Section A

Institution: Durham University

Unit of Assessment: UoA 5 Biological Sciences

Title of case study: The application of ecological models to inform contemporary conservation management and future planning in response to climate change.

Period when the underpinning research was undertaken: 2000 - 2018

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Prof Stephen Willis	Professor	October 1996 to June 2020
Prof Brian Huntley	Emeritus Professor	July 1981 to June 2018
Prof Philip Stephens	Professor	June 2007 to June 2020

Period when the claimed impact occurred: 1st August 2013 to 31st July 2020

Is this case study continued from a case study submitted in 2014?

No.

Section B

1. Summary of the impact

Durham University's Conservation Ecology Group (CEG) identify the potential impacts of climate change on biodiversity using ecological models. A wide range of stakeholders, including Conservation NGOs, national government bodies and international organisations have applied the outputs from these models to: (1) change conservation management plans for single sites and across national and international networks; (2) change national and international policy on biodiversity and (3) produce regional and global assessment outputs of the impact of climate change on natural systems. Durham's research has directed governmental and non-governmental policy at national and regional scales, stimulating climate change adaptation for biodiversity across the planet.

2. Underpinning research

Research undertaken at Durham University by Willis, Huntley and Stephens has been at the forefront of applied conservation research. The work of Durham's CEG has been fundamental in identifying the potential impacts of future climate change on species and both Willis and Huntley are members of the International Union for Conservation of Nature (IUCN) Climate Change Specialist Group. The CEG has convincingly demonstrated the link between climate and contemporary population and range changes for diverse taxa (R1, R2, R3). Further work has developed novel approaches to guide changes to protected areas and protected area networks such that many species can persist in the face of future climate change (R4, R5, R6). The group have published >80 scientific papers on recent and future climate change impacts, which have been cited 19,940 times. Our recent research has shown that:

- **There is a systematic signal of recent climate change having affected populations of both widespread and protected bird species** across Europe and USA (R1, R2). Work in 2016 demonstrated, for the first time, that there is a consistent signal of climate change on population trends of all of the common terrestrial bird species across Europe and the USA (R1, already cited 165 times). We have also shown that: (1) species protected as *Annex 1* species in Europe, under the *EU Birds Directive*, for which EU member states are obliged to implement special conservation measures, have had more positive population trends than non-Annex 1 species in recent decades (R2); (2) trends in population changes of common bird species are occurring in

directions consistent with projections related to future human-induced climate change (R3, cited 309 times).

- Tropical vertebrate species are equally likely to be as highly impacted by climate change as species from higher latitudes, and **projected shifts in tropical species ranges will have profound impacts on their future conservation within protected area networks** (R4, R5, R6). This work has highlighted that, despite protected areas globally having been designated with no consideration of ongoing climate change, in many situations the established reserve networks will continue to provide climatically-suitable habitats for species under future climate change (R4, R5). These findings have markedly affected conservation strategies globally. R5, and together with an accompanying companion paper (Hole et al. 2009. *Ecology Letters* 12, 420-431), have been cited 390 times.
- **Simulations can guide conservation actions at individual protected areas** and across networks of sites, including changes to network and site configurations (R5, R6). This work (R6) was the first to apply regional climate models to project climate impacts on vertebrate species at a finer-scale, and thus produce more realistic simulations. It was one of the first papers to demonstrate the very different potential impacts of climate change across different taxonomic groups, once their dispersal capabilities were considered.

The species distribution and abundance models developed at Durham are powerful tools for informing conservation policy on adaptation and mitigation, related to the impacts of climate change on species. These models have identified species that are vulnerable to climate change and which therefore need to be assisted in colonising new areas. Further, they have demonstrated the potential for high turnover of species across global protected area networks, and that such simulations can be used to guide future management at sites.

3. References to the research

Bold – Durham PIs. Underlined = Durham PDRAs

[R1] **Stephens, P.A.**, L. R. Mason, R. E. Green, R. D. Gregory, J. R. Sauer, J. Alison, A. Aunins, L. Brotons, S. H. M. Butchart, T. Campedelli, T. Chodkiewicz, P. Chylarecki, O. Crowe, J. Elts, V. Escandell, R. P. B. Foppen, H. Heldbjerg, S. Herrando, M. Husby, F. Jiguet, A. Lehikoinen, A. Lindstrom, D. G. Noble, J.-Y. Paquet, J. Reif, T. Sattler, T. Szep, N. Teufelbauer, S. Trautmann, A. J. van Strien, C. A. M. van Turnhout, P. Vorisek, & **S. G. Willis***. (2016) Consistent response of bird populations to climate change on two continents. *Science*, 352 (6281), 84-87. DOI: 10.1126/science.aac4858. *Corresponding author. (**174 citations**)

