Institution: University of Gloucestershire

Unit of Assessment: 17 Geography, Environmental Science and Archaeology

Title of case study: Applied ecology: from science to conservation policy and practice

1. Summary of the impact

Dr Anne Goodenough and Professor Frank Chambers undertake applied ecological research with importance for conservation and management, nationally and internationally. Working with, or commissioned by, major national bodies including The Heather Trust, Natural England, Countryside Council for Wales, British Trust for Ornithology and RSPB, their research on rare species and habitats influences major national policy (e.g. species conservation priorities, and degraded habitat restoration and conservation). Furthermore, their research informs evidence-based changes in management for species (leading to conservation of internationally declining songbird, the pied flycatcher, at key sites throughout the UK) and landscapes (blanket bog and heather moorland restoration in Wales and England).

2. Underpinning research

Species population decline and habitat degradation often have multiple interacting causes. Disentangling these is vital to understand mechanisms for change and to inform effective conservation. Innovative scientific research, as undertaken here using ecological and palaeoecological methods, has direct applications for both policy and practice. The underpinning research undertaken by Dr Goodenough (2008–date) and Professor Chambers (1999–date) was published in international peer-reviewed journals and reports of statutory conservation agencies.

(a) **Species decline and conservation.** The pied flycatcher (*Ficedula hypoleuca*), which breeds in UK woodland and winters in Africa, is one of many internationally migratory woodland birds declining throughout Europe. Quantifying decline, and understanding the multiple causes thereof, is a vital first step in formulating effective policy and management. Goodenough *et al*. (2009) were the first to quantify a decline of more than 25% (the threshold for listing as a species of conservation concern) in a study part-funded by the British Trust for Ornithology. Using hierarchical modelling, this determined that a key factor was decreased reproductive success (in UK) and that other factors acted abroad. As flycatchers throughout Europe depend on nestboxes for breeding, and reproductive success was decreasing, follow-on research (Goodenough *et al*., 2008; part-funded by the RSPB) examined the effects of nestbox orientation on breeding success. This found orienting boxes south-west (180°–270°) reduced breeding success by 24% and lower occupation by other birds used as key bio-indicators of ecosystem health (e.g. great tits, *Parus major*). In an innovative interdisciplinary study combining field ornithology with microbiology, Goodenough and Stallwood (2012) showed that south-west nestboxes had a 40% increase in microbial load, more pathogens, and smaller, weaker, offspring. Abundance of one allergenic fungus, *Epicoccum purpurascens,* explained 20% of variation in offspring quality and was much more abundant in south-west boxes, owing to microclimate (south-west boxes being warmer and wetter). Research led to placement of 350 additional nestboxes at a top-5 UK site.

(b) **Conservation and restoration of degraded landscapes.** Collaborative research with the Heather Trust (Chambers *et al*., 1999) applied palaeoecological methods innovatively to investigate recent upland spread of *Molinia* (purple moor grass—an invasive native species) and showed how such methods gave a much wider perspective on contemporary conservation concerns, such as loss of heather moorland. The work showed that, contrary to belief, the heather moorland had previously alternated over recent centuries between grass (though not *Molinia*) and heather dominance. The innovation led to contract research from statutory

agencies Countryside Council for Wales (now Natural Resources Wales; jointly published in Chambers *et al*., 2007; 2013) and English Nature (now Natural England) to investigate centennial vegetation changes in degraded moorland and blanket mire as an aid to conservation management. The data showed principal vegetation changes post-dated the start of the Industrial Revolution, and that there were multiple causes of degradation and *Molinia* spread. This commissioned research pioneered the use of palaeoecology directly by conservation agencies, helped 'Bridge the Gap' between long-term (i.e., palaeo-) ecological data and conservation practitioners, legitimised national funding for bog and moorland restoration and led to new sponsored investigations of recent moorland palaeoecology to inform conservation practice.

3. References to the research

The case study is underpinned by the following peer-reviewed publications. Impact factors derived from journal homepages; citations from Google.

