The impacts of long-term declines in insect abundance on ecosystem function

Lead Supervisor: David Roy, the Centre for Ecology & Hydrology
Email: dbr@ceh.ac.uk

Co-supervisors: Tom Oliver, University of Reading; Jeremy Thomas, University of Oxford; Tim Johns, Environment Agency

The plight of insects has generated worldwide attention from the scientific community and wider public. Recent interest was stimulated by a 27 year study[1] suggesting a loss of 75% in the biomass of flying insects from Protected Areas in Germany, quickly labelled as 'ecological Armageddon'. If replicated in other habitats and regions, the scale of this loss is likely to have major implications for the role of insects in ecosystem functioning (e.g. pollination, pest control, nutrient cycling and as a food resource for other species). There is a need to understand the linkages between the status of insect populations and human-driven environmental changes, such as climate change and habitat degradation, and their impact on the resilience of ecosystem functions and services which underpin human well-being.

This PhD project addresses the following questions:

1) Have insect populations changed consistently between geographic regions, habitats and taxonomic groups – focusing on a comparison between terrestrial and freshwater systems;
2) How does the resilience of ecosystem functions relate to trends in component species;
3) How are overall insect numbers/biomass and their resultant ecosystem functions affected by environmental drivers such as climate change and habitat degradation.

This PhD studentship will capitalise on some of the most comprehensive and rigorous long-term monitoring time series from across the globe for terrestrial and freshwater systems. This will aim to include (i) datasets co-ordinated by DR working with partners in the European Butterfly Monitoring Scheme (eBMS), providing assessments of butterfly population from 12 regions of Europe; (ii) comparable butterfly monitoring schemes from at least 2 regions of North America; (iii) long-running assessments of terrestrial insect abundance for moths and aphids in the UK; (iv) trends in the occupancy of more than 1000 insect species from the UK; (v) standardised sampling of the abundance of freshwater insects (and other invertebrates) from 5500 locations across England. In parallel, a trait dataset incorporating phylogeny will be developed to link insect species abundance to ecosystem functions (e.g. pollination/pest-control/nutrient cycling potential, role as food resource for other taxa).

New integrated modelling approaches will combine datasets across taxa and regions to provide a consistent assessment of the status of insect populations and ecosystem functions. Established insect monitoring schemes cover a range of geographic areas and taxon groups. Life history and

methodological differences amongst datasets, in addition to differences in spatial and temporal resolutions, provide statistical challenges. This PhD studentship will evaluate the pros and cons of simple trend assessments (i.e. linear models with an annual time-step) versus more complex methods such as nonlinear state-space models.

This project addresses a critical area – the link between insect declines, ecosystem function and impacts of environmental change – using novel and fast developing approaches. These include methods in data analysis, modelling and ecological interpretation. This PhD will have unrivalled access to datasets and expertise of the supervisors and their research groups. Through training and mentoring, discussion and literature research, the student will be given the opportunity to develop specific research questions for their thesis. The datasets and techniques to be implemented in this project have all been tested and published in high-level papers. The novelty in this project, which will allow the student to exhibit excellence, lies in a number of areas. 1) Developing approaches to synthesise data across a number of datasets. The different sampling methods and life history of insect groups will require evaluation of multiple statistical methods to accurately represent trends and their uncertainty. 2) Development of novel metrics of ecosystem function derived from phylogenetic and trait information. 3) Modelling of the impacts of environmental drivers on insect population and ecosystem function. This project has the opportunity to develop more complex and applicable metrics and models. These opportunities will allow the project to be molded to the student's expertise, which will make it feasible as well as exciting, and should allow the student to develop lead-author publications in high-profile journals.

As well as producing excellent science, we expect the project to contribute to potential solutions to mitigate the impacts of global change drivers on key ecosystem functions.

Training opportunities:

The student will be working with a thriving group of ecological modellers at the Centre for Ecology and Hyrdology and Reading and will benefit also from interacting with the Biological Records Centre at CEH and the Process Modelling group and Phylogenetics group at Reading. The student will make use of the supervisory group by interaction with Jeremy Thomas a world-leading insect ecologist. The student will have regular contact with Tim Johns, an expert in freshwater ecology at the Environment Agency offices close to CEH Wallingford, to spend time analyzing and interpreting freshwater monitoring datasets.

Student profile:

This project would suit a numerate candidates with an interest in developing skills in ecological modelling and conservation biology. Ideally, candidates will have an MSc with previous research project experience involving quantitative analysis, e.g. statistical ecology or process modelling. An additional skill is the ability to interact with a range of stakeholders, including data providers as well and NGOs and statutory agencies for which the project results are relevant. A desirable trait is a broad outlook on wider environmental issues in order to put these biodiversity change results in context and best realise impact from the research in this topical area.

References: (optional)

[1] Hallmann, C.A. et al. (2017) More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PloS one 12, e0185809.

http://www.reading.ac.uk/nercdtp