# BEE DISEASE

**Insect Pollinator Initiative funded**

## Welcome

Welcome to the first newsletter from the IPI Bee Disease project where we hope to present you with the progress from our project. Our project is one of nine funded under the banner of the Insect Pollinator Initiative, where two research councils, two government departments and a charitable foundation have provided funding to help understand and ameliorate pollinator decline. For more information on the Insect Pollinator Initiative, please see **https://wiki.ceh.ac.uk/display/ukipi/Insect+Pollinators+Initiative.**

In this first issue we hope to provide you enough information to understand the motivation and goals of the project, introductions to those scientists employed on the grant, and some results from the first sampling year. We hope you enjoy reading this newsletter.

**Dr. Giles Budge**
**Principle Investigator**

## Newsletter purpose

The purpose of this newsletter is to disseminate progress and results from the project entitled ‘Modelling systems for managing bee disease: the epidemiology of European Foulbrood’ which runs from November 2010 to October 2013 and is funded in the Insect Pollinator Initiative. The target audience ranges from end users like policy makers and beekeepers, through to members of the general public with an interest in bee disease. If you would like to subscribe to this newsletter please email **ipi@fera.gsi.gov.uk** or provide your contact details on the project website **(visit www.beedisease.co.uk and click on ‘IPI Project Updates’)**. Also, any feedback on the newsletter would be welcomed.

fera The Food and Environment Research Agency | Newcastle University | University of Bath | The University of Warwick

# Why pollinators are important

Pollinators provide vital pollination services both to agriculture and to wild plant populations to an estimated global value of €153 billion in 2005. Managed pollinators are of particular value because they service the specific needs of crop production, supplement the natural bank of pollinators and yet can be moved to different sites as part of husbandry regimes to facilitate pollination. Recent years have seen a global decline in pollinator populations, leading to concerns that the sustainability of agriculture and ecosystem service provision may be threatened as they decline.

Honey bee populations are threatened by a number of endemic and emerging diseases which have been implicated in large-scale losses in recent years. These diseases have been spread by the global industry in honey bees and their hive products. Much of the decline in bees has been associated with specific diseases that have emerged in new geographical areas as a result of long distance movement, e.g. Varroa and *Nosema ceranae*. In addition, several honey bee disease agents have been reported in other insects including Kashmir bee virus in *Vespa germanica*, Deformed wing and Black queen cell viruses in Bombus species, leading to concerns that many pathogens originally identified in the honey bee are actually more generalist insect pathogens. The movement and spread of emerging disease poses a real threat to bee populations that is difficult to manage because problems are often only identified after they have become difficult to eradicate.

There is a need to be able to manage diseases to mitigate their impacts and also prepare for the invasion by exotic pathogens to help ensure the future of managed pollination services in the UK. Such management requires new methods for predicting disease dynamics and investigating likely methods for disease control.

