Stiftelsen Lantbruksforskning

Jordbruks verket

Flower habitats to benefit natural enemies in apple orchards

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Conservation Biological Control (CBC)

•**Biological control** is a method of controlling pests using other living organisms but typically also involving an active **human management** role. It can be an important component of integrated pest management (IPM) programs.

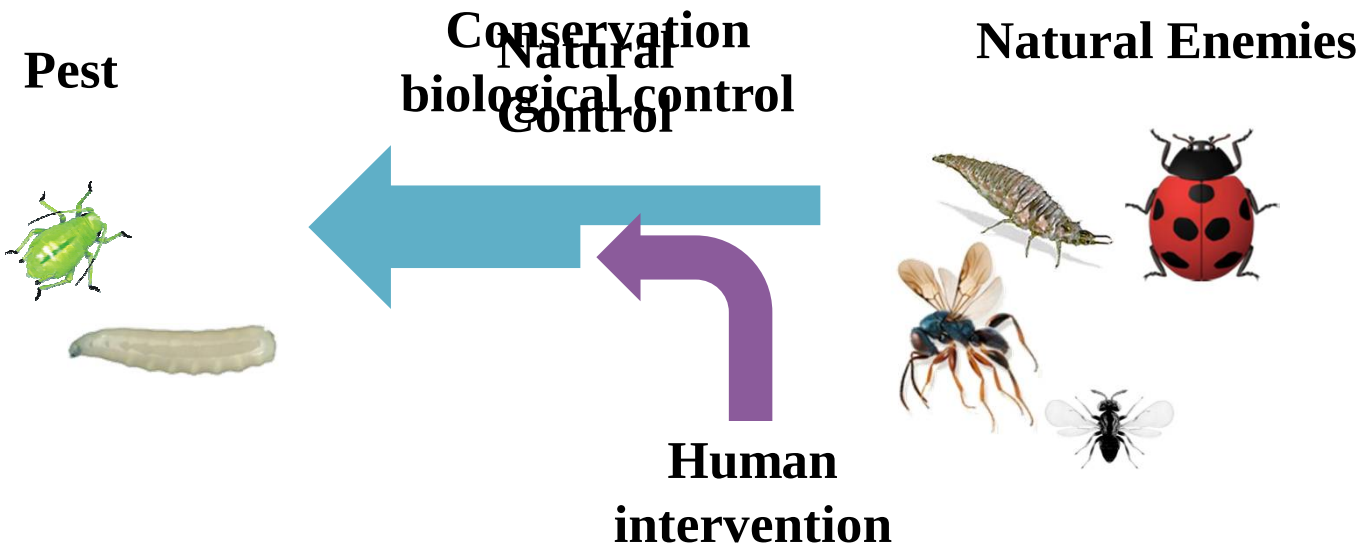
•**Natural enemies** of insect pests, also known as biological control agents, include predators, parasitoids, and pathogens. These can be imported to the agricultural system, or released in big amounts to suppress a target pest.

Predators

Parasitoids

Conservation Biological Control (Bevarandebiologisk bekämpning)

However, all insect pests are also suppressed by naturally occurring organisms and environmental factors, with no human input. This is frequently referred to as **natural control**.



Every time there is a human intervention to use preexisting biological control agents to increase pest control this is called **conservation biological control**.

Protection of natural enemies

Provision of adequate resources

Bevarandebiologisk bekämpning

•Mitigate the effects of habitat modification

•Surroundings (landscape), hedgerows, field margins, adjustment of tillage, polycultural practices…etc.

Habitat Management

Provision of floral resources by non-crop plants grown within or around the crop

Shelter (Skydd/bo)

Nectar

Alternative prey

Pollen

Supplementary food: Nectar and Pollen

Parasiteklar

•While some parasitoids (parasiteklar) are able to obtain needed resources from hosts or do not need to feed at all others require access to non-host foods.

•Floral nectar is taken by many species and can result in increased rates of parasitism.

•The flowers that can be used by parasitoids have exposed nectar that they can access (not hidden or superficial).

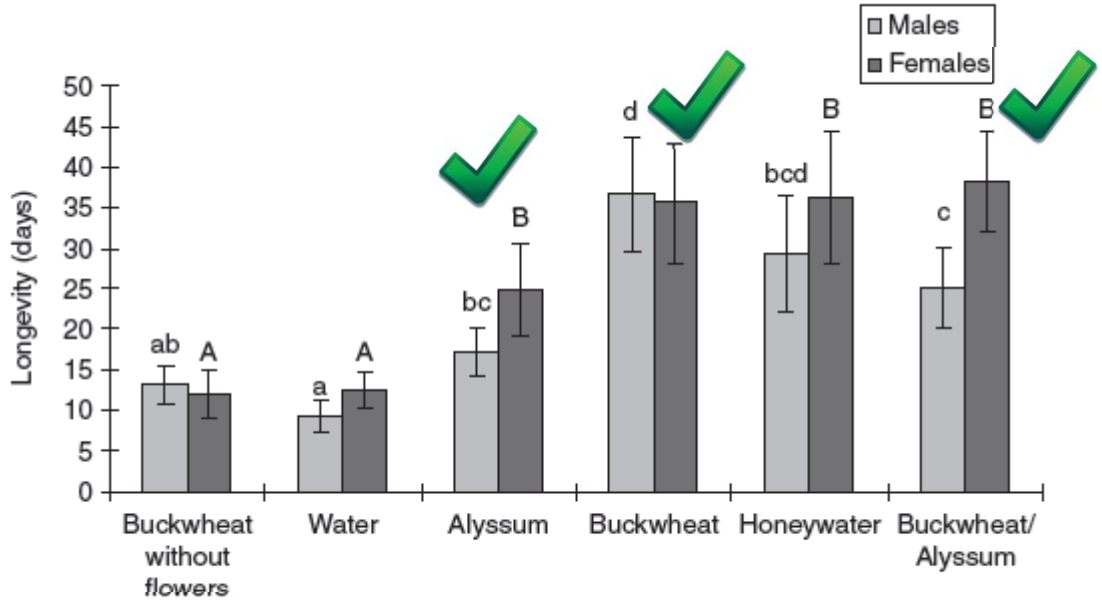
Phacelia sp.

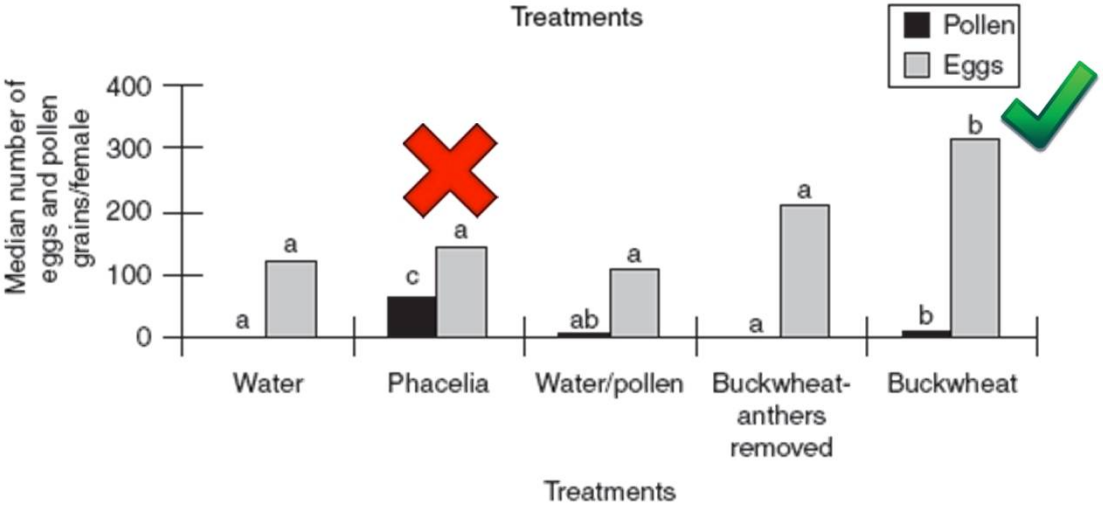
Strandkrassing

Bovete

Supplementary food: Nectar and Pollen

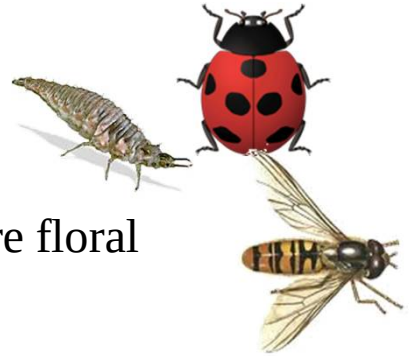
Vecklare





Irving *et al.* 2006. The effects of floral understoreys on parasitism of leafrollers (Lepidoptera: Tortricidae) on apples in New Zealand

Supplementary food: Nectar and Pollen



•There are two important groups of predators that require floral resources to survive as adults.

