

**OP-275 [Pollination and Bee Flora]
Bees' Eating Habits and Competition Uncovered using Cameras and DNA**

Hjalte Calberg Ro-Poulsen¹, Chatchai Kosawang¹, Henning Bang Madsen², Kim Bjerger⁵, Lasse Gottlieb¹, Laura Overby¹
Toke T. Høye⁴, Yoko L. Dupont³, Inger Kappel Schmidt¹

¹Department of Geosciences and Natural Resource Management, University of Copenhagen, Frederiksberg C, Denmark

²Department of Biology, University of Copenhagen, Copenhagen Ø, Denmark

³Department of Agroecology, Aarhus University, Aarhus C, Denmark

⁴Department of Ecoscience, Aarhus University, Aarhus C, Denmark

⁵Department of Electrical and Computer Engineering, Aarhus University, Aarhus N, Denmark

Wild bees are in decline, primarily attributed to loss of habitat. Fragmented habitats persist in an agricultural landscape, vulnerable to surrounding stressors. Among stressors, concerns have been raised that managed honeybees may competitively displace wild bees in protected areas.

The objective of this phd-work was to investigate whether beekeeping pose a risk to wild bee communities in protected areas of Denmark, specifically semi-natural grasslands and heathlands. Furthermore, studies of plant-pollinator interactions are crucial for our understanding of pollinator health and decline, but traditional methods, such as direct observations and manual pollen analyses, are very time-consuming and limit the quality of data. Thus, modern methodology such as metabarcoding and computer vision was applied.

Presented studies span across the season and 50 grassland-heathland sites of which 42 were sampled in May and July using pan traps to assess wild bee communities and proportion of honeybees. Competition was assessed through experimental introduction of beehives to one of two species rich calcareous grasslands during June and diet overlap was investigated using DNA-metabarcoding. On eight heathlands with varying densities of apiaries, 40 time-lapse cameras recorded heather (*Calluna vulgaris*) for 30 days during August and machine learning was used to assess visitation frequency of wild pollinators and honeybees.

Honeybees were generally low in abundance on studied sites, even when placed in a species rich grassland, but metabarcoding of the few individuals revealed diet overlap with bumblebees. However, honeybees were highly abundant on heathlands during the late-summer flowering of heather. Only few common species were detected and the effect of honeybees depended on time of the month, where negative effects were found early August.

Honeybees generally do not seem attracted to fragments of grasslands and heathlands in a Danish agricultural matrix, except in August, but may vary from country to country. Seasonal phenology is highly important to consider when assessing the effect of honeybees on wild bees. It is suggested that beekeepers investigate plant species are utilized during the season and when they may visit areas of conservation concern. For migratory beekeepers, it is stressed that hives are not mass-introduced prior to flowering.

Bees' Eating Habits and Competition Uncovered using Cameras and DNA

Traditional and modern methods to assess competition. Case studies in Denmark

Hjalte Calberg Ro-Poulsen

postdoc

hjrp@ign.ku.dk

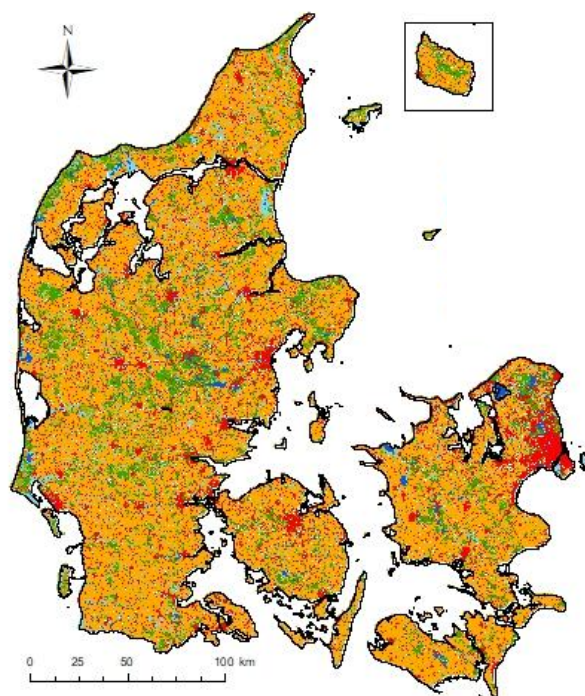
Department of Geosciences and Natural
Resource Management, UCPH

KØBENHAVNS UNIVERSITET



Where? Danish 'nature'

- Studies focused on grasslands and heathlands (primary habitat for the majority of threatened wild bees)



Levin G (2019)

Area Type

- Agriculture (62%)
- Urban (14%)
- Lakes/ivers (3%)
- Forest (13%)
- Wet open nature (6%)
- Dry open nature (4%)



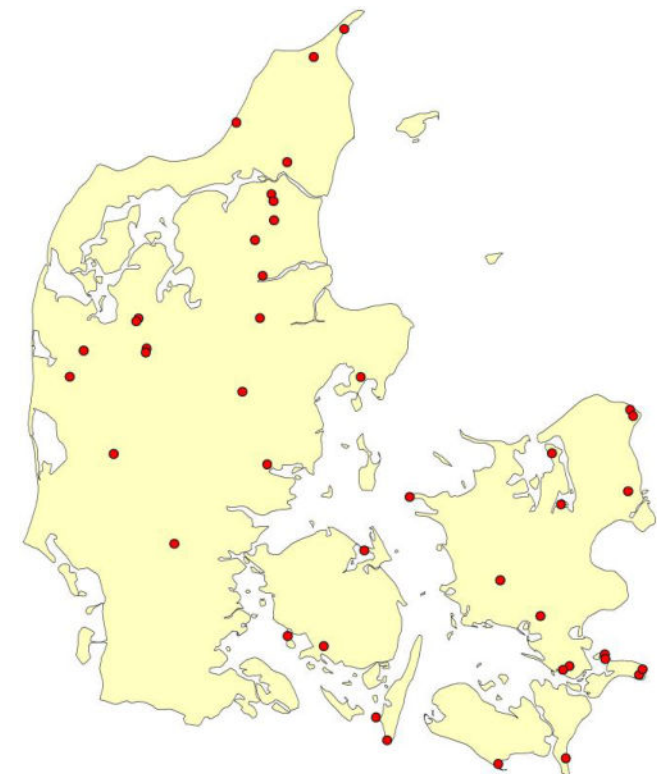
Surveying bees...

