TRAINING COURSE 4
24-25 February 2020
Paola, MALTA

How can we save bees through sustainable farming?

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Simone Marini

Landlab – Institute of life Sciences **- Scuola Superiore Sant'Anna**

Wild bees, ecology**, agro-ecology**

Photo: Simone Marini
Location: Montale (PT)
Italy – post-wildfire
area – Project ABEES

Contents

1) Pollinators and Agriculture: the Global pollinator crisis

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# *Pollinators and Agriculture: the Global pollinator crisis*

Photo: Agustín M. Bartual
Location: Acciaiolo (PI) Italy –
Project QuESSA

Natural enemies
(Holland et al. 2016)
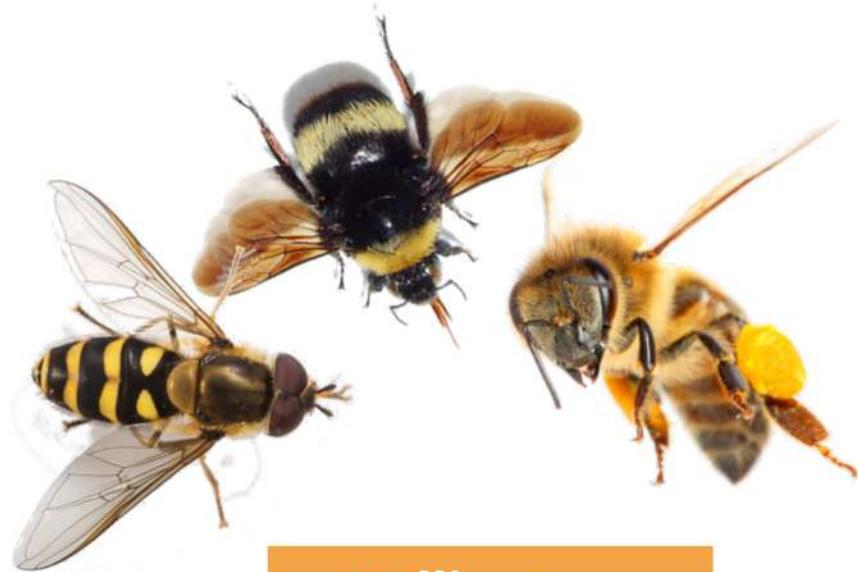
Pollinators
(Kremen et al. 2007)

The economic value of pollination

Wild bee communities $3,251 ha-1 ± 547
range $7–14,252

Managed honey bees $2,913 ± 574
range $0–18,679

Individual wild bee species up to $963 ha-1

Maximum contributions 16.0 ± 0.34 times higher than the mean contributions

Photo: Agustin M. Bartual
Project QuESSA

Ref: Kleijn et al. 2015.

* data from **53 studies** allowing to calculate the economic contribution of wild bees to crop production using the production value method. Financial contribution estimated from **FAO stats**.
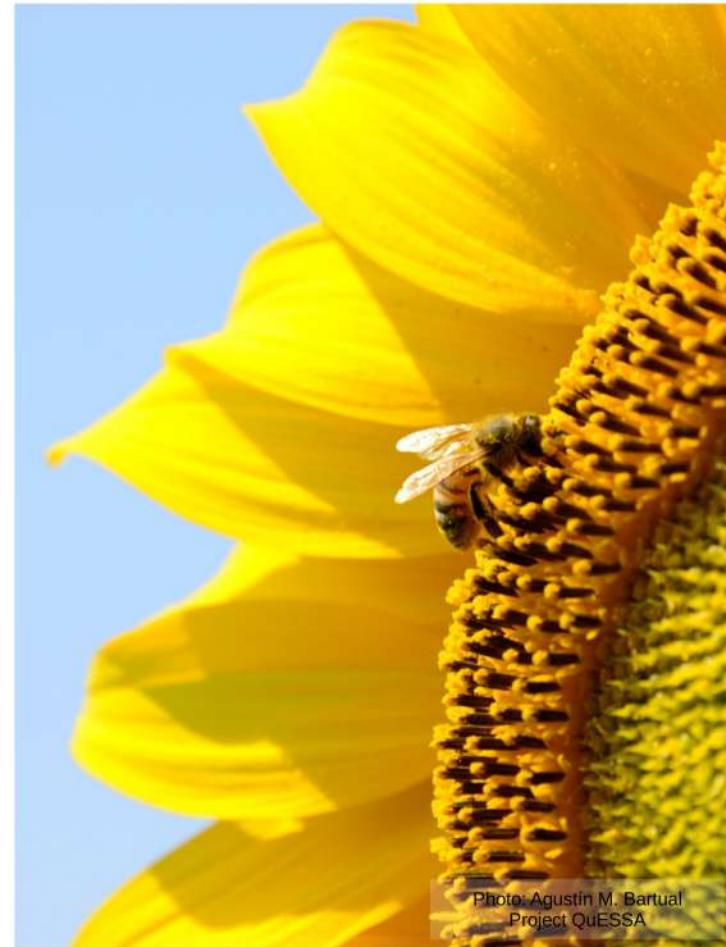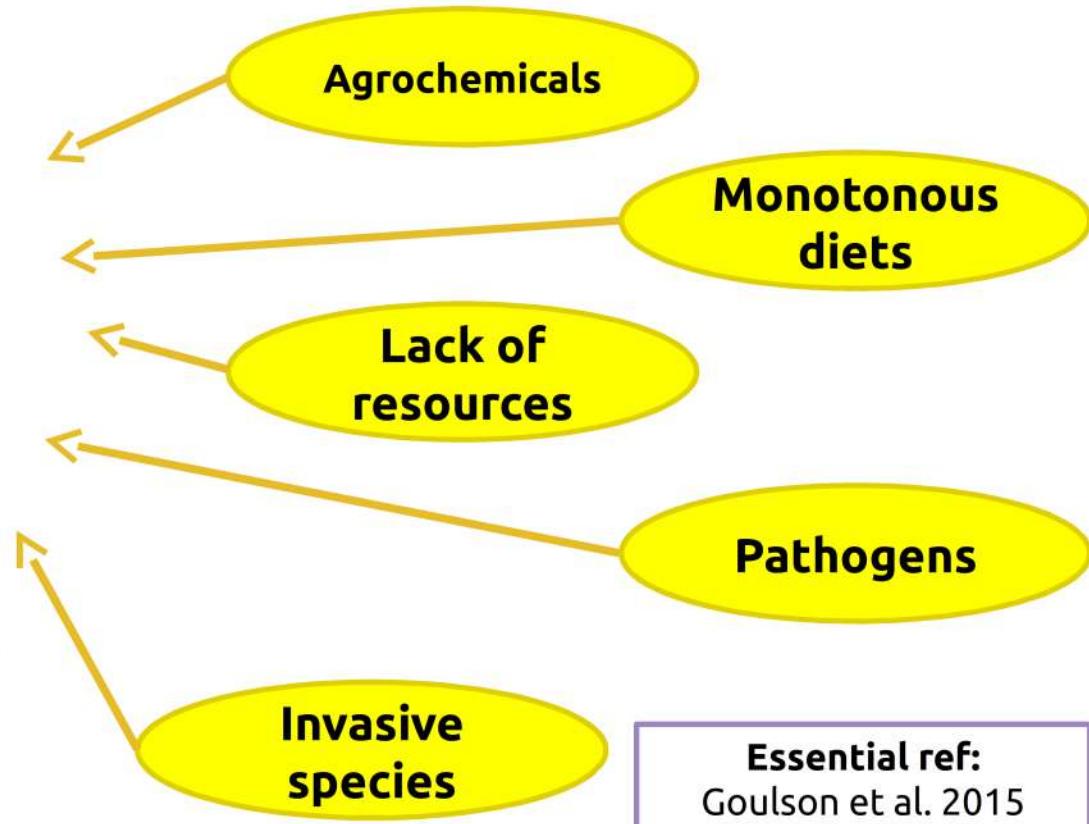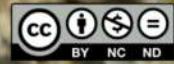
Around 1120 wild bee species in Italy!
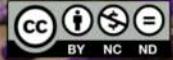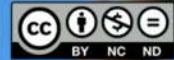
Ref: Mario Comba
http://digilander.libero.it/mario.comba/

The importance of
semi-natural habitats (SNHs)

Photo: Simone Marini
Location: Padule di
Fucecchio - Larciano
(PT) Italy

Why Semi-natural?

