7 RE-ESTABLISHMENT OF THE CHOUGH IN CORNWALL WITH REFERENCE TO ITS CONSERVATION IN WEST WALES

7.1 INTRODUCTION

The Royal Entomological Society (RES) (1986) after liaison with a wide range of agencies including the Nature Conservancy Council (NCC), National Trust, IUCN and Forestry Commission published a 'Code of Conservation Practice' on re-establishment with wider applications than entomology. It holds that "The use of re-introductions and re-establishment of animals and plants... is widely accepted as constructive for the conservation of the countryside". A view echoed by the NCC (1985) in their Corporate Plan 1986-1991. It is also though seen as a measure of last resort, with risks of undesirable side-effects, and inferior to translocation (Garson 1990).

As stated in Chapter 1, a primary aim of this project was to examine the feasibility of re-establishing[1] the Chough in Cornwall: this is a long-held desire of the Cornish people, of many amateur and professional naturalists in the south-west of England, and of others with interests in that part of the world, including H.R.H. Prince Charles - the Duke of Cornwall - who was an early supporter of the project. The link between Cornwall and the Chough is long-established, a fact evinced by the vernacular 'Cornish Chough' in many old bird books (3.2), and its position surmounting the Duchy's insignia (Figure 7.1). The Chough died out as a breeding species in Cornwall in the 1940s (3.3.1). Extinction in Cornwall also meant extinction in England, after a former distribution from Kent along the southern English coast around Land's End to north Devon (3.3). Recolonisation in Cornwall would assume wider implications insofar as it would provide for a more continuously distributed series of populations from Brittany along the coast of Wales to the Inner Hebrides (Table 1.2).

Given, therefore, and leaving aside for the moment the desires of local people, that the Chough as a species is: (i) scheduled as endangered within Britain; (ii) protected throughout Britain and the EEC; (iii) indigenous Cornish fauna of recent lineage; (iv) agriculturally benign; and (v) a 'flagship' species indicative of high quality natural and semi-natural habitats and low-intensity agricultural systems (Bignal & Curtis 1989), it is difficult to see the concept of re-establishment as contentious. [This is of course provided that the habitat can support a viable population.] However, the same can probably not be said for the methods that might be employed to attain this end (7.2).

In the wake of accelerating local extinctions across the world, the re-establishment of animal species as part of a conservation strategy is increasingly seen as a valid adjunct to conservation (NCC 1985). One of the first and most successful attempts has been with restoring the Arabian oryx in Oman, a project still underway which began in the early 1960s (Grimwood 1963, 1964). The first captive-bred oryx (17 in all) did not arrive in Oman until 1980 (Fitter 1982); six years later a net population increase of 10-15% per annum was forecast (Stanley Price 1986). This author believes that technically the Arabian oryx can make the necessary physical, physiological, behavioural and social changes needed to lead an independent existence in its native habitat, but notes that the attainment of independence may take a long time. Captive held representatives of species are very often the only available material with which to work; Martin (1975) reviewed many such examples in conservation.

With specific reference to birds, Martin, R.D. (ed.) (1975) Breeding Endangered Species in Captivity. Academic Press, London, UK. Maxwell, J.M. (2001).Halliday (1978), (2001).Mountfort (1978) and Gooders (1983) reviewed some recent attempts that have involved reintroductive elements. Birds-of-prey have often been the subject: these have ranged from the assisted natural recolonisation

1.'re-establish' is used in preference to 're-introduce' because it concerns a species in an area of former occupation (after the RES (1986) guidelines).

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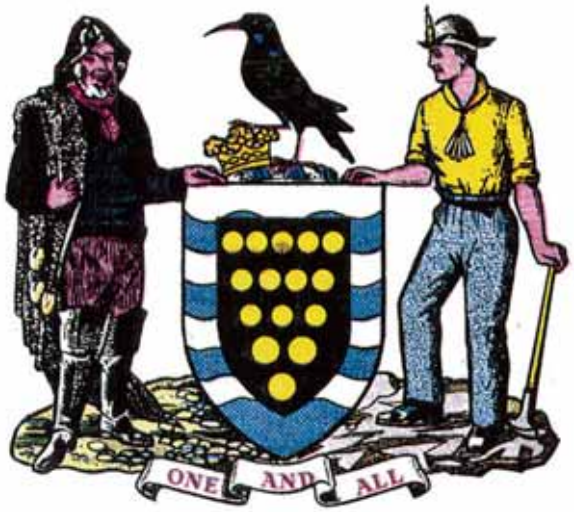

Description

Sable fifteen bezants in pile within a Bordure barry wavy of eight Argent and Azure and over the crest on a wreath Argent and Azure a Chough proper resting the dexter claw upon a ducal coronet Or; on the dexter side a fisherman holding over the exterior shoulder a net, and on the sinister side a miner resting the exterior hand on a sledge hammer all proper.

Figure 7.1
The Cornwall county shield

of the Osprey, recounted by Brown & Waterston (1962) and 'on television every year' (Gooders 1983) to recent attempts to return the Red kite to northern England, which the popular press has again avidly followed. After considerable expenditure in time, effort and resources, the White-tailed sea eagle is becoming established on Rhum off the west coast of Scotland (Love 1983); the same species has been the subject of an intensive project in Germany, recounted in great detail by Fentzloff (1984). On account of the passions they provoke, birds-of-prey are by no means the best subjects for such projects, but they do tend to be the ones that secure the high level of funding required. Re-establishment schemes are inherently expensive (Brambell 1977): the Arabian oryx project is costing millions of dollars, while the Cornell University Peregrine project was in the mid-1970s costing about $700 per release bird (Temple 1977). When not birds-of-prey or mammals which are considered beautiful, subjects are often otherwise large and showy, *viz* the Great bustard in southern England (Collar & Goriup 1980). Such attributes can work against successful recolonisation, for they attract public interest and consequent disturbance. Large individuals and their social organisations require large tracts of territory, and of course birds-of-prey are still regularly killed by many gamekeepers, certain farmers and shooters.

Slightly down the scale of public recognition, waterfowl and pheasants also attract wealthy devotees, and have provided subjects within the local extinction/captive breeding/re-establishment scenario (see, *e.g.* Kear 1975, Ridley 1986). The Nene or Hawaiian Goose story is well-known but somewhat chequered (Kear & Berger 1980, Devick 1982, Stone *et al.* 1983): after an auspicious beginning, during which numbers increased from *ca.* 600 in the early 1970s to *ca.* 925 in 1975, the population declined by about 50%, due to low reproductive success, mortality from introduced predators, and poor nutrition and relatively poor weather in the highland areas where the species became confined. A recovery plan was formulated in 1983 by the U.S. Fish & Wildlife Service which included a predator control programme, research into nutritional requirements, release sites at lower altitudes, and the recommendation that captive breeding continue to bolster the wild population.

