

8 GENERAL DISCUSSION

It was stressed at the outset that a vital part of conservation is a knowledge of the factors that limit the distribution of rare and endangered species. Many species-orientated 'rescue' projects have to confront the fact that the ecological requirements of their subjects are somewhat less than fully understood; there is also a requirement to understand the reasons behind declines. Usually the two are related. Research objectives such as these are fairly self-evident and usually at least tacitly acknowledged, but they are beset with difficulties: not least of which is the fact that the species concerned may have either already disappeared or exist at such a low ebb that their behaviours and apparent requirements may not be typical.

The habitat of a terrestrial bird population is usually defined by the ecologist and not by the ornithologist (Perrins & Birkhead 1983). This is because the fauna directly or indirectly depends on the first trophic level for its energy source, and this is always vegetation, usually a green plant or other autotroph which traps photo energy and converts it to available energy. This first level is controlled by various edaphic factors, only subsequently being used and shaped by consumers, *i.e.* the occupants of higher trophic levels.

Sometimes, the habitat or area supporting the individuals of a population is well-defined and obvious due to physical characteristics: classically, a small remote island or atoll. Where a population occupies a less obvious territory, an understanding of the ecology of the area needs to precede its definition and autecological study of a constituent species. A tit, for instance, may occupy a 'realized niche' at a particular height within the canopy of broad-leaved woodland but without an understanding of stratification within the woodland, knowledge of the tits occupying it will never be complete.

The Red-billed chough inhabits both islands such as Islay and Bardsey and also the continental Eurasian landmass. Several geographical races have been described. It is perhaps interesting to note that more sub-speciation exists in avifauna, which are (like taxonomists) principally visual creatures, than in mammals. Were Choughs mammals, there might be fewer so-called races and fewer problems when speaking of translocation; on the other hand, the Choughs of Islay may, in their 'realized' ecology, be substantially different from the Choughs of West Wales, or they may represent 'micro-geographic races' (Mayr 1959).

Whatever the outcome of such taxonomic arguments, the Chough *is* locally rare and specialized: a sedentary species limited in its distribution not so much by physical boundaries but by special habitat requirements. Clearly, in order to better protect those living in mainland Wales, it was necessary to undertake specific research there; and also to assess the feasibility of re-establishment in Cornwall, since Wales is the closest region, in terms of both distance and physical characteristics.

Unlike previous autecological studies of the species, which have all taken place within island strongholds, the population under study here was thinly and linearly distributed along a mainland coastline, which provided many obstacles to sustained continual monitoring. The population was at a very low level: *i.e.* 7 pairs in >100km of coast, separated into 4 blocks for the purposes of this study. Viability is assumed because of traditional occupancy but flock sizes seldom exceeded those of family units, *i.e.* 5-6 birds (except at Marloes, where 8-9 was common), and birds were often present only in pairs.

The paradox of the Chough in Britain is that it both needs man and yet shuns him. In this sense it is a throwback to old pastoral agriculture, when humans and their livestock occurred throughout the wilder regions and when scarcely an inch of countryside was unused. Modern farming derives extraordinarily high yield from minimal acreages, and results in a countryside either so heavily exploited it sustains little if any wildlife, or so neglected that it reverts to scrub. Neither of these options provides a species like the Chough with a viable resource, but in areas where a more

primitive agriculture still survives, the Chough may find a precarious existence.

Pastoralism is essentially the use of grazed land in support of livestock and a means of farming. Without meat to eat, milk to drink, or leather and wool for clothing, livestock would hardly be needed and there would be no pasture. The patchwork of enclosed fields, so traditionally a part of Britain and so beloved by many people, would be replaced by prairies of wheat, as has already happened in East Anglia; the sheep-grazed fells, downs and hills would be blanketed in scrub. Not only would the landscape alter radically, wildlife diversity would be much poorer. The decline of the Chough would be rehearsed with all other fauna and flora which evolved with and now depends on grazed grassland (*i.e.* pasture).

