Fowey Valley Bumblebee Project

Securing wild pollinators for agriculture: testing a new landscape-scale approach to sustainable management.

February 2019 – June 2023

Dr Rosalind Shaw
Fowey Valley Bumblebee Project Officer
rosalind.shaw@bumblebeeconservation.org

The Prince of Wales Charitable Foundation and Kelly's of Cornwall are generously supporting the Bumblebee Conservation Trust project, the Fowey Valley Bumblebee Project. The project is carried out by a part time (0.5 FTE) Project Officer, Dr Rosalind Shaw, with project partners contributing time and resources.

Background

Many pollinators, including bumblebees, are declining worldwide in response to interacting factors relating to agricultural intensification such as habitat loss, habitat fragmentation and pesticides. This multitude of co-acting stressors, rather than a single cause, makes the problem particularly difficult to tackle.

Pollinators are essential for sustainable farming and an estimated 65% of crop production by volume depends on insect pollination and determines both crop quality and quantity.

Farmers are however under considerable economic pressure to increase productivity, often resulting in agricultural intensification and increased cultivation of land previously left out of production. This reduces the availability of suitable habitats for wild pollinators, leaving their populations vulnerable.

The project partners in the upper Fowey Valley, Cornwall are committed to seeing a change in the way their land is managed for pollinators, in particular bumblebees. We have been testing and improving a new decision support tool, BEE-STEWARD, which models the impacts of land management changes on bumblebee populations over long time periods. We have established improvements needed to the model, to make it more valuable for land managers and conservation advisors.

Summary of achievements

Testing the model – we have been collecting information on the number of bumblebees seen in six areas across the upper Fowey Valley. We have compared this to the number of bumblebees predicted by BEE-STEWARD model, and they are correlated – this gives us confidence that the model can predict a 'good' landscape for bumblebees.

Adding new habitats to the model –in collaboration with project partners we decided on the most important new habitats to add to the model and have carried out a full season of flower surveys resulting in 14 new habitats relevant to farmland added. We have searched the literature and added another 7 habitats or management types from existing information.

Creating and adding more flower species to the model – BEE-STEWARD assesses a habitat and landscape based on the pollen and nectar supplied by flowers in that landscape at different times of year – we have searched for information on another 41 species and created a bespoke database to store the data in making it readily available to farmers and land managers.

Improving the BEE-STEWARD model – working with the model developers we have created a new version that can be used to look at the impacts of more than a single land holding, helping us understand how land managers can work together for bumblebees.

Public engagement and outreach - by giving talks, running bumblebee identification workshops and attending events we have talked to over 760 people about bumblebees!

The Fowey Valley Bumblebee Project is funded by:

Project partners: Duchy of Cornwall, University of Exeter, National Trust, Trewithen Dairy, Bumblebee Conservation Trust, Lanhydrock Estate

Example BEE-STEWARD report for a land manager

Below we give an example of how a report for a land manager look: as farm maps are considered confidential, we use a realistic worked example.

BEE-STEWARD results for YOUR FARM or landholding

Summary

BEE-STEWARD is a decision support tool which models the impacts of land management on bumblebee populations over long time periods.

The landholding for the report is a mixed farm including both arable and grazing for sheep and beef cattle.

The landowner was interested in improving the area for bumblebees and also in using a broader approach to farm in an environmentally focused way, using a natural capital land management approach that aimed to boost the 'public goods' provided by the farm, such as protecting water courses and planting trees to store carbon. We ran three scenarios in BEE-STEWARD to understand what would happen to bumblebee populations under a 'business as usual' approach, an Entry Level Countryside Stewardship approach or Natural Capital Land Management.

Headline results

- By implementing a **Countryside Stewardship** scheme, the amount of resources for pollinators in the landscape did increase. However, this did not lead to a long-term increase in the number of bumblebee colonies (per km^2) after 10 years when compared to the business-as-usual scenario.
- By using a full **Natural Capital Management** approach **the number of bumblebee colonies (per km^2) tripled** to 37.
- The maximum number of adult queens produced by the bumblebee colonies after 10 years remained similar in the Countryside Stewardship Scheme and Business-as-Usual scenarios, but **more than tripled** to 2076 when using the Natural Capital Management Plan.
- While using the Countryside Stewardship scheme will increase the nectar and pollen available for bumblebees in the landscape, it did not seem to have long-term impacts on bumblebee populations. By contrast, the Natural Capital land management plan resulted in much greater long-term benefits for bumblebees.