Blomflugor

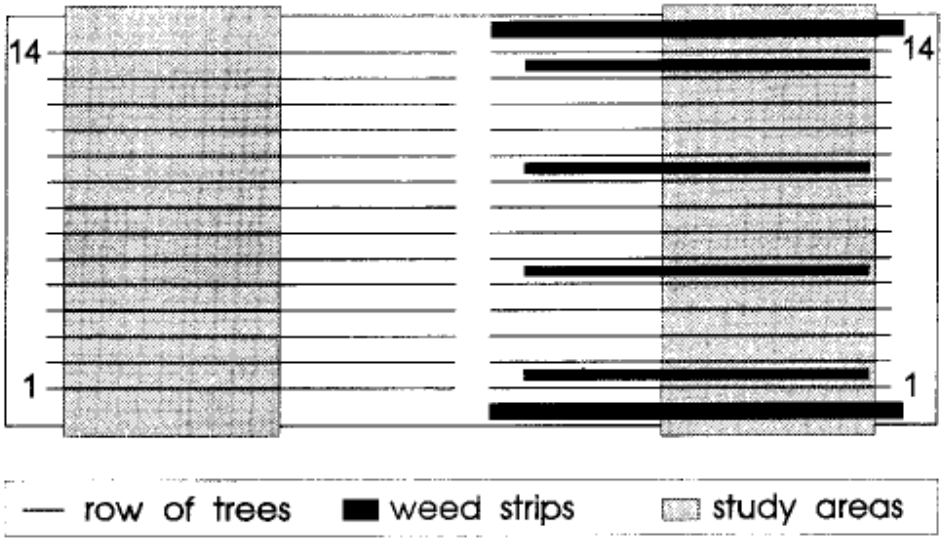
Nätvingar/ Guldögonslända

Supplementary food: Nectar and Pollen

Cikoria

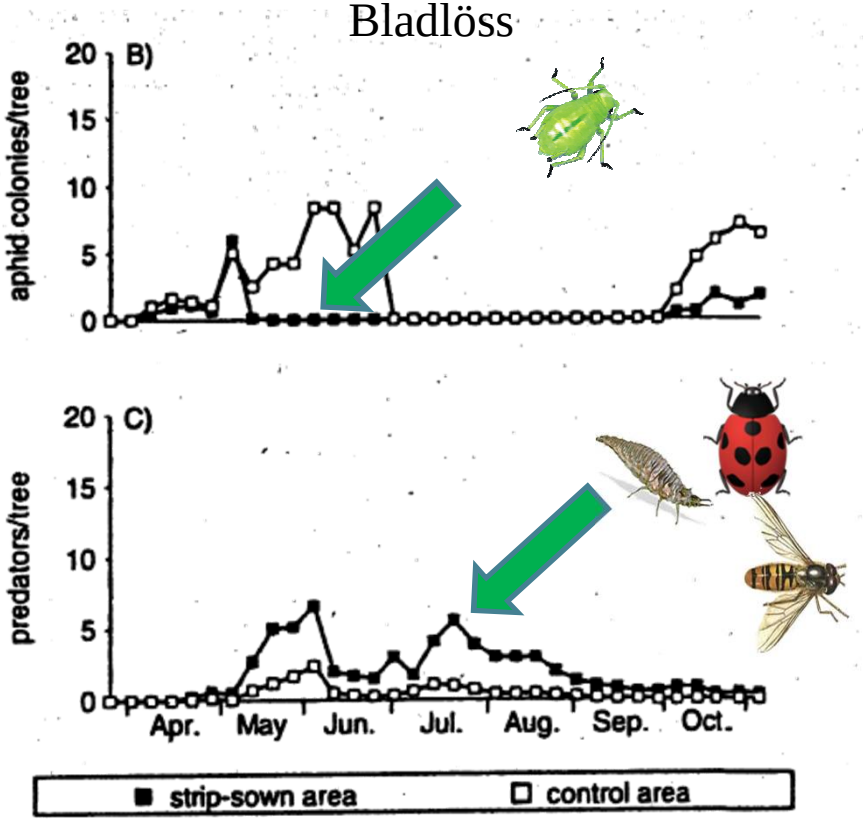
Supplementary food: Nectar and Pollen

•Several studies in apple have shown the attraction of these adults to flowering plants



Schematic design of the experimental orchard

Bladlöss



Wyss *1995. The effects of weed strips on aphids and aphidophagous predators in an apple orchard*

Shelter and Microclimate (Skydd/bo)

•Apple orchards are perennial crop systems thus potentially better for conservation biological control than are annual systems because they are subject to lower levels of disturbance.

• Resident populations of natural enemies may persist from year to year in perennial crops. Structures as hedgerows may help natural enemies to remain.

Picture:
W. Swiergel

Shelter and Microclimate

Artificial Shelter

Nätvingar/ Guldögonslända

Picture: L. Fernández

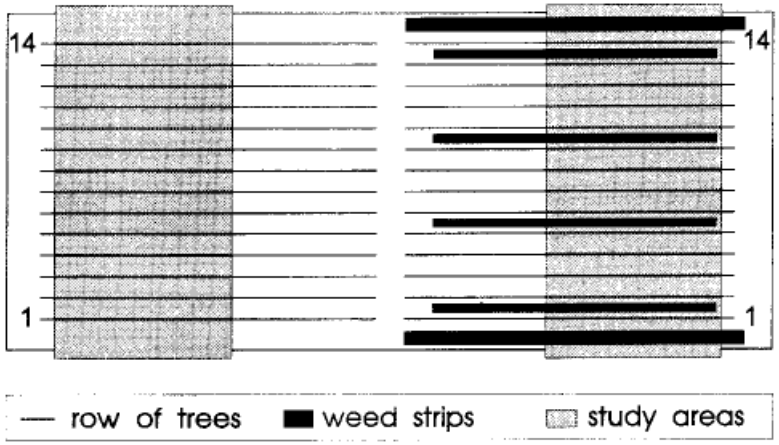
Tvestjärt

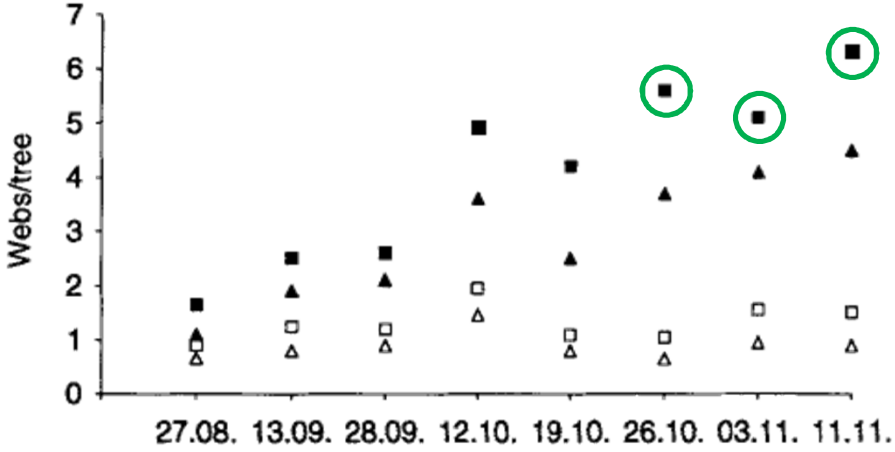
Artificial Shelter

Alternative Host or Prey

- Given sufficient alternative prey, populations of generalist predators may establish within a crop before the arrival and seasonal increase of pests.

- It also contributes to the survival of parasitoids when a suitable host is not present





Wyss 1995. The impact of spiders on aphid populations in a strip-managed apple orchard

Alternative Host or Prey

Unruh et al. 2012. Parasitism of leafrollers in Washington fruit orchards is enhanced by perimeter plantings of rose and strawberry.