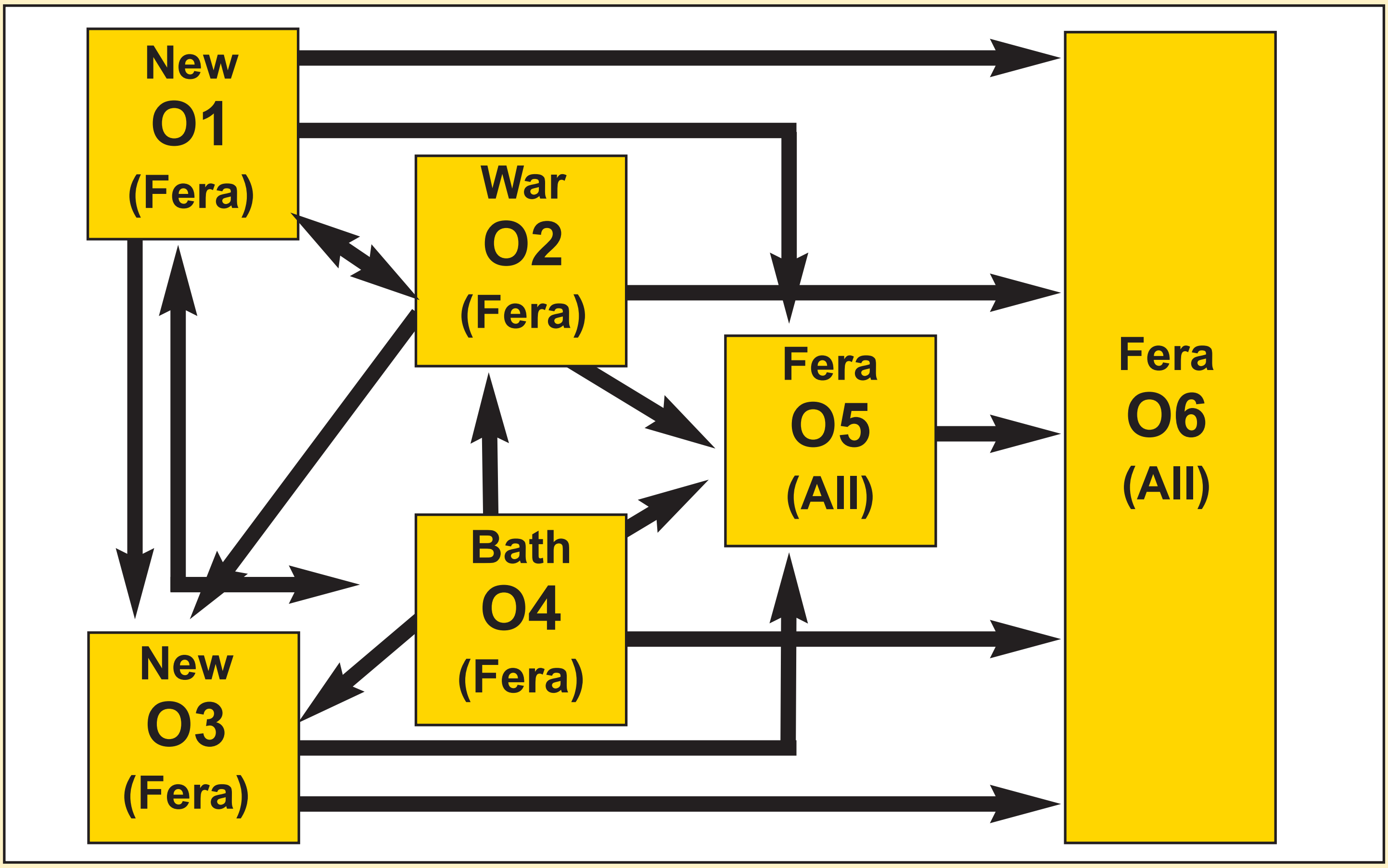
# Modelling systems for managing bee disease: the epidemiology of European Foulbrood

This project will provide a step change in our understanding of how honey bee diseases move within the colony, between colonies and between apiaries at the landscape level. The team will start with a disease for which we have plenty of data, European Foulbrood (EFB), and create the first models of their kind to understand how this disease moves through the UK landscape. We will also generate new data about how the pathogen, *Melissococcus plutonius*, behaves within the colony and study how the genetics of the bee, the behaviour of the beekeeper, and changing meteorological conditions determine the spread of disease.

Ultimately the aims are to develop a system that can make predictions about the epidemiology of a range of bee diseases that lead to the development of effective means of controlling disease occurrence. The project aims to:

- deliver improvements on how we inspect and monitor for EFB by improving the targeting of NBU inspections and how to decrease the impact of EFB and related diseases in our honey bee population.
- translate the results into useable practical biosecurity advice for beekeepers on how to effectively manage and minimise disease risks.
- produce guidelines for policy makers to ensure a framework exists to support any recommendations from improved disease control.

