

**Impact case study (REF3b)**

<b>Institution:</b>	University of York
<b>Unit of Assessment:</b>	5, Biological Sciences
<b>Title of case study:</b>	Recognition that global climate change is a major driver of biodiversity change and its implications for policy
<p><b>1. Summary of the impact</b></p> <p>Research at York provided strong empirical evidence that species are responding rapidly to recent anthropogenic climate change, and that climate change threatens many species with extinction. This research underpins key climate change impacts reported by the Intergovernmental Panel on Climate Change (IPCC), transforming international understanding of the magnitude of the threats to biodiversity and steering major national and international policy decisions affecting many sectors of society in 2008-13. The research stimulated governmental and non-governmental policy development at regional, national and intergovernmental levels, influencing climate change mitigation and adaptation strategies throughout the world.</p>	
<p><b>2. Underpinning research</b></p> <p>Work by Professors Chris Thomas, Jane Hill, and Alastair Fitter at the University of York has been at the forefront of research on the impacts of climate change on species and ecosystems. The research has transformed understanding of the sensitivity of species to climate change and the scale of the threat of extinctions from climate change. Indicators of the significance and reach of this research include: (i) Thomas' Marsh Award for Climate Change Research in 2011 and FRS in 2012, (ii) Hill's Marsh Award for Conservation Biology in 2011, and (iii) Fitter's FRS and CBE in the New Year Honours list 2010. Thomas has been an academic in Biology at York from 2004, Hill since 2001, and Fitter since 1972. Key conclusions of the York work are:</p> <ul style="list-style-type: none"> <li>• <b>The life cycles of species have changed as the climate has warmed.</b> Fitter documented climate-related changes to the flowering times of plants, using by far the largest long-term data set available (Fitter &amp; Fitter 2002). These influential findings spawned further research on a phenomenon now widely accepted as clear evidence of the impacts of global warming.</li> <li>• <b>Many different taxonomic groups have changed their geographic distributions in response to climate change.</b> Thomas, Hill and York PhD students (Hickling and Chen) demonstrated that terrestrial species have moved to higher latitudes and elevations; publishing the taxonomically broadest study in the literature to demonstrate latitudinal range shifts (Hickling <i>et al.</i> 2006), and the first documented evidence of elevation shifts of tropical invertebrates, for moths on Mount Kinabalu in Borneo (Chen <i>et al.</i> 2009).</li> <li>• <b>Terrestrial species have shifted to higher elevations at twice the rate previously thought, and latitudinal range shifts are three times faster than previously reported.</b> A global meta-analysis, led by Thomas and Hill (Chen <i>et al.</i> 2011), was the first to show that species' ranges have shifted further in regions experiencing greater warming, cementing the link between climate change and the distribution changes of species.</li> <li>• <b>Extinction risk.</b> The risks of climate change to biodiversity were identified in seminal work by Thomas (2004). This research provided projections of potential range losses and extinction by 2050, establishing a new focus for thousands of subsequent studies of climate change and biodiversity. Thomas and Hill subsequently co-developed a practical conservation risk assessment framework with conservationists (Thomas <i>et al.</i> 2011).</li> <li>• <b>Demonstration of climate-related extinctions at species' range boundaries.</b> Hill and Thomas demonstrated local extinctions at species' low-latitude and low-elevation range boundaries (Franco <i>et al.</i> 2006), and losses at low elevation boundaries in tropical regions.</li> </ul> <p>Research at York has unequivocally demonstrated that humans, via anthropogenic climate change, are driving major changes to the world's ecosystems and species, endangering many with extinction. It has ensured that climate change is now considered alongside other historical drivers of declines and extinctions in ecology, conservation biology and environmental policy.</p>	
<p><b>3. References to the research.</b> Supported by peer-reviewed grants (NERC, EU), the work has been published in major international journals, including <i>Science</i>, <i>Nature</i>, and <i>PNAS</i>. York PIs in <b>bold</b> and York researchers/PhD students <u>underlined</u>, NGO co-author <i>italicised</i>. Citation data from Google Scholar (GS), from September 2013.</p> <p><u>Chen I-C.</u>, <b>Hill J.K.</b>, two others &amp; <b>Thomas C.D.</b> (2011) Rapid range shifts of species associated</p>	