Parasiteklar

Colpoclypeus florus

Vecklare

Overwinter 5th instar

Rose

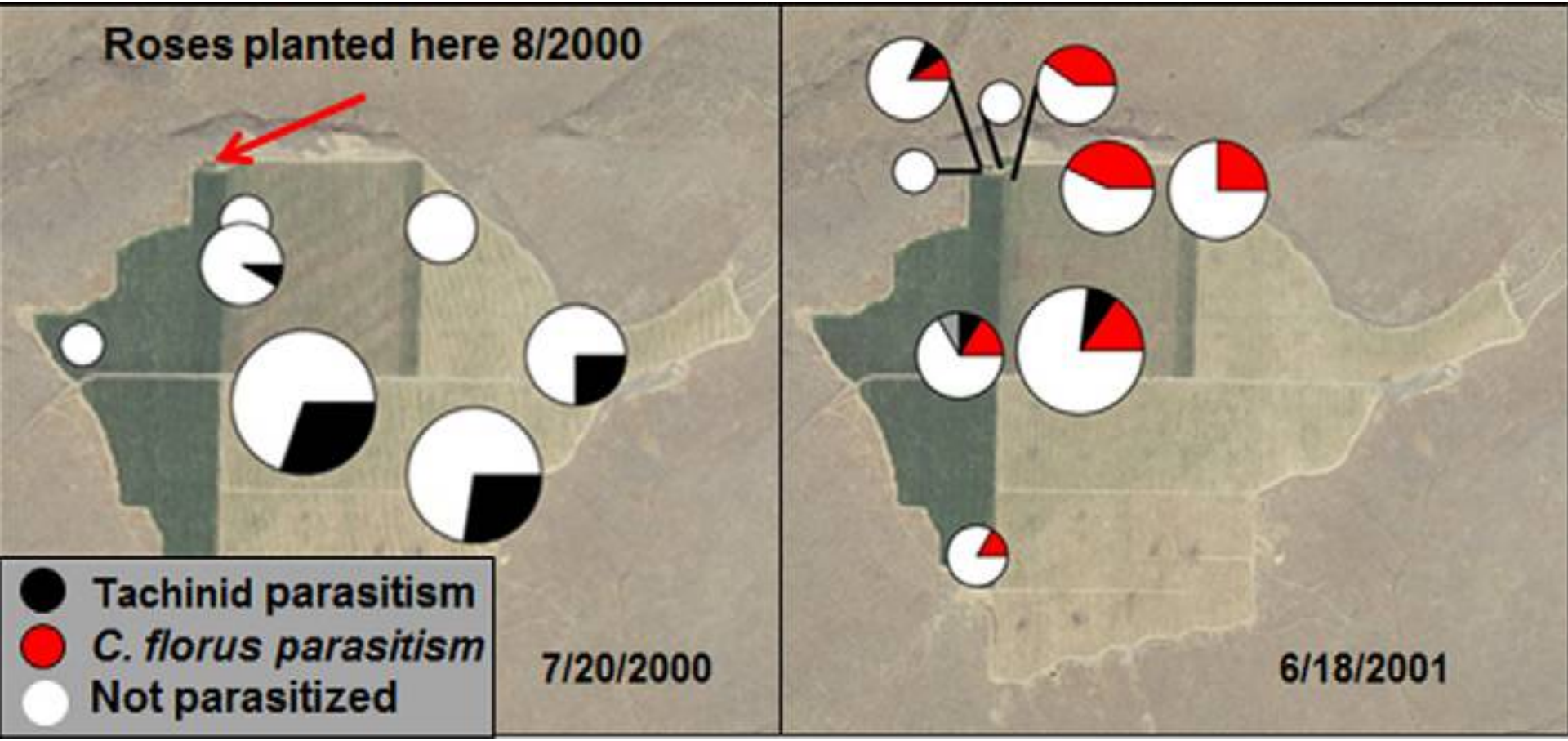
Strawberry

Apple orchards

Vecklare

Alternative Host or Prey

Unruh et al. 2012. Parasitism of leafrollers in Washington fruit orchards is enhanced by perimeter plantings of rose and strawberry.



Alternative Host or Prey

Tistel

Bladlöss

Nickelpiggor

Multiple Mechanisms

•Habitat management may benefit natural enemies by the simultaneous operation of more than one mechanism.

Natural enemies

Pest

Wyss 1995. The effects of weed strips on aphids and aphidophagous predators in an apple orchard

Non-harmful insects

Spiders

Wyss 1995. The impact of spiders on aphid populations in a strip-managed apple orchard

Key Issues in Habitat Manipulation

Landis *et al.* 2000. Annual Review of Entomology

- **The selection of the most appropriate plant species.**
- Adaptation to orchard design and practices.
  - Establishment
  - Competition with trees
  - Weeding
  - Selfrenewal

- The predator/parasitoid behavioral mechanisms which are influenced by the manipulation.

- The spatial scale over which the habitat enhancement operates.

- The possible negative aspects associated with adding new plants to an agroecosystem.

The selection of the most appropriate plant species.

Några växter som lockar många naturliga fiender

Naturliga fiender generellt	Parasitsteklar	t.ex.
Flockblomstriga *Apiaceae*	Flockblomstriga *Apiaceae*	fänkål, morot, palsternacka, koriander, dill, kummin, hundkäx, kvanne, björnloka
Korgblommiga *Asteraceae*		cikoria, prästkrage, färgkulla, blåklint, röllika, (renfana), (åkertistel)
Kransblommiga Lamiaceae		Backtimjan, oregano pepparmynta, revsuga, (salvia),
Rosväxter *Rosaceae*	Rosväxter *Rosaceae*	Älggräs, äpple, (ros)
Lejongapsväxter *Scrophulariaceae*		Axveronika
Blandat		Revsmörblomma, facelia, bovete, vindor, fläder, brännässla

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  - **Competition with trees**
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  - **Selfrenewal**
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- The spatial scale over which the habitat enhancement operates.
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Adaptation to orchard design and practices

- Etablering
- Placering
- Konkurrens

Adaptation to orchard design and practices

Adaptation to orchard design and practices

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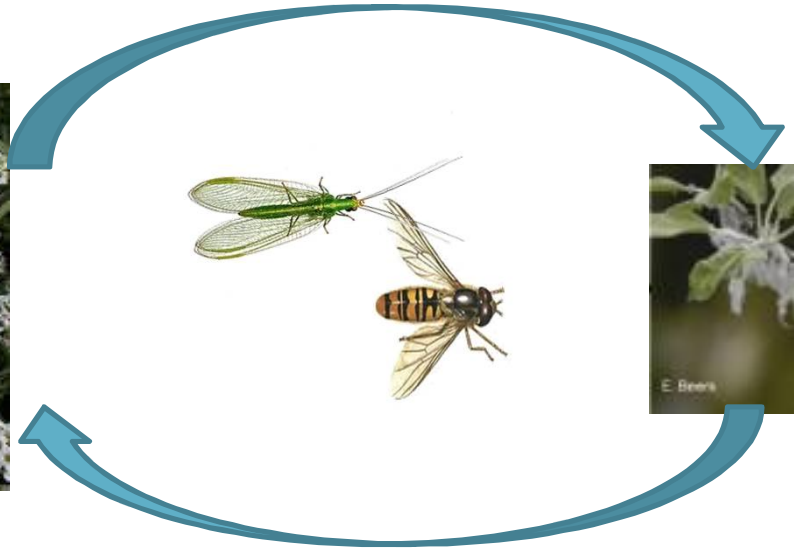
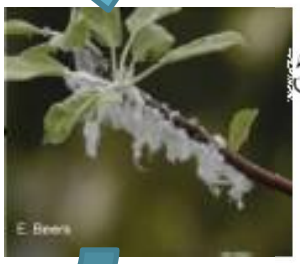
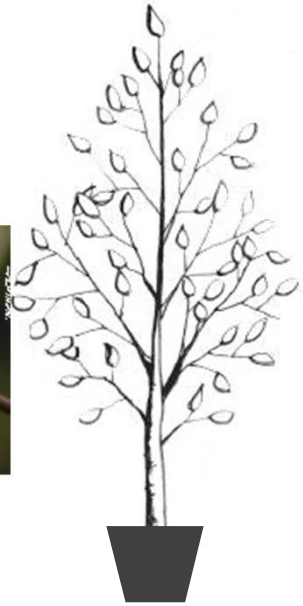
Predator/parasitoid behavioral mechanisms influenced by the manipulation