Recommendations

- The Natural Capital plans are predicted to lead to large benefits for bumblebee populations on the farm.
- Wildflower meadows provide the most pollen and nectar resources in total through the year.
- Early spring resources are important when queens are looking for nests and starting colonies and could be boosted. Ensuring spring resources are available in hedges such as early flowering willows or field maple and allowing them to flower using sensitive hedge management will help maintain pollinator populations in the long term.

Full report

Introduction

Bumblebees complete an annual life cycle – queens hibernate over winter and then start new nests in the following spring. The new nests are vulnerable in the early stages as the queen forages to collect nectar, and pollen to feed the larvae. Once the first generation of worker bees are produced, they go out to forage and the queen remains in the nest to lay more eggs. If the nests get big enough, they start producing queens and males, who will leave the nest and mate. The workers and the males then die off, leaving the queens to hibernate over winter.

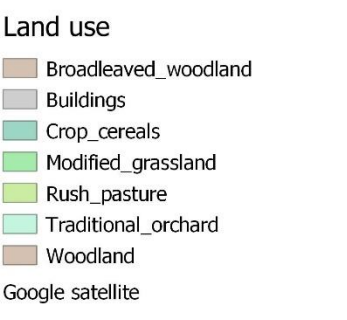
BEE-STEWARD uses information on the pollen and nectar available in different habitats and under different management regimes to compare how bumblebee populations will develop in different management scenarios. It can do this over long time periods, such as 10 years.

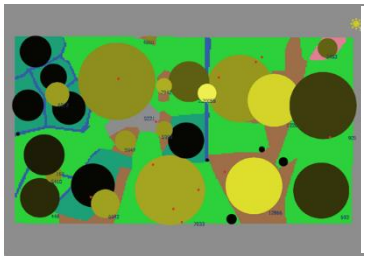
This landholding is a mixed arable and beef farm. The two options compared include a Countryside stewardship approach focusing on hedgerow management and installing nectar-rich margins and pollinator friendly game cover crops. The second option was a full ‘Natural Capital’ land management approach aimed at boosting public goods such as clean water, by installing wetland mosaics and restoring species rich grassland as well as altering management. The two options are compared to the ‘business-as usual’ scenario with no interventions.

1. Farm maps (please note these are EXAMPLE maps and scenarios as farm advice is confidential)

A) Baseline scenario

Imagery (c) 2023 Google, Imagery (c) CNES/Airbus, Getmappingplc, Infoterra Ltd & Bluesky, Landsat /Copernicus, Maxar Technologies





Dark circles represent areas of the farm with low numbers of nectar visits by bumblebees.

B) Countryside steward ship scenario

Apply Flower rich margins on south facing margins of arable fields in north west block

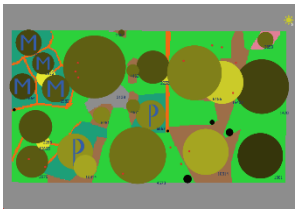
In central arable field, add pollinator friendly game cover crop

Reduce hedgerow management from annual to every 3 years, across farm.

Imagery (c) 2023 Google, Imagery (c) CNES/Airbus, Getmappingplc, Infoterra Ltd & Bluesky, Landsat /Copernicus, Maxar Technologies

Land use
- Broadleaved_woodland
- Buildings
- Crop_cereals
- Modified_grassland
- Rush_pasture
- Traditional_orchard
- Woodland

Google satellite



Increased visits by bumblebees across the farm shown by lighter circles

C) Natural Capital Land Management

Apply Flower rich margins on south facing margins of arable fields in north west block, boosting pollination and pest control.

Restore species rich grassland in areas near buildings

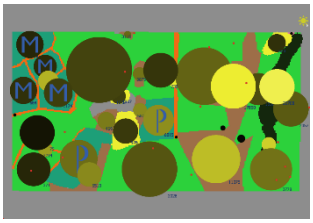
Reduce hedgerow management from annual to every 3 years, across farm.