Photo: Simone Marini
Location: Padule di
Fucecchio - Larciano
(PT) Italy

- **Modified**

- **Managed**

- In the **landscape matrix**

- Part of the **agroecosystem**

- **Spillover** from/to crops and natural elements

Semi Natural Habitats' classification

QuESSA

Width > 25m

Width < 25m

Fallow (FA)

Herb. areal (HA)

Photo: Agustín M. Bartual
Project QuESSA

Herb. linear (HL)

Photo: Agustín M. Bartual
Project QuESSA

Photo: Agustín M. Bartual
Project QuESSA

Shrubs and trees
cover < 30%

Woody areal (WA)

Photo: Agustín M. Bartual
Project QuESSA

Shrubs and trees
cover > 30%

Woody Linear (WL)
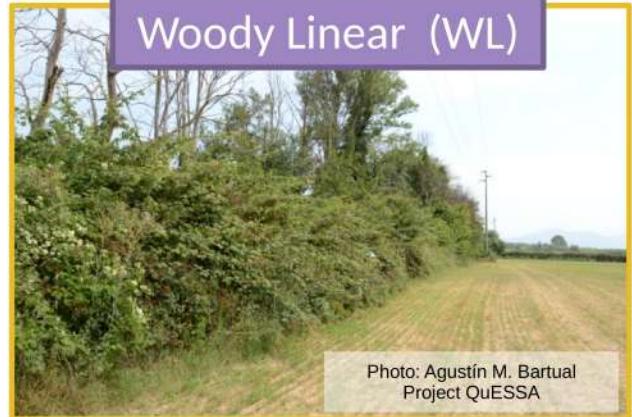
Photo: Agustín M. Bartual
Project QuESSA

Spillover to/from SNHs

Semi-natural habitats

Crops

Pollination service

Pollination service

Food resources

Food resources

Nectar

Nectar

Pollen

Pollen

Nesting sites and resources

Photo: Simone Marini

Essential reference: Michener 2007
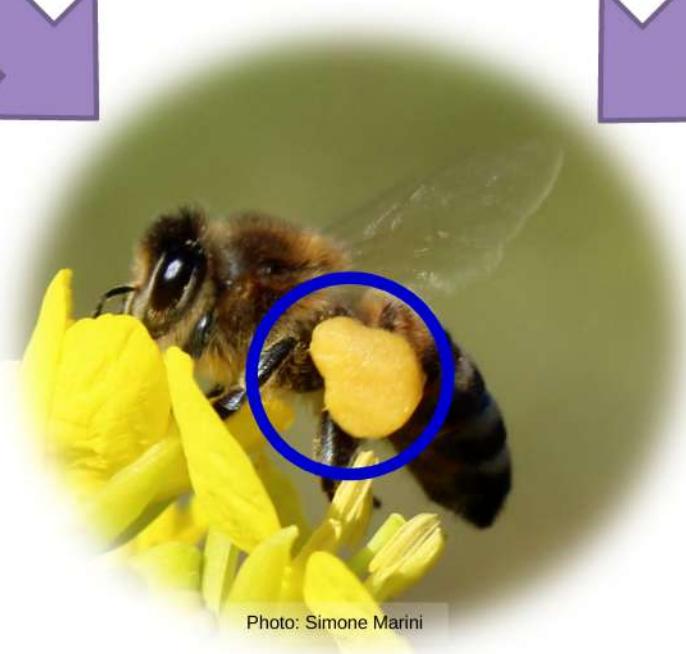
Case study 1

How SNHs structure and configuration affected wild and honey bee diversity

Photo: Agustín M. Bartual
Project QuESSA

Photos: Agustín M. Bartual
Project QuESSA

These is a knowledge gap regarding the **importance** and **contribution** of different **SNH types** in sustaining **wild bee communities**

1 Are **wild bees communities different** in the five **SNH types**?

2 Which **SNH types** are **preferred** by the **most abundant wild bees**?

3 At **landscape** level, what is the **effect of SNHs** surface on **wild bee** species?

From: Marini, 2017, p. 9-10

QuESSA

**2 triplets, edge and interior**

Edge 2

~25 m

Left active 4 days

Edge 1

Photo: Agustín M. Bartual
Project QuESSA

~400ml of soapy water

Placed at vegetation height

Photo: Agustín M. Bartual
Project QuESSA

Methods: Pan trap sampling

Field

Laboratory

Photo: Simone Marini
Project QuESSA

Photo: Simone Marini
Project QuESSA

Photo: Simone Marini
Project QuESSA

Photo: Simone Marini
Project QuESSA

Photo: Simone Marini
Project QuESSA
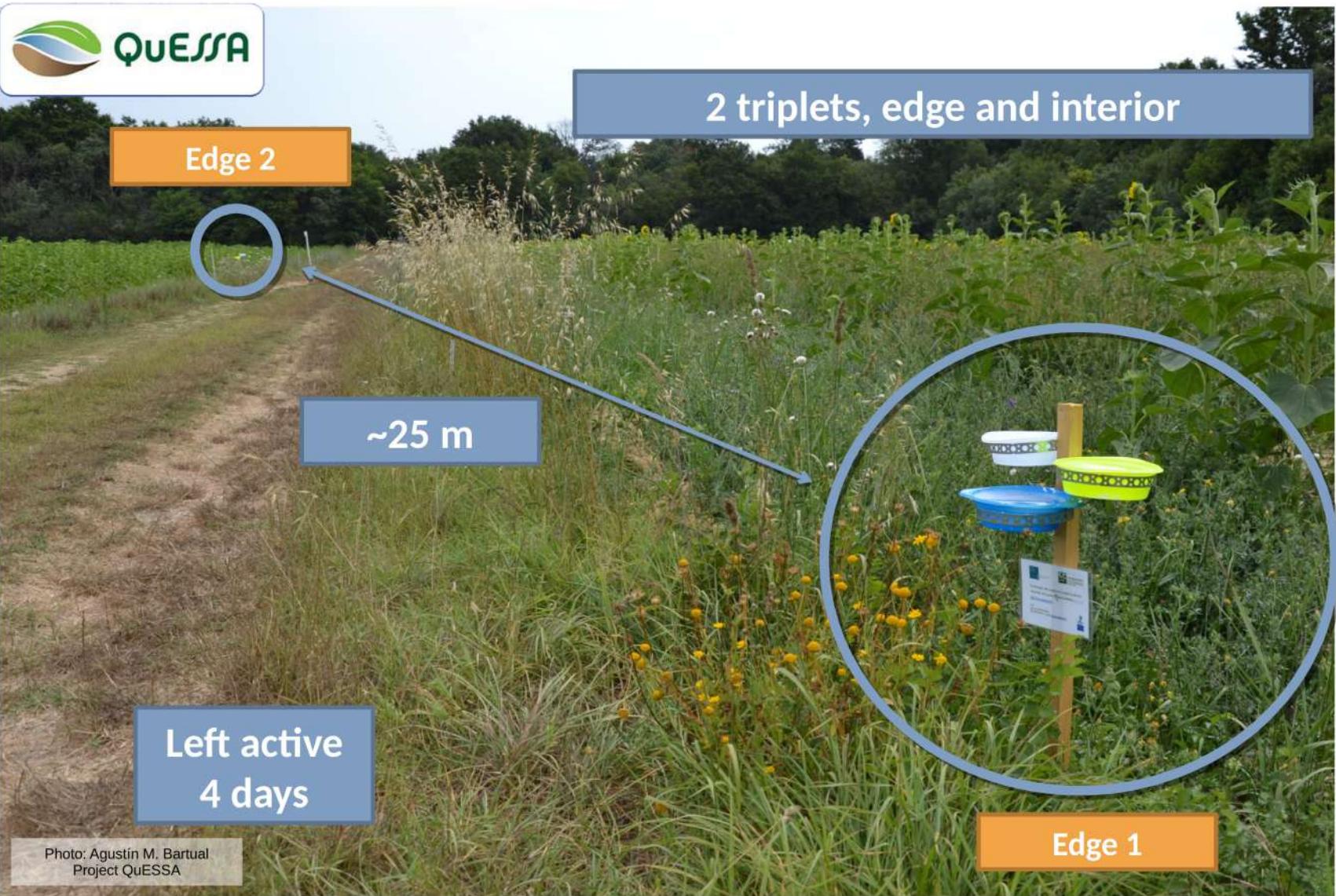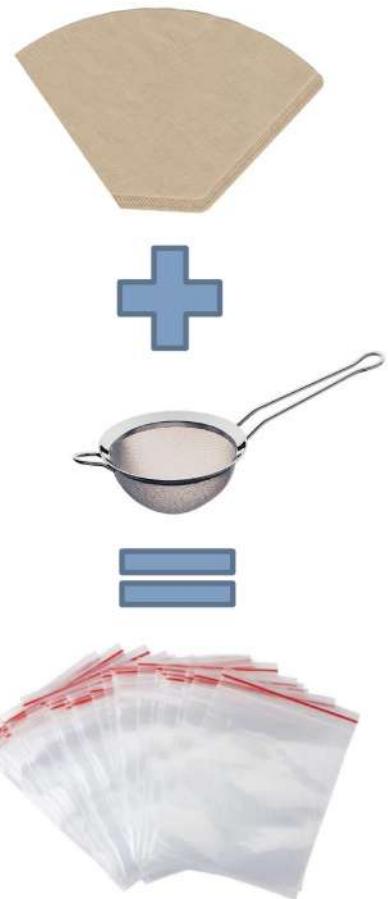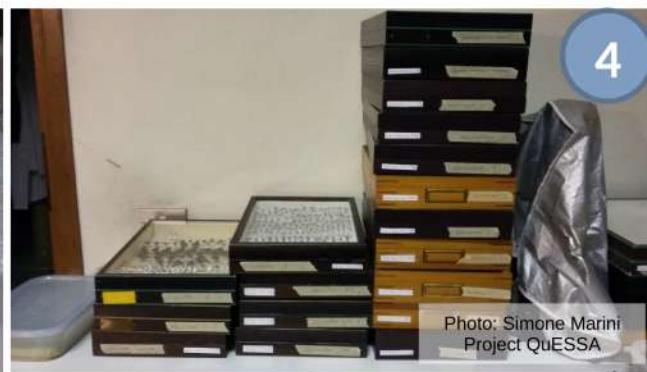
Determination at species or **morphospecies** level

