Institution: Anglia Ruskin University (ARU)

Unit of Assessment: Geography, Environmental Studies and Archaeology

Title of case study:
The use of citizen science in recording wildlife: ladybirds and invasive alien species

1. Summary of the impact (indicative maximum 100 words)

We set up one of Britain's first online recording projects (www.harlequin-survey.org) to track the spread and study the effects of an invasive alien species (IAS), the harlequin ladybird. We used this as a model to develop a recording programme for other IAS (www.nonnativespecies.org/recording/). The main areas of impact are: *(i) Informing conservation policy through collecting and analysing wildlife data* (e.g. GB non-natives surveillance and monitoring system stemmed from our work; long-term trends data used to address Convention on Biological Diversity targets); *(ii) Utilizing 'citizen science'* and *(iii) Changing public attitudes to IAS* (e.g. by engaging the public, changing the way that IAS are recorded; educating and training the public).

2. Underpinning research (indicative maximum 500 words)

Invasive alien species (IAS) can cause serious disruption to ecosystem function and are regarded as one of the main drivers of global biodiversity loss (along with habitat loss and climate change). The harlequin ladybird *Harmonia axyridis* (Coleoptera: Coccinellidae) was released in Europe and the Americas as a biological control agent of pest aphids and coccids. Whilst not deliberately released in Britain, it was first recorded there in 2004. As part of our research, in March 2005 we launched one of the country's first online recording projects (Harlequin Ladybird Survey - www.harlequin-survey.org) to track its spread and study its effects.

From our field data, plus large datasets submitted by the public (UK records verified by us), we have been able to:

1. Map in unprecedented detail the spread of *H. axyridis* in Britain and discover its habitat requirements and life cycle: the north-westerly rate of spread was calculated as 94 km/year and the species has two generations per year in Britain (Brown et al, 2008a).
2. Reveal significant declines in several ladybird species since the arrival of *H. axyridis* (Brown et al, 2011; Roy et al, 2012).
3. Using molecular techniques to analyse *H. axyridis* gut contents, reveal trophic interactions in the field: the species was directly feeding on at least two other ladybird species (*Adalia bipunctata* and *A. decempunctata*) (Thomas et al, 2013). Such intraguild predation is implicated in population declines of the prey species.
4. Map the spread of *H. axyridis* in Europe (Brown et al, 2008b).
5. Calculate long term (1990-2010) trends for Britain's 47 ladybird species (Roy et al, 2011): ten species significantly declined over this period, five increased, and the remainder showed no change. 110,000 species records (some historic) were collated and verified by the team (especially Peter Brown and Helen Roy) in order to calculate these trends and map the species.
6. Assess the accuracy and value of data collected via citizen science programmes (Gardiner et al, 2012): data from unverified citizen science overestimated species richness and diversity values in comparison to verified data.

Three Anglia Ruskin University (ARU) researchers were involved in this work. Dr Helen Roy has been researching ladybirds since her PhD (Rothamsted Research 1994-1997). At ARU she was Lecturer/Senior Lecturer (1997-2007) and Reader (2007-2008) and has since maintained her key role in this collaborative project, at NERC CEH. Dr Peter Brown was employed as Ladybird Survey Project Officer (NERC CEH / ARU 2005-2007). At ARU he was also a PhD student (2006-2010), Research Fellow (2010-2011), Lecturer (2011-2013) and is now a Senior Lecturer. Dr Alison Thomas (ARU Lecturer and Senior Lecturer 1996-2013) became involved in genetic aspects of the ladybird work from 2005.

The collaborative nature of our work has been a key to its success, with three principle organisations working together on the ladybird project: ARU (1997-date), NERC CEH (2004-date) and University of Cambridge (1990-2008), supported by the National Biodiversity Network (NBN) and DEFRA. Helen Roy and Peter Brown lead the Harlequin / UK Ladybird Surveys (previously led until 2008 by the late Professor Michael Majerus, University of Cambridge). The team collaborated with further UK institutions (e.g. University of Hull, Rothamsted Research) and with international colleagues in Europe, North America and Japan. Use of different resources and skills across members of staff at the various institutions has maximised the potential of the projects, with relatively small budgets.

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

1. **Brown, P.M.J., Roy, H.E.,** Rothery, P., Roy, D.B., Ware, R.L. and Majerus, M.E.N. (2008a) *Harmonia axyridis* in Great Britain: analysis of the spread and distribution of a non-native coccinellid. *BioControl* 53: 55-67. *[Included in REF2]*

2. **Brown, P.M.J.,** Adriaens, T., Bathon, H., Cuppen, J., Goldarazena, A., Hägg, T., Kenis, M., Klausnitzer, B.E.M., Kovar, I., Loomans, A.J.M., Majerus, M.E.N., Nedved, O., Pedersen, J., Rabitsch, W., **Roy, H.E.,** Ternois, V., Zakharov, I.A. and Roy, D.B. (2008b) *Harmonia axyridis* in Europe: spread and distribution of a non-native coccinellid. *BioControl* 53: 5-21. DOI 10.1007/s10526-007-9132-y