In central arable field, add pollinator friendly game cover crop

Imagery (c) 2023 Google, Imagery (c) CNES/Airbus, Getmappingplc, Infoterra Ltd & Bluesky, Landsat /Copernicus, Maxar Technologies

Land use
- Broadleaved_woodland
- Buildings
- Crop_cereals
- Modified_grassland
- Rush_pasture
- Traditional_orchard
- Woodland

Google satellite



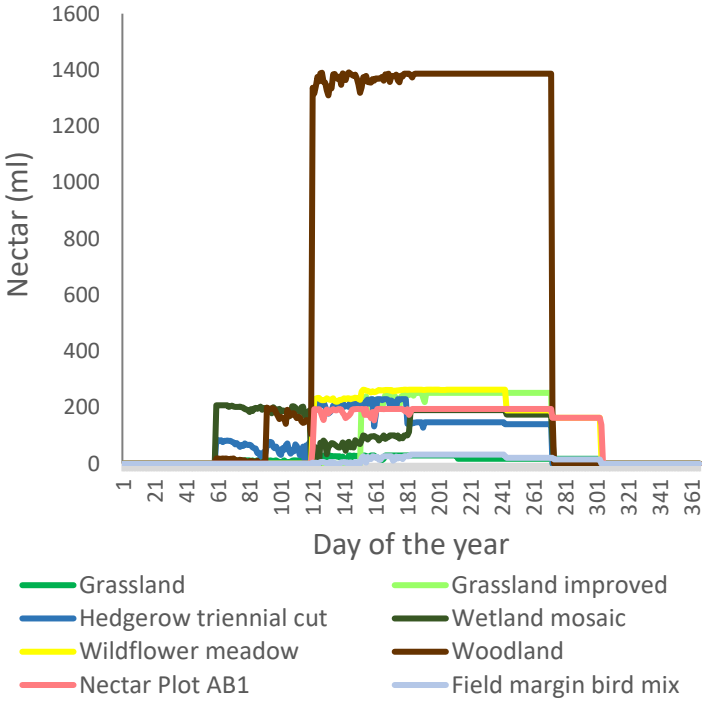
Allow wetland mosaic of willows, and wet-loving herbs such as meadowsweet, water mint and yellow flag to develop around watercourse, protecting river and preventing sediment entering water course

Note that there are more nectar visits spread out throughout the farm, and fewer areas with no nectar visits

2. Nectar and pollen provision throughout the year

- In all scenarios, the woodland habitats are providing the most nectar in total, as they cover a large area.
- By reducing the frequency of hedgerow management, the hedgerows provided over 2x as much nectar during the month of May, an important time for bumblebees.
- Wetland mosaics also provided important spring resources.
- The amount of nectar provided per m^2 of habitat is greatest in the nectar-rich margins.

a)



b)

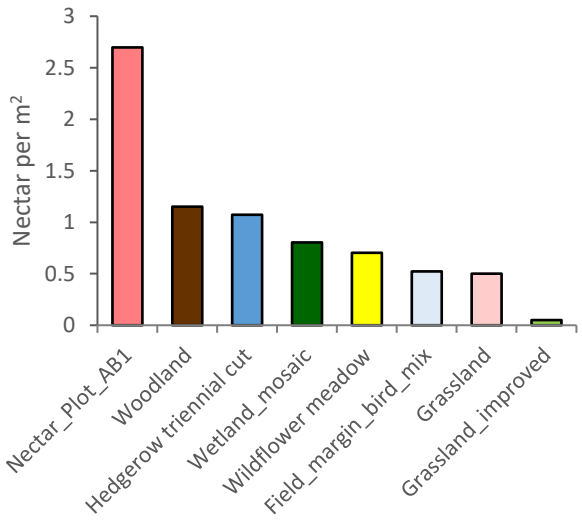


Figure a) shows the habitats providing nectar for bumblebees throughout the year, based on the total area of that habitat. Figure b) shows the amount of nectar provided per m^2 of each habitat.

