

Habitat Enhancements to Support Bees: Agriculture to Urban Research

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Overview

- Bees and pollination service for agriculture
- Threats to native bees
- Bees in urban landscapes
- Bee conservation informed by bee biology
- UC Davis Habitat restoration work to support bees and pollination

Pollinators - key ecosystem service

- 60-70% of all flowering plant species require it.
  (Axelrod 1960, Bawa 1990)
- Reproduction limited by lack of pollinators (46% - 72% of populations studied).
  (Ashman et al. 2006)

- 35% of primary food crops benefit from animal pollinators (Klein et al. 2007)
- Of 1300 crops worldwide, 70% require animal pollinators for one or more cultivars
  (Roubik 1995)

Pollination by bees supports our food and fiber supplies

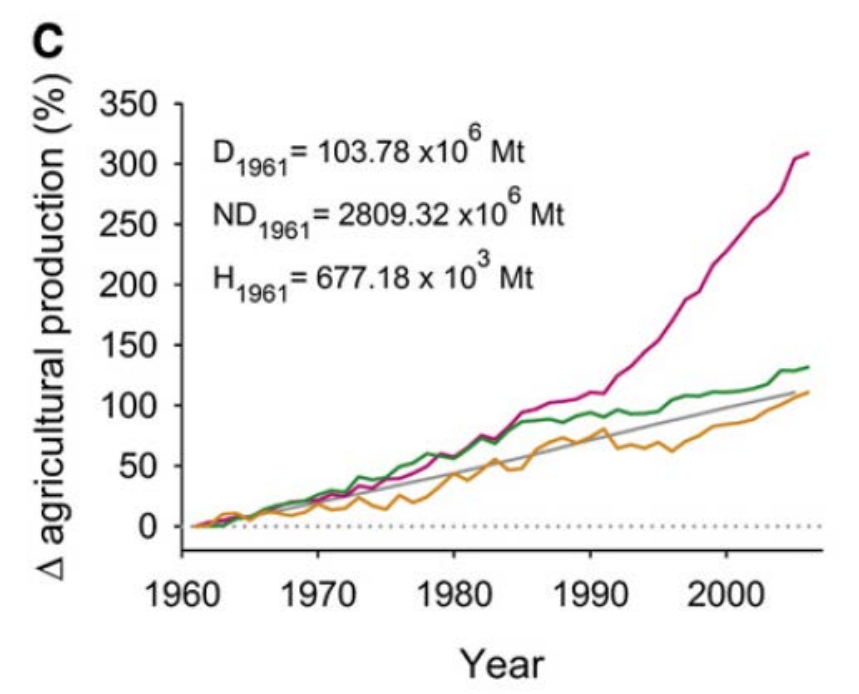
Without bees, crop production and yields suffer

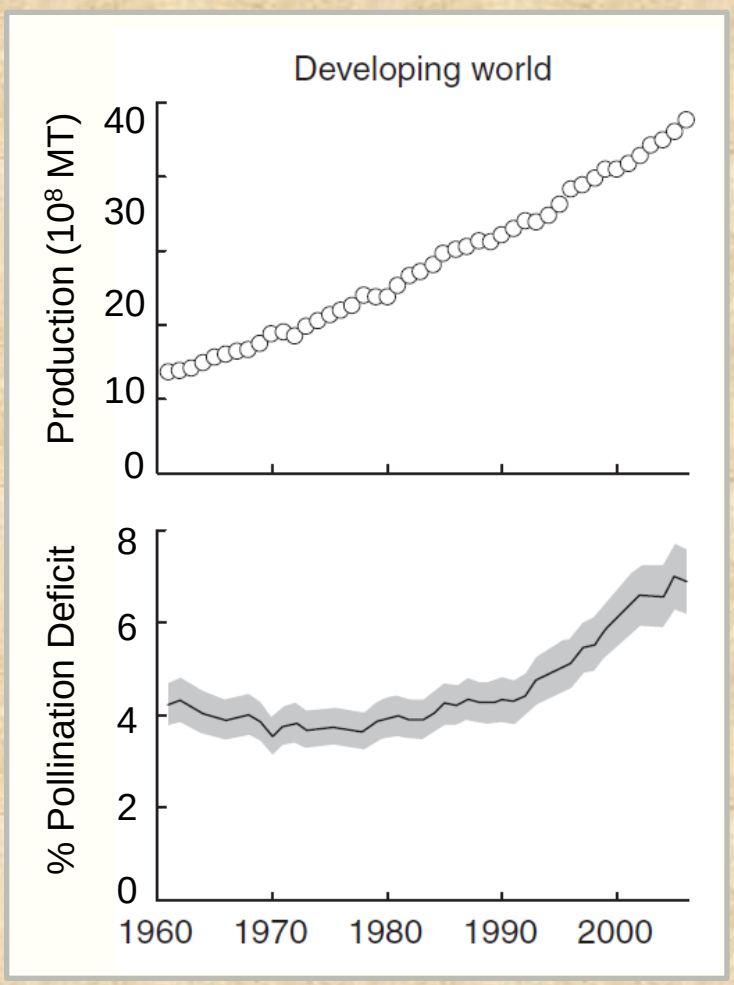
- Global value of pollination = $220 billion per year