3. **Brown, P.M.J.,** Frost, R., Doberski, J., Sparks, T., Harrington, R. and **Roy, H.E.** (2011) Decline in native ladybirds in response to the arrival of *Harmonia axyridis*: early evidence from England. *Ecological Entomology* 36: 231–240. DOI: 10.1111/j.1365-2311.2011.01264.x

4. Gardiner, M., Allee, L., **Brown, P.M.J.,** Losey, J., **Roy, H.E.** and Smyth, R. (2012) Lessons from lady beetles: Accuracy of monitoring data from US and UK citizen science programs. *Frontiers in Ecology and the Environment* 10: 471–476. *[Included in REF2]*

5. **Roy, H.E.,** Adriaens, T., Isaac, N., Kenis, M., Onkelinx, T., San Martin, G., **Brown, P.M.J.,** Hautier, L., Poland, R.L., Roy, D.B., Comont, R., Eschen, R., Frost, R., Zindel, R., Van Vlaenderen, J., Nedvěd, O., Ravn, H.P., Grégoire, J-C., de Biseau, J-C. and Maes, D. (2012) Invasive alien predator causes rapid declines of native European ladybirds. *Diversity & Distributions* 18: 717–725. *[Included in REF2]*

6. **Thomas, A.,** Trotman, J., Wheatley, A., Aebi, A., Zindel, R. and **Brown, P.M.J.** (2013) Predation of native coccinellids by the invasive alien *Harmonia axyridis* (Coleoptera: Coccinellidae): detection in Britain by PCR based gut analysis. *Insect Conservation & Diversity* 6: 20-27. DOI: 10.1111/j.1752-4598.2012.00184.x

All references are papers published in recognised international journals that have a rigorous peer-review process. Researchers from this impact statement are shown in bold.

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

It is important to heighten awareness of IAS with the public for two main reasons: firstly, their actions may be changed if they are better informed (e.g. in terms of purchasing and/or releasing exotic pets or plants); secondly, they may be used in monitoring programmes to spot newly arrived or spreading IAS. 'Citizen science' projects can have a major role in both. We have used relatively high profile organisms (starting with the harlequin ladybird *H. axyridis*) in projects to engage the public in the science of IAS. The generation of interest and enthusiasm led to a large and high quality dataset. This was then used as a model for development of a public recording project for other invasive animals and plants (Recording Invasive Species Counts – RISC – www.nonnativespecies.org/recording/) launched in 2010. Peter Brown carried out development work for RISC, which is led by Helen Roy and operates in collaboration with the GB Non-native Species Secretariat and National Biodiversity Network.

Specifically, the research has had impact through:

(i) Informing conservation policy through collecting and analysing wildlife data

- The Harlequin Ladybird Survey not only led to the development of RISC but also to the Non-native Species Alert (surveillance and monitoring) system that Helen Roy leads as part of the GB Non-Native Species Information Portal. The driver for this is the importance of early warning and rapid response in reducing the £1.7 billion that non-native species cost the UK economy (see CABI report http://cabiinvasives.wordpress.com/2010/12/15/the-economic-impact-of-invasive-species-on-great-britain-revealed/).
  The following two quotes refer to the RISC project:
  - Welcoming the [RISC] project Wildlife Minister Huw Irranca-Davies said, "Non-native species that become invasive are one of the greatest threats to wildlife worldwide. They are estimated to cost the British economy at least £3 billion a year, and their impacts can be far reaching – they have adverse impacts on our native wildlife by predation, competition and spread of disease. They can threaten economic interests such as agriculture, forestry, fisheries and development."
  - Dr Niall Moore from the Non-native Species Secretariat said, "The Non-native Species Information Portal is a key outcome of Governments' long-term commitment to tackle the serious problems posed by invasive non-native species. It provides us with the basic information we need on which to base objective and sound policy: we need information on trends to see where to put our effort in future years and we need greater public involvement – provided through RISC. We also need to be alert to new species turning up so we can respond rapidly and hopefully keep them out – the Asian hornet is a good example."
- We calculated long term (1990-2010) trends for Britain's 47 ladybird species (Roy et al, 2011) for use by the Joint Nature Conservation Committee (JNCC) as a biodiversity indicator. Due to lack of data there are few taxa for which equivalent trends are available. Indeed, with ladybirds, only five other taxa (bryophytes, moths, bees, wasps and ants) are covered by the 2013 JNCC report - see http://jncc.defra.gov.uk/pdf/488_Webv2.pdf. Such reports are produced for the UK Government and used to steer policy, e.g. in helping meet obligations under EU law to halt biodiversity loss: our work helps address Convention of Biodiversity: Aichi Biodiversity Targets 1 and 9 (see www.cbd.int/sp/targets).
- Politicians' awareness of IAS was raised: a parliamentary question relating to our *H. axyridis* research was answered in the House of Commons (25/01/2011); Parliamentary Office of Science & Technology Postnote 303 (2008) features our research.
- Our research featured in three DEFRA reports:
  - England Biodiversity Strategy: promoting the recovery of declining species and habitats (17. Impact of Invasive species in England) (2011). Of more than 3,000 non-native species the 49 (including *H. axyridis*) with the greatest potential impact on native wildlife were independently identified.
  - Nuisance Insects and Climate Change (2009).
  - Summary of Responses to the Consultation on (1) The Review of Schedule 9 to the Wildlife and Countryside Act 1981 and (2) The Ban on Sale of Certain Non-native Species (2009).