3. Results and Recommendations

- By implementing a **Countryside Stewardship** scheme, the amount of resources for pollinators increased, however it did not lead to long term increase in the number of bumblebee colonies (per km^2) after 10 years compared to the business-as-usual scenario.
- By using a full **Natural Capital Management** approach **the number of bumblebee colonies (per km^2) tripled** to 37 after 10 years compared to 10 in the business-as-usual scenario.
- The maximum number of adult queens produced by the bumblebee colonies in year 10 also did not increase under the Countryside Stewardship Scheme but in **more than tripled** to 2076 when using the Natural Capital Management Plan.
- While using the Countryside Stewardship scheme will increase the nectar and pollen available for bumblebees and other pollinators on the farm, it did not seem to have long term impacts on bumblebee populations. The Natural Capital land management plan resulted in greater long-term benefits for bumblebees.

- Early spring resources are important in when queens are looking for nests and starting colonies. Ensuring spring resources are available in hedges such as early flowering willows or field maple and allowing them to flower using sensitive hedge management will help maintain pollinator populations in the long term. Wetland mosaics, especially when they have willow present, provide good spring resources and nesting habitat.
- In terms of best resources for smallest area of land, nectar rich plots are the best.
- Wildflower meadows have good summer resources and can still be used for a hay cuts or extensive grazing later in the year.

4. Example pictures of habitats

Species rich wildflower meadows



Wetland mosaics

Uncut hedge with blackthorn bloom in spring

Photos: Rosalind Shaw

Further information on BEE-STEWARD modelling

What is BEE-STEWARD?

BEE-STEWARD is a computer software tool, developed by the University of Exeter, designed to help farmers and land managers see how pollinator-friendly management could affect bee survival and pollination. A detailed model of bumblebee behaviour predicts how bumblebee colonies grow and reproduce based on the food and nest sites availability in the landscape. The simulated bumblebee queens emerge in April and can nest in any semi-natural habitat such as hedges, semi-improved grassland or woodland. How large the colonies grow, and how many queens the colony produces for the following year depends on the amount of pollen and nectar available in the surrounding landscape. Farm maps of different habitats combined with information on flower abundance, and how much pollen and nectar different flowers provide, are used in the model to predict bumblebee populations on a specific farm or land holding.

BEE-STEWARD predictions

The current BEE-STEWARD predictions are for the Buff-tailed bumblebee (*Bombus terrestris*) over a 10 year period. The model was run twenty times, which provides an estimate of how variable the results are. BEE-STEWARD was run for three scenarios, the 'business-as-usual' scenario of current land use, Countryside stewardship scenario where the farm is managed under an Entry Level countryside Stewardship scheme and a full scenario, where the entire farm holding is managed for natural capital benefits.

The original BEE-STEWARD paper was published as –

Becher, MA, Twiston-Davies, G, Penny, TD, Goulson, D, Rotheray, EL, Osborne, JL. Bumble-BEEHAVE: A systems model for exploring multifactorial causes of bumblebee decline at individual, colony, population and community level. J Appl Ecol. 2018; 55: 2790– 2801. https://doi.org/10.1111/1365-2664.13165

The data used in BEE-STEWARD has been collected from a series of reports and studies.

Habitat data taken from

Becher, MA, Twiston-Davies, G, Penny, TD, Goulson, D, Rotheray, EL, Osborne, JL. Bumble-BEEHAVE: A systems model for exploring multifactorial causes of bumblebee decline at individual, colony, population and community level. J Appl Ecol. 2018; 55: 2790– 2

Ouvrard, P. and Jacquemart, A.-L. (2018), Agri-environment schemes targeting farmland bird populations also provide food for pollinating insects. Agr Forest Entomol, 20: 558-574.

Shaw et al Fowey Valley Bumblebee Project dataset

Staley, J.T.; Dean, H.J.; Adams, N.P.; Amy, S.A.; Botham, M.S.; Chapman, R.E.; Baldock, K.S.; Pywell, R.P. (2020). Biodiversity and structural data from hedgerow management and rejuvenation experiments in England, 2005-2016 NERC Environmental Information

Flower data references available on request.

Acknowledgements: We would like to that our funders for their support, project partners and land managers in the Fowey area for access to land for carrying out surveys and engagement with the project and volunteer bee walkers and flower counters for collecting data.

For further information, please contact rosalind.shaw@bumblebeeconservation.org or enquiries@bumblebeeconservation.org

Photo: Buff-tailed bumblebee *(Bombus terrestris)* by Laura Spiteri