POPULATION ECOLOGY AND CONSERVATION OF RED-BILLED CHOUGHS IN SCOTLAND

Final report on Knowledge Transfer Project – Summary Document
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1. Introduction & Overview

1a) Overall aims

This document summarises the main conclusions and recommendations of a Knowledge Transfer Research Project into the ecology and conservation of choughs in Scotland. The work was led by Dr Jane Reid (University of Aberdeen), Professor Pat Monaghan, (University of Glasgow), Dr Eric and Mrs Sue Bignal (Scottish Chough Study Group) and Dr Davy McCracken (Scottish Agricultural College). Dr Maria Bogdanova was employed as the post-doctoral research assistant on the project. The work was carried out in partnership with Scottish Natural Heritage (SNH) and the Royal Society for the Protection of Birds (RSPB). Funding was provided by a Knowledge Transfer Grant from the Natural Environment Research Council (NERC, PIs P. Monaghan & J. Reid), with matching partnership funding and in-kind support from SNH and RSPB.

The overall aims of the project were to develop the scientific understanding of the population ecology of choughs on Islay, and to use this understanding to inform the development of appropriate conservation strategies and policies. The project built on existing long-term research on Islay's choughs. It involved further analysis of long-term data, plus two years of intensive fieldwork designed to answer specific questions. The work aimed primarily to understand the ecology of choughs in their sub-adult years (ie, from fledging to breeding age). Survival from fledging to breeding is a key factor in causing population change. However, relatively little was previously known about the behaviour and ecology of choughs during this time.

The main report, which is available on request, provides an overview of the results of the scientific study and focuses on presenting the scientific evidence on which resulting recommendations for chough conservation management on Islay are based. The report is written with the intention of presenting the results of the data analyses, and the rationale underlying those analyses, in a way that is accessible to non-specialists. Further details of analyses and technicalities are provided in published, peer-reviewed papers and/or are available on request.

The report aims to provide information that will be of use to policy makers and conservation practitioners, and also highlights topics where further research is required before informed management decisions can be taken.

1b) Project rationale

One major and critical challenge facing conservation managers is the need to devise effective conservation management policies that are based on sound scientific evidence, but also feasible and compatible with agriculture and other competing demands on land-use, and with management aimed at conserving other species or habitats. Such evidence-based policies must be based on a sound scientific understanding of the factors that cause changes in the numbers of the focal species, and of the links between these factors and management policy. A key step in the development of any management policy should therefore be to identify which demographic rates (survival and reproduction) are primarily responsible for causing population change, and which environmental factors are in turn responsible for causing variation in these demographic rates.

The long-term demographic and ecological data that are required to achieve this understanding are rarely available for natural populations, especially those of immediate conservation concern. Furthermore, to provide adequate context and highlight the full range of appropriate management approaches, analyses should ideally be replicated across multiple populations of the focal species inhabiting different environments. Such parallel demographic and ecological studies would make it possible to assess the general applicability of findings, and to develop conservation policies that can be coordinated across populations and are locally effective. However, due to the substantial data required, the need for rigorous and detailed analysis, and difficulties in effectively communicating and implementing scientific knowledge, such large-scale application of rigorous ecological science to biodiversity conservation is rarely achieved with respect to any species of conservation concern.

Scottish and European pastoral agricultural ecosystems are of high biodiversity value, and reflect particular socioeconomic structures that are themselves increasingly rare. These ecosystems support numerous rare and threatened animal and plant species of high national and international conservation priority. The red–billed chough *Pyrrhocorax pyrrhocorax* is one such species, which serves as a high-profile figurehead for the conservation of pastoral agricultural ecosystems.

The overall aims of this project were to use existing long-term data, and further targeted fieldwork, to quantify and understand demographic variation in choughs in Scotland in relation to habitat and land-use, and to use this understanding to make recommendations for the successful conservation of choughs in Scotland.

1c) Specific aims and achievements

The project had five main aims as follows:

Aim 1: To establish an ongoing dialogue between scientists studying environmental factors driving population change and those responsible for managing the environment to conserve protected species.

