings. For all the surveyed areas in Britain and Ireland, the general proportion of rough grass present was only 29%, yet it dominated the feeding records, with 50% of all Chough feeding incidents (fig. 6 includes habitat definitions). Feeding frequency might simply reflect whichever habitat is most abundant; to correct for this, we can divide percentage feeding occurrence in each habitat by its percentage availability, to obtain an index of usage (fig. 6). An index greater than 1 then represents an increased usage by feeding birds. Maritime turf and machair are clearly also important feeding habitats.

Machair is common in Ireland, and to a lesser extent on Islay. In both areas, it is an important feeding habitat for Choughs; in summer, they will fly long distances from their nest-cliffs to feed in it. In winter, these low-lying dune grasslands are crucial feeding areas where large winter flocks gather (Bullock 1980; Warnes 1982), at times in excess of 100 individuals (F. King in litt.). Such sites are often adjacent to beaches where seaweed accumulates after winter storms. This tidewrack also represents an important winter food resource, where shorehoppers Orchestia gammarella and larvae of kelp fly Coelopa frigida are the main prey (Bullock 1980).

Improved grass was used less than might be expected on a purely random basis during the breeding season; and arable land was not used at all. There are only a few recorded instances of Choughs feeding in arable fields, mostly in autumn or winter: e.g. harvested carrot and potato fields in Ireland in autumn (IDB personal observations); recently ploughed and resown coastal fields in September (A. Moralee in litt.); turnip fields in winter on the Isle of Man (E. D. Kerruish in litt.) and in Co. Cork (P. Smiddy in litt.). On Anglesey, Choughs fed on surface barley grains in the stubbles in autumn and winter, and noticeably so when more favoured sites were frozen after heavy frosts (Bullock 1980).
The Chough in Britain and Ireland

Machair = short (usually grazed) level turf over sand, typically behind or near dune systems
Maritime turf = short, herb-rich turf on clifftops and headlands, drenched by spray in winter (thrift Armeria, sea plantain Plantago maritima, buck’s-horn plantain P. coronopus); Rough grass = ‘unimproved’ grassland, usually unploughed for at least ten years, typically a mossy, herb-rich turf usually on poorer soils; Improved grass = richer pasture, often on deeper soils, with evidence of recent ‘improvement’—fertilised, ploughed or reseeded

Fig. 6. Selection by Choughs Pyrrhocorax pyrrhocorax of habitats for feeding in relation to habitat-availability in survey areas

Inland Choughs usually occur in mountainous country where sheep pastures prevail. At such sites in Ireland and Wales (fig. 7), 84% of all feeding incidents occurred in rough grass despite its being only 40% of the available habitat. Over three-quarters of all the feeding incidents in rough grass occurred in sheep-grazed terrain; in Ireland, this feature was particularly striking where so much inland country is dominated by waterlogged, peaty ground. Chough sites were often located near the better-drained soils on small sheep farms in an otherwise boggy landscape. Another notable feature of inland feeding is the higher index of usage of improved grass compared with the coast (fig. 7). J. Grasse (in litt.) has shown in mid Wales that Choughs are using reseeded areas of moorland where acid grassland has been harrowed, reseeded and limed. This has striking parallels with observations made in Ireland in 1982 (IDB personal
Fig. 7. Selection by inland Choughs *Pyrrhocorax pyrrhocorax* of habitats for feeding in relation to habitat-availability in survey areas observations), where at one inland mountain area dominated by acid rocks (e.g. quartzite) several Chough sites were located in crags above bands of limestone where a richer, 'sweeter' turf was available.