- In the United States…
  - Honey bees = $14.6 billion
  - Wild bees = $3+ billion

- A nationally and globally-recognized need to develop strategies that support bees on farms

Pollination demand will increasingly exceed supply





Aizen et al 2009 a,b

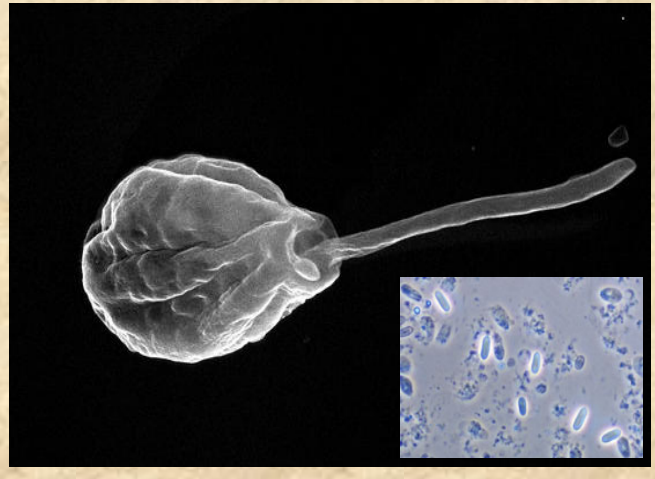
Wild bees contribute to crop and other pollination

- 4,000 species of wild bees in the US
- Many are very efficient crop pollinators
- For small-scale contexts like urban and market gardens wild bees may be easier to manage

