

Institution: University of Leeds		
Unit of Assessment: A05 Biological Sciences		
Title of case study: Informing policy to mitigate insect pollinator decline		
Period when the underpinning research was undertaken: 2005-present		
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:
Professor WE Kunin	Lecturer, Senior Lecturer, Reader, Professor of Ecology, Principal Investigator	Jan 1996 - present
Dr JC Biesmeijer	Research Fellow, Visiting Research Fellow	29/03/2004 – 2010 2011 – 31/07/2012
Dr. L Carvalheiro	Lecturer	01/08/2012 – 30/06/2014
Dr. Mark Gillespie, Dr. Mark Goddard, Dr. Rory O'Connor Dr. Catherine Jones	Research Fellow, Co-researcher and co-author Research Fellows, Co-researchers and co-authors	01/09/2010 – 07/05/2015
	Technician, PDRA, Co-researcher and co-author	01/05/2011-31/10/2014 01/04/2011-30/09/2014 01/09/2014-30/11/2015 05/05/2015-30/09/2017
Period when the claimed impact occurred: August 2013 to July 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact (indicative maximum 100 words) Leeds' research on bees and other insect pollinators has guided <i>National Pollinator Strategies</i> for the UK and internationally, leading to changes in <i>agri-environmental payments and management schemes</i> , the <i>planting of floral resources</i> on 1000s of ha of private and public lands, and the creation of national and regional <i>pollinator monitoring programmes</i> . These actions have been driven by increased <i>public and policymaker knowledge</i> and concern about declines in wild pollinator abundance and biodiversity. Leeds-based research has played a pivotal role in informing public and Parliamentary discussions, contributing to policy development, and has served as the model for one component of the national monitoring programme.		
2. Underpinning research (indicative maximum 500 words) Insect pollinators have both direct conservation value and provide valuable services in pollinating crops (ca. GBP290,000,000,000 globally per year*, GBP430,000,000 in UK*) and wildflowers (estimated UK value between GBP39,000,000 and GBP538,000,000 per year*). There has been increasing concern in recent decades about declines in pollinator abundance and diversity, and in the pollination services they provide. Leeds-led research provided the first solid data demonstrating widespread losses in biodiversity of pollinators and their floral resources across Britain and mainland Europe. Subsequent work has continued to refine those findings, extending the work to assess drivers and consequences of declines, and to propose management options and monitoring methods. Major findings include: <ul style="list-style-type: none"> • Pollinator diversity has declined in Britain and NW Europe. Seminal analyses of species records from landscapes across Britain, the Netherlands and Belgium (R1, R2, R3) showed that biodiversity of bees has declined since 1980 in ¾ of sites with sufficient data for analysis. In both bees and hoverflies, declines were most pronounced in dietary and habitat specialists, and species with low dispersal ranges and long generation times. A narrower set of species has come to dominate over time and across space, implying less resilient pollination services. • Pollinator declines are real. The statistical rarefaction methods employed in (R1) could be affected by sampling biases. Refined statistical methods (R3) confirmed the earlier results, and showed evidence of declining spatial diversity, but recent resurgence in some taxa (solitary bees), findings that have been verified through field re-surveys of historically surveyed sites. • Animal-pollinated plants have declined in parallel with their pollinators (R1, R3, R4). Leeds' research demonstrated declining distributions of insect-pollinated wildflowers (R1) relative to other plant species. More recently, we also provided the first clear evidence of 		

historic declines since the 1930s (and recent partial resurgence) in regional and national-scale floral nectar resources (**R4**), a potential driver of pollinator dynamics. This work is by far the most extensive floral resource inventory yet published, providing detailed breakdowns geographically and identifying key habitats and species; it was deemed the best contribution in 2017 to conservation science by the RSPB. Our team has also assessed floral resources and pollinator stocks in urban environments, identifying key management interventions for maintaining urban pollinator populations (**R6**).