[R2] Sanderson, F.J., Pople, R.G., Ieronymidou, C., Burfield, I.J. Gregory, R.D., **Willis, S.G.,** Howard, C., **Stephens, P.A**., Beresford, A.E. & Donald, P.F. (2016) Assessing the performance of EU nature legislation in protecting target bird species in an era of climate change. *Conservation Letters,* 9, 172–180**.** (**74 citations**)
DOI: 10.1111/conl.12196

[R3] Gregory, R.D.*, **Willis, S.G.***, Jiguet, F., Pazderova, von Strein, A., Vorisek, P., Couvet, D., **Huntley, B.** & Green, R.E.* (2009) An indicator of the impact of climate warming on European bird populations. *PLoS One*, 4, e4678. doi:10.1371/journal.pone.0004678. * Equal contributors. (**316 citations**)

[R4] Bagchi, R., Crosby, M., **Huntley, B.,** Hole, D.G., Butchart, S., Collingham, Y.C., Kalra, M., Rajkumar, J., Rahmani, A., Pandey, M., Gurung, H., Trai, T., Van Quang, N. & **Willis, S.G.*** (2013) Evaluating the effectiveness of conservation site networks under climate change: accounting for uncertainty. *Global Change Biology* 19, 1236-1248. DOI: 10.1111/gcb.12123 *Corresponding author (**79 citations**)

[R5] Hole, D.G., **Huntley, B.,** Arinaitwe, J., Butchart, S.H.M., Collingham, Y.C., Fishpool, L.D.C., Pain, D.J. & **Willis, S.G.** (2011) Towards a management framework for key biodiversity networks in the face of climatic change. *Conservation Biology,* 25, 305-315. DOI: 10.1111/j.1523-1739.2010.01633.x (**102 citations**)

[R6] Baker, D. Burgess, N.D. Butchart, S.H.M., Carr, J., Hartley, A., Smith, R., Belle, E. & **Willis, S.G.** (2015) Assessing climate change impacts for vertebrate fauna across the West Africa protected area network using regionally appropriate climate projections. *Diversity and Distributions*, 21, 991-1003. DOI: 10.1111/ddi.12337 (**35 citations**)

R1 has been submitted to the current REF and rated as 4* during internal and external grading. R3 and R4 were submitted to REF2014 and rated at least 3*. All papers are published in internationally respected peer reviewed journals and are highly cited (Google Scholar 15/02/2021).

4. Details of the impact

Durham University (DU) research on climatic change and wildlife has had a global impact on conservation policy and environmental management related to biodiversity conservation. They have worked with many non-academic stakeholders, shaping local, national and international policy and governance. The research has been applied at levels from individual sites to supranational conservation networks has informed decision making in >12 governments and >20 non-government organisations. Examples of such work include:

Impacts on conservation NGO policy

1) [E1,2] We have collaborated extensively with BirdLife International, a global conservation body that represents >200 national conservation charities, to estimate the threat of ongoing climatic change to BirdLife's global *Important Birds and Biodiversity Network (https://www.birdlife.org/worldwide/programme-additional-info/important-bird-and-biodiversity-areas-ibas).* Our research has underpinned the climate adaptation strategy for this global conservation consortium, leading to the development of climate adaptation strategies for conservation globally. For example, the Royal Society for the Protection of Birds (RSPB), the UK BirdLife partner, has used our work for two decades to guide strategies for species introductions and climate-conscious management priorities across its 200+ UK nature reserves. An example is RSPB's strategy on reintroduction sites for the rare Cirl Bunting in the UK, which was guided by suitability simulations from CEG. BirdLife's '*BirdLife's Position on Climate Change'* document (2008 & subsequently 2015) [E1] is the basis upon which the organisation advises its 200+ partner organisations working on the ground. Along with grey literature reports and books, the document uses Durham's *'Climatic Atlas of European birds'* and three peer-reviewed papers, two of which were produced by Durham, as the scientific rationale guiding their position. This document has led partner organisations to adapt management plans for individual sites in sub-Saharan Africa (e.g. Rwanda, Uganda, Burundi site examples described in E2).