The Very Handy Manual:

How to Catch and Identify Bees and Manage a Collection

A Collective and Ongoing Effort by Those Who Love to Study Bees in North America

Last Revised: September 2015

QuESSA

- 15 **Block landscapes**

- 50 **SNHs**

- 50 **SNHs landscapes**

Legend

Selected SNHs
- ● Fallow
- ■ Herb. areal
- ◆ Herb. Linear
- △ Woody areal
- ⬠ Woody linear
- ⬚ SNH landscape
- ★ Reference field #4

Block landscape
SNHs typology
- Woody areal
- Woody linear
- Herb. areal
- Herb. linear
- Fallow
- River or stream

Map data copyrighted OpenStreetMap contributors and available
from https://www.openstreetmap.org - PhD Thesis Simone Marini

From: Marini, 2017, p. 12

Case study 1: SNH wild bees

Regression models for **local** SNH types effect

1

Response variables

- Female wild bee richness
- Female wild bee abundance
- Female wild bee Shannon div.

Explanatory variables

- SNH typology
- Triplet position
- Sampling round

Random effect

- Block Landscapes

Richness
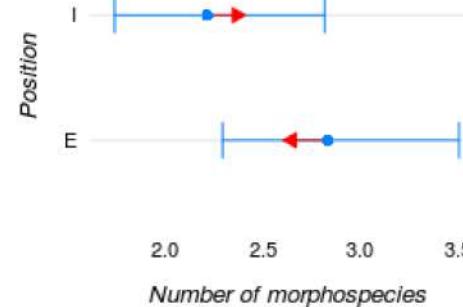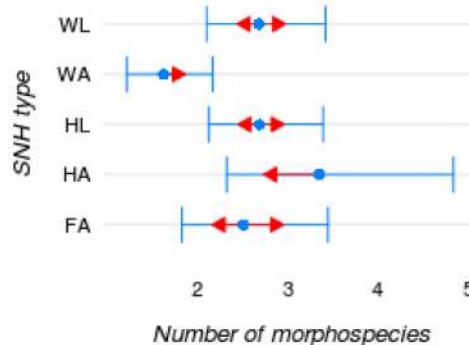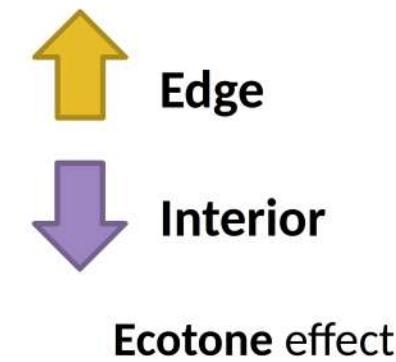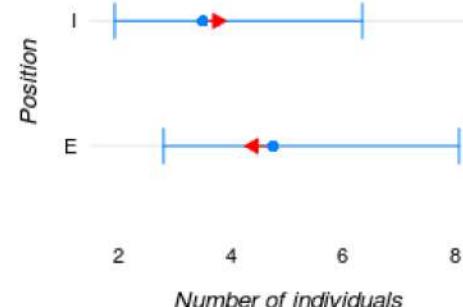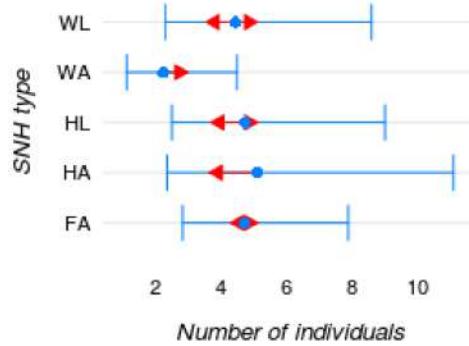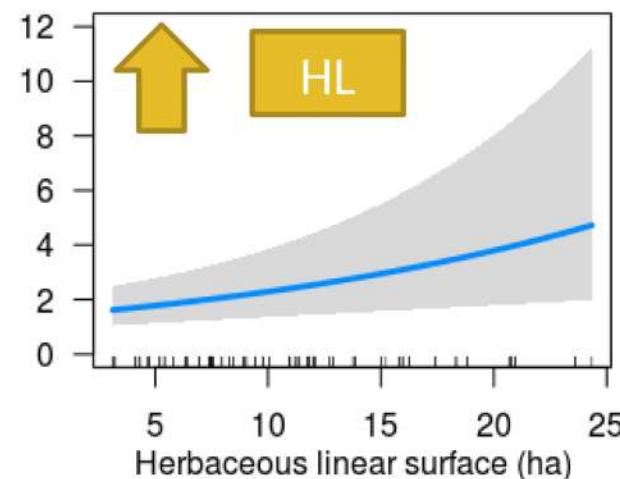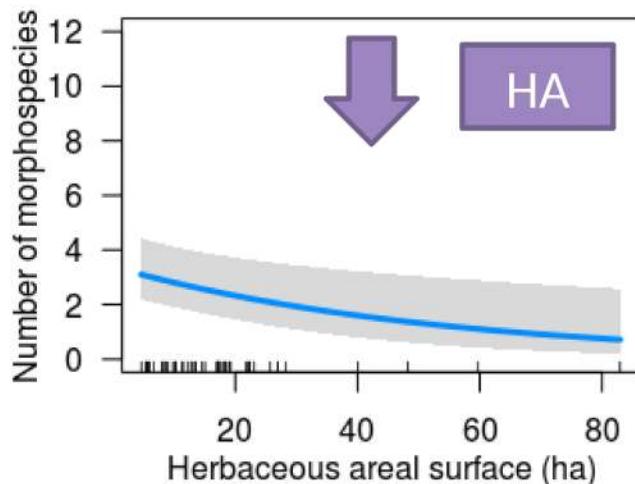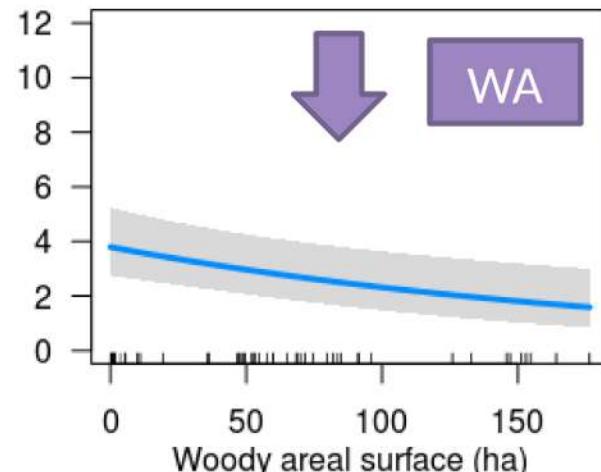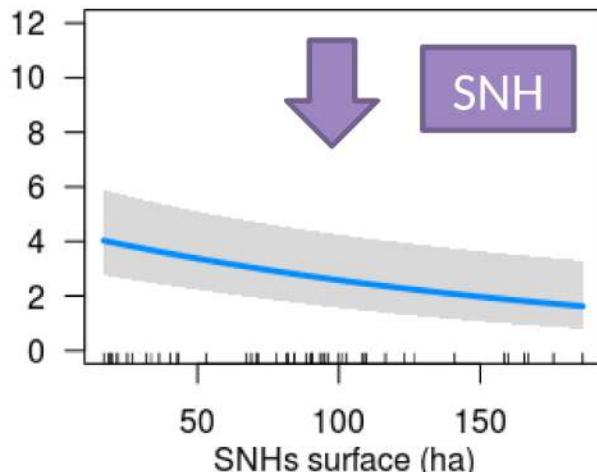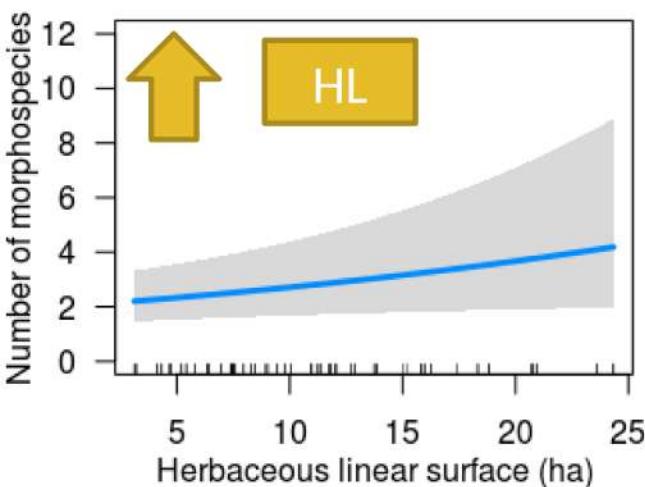
SNH type: WL, WA, HL, HA, FA
Number of morphospecies