- **Standardised pollinator monitoring can be effective.** Given the economic and ecological value of pollination, the poor availability of standardised pollinator population data and the high number of data-deficient species [Source 1] are cause for concern. National pollinator monitoring programmes have been developed in the UK, in mainland Europe and beyond, providing vital policy support. Our research (**R5**) assessing the effectiveness and feasibility of different survey methods has played an important part in developing and testing standardised methods for monitoring pollinator populations, providing a foundation for on-going impact.

Our research programme has a strong history of funding from a range of sources, including the EU (FP6 ALARM project, FP7 STEP, SCALES and EU-BON projects, summing to EUR1,890,000 in Leeds funding), UK Research Councils (Insect Pollinators Initiative Urban Pollinators and AgriLand projects, NERC BioDar and DRUID projects, BBSRC GCRF VOICES project, summing to GBP2,730,000 in Leeds funding), with additional support from Defra (3 contracts to design, pilot and implement a national Pollinator Monitoring Scheme) and the Bill & Melinda Gates Foundation. ★ Lautenbach *et al.* (2012) *PLoS One* 7: e35954; ★ Breeze *et al.* (2011) *Agriculture, Ecosystems & Environment* 142: 137-143; ★ Breeze *et al.* (2015) *Ecological Economics* 11: 76-85

3. References to the research (indicative maximum of six references)

Our research has been funded by multiple UK, EU and international grants, and has been widely cited both by researchers and policymakers. Leeds authors are shown in **bold** face; collaborators on shared research grants in *italics*, and junior (Postgraduate or postdoctoral) researchers underscored. Citations from Google Scholar, assessed 28 October 2020.

1. **JC Biesmeijer**, *SPM Roberts, M Reemer, R Ohlemüller, M Edwards, T Peeters, AP Schaffers, SG Potts, R Kleukers, CD Thomas, J Settele, WE Kunin* (2006) Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. *SCIENCE* Volume: 313 Issue: 5785 Pages: 351-354 Times Cited: **2,696**. *Provided the first empirical evidence of national and regional declines in pollinator species richness post-1980, and contracting distributions of animal-pollinated plants in the UK and Netherlands. Still a seminal paper in documenting pollinator declines.*
2. *SG Potts, JC Biesmeijer, C Kremen, P Neumann, O Schweiger, WE Kunin.* (2010) Global pollinator declines: trends, impacts and drivers. *TRENDS IN ECOLOGY & EVOLUTION* Volume: 25 Issue: 6 Pages: 345-353 Times Cited: **4,048**. *A review summarising the burgeoning literature on pollinator declines building upon Ref 1, and exploring evidence for the causes and consequences of these declines.*
3. **LG Carvalho, WE Kunin, P Keil, J Aguirre-Gutiérrez, WN Ellis, R Fox, Q Groom, S Hennekens, W Van Landuyt, D Maes, F Van de Meutter, D Michez, P Rasmont, B Ode, SG Potts, M Reemer, SPM Roberts, J Schaminée, MF WallisDeVries, JC Biesmeijer. (2013) Species richness declines and biotic homogenisation have slowed down for NW-European pollinators and plants. *ECOLOGY LETTERS* Volume: 16 Issue: 7 Pages: 870-878 Published: JUL 2013 Times Cited: **293**. *Builds on Ref 1 with refined analytical methods and wider taxonomic (adding butterflies) and geographical (adding Belgium) scope, with finer temporal resolution, and documenting biotic homogenisation in pollinator communities across space.***
4. *M Baude, WE Kunin, ND Boatman, S Conyers, N Davies, MAK Gillespie, RD Morton, SM Smart, J Memmott* (2016) Historical nectar assessment reveals the fall and rise of floral resources in Britain. *NATURE* Volume: 530 Issue: 7588 Pages: 85-88 Published: FEB 4 2016. Times Cited: **190**. *Provides the first national-scale inventory of floral nectar production (a vital resource for pollinators), and documents historic declines and recent resurgence in these resources.*
5. **RS O'Connor, WE Kunin, MPD Garratt, SG Potts, HE Roy, C Andrews, CM Jones, JM Peyton, J Savage, MC Harvey, RKA Morris, SPM Roberts, I Wright, AJ Vanbergen, C Carvell** (2019) Monitoring insect pollinators and flower visitation: the effectiveness and feasibility of different survey methods. *METHODS IN ECOLOGY AND EVOLUTION* Volume 10: Pages 2129-

