Institution: University of Hull

Unit of Assessment: C17: Geography, Environmental Studies and Archaeology

Title of case study: Hypothesis-led citizen science: The 'Conker Tree Science' project

1. Summary of the impact

Since 2002, the highly-invasive horse-chestnut leaf-miner moth has caused significant damage to horse-chestnut trees as it spread rapidly across the whole of England and Wales. It is unclear how this species has spread so quickly and so successfully. This case study outlines 'Conker Tree Science', a project that addressed this question and, in so doing, had impact of significance and genuine reach on the public's understanding of, and engagement with, our changing environment.

The impact of 'Conker Tree Science' encompassed three main elements. First, it produced a cohort of citizen scientists undertaking useful field-observations for genuine, hypothesis-led science. Second, the success of this project was so notable that 'Conker Tree Science' was used as evidence of best practice for 'citizen science' by RCUK. By extension, this process will help to produce further citizen scientists. Third, the project was also celebrated widely in the national media and as such, the project's reach was substantial as it informed the public about environmental issues and challenges. In addition, the project's data also contributed to Forestry Research (the Forestry Commission research institute) in its understanding of the diffusion of this invasive species.

2. Underpinning research

A series of invasive insect pests have entered the UK recently and have been identified by DEFRA as significant risks to trees. The horse-chestnut leaf-miner moth (*Cameraria ohridella*) was first identified as a species in 1985 after specimens were collected in Macedonia. It has since colonised most of Europe, spreading at a rate of over 30 km per year. It appeared in Wimbledon in 2002 and it now covers most of England and parts of Wales.

We do not know how the moth spread so rapidly, although active flight over short distances combined with spread on the wind could be an explanation (Pocock et al. 2011). The moth causes severe discolouration and defoliage of horse-chestnut trees. This reduces photosynthetic capacity and results in smaller seeds; for some people, this effect also threatens an iconic tree of the British landscape.

A key problem was a lack of research into this pest and the difficulties of gathering sufficient nation-wide, verifiable field-data of adequate geographical precision to analyse this species and its spread. Therefore Evans (Lecturer and Senior Lecturer, Hull, from 2010) and Pocock (Bristol, 2010-11; Centre for Ecology and Hydrology, from 2011) developed a novel hypothesis-led citizen science project using Public Engagement funding from NERC (2010-2013). This project produced the research and its impact simultaneously. Only the research is discussed in this section.

The research was based upon using citizen-gathered data to provide enough information to assess the diffusion of *C. ohridella* and impediments to its spread. The moth is attacked by a range of generalist parasitoid wasps that attack other species of leaf-mining moth and leaf-mining flies and beetles. Research in continental Europe found that the mortality rate of *C. ohridella* due to parasitoids is usually less than 10%: much lower than for most leaf-mining insects (that suffer mortality rates due to parasitoids of 50-80%). This suggests that parasitoids alone cannot limit the damage to horse-chestnut trees effectively (Pocock et al. 2011). Given the lag in parasitoids responding to the *C. ohridella* invasion, we expected that more wasps would attack the moths at sites where the moths have been established longest. To test this hypothesis we needed accurate, extensive and robust field-data about the distribution of this species across broader temporal and spatial scales.

The project therefore encouraged and enabled the public to gather enough data for us to test this hypothesis. A purpose-built website (established in 2010) informed the public how to identify a tree under attack, how to collect and bag leaves, how to count leaf-mines, moths and parasitoids, and how to record this information in a systematic manner on the website [1]. Response rates were

good, but we recognised that we needed more data contributed from a wider range of sites.

Therefore, in 2011 we joined a consortium funded by JISC to develop a smartphone 'app' centred on our 'Conker Tree Science' [2]. This enabled Android and iPhone users to record exact locations of damaged trees via the GPS on their smartphone: giving us geo-located data. The public were also encouraged to provide a photograph, a damage score and additional information about the tree.

The additional data greatly increased the accuracy of information about the spread and effects of *C. ohridella*. In all, 5,500 records were collected from all over the UK in the four month recording period during 2010 and 2011 (ten times more data than was produced in previous years) (Pocock and Evans 2011) [2]. These data were collected and archived via the website and the app: all data were therefore ground-truthed and the research produced a better appreciation of the diffusion of *C. ohridella* across the UK and its impact on Horse-Chestnut trees.

These results were recorded by Forestry Research - the Research Office of the Forestry Commission who have a remit to undertake research into UK forestry issues, to inform and support the UK Government's policies on Forestry, and to transfer knowledge about forestry effectively. Our research contributed to the series of maps that Forestry Research produced to demonstrate the spread of the leaf-miner moth across Britain. These maps were embedded within the webpages of Forestry Research that are dedicated to the leaf-miner problem.