On the basis that pairs feed within 1 km of their nest sites, the survey habitat data were re-analysed for those 1-km squares without breeding Choughs, those with one breeding pair, and those with either more than one pair or in which Chough flocks were seen feeding. The results support the idea that the quality of coastal habitats influences Chough distribution: the squares with the highest breeding densities also had the greatest proportion of rough grass and maritime turf: key feeding habitats (fig. 8). The importance of a grazing regime to feeding Choughs is demonstrated by analysing feeding records according to livestock present (table 5). Traditional pasture grazed by sheep appears to be the most favoured combination. Sheep grazing gives the closest-cropped sward (Moore 1966); measurements in Ireland found vegetation height to be only 1-3 cm in the best feeding areas. Sheep and cattle faeces also contribute dung beetles

### Table 5. Survey of Choughs *Pyrrhocorax pyrrhocorax* in Britain and Ireland in 1982: number of feeding incidents in relation to grazing regime

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Machair</th>
<th>Maritime turf</th>
<th>Rough grass</th>
<th>Improved grass</th>
<th>Heather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep</td>
<td>6</td>
<td>28</td>
<td>185</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Cattle</td>
<td>3</td>
<td>3</td>
<td>72</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>Horses</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>16</td>
<td>94</td>
<td>51</td>
<td>20</td>
<td>26</td>
</tr>
</tbody>
</table>
Fig. 8. Habitat proportions in areas of different breeding density of Choughs *Pyrrhocorax pyrrhocorax*

*Aphodius* as a food source. In Scotland, short pasture grazed by cattle is the main feeding habitat in all seasons; dung beetles are the staple food and adult beetles occurred in 90% of samples of nestling diet (Warnes 1982). The high number of feeding incidents in maritime turf without livestock is no doubt due to its naturally low growth form. This vegetation is usually 1 cm or less in height as a result of extreme exposure in winter. It is sometimes grazed by sheep and can be rich in leatherjackets in summer.

**Factors affecting numbers and distribution**

At nearly 1,000 pairs, the British and Irish population must represent a significant proportion of the European population, particularly in view of reported declines at several other European stations (Sorci *et al.* 1971; S. Lovari *in litt.*; A. Thomas *in litt.*). It seems pertinent, therefore, to review the factors that may be affecting Choughs here, and bring up to date those first itemised by Rolfe (1966).

**Land-use changes**

More than any other single factor isolated by the survey, grazing illustrates how changes in land use impinge on the Chough and its ecology. There are several cases where changes in livestock (with consequent changes in the habitat) appear to have affected Chough populations. On Ramsey Island,
Dyfed, farming ceased around 1968 and livestock were removed. At this time, the island held eight breeding pairs of Choughs. In the following years, the proportion of rough grass fell from nearly 70% to 40%. In these years, rabbits *Oryctolagus cuniculus* provided the only grazing pressure, and Choughs fed noticeably in these areas (Cowdy 1973). By 1975, rank heather and bracken occupied over half the island, and the Chough numbers fell to four pairs, the level at which they have remained (Bullock *et al.* 1983c). On Bardsey in 1958, Hayward (1958) considered the stock-carrying capacity to be far from realised. Today it must be near the limit, with over 400 sheep and 25 Connemara ponies. Chough numbers on Bardsey have risen from two breeding pairs in 1958 to seven in 1981; the present system of intensive mixed grazing throughout the island seems much to their liking.

The recent history of the Calf of Man tells a similar story. Farming ceased on the island in 1958 when it became a bird observatory. At this time, there were at least 30 resident Choughs, including ten breeding pairs. With the removal of the livestock, the short-grazed pasture became increasingly rank, until by 1970 it was described as 'very overgrown', with the associated spread of bracken into grassland areas. At this stage, the Chough numbers were at their lowest: only 12 birds including four breeding pairs, which raised no young. In 1969, Loghtan sheep were introduced for the first time. In the next ten years, these built up to around 100 ewes; the Chough has shown a parallel recovery, doubling in the last ten years to eight breeding pairs (in 1982), which raised 21-22 young (Bullock *et al.* 1983b) (fig. 9).

![Fig. 9. Numbers of breeding Choughs *Pyrrhocorax pyrrhocorax* and number of sheep on the Calf of Man during 1959-82](image-url)
The way Chough numbers seem to respond to such stocking levels suggests both a clue to some of the past declines and the key to its future welfare. Might it be that major changes in land use in coastal areas were responsible for the shrinkage in the Chough's range during the last century?