Threats to native bees

Habitat loss

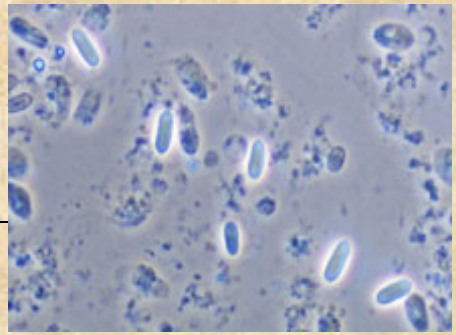
Tillage



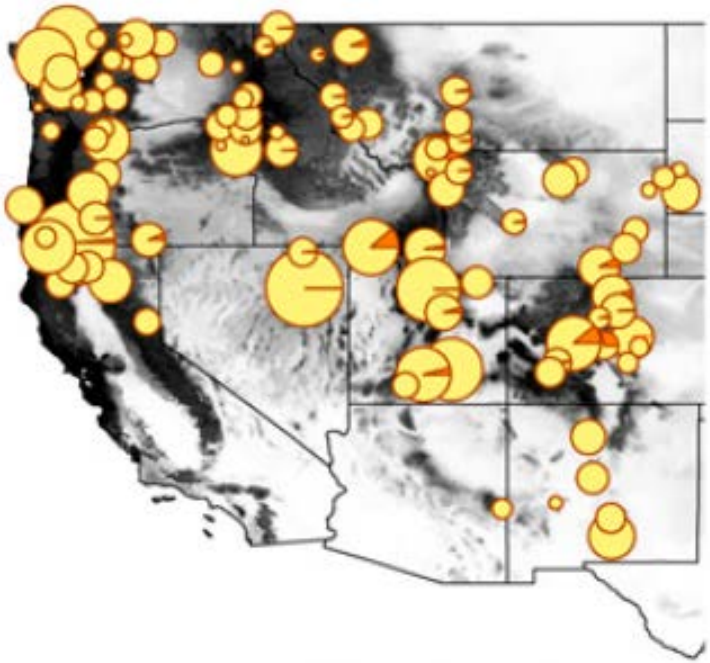
Disease

Pesticide

Disease



Historic & Current range



Incidence of Nosema

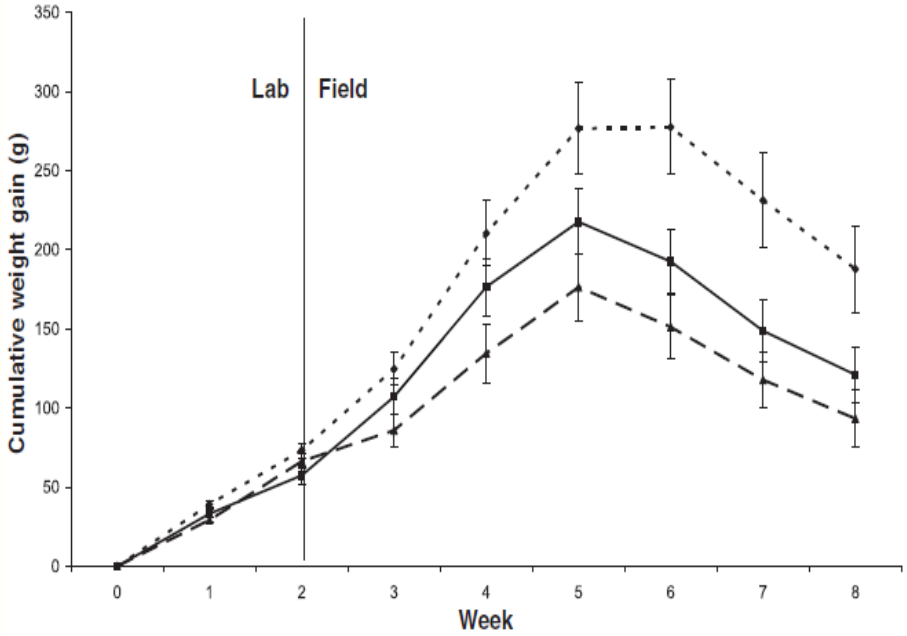
- ***B. vosnesnskii*** 1.3%
- Common within historic range

- ***B. occidentalis*** 37.2%
- Regionally extinct
- (or nearly so)

Pesticides

- Pesticides
  - Insecticides, fungicides, herbicides
  - New chemicals and formulations

Bumble bees feed environmentally-reasonable doses of neonicotinoid



March 2012- Science

Habitat fragmentation and loss of semi-natural habitats reduce bee abundance and diversity

1 km

- Isolation from natural habitat leads to decline in pollination 20 of 22 studies
  - Ricketts et al 2008
- Yolo County CA, 5 of the 6 most important crop pollinators
  - Willams and Kremen

Local loss

Bombus californica
Peponapis pruinosa
B. vosnesenskii
Melissodes spp.
Halictus farinosus

Intensive agriculture – negatively impacts bees

- Global demands for pollination dependent food is increasing
- Honeybees facing continued threats and declining numbers
- Great need for integration of wild and managed native bees

Bees in urban landscapes.