Aim 2: To identify apparent drivers of temporal and spatial variation in chough demography on Islay, focusing particularly on demographic rates that are known to constrain population growth rate, and their links with environmental factors that could feasibly be managed.

Aim 3: To investigate whether patterns and correlates of demographic variation observed on Islay also apply to chough populations on Colonsay and the Isle of Man.

Aim 4: To use the resulting understanding of chough population ecology to identify management approaches, times and locations that are likely to be most effective with respect to chough conservation, and to consider how chough demographic rates might respond to management action.

Aim 5: To facilitate wider transfer of knowledge among conservationists, population ecologists and land managers across Europe by hosting an international chough conference, and to communicate our work to local people by giving presentations on Islay and elsewhere.

2. Summary of scientific conclusions and recommendations

The evidence supporting each conclusion is presented in the main project report (available on request).

1) Conservation status

The islands of Islay and Colonsay hold virtually the entire Scottish population of red-billed choughs (*Pyrrhocorax pyrrhocorax*). This species is of high conservation concern across Europe and an important figurehead for the conservation of low intensity agricultural ecosystems and the mosaic of habitats such systems generally provide. The number of breeding pairs of choughs on Islay has varied over the last 25 years and was estimated at approximately 55 pairs in 2007. Adult breeding success and survival have remained relatively stable. However, first-year survival rates during 2007-2009 were lower than any observed during 1983-2007. Were the rates of survival and breeding success observed in recent years to continue, the number of choughs breeding on Islay would be expected to decrease over coming years. The status of the Scottish chough population as of high conservation concern should therefore be maintained.

2) Sub-adult survival as a focus of management

Over the last 25 years, one main factor driving variation in the number of choughs on Islay has been variation in the probability that a chough will survive through its first two years of life (i.e., from fledging to age two). An effective way of maintaining or increasing the number of choughs on Islay would be to increase the probability that birds survive these sub-adult years, or at least reduce the frequency of years in which sub-adult survival is poor. There is therefore a need to consider whether it is feasible to identify and implement management practices designed to increase the survival of sub-adult choughs. Such management should not, however, have any detrimental consequences for the adult birds.

3) Monitoring adult survival and breeding success

The number of choughs on Islay is expected to be very sensitive to any change in adult survival (the probability that an adult chough will survive from one year to the next), and reasonably sensitive to any change in breeding success (the number of chicks fledged per breeding attempt). While adult survival and breeding success have recently

been relatively stable on Islay, it is important to continue to monitor adult survival and breeding success and to ensure that any decline can be rapidly recognised, investigated and effective mitigation measures put in place.

4) Among-year variation in sub-adult survival

During 1983-2005, variation in the survival of sub-adult choughs was correlated with variation in local weather (specifically, temperature and rainfall) and indices of the abundance of *tipulid* larvae (indices based on large scale surveys of inter-annual variation in *tipulid* larvae in Scotland). Although correlation cannot prove direct causation, these data indicate that among-year variation in sub-adult survival may be caused by large-scale variation in weather and food abundance. These factors are difficult to manage directly. However, there is some evidence that the effects of weather and *tipulid* abundance on chough survival depend on the density of breeding pairs of choughs, and on the habitat surrounding nest sites. Specifically, effects of variation in *tipulid* abundance on survival through the first year of life were less marked in choughs that had fledged from nest sites that were surrounded by more suitable foraging habitat and where neighbouring pairs of choughs were further away. Effects of poor weather and low food abundance on chough survival might therefore be minimised or ameliorated by appropriate management of the habitat surrounding nest sites and nest site density. Future nest site provision should be planned with these data in mind.

The possibility that variation in other factors, such as predation, disease and specific agricultural practices has caused the observed variation in chough survival during 1983-2005 could not be quantitatively tested and cannot be ruled out.

5) Predicting sub-adult survival

In theory, the statistical model that we developed using data from 1983-2005 (section 6) should allow us to predict the likely first-year survival rate for any particular cohort of choughs in advance. This could allow additional management to be implemented in years when sub-adult survival is expected to be low. Further years of data are required to validate how accurate and useful this approach might be. The model could be effectively validated in 2010 once five years of additional data have accumulated. However, preliminary analyses suggest that the model does not accurately predict the low first-year survival observed during 2007-2009. Some additional and as yet

unidentified factor may therefore have caused the extremely low first-year survival in these two years.