Pheasants appear, on the surface, ideal *captive breeding/re-establishment subjects*: they are adaptable, and prolific breeders with a long captive history. Matt Ridley of the World Pheasant Association (WPA), in an unpublished document (*Re-introducing pheasants to the wild*) in the mid-80s, saw the Cheer pheasant as a prime candidate for re-establishment. The project began in 1978 in the Margalla Hills National Park, Islamabad, Pakistan, after the species died out there in 1976 (Hussain 1986). The chosen site was a fully protected area of apparently ideal country: steep, grassy slopes typical of the middle ranges of the Himalayas (Lelliot 1981, Garson 1983). Between 1978 and 1985 nearly 2000 eggs were despatched to Pakistan from WPA sources in the U.K. but <15% survived to 6 weeks (Ridley 1986). As with the Nene, the plan had to be rethought; even those poults which did leave the open-topped rearing pens were not surviving. The main problems were poorly developed predator avoidance behaviours and habitat deficiencies (Garson *et al.* 1991). Once rearing techniques were refined, such as by reducing human contact with young birds and rearing with actual or surrogate Cheer parents, survivability improved and breeding in the wild has been attempted. However, great problems with habitat suitability remain. As with the Chough, the Cheer pheasant has evolved in close association with human land management practices, and depends very much on such for its future (*ibid*.).

The RES (1986) code, referred to above, states that "re-establishment for conservation may be species-orientated or site-orientated." As a rather extreme example of the latter, Anderson (1986) recounts a case study of restoring an entire National Park in Africa. The Cornish 'Operation Chough' project has elements of both and is compatible with the NCC's Corporate Plan 1986-1991, which said: "Creative conservation seeks to enlarge the resource of nature by reintroducing species which have been lost"; such schemes "are an important means of replacing some of the past losses of wildlife". The plan also mentions the importance of "local initiatives". The NCCS is responsible for the Scottish sea eagle project.

Guidelines that reflect scientific opinion on release programmes were drawn up in 1960-70s mainly

under the auspices of the International Union for the Conservation of Nature and Natural Resources (IUCN) (see, *e.g.* Anon 1967, 1987) and the then World Wildlife Fund (WWF) (Boitani 1976). The U.K. Committee for International Nature Conservation set up a working group on introductions, which reported in 1979. The recommendations of this report have been adopted by both the NCC and the Royal Society for the Protection of Birds (RSPB) as a set of criteria to test the suitability of proposed release programmes. These criteria are summarised in Table 7.1.

Table 7.1 Criteria for re-establishment of locally extinct species

1	There should be good historical evidence of former natural occurance
2	There should be clear understanding of why the species was lost to the area. In general, only those lost through human agency and unlikely to recolonise naturally should be regarded as suitable candidates for re-establishments
3	The factors causing an extinction should have been rectified
4	There should be suitable habitats of sufficient extent (of sufficient quality) to which species can be brought
5	The individual organisms taken for such attempts should be from a population as close as possible to that of the native population
6	Their loss should not prejudice the survival of the population from which they are taken

With regard to the Chough, criterion #1 is not in dispute (see Chapter 3), and #2 was also discussed in that chapter: the Chough is a sedentary species and therefore unlikely to recolonise naturally (Coombs 1978). Criteria #3 and #4 are addressed, in part at least, by this project. Criteria #5 and #6 would not apply if captive-bred founder stock were used (see below).

To summarise (if it is agreed that the concept is sound): before re-establishment of the Chough in Cornwall is seriously considered in any material way, the causes behind the original disappearance and the feasibility of successful recolonisation have to be understood as well as possible. These issues are examined in this chapter, which has been published in a reduced form in Meyer (1989a).

7.2 METHODS OF ASSESSING FEASIBILITY

The feasibility of returning the Chough to Cornwall depends on 4 main provisos: (1) understanding as fully as possible the reasons for its original decline; (2) investigating whether Cornwall is able to support the species today; (3) if so, investigating how a viable wild population could be re-established; and (4) assessment and, if appropriate, implementation of a re-establishment programme. These provisos are closely related to the general criteria given in Table 7.1.

The first of these provisos was analysed and discussed in Chapter 3; the results are summarised in Section 7.3.1. No. 2 has formed an important part of this project, and was addressed by analysis of the background habitat and invertebrate spectra in Cornwall, and by their comparison to those used currently by Choughs in West Wales, and is further discussed in Section 7.3.2. The third proviso is the equivalent of Criterion 4 in Table 7.1, and depends on biological and practical considerations; these are outlined in Section 7.3.4. Proviso #4 will rely on decisions taken by other interested parties and agencies based upon the results of this project and those of other workers, and is discussed in Section 7.4.

7.3 SUMMARY RESULTS

7.3.1 THE DECLINE

Darke (1971) and more recently Owen (1985) have discussed some of the factors involved in the decline of the Cornish Chough; for a full review see Section 3.4. The factors believed to be largely responsible are both direct and indirect. Among the direct effects are disturbance caused by physical human presence (*cf.* 6.3.3), hunting, egg-collecting, trade in live birds. The indirect effects presented by increasing human pressure, particularly the changes in habitat brought about by agricultural change have obviously been important (3.4.6e); these embrace the decline of tin mining, changes in the pattern of crofting, the reduction of grazing pressures and the consequent scrubbing-over of previously grazed cliff regions, the ploughing up of natural and semi-natural habitats, especially heathland (Mitchley 1990), increasing intensification, application of chemicals and biocides (see also Appendix III), the development of tourism and the opening up of the countryside by road and rail arteries (fuelling the increasing physical presence mentioned above), and the destruction of Choughs in gin traps set for rabbits. Disease might have played a part in the decline but it is unlikely to have been a primary cause (3.4.4). There is little evidence of any inter-specific competition or heavy predation pressure (3.1, 3.4.5 & 6.3.3).

Data presented in Section 4.5 showed that habitat differences which existed between Wales and Cornwall in the mid-C19 have virtually disappeared (see Sections 4.6 & 7.3.2).

7.3.2 THE HABITAT AND PREY BASE

Results of behavioural studies of feeding Choughs in Wales indicate that quality of prime cliff habitat is of more importance than the extent of various sub-optimum habitats (6.3.2 & 6.4). Breeding records were of little value in assessing the relative performance of the study areas owing to inadequate annual data. The impression gained during the course of this study is that successful breeding of the currently very thinly distributed population is governed more by extrinsic factors (*e.g.* human disturbance) than deficiencies of habitat quality *per se*. High juvenile survival has been shown in other corvids, *i.e.* Jackdaws, Rooks, Carrion crows and Ravens (Holyoak 1971) in contrast to the Great tit (Bulmer & Perrins 1973) and various other species (Lack 1946, 1954).