## Impact case study (REF3b)

with high levels of climate warming. *Science* 333:1024-1026. DOI: 10.1126/science.1206432. >310 GS citations

Chen I-C., 5 others, **Hill J.K. & Thomas C.D.** (2009) Elevation increases in moth assemblages over 42 years on a tropical mountain. *PNAS, USA* 106:1479-1483. DOI: 10.1073/pnas.0809320106. >125 GS citations

**Fitter A.H.** & Fitter R.S.R. (2002) Rapid changes in flowering time in British plants. *Science* 296: 1689-1691. DOI: 10.1126/science.1071617 >625 GS citations

Franco A.M.A., **Hill J.K.** et al. (2006) Impacts of climate warming and habitat loss on extinctions at species' low-latitude range boundaries. *Glob Change Biol* 12:1545-1553. DOI: 10.1111/j.1365-2486.2006.01180.x. >135 GS citations

Hickling R., Roy D.B., **Hill J.K.**, Fox R. & **Thomas C.D.** (2006) The distributions of a wide range of taxonomic groups are expanding polewards. *Glob Change Biol* 12:450-455. DOI: 10.1111/j.1365-2486.2006.01116.x >485 GS cites

**Thomas C.D.** et al. (2004) Biodiversity conservation. Climate change and extinction risk. *Nature* 430: DOI:10.1038/nature02719. >3,250 GS citations to a pair of associated 2004 papers.

#### 4. Details of the impact

The York research strongly affected the conclusions of international reports on the impacts of climate change. In conjunction with the original research, these influenced climate-related policy development and actions by intergovernmental, governmental and Non-Governmental Organisations (NGOs) during 2008-13. *“York research on the responsiveness of and risks to biodiversity from climate change has pervaded public and political thinking throughout the world. There can be no doubt that this has thereby framed a major component of the policy context within which all national and international discussions, agreements, policies and legislation have been set”*, according to Guy Midgley, South Africa's lead for long term climate change adaptation planning, and negotiator for the UN Framework Convention on Climate Change (UNFCCC).

**Contribution to policy-facing reports.** York research is prominent among the evidence and conclusions of the Intergovernmental Panel on Climate Change 4<sup>th</sup> Assessment Reports (IPCC AR4, 2007), which were marked by the award of the Nobel Peace Prize to IPCC. Specifically:

- IPCC AR4 cites 24 publications by York biologists, and Thomas was an expert reviewer.
- York research allowed the IPCC to draw its main conclusions about the impact of climate change on terrestrial biodiversity: e.g. Fitter & Fitter (2002) is cited as evidence for the earlier timing of spring events (Working Group II, Section 1.3.5.1), and Hickling et al. (2006) as evidence for latitudinal changes to the distributions of species (WGII, Section 1.3.5.2).
- IPCC lead-author Midgley states: *“The IPCC's AR4 judgement that ‘In terrestrial ecosystems, earlier timing of spring events and poleward and upward shifts in plant and animal ranges are with very high confidence linked to recent warming’ stems very strongly from research carried out at York. Thomas and Hill studies constitute nearly three-quarters of individual species range shifts among terrestrial species reported in IPCC AR4 (WGII, Table 1.9), contributing more cases of terrestrial distribution changes than any other research group in the world.”*
- This York-associated conclusion constitutes one of only five IPCC assessments as having very high confidence across all sectors of climatic change and impacts.
- Midgley notes that *“two of 18 key impacts of climate change listed in the summary for policymakers (Figure SPM.7) are (i) changes to the distributions of species and (ii) extinction risks to species; both based strongly on the research at York.”*
- These IPCC reports engaged nearly all the world's nations, thousands of NGOs, and thousands of natural and social scientists, so the implications of York research have been widely taken up across diverse sectors. The impact of the IPCC report and York research are outlined below.