The Chough, used in heraldry and symbolically from the earliest times, and now recognised as a flagship species by official conservation bodies concerned with the maritime cliffscape, has perhaps still another role to play, as an harbinger for the greater countryside, a symbol for the need to return to a saner method of farming: 'less input - less output - more diversification'. It may be restressed here that the Chough was once an inland species and occurred across much greater tracts of countryside than is now the case.

While there is no doubt that coastal low-intensity pastoral systems (see, *e.g.* Signal & Curtis 1989) form an indispensable component within the Chough's present-day overall habitat requirements (the 'functional unit'), it is thought that the species evolved in montane regions and spread to coastal districts in western Europe (Guillou 1981). The results of my behavioural studies, while requiring further work, indicate that the species, in western Europe at least, performs marginally better in natural cliffscape than in pastoral agriculture. The species selects the former preferentially, and foraging success and efficiency are superior, even than in pastoral agriculture managed to suit Choughs. Componental examination of the habitats associated with Chough feeding events showed that those most consistently selected were more likely to be the product of natural abiotic forces rather than of pastoral agriculture: bare earth (identified in >40% of all feeding occurrences), maritime therophyte communities (nearly 16%) [bare earth is a consistent factor within therophyte communities], rock-vegetation/earth interfaces (28%), cliff crevices (>21%). The top five preferentially selected broader habitat categories were all primarily the product of natural forces, not man: cliff-slopes, maritime grassland (except where grazed by domestic animals), ant-created habitat, species-rich grassland and therophyte zones. Sheep-grazed grassland, the most frequently selected man-created habitat, was used in 15.4% of all feeding events.

After retreat to the cliffs, any reduction in available substrate would have made Choughs increasingly dependent on man and his agricultural practices nearby. While these were in a semi-natural state, Choughs could have compensated, but with increasing intensification, the ploughing up of heathland, the introduction of monotonous rye-grass/clover swards, the profligate use of artificial fertilisers and herbicides, the in-stalling of cattle, and the growth in cereal farming, their survival became increasingly difficult. Moreover, where this was compounded by direct persecution, such as hunting with increasingly sophisticated weaponry (muzzle loaders were replaced with breech loaders etc.), the collecting of eggs and specimens (live and dead), incidental disturbance caused by the advent of tourism during the Victorian age, the motor car and railway train, plus other hazards, *e.g.* gintraps for rabbits, survival became at times impossible, and the species rapidly retreated across southern England and became greatly reduced even within its western seacliff stronghold (see, *e.g.* Rolfe 1966, Darke 1971, Donovan 1972, Penhallurick 1978, Balchin 1983, Bullock *et al.* 1983a, and Owen 1985).

So is the Chough a species of the seacliffs or of pastoral agriculture? The simple answer is 'both', but that is only a description and not an explanation. Broad-based habitat assessment, as undertaken during this study, should be replaced by improved techniques of cliff assessment on a scale which relates to Chough behaviour, *i.e.* their ability to exploit complex mosaics, and small patches/zones of optimum habitat. I wish here to draw together elements from the preceding chapters and explain, by virtue of their separate aims, the different facets of the Chough's habitat

requirements in West Wales, and then to relate these to a hypothetical situation in Cornwall. Realisation of the fact that Chough usage of pastoral components is greatly influenced by cliff quality reduced the need for precise descriptions of contiguous farmland. Therefore, to manage Chough populations it is probably better to aim for a high quality cliffscape rather than rely on neighbouring agricultural management outwith conservation areas.

The kind of conservation measures needed are much better understood now than they were even in the eighties. Mitchley (1990) has produced a timely and cogent Sea cliff management handbook for Great Britain which illustrates the complex nature, ramifications and side-effects of management. Under the heading "Restoration grazing management" Mitchley gives the following options "(i) [re-]introduction of grazing after variable periods without grazing, (ii) increase in stocking rate, (iii) decrease in stocking rate, and (iv) removal of grazing altogether". He cites the Chough and Large blue butterfly *Maculinea arion* as examples where the restoration of grazing is designed to improve the habitat. The decline and ultimate extinction of the Large blue has a parallel with that of the Chough in both local geography and timescale (Thomas 1977). A common reliance upon ants of the *Myrmica* genus, and the susceptibility of these to the sort of habitat changes that are known to affect Choughs directly, serve to illustrate the fundamental effects of habitat change on the higher trophic levels. However, the introduction of grazing onto natural communities or those in which the influence of man is secondary to natural maritime exposure can seldom be justified. Elsewhere, the history of sites, and the full implications of restorative grazing management must be planned very carefully and frequently monitored with the support of fixed point photography.