Strandkrassing



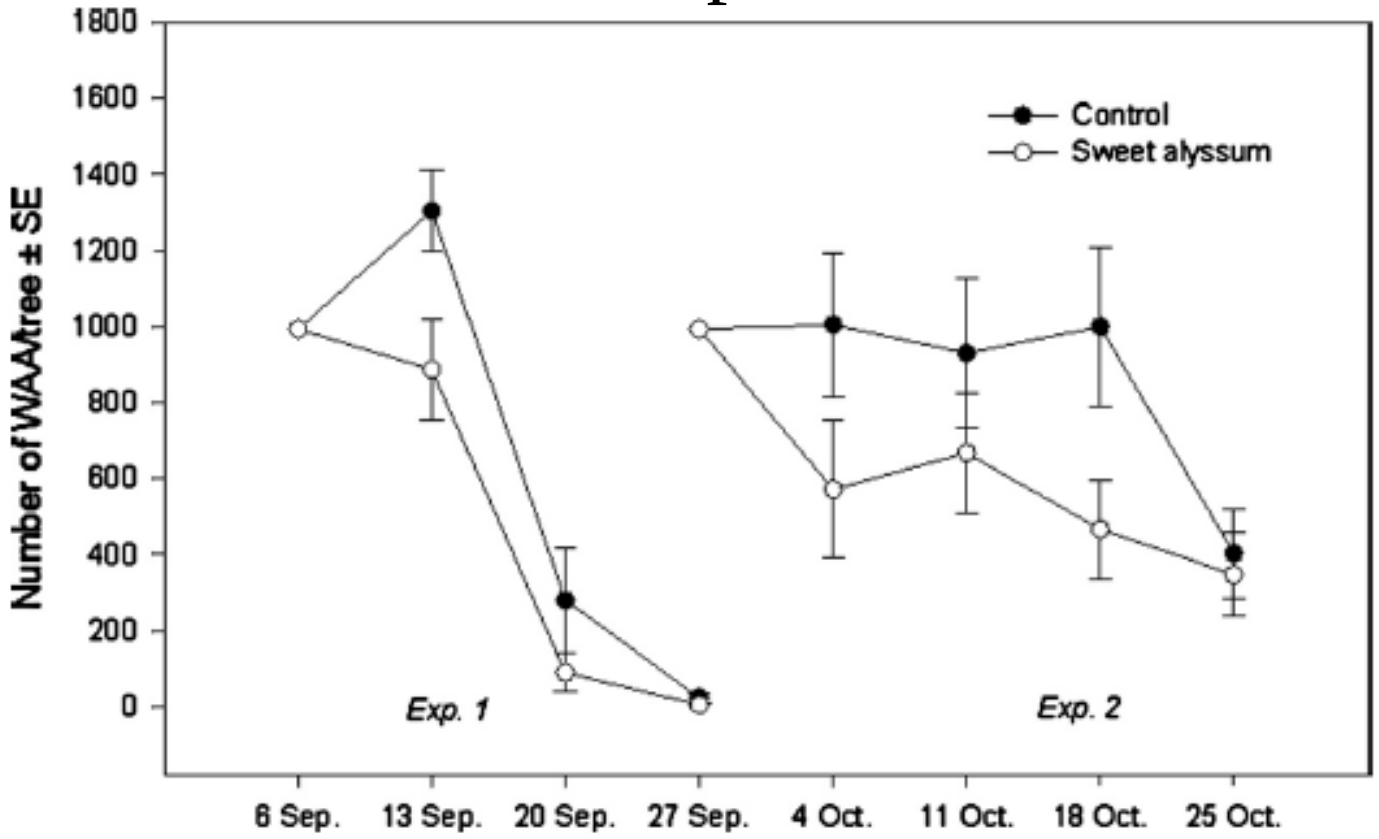




Gontijo *et al.* 2013. Flowers promote aphid (bladlos) suppression in apple orchards.

Marking revealed that natural enemies regularly moved from sweet alyssum (strandkrassing) to the surrounding orchard.

Predator/parasitoid behavioral mechanisms influenced by the manipulation



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•The predator/parasitoid behavioral mechanisms which are influenced by the manipulation.

•The spatial scale over which the habitat enhancement operates.

•The possible negative aspects associated with adding new plants to an agroecosystem.

The spatial scale over which the habitat enhancement operates

•Implications for the **area**, **shape** and **distance** of resources and shelter for predators and parasitoids.

•The question of the **optimal shape and distribution** of habitats to enhance natural enemies is not well understood and difficult to answer.

•Concepts of **connectivity** indicate that connecting such habitats with existing boundaries may facilitate their initial colonization and interchange within the field margin natural enemy community. From this point of view it has been observed that the distance is crucial.

Ricci 2011. Effects of hedgerow (lähäck) characteristics on intra-orchard distribution of larval codling moth

Sigsgaard 2013. Public communication

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•The predator/parasitoid behavioral mechanisms which are influenced by the manipulation.

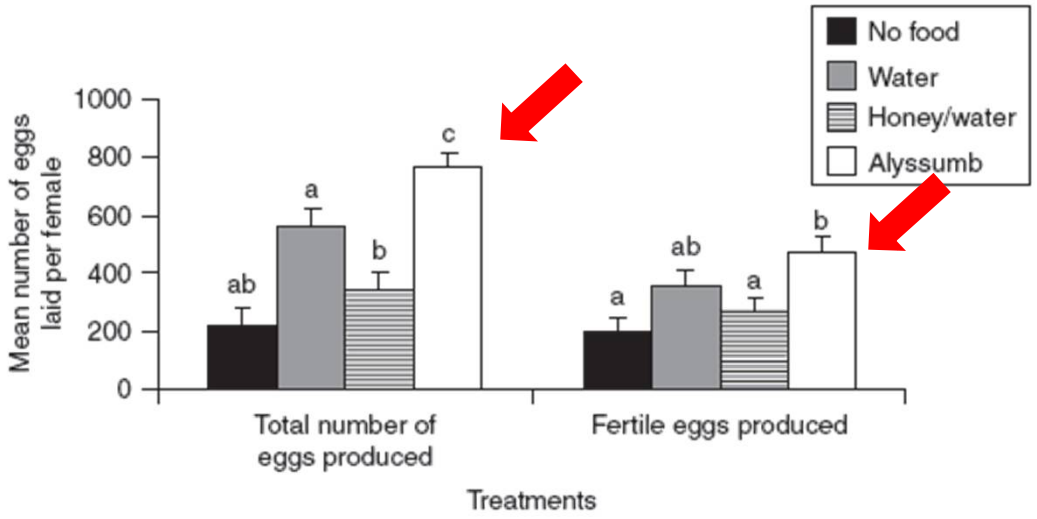
•The spatial scale over which the habitat enhancement operates**.**

•**The possible negative aspects associated with adding new plants to an agroecosystem.**

The possible negative aspects of habitat management

•It has been observed as that in some occasions the plants provided could be used as resources by the pest being targeted.

Irving *et al.* 2006 The effects of floral understoreys on parasitism of leafrollers (Tortricidae. Lepidoptera) on apples in New Zealand



•In choice experiments, leafroller larvae in the laboratory consumed more than three-fold more apple leaf material than they did of the three understorey species.

•Although alyssum increased leafroller fecundity and longevity.

•Naturally occurring leafroller damage was up to 29% lower above all the floral habitat.

•So far no negative effects from leafrollers have been found in the articles revised in apple.

Other Advantages of Habitat Manipulation

Jonsson *et al.* 2008. Biological Control

(1) It is a practice which individual growers can adopt, in contrast with classical biological control schemes which are usually coordinated at the regional, national or continental scale.

(2) It usually involves a conspicuous change to the farm landscape (e.g., ‘beetle banks’ or flower strips) so it can readily be used to support ‘green’ marketing strategies (labeling).

GREENING WAIPARA

•Restores vineyard habitats by planting native plants among and near the vines.

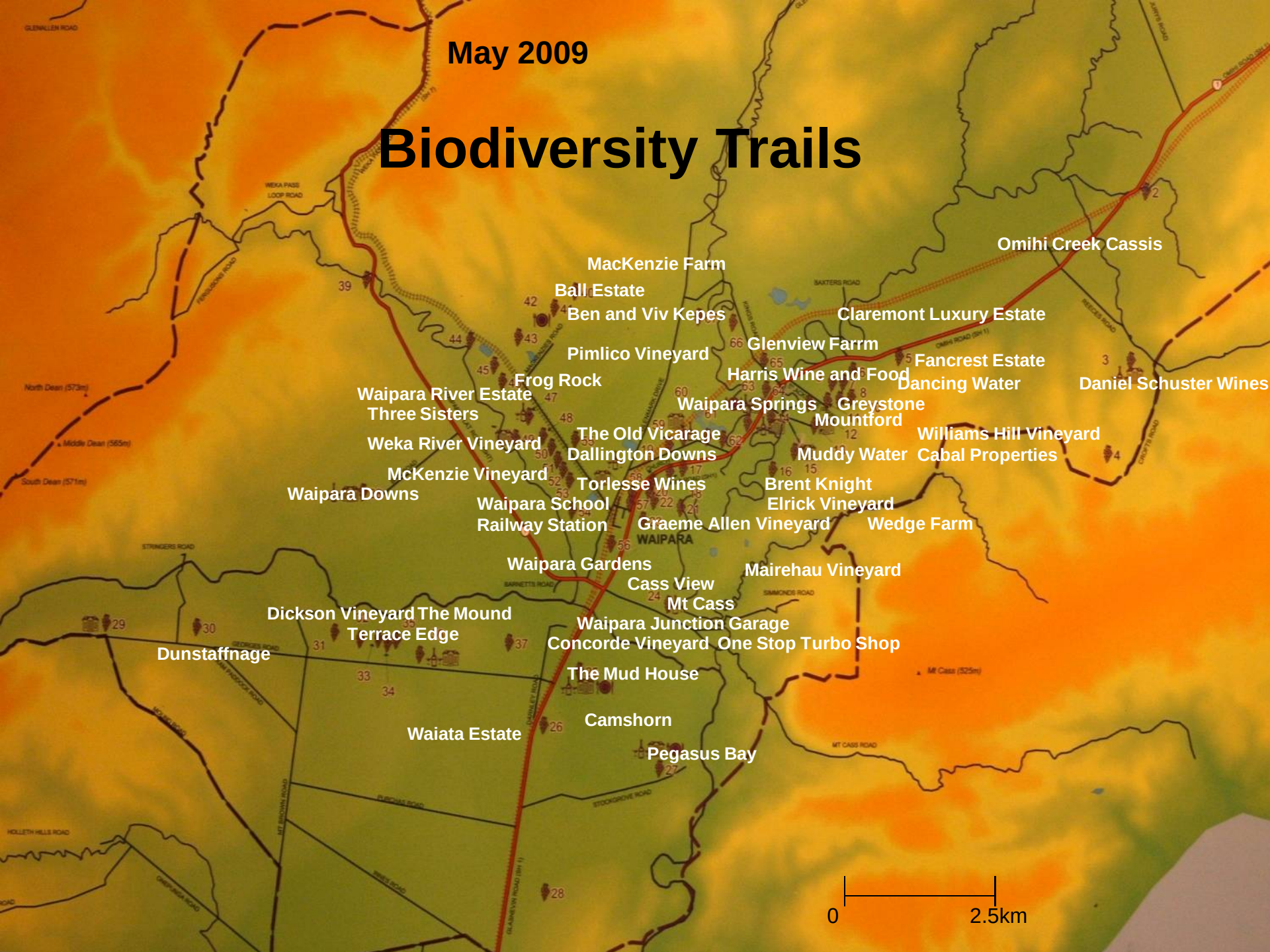
•The native species should
provide nectar to support beneficial insects.