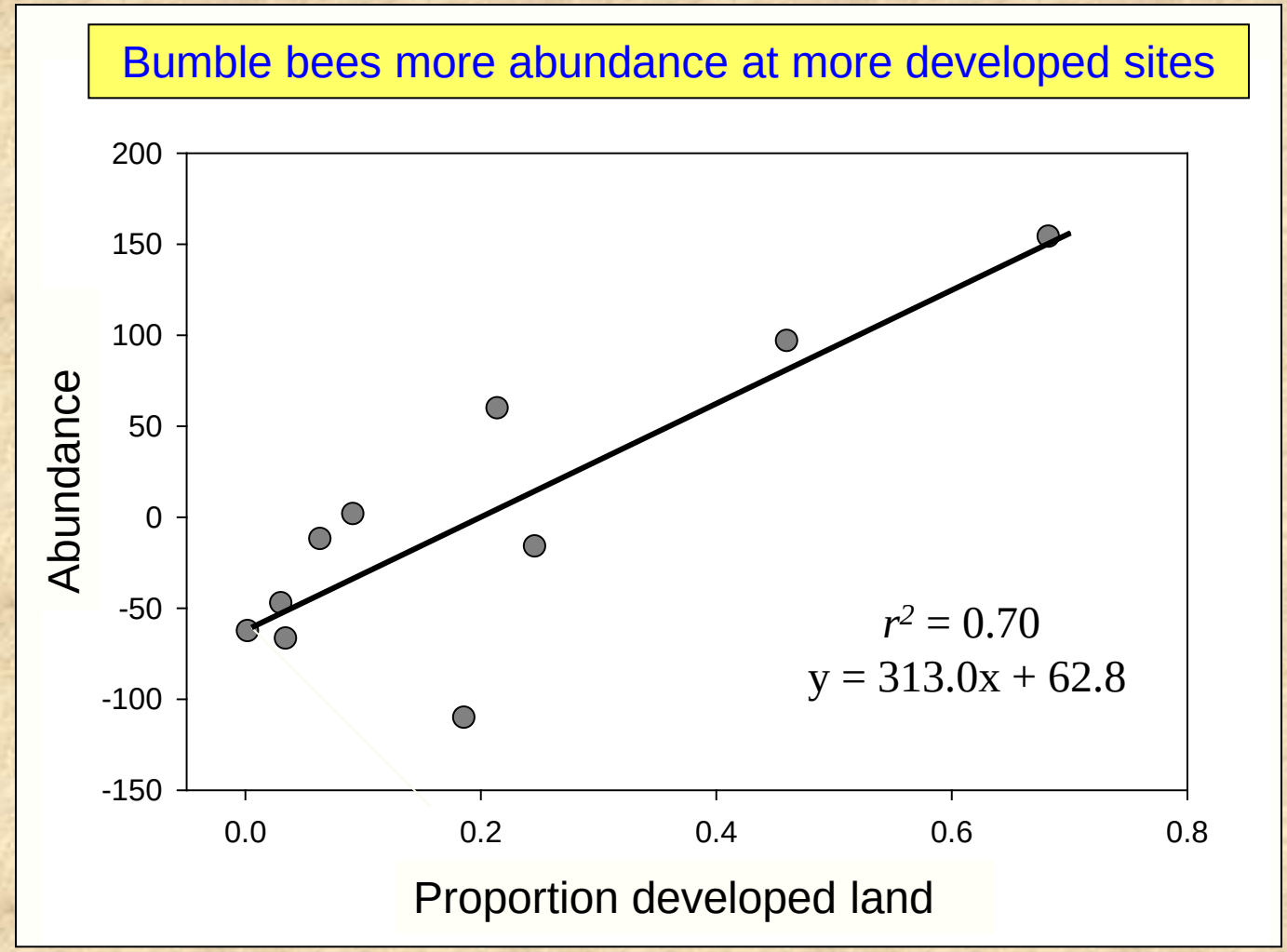
- Role in gardens and urban farms
  - Vegetable and fruit production
  - Native bees have a unique role to play

- Bees do well in cities
  - San Francisco – bumble bees
  - Philadelphia – bumble bees
  - Tucson AZ – all species associated with certain flowers
  - Characteristics of how & where they live and what they eat determine how well they do.