From 1846 (with the repeal of the Corn Laws) to 1870 was the 'Golden Age' of farming. This coincides with the disappearance of Choughs from many areas. Other forces must have interacted with this. For example, in the 1860s the railway arrived in Cornwall. This led to a boom in dairy farming to supply the demand for milk in London, with the consequent improvement of Cornish coastal pastures. With the two world wars, ploughing and cropping also burgeoned. These times pushed arable land and managed pastures right up to the cliff edge, and the 1920s and 1940s saw the last Chough losses from the north Cornish coast; the terrible winter of 1946/47 may have set the final seal on the last breeding pairs there (fig. 1).

Similar forces are still at work today. The shifts in fortune of the island populations on Bardsey, Ramsey and the Calf are eloquent witness to the role of livestock in the Chough's fate. The spread of arable farming is a more serious threat. In Brittany, Chough pairs have disappeared recently from those areas where ploughed land has pushed right to the coast; they survive now only on a few headlands and islands where the narrow coastal strip of maritime heath or sheep- and cattle-grazed pasture is still intact.

Parts of Dyfed already look remarkably similar to Cornwall; it is perhaps only the greater proportion of sheep-grazed pasture that sustains the present Chough population there. Areas in western Dyfed which used to have breeding Choughs now closely resemble unsuitable breeding areas (Bullock et al. 1983c) (fig. 10). In Northern Ireland, such changes may have had their effect already. The population there has dwindled from 21-22 pairs in 1963 to around ten pairs at present. The decline there is perhaps partly due to improvement of coastal pastures, but also indirectly to the associated clifftop fencing, which allows formerly grazed slopes to revert to bracken or scrub.

Fig. 10. Habitat proportions in present and former breeding areas of Choughs *Pyrrhocorax pyrrhocorax* in coastal Wales.
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Human disturbance

Though tourist pressure has increased in recent years, the cliffs and rough grassland where Choughs nest and feed are still relatively free of people. Tourist development at some coastal sites may displace some feeding Choughs, though in general the species is extremely tolerant of human presence and continues to breed at several tourist spots. Prolonged disturbance, such as climbing in inland quarries in the vicinity of traditional nest sites, seems the only serious form of direct threat.

Human persecution

Ryves (1948) mentioned gintraps set on cliffs for rabbits as slaying many Choughs in Cornwall in the early 1900s. Although such traps are uncommon today, a corpse with a smashed leg found in Co. Kerry in 1979 (IDB personal observation) probably met a similar fate. Shooting certainly killed many Choughs in former times, and they are occasionally still illegally shot today by farmers in mistake for crows. Reports from Brittany (A. Thomas in litt.) suggest that shooting for sport remains a serious threat to Choughs there: a couple of offshore islands now hold most of those remaining.

In the past, eggs and young were both taken regularly (the latter for pets). It is not known to what extent this occurs today, though at least one site in North Wales is known to have been robbed nearly every year when the young are about three weeks old (R. Fisher in litt.).

Isolation and inbreeding

Choughs are extremely sedentary, which means that once extinct in an area (as in Cornwall) recolonisation may take some time. There is, however, clearly a dispersal of young birds in their first autumn and winter, with individuals recovered up to 140km from their natal site. The recolonisation of Anglesey almost certainly occurred from mainland Wales, probably from colonies 30 to 40km distant at the time. With a known range of 140km, we can speculate that Cornwall could be recolonised from Pembrokeshire (100km away) or less possibly from Brittany (160km away). The likelihood of inbreeding being a serious problem in isolated populations is unknown. The considerable distances which young birds can fly during their first-year dispersal would diminish this threat, through the sporadic arrival of immigrants from outside areas.

Disease

The effects of disease on Choughs are little documented. Chough chicks found dead on Bardsey (S. Cowdy in litt. 1967) showed no evidence of disease or parasites. Juveniles caught on Bardsey in 1979 carried many parasites, though this was more likely a result of being in poor condition. In two post-mortem of adults from Wales, death has been linked possibly to pseudo-tuberculosis: one was positive, the other uncertain. Lameness, a symptom of pseudo-tuberculosis in domestic turkeys, is occasionally noted in wild Choughs. Aspergillosis has been mentioned as occurring among Choughs caught at winter roosts (G. King in litt.).
Toxic chemicals
At the height of the organo-pesticides problem in the 1960s, three Chough corpses analysed had low levels of DDE, dieldrin and mercury (Rolfe 1966). The use of such chemicals was probably much lower on the western coasts than elsewhere, and dieldrin, aldrin and DDT are now widely banned. The threat of sheep-dip chemicals seems slight. The consumption of grain in autumn and winter (Bullock 1980) may expose Choughs to mercury, though they usually feed in stubbles rather than on the treated, winter-sown seed.