Position: I, E
Number of morphospecies

Woody areal

Woody linear

Abundance

SNH type: WL, WA, HL, HA, FA
Number of individuals

Position: I, E
Number of individuals

Edge

Interior

Ecotone effect

From: Marini, 2017, p. 17

Case study 1: SNH wild bees

Regression models for **landscape** SNH types effect

From: Marini, 2017, p. 20

Case study 2

How each SNH type contributed to feed wild bees through their flower resources

Photo: Agustín M. Bartual
Project QuESSA

Photos: Agustín M. Bartual
Project QuESSA

How many floral resources do the various SNH typologies provide to sustain wild bee populations?

1 Determine **which semi-natural habitat** provides a higher **amount** and **diversity** of **floral resources**, and which one has the highest resources **stability** in time

2 Describe the **pattern of visits** in the different **SNHs** and how this **varies** in **time**

3 Determine if **network metrics** are affected by **land use** configuration of the **surrounding landscape**.

From: Marini, 2017, p. 27-28

6 apiaries

6 landscapes, 1km radius

4 SNHs in each

6 sampling times

Legend
- ★ Central apiary
- Selected SNHs
- ■ Herb. areal
- ◆ Herb. linear
- △ Woody areal
- ⬠ Woody linear

0   2.5   5   7.5   10 km

0   300 600 900 m

Map data copyrighted OpenStreetMap contributors and available
from https://www.openstreetmap.org - PhD Thesis Simone Marini

From: Marini, 2017, p. 29
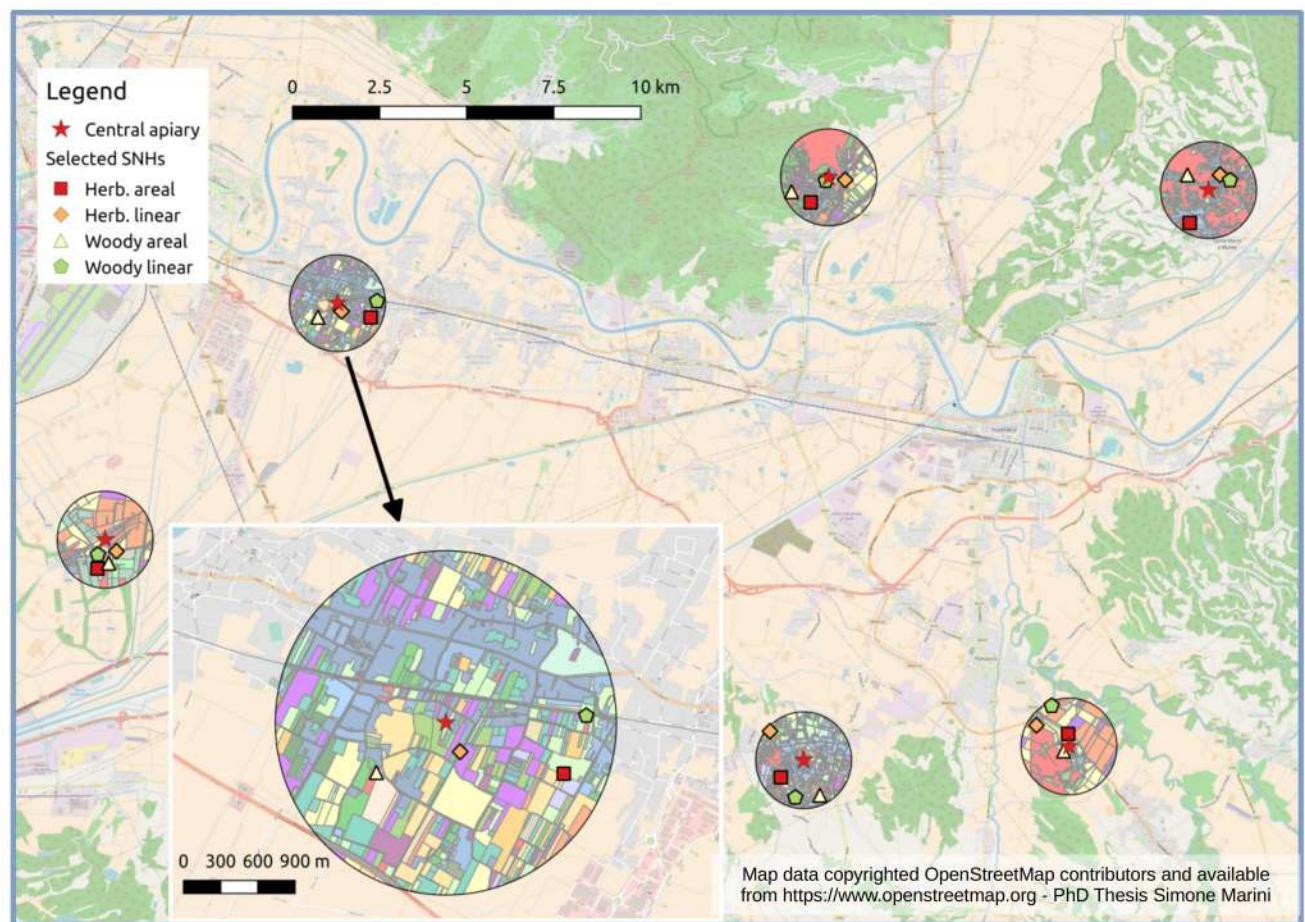
2 vegetation **sub-transects** of **50m**