In this study, a detailed botanical investigation of key feeding sites revealed a predominance of edge zones and ecotones; the *Aira praecox* sub-community of the *Armeria-Cerastium* maritime therophyte community being, by far, the most frequent type. *Aira praecox* (Early hair-grass) was found growing in 56.8% of the 58 quadrats surveyed, but represented a mean cover of only 1.4%, tending to confirm it as an indicator species. The main cover-types within this survey were *Festuca rubra* (Red fescue) (15.5%) and exposed substrate (14.1%); no other cover-type exceeded 5%. Evidence of sheep grazing (*i.e.* dung) was found in 17.2% of the samples surveyed but dung represented only 0.3% cover, a factor exceeded by rabbit dung (=0.5%).

Rabbits were a far greater grazing pressure before the outbreak of myxomatosis, their dramatic reduction in the 1950s exacerbated an already deteriorating situation (Sumption & Flowerdew 1985) which had begun with the abandonment of many crofts and the decline of domestic herbivores such as draught horses and pit ponies on cliff headlands during the C19, a process complete after World War II (see, *e.g.* Roberson & Stamp 1941, Balchin 1983, Mitchley 1990). Where present in reasonable numbers, as at Newgale-Solva, the importance of rabbits should not be underestimated (Mitchley 1990). According to Carrington (1951, *op cit.*), 9 rabbits = 1 sheep in grazing ability. Sheep stock-rates are critical (Liddle 1975): 1/0.405ha permits tall grasses, but 3/0.405 creates a low sward. Where the fencing of cliffs is not possible due to practical, planning or financial constraints, unenclosed grazing is deterred by the risk of unleashed dogs causing stock to panic with fatal consequences. In such circumstances, rabbits or goats are an alternative which might well be considered or encouraged as part of a coordinated management approach.

Livestock create open, low profile vegetation and dung, which combine to increase the invertebrate biomass and render it available to Choughs and other wildlife. In the absence of domestic livestock, Choughs rely on abiotic factors (*e.g.* exposure) to create open conditions, and an unenhanced invertebrate spectrum. If they are to have access to soil invertebrates, there is also an apparent need for suitable conditions which do not involve prolonged and regular freeze-ups. In Britain and Ireland, where mountains and valleys do not exist as in the Chough's main Eurasian range, the species is now concentrated on and around the cliffs of western seaboard. Central to the understanding of the species is a knowledge of the factors which determine this distribution and, within it, the relevant importance of cliffs *per se* and the adjoining pastures.

Increased understanding of the role of Cornwall and Brittany in the decline of the Chough and their potential for revival will throw light on the Welsh position and help safeguard it. If the Chough were limited by bioclimatic factors alone, and the non-freeze factor was shown to be the key factor, a south to north decline in Britain would not be expected, whilst an east to west one, ending up in Cornwall, would. It seems that bioclimatic factors were superseded by human agency and revolutions in agriculture, industry, affluence, mobility and leisure. Recent stabilisation and recovery of the Chough, particularly in two areas, due to a reversal of former deleterious agricultural practices, *i.e.* Calf of Man (Bullock & del-Nevo 1983) and Bardsey Island (Roberts 1985) further support the contention that the recent decline of the Chough is associated with human agency but so is its recovery. Recolonisation of Anglesey (1958), Montgomery (1959) and Denbighshire (1962) (Owen 1989) point to a response to increasing protection.