Climate
The climate on the west coast of the British Isles is different from elsewhere in the Chough’s range, where it inhabits rocky, mountainous country. The Atlantic coasts enjoy milder winters (e.g. average minimum temperatures not less than 4.5°C), leading one to speculate that winter temperatures may limit the Chough’s range. The maritime climate usually guarantees freedom from the snow and frosts which bury or freeze its feeding grounds. The warmer winter soil temperatures may also sustain greater insect activity, crucial to its diet. The feeding congregations in machair are an example of this: a habitat where high soil insect numbers and freedom from frost guarantee a winter food resource.

BTO ringing returns show that most Chough deaths are in February (fig. 4). There is evidence of increased mortality in severe winter weather which probably caused a fall in the number of breeding pairs in mid Wales in 1982 (Bullock et al. 1983c). This may explain the better performance of coastal pairs compared with the inland populations. Though climate may dictate the Chough’s general distribution at these latitudes, it cannot explain all of the past declines. It might account for the disappearance from many inland stations in the last century, but not from the southern counties of England. Rolfe (1966) noted that the decline of the Chough in some areas matches the period of cold winters and wet summers between 1820 and 1880. On closer analysis, this theory is less conclusive. The worst periods of sustained cold in the 19th century were during 1837-55 and 1878-98, whereas many breeding areas, as far apart as Cornwall and the Western Isles of Scotland, were abandoned between 1860 and 1880.

Predation
There is very little evidence identifying the main predators of the Chough. Mammalian predators have been suggested (Rolfe 1966), but these would be lucky indeed even to reach a nest. Choughs nesting in buildings may be more vulnerable. Warnes (1982) considered ferrets Mustela furo, rats Rattus and feral cats Felis to be possible culprits for such predation of nests on Islay. The reaction of feeding flocks to Ravens or Peregrines Falco peregrinus is unequivocal: the Choughs take to the wing. This suggests that both may be occasional predators, but the Peregrine has been unfairly cast as the implacable enemy of Chough. As the two are often neighbours, some skirmishes are inevitable, but actual kills are extremely rare (Ratcliffe 1980). Other evidence (Bullock et al. 1983a) suggests that Great Black-
backed Gulls *Larus marinus* may be a more significant predator, especially of juveniles.

**Competition**

The degree to which Chough competes with other crows is poorly understood. At one time, the Jackdaw was thought to have ousted the Chough from much of its range; this idea is now generally discredited. Though their diets do overlap to some extent, the Jackdaw is, in general, a surface feeder, whilst the Chough digs deep for its food. Where they are adjacent, Choughs use the thin, poorer soils (e.g. rough pasture and heathland), whilst Jackdaws and Rooks are more attracted to the better farmland soils of improved pasture or arable (Bullock 1980). If the Chough's success is due to its ability to exploit such marginal land, how far is the continued improvement of coastal pasture bringing the Rook and the Jackdaw into competition with it?

**Discussion**

Looking back to the 1963 survey and comparing the results, county by county, with the figures for 1982, we conclude that the Chough population has basically been stable, with evidence of a few local increases in the past 20 years. There has been a probable increase in Scotland (Warnes 1983), and also in Wales (Bullock et al. 1983c). The Isle of Man population appears stable (Bullock et al. 1983b). Although there has been a decline in Northern Ireland, in the rest of Ireland the main population remains healthy and stable. Yet the Chough is a rare bird, and appears ever to have