10 vegetation plots in each

Select **plant** species having a **frequency ≥ 3 plots**

Wild bees -> **20** visitation rate **plots 18'' each**

Honey bees -> **3** visitation rate **plots 2' each**

Response variables

1

- Fl. resources richness
- Fl. resources abundance

~

Explanatory variables

- SNH typology
- Sub-transect position

- Sampling round
- SNH typology : sampling round

Random effect

- Landscapes

Woody areal ↓ / **Herb. areal** ↑

Woody linear = / **Herb. linear** ↑

June-July ↓ / **April** ↑
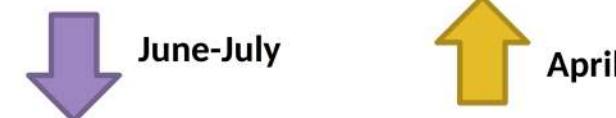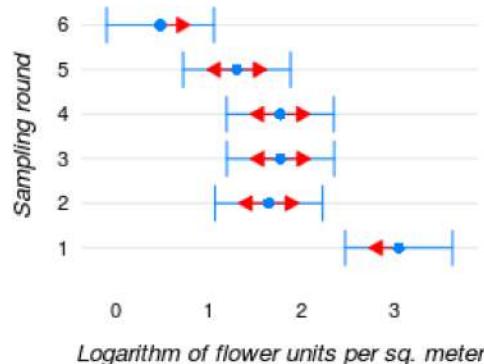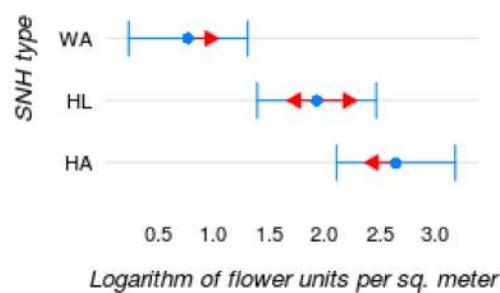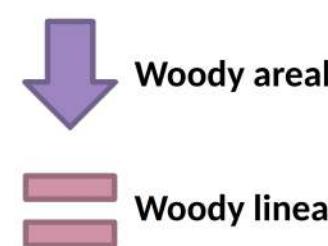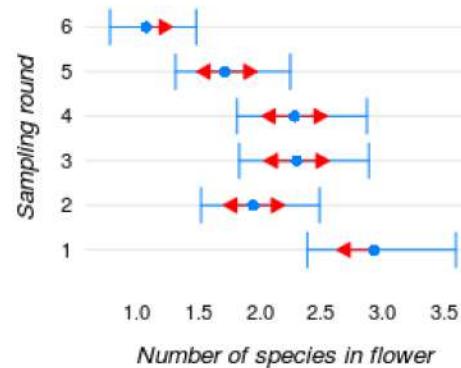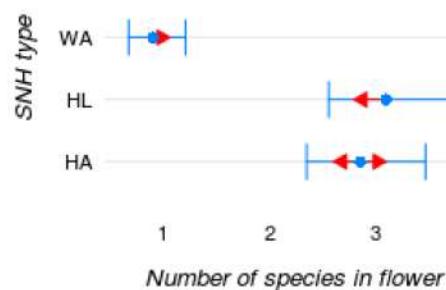
1 Errors:
Gamma distr.
Log link

Response variable

▪Flower abundance stability

~

Explanatory variables

•SNH typology

Random effect

•Sub-transect position

⬇ Woody areal

▬ Woody linear

⬆ Herbaceous areal

⬆ Herbaceous linear

2

SNH Woody linear

Wild bees

Plants

Andrena sp 46 male

Andrena sp 56 male

Andrena flavipes fem

Bombus pascuorum fem

Bombus ruderatus male

Bombus terrestris fem

Halictus scabiosae fem

Anthophora plumipes fem

Xylocopa violacea fem

Rubus ulmifolius

Lamium maculatum

Vinca major

Robinia pseudacacia
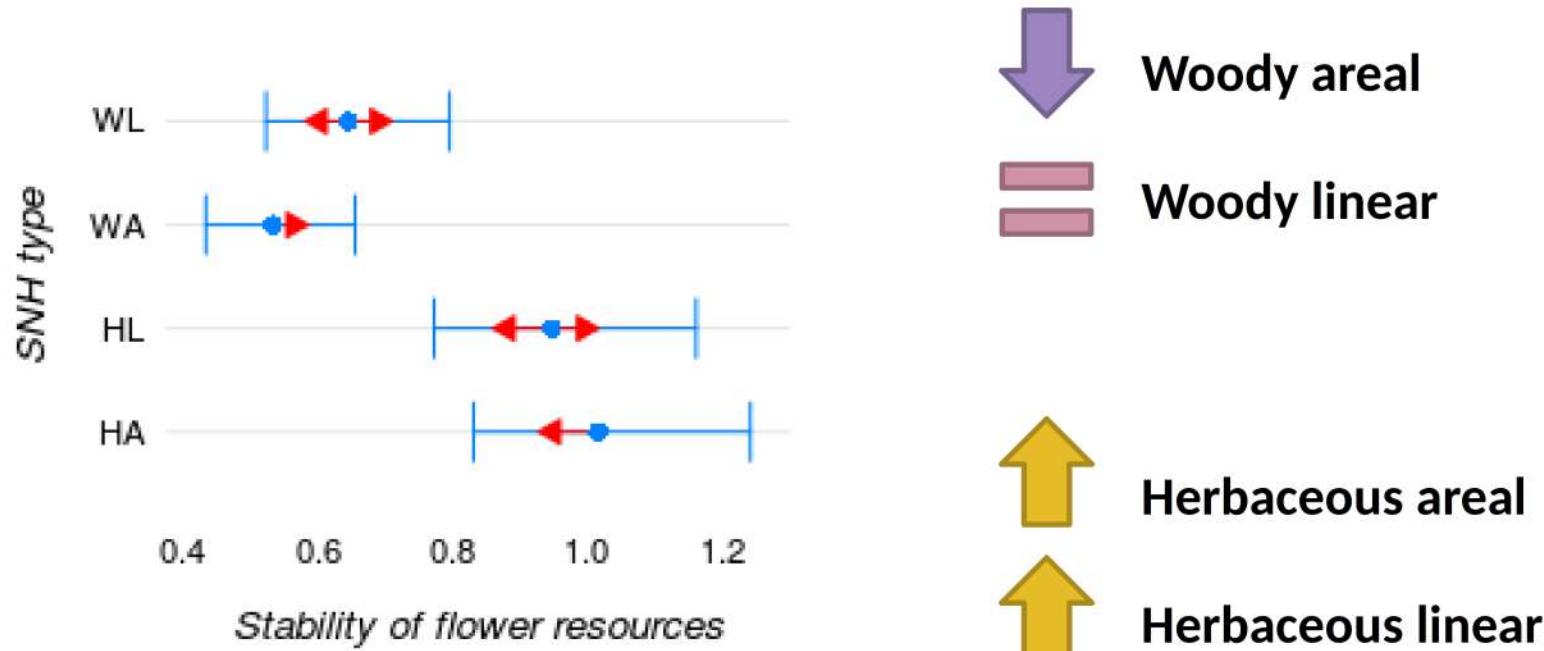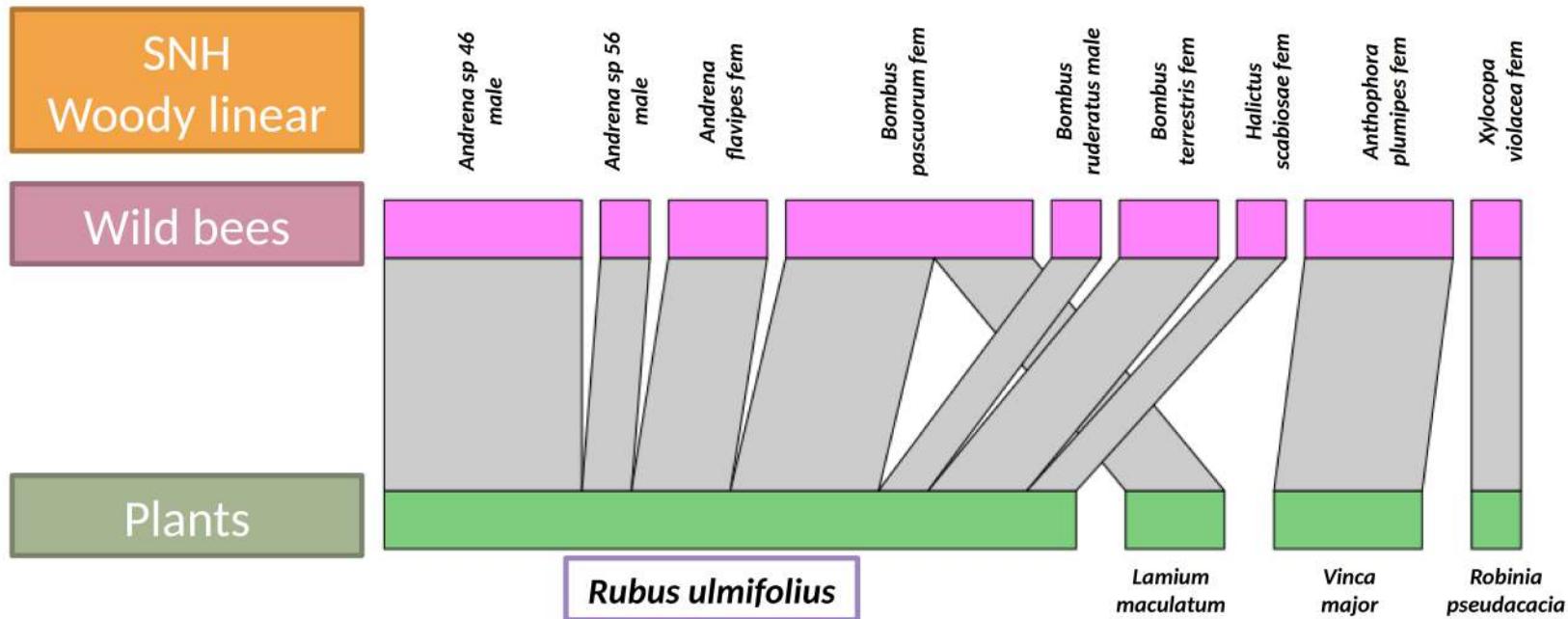
SNH type	Wild bee entities	Plant species	Generality	Vulnerability	Connectance	Interaction evenness	Nestedness	H2
Herb areal	44	21	1.58	3.18	0.06	0.56	12.07	0.70
Herb linear	37	14	1.50	3.19	0.09	0.53	20.90	0.82
Woody areal	**17**	**7**	1.14	2.48	**0.15**	0.55	**37.41**	0.90
Woody linear	**9**	**4**	1.24	**4.58**	**0.28**	0.61	**34.55**	0.72