# Project structure




The project is broken into six interacting objectives (O1-O6) each led by a partner institute with support from others within the consortium. We will begin by using **statistical modelling (O1)** to investigate risk factors for spread of EFB by identifying key landscape, management and climatic features which impact on the risk of spread of the disease. We will then develop **hierarchical models of disease transmission (O2)** using the outputs from the statistical analyses to predict disease spread in time and space.  Next, **spatially explicit GIS models (O3)** will explore disease management options that can be applied in the UK landscape. **Genetically explicit statistical models (O4)** will inform how host and pathogen genetics affect disease spread. Once the modelling tools are developed (O1-O4), they will be **applied to other pollinator diseases (O5)**.

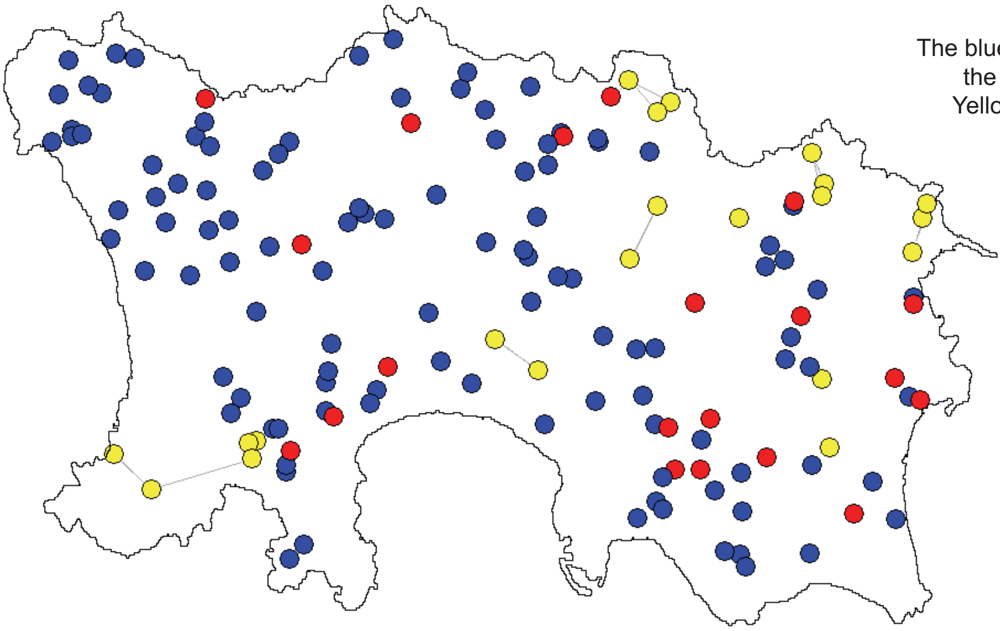
Finally, all outputs feed into a dedicated **dissemination and extension objective (O6)** which aims to transfer information to end-users to maximise the impact of the modelling outputs.

**Key**
The Food and Environment Research Agency (Fera)
University of Newcastle (New)
University of Warwick (War)
University of Bath (Bath)

# American Foulbrood in Jersey: a test bed

The Newcastle team (Mark Shirley and Steve Rushton) and Fera (Giles Budge) have been looking at the 2010 outbreak of American Foulbrood (AFB) in the State of Jersey. This is an interesting situation because it allows us to test out some of the models and analyses we intend to perform on the data from England and Wales, but in a small, self-contained system.

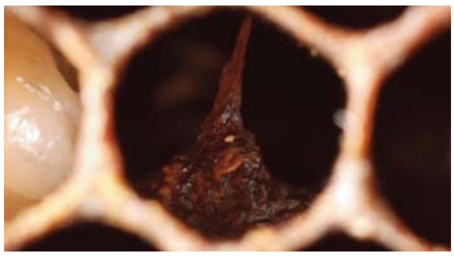
We began by looking at clustering and discovered significant evidence of several small geographic clusters of disease on the island (below).



The blue dots represent healthy colonies and the red dots colonies diseased with AFB. Yellow dots show where small geographic clusters of disease have formed.

Next we used linear mixed effect models to demonstrate that AFB prevalence within 1 km was a significant positive predictor of the likelihood of AFB cases occurring at an apiary. In addition, a landcover variable which represented stability of floral resources was a significant negative predictor i.e. colonies with fluctuating floral resources were associated with the presence of disease.