- Trapping



Survey of bee communities in May and July (project "Grazing4Diversity")

- Baseline survey of year-round grazed areas (not competition study)
- 42 dry open year-round grazed sites (four plots pr. site)
- Predominantly grasslands and heathlands



Survey of bee communities in May and July (project "Grazing4Diversity")

May

953 individuals (**9 honey bees**)

82 species

July

2944 individuals (**151 honey bees** -
primarily on heathlands)

91 species

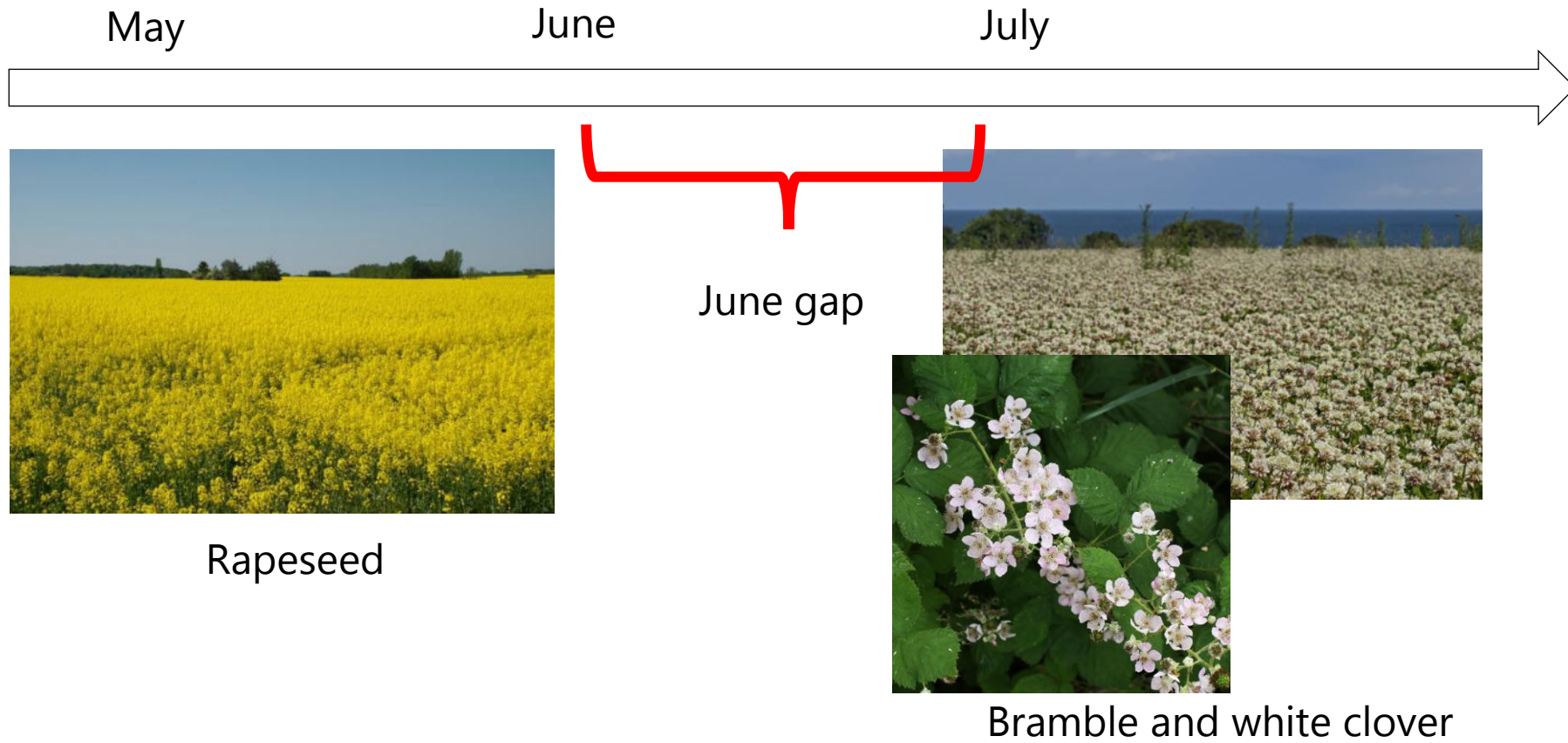
Total

3897 individuals (**160 honey bees; 4%**)

127 species (43% of Danish bee species)

15 redlisted

Where are the honey bees in May and July?



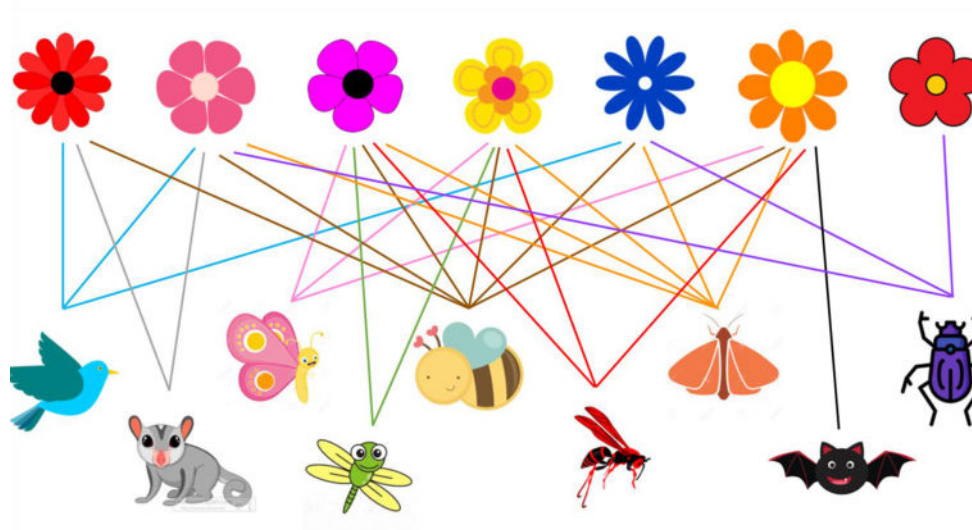
*Highly simplified. For more details on Danish honey bee resource use, see:
Dupont, Y. L., Greve, M. B., & Kryger, P. (2022). Honningbiernes pollenforsyning i danske landskaber.
Aarhus Universitet, DCE – Nationalt Center for Miljø Og Energi, Videnskabelig rapport nr. 517.

