CORRESPONDENCE

Pollinator declines: reconciling scales and implications for ecosystem services [version 1; peer review: 2 approved]

Ignasi Bartomeus¹, Rachael Winfree²

¹Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, SE-75007, Sweden

²Department of Ecology, Evolution and Natural Resources, Rutgers University, New Brunswick NJ, 08901, USA

V1 First published: 02 Jul 2013, 2:146
<https://doi.org/10.12688/f1000research.2-146.v1>
Latest published: 02 Jul 2013, 2:146
<https://doi.org/10.12688/f1000research.2-146.v1>

Abstract

Despite the widespread concern about the fate of pollinators and the ecosystem services they deliver, we still have surprisingly scarce scientific data on the magnitude of pollinator declines and its actual contribution to crop pollination and food security. We use recently published data from northeastern North America to show that studies at both the local and regional scales are needed to understand pollinator declines, and that species-specific responses to global change are broadly consistent across scales. Second, we show that bee species that are currently delivering most of the ecosystem services (i.e. crop pollination) are not among the species showing declining trends, but rather appear to thrive in human-dominated landscapes.

Keywords

bee, pollinator, decline, extinction, ecosystem provider, crops, decline

This article is included in the **Ecology and Global Change** gateway.

Open Peer Review

Approval Status

	1	2
version 1 02 Jul 2013	view	view

1. **Gary Luck**, Charles Sturt University, Albury, Australia

2. **Ryan Chisholm**, National University of Singapore, Singapore, Singapore

Any reports and responses or comments on the article can be found at the end of the article.

Corresponding author: Ignasi Bartomeus (nacho.bartomeus@gmail.com)

Competing interests: No competing interests disclosed.

Grant information: This work was supported by United States Department of Agriculture NIFA-AFRI 2009-65104-05782 to R Winfree and N M Williams, Multi-state project 08204 to R Winfree and NSF BIO DEB collaborative grant #0554790/0516205 to C Kremen, N M Williams, and R. Winfree.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Copyright: © 2013 Bartomeus I and Winfree R. This is an open access article distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. Data associated with the article are available under the terms of the [Creative Commons Zero "No rights reserved" data waiver](#) (CC0 1.0 Public domain dedication).

How to cite this article: Bartomeus I and Winfree R. **Pollinator declines: reconciling scales and implications for ecosystem services [version 1; peer review: 2 approved]** F1000Research 2013, **2**:146 <https://doi.org/10.12688/f1000research.2-146.v1>

First published: 02 Jul 2013, **2**:146 <https://doi.org/10.12688/f1000research.2-146.v1>

Main text

There is widespread concern regarding the fate of pollinators and the ecosystem services they deliver¹. However, the information we have is still limited and at times appears contradictory. Four recent articles, three from *Science* and one from *PNAS*, highlight this point^{2–5}. Burkle *et al.*² show that 50% of the bee species in one locality in the Midwestern USA became locally extinct during the last century, which in combination with recent evidence that wild pollinators are critical to global crop pollination³, has led some to conclude that we might face an imminent collapse of crop pollination⁴. In contrast, Bartomeus *et al.*⁵ explored bee declines over a similar time scale but at a regional scale (the northeastern USA) and reported only a 15%, non-significant decline in bee species richness. Here we present new analyses that help to reconcile this apparent contradiction in the magnitude of bee declines, while also suggesting that any effects on crop pollination might be less than previously thought.

First, we used the 67 bee species included in both the regional-scale⁵ and the local-scale² analyses (see data file below) to show that the two studies in fact found broadly consistent results: the locally

extinct species of Burkle² tend to be declining regionally, whereas the locally persistent species tend to be increasing regionally (Figure 1A, ANOVA: $F = 5.89$, $df = 1,65$, $P = 0.01$). Second, we used data from Garibaldi *et al.*³ on the bee species that provide ecosystem services to four crops in the region covered by Bartomeus *et al.*⁵ to show that these ecosystem service providers tend to have increasing population trends compared to non-ecosystem service providers (Figure 1B, $F = 7.12$, $df = 2,184$, $P = 0.001$). All analyses were conducted in R⁶.

Northeastern North American bee species information on population trends and ecosystem services delivered

1 Data File

<http://dx.doi.org/10.6084/m9.figshare.701173>

Thus, our analyses demonstrate that, as one would expect, local-scale extinctions do not imply regional-scale extinctions; and that bee species that are important crop pollinators are less likely to be declining at the regional scale. It is important to remember that all

Figure 1. Trend in bee species' relative abundance in northeastern North American calculated over the period 1870–2011. **A)** For species that either became locally extinct or persisted in Carleville, Illinois. **B)** For species that either are not ecosystem-service providers to crops (non-ESP), are at least occasionally ecosystem-service providers to crops (ESP), or are among the species cumulatively responsible for 90% of the pollinator visitation to at least one crop (main ESP). Regional data from Bartomeus *et al.*⁵, local data from Burkle *et al.*² and crop pollinator data from Garibaldi *et al.*³.

bee species may well be crucial to providing ecosystem functions in natural systems and therefore merit conservation attention.