(2) [E2,E3] We have worked with The National Audubon Society, the USA's largest conservation NGO, to develop a climate action plan for the whole of the Americas (https://www.audubon.org/conservation/climate/actionplan; see page 7 of E3 acknowledging Durham's modelling role), which is now used as the underpinning framework for all their actions and advocacy work on the impacts of climate change on biodiversity across the region. This action plan is driven entirely by the projections of climate-induced range shifts of birds across the Americas (North, Central and South America) undertaken at Durham.

Impact on European Union policy

Durham research was instrumental in the retention of the EU Birds Directive, following a 2015 EU review (E2, E4), and thus, the conservation policies and strategies of the 28 member states. Research (R2), in which Durham climate modelling was key, was used by the RSPB and BirdLife International to demonstrate that the EU Directive was working effectively. A synthesis of the findings was distributed by the EU science policy department as an 'EC Science for Environmental Policy' note – 30th Sept 2016, to >20,000 governmental policy staff across the EU. The EU commissioned report '*Evaluation study to support the Fitness Check of the Birds and Habitats Directives'* cites, as one of its 'main sources of evidence', Sanderson *et al.* 2016 (R2). Thus, the research was critical in keeping this Directive in place, and hence continuing to protect key wildlife across Europe, at a time when 'the future of the legislation [was] in doubt' (Mike Clark, RSPB Chief Executive; see foreword in http://ww2.rspb.org.uk/images/defendingnature_tcm9-406638.pdf).

Impact on International Climate Change Policy

1) [E5,E6] *United Nations (UN) Convention on Biological Diversity (CBD) Aichi Biodiversity Targets.* The Aichi Biodiversity Targets were established in 2010 to protect global biodiversity. 'Target 10: Vulnerable Ecosystems', updated in 2016, is directly supported by a primary indicator derived from Durham research [R3] "Climatic impacts on European and North American Birds" [E6]. The indicators are used globally to monitor the progress of member states against the targets from

the Strategic Plan for Biodiversity 2011-2020. Thus, the indicators are used by the 196 member states, plus the EU, to guide their conservation actions.

2) [E7] *UN Climate Change Conference (COP21) meeting in Paris, Dec 2015.*
In 2015, The National Audubon Society and Birdlife International published a report '*Messengers: what birds tell us about threats from climate change and solutions for nature and people'* which cites nine Durham publications (including R3, 4, 5) and uses case studies based on this work to illustrate the predicted effect of climate change on bird population. This report formed the major plank of the organisations' lobbying at COP21 meeting, which resulted in a global agreement to reduce the impact of human-made climate change on ecosystems and forms the basis of both organisations' climate change adaptation policies.

Impacts on Conservation Management

(1) [E8] *UN Environment Programme (UNEP): Impact on transboundary protected area management across West Africa to cope with climate change.*
Durham-led research, funded by UNEP, explored the impacts of climate change on biodiversity across West Africa, specifically focused on Chad, Gambia, Mali, Sierra Leone and Togo (e.g. R6). The findings were used to identify gaps and future threats to the important West African protected area network in this region. The outputs of the modelling illustrate the vulnerability of all bird, mammal, amphibian and reptile species in the region and summaries of these vulnerabilities have been added to the world database on protected areas (e.g. Figure 1), made available by the IUCN World Conservation Monitoring Centre (WCMC). The modelling has since been used to inform conservation activities across the region (see e.g. subsection 2 below). The changes simulated by Durham models also formed the basis of future-proof site conservation prioritisation strategies for the entire network (http://parcc.protectedplanet.net/en/recommendations-and-planning/identification-of-priority-areas-for-biodiversity-conservation).