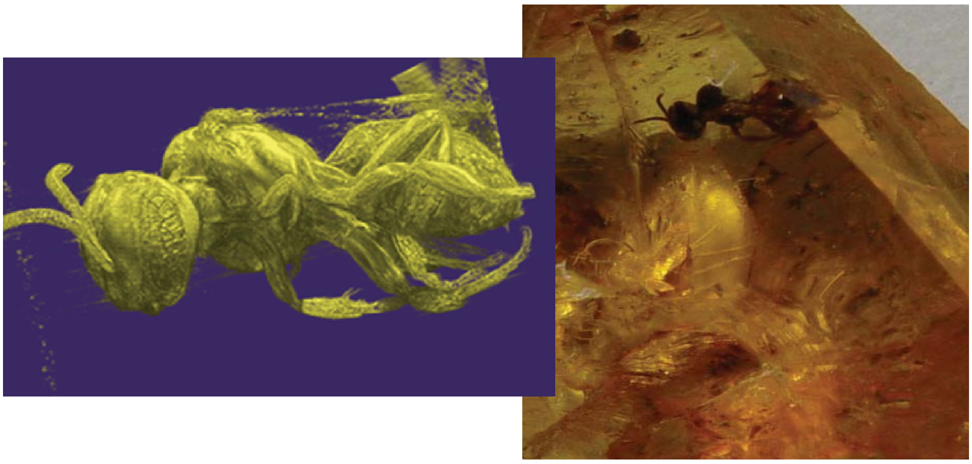
Data from Jersey were also used to generate a network model of colonies, forming routes for disease spread between colonies based on geographic proximity and colony ownership. The resulting network demonstrated the 'small world effect'; in that the connection pattern between colonies produced a much denser network than one would expect if connections were formed at random. Networks exhibiting this small world property are more susceptible to the spread of diseases.



# Project team at full strength

The project team became at full strength as of December 2011 when the final 2 post doctoral researchers were employed by Bath and Warwick.

Mark Greco has been involved in the management and application of European Honeybees (*Apis mellifera*) and Australian stingless bees since 1991. In 2005 he introduced a new technique, Diagnostic Radioentomology (DR), for non-invasive studies of insects which he recently used to describe a new species of ancient bee trapped in amber (see image below).



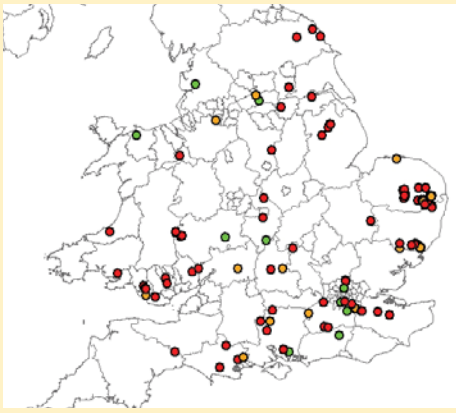
Dr Mark Greco, University of Bath

Dr Samik Datta, University of Warwick

Samik Datta has been involved in the mathematical modelling of the basic life processes occurring in marine ecosystems, using partial differential equations which allow the comparison of many independent variables. A combination of analytical and numerical methods were used to produce new models which compare favourably with the classical models used previously. One such new model demonstrated that organisms within marine ecosystems make size jumps as they become able to feed on increasingly large prey.

# 2011 field sampling

The inspectors from the National Bee Unit at Fera had a successful year finding European Foulbrood, with annual prevalence up on 2010. So there were plenty of samples available for the project. In total, 148 diseased colonies were sampled (red dots); 40 contact colonies i.e. healthy colonies in diseased apiaries (amber dots); and 16 healthy colonies from healthy apiaries (green dots). Overall, 2898 larvae have been stored ready for culturing and genotyping. A big thank you to all those beekeepers who participated by providing brood frames. We could not do this project without your continued support.



# And finally......

We hope you found this newsletter informative. The next issue will report the findings from the second year of the project and will be available from January 2013. For more information please see our project website (www.beedisease.co.uk) or email us on ipi@fera.gsi.gov.uk.