Author contributions

IB analyzed the data and IB and RW wrote the manuscript.

Competing interests

No competing interests disclosed.

Grant information

This work was supported by United States Department of Agriculture NIFA-AFRI 2009-65104-05782 to R Winfree and N M Williams, Multi-state project 08204 to R Winfree and NSF BIO DEB collaborative grant #0554790/0516205 to C Kremen, N M Williams, and R. Winfree.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

References

1. Potts SG, Biesmeijer JC, Kremen C, *et al.*: **Global pollinator declines: Trends, impacts and drivers.** *Trends Ecol. Evol.* 2010; **25**(6): 345–353.
[PubMed Abstract](#) | [Publisher Full Text](#)
2. Burkle LA, Marlin JC, Knight TM: **Plant-pollinator interactions over 120 years: loss of species, co-occurrence, and function.** *Science.* 2013; **339**(6127): 1611–1615.
[PubMed Abstract](#) | [Publisher Full Text](#)
3. Garibaldi LA, Steffan-Dewenter I, Winfree R, *et al.*: **Wild pollinators enhance fruit set of crops regardless of honey bee abundance.** *Science.* 2013; **339**(6127): 1608–1611.
[PubMed Abstract](#) | [Publisher Full Text](#)
4. Tylianakis JM: **Ecology. The global plight of pollinators.** *Science.* 2013; **339**(6127): 1532–1533.
[PubMed Abstract](#) | [Publisher Full Text](#)
5. Bartomeus I, Ascher JS, Gibbs J, *et al.*: **Historical changes in northeastern US bee pollinators related to shared ecological traits.** *Proc Natl Acad Sci U S A.* 2013; **110**(12): 4656–4660.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
6. R Development Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL 2008.
[Reference Source](#)

Open Peer Review

Current Peer Review Status:

Version 1

Reviewer Report 03 July 2013

<https://doi.org/10.5256/f1000research.1455.r1040>

© 2013 Chisholm R. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Ryan Chisholm

Department of Biological Science, National University of Singapore, Singapore, 119077, Singapore

This is a straightforward analysis and the interpretations are justified. I have two minor comments:

- Figure 1B shows that ecosystem-service-providing (ESP) bee species tend to be increasing whereas non-ESP species tend to be decreasing. But how is ESP measured? Is there any possibility that this result could be artefact, in that declining species are now rare and that therefore their ESP behaviour is less likely to be recorded? I would like to see this issue addressed briefly.
- The final sentence "It is important to remember that all bee species may well be crucial to providing ecosystem functions in natural systems and therefore merit conservation attention." seems like a non-sequitur, because the authors have just finished talking about how important pollinators are less likely to be declining. Presumably the authors mean that we have incomplete information and that it would be risky to assume that apparent non-pollinators are genuinely playing no useful ecosystem-service role. This could be expressed better.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response () 10 Jul 2013

Ignasi Bartomeus

Regarding your first comment, ESP is measured as any bee species visiting flowers of at least one of four main crops the study area, based on data we collected in the recent period (2004-2011) and published in [Garibaldi et al., 2013](#). Thus the reviewer is correct that there could have been species that were ESP in the past but, due to population decline, were not recorded as ESP in our recent surveys, and our results should be interpreted in this light.

However, we believe that our finding, that ESP are declining less than other species, has generality for two reasons. 1) We report in [Bartomeus et al. 2013](#) that most of the bee species that have been declining over the past 140 years in our study region are still frequently recorded, hence our measure of ESP as "any species observed visiting crops at least once" should capture declining species as well if they commonly visit crops. 2) Even the current ESP are a subset of the historical ESP, [Garibaldi et al., 2013](#) shows that under this current situation, wild pollinators enhance fruit set, suggesting that the resilience of the current ESP to global change may buffer the effects of a pollinator decline. Lastly, on a priori grounds it would not be surprising if ESP were more robust to land use change (a primary form of global change in our study region) than non-ESP because by definition species found pollinating crops are able to persist in agricultural areas.

Regarding your second question, it is important to note that the last sentence refers to "natural systems." While our data and analyses refer to simplified crop systems, where a few dominant pollinators are responsible for most of the function delivered to a single plant species (the crop), natural systems are far more complex and high levels of bee diversity are likely to be necessary to provide function to the full community. Hence our results should not be extrapolated to other, non-agricultural systems.

Ignasi Bartomeus & Rachael Winfree

Competing Interests: No competing interests were disclosed.

Reviewer Report 03 July 2013

<https://doi.org/10.5256/f1000research.1455.r1039>

© 2013 Luck G. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Gary Luck

Department of Wildlife Ecology and Management, Charles Sturt University, Albury, Australia

This short article comes to the important conclusion that while declines in pollinator [bee] abundance at local and regional scales are generally consistent, these declines are not occurring among those species responsible for delivering the majority of pollination services to particular crops. This insight makes a valuable contribution to the recent debate on the implications of pollinator declines for food production and will hopefully spur more studies that look closely at the relative contribution of different species to delivering pollination services across different crop types, and how the abundance of these species has changed over time.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of

expertise to confirm that it is of an acceptable scientific standard.

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com

F1000Research