From: Marini, 2017, p. 37-38

Case study 3

How woodlands' management and wildfires affect the wild bee population?

Photo: Simone Marini
Location: Montale (PT) Italy –
post-management area –
Project ABEES

Wild bees & semi-natural habitats' (SNHs) management

Semi-natural habitats (SNHs)

Crops

Management

Site 16 management – 09 March 2018

Photo: Simone Marini
Location: Montale (PT) Italy –
post-management area –
Project ABEES

Photo: Simone Marini
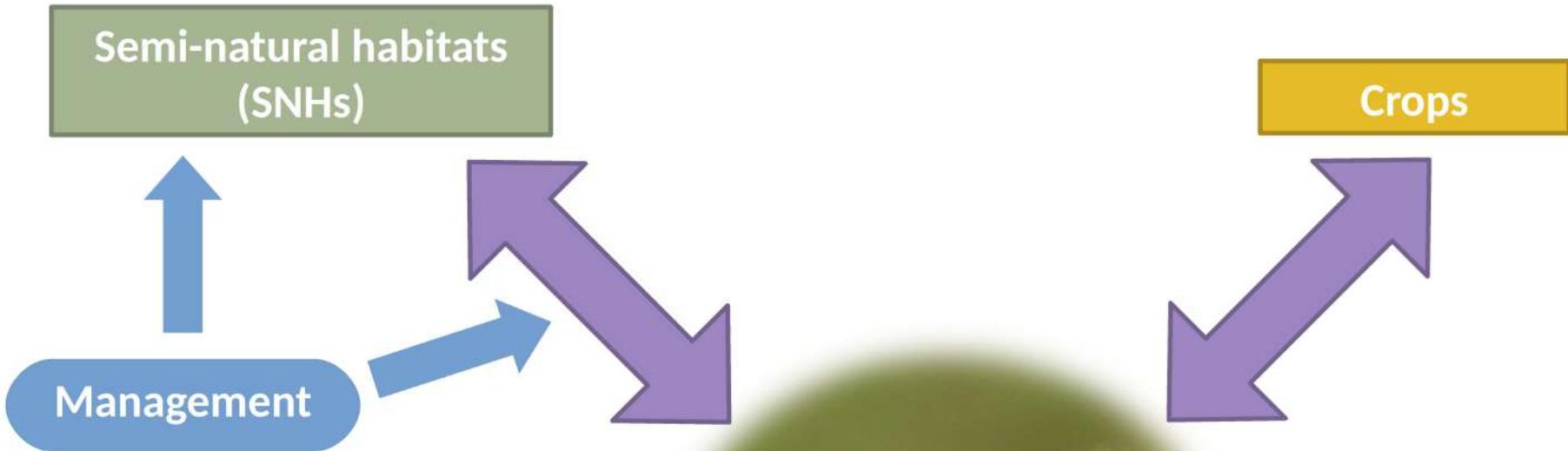
LA NAZIONE /Pistoia /Cronaca

CRONACA

Situazione drammatica a Montale, evacuate una decina di abitazioni / VIDEO

Il rogo è ripartito su 3 fronti

Pubblicato il 17 luglio 2017
Ultimo aggiornamento: 18 luglio 2017 ore 00:11

~ 370 ha

Incendio a Montale, la situazione non è ancora sotto controllo. Le indicazioni del Comune

🕒 18 luglio 2017 10:39   🏷 Cronaca   ⌂ **Montale**

CRONACA

Montale una settimana dopo l'incendio: sembra di essere sulla Luna / FOTO/ VIDEO

Collina devastata e ora anche pericolosa: senza alberi e piante rischio frane e allagamenti

Site 06 – 23 February 2018

Photo: Simone Marini
Location: Montale (PT)
Italy – post-wildfire area –
Project ABEES

PROJECT

Management effect on pollinator community in the semi-natural habitats of the Pistoia valley

Fondazione Cassa di Risparmio di Pistoia e Pescia - founder of the project

Young researcher: Dr. **Simone Marini**
Scientific director: Dr. **Anna Camilla Moonen**

Average **burnt area** in Italy from 1980 to 2016:

105450 ha

Average **number** of fires in Italy from 1980 to 2016:

9127

Ref: http://effis.jrc.ec.europa.eu/applications/data-and-services/
Accessed 25/02/2019