The key factors appear to be changes in transition between landscape governed by natural and semi-natural forces. Domesticated grazing animals are a comparatively recent event in evolutionary terms. *Ad hoc* subsistence farming and low-input extensive systems would certainly have been environmentally friendly and complemented natural forces. Choughs, apparently occupying a niche with little competition, might have been expected to take advantage of human activities which extended that niche, and this is indeed what probably happened during the Middle Ages until the rate of change became too fast and too severe: a process which perhaps began in the late-C17 and accelerated until conservation imperatives began to take effect in the mid-C20. Signs that populations elsewhere in Europe (Bignal & Curtis 1989) and the Republic of Ireland (R. Nairn pers. comm.) are also under pressure indicate that extinction in England will be followed elsewhere unless comprehensive conservation measures are implemented.

As stated, the knowledge gained from this study was to be applied in Wales and related to Cornwall. Conservation of the species in Wales had not waited upon the commencement of this work. It had been a matter of concern to local conservation interests for some time. At Cemaes Head, positive management for Choughs had been in train for many years. At Strumble, the area was first protected in 1954, extended in 1977 to include Strumble Head itself, and further extended in 1988 (S.B. Evans pers comm.). These two nearby examples show that a variety of conservation measures, dependent upon local criteria, are probably both inevitable and necessary. With the Mwnt-Cemaes/Strumble duality serving as an example, it is possible to postulate an integrated system of land-use which blends traditional farming with broader conservation interests. A *mixed* grazing regime can be envisaged: employing cattle, sheep and possibly horses, for their differential grazing strategies, at variable stocking rates, and yet flexible enough to be sensitive to extrinsic seasonal demands and local constraints. Sometimes, perhaps where there is a history of grazing such as at Cemaes Head, stocking rates could be very high. The effects of less controllable resources, such as rabbits would, if present in appreciable numbers, be a bonus. Since Choughs are known to utilise burnt areas for food (Haycock & Bullock 1982), 'cool' localised burning or 'swaling' of gorse could be utilised to supplement grazing; this has historically been a common and effective way of controlling scrub and it provides 'first bite' spring fodder for livestock. And when harvested, 'furze' provides a useful domestic fuel.

In the two southern study areas (Newgale-Solva and Marloes), reduced pastoralism was possibly more than offset by increased rabbit and ant populations and increased exposure caused by slopes facing south, west or east, rather than north or north-west. The result was more bare ground receiving more early morning sunshine at an angle of dip, *ca.* 45°, which achieved maximum insolation. These factors combined to the benefit of the invertebrate biomass, and, therefore, to Choughs. It was very noticeable that the only such slope at Cemaes (east-facing and therefore receiving early morning sun), albeit of a quite limited extent, was intensively used by Choughs at all times of the year.

Inevitably, the species has in the past been painted as black as other crows, but there is evidence to suggest that it is actually of benefit to man. Garcia Dory (1983) demonstrates a role, the fertilization of mountain pastures in N Spain, which might have parallels elsewhere. The high

nitrogen content in animal dung kills the herbage beneath and dead circles of vegetation are numerous and widespread. Good management of such pasture would be to spread the dung and avoid excessive concentration. The Chough, Dory states, undertakes this task:

"When the dung dries, the coleoptera establish themselves in it and their arrival attracts the birds. *Pyrhocorax pyrrhocorax* arrives first, with its long beak it perforates the top layer of the dung searching for the beetles which are at the bottom. They are able to catch the biggest insects (*Geotrupes*) with their curved bill (which differentiates them from *P. graculus*)... Once the 'top of the box' is open, *P. graculus* intervenes and looks for the smaller *Staphylinus* and *Aphodius* found inside... both species of choughs shred the dung to try and find the earthworms at the bottom. This process results in the breaking up and spreading of the dung around the pasture with the consequent benefit for the plants...

"Choughs carry out this work very quickly, a flock of 10-15 birds can deal with a pat of dung in a few minutes. Once they have finished ... they fly to another place to repeat the operation...

"One can conclude that the availability of food for these birds is very high, almost unlimited..."