1. **Goodenough, A.E**., Elliot, S.L., Hart, A.G. (2009) The challenges of conservation for declining migrants: are reserve-based initiatives during the breeding season appropriate for the Pied Flycatcher? *Ibis*, 151, 429–439. [Journal Impact Factor 2.43, cited =9 + one book and one policy document]
2. **Goodenough, A.E**., Maitland, D.P., Hart, A.G., Elliot, S.L. (2008) Nestbox orientation: a species-specific influence on occupation and breeding success in woodland passerines. *Bird Study*. 55, 222–232 [Journal Impact Factor 0.868, cited =8 + one book aimed at conservation practitioners]
3. **Goodenough, A.E**., Stallwood B. (2012) Differences in culturable microbial communities in bird nestboxes according to orientation and influences on offspring quality in great tits *Parus major*. *Microbial Ecology*, 63, 986–995. [Journal Impact Factor 2.91; cited =1]
4. **Chambers, F.M**., Mauquoy, D. and Todd, P.A. (1999) Recent rise to dominance of *Molinia caerulea* in Environmentally Sensitive Areas: new perspectives from palaeoecological data. *Journal of Applied Ecology*, 26, 719–733. [Journal Impact Factor 4.74; cited =50]
5. **Chambers, F.M**., Mauquoy, D., Gent, A., Pearson, F., Daniell, J.R.G. and Jones, P.S. (2007) Palaeoecology of degraded blanket mire in South Wales: data to inform conservation management. *Biological Conservation*, 137, 197–209. [Journal Impact Factor 3.794; cited =16]
6. **Chambers, F.M**., Cloutman, E.W., Daniell, J.R.G., Mauquoy, D. and Jones, P.S. (2013) Long-term palaeoecological study (palaeoecology) to chronicle habitat degradation and inform conservation ecology: an exemplar from the Brecon Beacons, South Wales. *Biodiversity and Conservation*, 22, 719–736. [Journal Impact Factor 2.264; cited =2]

Details of contract research

Countryside Council for Wales, contract science report no. 420: *Recent Vegetational Change in Welsh Blanket Bogs: a palaeoecological appraisal.*

English Nature, contract VT014: *A Preliminary Examination of the Vegetation History of Moorland in Northern England*.

4. Details of the impact

[Superscripts are References to sources in Section 5]

Changing policy: Meeting a need (identified by RSPB and British Trust for Ornithology) for research into population declines in woodland migratory songbirds, Goodenough *et al*. (2009) examined data from the RSPB-managed Nagshead Nature Reserve, a nationally important site for pied flycatcher.

Species-specific research was a strategic priority at this site (2001–2004 & 2004–2008 Reserve Management Plans) and throughout the UK [1, 2]. This research showed substantial decline in flycatcher numbers, providing important detail for the species profile created by BTO and Joint Nature Conservation Committee (cited: http://www.bto.org/birdtrends2010/wcrpiefl.shtml), which informs national policy (Biodiversity Action Plans). This in-depth work informed additional research (by BTO) on the geographical extent of the decline and was instrumental in pied flycatcher being listed as of conservation concern throughout the UK [1].

Changing practice: Researching the multiple causes of decline, especially those relating to breeding success, was an acknowledged RSPB priority, which Goodenough *et al*. (2008) and Goodenough & Stallwood (2010) addressed. The finding that nestbox orientation affects breeding success (Goodenough *et al*. 2008), probably related to directional differences in nestbox microbial load (Goodenough & Stallwood, 2012), changed RSPB management practice [2]. At Nagshead, new guidelines mean nestboxes are oriented away from south-west, improving breeding success by pied flycatchers by *c*. 20%. This change is critically important to ensure effective conservation and buffering decline at a nationally important site for an internationally declining species. This good practice has been shared with other RSPB sites with nestbox schemes that support pied flycatchers (e.g. Gwenffrwd–Dinas in mid-Wales) [2].

Wider impact: Dissemination of these research findings by Dr Goodenough to Gwent Wildlife Trust staff and volunteers at an annual training event (March 2011) attended by more than 50 people, led to altered nestbox placement policy for 28 woodland-based nestbox schemes (involving ~800 nestboxes) throughout S. Wales [3]. This benefits the entire small songbird community, including Redstart—another declining bird of conservation concern—by increasing breeding success and allowing population growth. The project is among the top five in the UK [3]. Internationally, the findings concerning nestbox orientation were cited in an International Avian Conservation manual http://www.conservationevidence.com/actions/498 —part 58).