**International action.** The York work as represented in these reports has been heavily used by all sectors of society in 2008-13 as a sound basis for the dissemination of knowledge, formulation of policies, and development of mitigation and adaptation activities. For example:

- *“IPCC AR4 reports, which were so strongly influenced by the York work, have underpinned all international climate change negotiations, policy making and adaptation strategies from 2008 onwards”* and *“contributed to the development of national policies in most countries in the world”* says Midgley, who also states that *“concerns around biodiversity impacts due to climate change have been [a] critical influence on developing world perceptions of risk, and [formulation of]*

## Impact case study (REF3b)

*critical mitigation and adaptation responses*”, including in South Africa.

- Non-academic Australian and USA national and state environmental reports include ~2000 citations to IPCC as well as direct citations to Hill and Thomas (e.g. Department of Environment Climate Change & Water, New South Wales, Australia).
- *“In the US, the policy changes that have arisen directly and indirectly because of [the York] work include state and national centers for dealing with the biological impacts of climate change”*, states Lee Hannah, Senior Fellow at international NGO Conservation International.
- IPCC-reported York evidence contributed to global-scale initiatives and policy development through the UNFCCC and Conference of Parties (CoP). These provide means by which 195 member nations and ~30 international agencies seek agreement (e.g. at Copenhagen 2009 and Doha 2012 congresses) on globally-integrated approaches to the development of climate change mitigation and adaptation strategies. The need for agreement is predicated on IPCC-reported scientific evidence, which for biodiversity impacts stems from the York research.
- International NGOs draw on York work. Hannah says that *“Conservation International and numerous other NGOs have drawn on this work, both directly and [through] AR4 reports, when developing their positions at international climate change and biodiversity congresses, such as the UNFCCC”* and that Thomas *“has had a deep influence on the IUCN [International Union for the Conservation of Nature] red list process for climate change”*.
- Jonathan Mawdsley, program director of the Heinz Center, highlighted the link between Thomas’ research and UNFCCC communications, which led to the Convention on Biological Diversity deciding to convene a Technical Advisory Group *“to channel advice from convention participants to the UNFCCC on...climate change and biodiversity”* (Mawdsley *et al.* 2012). Thus, York research influenced the decision to establish a process whereby climate change and biodiversity issues and advice from all nations are collated under the aegis of UNFCCC.

**Impact on UK and EU policy development.** UK and EU policies on climate change have been driven by the IPCC AR4 reports, and strongly reflect the York research on biodiversity impacts.

- *UK policy-making.* The first report of the Committee on Climate Change (2008, e.g. p. 16), the Climate Change Act 2008, the Department of Energy & Climate Change (DECC) 2009 Impact Assessment, and a series of other DECC reports and statements, including annual carbon budget and emissions statements, all draw on the York-influenced IPCC AR4 reports for scientific evidence and as a motivation to develop mitigation and adaptation strategies.
- *UK emissions targets.* Members of Parliament used concern for biodiversity (i.e. from York research) in the UK Climate Change Act debate (Hansard 9/6/08) to argue for 80% reduction of greenhouse gas emissions by 2050 (20% above the government-proposed 60%). After debates in the Commons and Lords and advice from the Committee on Climate Change (mentioning the limited adaptive capacity of biological systems), the 2050 target was indeed set at an 80% cut. The Climate Change Act (Nov 2008) made the UK unique in introducing *“a long-term legally binding framework to tackle the dangers of climate change”* (CCC 2013).
- *EU emissions targets.* The Council of the European Union’s adoption (6/4/09) of the climate energy legislative package is *“designed to achieve the EU’s overall environmental target of a 20% reduction in greenhouse gases ... by 2020”*. Martin Horwood MP stated that *“The IPCC fourth assessment report, quoted extensively in these [EU] documents, paints the familiar picture of potential species extinction...”* (Hansard, 13/6/09). This reveals how Thomas’ scientific insights about extinction have become ‘common understanding’ within relevant policy debates. This legislative package is a framework for legislation in all EU member and linked nations.