•Special emphasis in tourism

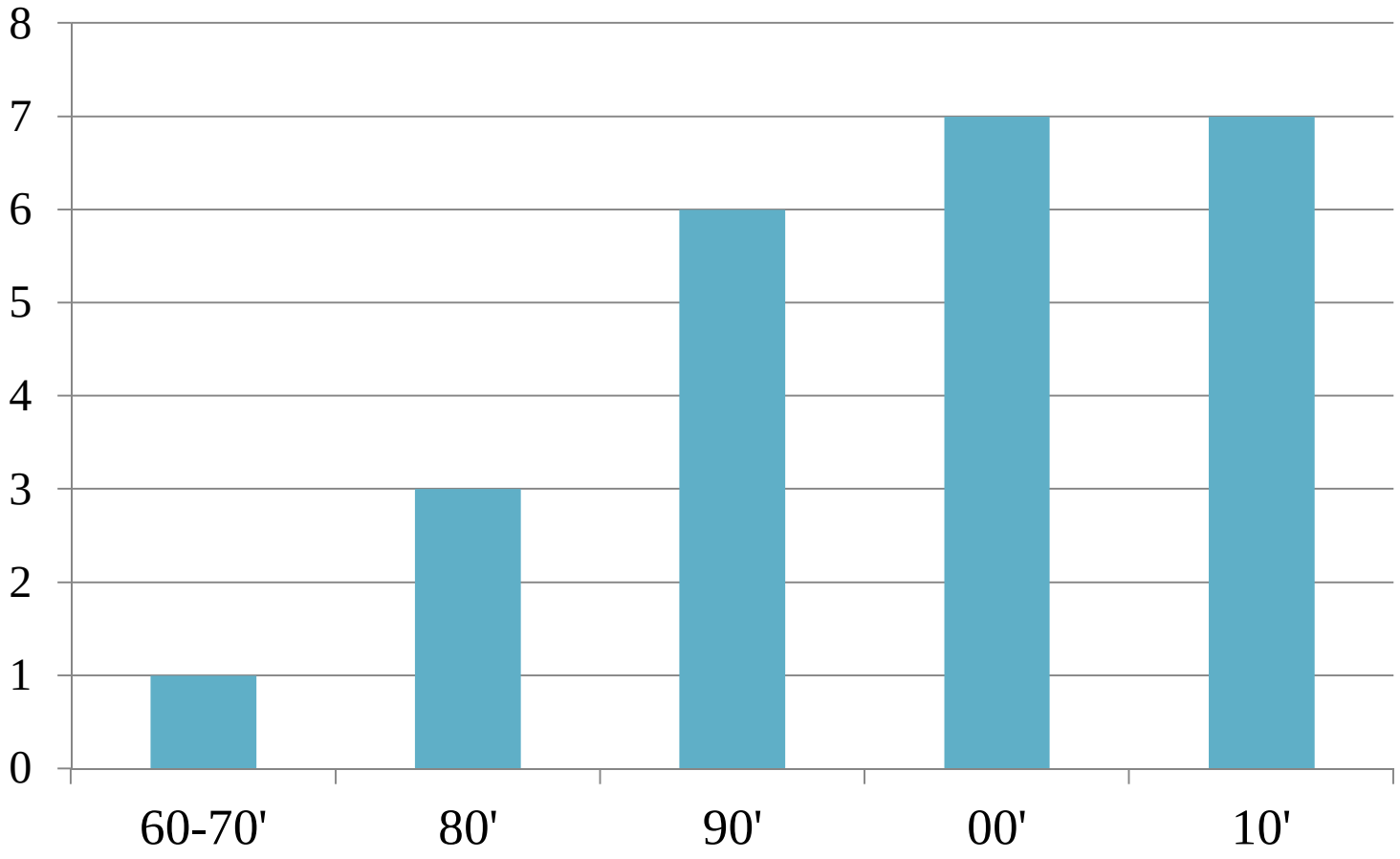
Bio-Protection

May 2009

Biodiversity Trails



Literature review: Apple Orchards



Number of articles on habitat management on apple in different time periods (total = 24).

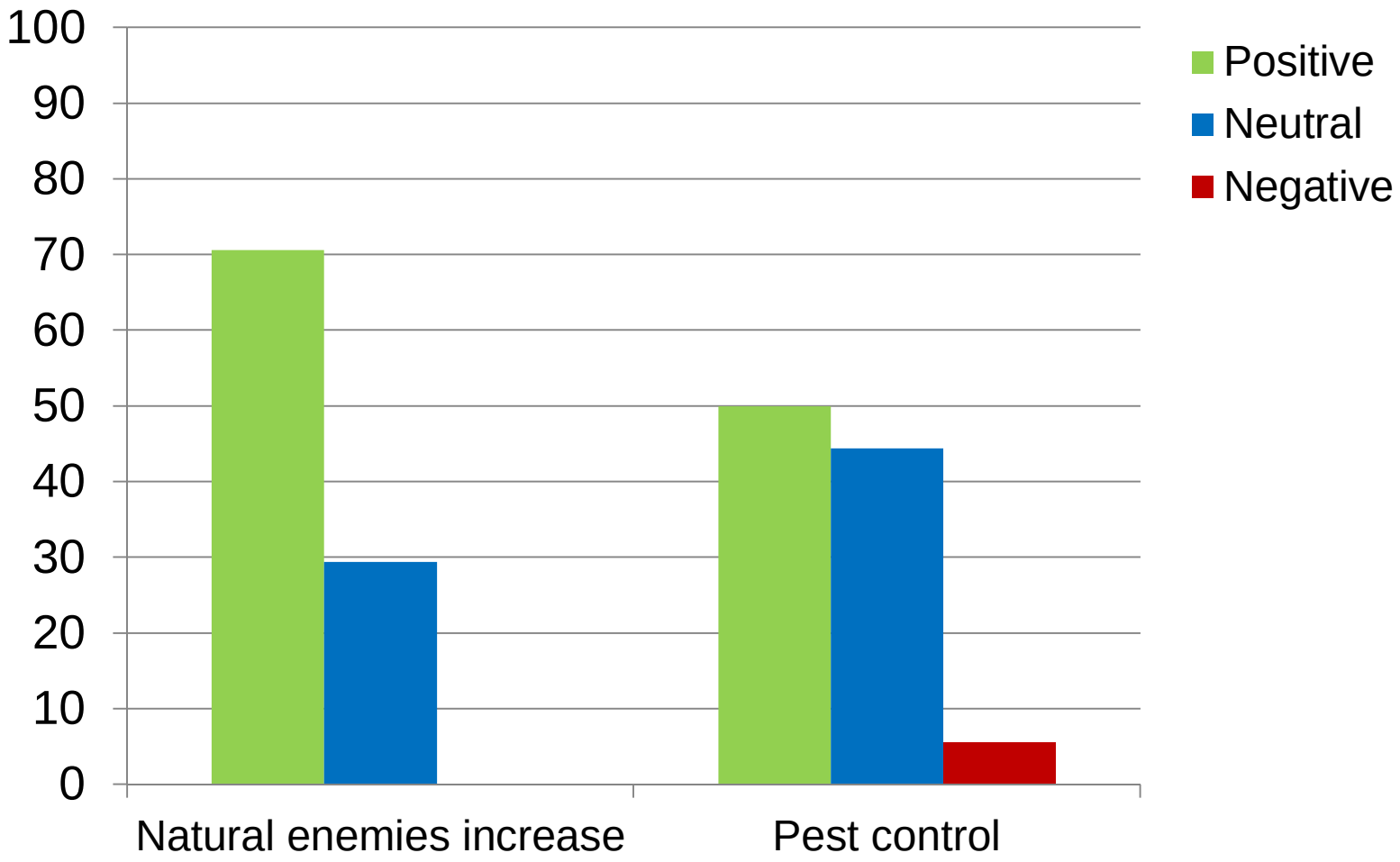
Literature review: Apple Orchards

- A great variation among type of experiments
  (Continent, pest species, main natural enemies, type of habitat, looking at diversity)

- General studies look at:
  - Complex flower strips.
  - Measuring the main pests present.
  - General natural enemies sampling (sticky traps, direct observation).