What if we introduced beehives to a biodiversity- and wild bee hotspot (dry calcareous grassland) in June?



Surveying bees...

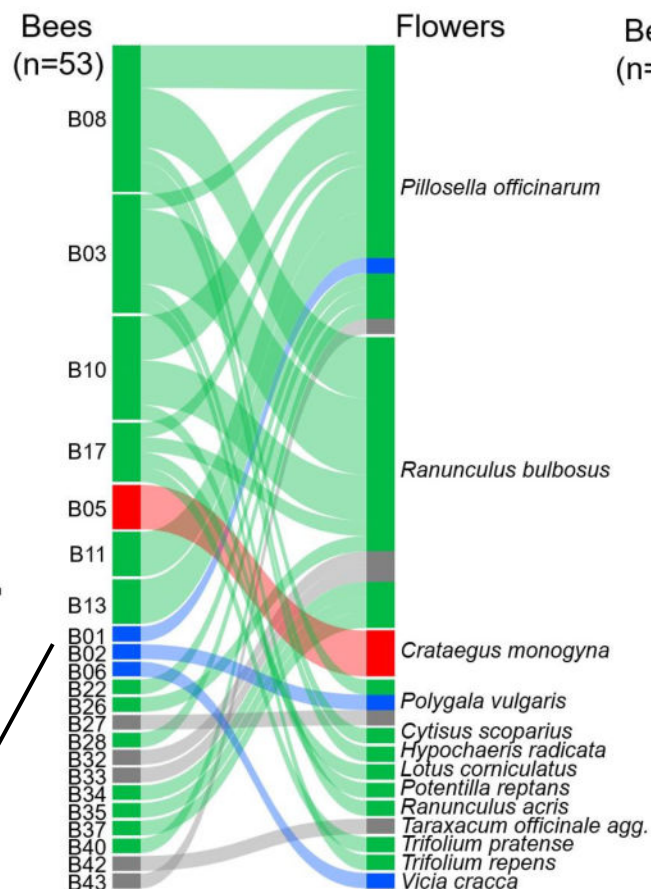
- Trapping
- Manual observations
 - Weekly transect surveys before, during and after introduction



- Solitary bees
- Bumble bees
- Honey bees
- Cuckoo bees

Experimental site

Pre-introduction



B01

Bombus lapidarius



B02

Bombus terrestris agg.