Such revelations are fascinating and make us question our prejudices. It displays the interdependence between different life forms, and gives an insight into the ramifications of just one predator-prey relationship. It also shows the value of broad-based studies and of cooperation between workers in different fields. The life-cycle biology of the invertebrate prey base requires better understanding for their own conservation as well as for that of their predators. Many complete their life cycle within one calendar year, and are greatly affected by short-term or erratic management. Distribution maps, of varying degrees of completeness, are available for some groups, and information at the level available for birds and plants would be a useful source of correlative information, especially as prey ranges become known to a higher taxonomic level. Although exhaustive species-lists are less important than an understanding of the one or two main prey taxa in their respective seasons (Feare 1984), it increases understanding of ecological relationships with invertebrates if vertebrate zoologists take their level of invertebrate prey identification to a species level whenever possible (A. Stubbs pers. comm.).

Such information could help to throw light on the Chough's prey selection since there are dietary components in SW Britain which are not recorded farther north or appear to be less important. For example, ants and earthworms are taken in greater numbers than in Islay, North or central Wales; this could be due to a variety of reasons: *e.g.* a response to northerly declining ant diversity, or a dietary deficiency in southern Choughs. Despite clues to the contrary (*e.g.* Ussher & Warren 1900), earthworms had not previously been acknowledged as a regular prey species. The work of Garcia Dory, quoted above, shows that earthworms are a regular component in the diet of Choughs much farther south than Cornwall. In this study, their chaetae were present in 20% of all Welsh faeces examined ($n=277$) and in 75% of 99 collected in a brief Cornish winter study (in Wales, the winter value rose to 29%). This apparent relatively high usage of earthworms in West Wales and even higher in Cornwall (by 'pioneer' birds) when viewed in context with apparent avoidance in the core of the northern range must raise the possibility of a sub-optimum diet. Earthworms are transport hosts for several pathogens, and they are never taken by captive birds from choice. Gapeworm is one such pathogen, and it is known to be a problem in captive birds (Keymer 1982) and of Choughs in particular (pers. obs.). It is endemic in the wild Chough population and caused the death of one of two Cornish birds (see Appendix VII). Gapeworm is of increased risk to stressed, and inexperienced or young birds not feeding as profitably as established birds (Thompson 1983, Brown & Thompson 1986, D.B.A. Thompson pers. comm.). Stress, because it is difficult to measure, is underestimated in translocation and captive-breeding programmes, although it is now acknowledged in bird-of-prey breeding ventures (Cade 1980, Haigh 1984, L. Hurrell pers. comm.).

Local people should perhaps be made aware of latent factors such as these so that too much is not hoped for too quickly. The Chough is a much loved emblem, as important to the Cornish as the Kangaroo is to Australians, and the Kiwi to New Zealanders. It is found on the logos of businesses, the badges of official departments, and the insignia of local RAF squadrons. There is also Cornish nationalism, *Mebyon Kernow*, with its roots in the ancient Stannaries; the Chough symbolises this nationalism and links Cornwall with other Celtic countries. It is a species which well illustrates a driving force behind species conservation: not merely of interest to scientists and naturalists but of real local concern, much as the White stork is to Dutch and Danish people.

If it is agreed that re-establishment of the Chough in England is a creative and benign objective, and conforms with legal requirements, the need is for a *modus vivendi* which satisfies scientific and practical criteria. The nesting habitat in Cornwall survives as it has in generations past, the invertebrate prey biomass appears richer than in Wales, and human attitudes to wildlife have changed radically. Past differences in land use between Wales and Cornwall now largely balance; exactly how these (and concomitant human practices) separately affected Choughs a century and a half ago remains a matter of conjecture but West Wales is plainly capable of now supporting the species. It is likely, though, that increased management and more grazing will be needed to restore fully functional units in Cornwall around population centres. Given the well-known deleterious effects inherent in maintaining small populations (see, *e.g.* Denniston 1978, Franklin 1980, Mace 1986), there is a need for *Operation Chough* to proceed as swiftly as possible so that problems associated with increased homozygosity of any deleterious recessive genes present in the population do not become manifest and can be prevented by out-breeding, hopefully with the wild vagrants that still appear from time to time on the Cornish cliffs.

There is a joke in Cornwall that the Duchy is symbolised by three threatened species: the tin-miner, the fisherman and the Chough. The prospect of any of these again becoming an important feature of the county's future is remote, but the revival of the wildlife emblem would be seen as a symbol of recovery from the economic blight which followed the demise of the two principal industries.