2140. Times cited **14**. *Tests applicability of standardised methods for pollinator monitoring, underpinning the UK national Pollinator Monitoring Scheme (PoMS)*.

6. KCR Baldock, MA Goddard, DM Hicks, WE Kunin, N Mitchunas, H Morse, LM Osgathorpe, SG Potts, KM Robertson, AV Scott, PPA Staniczenko, GN Stone, IP Vaughan & J Memmott (2019) A systems approach reveals urban pollinator hotspots and conservation opportunities. NATURE ECOLOGY AND EVOLUTION Volume 3: pages 363-373 DOI: 10.1038/s41559-018-0769-y Times cited: **66**. *One of a series of paper on pollinator communities in cities, assessing the relative importance of different urban land uses and management practices for maintaining pollinators and pollination networks.*

4. Details of the impact (indicative maximum 750 words)

Leeds-based research has guided national pollinator strategies, contributing directly to agri-environmental policy and land management, and both instigating and shaping pollinator monitoring schemes in Britain and internationally.

Policy support. Fueled by public and scientific concern, the topic of pollinator conservation and monitoring has been incorporated into policy. R1 contributed to three reports of the Parliamentary Office of Science and Technology, two in this reporting period (PostNote #442, 2013; #619, 2020) [**Source A**] with Prof. Kunin presenting findings at a launch workshop of the former (September 2013), and asked to review the latter. Leeds' work (R1-3) contributed to the development of multiple *National Pollinator Strategies*, including those of England (2014), Scotland (2017), and the United States (2015) [**Source B**]. These strategy documents lay out detailed programs for governmental and societal action, with policy goals subject to periodic progress reviews. R1 and R2 figured in the Intergovernmental Panel on Biodiversity and Ecosystem Services' (IPBES, 2016) *Assessment report on pollinators, pollination services and food production* [**Source C**], as well as in UN Food and Agriculture Organization policy documents (2017) [**Source D**]. These documents set national and international pathways and targets, shaping global policy development.

Agri-environmental and urban land management. Key goals of the National Pollinator Strategies include changes in agricultural and urban land management, and Leeds research has helped guide this process. Prof. Kunin participated in Natural England workshops that designed revised agri-environmental management schemes for England (the mid-tier "*Wild pollinator and farm wildlife*" package within the Countryside Stewardship scheme, 2015 onwards, **Source E**), thereby directly affecting land management in 1000s of farms across England (e.g. 19,000 ha of pollen and nectar plantings in 2018*). Leeds' research on pollinator declines (R1-2) was also cited in decisions to restrict use of systemic pesticides (e.g. neonicotinoids) demonstrated to be harmful to bees [e.g. **Source F**]. Floral plantings from the Urban Pollinators project (R5), together with our published floral resource databases (R4), have influenced wildflower plantings and management of lawns and road verges in multiple UK and European cities [e.g. **Source G**].

Pollinator monitoring. A key element of UK National Pollinator Strategies is to institute robust measurement of pollinator populations and diversity, providing policy support by assessing the effectiveness of interventions. Kunin has been a member of the Defra-funded team that designed, piloted (R5) and has implemented a British national Pollinator Monitoring Scheme (PoMS, 2016) [**Source H**], to inform policy by providing standardized pollinator abundance and diversity data. A substantial component of the monitoring protocol (standardised pan-trapping arrays) was directly modeled on the IPI AgriLand project's research methods (e.g. R5), which in turn were based in part on method testing research carried out in the ALARM and STEP projects (Westphal et al. (2008) *Ecological Monographs* 78(4):653-671). Prof. Kunin served as reviewer for the EU's European Pollinator Monitoring Scheme (EUPMS), again largely based on PoMS (and thus Leeds' AgriLand) pan-trap arrays.