**Impacts on conservation organisations and their policies.** York research has directly or indirectly affected policy development in virtually all environmental/conservation NGOs, government departments and agencies, and state and province agencies throughout the world.

- Defra, Natural Resources Wales, other UK agencies, and conservation NGOs such as the Royal Society for the Protection of Birds have developed new internal structures and employed staff both in climate change advocacy (mitigation) and practical conservation roles (adaptation). Their motivation is mainly the perceived risks and knowledge that species are already responding to climate change – both established for the UK by York researchers.
- Independently of IPCC, the Defra report *“Conserving biodiversity in a changing climate: guidance on building capacity to adapt”* (Hopkins *et al.* 2007) represents guidance that has

## Impact case study (REF3b)

been in place for all UK government agencies and conservation NGOs in 2008-2013. John Hopkins, UK government conservation agency employee for over 30 years, states that the report “*drew heavily upon [Thomas and Hill’s] work, much more so than any other authors*” and that “*...there are few other academics who have been so successful at producing policy relevant world class publications ... and support[ing] policy makers and practitioners.*”

- Natural England has produced a “*Terrestrial Biodiversity climate change impacts Report Card 2012-13*”, with Thomas on the working group (its conclusions underpinned by York research).
- Natural England commissioned in 2012-13 assessment of the climate change risks to over 3000 UK animal and plant species, using Thomas *et al.*’s (2011) risk framework.
- Direct references are made to Thomas’ work as well as to IPCC by globally-leading organisations, including the International Union for the Conservation of Nature, World Wide Fund for Nature, Birdlife International, and Friends of the Earth. Conservation International’s Lee Hannah states: “*The understanding developed by York researchers in recent years has ... resulted in a marked redistribution of resources in this field, including structuring of climate change biology units within national and international NGOs, such as Conservation International. Most NGOs now employ specialist climate change researchers and policy makers, as well as integrating the threat of climate change throughout their organizations. The insight from the York research has therefore affected international NGO and governmental thinking at levels from line staff researchers to that of senior policymakers*”.
- At intergovernmental level, the UN Collaborative Programme (involving FAO, UNDP, UNEP) on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN REDD+) involves 44 partner countries, spanning Africa, Asia-Pacific and Latin America; influenced by the York-realisation of the threats to biodiversity from climate change.

**Impacts on public discussion.** Primary reporting of York research on television, newspapers, radio and electronic media (~5000 reports) is estimated to have reached “*millions of people around the world*” (Pearson 2011), influencing legal cases (e.g. expert evidence by Thomas to two US cases) and inspiring books on the subject. The Smithsonian’s Pearson wrote a popular science book on the ecological impacts of climate change that drew upon Thomas’ “*extensive body of work ... numerous times*”; American journalist Kolbert focussed on Thomas and his work in her acclaimed “*Field Notes from a Catastrophe: Man, Nature, and Climate Change*” (which received a Heinz Award 2010 and Sierra Club Award 2011); and Hannah (2012) extensively referenced research by Thomas to provide “*a clear explanation of the science [of extinction risk] for conservationists, researchers, teachers, students, and policy-makers.*” Hence, York research has contributed to wider discussions of the relationship between humanity and the biosphere.

##### 5. Sources to corroborate the impact

- Climate Change Act (2008) acc 25/2/13 <http://www.theccc.org.uk/about-the-ccc/climate-change-act>
- Committee on Climate Change (2008) *Building a low-carbon economy – the UK’s contribution to tackling climate change*. First Report of the Committee on Climate Change, London.
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- Pearson RG (2011) *Driven to Extinction: Impact of Climate Change on Biodiversity*. Sterling NY. The UN REDD+. <http://www.un-redd.org/> accessed April 2013.