162. Chough *Pyrrhocorax pyrrhocorax*, Islay, Scotland, 1975 (Rodney Dawson)
been so. The reasons must lie in its own biology. For example, why is the Chough (which at all other times of year is as social as are Rooks and Jackdaws) a solitary nester? With its specialised diet, perhaps pairs are spaced out in order to guarantee sufficient food for their young. On the coast, nests are spaced over 1 km apart; significantly, pairs fed within an average of 1 km of the nest. Inland, the spacing of nests is twice this, and pairs must fly twice as far for food. Occasionally, natural nest sites may be a limiting factor, as occurs in machair areas in Ireland, where Choughs may resort to old buildings to take advantage of good feeding habitats away from
cliffs. In general, however, it appears that Chough breeding density is controlled by the quality of feeding habitat, and that coastal feeding habitats are richer than those available inland. Elsewhere in the world, the Chough seems to be a bird of montane grasslands; its poorer breeding performance in inland areas in Britain and Ireland suggests that this traditional niche is not ideal at these latitudes. The analysis of habitat usage from the 1982 survey shows the importance to Choughs of marginal land—dry maritime heath, maritime turf, machair and traditional pasture—and the vital role of grazing by livestock in maintaining them as suitable feeding habitats. This makes the Chough dependent on a landscape created largely by man. Indeed, it is hard to imagine that Choughs were so widespread before human activity created the open habitats in which they can feed. The Chough stronghold remains 'the Celtic fringe': the traditional sheepwalks and rough cattle pastures of the west. Presumably only in maritime areas can it find the combination of mild winters and a guaranteed year-round abundance of soil invertebrates.

Of all the factors reviewed in this paper as possible influences on Chough numbers, it is our opinion that changing land-use is potentially the most serious. There is a strong case for believing that agricultural improvements caused the extinctions from the English counties. Such changes are still at work in Welsh and Northern Irish coastal areas, and forestry is a new threat to some upland feeding grounds.

Elsewhere in Britain and Ireland, the present population seems secure. In most Irish and Welsh areas, sheep numbers are as high as (and often higher than) in the past. The future of the Chough would seem assured so long as traditional farming practices are maintained within the narrow coastal strip on which it depends.

Future monitoring

Another comprehensive population survey may not be necessary for 20 years or so. Until then, a simple census method would be to identify the main winter feeding areas (e.g. machair) and winter roost sites, and to use such counts to form an annual index of the Chough population.

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The Chough in Britain and Ireland

Dr Gareth Thomas of the RSPB supervised the project throughout, and he and Dr Raymond O'Connor of the BTO kindly read and criticised a draft of this paper.

Summary

The 1982 International Chough Survey located a total of 905 breeding pairs in Britain and Ireland, the bulk of them in Ireland (567-682 pairs). Wales held 139-142 pairs, Scotland 61-72 pairs and the Isle of Man 49-60 pairs. In Brittany, 25-35 pairs were recorded. In addition, a total of 825-858 non-breeding Choughs was found, representing 31-32% of the total summer population. General distribution remains almost exactly as shown in The Atlas (Sharrock 1976). The Irish population appears stable, as does that of the Isle of Man; there have probably been increases in Wales and Scotland, and declines in Northern Ireland and Brittany.

Of all pairs, 86% were coastal; only in Co. Kerry and North Wales were there significant numbers breeding inland. Choughs are not colonial: nests were spaced 1.4km apart on average. Average clutch size throughout was 3.88 eggs, and fledging success was 2.38 young per pair. Scottish Choughs laid the most eggs, but had the lowest breeding success; Irish birds laid fewest, but with greatest fledging success. Mortality appears to be high in the first two years of life, with greatest losses in the winter months, especially February.

The Chough relies on access to the soil where it can dig for soil invertebrates. Feeding records showed the importance of rough unimproved grassland grazing by sheep or cattle. Machair and maritime turf were also important feeding habitats; improved pasture and arable land were not. The implication is that the quality of coastal habitats influences Chough numbers, particularly as 88% of pairs were found to feed within 1km of the nest site. Inland pairs also relied on sheep-grazed mountain pasture, but at some sites liming of upland pastures attracts feeding Choughs.

Factors affecting the Choughs are reviewed. At the latitudes of Britain and Ireland, climate probably dictates its broadly maritime distribution. Within this constraint, it is largely dependent on patterns of human land use. The poorer grazed pastures appear to be its niche; it remains vulnerable to any change from the pastoral tradition, either by removal of livestock (which allows bracken or scrub to develop) or intensification towards dairy or arable farming (which deplete soil invertebrate faunas).

References


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