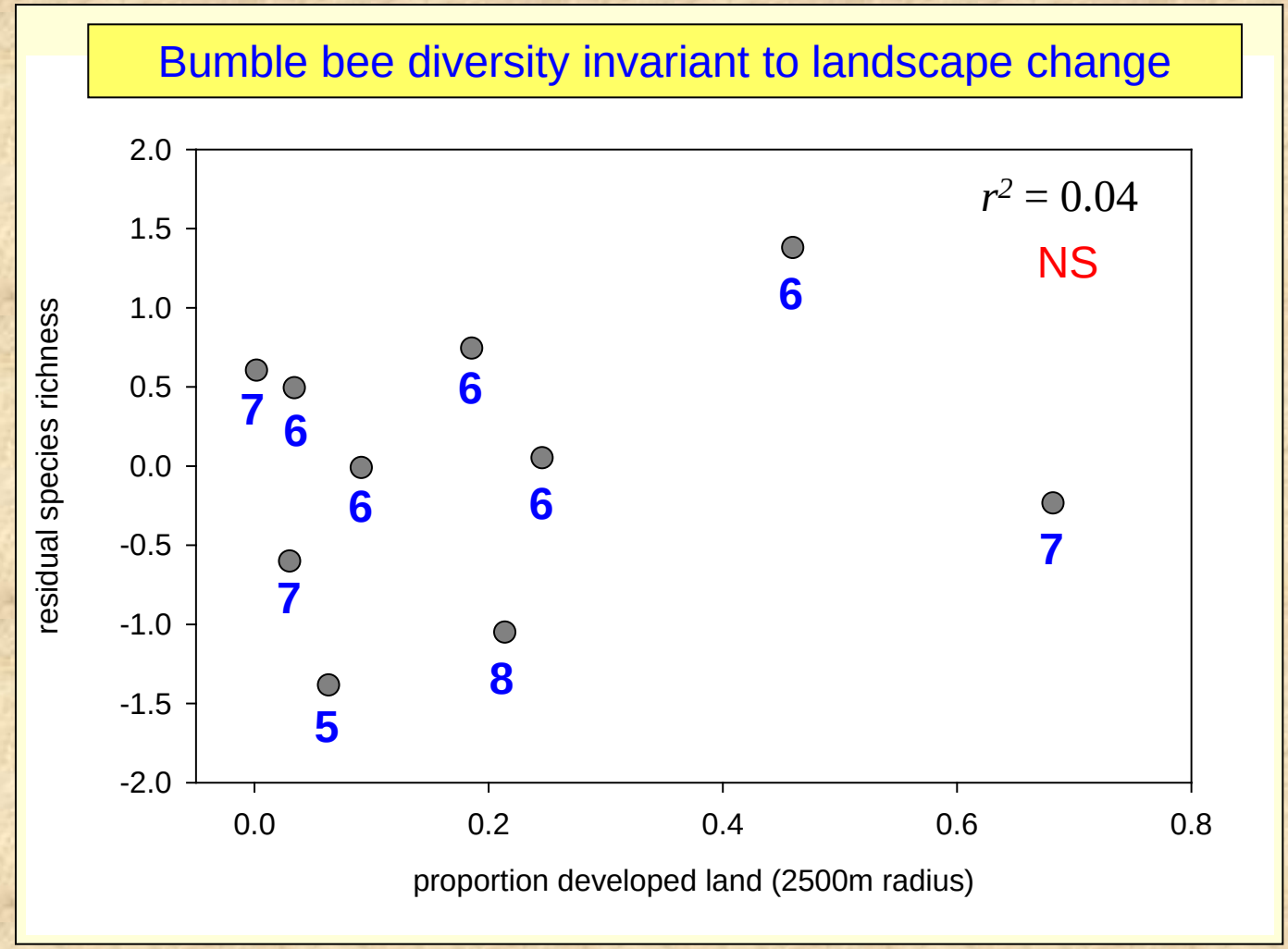
Bumble bees in an Urban landscape

- Study Area
- 10 restored meadows with wooded periphery
- Sites spanned gradient of urban development 0.1% - 68%
- Surveyed each site 3 times; Jun-Aug 2006

Bumble bee abundance in restored meadows in Philadelphia



Bombus spp. richness



What do bees need and how do we provide it to them?