6) Spatial variation in sub-adult survival

Sub-adult survival varied with natal location such that choughs reared in specific nest sites, and in specific areas of Islay, were more likely to survive to breeding age than choughs reared in other nest sites or areas of Islay. Specific areas of Islay have therefore been particularly important in maintaining the island's chough population. These include the Ballygrant Valley, the area around Loch Gruinart and Sanaig, and the south-east Rhinns. The factors that cause this variation could not be fully identified in this study, but might include variation in habitat and properties of a nest site's physical location (such as its distance from exposed Atlantic coasts). In some of these areas (e.g. the Ballygrant Valley, breeding success has been poor in recent years, possibly associated with a decline in the condition of existing nest sites. It would therefore be prudent to provide and maintain suitable nest sites and foraging habitat in the areas of Islay that have consistently produced choughs that survive well.

7) Foraging sites: the importance of coastal dune systems

On Islay, *ca* 90% of observations of foraging flocks of choughs during April 2006 - March 2008 were in areas associated with coastal dune systems, particularly at Ardnave and Kilchoman. Sub-adult choughs used a variety of habitats within and around these areas, including grazed and largely ungrazed dune grasslands, kelp beds, bare sand, cliff and heath. Coastal dune systems are therefore of major importance for sub-adult choughs on Islay and should be maintained in a state that maximises the abundance and availability of the chough's invertebrate prey. Our data on the foraging behaviour of sub-adults suggest that this will be best achieved by maintaining a mosaic of suitable open habitats containing a diversity of vegetation heights and structures, thereby providing a variety of resources for choughs to exploit in different seasons and years.

8) Foraging sites: the importance of silage fields

Most of the remaining *ca* 10% of observations of foraging flocks of choughs were in newly cut silage fields. This habitat was used by a substantial proportion of newly fledged and sub-adult choughs during June-August, and is likely to provide an

abundance of food for newly fledged young. The extensive use of this habitat when available suggests that cut silage fields are a highly profitable foraging resource for sub-adult choughs, particularly in summer (a time when sub-adult mortality can be high). Both the timing of the closing off of fields to grazing animals, which influences the pattern of change in grass length, and the timing of the silage cutting, therefore influences foraging opportunities for choughs. Some preliminary data suggest that silage fields that were cut in June may be used more, and used for longer, than fields cut in July or August. This possibility requires further investigation. More detailed study of the foraging sites used by young choughs in areas where silage fields are not available (e.g. on Colonsay) may be useful in evaluating its importance on Islay.

The introduction of support for grassland management schemes that influence the timing and synchrony of field closure and silage cutting across Islay should therefore be considered where appropriate. It might be beneficial to encourage some early (June) silage cutting in areas of importance for choughs, and this possibility urgently needs to be tested. Any encouragement of such early cutting should be accompanied by further detailed study of chough use of silage aftermath in relation to the timing and spatial pattern of cutting to further investigate and evaluate the importance of this resource.

9) Roost sites

During April 2006 - March 2008, sub-adult choughs used three main roosts, at Ardnave, Kilchoman and Dun nan Nighean. The Ardnave and Kilchoman roosts were located within the main sub-adult foraging sites. Choughs also roosted at the same or nearby sites during 1986-1988, suggesting that sub-adult choughs are relatively faithful to specific roosts. However, the relative use of the different roosts has changed over recent years, with a greater proportion of sub-adult choughs now using Ardnave rather than Kilchoman. It is not clear whether this change reflects the provision of a new roost site at Ardnave, changes in foraging habitat at one or both sites, or to some other factor.

Suitable roost sites need to be maintained at or near the key foraging sites for sub-adult choughs, particularly at Ardnave and Kilchoman. Suitable foraging habitat must also be maintained around the key roost sites. Provision of safe roost sites at other foraging sites could also be considered.