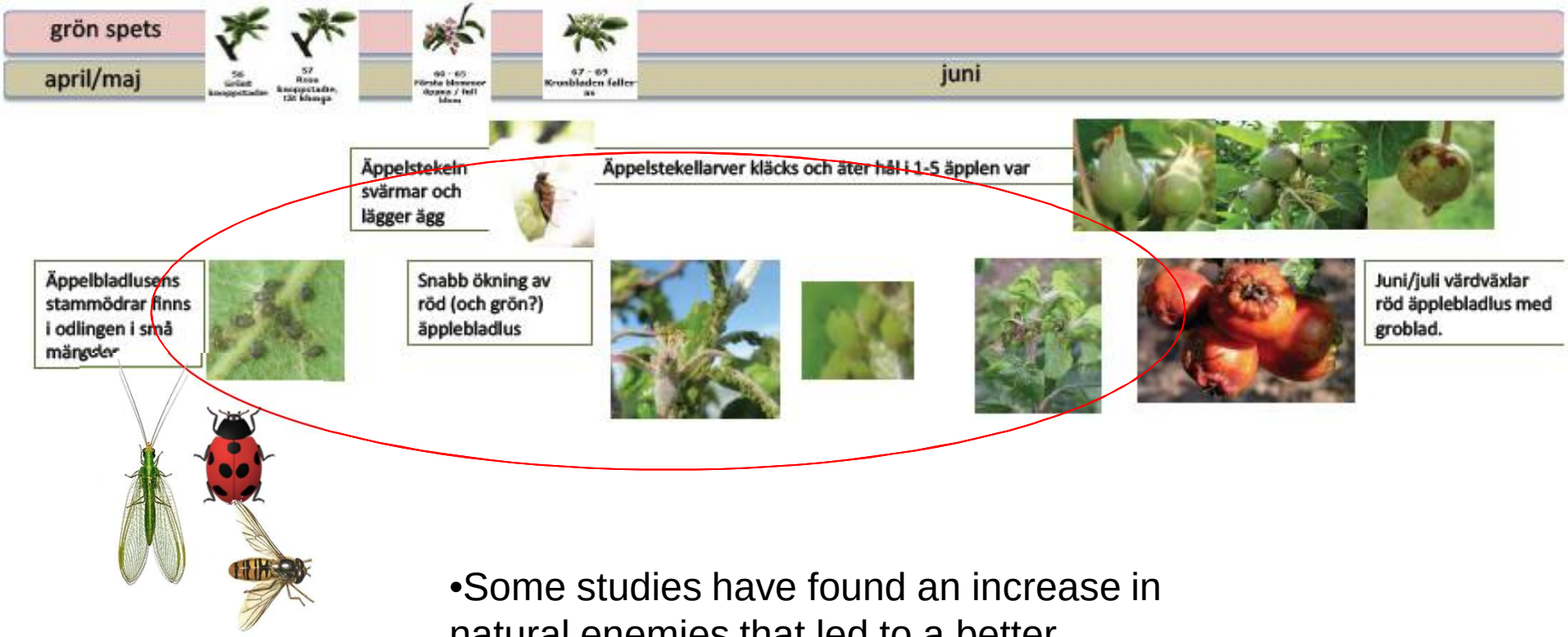
- Specific look at:
  - Selected plants.
  - Effect on one target pest species.
  - Specific sampling for the natural enemy of interest (parasitism).
  - Attempt to describe the mechanism.

Literature review: Apple Orchards



Percentage of revised articles on habitat management on apple with positive, neutral and negative results for N.E increase (total = 17) and pest control (total = 18).

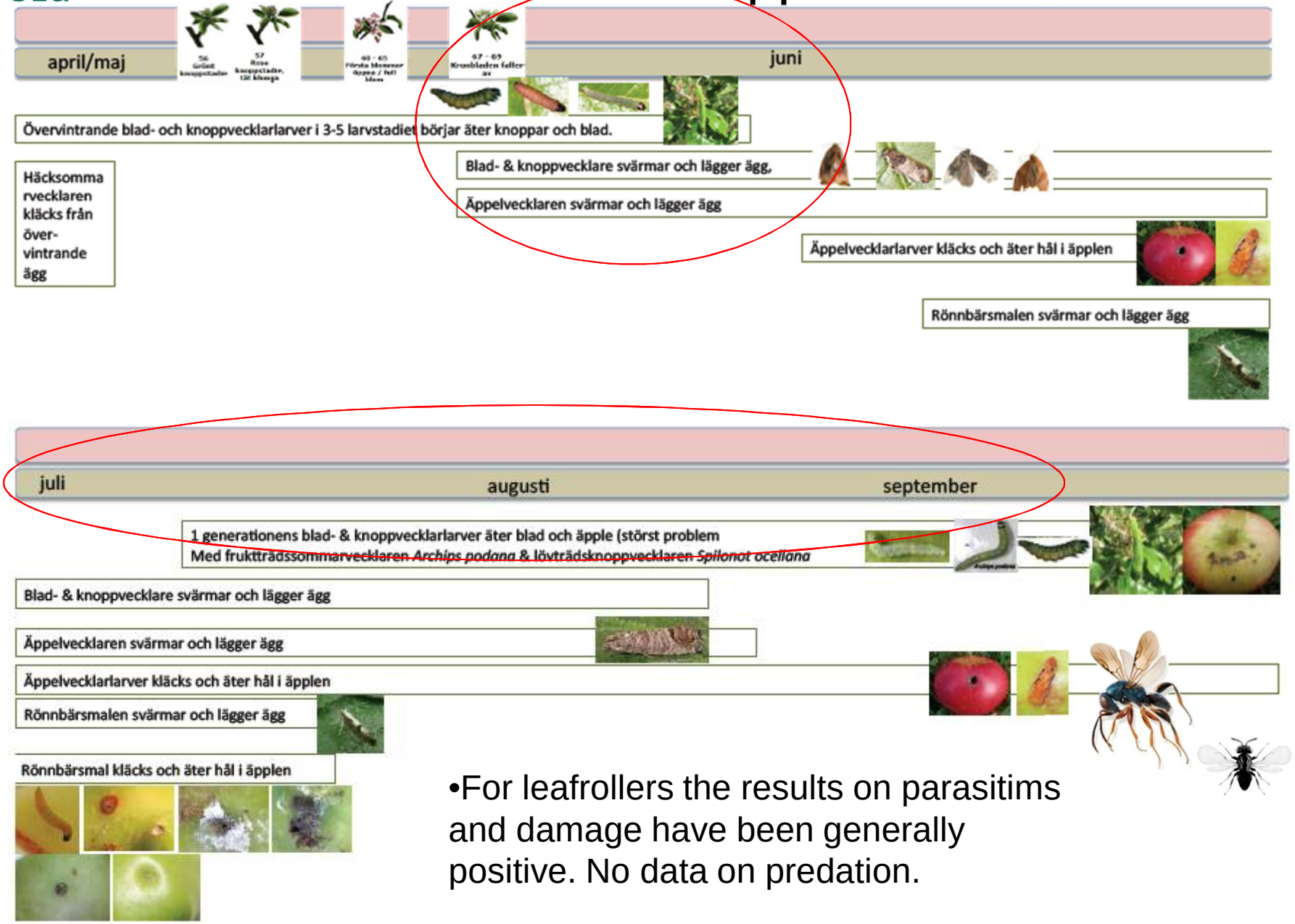
Literature review: Apple Orchards



•Some studies have found an increase in natural enemies that led to a better control of aphids.

•Others observed that this could be density dependent.