(ii) Utilizing 'citizen science' and changing public attitudes to IAS

The way that IAS are recorded has been changed, as have attitudes towards them. This was achieved through successfully engaging the public in citizen science projects, and the use of new technology:

- Over 950,000 unique visitors (and over 1.1 million website visits – data available from October 2006 – July 2013) to www.ladybird-survey.org, www.harlequin-survey.org and www.nonnativespecies.org/recording thus substantially raising awareness of IAS.
- 15 exhibitions for the public, including three very major ones: 1. Royal Society Summer Science Exhibition (30/06-04/07/2009; 5,500 visitors; 77 press articles generated); 2. Moscow Science Festival (08-10/10/2010; over 30,000 visitors) by invitation of the British Embassy (Moscow) in a scheme to link British and Russian science; 3. BBC Gardeners' World (15-19/06/2011; over 100,000 visitors).

- 50 public outreach events (2005-13), e.g. bug hunts & insect displays.
- 26 television interviews and features (e.g. BBC 1 10 O'clock News 07/11/2006; BBC Autumnwatch 16/10/2009); 80 radio interviews, including 20 on national radio; over 200 newspaper and magazine articles featuring our research (2005-13).
- Articles in major magazines such as BBC Wildlife (one major feature and three smaller ones), National Geographic (one page feature, September 2008) and Observer magazine (three page feature, 15 January 2012).
- Annual column on ladybirds in the popular journal British Wildlife (readership of 25,000) written since 2009.
- Helen Roy and Peter Brown were members of the Royal Entomological Society National Insect Week steering group in 2006 and 2008.

(iii) Educating and training the public on IAS and ladybirds

- Our research was used extensively for education purposes. For example, our work on *H. axyridis* spread was used: 1. by OCR in a 2009 GCSE examination question; 2. as a case study for an AQA Human Biology book (Lowrie & Goodger, 2009); 3. in a schools activity pack published with BBC Breathing Places (April 2011).
- 7 training workshops run (over 100 people trained in ladybird identification and ecology).
- 52 talks (2005-13) delivered to wildlife societies, schools, etc.
- Our book on the ladybirds of Britain and Ireland (Roy et al, 2011) sold out within 9 months and went to reprint (over 700 copies sold).
- Our colour field chart for identifying British ladybird species (Majerus et al, 2006) sold over 34,000 copies (2006-12).
- Over 20,000 free copies of a ladybird identification chart downloaded or distributed at outreach events.

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

Impact (i)

- Head of **GB Non-Native Species Secretariat,** www.nonnativespecies.org (This person is best placed to corroborate impact of the RISC project and also see quote in section 4.(i) above.)
- Chief Executive of **National Biodiversity Network Trust,** www.nbn.org.uk (Corroboration of the impact of the ladybird projects – letter available from HEI on request.)

Impact (ii)

- Senior Scientist, **Research Institute for Nature and Forest (INBO), Belgium,** www.inbo.be (Collaborating organisation which can comment on our use of citizen science to gather data on IAS – letter available from HEI on request.)
- Head of Risk Analysis and Invasion Ecology Section, **CABI,** www.cabi.org (Collaborator who can comment on our use of citizen science to gather data on IAS - letter available from HEI on request.)

Impact (iii)

- Biological Records Centre Head of Research, **NERC Centre for Ecology and Hydrology,** www.brc.ac.uk (Corroboration of impact relating to outreach and materials produced for the public – letter available from HEI on request.)

www.bbc.co.uk/breathingplaces/ladybird-survey/

www.ceh.ac.uk/news/news_archive/2010_news_item_08.html

www.ceh.ac.uk/news/news_archive/Nearly-2000-nonnative-species-GB_2012_39.html

http://royalsociety.org/summer-science/2009/ladybird-ladybird/

- Lowrie. P. and Goodger, B. (2009) *AQA Human Biology A2.* Nelson Thornes. ISBN 978-0748782789.
- Roy, H.E., Brown, P.M.J., Frost, R. and Poland, R.L. (2011) *Ladybirds (Coccinellidae) of Britain and Ireland.* NERC Centre for Ecology & Hydrology, Wallingford. ISBN 978-1-906698-20-1.