10) Specific foraging locations

Sub-adult choughs foraged at specific locations within Ardnave/Killinallan and Kilchoman/Kilchiaran. These locations tended to have relatively shorter and/or less variable swards, more old cow pats and sparser and more diverse vegetation than locations within these same sites at which sub-adult choughs were not observed to forage. However these effects varied among years (for example a difference in sward height was observed in one year of the study but not the other) and the magnitude of the difference was small (less than 1cm). Given the factors known to affect invertebrate populations, the best management approach may therefore be to aim to maintain a largely open habitat matrix that contains a variety of flora with differing vegetation heights and structures at a small spatial scale. Judicious use of grazing animals might be the best means of achieving this.

11) Sub-adult mortality and parental state

Years in which first-year survival was low were characterised by particularly low survival through the late summer. Most choughs that died before the end of their first year died after they had left their natal territories and joined sub-adult flocks in the coastal dunes and silage fields. The different survival rates of choughs reared in different areas of Islay therefore occurred after the young choughs had reached the flocks.

The extremely low first-year survival rate in 2007-2008 was associated with a marked reduction in the time that parents spent with newly fledged offspring compared to 2006-2007. First-year survival rates of fledglings also vary with characteristics of their parents, including age and lifespan.

These data suggest that the conditions that a chough experiences on its natal territory can have long-term effects on its subsequent survival. Sub-adult survival might therefore be linked with parental state and conditions at the nest site, as well as conditions experienced in the sub adult flocks. Maintaining appropriate habitat diversity and hence foraging conditions on breeding territories is also likely to be important in producing choughs that survive well.

To increase or maintain sub-adult survival rates, appropriate conditions should therefore be maintained on breeding territories as well as the foraging areas subsequently used by flocks of sub-adult choughs.

12) Comparison with other chough populations

Overall, chough breeding success and survival was broadly similar on Islay, Colonsay and the Isle of Man. However on average, choughs reared slightly fewer fledglings per breeding attempt on Islay than on Colonsay or the Isle of Man. Choughs on Islay were more likely to survive through their first year but less likely to survive through their second year and as adults than choughs on Colonsay or the Isle of Man. The relatively low population growth rate of choughs on Islay compared to Colonsay and the Isle of Man therefore reflected lower average breeding success, second-year survival and adult survival rather than lower average first-year survival. Breeding success was correlated across all three populations, suggesting that annual breeding success may be to some degree influenced by large-scale factors (such as climate).

This suggests that Islay's choughs may be slightly under-performing with respect to breeding success and adult survival, which again suggests a need for more appropriate management of the habitats around breeding territories.

13) Monitoring management efficacy

This study has demonstrated, through the combination of analysis of long-term data and targeted fieldwork, that there is considerable potential to build a conservation management strategy for choughs in Scotland based on a rigorous base of scientific evidence.

This approach should be maintained and improved through continued monitoring of breeding success and survival. In addition, there is a need to ensure that the effectiveness of any management actions applied at an individual farm level are also assessed, not solely by monitoring compliance with the management prescriptions but also monitoring the impact of the actions on habitat diversity and quality and whether the intended conservation benefits are indeed being achieved.

3. Summary of agreed recommendations and actions

These recommendations were discussed and agreed at the project meeting on Islay, April 2009. In attendance were Rae McKenzie, Angus Laing and Stuart Shaw (Scottish Natural Heritage), Andy Schofield, Jeremy Wilson and Sarah Davies (Royal Society for the Protection of Birds), Eric, Sue and Caitlin Bignal (Scottish Chough Study Group), Davy McCracken (Scottish Agricultural College), Pat Monaghan (University of Glasgow), Maria Bogdanova (Centre for Ecology & Hydrology) and Jane Reid (University of Aberdeen). Jack Fleming and James How (RSPB) attended for the presentation and discussion of scientific results but not the discussion of recommendations.

1) Due to the low rates of sub-adult survival during 2007-2009, the number of choughs breeding on Islay is expected to decrease over the next 2-3 years. The status of choughs as being of high conservation concern should therefore be maintained and the policies of SNH and RSPB should reflect this status. Population size and demography of adults and sub-adults should continue to be monitored closely.