B03

Lasioglossum quadrinotatum

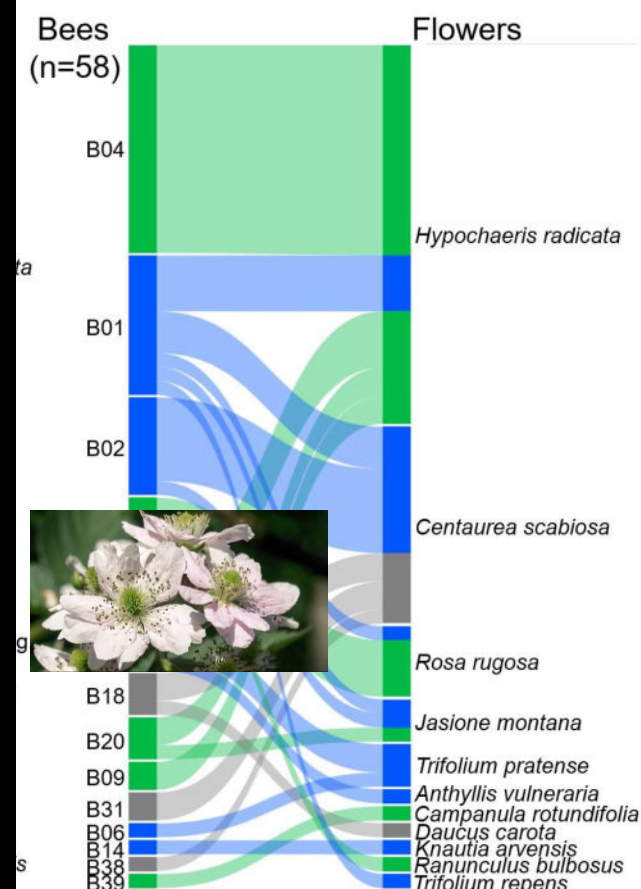


B04

Panurgus calcaratus



Post-introduction



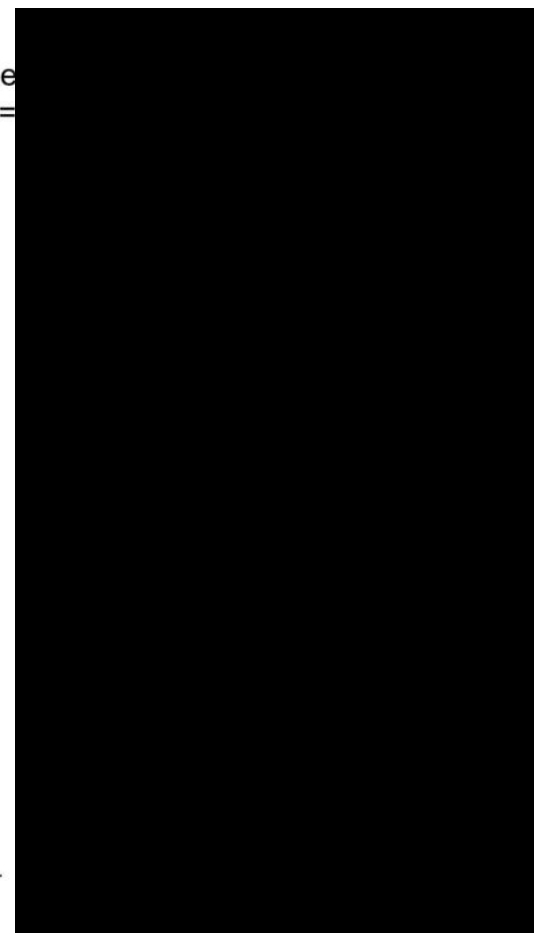
B05

Apis mellifera



x10

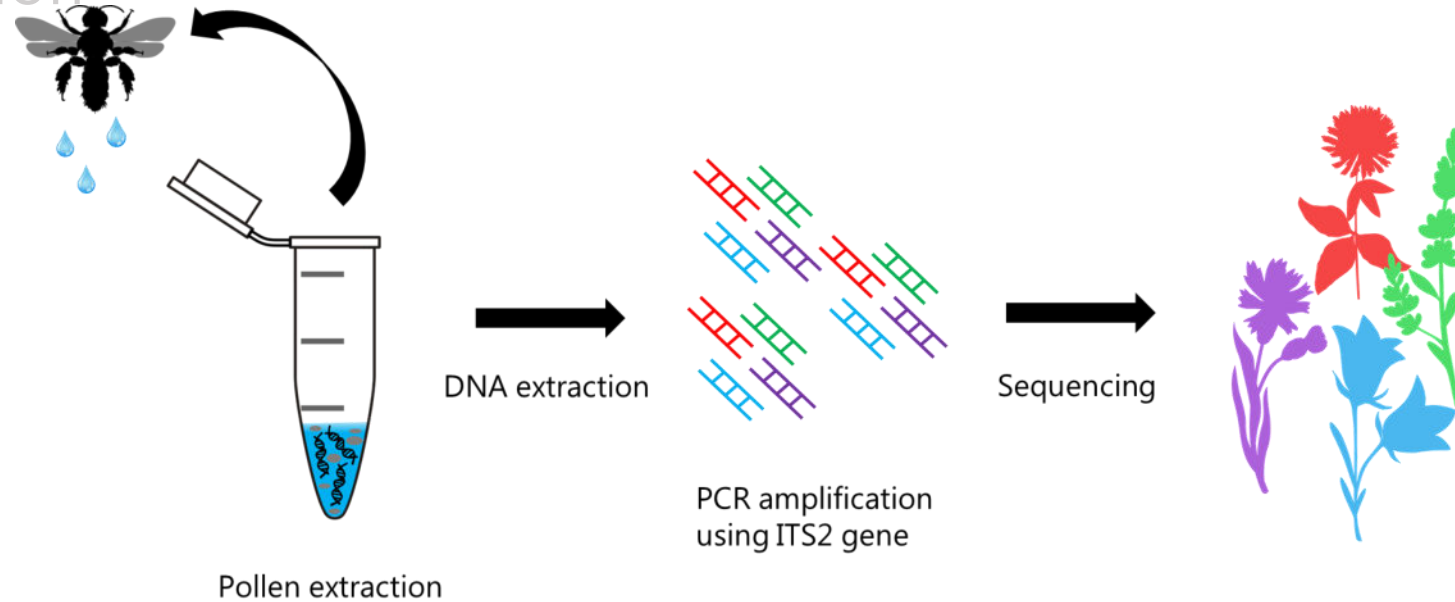
Introduction



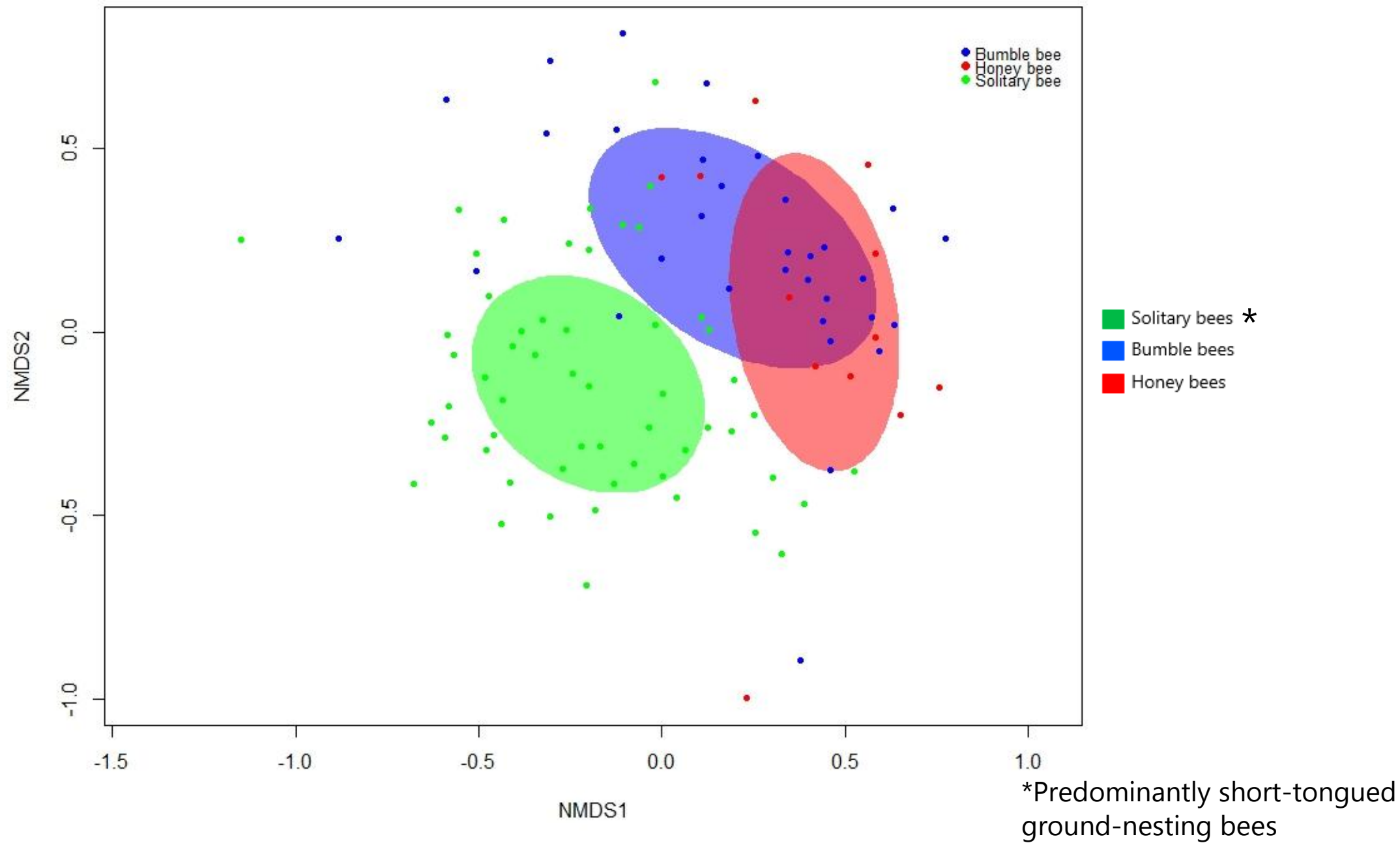
Surveying bees...