On the basis of foraging economics, Chough habitat to the south of the Welsh region, even though agriculture is more intensive and the quality available habitat reduced to a narrow coastal zone, is more productive of invertebrate prey than northern 'upland' pastoral farmland and scrubby cliffs. However, despite an inferior cliffscape, the invertebrate *diversity* in Chough feeding areas, was greatest at Mwnt-Cemaes (Table 5.2), as was the frequency with which beetles (the major prey taxon) were found at actual feeding sites (Table 5.4); at Strumble (the other northern site) beetles were found only slightly less frequently. This apparent contradiction is partly explained by the fact that while behavioural observations were possible on clifflands, invertebrate sampling very often was not, and this will have caused under-representation of cliff habitats. Invertebrate diversity in Cornwall is discussed below.

Optimum conditions for Choughs would have the dual advantages of: good quality clifflands, including slopes with sparse vegetation (maintained by exposure, geology, and/or high grazing levels) and a range of aspects to the southern hemisphere, in order to capitalise on the effects of exposure (west to south) and morning insolation (east to south) promoting invertebrate activity; and (ii) an abutting pastoral low-intensive agriculture from which livestock has access to the cliff region.

It was noticeable that one small patch of suitable cliffslope at Cemaes Head, maintained at an optimum level more by a mosaic of rock and shallow soil than exposure, was exhaustively used by Choughs at all times of the year. Similarly, on a narrow promontory, Dinas Fawr, near Solva (Figure

2.8), the south-facing side, rich in invertebrates, particularly ants (see Chapter 5), was frequently used by Choughs while the opposite side, sheltered from prevailing winds, was heavily scrubbed and never seen to be used for feeding even though it supported a successful nest site; where the coastline turned northwards from Dinas Fawr, and yielded a westerly aspect, it was again intensively used. A similar situation applied at Marloes (see Section 2.3.2, Figure 2.10). Usage by Choughs of the study areas is explained in Appendix VIII.

Against this could be argued that Choughs survived longest in Cornwall on the north-facing coast (Figure 3.2). It is possible that *generalised* coastal aspect is secondary to the pattern of radial decline shown in Figures 3.3 and 3.4. The site of the last breeding Choughs in Cornwall appears, even several years after their departure, very suitable **(Figure 7.2).** This impression was further enhanced by botanically-based investigations (4.4.2). Even a generalised north-westerly facing coastline, if indented, accommodates a range of aspects including south-westerly ones, *viz* Cemaes and Strumble Heads (Figures 2.6c & 2.7). If quality of habitat is more important than extent, it is quite possible that coves and promontories on a north-west facing coast will provide pockets of habitat as suitable as might be found on greater reaches of south-west facing coast. Promontories are, of course, the next best thing to entire islands, which accommodate the greatest length of coastline (necessarily of all aspects) relative to land mass. With the added benefits of mainland herbivore access, and sympathetic surrounding agriculture, optimality will be increased still further.

One important difference, historically, between Cornwall and all other regions of the British distribution is the absence of substantial off-shore islands. When human persecution was a serious threat to Chough viability in Cornwall, the presence of islands, such as exist in Brittany (certainly responsible for the continued existence of Breton Choughs (A. Thomas pers. comm.)) and in all other parts of their recent and current British range, would have provided invaluable sanctuaries;

Figure 7.2
Beacon Cove , the home of the last Choughs in Cornwall

a view supported by Rolfe (1966). The islands of Ramsey, Skomer and Bardsey in Wales are all important recruitment centres. The Calf off south-west Isle of Man safeguarded Manx Choughs when indiscriminate shooting in the C19 almost totally wiped it out (Cullen 1989). Rathlin off N Ireland, and Islay, which supports most of the Scottish population, are further examples of the strategic importance of islands as population centres.

There is no record that the Isles of Scilly, though in many ways an ideal location, have ever supported a resident population. They are possibly too distant, at 45km off the south-west of Cornwall, to be a mainland recruitment centre, and there are no other islands of sufficient size closer inshore. Lundy Island, midway between the English south-west peninsula and south Wales in the Bristol Channel, would probably have been a staging post between the two regions, as well as supporting its own small population until this died out due to human activity at the end of the C19 (Owen 1985). Darke (1971) reports one bird staying there for 10 days in 1952. Two Choughs, which appeared fortuitously at the beginning of the project in east Cornwall, in an area close to the city of Plymouth with no previous record of Chough occupancy, appeared to experience no day-to-day survival difficulties until one was affected by Gape worm *Syngamus trachea* infection (see Section 3.4.4 and Appendices IV & VII). The remaining bird departed about 3 weeks later (7.5).

When invertebrate diversity in Cornwall was compared to that in Wales (5.3.4), it was found to be considerably richer, perhaps responding to a north>south cline in invertebrate biomass (see also Chapter 8). Research in Wales was directed largely by current Chough usage while that in Cornwall could not be, save that the areas surveyed were all historically important for Choughs (2.3.3). Actual sampling sites in Cornwall were selected on the basis of morphological similarity with used sites in Wales, and as the Welsh trips were followed immediately by equivalent Cornish work, in all other respects at least, the research was comparable. Any bias that existed in Wales regarding under-sampling of precarious cliff sites would have been replicated in Cornwall.

The accessible sites chosen as having a high potential feeding quality in Cornwall all had diversity indices (*D*) >20.0. Those appearing slightly less favourable for Choughs (equivalent to the Welsh 'control' sites) ranged from *D* 6.7 to 12.9, more diverse than all the Welsh sites except Mwnt-Cemaes, which was unique insofar as it was a reserve long managed for its Chough population (P. Taylor pers. comm.). Even so, its diversity within prime feeding sites was slightly less than that of the 'worst' Cornish site: the Lizard (*D*=19.6 *cf. D*=20.4).

The key prey taxa were also all more abundant in Cornwall, with the exception of the Nematocera and Carabidae (see Figure 5.5 and Section 5.4 (p.154)). Earthworms in Cornwall were the only taxon with a regional Availability Index (*AI*) >1.0; but without more work the significance of this cannot be evaluated. Hymenopteran values were virtually identical between the two regions, perhaps vindicating the selection of sites in Cornwall. Since it would be wholly against accepted Erringtonian law (3.4.5a) to suggest that the invertebrate prey base in Wales is permanently reduced by Chough activity, it may be concluded that the invertebrate prey base in Cornwall is either more diverse or, more likely, that a broader sampling programme would reduce the regional disparity.