The project team published initial results (Pocock, Evans, Straw and Polaszek 2011). A fuller, more detailed article from the project is currently under review (accepted subject to minor revisions with *PLOS ONE*: Pocock and Evans). Forest Research officers also note our work in their article (Straw and Williams 2013).

3. References to the research

- Pocock, M. and Evans D. (2011) *Conker Tree Science*, Final Report to NERC: University of Bristol and University of Hull (April 2011).
- Pocock, M. and Evans, D. (2013) Conker Tree Science: Public Engagement and Real Research, in Bowater, L. and Yeoman, K. (eds.) *Science communication: A practical guide for scientists*, Chichester: Wiley-Blackwell, pp. 254-256.
- Pocock, M.J.O. and Evans, D. M. (under review) Revealing an invasive species' biology with hypothesis-led citizen science, *PLOS ONE* [accepted subject to minor revisions].
- Pocock, M., Evans, D., Straw, N. and Polaszek, A. (2011) The Horse-chestnut Leaf-miner and its parasitoids, *British Wildlife*, 22, 305-313.
- Straw, N. and Williams, D. (2013) Impact of the leaf miner *Cameraria ohridella* (Lepidoptera: Gracillariidae) and bleeding canker disease on horse-chestnut: direct effects and interaction, *Agricultural and Forest Entomology*, 15, 3, 321-333. DOI: 10.1111/afe.12020.

GRANTS

The quality of this research is evidenced by the funding from:

- Pocock, M. and Evans, D., *Conker Tree Science*, NERC Public Engagement Grant, £23,000 (2010-2013).
- Kilbey, D., Pocock, M. and Evans, D., *Nature Locator*, JISC, £65,000 (2011).

4. Details of the impact

The impact of this research is three-fold:

First, the 'Conker Tree Science' project produced a cohort of thousands of citizen-scientists producing verifiable, geo-located scientific field-data across time and space. These data greatly enriched our understanding of *C. ohridella,* its impacts, and the spread of this moth. These data resulted in scientific publications (noted in section 3), but the impact we emphasise here is how these citizen scientists were prompted to record the environmental impact of this invasive pest.

Their engagement is evidenced by the following figures:

- we generated 10,000 data points from members of the public over a 3-year period

- we received 6,160 uploads to our data set from 2,450 devices during 2011-12
- an additional 1129 people took part in the project using the website, with 2646 records added.
- over 2,100 people took part in the parasitoid research. Here we asked citizen scientists to calculate parasitism rates of the moths by running mini-experiments at home/school (Pocock and Evans 2011; Pocock and Evans (under review)) [2: post 31 Oct 2011; post 12 October 2011].

These numbers evidence the substantial reach of this project into the public domain. The scientific community benefitted from this exercise due to the production of robust field-data. Members of the public benefited from an enhanced sense of engagement with, and understanding of, their environment. They also benefited from an increased engagement with the inputs, processes and results of environmental research – this was evidenced by reviews of the App on iPhone App Store (68 ratings) and Android Market (23 ratings) and feedback left by users of the website [1; 3].

Second, the project, and its successful engagement with this wide public, also had an impact on the growing field of 'citizen science' and how this is best practiced. This is evidenced by the publications and events that celebrate 'Conker Tree Science' as an example of best practice in citizen science and, indeed, of the best citizen science that Britain has to offer:

- 'Conker Tree Science' was selected by RCUK for its website as a leading example of 'excellence with impact'. Indeed, for RCUK this is one of the dozen best examples of work they have funded with 'Policy' impact "…which makes a significant contribution to the UK's economy, society and quality of life" [4].
- RCUK also included the project in the official book that marked the Queen's Diamond Jubilee (2012). RCUK had two pages to represent the best of British Research. It cited its Royal charter and its "duty to disseminate and communicate research to the public" [5: 306], and then highlighted 'Conker Tree Science' as the best example of Citizen Science is a section concluding "We take the research beyond the Universities" [5: 306]. In their words: "It's a great example of how the public can get involved in an active piece of research" [5: 306]. The book was presented to The Queen and was delivered to every head of state round the world.
- 'Conker Tree Science' was also used as an example of how to test and modify citizen-science. It featured in the recently published 'Guide to Citizen Science' (produced by the UK Environmental Observation Network). This guide provides best practice guidelines at the national level for Citizen Science; it is freely available via the UK Environmental Observation Network website [6].
- This project is also used by Research Councils as an example of good practice. The Media & Public Engagement Manager at NERC, uses Conker Tree Science in her training of NERC-funded researchers [7]. Likewise, Evans was invited to speak at the 2012 'Town Meeting' of the BBSRC 'Tree Health and Plant Biosecurity Initiative' on ways of using citizen science to help monitor the arrival and/or spread of invasive insect species.