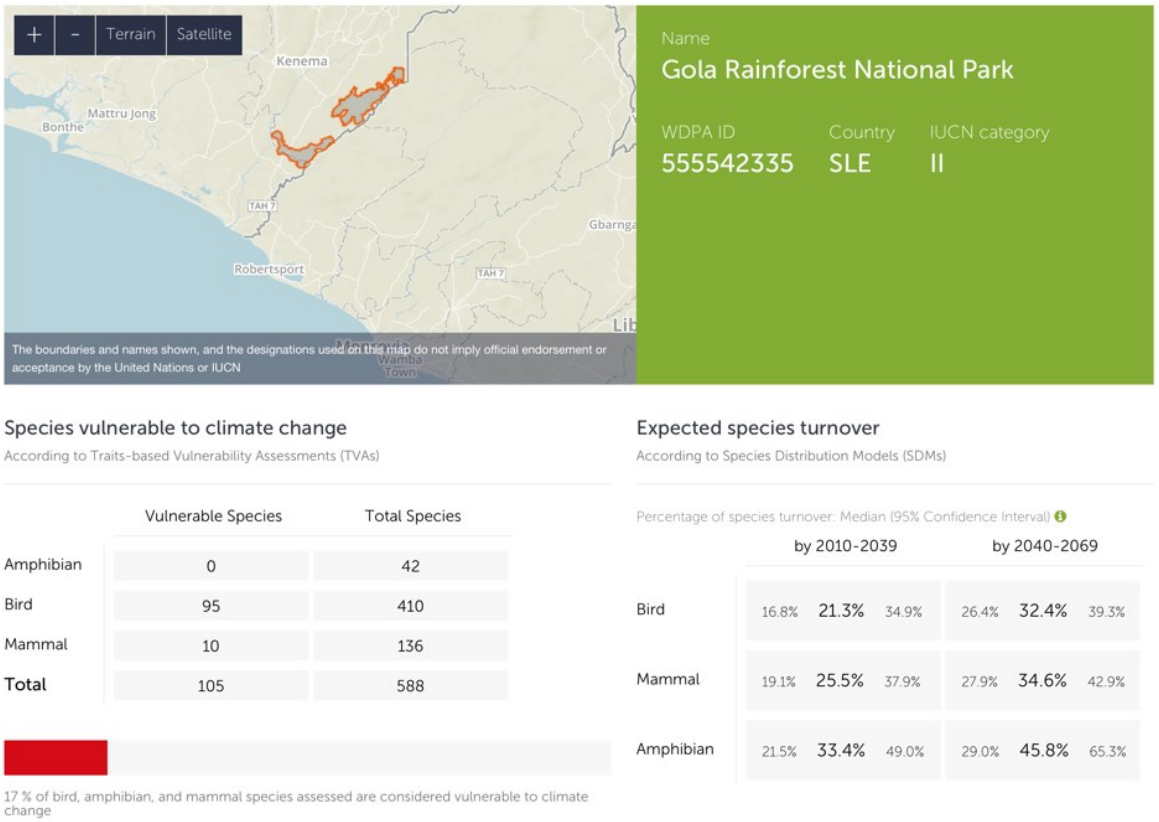

Figure 1: An example of summary statistics for a West African protected area based on Durham modelling work. This particular protected area, in Sierra Leone, has now signed a transboundary agreement with adjoining Gola National Park in Liberia (not shown) as a result of our work (see below).

(2) [E8] *On-the-ground activities to enhance climate change resilience of protected areas.*

As a result of the research described in (1), five West African pilot sites were selected (http://parcc.protectedplanet.net/en/regional-and-national-activities/transboundary-pilot-site-activities) where protected areas in neighbouring countries abut each other. Figure 1 shows one such protected area in Sierra Leone, bordering Liberia. In these areas, transboundary protected areas will help species adapt to climate change, i.e. regions where adjacent protected areas in different countries will be more closely managed to facilitate species moving between protected areas in response to changing climate. In all, five transboundary agreements were signed (most in 2016) between countries and joint protected areas management plans integrating climate change were established.

(3) [E9] Finally, work from Durham has been influential in the *IUCNs 'Guidelines for Assessing Species Vulnerability to Climate Change'* including contributing 2 of 10 case studies (pages 71-73, pages 87-89). These guidelines are being used by protected area managers, and local, national and regional conservation managers and planners, to implement changes to management or to priority species on the basis of better-informed species vulnerabilities to climate.

5. Sources to corroborate the impact

E1 BirdLife's *Position on Climate Change* Document. Available in full at: https://issuu.com/birdlife-international/docs/birdlifepositiononclimatechange
E2 Testimonial, Director of Conservation, Birdlife International
E3 Audubon Climate Action Plan for the Americas
E4 Commissioned Evaluation Study to support the Fitness Check of the Birds and Habitats Directives
E5 Aichi Targets Web Pages https://www.cbd.int/sp/targets/ (accessed 9/4/2020)
E6 CBD 2015 Report on key global biodiversity indicators (Table 1, Target 10, p22)
E7 The *Messengers: what birds tell us about threats from climate change and solutions for nature and people*
E8 PARCC Report: Summary of main outputs (particularly p33-36)
E9 IUCN *SSC Guidelines for Assessing Species' Vulnerability to Climate Change*