Analysis of faecal evidence (5.3.5) provides incontrovertible proof of prey selection and helps to validate invertebrate sampling. In this way, the true value of Dermaptera (present in 8% of 277 faecal samples) is probably more accurately revealed. Unfortunately no pellets were available from the Welsh population. Their availability would have reduced latent bias in the assemblages even though a comparison from the early Cornish investigation (5.3.7) showed that many of the taxa found in the pellet range were also represented in the faecal assemblage; the exceptions being Lepidoptera and certain beetle species, notably Curculionidae and Geotrupidae. No dipterous evidence was found in the Rame pellet assemblage. Additionally, most of the taxa represented in the Cornish pellets were found in Welsh faeces (Table 5.18). Nevertheless, the collection of pellets from Wales would have been valuable in helping to validate the faecal evidence, in particular, low hymenopteran values; there was, however, considerable evidence to

indicate that ants are selected preferentially for feeding to nestlings, and that this accounts for their relative scarcity in adult faeces. It was not possible to examine directly chick diet for the same reason as it was not possible to collect pellets, *i.e.* nest and roost sites were inaccessible.

Notwithstanding these shortcomings, some useful information was achieved by the Welsh faecal evidence, which, with direct evidence from specific feeding sites, confirmed that the important invertebrate prey taxa for Choughs in Wales were Oligochaeta, Diptera, Hymenoptera and Coleoptera. Cereal grain formed the bulk of the vegetable intake, taken mainly in late summer, autumn and early winter (Figure 5.6). This highlights the seasonality of Chough behaviour. Where the agriculture allows, Choughs tend to move into pastoral systems during the winter; a little to the north, Owen (1985) found the same pattern of behaviour. An examination of comparative foraging success (Chapter 6), however, suggests that this is accounted for by sub-optimum cliffs, possibly due to geology or encroachment by scrub where exposure and/or grazing pressures are low.

The quality of habitat in Cornwall is assessed as being analogous to that used by Choughs in Wales. There is some evidence to show that grazing pressures, other than on conventionally improved monocultures, are generally less in Cornwall. Bullock (1985) considered the coastal pasture at Predannack, the sampled area during the present study, to be "borderline" for Choughs. In coastal parishes, the differences are not great but sheep numbers are significantly less in Cornwall ($P<0.01$; see Section 4.6.2): in fact less than half the Welsh number; this is partly redressed by a significantly greater ($P<0,05$) population of cattle. The resource of cow-dung provides a potential year-round source of invertebrate fauna, even during adverse weather conditions. Dung can be probed, broken open or turned over depending upon its condition, and it also creates favourable conditions for soil invertebrates, such as tipulids, in the aureole beneath. Recourse to cattle-grazed vegetation (even improved *Lolium* ryegrass swards) is probably an essential element to year-round Chough viability if the cliffscape is anything less than optimum. It would, though, be possible to substitute horses and ponies for cattle, since the important dung fauna, such as scatophagid flies, the scarabaeid *Aphodius rufipes* and tipulid larvae, and are not usually dung specific (R. Crowson pers. comm., Ritcher 1958, Landin 1961).

Populations are usually restricted by social factors or by the resource in shortest supply (Watson 1973), and so this aspect of Cornwall's suitability might be crucial: is such a shortfall identifiable in *key* areas, and if so, how revertible is it? In order to understand this and form a sensible answer, the exact physical area of any re-establishment attempt must be clearly defined so that management effort can be concentrated where it will be most effective. This is, of course, precisely what is happening in areas of Britain which currently support Choughs and where conservation interests have influence. Such a convergence illustrates an important aspect of this study, and the benefits which can accrue from separate yet allied projects. It is probably reasonable to argue that if such management is possible in areas of current distribution, then there is no reason why similar management should not be exerted on corresponding sections of coast elsewhere. It is the focus of attention that is the critical exercise. An accurate identification therefore of proposed 'functional units' (see Section 4.1) in Cornwall (within a continuum or extended complex) is important, and should extend beyond the narrow limits allowed by this initial study.

On the other hand, it is surely possible to prevaricate endlessly. Re-establishment of locally extinct fauna or flora is not an exact science. One of the key benefits of the Lizard is its strategic position and the concerted conservation interest within the region. Whether or not there are more suitable localities than the Predannack cliff region is a matter for discussion. On the basis of my own experience coupled to that of Ian Bullock, the western coast of the Lizard, including the Point itself, provides the best opportunity due to its extensive rugged and exposed coastline of proven historic significance, central position and tradition of rough grazing.

With increasing awareness and affluence, the problem of persecution in Cornwall should today be averted, indeed, it is reasonable to expect that the Cornish would guard jealously their national

emblem were it to return once more as a breeding species. The above-mentioned lack of off-shore islands in Cornwall to act as Chough refuges, sanctuaries and recruitment centres could to some extent be turned into an advantage if the Lizard and West Penwith peninsulas were to be regarded as quasi-islands and the *problems* associated with human presence removed (7.4).

With regard to this idea, the concept of island biogeography and the use of habitat islands as nature reserves is discussed by Diamond (1975), May (1975), Diamond & May (1976), and Simberloff & Abele (1976). Although there would undoubtedly be problems of human encroachment, it is difficult to see wild terrestrial predators posing a significant problem to a species such as the Chough. Problems of reduced genetic diversity, often appearing in isolated island communities, would be reduced or removed altogether if a continuum of such sites could be established, effectively 'linking' Brittany in the south with Wales in the north.

As a footnote, the behavioural deficiencies of captive bred birds when released into the wild should not be overlooked. Dowell (1990 a,b) demonstrated the vulnerability of pheasants and partridges reared without the benefit of same-species parental influence. Exactly how close the parallel is between common game prey species such as these and the Chough, which is high up its own food chain, and preyed upon by only one species, the Peregrine, itself rare, is debatable but will only be answered by experience. Ryves (1948) and Ratcliffe (1980) believed that the Peregrine did not pose a significant threat to Choughs (see also Section 3.4.5a). Re-establishment in Cornwall will inevitably be a long term project, as Young & Hussain (1990) said in relation to the Cheer project in Pakistan "[b]ecause no long-term pheasant reintroduction programme has been attempted

7.3.3 CAUSES OF EXTINCTION IN CORNWALL

The principal causes which I believe brought about the extinction of the Chough in Cornwall are summarised in Table 7.2.