2) Successful conservation of choughs on Islay is likely to rely on appropriate management of the main flock foraging areas (i.e. the main dune systems and, where relevant, early-cut silage fields) and individual breeding territories. Data from the chough research project allows the key habitats and locations to be identified. The management aim should be to generate a diversity of habitats that support high plant and invertebrate diversity, thereby increasing the range of foraging options that will be available to choughs at any point in time. There should not be a focus on the provision of any single food resource by over-emphasis on any single management approach.

3) Over the coming years, the main mechanism available for funding appropriate conservation management for chough will be through developing appropriate farm-level applications to the Scottish Rural Development Programme (SRDP). There are currently no chough-specific options available within the SRDP. Introduction of any such new options to the SRDP will require approval from the European Commission. In the medium to long term, consideration needs to be given not only to what such chough-specific options would consist of but also what the potential impacts of any such chough-specific measures would be (since it would not be desirable to produce simple, uniform habitats for choughs rather than the complex diversity that seems to be required).

4) In the short-term, the conservation importance of choughs in Argyll should be emphasised by a combination of raising the profile of choughs more within the SRDP application interface and also directing prospective applicants from Islay and Colonsay to those existing options that are of direct relevance and potentially beneficial for choughs. These existing chough-relevant measures also need to be drawn to the attention of agricultural and conservation consultants who draw up SRDP applications for Islay and Colonsay.

Action: Scottish Natural Heritage to ensure that the profile of chough is raised within the accompanying SRDP documentation and that existing chough-relevant measures are adequately signposted on the SRDP website and related documentation.

Action: Eric Bignal to draft a brief for consultants that explains how available SRDP options can be used to benefit choughs in the context of chough areas.

5) A number of key farms on Islay have already had their SRDP plans approved, and the conditions of the contracts mean that further changes cannot be made for 5 years. Additional farms that cover key dune areas for which SRDP plans have not already been agreed should be encouraged to enter the scheme with a plan that is appropriate for choughs. In addition, any new plan should contain a clause which states that, if any management is found not to be having the intended effect, then that management can be changed during the course of the five years of the scheme.

Action: Scottish Natural Heritage and Eric Bignal to approach relevant farmers and encourage participation in SRDP.

6) Unlike the negotiation of an individual management agreement, to be successful any application to the SRDP needs to score sufficient points to be judged favourably against any other applications competing for the limited SRDP funds. It is unclear as yet what impact this will have the willingness of farmers to submit SRDP plans or on the content of those plans that are submitted (given that other options within the SRDP may be more financially rewarding when compared to options of relevance to chough). There is need within Argyll at least to ensure that the SRDP assessment process takes chough needs fully into consideration and does not (especially outwith designated sites but where choughs occur) approve plans that are more financially beneficial to the applicants but which contain SRDP options that may be less beneficial or detrimental for choughs.

Action: Scottish Natural Heritage to feedback to the SRDP review to encourage appropriate future development of options and associated payments.

7) There is presently no provision for biological (as opposed to basic compliance) monitoring within the SRDP scheme. To ensure that impacts can be measured and appropriate changes can be made to future SRDP plans, the biological outcomes of existing plans need to be monitored (using appropriate biological metrics) over and above the basic compliance monitoring that individual farms may or may not receive. In the immediate term, monitoring of outcomes should be prioritised on the major dune systems that are essential for sub-adult choughs.

Action: Scottish Chough Forum to write a letter to relevant ministers raising concerns over the provision for biological monitoring and assessment within the SRDP. This letter will raise specific issues resulting from research on choughs on Islay, but will discuss these issues in the context of more general aspects of the need for monitoring. Pat Monaghan to draft the letter and circulate to other Forum members for input.