Literature review: Apple Orchards



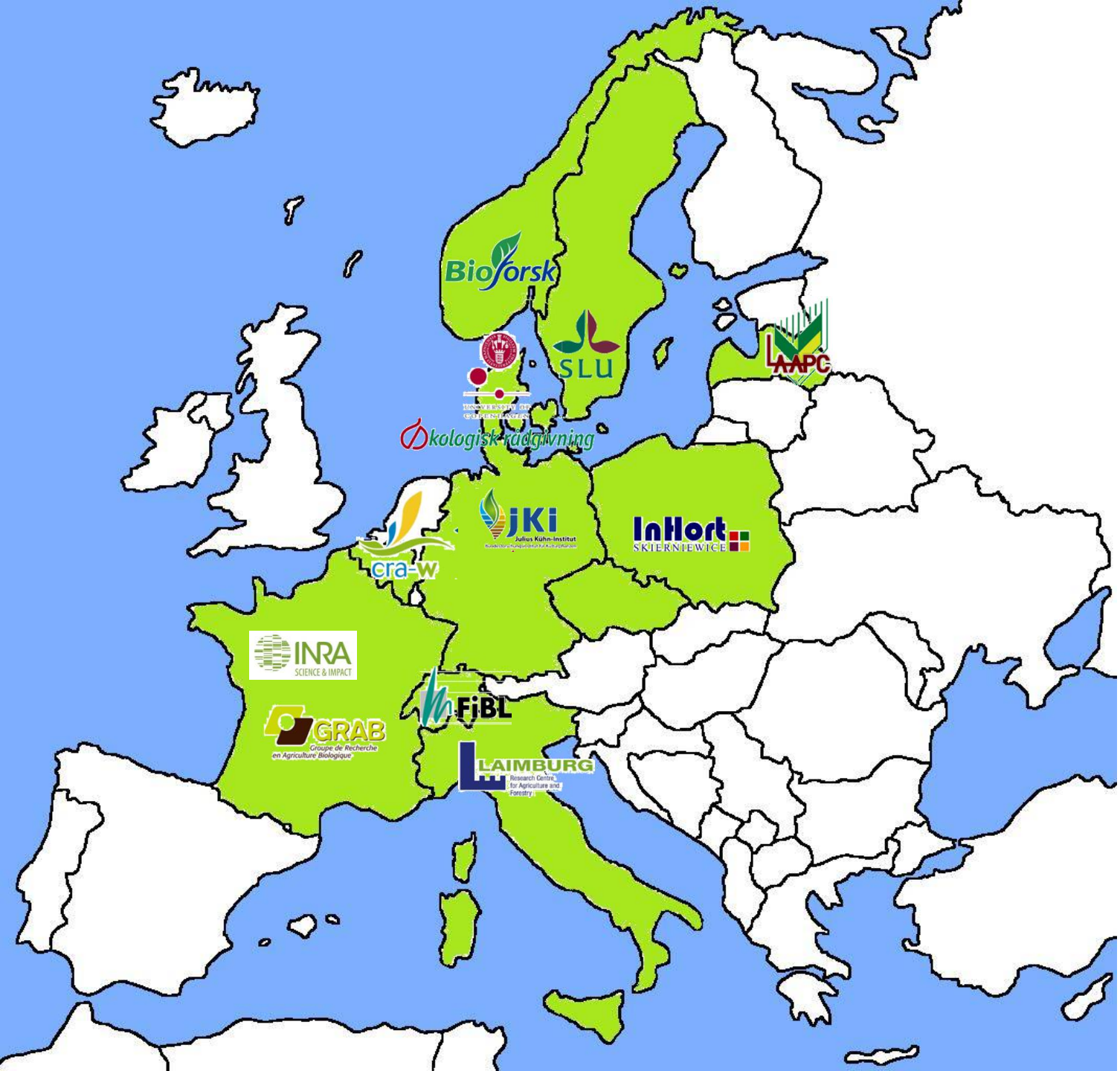
- For leafrollers the results on parasitims and damage have been generally positive. No data on predation.

ECOORCHARD - **Innovative design and management to boost functional biodiversity of organic orchards**

A CORE Organic + project
2015-17

ECOORCHARD partners

UNIVERSITY OF COPENHAGEN



Consortium

- 12 partners
- 10 countries

Hypotheses

The resilience of organic orchards versus pests can be improved through the implementation of specific methods and tools for increasing functional biodiversity.

– **Methods and tools will be applicable for commercial** organic fruit growers in a wide range of economic and ecological situations.

– **An active network of committed stakeholders,** including practitioners ,but also from science side, can be created which takes care of the dissemination and implementation

Main objectives

1. To develop feasible tools for (re)design of organic apple orchards and to adopt specific management practices with the aim to increase orchard resilience through higher functional (agro-)biodiversity (FAB).

2. Compare effects of FAB management across Europe for shared key pests (aphids, codling moth) and their natural enemies.

Sub-objectives

1. To identify promising techniques, tools and monitoring protocols to improve management of functional biodiversity**,** which enhance the performance of natural enemies, reduce pest and disease, and are **adapted for farmers' implementation.**

2. To assess promising techniques, namely specific **flora introduction to provide alternative food/prey, and specifically adapted habitat management.**

3. To create **a European-wide network of stakeholders** for functional biodiversity management in organic orchards.

4. To **learn from a participatory approach** about potential constraints solve these constraints by iterative re-evaluation.

Schematic representation of the project

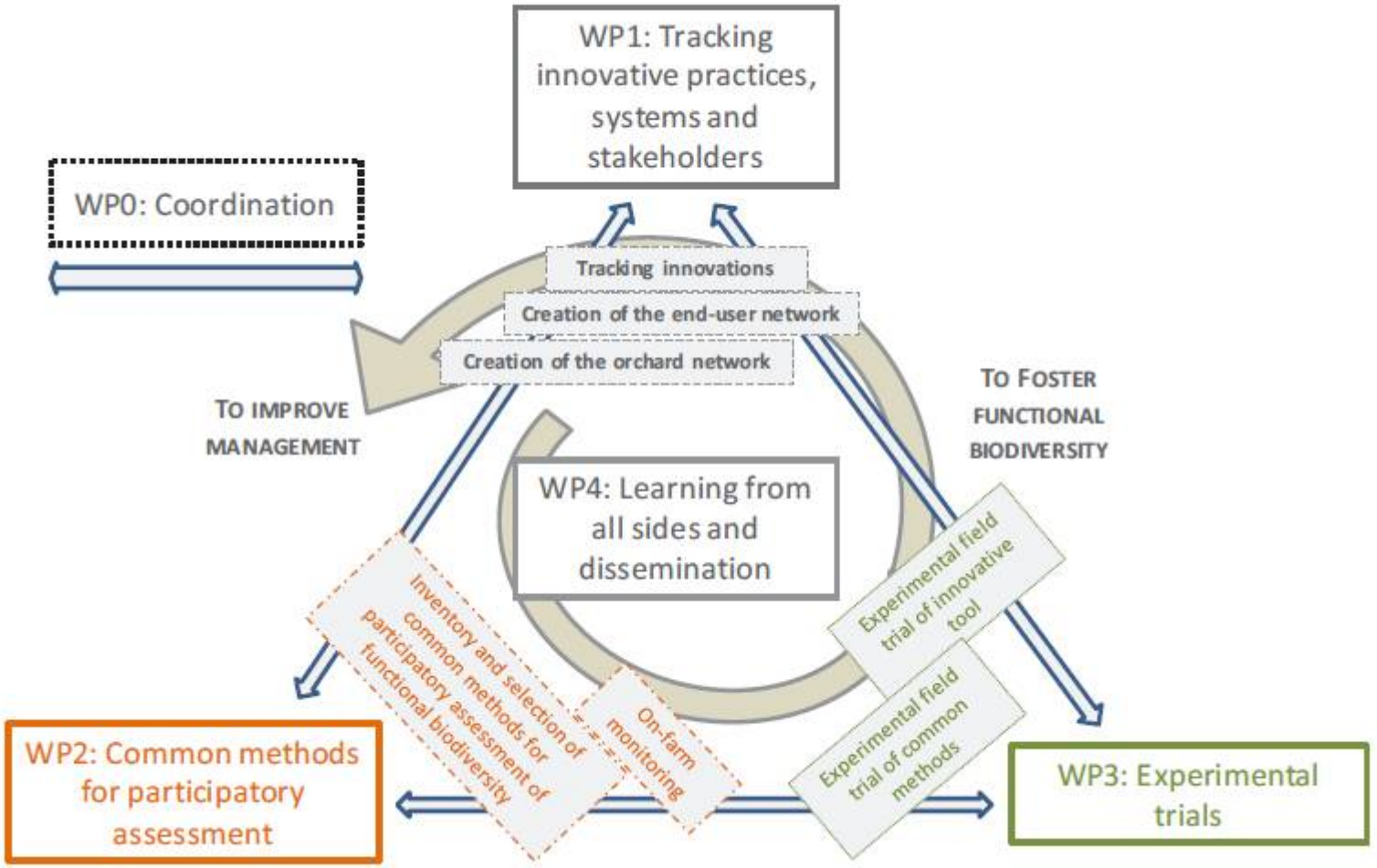


Diagram: Servane Penvern

WP1 - Tracking innovative functional biodiversity practices and systems

(JKI, Annette Herz / co-leader: INRA, Servane Penvern)

Objectives:

• To collect knowledge on FAB management and related practices experimented or already implemented in European fruit growing

• To analyze their pro and cons in terms of adoption, implementation, efficacy towards functional biodiversity and impacts on farm performances.

• To select challenges, methods and innovations that could be targeted in WPs 3 & 4 in order to either solve, validate or test them in a common European-wide approach

• To identify and set up a voluntary and participative platform of stakeholders (EBION: “European Biodiversity Orchards Network”) for active exchange of data during the project .

Deliverable:

The organic fruit sector will obtain a European-wide stakeholder platform which delivers scientifically and technically proved information on how to establish and manage more resilient orchards.