Table 7.2 The causes behind the extinction of the Chough in Cornwall

1	An east to west decline in southern England left virtually a relict population isolated in Cornwall. The decline in England was progressive and probably the result of harmful human influences, principally land-use change, on habitat; Atlantic oceanicity and a more primitive or independent Celtic human economy to the west helped to slow the decline.
2	Isolation in Cornwall with little or no genetic exchange with France and Wales prevented population recruitment.
3	Deleterious human land-use eventually took effect in Cornwall, resulting in retreating outposts in West Penwith and on the north coast.
4	Decline of tin-mining and coastal crofts drastically reduced beneficial coastal grazing and allowed encroachment of scrub.
5	Direct and indirect human persecution (egg-collecting, specimen- and trophy-hunting, robbing of nests for young, inadvertent trapping in rabbit-gins etc.) exacerbated the agricultural changes.
6	A lack of off-shore islands, especially farmed ones, allowed no refuges or sanctuaries.
7	Finally, No. 1 prevented recolonisation after protection.

before, we have had to learn from our mistakes".

7.3.4 RE-ESTABLISHMENT STRATEGIES

If the hypothesis 'Cornwall can again support a viable population of wild Choughs' is accepted within reasonable confidence limits, what are the available options for re-establishment? They are summarised in Table 7.3.

Table 7.3 The options available for re-establishment.

1	Do nothing: wait and hope for natural recolonisation. This is obviously dependent upon at least one pair arriving together; to form a viable prospect, further genetic input would need to be forthcoming. With a sedentary species like the Chough, such an eventuality is highly improbable.
2	Option 1 + constructive land management. In other words: hope for natural recolonisation while working to provide for optimum conditions in which arriving potential recruits would settle. This option sounds attractive but it is probably fundamentally flawed, in that it would be necessary to be able to prophesy precisely the landfall point of immigrant birds. As the Rame episode showed (Appendix IV), this is not possible.
3	Physical introduction of founder stock. The various sub-options are: (a) release of (sub)adults into a suitable site or sites; (b) controlled release of captivity-dependent adults; and (c) controlled release of sub-adults, preferably bred on site with parents (captive-bred) retained in natal aviary.

Option #3 is considered to be the only realistic option if the aim to re-establish the Chough in Cornwall is to be more than just a pipe-dream; a supposition reinforced by the unfortunate outcome of the Rame study (Meyer 1990, see Appendix IV). Sub-option #3a is (with captive bred birds) high risk, potentially wasteful, and cannot be recommended; #3b concerns birds which would be 'state-' but not 'site-imprinted' (*i.e.* conditioned to a captive state, dependent upon protection and requiring supplementary feeding, but not imprinted upon a natal site, they would therefore lack necessary survival skills and be more prone to straying); it is probably not sustainable except under exceptional circumstances. The third sub-option (#3c) has the best chance of success since it is the most controllable and would ideally involve birds with fidelity to site and parental presence.

An inevitable question posed by the adoption of Option #3 would be: from where would the founder stock be obtained? Choughs are fully protected under the Wildlife and Countryside Act 1981 and in Annex I of the EC Directive on Wild Birds (1985). Accordingly, wild-caught European Choughs are not available and translocation not possible at the present time. The option to obtain birds of alien racial origin outwith Europe would be resisted by legitimate scientific and conservation concerns. The use of alien races within a project to restock the Great eagle owl population in West Germany has been criticised Wirth (1990). The alternative is the use of indigenous captive-bred stock (7.3.5).

The source options for stock are: (i) rationalise current *ad hoc* effort; (ii) maximise potential of available captive stock; and (iii) supplement captive stock with wild 'material'. Rationalisation (source option #i) should include a full genetic and demographic study (Mace 1986), even so it would not fully exploit the existing resource unless it integrated option (ii), which requires input from keepers and breeders currently outwith the project in order to maximize the available gene pool. There is a danger associated with this option, namely: unless keepers come into the project

voluntarily an illegal trade in wild Choughs could be encouraged. There is a long history of exploitation (witness the current captive population) and this is not yet wholly ended. The market creation danger has also been recognised in relation to exotic pheasants (Garson 1990). The goodwill of registered keepers must be sought and they should be encouraged to join the project.

Option (iii) would not conform to NCC and IUCN guidelines unless it could be shown that collection from wild sources would be likely to have no destructive effect on remaining wild populations. It would then require a recommendation from NCC to the Department of the Environment to grant a licence. Overall, it would need to be confirmed that an attempt to re-establish the Chough in south-west England was a feasible and desirable objective for the conservation of the species. Scientifically, there is no reason why Option (iii) should not be considered. A possible scenario might involve a minimal yield of 1 egg per nest from sites which consistently fail; such eggs could be incubated artificially or cross-fostered (Fyfe *et al.* 1978, Dixon 1986) possibly by Jackdaws or doves. [Embryonic imprinting is not known to occur with altricial species (O'Connor 1985).]

If a 'doomed surplus', caused where natural mortality is determined by population density, seasonal food availability or some other naturally occurring limiting factor (Perrins & Birkhead 1983) could be identified (*e.g*. regularly failing nests), a scientific, biological and conservation resource could be created, which would have as an additional side-benefit the lessening of natural wastage at the site of wild origin. The offspring so produced could be used either as captive founder stock or as release material. However the situation would be paradoxical in that such a doomed surplus might consist of individuals of lower genetic quality; if so while this would reduce the consequence (were they to survive) to the original gene pool, it would also engender low quality input into a wild founder population, perhaps the very thing one would wish to avoid. In any event, such a measure could only be justified if it could be reasonably shown to represent no serious risk to stable wild populations. On the other hand, It would also be useful to know whether Choughs, normally single-brooded, can compensate for occasional egg loss, and whether they can 'double clutch' if they lose a clutch soon after production, as is suggested by Ralfe (1905).

As a footnote, it is perhaps worth pointing out that bird-protection originated to protect birds against deliberate exploitation and not against constructive initiatives. This was well expressed by Frankel & Soule (1981) "Designed to protect or limit the commercial exploitation of wildlife, [these] statutes also effectively cripple legitimate scientific activities that can increase our knowledge and help to protect rare and endangered species".

7.3.5 CAPTIVE BREEDING

Captive Choughs are available to conservation because Choughs have been maintained in British zoological collections since earliest times due in large part to their popularity as pets (Chapter 3). The present captive population of Choughs is a valuable resource. With development of the breeding programme, it will increase and help to reduce the threat to wild populations. However, there must be safeguards and, accordingly, Frankel and Soule (1981) recommended *Designated Captive Breeding Programmes*, which, in summary, advises that (i) target species should be truly endangered and that extinction would have cultural or ecological impact; (ii) the programme would enhance survival prospects; (iii) data would be recorded to the highest standard and made available to all *bona fide* parties; (iv) a *breeding plan* would be agreed to meet certain genetic, demographic, behavioural, veterinary and husbandry standards with expert consultation; (v) there would be binding agreement between cooperating institutions to the breeding plan; and (vi) there are means to monitor progress and accountability.