Fires in Italy
Burnt area from 1980 to 2016

Burnt area - ha

Year

Source: http://effis.jrc.ec.europa.eu/applications/data-and-services/

Fires in Italy
Number of fires from 1980 to 2016

Number of fires

Year

Source: http://effis.jrc.ec.europa.eu/applications/data-and-services/
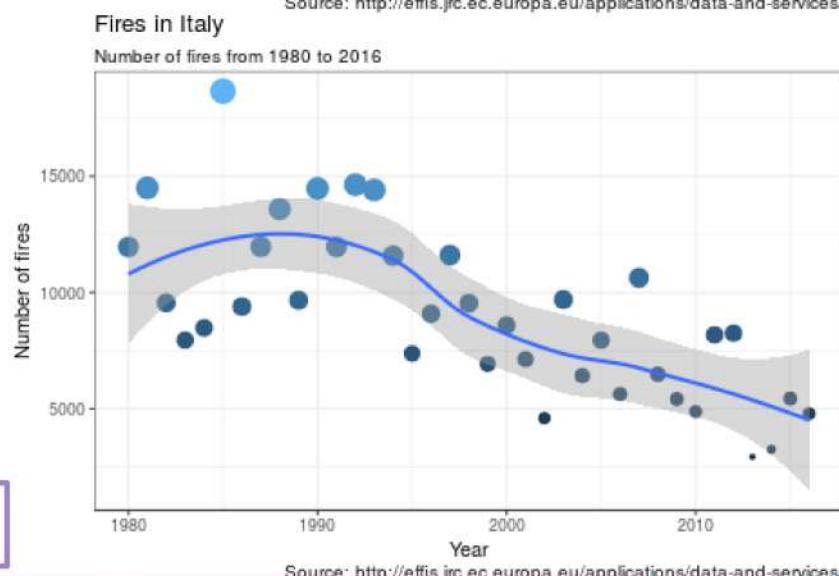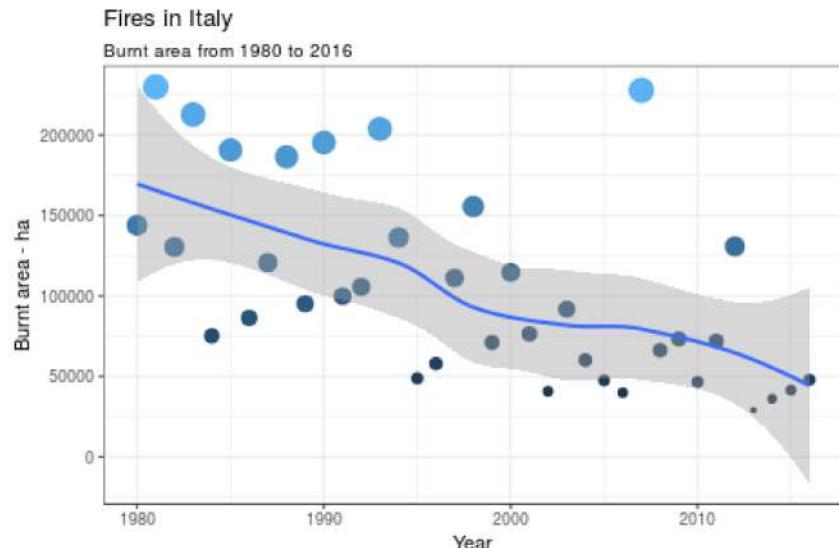
- The **fire effect** on flower resources and pollinators **needs to be studied in detail!**

- **Never studied in Italy!**
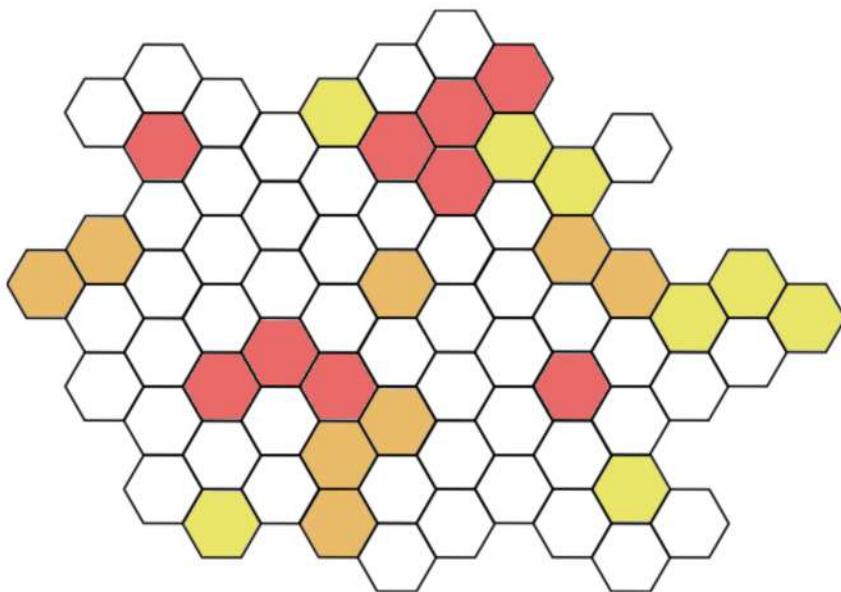
Matrix of burned and unburned sites

Site 8 managed and burnt – 08 March 2018

Photo: Simone Marini
Location: Montale (PT)
Italy – post-wildfire area –
Project ABEES

SNHs' management regime and fires may interact!

Essential ref:
Keeley et al., 2011
Brown et al., 2017
Mola & Williams, 2018

1) **Wildfire** would **open up the vegetation** and stimulate the presence of **floral resources**, which can attract **pollinators**

2) The **woodland wild bee communities** depend on the **management regime**, since management **increases light availability** stimulating **floral resources** for pollinators

3) **Wildfire**, modifing the **flowering plant species composition**, may alter the **wild bee** community **toward** more **generalist bee species**.

TO BE TESTED USING 2019 DATA, AFTER BEE SPECIES COMPLETE DETERMINATION!

Habitat	**Burned**	**Not burned**
Not recently Managed	4 sites	4 sites
Recently Managed	4 sites	4 sites

Legend

Sampling points

▲ Not burned, Not managed
▲ Not burned, Managed
● Burned, Not managed
● Burned and Managed
▬ Burned area

Map data copyrighted OpenStreetMap contributors and available from https://www.openstreetmap.org - Project ABEES

Site 11 – 26 April 2018

1m²

50m

Photo: Simone Marini
Location: Montale (PT)
Italy – post-wildfire area –
Project ABEES

- **2 transects** one at edge and one 20m in the interior

- **10 plots** of 1m² per transect

- **Counted each flower or inflorescence** per species and estimated **cm² per each inflorescence**

Ref: Westphal et al. 2008

Site 11 – 26 April 2018

Photo: Simone Marini
Location: Montale (PT)
Italy – post-wildfire area –
Project ABEES

- **1 ha area** around the sampling point

- Walk it at constant and slow peace for **30 minutes**.

- **Count each pollinator visit** and link it to the **visited plant**.

Ref: Westphal et al. 2008

Plant species	Mean cm2 per square meter
Paliurus spina-christi	87,5
Fraxinus ornus	56,5
Dittrichia viscosa	29,6
Euphorbia helioscopia	27,9
Crataegus spp	24,8

Site 03 – 24 May 2018

Coleostephus myconis — 6,5

Photo: Simone Marini
Location: Montale (PT)
Italy – post-wildfire area –
Project ABEES
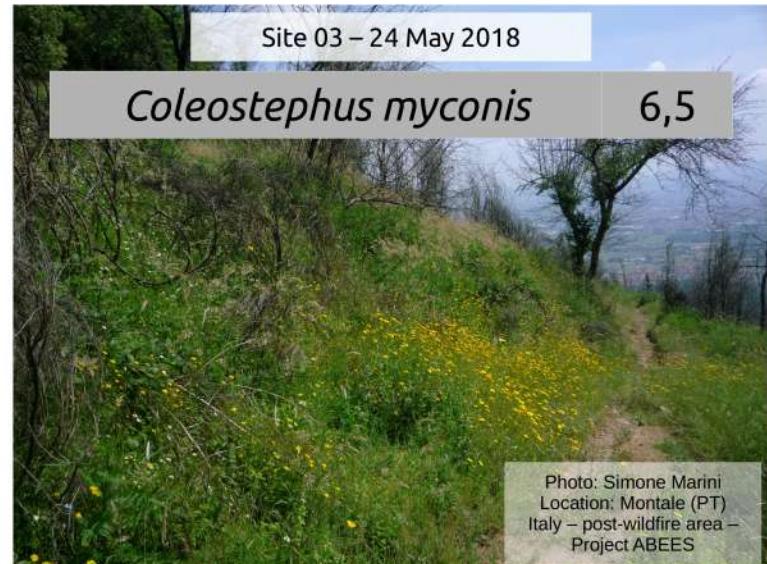
139 different **flowering plant species!**

Site 08 – 02 July 2018

Cirsium vulgare — 2,5

Photo: Simone Marini
Location: Montale (PT)
Italy – post-wildfire area –
Project ABEES

Site 02 – 27 September 2018

Dittrichia viscosa — 29,6

Photo: Simone Marini
Location: Montale (PT)
Italy – post-management
area – Project ABEES