Knowledge of bee biology–their needs–will help inform how to conserve and augment their populations in degraded landscapes and in gardens

Floral Resources

Bee traits

- Body size
  - flower interactions
  - foraging distances
  - bee tongue lengths

Floral Resources

- Flower traits
  - Pollen
  - Nectar
- Not all horticultural varieties offer rewards
- Choose some rewarding varieties

Floral Resources

- Flower traits
  - Diverse flower morphologies
- Continuous bloom over the season




Nesting materials

Andrej GOGALA

Westrich

Other nesting requirements

- Soil type
  - Particle size
  - Salt content
  - Moisture
- Slope
- Wood density
- Temperature

Anthophora plumipes

Managing nesting resources

- Artificial nest sites
  - Bee blocks
  - Reed cane bundles

Managing nesting resources

- Augment nest habitat
  - Reduce mulch
  - Diverse sun-shade
  - Nest materials
- Overwintering sites

Implications of life history for conservation in urban landscapes

Simple rules of thumb

- A diversity of flower types supports a diversity of bees
- Bees eat pollen and nectar not petals
- Flowers must be available throughout the season
- Nest sites are as likely as flower resources to limit bees
- Bare ground will help some, so don’t mulch it all.

Conserving bees through habitat enhancement

1. Choosing native wildflowers to support pollinators

2. Test wildflowers for their establishment and attractiveness to pollinators

3. Develop establishment and maintenance methods that are accessible to farmers – affordable, feasible

Restoring floral resources for native pollinators in agricultural landscapes

Identifying Floral Resources

Floral resources to support native pollinators

- Bees have diverse sizes and forms

Including flower species of varying sizes and shapes

- Bees fly at different times of year (phenology)

Including flower species that bloom throughout the seasons




Designing a bee – conservation friendly palette

1. Provide continuous bloom
2. Preferred by bees
3. Native to CA
4. Drought tolerant

Empirically-based

- Pollinator preference
- Rank use relative to plant rank abundance

21 sites
~ 8700 collection records

A focus on forbs

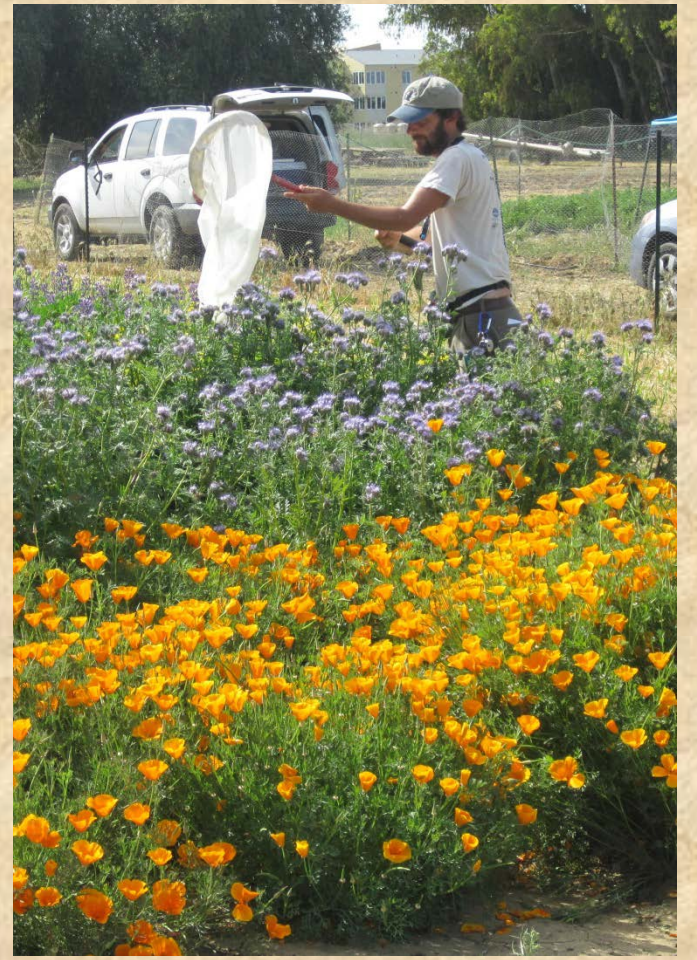
Forb species list

Annual and Perennial Mix	Bloom time
Lupinus succulentus	Spring
Phacelia tanacetifolia	Spring
Trifolium wildenovii	Late Spring - Summer
Trifolium fucatum	Late Spring
Trichostema lanceolatum	Summer late summer
Eschscholzia californica	Spring
Phacelia californica	Early summer
Lupinus formosus	Late Spring-Summer
Lotus scoparius	Summer
Grindelia camporum	Summer-Fall