This section is intended as an overview to captive breeding programmes and discusses their general relevance to *Operation Chough*. All captive breeding programmes involving rare fauna should have an international studbook base (G. Mace pers. comm.). The very first studbook for an endangered species (European bison) was established in 1932, but it was another 30-40 years before the ethic became established. Seal (1986) succinctly discusses captive propagation goals and considers that

by the year 2000, there will be a need for about 500 studbook-like programmes (in 1984 there were 61 (Glatson 1986)). The relatively recent growth of interest in captive breeding programmes, as tools for conserving species threatened by habitat deficiencies, was reviewed in 1975 by Martin; Cade (1986) examined exhaustively all projects (mainly in the USA and Europe) concerning diurnal raptors. [Professor Cade is well-known for his work on Peregrine and Bald eagle rehabilitation in North America.]

Georgina Mace (1986) outlined the genetic problems besetting small populations in captivity (see also Soule 1980). She concluded that although small founder populations might be comparatively as genetically diverse as larger populations, which have reduced sets of alleles due to genetic drift caused by successive captive generations, the general maxim that the greater the number of individuals, from a range of sub-populations and genetic backgrounds, the better will be the chances of maintaining a maximum of the pre-existing genetic diversity. Foose (1983) described the aim of 'zoo-banks' as "maintenance of the maximum amount of genetic diversity available in the founder stock that has evolved in wild populations". Matthews (1973) expressed some of the difficulties in relation to waterfowl, a family with which there has been some success.

The problems are not only genetic. With regard to behaviour, Monaghan (1990) points out that like many corvids, Choughs are highly social birds, and that keeping social animals in captivity can give rise to many problems. It is easy to see that young and inexperienced birds, even if released directly from a natal aviary into a suitable habitat are going to lack important survival skills such as predator avoidance: an increasing problem with the expansion of the Peregrine, in Cornwall as in North America. Monaghan also mentions the possible adverse effects on sexual and social behaviour in individuals deprived of natural filial and sexual imprinting. It obviously behoves keepers of such species in captivity to consider very carefully the structure of their groups (*ibid*.). However, most research into social structuring of Choughs has been carried out on Islay, where large communal roosts occur and the Chough exists at a comparatively high density (Still *et al.* 1986), which is not the case in West Wales. It is a matter of conjecture whether the two situations are fundamentally analogous, and whether empirical data derived from one should be applied to the other. Where there is an absence of complex social gatherings, it is difficult to see how truly comparable data can be gained. The social structuring of Choughs in Wales remains largely unknown.

At present, 25 captive individuals are available to *Operation Chough* from which it is hoped to breed a nucleus founder stock for re-establishment. These are a miscellany of genotypes although, so far as is known, all of the nominate north-western race. They were acquired over a period of many years from legitimate sources, and are mainly of avicultural origin pre-dating legislation. Although, as mentioned above (7.1), captive breeding programmes have been employed with considerable success with waterfowl and pheasants, and with owls too (von Frankenburg 1974, Warburton 1984, von Frankenberg und Ludwigsdorf *et al.* 1984), breeding results within *Operation Chough* have so far been poor, and only one person within the UK has apparently mastered the technique of successfully breeding Choughs in captivity. One of the main problems in the past has been differentiating the sexually monomorphic cohorts, but this has now been successfully resolved by the use of laparoscopy (see also Figure 1.5). Remaining problems concern areas such as incompatibility between sexes; incorrect sex ratios in sub-adult and non-breeding groups; timing and methods of pairing birds; housing architecture (size, degree of seclusion and isolation from cohorts and external stimuli etc.); nest location (degree of exposure/darkness etc.); diet - quantity, mode and regularity of serving (*ad lib* causes less disturbance but discourages hunting stimului and exercise etc.).

No difficulty in maintaining bodily condition has been experienced: Choughs will take a wide variety of easily obtainable foods, however, when kept in seclusion and deprived of external stimuli, obesity and diminished fitness can result (pers. obs.).Incorrect age and sex ratios should, with the acquisition of more stock and the passage of time, have been corrected (Woolcock 1990). When all else fails, semen collection and artificial insemination (Boyd 1978, Brock *et al*. 1984) have been used successfully with species far smaller than the Chough: *i.e.* parrots and finches (Samour 1986),

but it is time-consuming and stressful to the bird (Luthin *et al.* 1986).

If and when young, intended for release into the wild, have been produced in the past, their imprinting on humans has often been a problem. But work on non-passerine species is beginning to pay off: for example, that carried out on visual and auditory isolation-rearing at the International Crane Foundation (*op. cit*. for a comprehensive review). Increasingly, fledglings are fed from behind blinds with glove puppets. Jones (1981) discussed socialisation problems with raptors, and indeed much of the experience has been with raptors. Rearing young in creches shows promise (C. Jones pers. comm., Bruning 1984, Martin 1984), and Jones (1984) believes that falcon chicks must not be allowed to become over-hungry.

Undoubtedly, there will be survival deficiencies when aviary bred birds endeavour to take their place in the wild, and undoubtedly there will be losses. Whether or not these are sustainable cannot be answered until a pilot project is underway. The captive bred Chough currently living on the North Cornish coast appears to have survived for several months satisfactorily but others, it is believed, have perished. It is undoubtedly tricky playing at God: deciding which species to help and which to abandon, but Seal (1986) reminds us that "Not to act is to act. The necessity for action always presents the possibility of unpleasant alternatives".

7.3.6 POTENTIAL RE-ESTABLISHMENT SITES

The three Cornish study areas, described in Chapter 2, were selected within regions believed most able to sustain re-establishment. To recap: these were regions known to have previously supported good Chough populations, and which retained elements of habitat quality similar to those used by Choughs in West Wales. The areas were: C1/North Cornwall (Tintagel - Park Head), C2/West Penwith, and C3/The Lizard (Figure 2.1). I have endeavoured in Table 7.4. to set out qualitatively the principal merits and demerits of each site in much the same way as Anderegg *et al*. (1984) convincingly did for potential release sites for the Lammergeier in the Alps.