8) Adequate nest and roost sites need to be maintained and/or provided in key areas of Islay, as informed by the long-term Scottish Chough Study Group data. The easiest means of resourcing nest and roost site maintenance and provision on those farms which fall within designated areas is to include this work within the SRDP plans (since the SRDP allows for funding capital works on designated sites). Hence relevant farms within designated areas that have yet to enter the scheme should be encouraged to include nest site repair/provision in their plans, while relevant farms who have already submitted plans should be encouraged to submit an additional proposal concerning nest site repair/provision. An additional mechanism needs to be put in place to either justify the funding through the SRDP of nest site repair/provision on farms outwith designated sites or identify appropriate funding sources that could be utilised in such instances. Although farms in the Ballygrant valley and other parts of Islay such as the south-east Rhinns lie outwith the designated area, the long-term importance of these sites (as emphasised in the findings from this study) for the maintenance of the chough population could potentially be used as a justification for the use of SRDP to fund nest site repair/provision on those farms

Action: Scottish Chough Study Group to provide SNH (in the form of a confidential annex to this report) with an updated list of existing nest sites that are in serious disrepair, and of historically productive or suitable habitat areas where no nest sites are currently available. These sites should then be prioritised for nest site maintenance or provision.

Action: Scottish Natural Heritage to encourage SRDP plans for the priority list of nest sites.

Action: Scottish Natural Heritage to liaise with Jane Reid and the Scottish Chough Study Group to ensure that long-term chough data are used to support SRDP applications where appropriate.

9) Further data regarding chough use of silage fields in relation to the timing of closing off of fields, fertilisation use and cutting need to be collected and/or analysed. This could include analysis of existing RSPB data on cutting dates in relation to chough survival patterns and use of dune systems. Meanwhile, SRDP plans for farms in key chough areas should include a diversity of grassland management options.

Action: Jane Reid and James How to liaise over access to and analysis of existing data. RSPB and Eric Bignal to consider options for early cutting specific fields at Ardnave and Smaull and monitoring chough usage.

10) The RSPB's plans to restore habitat for choughs on the Oa should be encouraged and supported.

Action: Scottish Chough Forum to write a letter to relevant RSPB managers to emphasise the potential importance of habitat restoration on the Oa for choughs, particularly given the context of the decrease in Islay's population that is predicted for coming years. Pat Monaghan to draft the letter and circulate to other Forum members for input, and to liaise with the RSPB members of the Scottish Chough Forum to decide the most appropriate recipients.

11) On Islay, survival rates of sub-adult choughs have recently been low. Consequently, the number of breeding pairs is likely to decrease in coming years. Choughs have retracted from areas of Islay that have recently been highly productive and/or held several breeding pairs. To attempt to address this situation, land management regimes that differ in emphasis from recent practices should be adopted under the SRDP. Given this situation, it is imperative that baseline monitoring of chough demography (breeding success and sub-adult and adult survival) should continue on Islay. These data will help provide a sound scientific basis on which the efficacy of SRDP plans can be evaluated. The most efficient and effective way to achieve this monitoring will be to support the Scottish Chough Study Group in the continuation of the long-term demographic study on Islay. Support may come through direct financial assistance, in-kind support through provision of

accommodation and vehicles, and through assistance with data collection (for example through continued RSPB monitoring of choughs on the Oa).

Actions: Scottish Chough Study Group, Pat Monaghan and Jane Reid to draft and cost a proposal for ongoing monitoring and scientific work and to look for potential funders. Some support package urgently needs to be put in place to support monitoring through 2009-2010. Scottish Natural Heritage and Glasgow Natural History Society will be approached for this in the first instance.

Depending on the funding stream, future applications may require support from bodies such as RSPB and SNH and should be put together in a co-ordinated way that draws on expertise, opportunities and priorities afforded by the Scottish Chough Forum.

12) Opportunities to compare the demography and ecology of Islay's choughs with that of other chough populations should be exploited to the full. This may include demographic comparisons of the sort already run with the Manx Chough Project and Colonsay, but also closer comparison of foraging diversity and machair management.

Action: Jane Reid to continue to talk to Welsh chough researchers about the possibilities for demographic comparisons. Jeremy Wilson to look into unpublished RSPB data from Wales.

13) The final report should be made available electronically, together with supporting documentation and photographs. The executive summary and recommendations should also be available separately, and should be disseminated to farmers and land-owners in chough areas of Islay.

14) Consideration should be given to holding a meeting providing feedback from the project and emphasising (to farmers within and outwith designated sites and their associated consultants) the chough-relevant aspects of the SRDP and how best to develop appropriate plans

15) The Scottish Chough Forum should continue to meet bi-annually to ensure continuing and efficient exchange of information between scientists, conservationists and policy makers.