WP1 - Tracking innovative functional biodiversity practices and systems

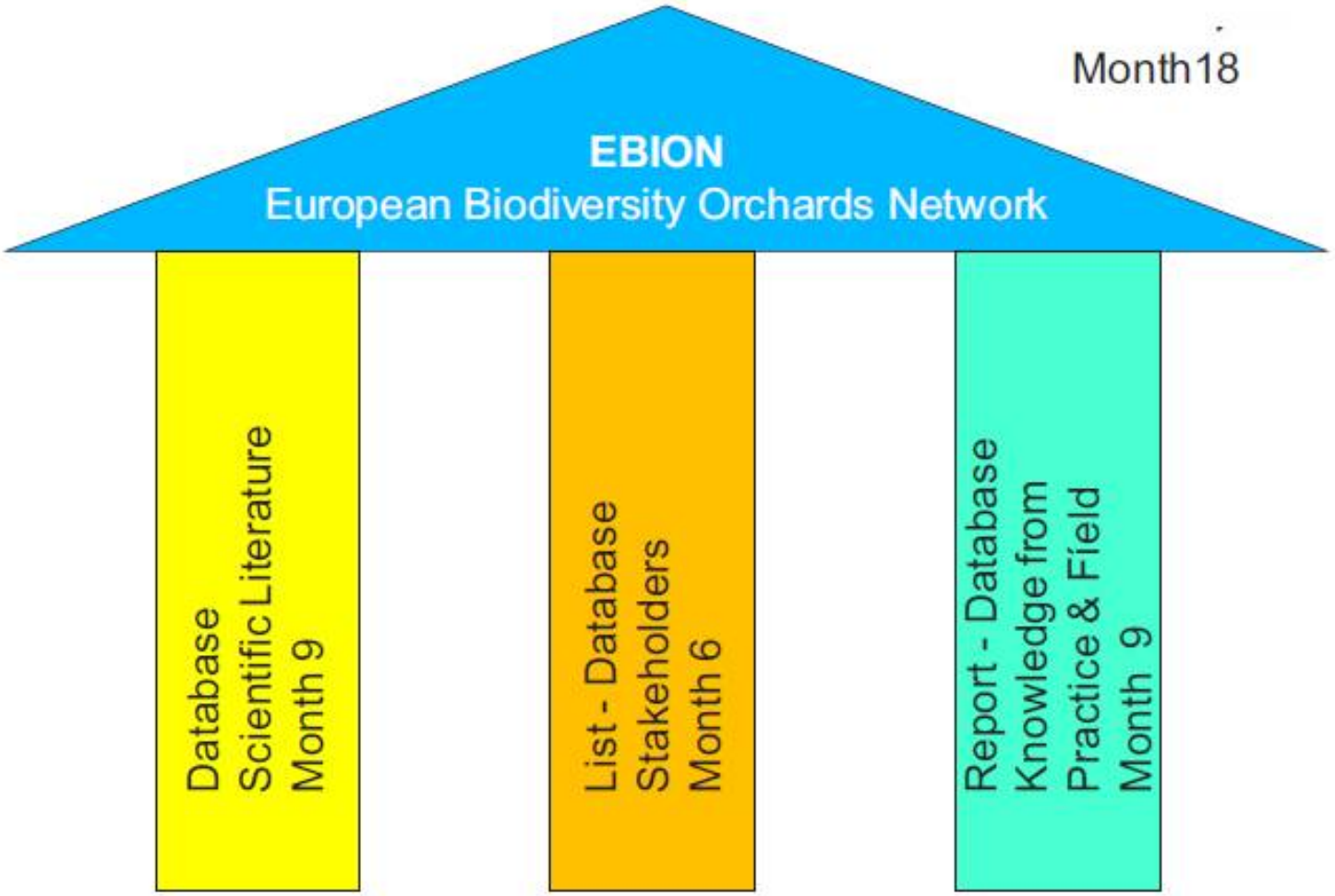


Diagram: Annette Herz and Servane Penvern

Ebion website

Picture: Annette Herz

WP2 - Common methods for participatory assessment of functional biodiversity

(Leader: GRAB, François Warlop / co-leader: UCPH, Lene Sigsgaard)

Objectives:

• To collect, test, analyze and classify **different methods for assessing the impact of FAB** management regarding their suitability for practice, extension and science.

• To **assess operational-oriented protocols** with scientifically-sound methods.

• To **develop protocols for participatory monitoring of FAB** efficiency in a wide range of apple orchards of the network.

Deliverable:

Management of existing and design of future orchards will be supported by simple protocols for monitoring of functional biodiversity elements that are suitable for wide adoption in different European countries.

WP3 – Europe-wide experimental trials of new orchard design

(FiBL, Franco Weibel/co-leader: Laurent Jamar CRA-W)

Objectives:

· To **research BTW flower strips** which are FAB elements that can be implemented rapidly and on large scale by organic fruit growers in their existing orchards.

· To test the **suitability of using region- and soil-specific flower mixtures**, and develop methods for their practical implementation and management.

· To assess **the effect of BTW flower strips** on the abundance and activity of **natural enemies** and on their effect to reduce **pest** pressure and pesticide applications.

· To develop **recommendations for growers/advisors** in WP4 on different methods to install and manage BTW flower strips.

Deliverable:

A novel, functional biodiversity system that can be adopted into existing orchards will be tested and validated for both, (i) its effect on pest control and pesticide reduction and (ii) on its practical feasibility across 6 European countries.

In-Between-Tractor-Wheel Flower Strips (BTW)

Picture: Franco Weibel

WP3 – Europe-wide experimental trials of new orchard design

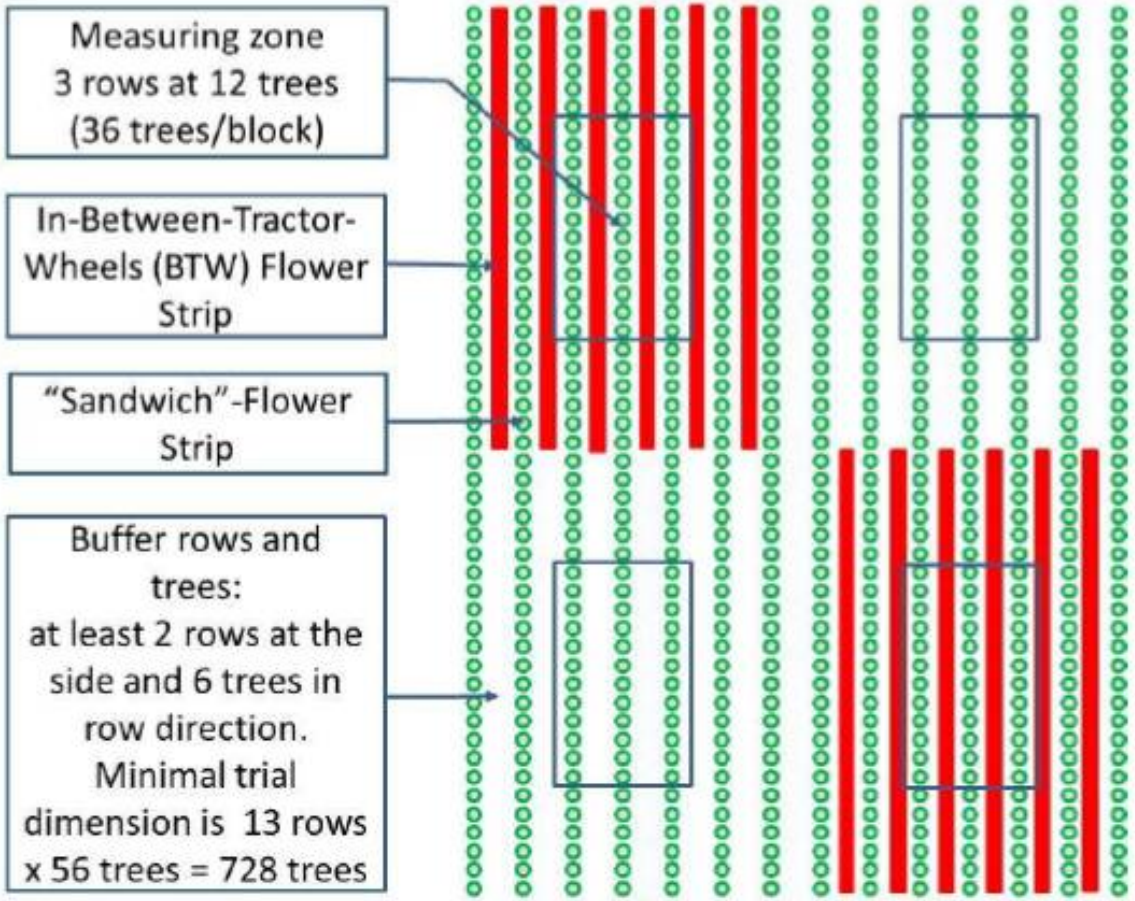


Diagram: Franco Weibel

- 6 partnering countries:
- In at least two organically managed orchards per country
- The creation of BTW-flower Strips, or/and other biodiversity-increasing elements identified in WP1 will be tested in a scientific approach.

WP4 - Learning from all sides and dissemination

(INRA, Marc Tchamitchian/ co-leader: SLU, Mario Porcel)

Objectives:

· To **adapt monitoring methods** and practices for FAB orchard management **to end-users needs** and constraints, with the active participation of stakeholders.

· To **disseminate project results** within a strong, collaborative stakeholder network created in the project.

· To characterize various **modes of participation** used in the project and analyze the **learning processes** between involved stakeholders.

Organic growers meeting

Picture: Weronika Swiergiel

Thank you for your attention!