The Lizard peninsula emerged as the leading contender despite scoring least well in invertebrate diversity at sites identified as prime potential feeding areas (Table 5.8). However, all Cornish sites surpassed the Welsh ones in this respect, and when background invertebrate abundancies were analysed (*i.e.* in areas adjacent to the former but considered marginally less favourable), the Lizard scored higher than anywhere else (Table 5.10; and see Chapter 5.3.4). It is furthermore possible to conclude that a flock of Choughs established on this peninsula would be able to expand westwards via West Penwith (a distance of *ca*. 40km across Mounts Bay) to North Cornwall or directly overland (*ca.* 50km). Bullock (1985) inspected blocks of land within the same areas, and

Table 7.4 Merits and demerits of potential Cornish re-establishment sites. Merits emboldened

C1/ North Cornwall	**Includes area of latest occupation. Long stretch of coastline, with necessary variety of elements, extending in the south to C2 and in the north to Devon and beyond. Closest region to existing range (and the possible Lundy Island staging post), and therefore the most likely first landfall of natural immigrants from Wales. Accommodates some very sympathetic farmers and land-owners, and stretches of wild relatively unpeopled coast, which increase beyond Bude.** No obvious focal point for concentration of effort. Possibly no discrete landmass of sufficient size to support more than scattered pairs during early stages. Security risk: difficult to warden and monitor progress of birds. Likely disturbance: supports popular tourist towns, *e.g.* Newquay, Padstow and Tintagel; climbing locations and other outward-bound traffic; and continuous coastal footpath.
C2/ West Penwith	**Abuts C1. Large dicrete ESA (Environmentally Sensitive Area) with 'good' blend of appropriate low-intensity mixed agriculture: many small fields (*ipso facto* many walls); traditionally supports outwintered cattle. Possibility of aid for participating farmers under various schemes, *e.g.* 'set-aside'. Highest and most varied proportion of coastline to landmass, with continuous south- and north-facing coasts including good NT owned reserves. Centre of historic Chough range in Cornwall; between other 2 contenders. Mild climate, high exposure. Large number of tourists are a source of funding and can, with care, help to create Chough-friendly conditions.** Mixed ownership: possibility of diluted management. The most popular tourist region within Cornwall, and suffers most concerted and exacerbated pressure of all over entire area. Land's End is centrally situated and attracts over 1m people p.a.; such high levels of tourism usually create problems of erosion, habitat degradation and disturbance. Extremely low or absent sheep population.
C3/ The Lizard	**Large discrete area with mild climate, a variety of exposure aspects from due east to due west over long and rugged coastline. Largely under management, *e.g.* NCC, NT, MOD and private owners sympathetic to the overall aims of re-establishment and offering indefinite continuity. Long tradition of rough-grazing on cliffs, continued now partly for conservation reasons including Choughs. Low tourist pressure generally. Extremely important scientifically; the best heathland site in Cornwall, subject of several specialist studies, *e.g.* Malloch (1971), Hopkins (1983) and Hughes (1990); unique geology which provides a great range of crevices, unlike C1 and C3. Forms part of continuum between Rame peninsula in east Cornwall (site of recent natural occurrence), Looe Island and C2, about 40km distant. Nearest landfall site to Brittany. Good security prospects and opportunities of aviary seclusion; the region is already ably wardened. Accessible to the *Rare and Endangered Birds Breeding Centre* at Hayle, which houses the nucleus founder stock.** Emerged poorest of the 3 Cornish sites in terms of invertebrate species-diversity (but see Chapter 5.3.4). Choughs disappeared earlier than from C1 and C2 (see 3.3.1). Site most dissimilar to and farthest from regions of occurrence in Wales. Botanical rarities would restrict grazing in some areas.

also considered the Lizard to be the foremost site.

7.4 HABITAT MANAGEMENT

Changes in land-use and extensive removal of domestic herbivores from the cliffscape, coupled to the decline of the Rabbit population following myxomatosis (Sumption & Flowerdew 1985), has led to vegetation changes on a huge scale in Britain (Mitchley 1990). Mitchley gives an example of the knock-on effects: wild White clover seeds were added to commercial grass seed mixes at the beginning of this century with the consequent improvement of inbye land (near the farmstead) and abandonment of outbye land including the semi-natural maritime clifftop vegetation with consequent deterioration.

The vegetation changes pose severe problems for conservation management; and the problems are particularly pronounced in the seacliff landscapes of southern Britain, where the decline in domestic grazing and the consequent overgrowth of cliff-tops with coarse grasses, bracken and scrub has been widespread. Mitchley ponts out that the conservation manager has to devise management solutions to these problems.

In the main, the following recommendations apply both to the conservation of existing Chough populations and re-establishment in Cornwall:

1. Continue and extend Welsh population studies, introducing as a matter of urgency, a coordinated colour-ringing programme, extended from the Islay and Bardsey programmes, in order to monitor survival and dispersal. Even if the feasibility of re-establishment is not accepted at the present time, data from such studies would be useful for future proposals and for the conservation of wild populations.

2. Where lapsed, restore coastal management, as set out in Table 7.5, in order to deter blanket scrubbing and encourage a mosaic of different habitat types (hitherto identified as important by Donovan 1972, Gamble 1984, and Bullock *et al*.1986; see also Chapters 4 and 5). Increase stocking levels of sheep (and/or goats) to levels comparable to areas of Wales which support higher levels of Choughs, *e.g.* the Lleyn peninsula (G. Roberts pers. comm.).

3. Create earth exposures by whatever method is appropriate; this may be within usual regimes of land management, or by more eccentric, site-dependent methods, if not damaging to other biological systems.

4. Limit disturbance. Although human pressure can have beneficial side effects in creating low profile vegetation and exposure zones (*e.g.* along paths through rank growth), disturbance at breeding sites from April to June is a serious problem (6.4). Plans to reroute or create new coastal footpaths should avoid traditional nest-sites during the breeding season. Dogs *must* be controlled near key feeding areas and traditional nest sites; this is also necessary to prevent the worrying of stock and promote farmer co-operation.

5. Create 'island' refuges. Promontories, headlands and capes can be managed virtually as islands and protected from undue human disturbance. The ESA initiative extends this possibility.

6. Supplemental feeding has been shown to be valuable in the conservation of endangered species such as the Mauritius kestrel (C. Jones pers. comm.). Such a strategy with newly-released Choughs could help pioneers through difficult acclimatizatory periods, *e.g.* during severe weather and droughts. Supplemental feeding for a predominantly insectivorous species could involve provision of mealworm *Tenebrio molitor* larvae at traditional points such as at the natal aviary; see also

Recommendation #9 in Table 7.4.

Table 7.5 Land management objectives for application in Chough and prospective Chough areas.

	Objective
1	Open maritime cliff/*Armeria*/therophyte communities maintained by geological structure, exposure to prevailing winds and/or grazing. A combination of such pressures will create rich and varied mosaics of vegetation (long and short), dung enrichment, trampled paths, and earth exposures
2	Semi-natural well-grazed maritime and species-rich grass communities, such as '*Festuca-Plantago* swards'
3	Low intensity mixed farming regimes
4	Grazed wall-banks
5	Managed but unploughed pasture (rough, unimproved or semi-improved)
6	Scarification of ground where possible in place of ploughing
7	Localised and strictly controlled 'cool' burning or swaling
8	Out-wintering of cattle, where not deleterious to botanical or other considerations
9	Strip-cultivation of non-harvested cereals as conservation measure to provide supplemental food in late summer and autumn (also carrying additional benefits to other wildlife); such areas could be rough grazed
10	Avoid burning stubble; encourage 'untidy' or 'eccentric' farming in critical areas, *e.g.* leave spillages *in situ*, and field headlands unploughed
11	Avoid usage of biocides, including antiparasitic 'Ivermectin-types'

Table 7.5
Land management objectives for application in Chough and prospective Chough areas.