Status assessment. STEP project work led by Biesmeijer and Kunin led to the publication of the first IUCN (International Union for the Conservation of Nature) *Red List for European Bees* [**Source I**], thereby affecting conservation planning, influencing resource allocation, and informing policy and international biodiversity conventions. The species identified within it as Vulnerable, Endangered or Critically Endangered, are prioritized by EU and national policy for conservation

action. The Red List also highlighted the high fraction of bee species (57%) that were “Data deficient,” underscoring the need for better pollinator monitoring.

Public understanding of science. The increased policy interest in monitoring and protecting pollinator communities reflects growing public knowledge and concern about the topic. R1 attracted wide international public attention to declines in wild bees in Britain and Europe, fueling 100s of news stories on television, radio, newspapers, and online [Source J]. Immediately after the publication of our work, there was an abrupt and substantial increase in internet searches on bee and pollinator declines [Source J], reflecting a step-change in public interest in the topic which has persisted to this day.

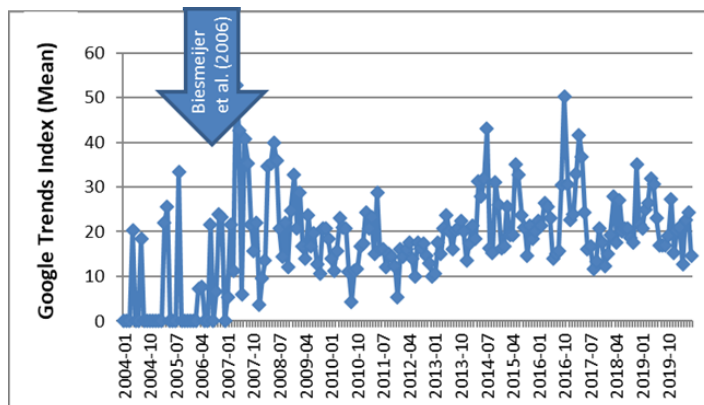


Fig. 1. Google searches on “pollinator decline”, “bee decline” and “bee extinction” before and after publication of Ref 1. Mean of search indices from Google Trends, downloaded June 2020. [Source J]

The result has been greatly increased and sustained public understanding and concern about pollinator declines. By 2014, a YouGov poll [Source J] showed that 85% of British people surveyed were concerned about “bees dying off” as their highest-ranked environmental concern, and 57% listed “bees” as the endangered species they would most wish to save (4x the next highest response). Whilst it is impossible to quantify how much of this directly stems from Leeds’ research, it has clearly played a pivotal role in bringing the issue to prominence.

* Defra (2018)

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/683972/future-farming-environment-evidence.pdf

5. Sources to corroborate the impact (indicative maximum of 10 references)

Source A: UK Government Parliamentary Office of Science and technology (POST) notes:

- POSTnote 442 (September 2013) Reversing Insect Pollinator Declines: <https://post.parliament.uk/research-briefings/post-pn-442/>
- POSTnote 619 (March 2020) UK Insect decline and extinctions. <https://post.parliament.uk/research-briefings/post-pn-0619/>

Source B: National Pollinator Strategies:

- **UK Government policy document: The National Pollinator Strategy:** for bees and other pollinators in England, November 2014.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/409431/pb14221-national-pollinators-strategy.pdf . Progress report for National Pollinator strategy for 2016 (citing IPBES report):

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794670/nps-progress-report2016.pdf - this shows range of *initiatives, activities and changes that have taken place as a consequence of the National Pollinator Strategy*. Includes publication of policy and practice note (Oct 2015) on urban pollinators (part of Insect Pollinators Initiative) <https://nerc.ukri.org/research/partnerships/ride/lwec/ppn/ppn20/>

University of Leeds researchers are involved in Implementing the Pollinator Monitoring and Research Partnership – see

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/912826/nps-implementation-plan-2018-2021.pdf

- Research (Potts *et al.*, 2010; Biesmeijer *et al.*, 2006) cited in **United States Pollinator Health Task Force National Strategy** to promote the health of honey bees and other pollinators (May 2015, The Whitehouse, Washington).