From: Marini & Moonen 2019
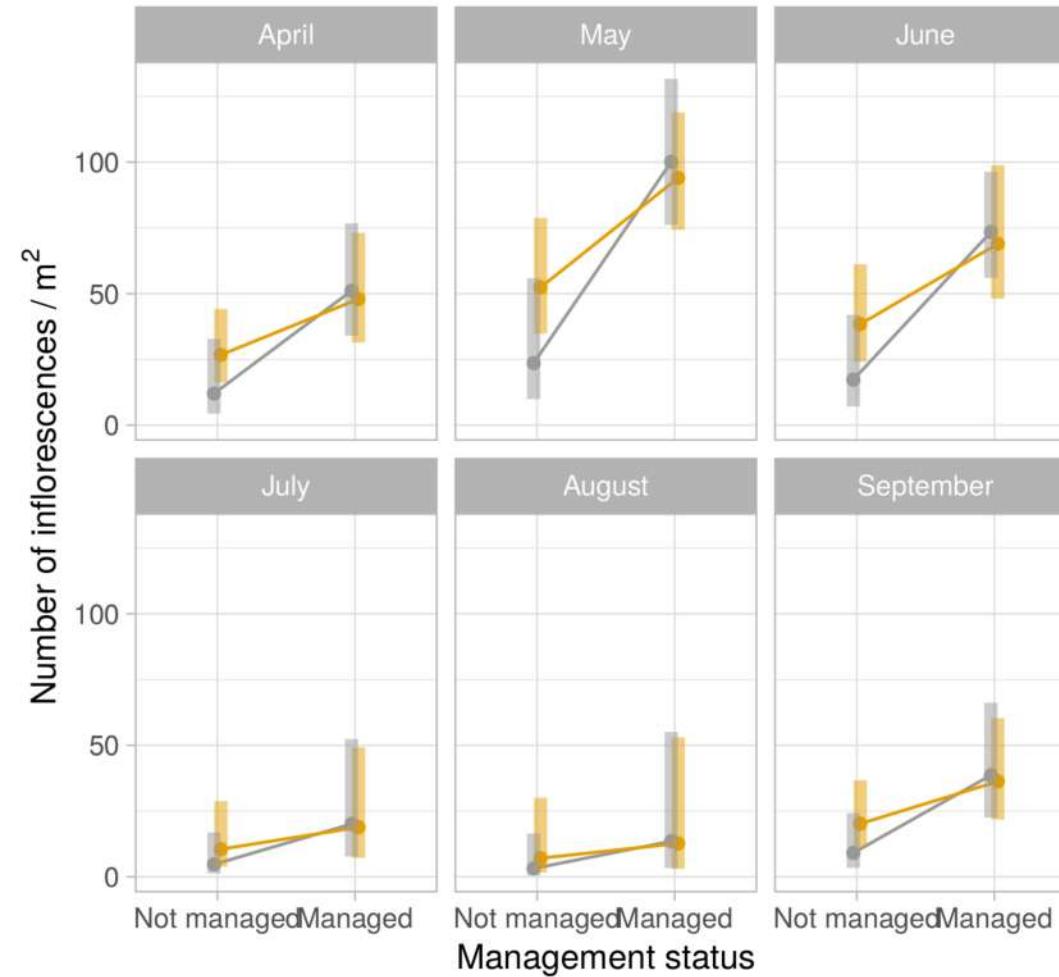
- **Sampling time** affected significantly flower resources [F= 6.528, p = <0.0001].

- *Interaction* among *management and post-wildfire* statuses **marginally significant** [F=2.844, p = 0.0917].

- **31** bee **genus**
- **2089 visits**

Genus	Number of visits
Bombus	481
Apis	230
Lasioglossum	228
Halictus	207
Andrena	112
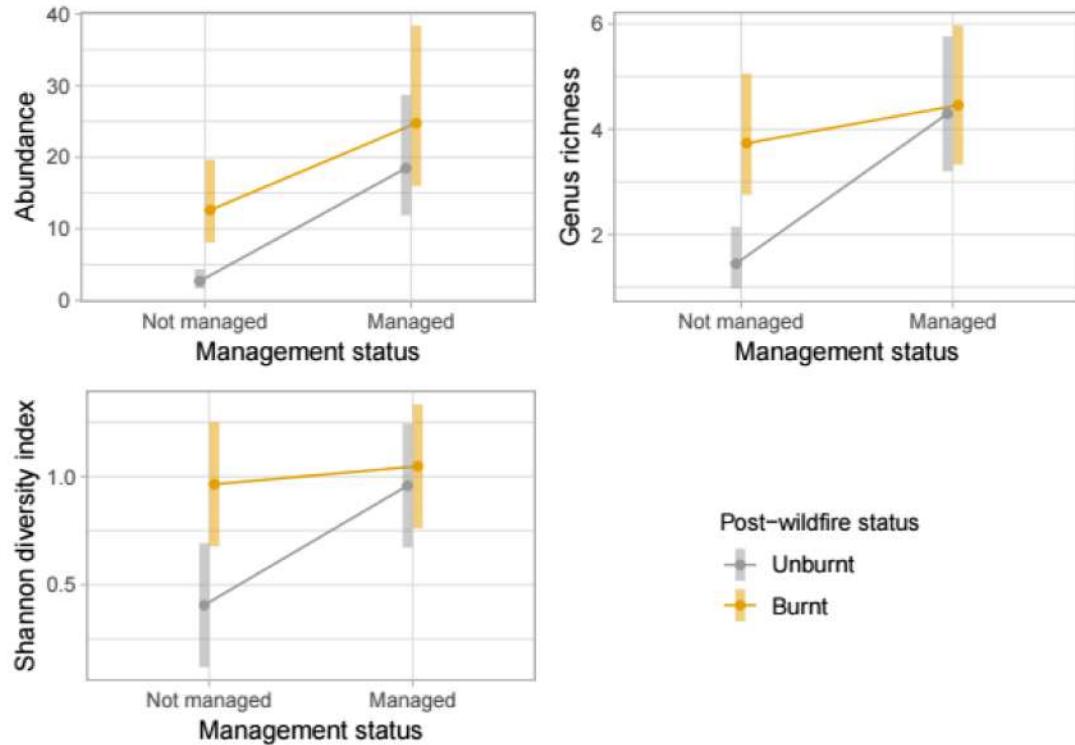
- Affected by **management status** [F= 345.664, p <.0001; F= 28.347 p <.0001; F= 8.581 p= 0.0043, respectively];

- **post-wildfire status** [F= 172.532, p <.0001; F= 17.180 p <.0001; F= 8.911 p= 0.0037, respectively];

- and by **their interaction** [F= 79.982, p <.0001; F= 14.717 p <.0001; F= 4.682 p= 0.0332, respectively].

From: Marini & Moonen 2019

- **Pan-traps** trapping (March-October 2019)

- **Transect walks** observations (March-October 2019)

- Determining bees at **species level – <u>in progress!</u>**

- Analyse the **community composition** - specialist bee species /generalist bee species – <u>in progress!</u>

  - **24** pan traps in **8 clusters**

    - **Spaced** by **10/20m**

      - **24 hours active**

Ref: Westphal et al. 2008

Photo: Simone Marini
Project ABEES

Photo: Simone Marini
Project ABEES

Photo: Simone Marini
Project ABEES

10m

Final discussion

ReNature

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 809988.

PROMOTING RESEARCH EXCELLENCE IN NATURE-BASED SOLUTIONS FOR INNOVATION, SUSTAINABLE ECONOMIC GROWTH AND HUMAN WELL-BEING IN MALTA.

Manage to **enrich flower abundance** and diversity

Mown according to local flower resources

Avoid drift of herbicides and pesticides

...

Photo: Agustín M. Bartual
Project QuESSA

Photo: Agustín M. Bartual
Project QuESSA

Enrich the **diversity** of crops

Sown mass flowering crops with different **blooming** times

Preservation of SNHs and Natural Habitats

…

Thanks for ATTENTION!

FONDAZIONE
CASSA DI RISPARMIO
DI PISTOIA E PESCIA

Simone Marini
simone.marini.it@gmail.com
s.marini@santannapisa.it

Photo: Simone Marini
Location: North-West of the town Montale (PT) Italy – Project ABEES

References – in order of appeareance

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