Habitat dynamics

Chambers *et al.* (1999) showed how palaeoecological methods could be used to test received opinion on loss of heather and spread of *Molinia* within moorland. Cited 50 times, academics elsewhere, conservation practitioners and agencies [4, 5] regard this research as evidence of the value of palaeoecology (long-term ecology) to palaeoecology, and legitimised practical attempts to control *Molinia*. This pioneering work led directly to contract research from statutory national conservation agencies in Wales (Contract Science Report 420, CCW [6]) and England (Project Contract VT014, English Nature [5]) on blanket mire and moorland.The commissioned contract research demonstrated the utility of such methods for blanket mire (Chambers et al., 2007, 2013), which informed the treatment of priority habitats in the Welsh uplands [4, 7], and led to the initial drafting by CCW of an EC-LIFE application [4].

Prof Chambers contributed to the inaugural ‘Bridging the Gap’ (BtG) symposium in Hull (designed to forge links with practising conservation agencies), and to subsequent BtG Newsletters; to an international symposium in Stirling involving palaeoecologists and conservation practitioners; and to a session on use of past history (palaeoecology) at a Peatlands Symposium (Durham)—which all prompted the Yorkshire Peat Partnership to sponsor a PhD student (under Prof. Chambers’ supervision) to investigate the palaeoecology of sites they are restoring, to inform their conservation management [8].Cited by Davies and Bunting (2010) [9] as having major impact on a key question for UK conservation policy, his research led ultimately to a call for a review of the value of the utility of palaeoecology to conservation by Natural England, for which he was a prime consultee, influencing a subsequent tender invitation (2012). The academic/practitioner group dealing with biodiversity at the international PALAEO50 Conference (Oxford, Dec 2012) cited his

2013 paper as informing three follow-up questions in the current top 50 research questions in palaeoecology: those concerned with assessing "the extent of [past] human influence and [the use of palaeoecology to inform] the management of cultural landscapes" (Seddon *et al*., in press, line 313) [10]. Chambers' research is regarded as having the greatest impact on upland policy in Wales of any commissioned by CCW during the past 17 years [4].

These examples show how innovative uses of ecological and palaeoecological scientific research have been applied to species- and habitat-conservation by principal bodies and statutory conservation agencies. The findings influenced change in direction of policy and attitude, and led to changes in management and conservation of rare species and habitats.

5. Sources to corroborate the impact

1. Statement from British Trust for Ornithology explaining the importance of Dr Goodenough's work for informing policy and practice at a national level.

2. RSPB testimony—details the need for Dr Goodenough's research, changes to practice made as a result, and the implications of these changes (joint letter from former/current RSPB Reserve Managers who, together, span the whole period of Dr Goodenough's research).

3. Gwent Wildlife Trust (GWT) testimony on the importance of research, and training provided by Dr Goodenough based upon this research, on setting up optimal nestbox conservation schemes throughout South Wales (Letter from GWT Volunteer Officer).

4. Testimony, Countryside Council for Wales (Natural Resources, Wales); details origin and nature of contract research conducted for CCW and significance of the impact of that research.

5. Testimony from Natural England regarding origin and impact of contract research, Project Contract VT014, English Nature.

6. (2001) *Recent Vegetational Change in Welsh Blanket Bogs: a palaeoecological appraisal*. CCW Contract Science Report no. 420, Countryside Council for Wales, Bangor.

7. (2003) Jones, P.S. *et al. Priority habitats of Wales: a Technical Guide.* Countryside Council for Wales, Bangor. [Section 8.3 Blanket bogs; cited on p. 97].

8. The University of Gloucestershire commissioned independent consultants (Innovation Partnerships Ltd) who produced a report that summarises, in respect of information from Yorkshire Wildlife Trust and the Yorkshire Peat Partnership, the impact of contracted and sponsored palaeoecological research by Prof. Chambers *et al*. in England.

9. Davies, A.L. & Bunting, J. M. (2010) Applications of Palaeoecology in Conservation. *The Open Ecology Journal,* 3**,** 54-67. [Case study 2, addressing Q. 79]

10. (in press, 2014) Seddon, A. *et al*. Looking forward through the past: identification of fifty research questions in palaeoecology. *Journal of Ecology*, in press [online version available].