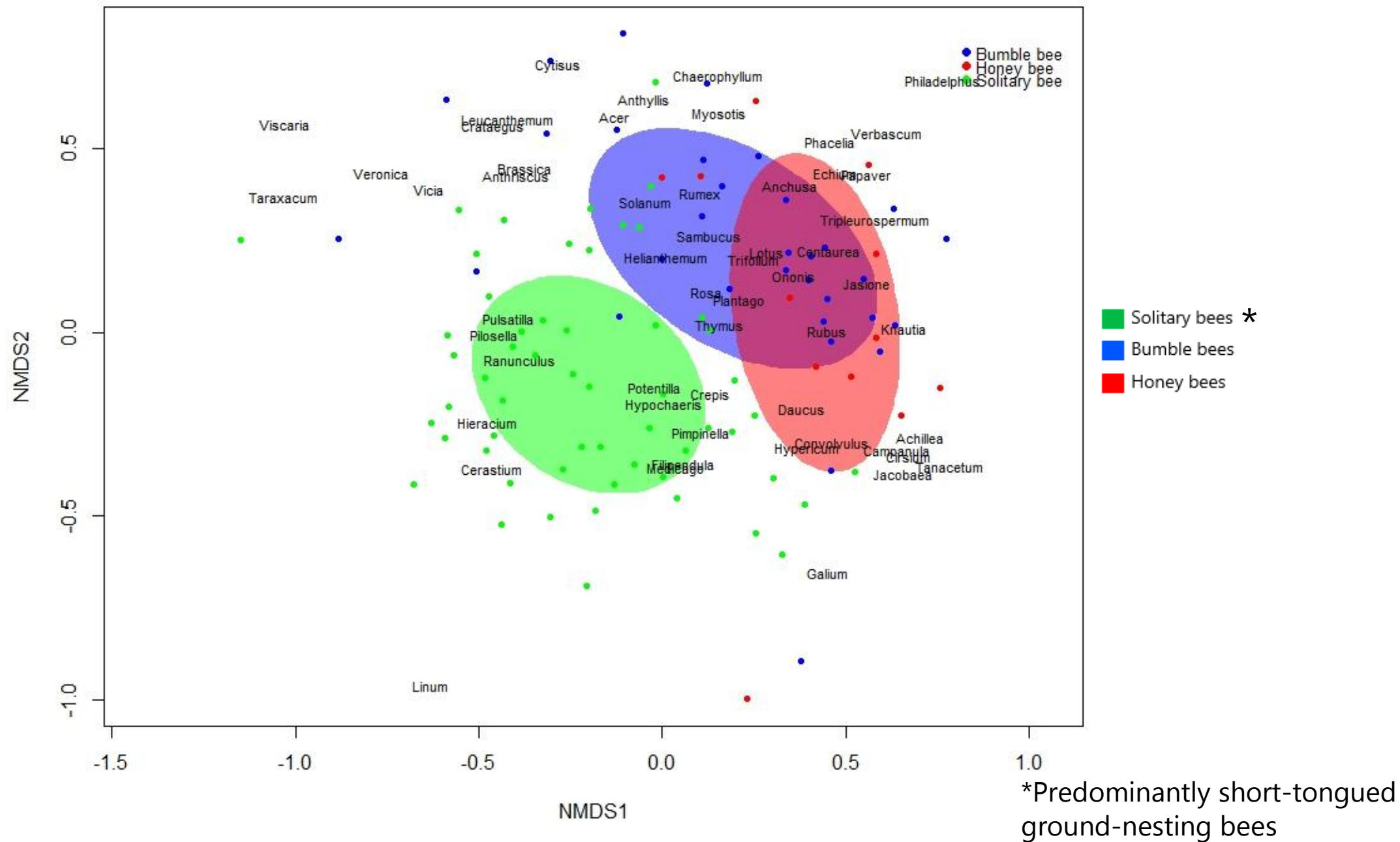
- Trapping
- Manuel observation
- Metabarcoding