Therefore, future citizen scientists, and scientists hoping to use citizens with mass field-data observation and collection, all benefit from this project's development of best practice (as recognised by RCUK).

Third, 'Conker Tree Science' had impact as an initiative that 'enhanced public attitudes and values about ecological change' while also 'changing public awareness and behaviours in relation to the Environment' [8: 69].

In particular, the reach of this impact was demonstrated by its substantial media coverage (and this reach can be quantified):

- The project was launched on BBC Radio 4's *Material World* programme (10 June 2010). It subsequently featured on BBC 1's *The One Show* (16 September 2011, average daily audience 5 million) [2: post 20 September 2011], and BBC 2's *Autumnwatch Unsprung* (2.2 million viewers, 14 October 2010).
- Regular updates were featured on regional ITV and BBC news bulletins, and on local radio.
- The research was also featured throughout the print media, including:
    - *The Observer* (7 July 2011),

- *The Times* (30 August 2011),
- *Metro* (6 September 2011),
- *The Daily Mail* (12 September and 10 October 2011),
- *The Telegraph* (16 September 2011) and
- *The Sunday Times* (18 September 2011). [2: section 'Publicity, presentations etc.'].

- In 2012, as a result of the success of "Conker Tree Science," we partnered *The Observer* newspaper (circulation 250,000) to develop a new citizen science project to monitor the spread of 10 invasive species (included horse chestnut leaf-miners). This too increased public awareness of this threat and about our shifting ecosystems [9].
- The smartphone app had 18,000+ downloads in 2011, and for a time was the most downloaded educational app in 2011 [4; 2: post 20 September 2011].

Beneficiaries here include members of the public who learn more about the environment. School children also benefit by taking part in the scientific method and learning how it is used to tackle contemporary environmental issues. This will be the case especially here, as the reach of this dissemination has been so broad.

Finally, the project also generated data for Forestry Research:

- The data have been combined with other data about the leaf-miner to generate understandings of how the species has spread geographically and the pace of this diffusion (see maps at [10]).
- These beneficiaries include the Forestry Commission and users of forests and woodlands for recreational purposes. This citizen science approach also outlines a possible way to monitor other tree pathogens and forest pests in the future.

In sum, this project influenced the behaviour and knowledge of 5000+ individuals [2: post 12 October 2011]. It informed and enhanced their understandings of the environment and its changes, made them think about conservation, and prompted them to gather field-data for better understandings of the leaf-miner problem. As such, this project became an example of best practice 'citizen science' and it was celebrated as such by RCUK. The initiative was also celebrated by the national media and, via this route, this environmental issue reached millions more people. Finally, the data produced was of publishable quality and also informed how Forestry Research understand and represent the problem of the Horse-chestnut leaf-miner moth. All this constitutes impact of significance and reach.

5. Sources to corroborate the impact

[1] *'Conker Tree Science'*: http://www.conkertreescience.org.uk.

[2] JISC End of Project Report: http://naturelocator.ilrt.bris.ac.uk/ [post: 31.10.11]. Note that JISC End of Project Reports are expected in this form.

[3] Google Play apps store: https://play.google.com/store/apps/details?id=uk.ac.bris.ilrt.leafwatch

[4] RCUK *'Excellence with impact'*: http://www.rcuk.ac.uk/media/brief/impactcase/policy/Pages/pocock.aspx

[5] *The Queen's Diamond Jubilee 2012 Souvenir Album* (2012) "A Meeting of Minds: Research Councils UK provides scientific funding and helps researchers engage with the public about the latest developments in the field", Regal Press Limited 2012 (St. James' House), London, 306-07.

[6] Tweddle, J.C., Robinson, L.D., Pocock, M.J. & Roy, H.E (2012) *Guide to citizen science: developing, implementing and evaluating citizen science to study biodiversity and the environment in the UK*, Natural History Museum and NERC Centre for Ecology & Hydrology for UK-Environmental Observation Network, 32pp. [available at: www.ukeof.org.uk/resources/citizen-science-resources/guide-to-citizen-science].

[7] Corroborator: Media and Public Engagement Manager, NERC.

[8] REF2014 (2012) *Panel Criteria and Working Methods*, Bristol, 69.

[9] *The Observer* citizen science project:

http://www.guardian.co.uk/environment/gallery/2012/jan/15/citizen-scientist-invasive-species-pictures.

[10] Forest Research: *Horse chestnut leaf miner* - Cameraria ohridella, http://www.forestry.gov.uk/website/forestresearch.nsf/ByUnique/INFD-6YUBY5.