<https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf>

Source C: IPBES assessment report Biesmeijer *et al.*, (2001), Potts *et al.*, (2010), Carvalheiro *et al.*, (2013, 2014), Shackelford *et al.*, (2015), Baldock *et al.*, (2015), Senapathi *et al.*, (2015), cited in **IPBES 2016 policy recommendations**

Citation: IPBES (2016): Summary for policymakers of the assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production. S.G. Potts, **J. C. Biesmeijer**, *et al.*, (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. https://ipbes.net/sites/default/files/spm_deliverable_3a_pollination_20170222.pdf

Source D: UN FAO policy Biesmeijer *et al.*, (2006) Cited in: **United Nations FAO Policy Analysis Paper - Mainstreaming of Biodiversity and Ecosystem Services With A Focus On Pollination**, Jan 2016 <http://www.fao.org/3/a-i4242e.pdf>

Source E: UK Countryside Stewardship. Countryside Stewardship: Mid Tier wild pollinator and farm wildlife package 2015 onwards – grant scheme arising from UK National Pollinator Strategy. <https://www.gov.uk/government/publications/countryside-stewardship-farm-wildlife-package>

Source F: European Food Safety Authority, EFSA guidance document on the risk assessment of plant protection products on bees (*Apis mellifera*, *Bombus* spp. and solitary bees). Updated 2014. *EFSA Journal* 2013, 11(7): 3295, 268 pp. Ref 1 is 1st paper cited in main text. <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2013.3295>

Source G: Wildflower plantings and management of lawns and road verges in multiple UK and European cities - Wilk, B., Rebollo, V., Hanania, S. 2019. A guide for pollinator-friendly cities: How can spatial planners and landuse managers create favourable urban environments for pollinators? Guidance prepared by ICLEI Europe for the European Commission.

Source H: National Pollinator Monitoring Scheme. Contribution by Kunin (with collaborators) to “**Design and Testing of a National Pollinator and Pollination Monitoring Framework**” - April 2016. Carvell, C., **Kunin, W. E.**, *et al.*, (2016) Design and Testing of a National Pollinator and Pollination Monitoring Framework. Final summary report to the Department for Environment, Food and Rural Affairs (Defra), Scottish Government and Welsh Government: Project WC1101. <http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=19259>

Source I: IUCN Red List Contributed to developing the **IUCN’s Red Listing for bees** – through the work done on the EC FP7 project “Status and Trends of European pollinators (STEP)”. The Red Listing provided, for the first time, information on all 1,965 wild bee species in Europe, including their status, distribution, population trends and threats. It was found that 9.2% of European wild bee species are threatened with extinction, while 5.2% are considered likely to be threatened in the near future. A number of policy recommendations were made, for species conservation, habitat conservation, agri-environment schemes and agricultural production. Biesmeijer was a major contributor, specifically acknowledged in report.

<http://ec.europa.eu/environment/nature/conservation/species/redlist/bees/acknowledgements.htm> (updated 22/04/2015). Full document at:

<https://portals.iucn.org/library/sites/library/files/documents/RL-4-019.pdf> Citation: Nieto, A.,

Biesmeijer, J.C., *et al.*, 2014. **European Red List of bees.** Luxembourg: Publication Office of the European Union.

Source J: Press coverage of the Biesmeijer *et al.* (2006) paper Excel spreadsheet 1,2,3; **Google Trends data (2004-present) on “Bee declines”, “Pollinator declines”, “Bee extinction”** Excel spreadsheet 4, **YouGov poll results, 26-27 June 2014** Excel spreadsheet 5.