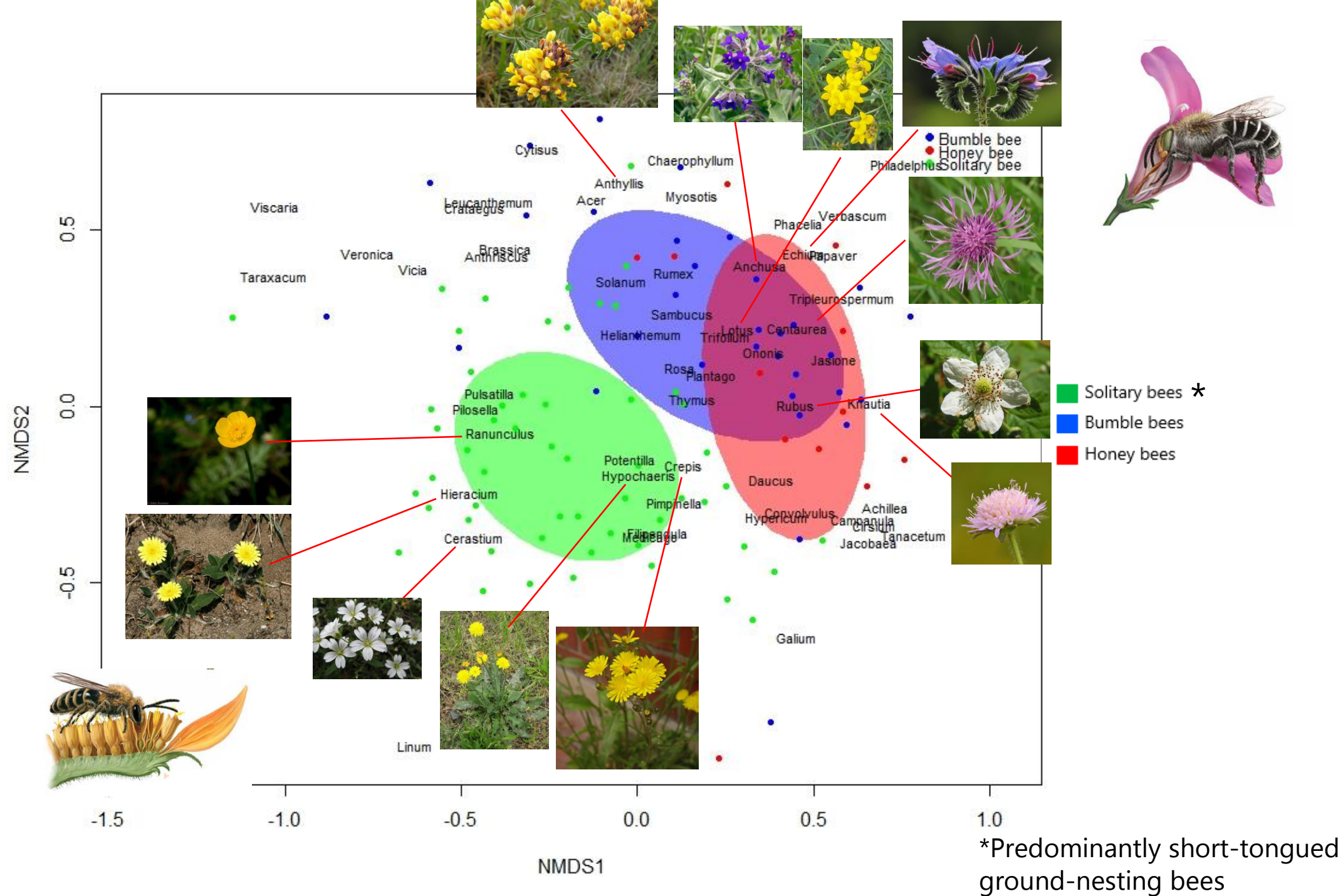
Laura Overby
Msc thesis work



- 100 individuals representing different functional groups and time periods (56 solitary bees, 32 bumble bees and 12 honey bees)
 - Collected on 28 plant species
- 156 plant genera identified through sequencing

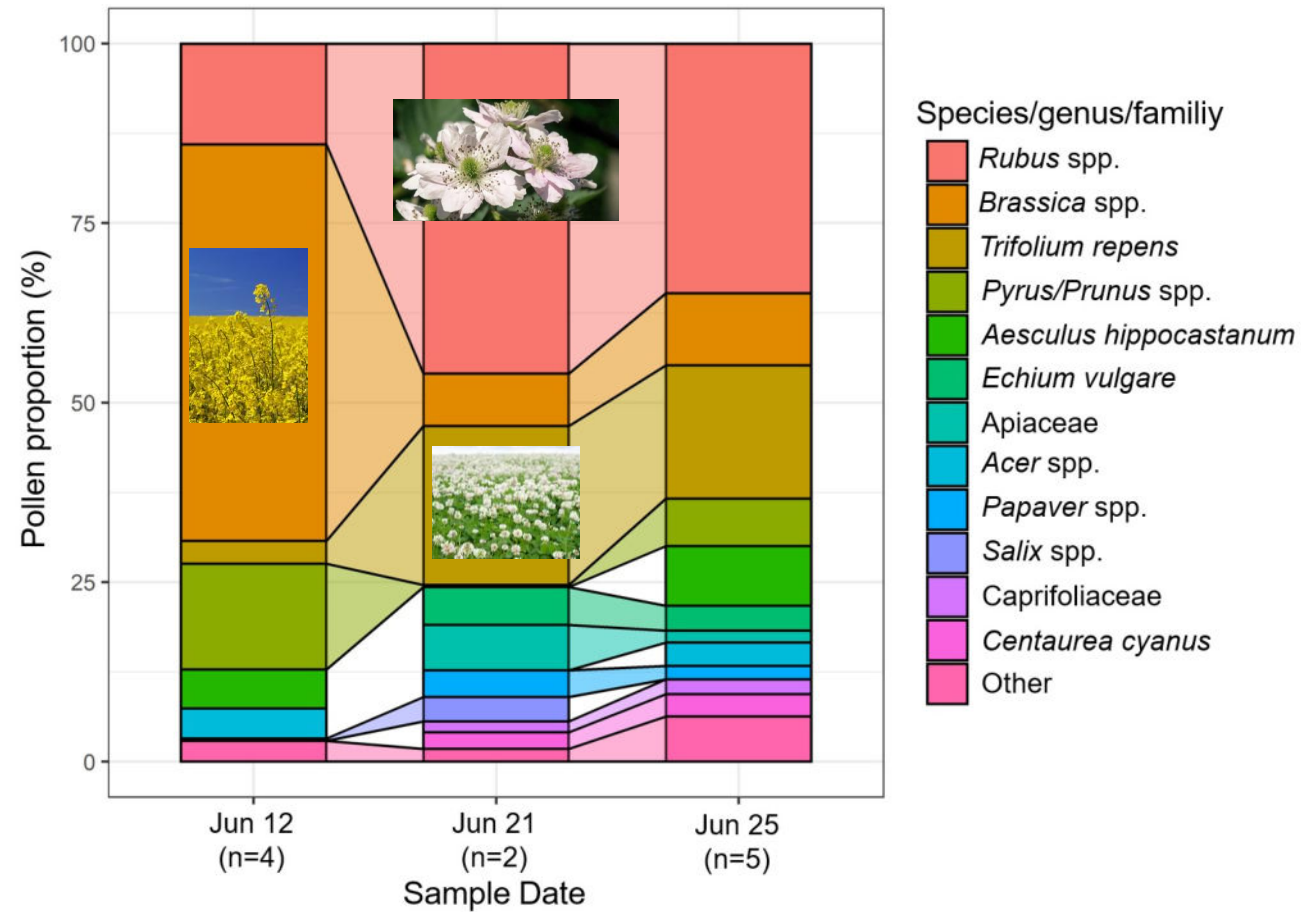






Hive pollen samples

Pollen samples



August

May

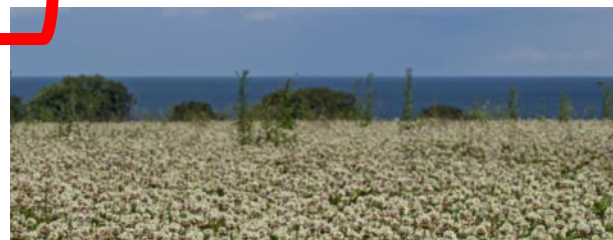
June

July

August



June gap



Heather (*Calluna vulgaris*)

Surveying bees...