7.5 DISCUSSION

The results of this project suggest that the extinction of the Chough in Cornwall was caused by human persecution (seemingly at a far higher level than elsewhere within its British and Irish ranges) exacerbating unsatisfactory habitat changes caused by agricultural improvement and general coastal degradation following the decline of the coastal crofters and miner-farmers. The absence of island refuges, and the remoteness of contiguous populations in Wales prevented natural recolonisation.

The dye had been cast before the tithe surveys in the mid-C19, and were it possible to know the status of the species in West Wales prior to this, a similar picture might be found there. By the 1840s, though much reduced in Wales, the Chough was hanging on, no doubt bolstered by dispersal from the north and local islands. Here the species continued to survive at a low level, in much the same way as happened in Brittany, where there were also island sanctuaries.

Before addressing the key question 'Can Cornwall again support a viable Chough population?' we should be sure that it is a good idea. A question originally addressed in Table 1.2. It would be wrong to describe the Chough as an endangered species even though it is extinct in England, and globally there are certainly many more deserving cases in need of conservation. However, the efforts to protect it are a genuine and sincere response from local people who associate with the species, and are prepared to finance efforts to help it; they might be less likely to put that money into less immediate projects. Since the funding is locally generated it is not conflicting with other nature conservation priorities. Leaving aside, for the moment, local, cultural and sentimental reasons, it may simply be restated that the Chough is (i) a valuable indicator of a healthy cliff environment; (ii) a benign species without any of the vermin connotations that are commonly associated with other crows; (iii) protected throughout Europe, specially so within Britain; and (iv) within NCC criteria for acceptable re-establishment as an act of constructive conservation. Furthermore, its revival in Cornwall (=England) would reinforce its status in Britain and NW Europe generally.

As to feasibility, the short, safe answer is 'maybe' but can we be braver and more accurate than that while retaining objectivity? The easiest and least contentious recommendation is wait-and-see/hope-for-the-best, and this would certainly please the purist who would rather see a species die out than be interfered with; against this is a not unreasonable theoretical argument that man has been interfering with species ever since he first learnt to use fire and the stone axe. The NCC explicitly acknowledged this in its Corporate Plan 1986-1991 (Theme 8: Constructive conservation (NCC 1985)). The occasional appearance of vagrant Choughs in Cornwall (Darke 1971) supports both the 'do nothing' and 'helping hand' factions but it is improbable to expect enough vagrants to converge on the *same* bit of *suitable* coastline at the same time. The two birds which appeared at Rame in 1986 (Meyer 1990, see Appendix IV) might well have founded a successful outpost had there been other pairs stationed along the coast as is the case in Dyfed. After the death of one (believed to be female), the remaining bird spent 3 weeks patrolling the coast before apparently drifting away westward along the coast and thence possibly up the Fowey estuary, for it was last reliably reported (and the evidence of its feeding witnessed by me) in a steep pony-grazed field near Bodmin in central Cornwall (T.O. Darke pers. comm.). If the bird maintained this orientation, it is tempting to speculate that it might have gone to West Wales, perhaps from whence it came.

One captive bird of an unknown number released covertly without *Operation Chough* knowledge in autumn 1990, remained faithful to a stretch of coast near Port Isaac in North Cornwall at least until the time of writing (March 1991); one other is known to have died (S. Christophers, M. Ellis, A. Langdon pers. comm's.). It is a feature of Chough vagrancy to Cornwall that birds are seen on different stretches of coast, *e.g.* the north, West Penwith, Mevagissey, Looe and as far east as Plymouth. Viewed in this light, natural immigration represents an unfortunate wastage of genetic stock. Even one population centre would provide a focus for wandering birds and a reservoir of genetic material to support others.

How feasible is the founding of a population focal point? Of all the available sites with a good historic record of Chough activity, the Lizard peninsula was considered by Ian Bullock in 1985 as the "most promising", with this I concur. Whether localities other than the Predannack region sampled during the present study are contenders is a matter for discussion between interested parties and local land-managers. I would, on the basis of two visits, recommend further consideration of the cliffs around Kynance. Ian Bullock (*ibid.*) rated this section of coast the most highly of all those NT properties he visited, it is though subject to higher visitor pressure than the Predannack site a little to the north; Bullock did not consider the heavy pressure at Kynance a problem, indeed he also pointed out the beneficial side-effects of human trampling noted during the present study. The consensus of available opinion is that the western Lizard coast offers the best hope for successful recolonisation. It is a National Nature Reserve and has largely multiple sympathetic ownership; there are bioclimatic and geological advantages; a variety of aspects; and it occupies a centrally strategic yet remote position within Cornwall.

The work needed to create favourable habitat for Choughs on the Lizard, if sufficient does not already exist, would involve extension and development of current management policy: a continuation of the burning and pastoralism, extending this and increasing stocking rates where necessary consistent with constraints imposed by conflicting nature conservation interests (in this case botanical) in order to improve the invertebrate prey-base and its accessibility to Choughs. Managed sensitively and pragmatically, any advantages accruing to Choughs would also benefit the lower trophic levels of the area and increase species diversity.

The long-term feasibility of re-establishment involves more than a trust in the suitability of habitat quality. There will be a need to monitor released birds by counts and perhaps telemetry, and certainly a need for careful wardening and observation of survivorship, especially in relation to possible Peregrine predation. There will probably also be a need to provide back-up care in the form of supplemental food (or at least retain this option and monitor the conditions which would trigger its implementation), guard those feeding-, roosting- and nesting-sites shown by monitoring to be of crucial importance during the early years of actual re-establishment.

The presence of recolonising Choughs on the Lizard would inevitably lead to increased public interest in the area, and this would incur both the costs and benefits common to many other sites of great natural and public interest. Financial benefits could be utilised to safeguard the area for the benefit of all wildlife, and there would exist an opportunity to manage the pressure in a constructive way rather than as damage limitation. Sufficient funds should initially be forthcoming from local and business interests to prevent the project from creating problems of conflicting priorities. A fixed observation centre with video monitoring equipment would serve both scientific monitoring and public interest; it would help to prevent excessive disturbance and provide educational opportunities. Such facilities could be linked to off-limits captive stock so as to minimise their disturbance, provide security and a point of continual interest for visitors.