- Trapping
- Manual observations
- Metabarcoding
- Camera monitoring and AI



- **40 cameras** distributed on **eight heathlands** with varying colony-density
- Image captured every 30 sec from 9:00-18:00
4/8-2/9

~1.050.000 images



Flowering intensity
(% purple pixels)





Algorithm (YOLOv8) was trained to detect pollinators, which were manually sorted into:

Honey bees



43048

Solitary bees



211

Bumble bees

217



Butterflies

2042

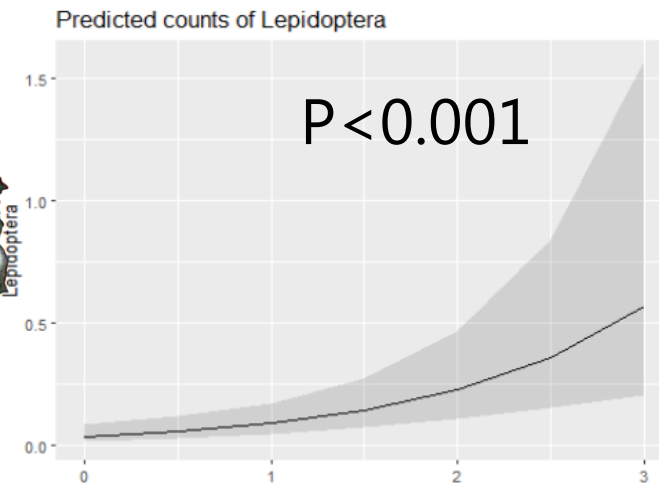
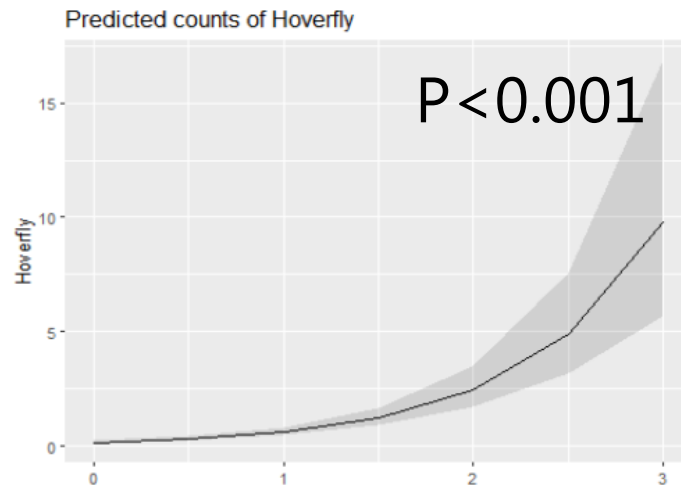
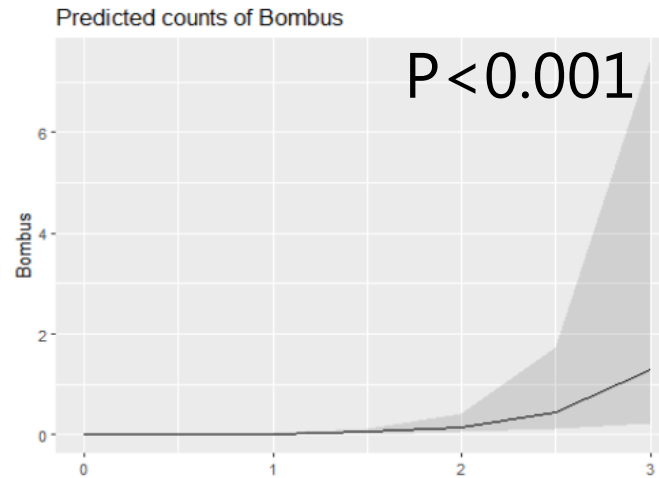
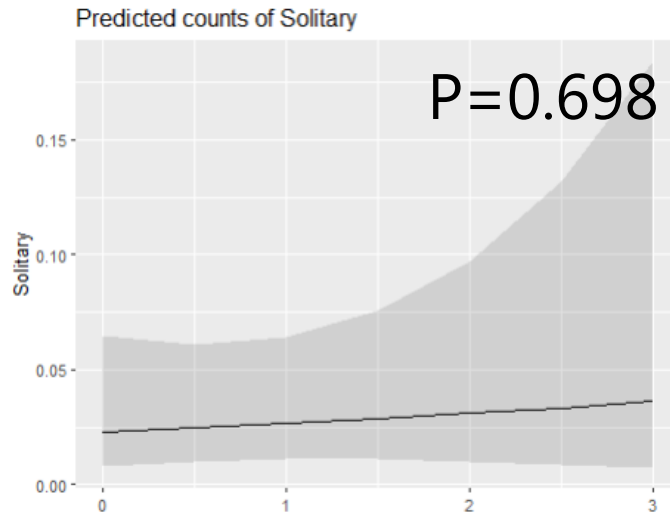


Hoverflies

2026



Generally few and common species, which correlate positively with honey bee count



Log()

Log()

Honey bee count is a really good surrogate measure for optimal foraging conditions, e.g. resource availability and weather conditions...

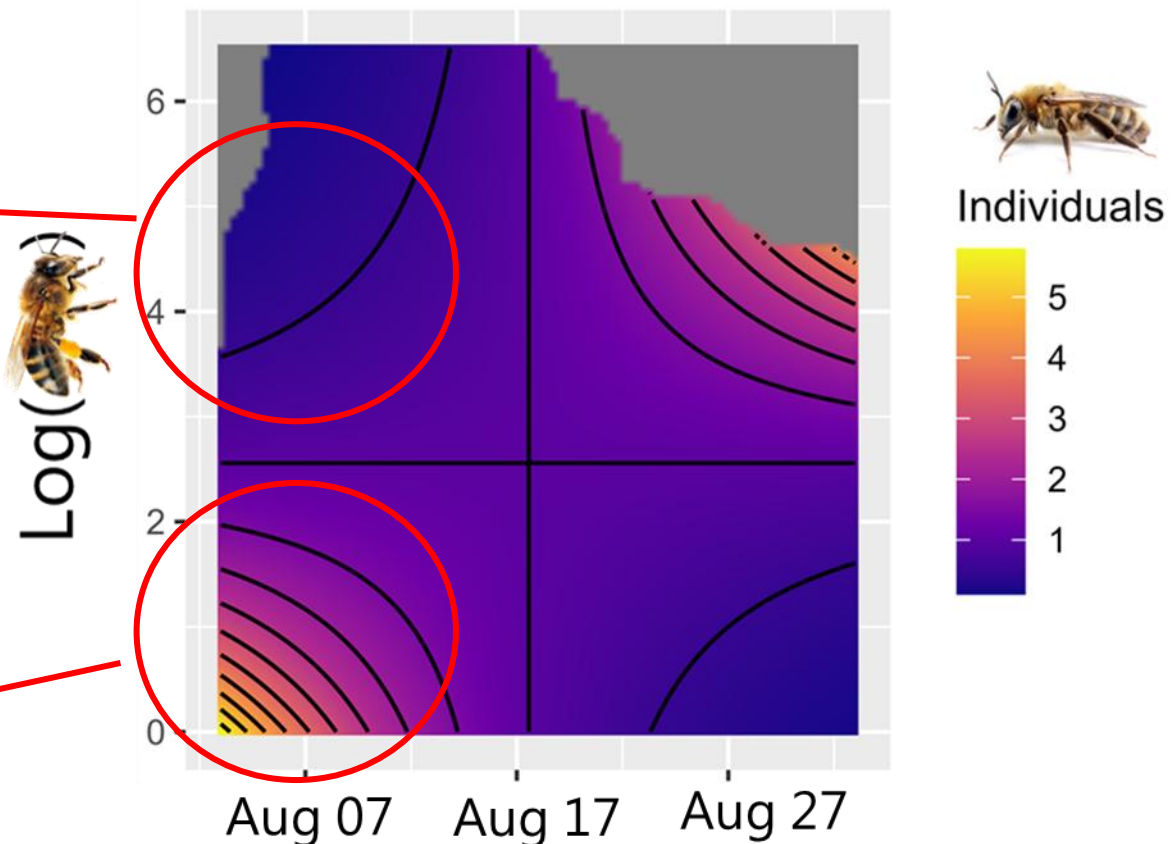
Be aware of timing

- Negative effect of honey bees on solitary bees early August (preliminary results)

More honey bees
Fewer solitary bees



Fewer honey bees
More solitary bees



Implications

- Honey bees do not seem attracted to fragments of grasslands and heathlands in a Danish agricultural matrix, except in August
-> **Impact of competition depends on time and place**
- **Be aware of seasonal resource-use by honey bees and diet-overlap**
 - eDNA from individual bees is an effective method to survey resource-use by both wild bees and honey bees in a given area
 - Traditional pollen samples from hives are highly informative for competition implications
- **Do not mass-introduce hives prematurely**, e.g. to heathlands in July before heather bloom in August

Tak!



15. Juni Fonden

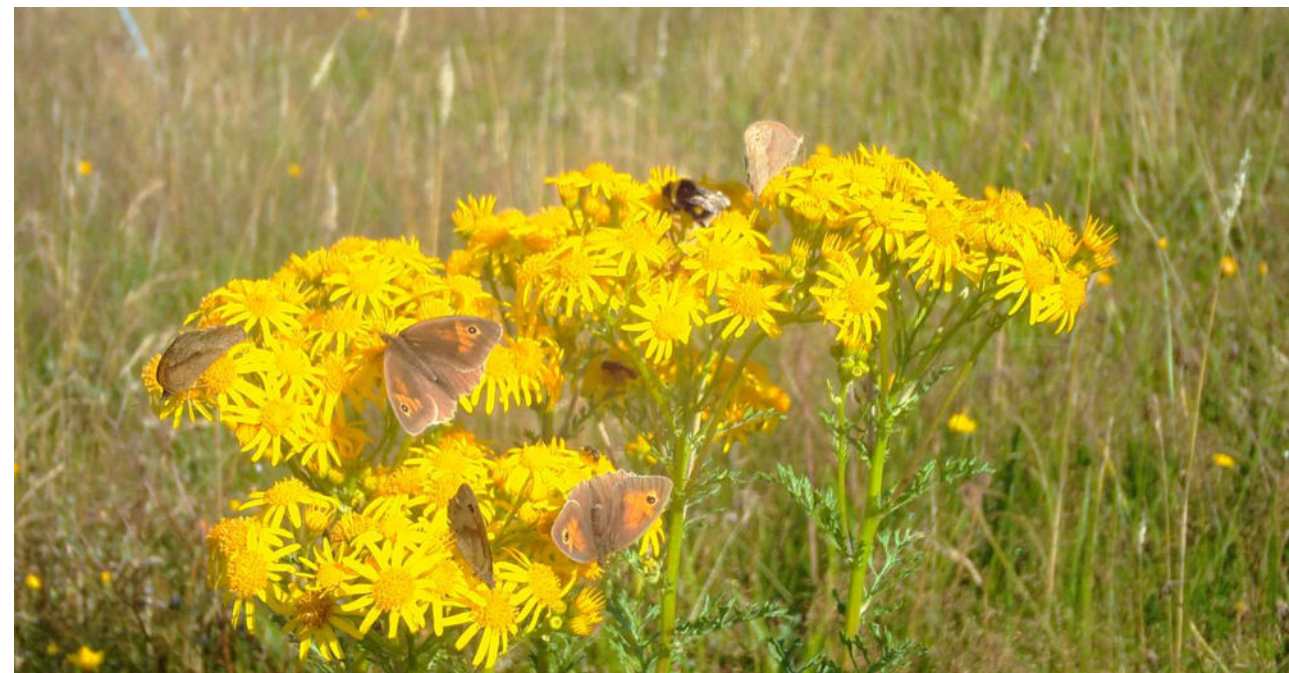
AAGE V.
JENSEN
NATURFOND



WINGSCAPES 17°C DB12 02 JUL 2020 08:00 am

Supervisors:
Inger K. Schmidt
Toke T. Høye
Yoko L. Dupont

Mentor/guru:
Henning B. Madsen



WINGSCAPES 20°C BRA2 19 JUL 2024 09:00 am

Et al.:
Chatchai Kosawang
Laura Overby
Kim Bjerger
Lasse Gottlieb

David Byriel
Mathias Justesen

hjr@ign.ku.dk