Annual a perennial mix

Testing establishment

Data collection



Pollinator visitation

Observation results

Insect group	Number of visitors
Native bees	9,656
Honey bees	8,168
Flies	287
Butterflies and moths	185
Wasps	104
Beetles	279

Best performing plants

LACY PHACELIA:
annual
Spring

ARROYO LUPINE:
annual
Early spring

CHICK LUPINE:
annual
Late spring/summer

CALIFORNIA POPPY:
perennial
Spring-summer

CALIFORNIA PHACELIA:
perennial
Early summer

BOLANDER'S SUNFLOWER:
annual
Summer

SUMMER LUPINE:
perennial
Summer -fall

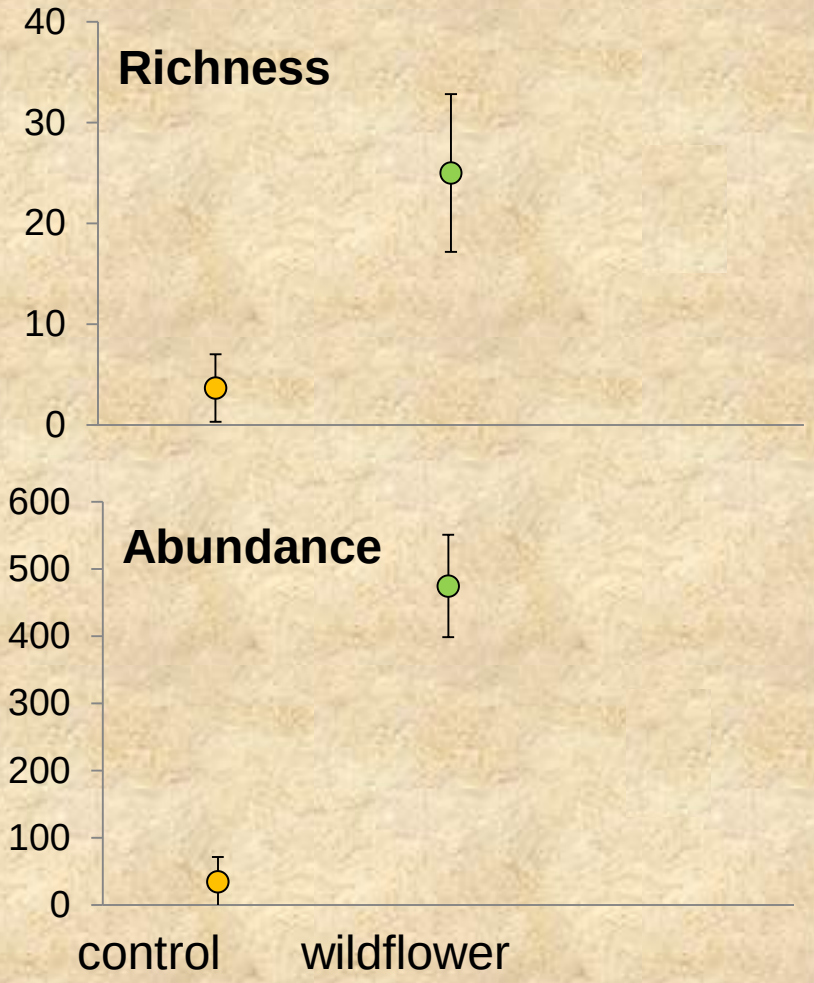
VINEGAR WEED:
annual
Late summer -fall

VALLEY GUM PLANT:
perennial
Summer - fall

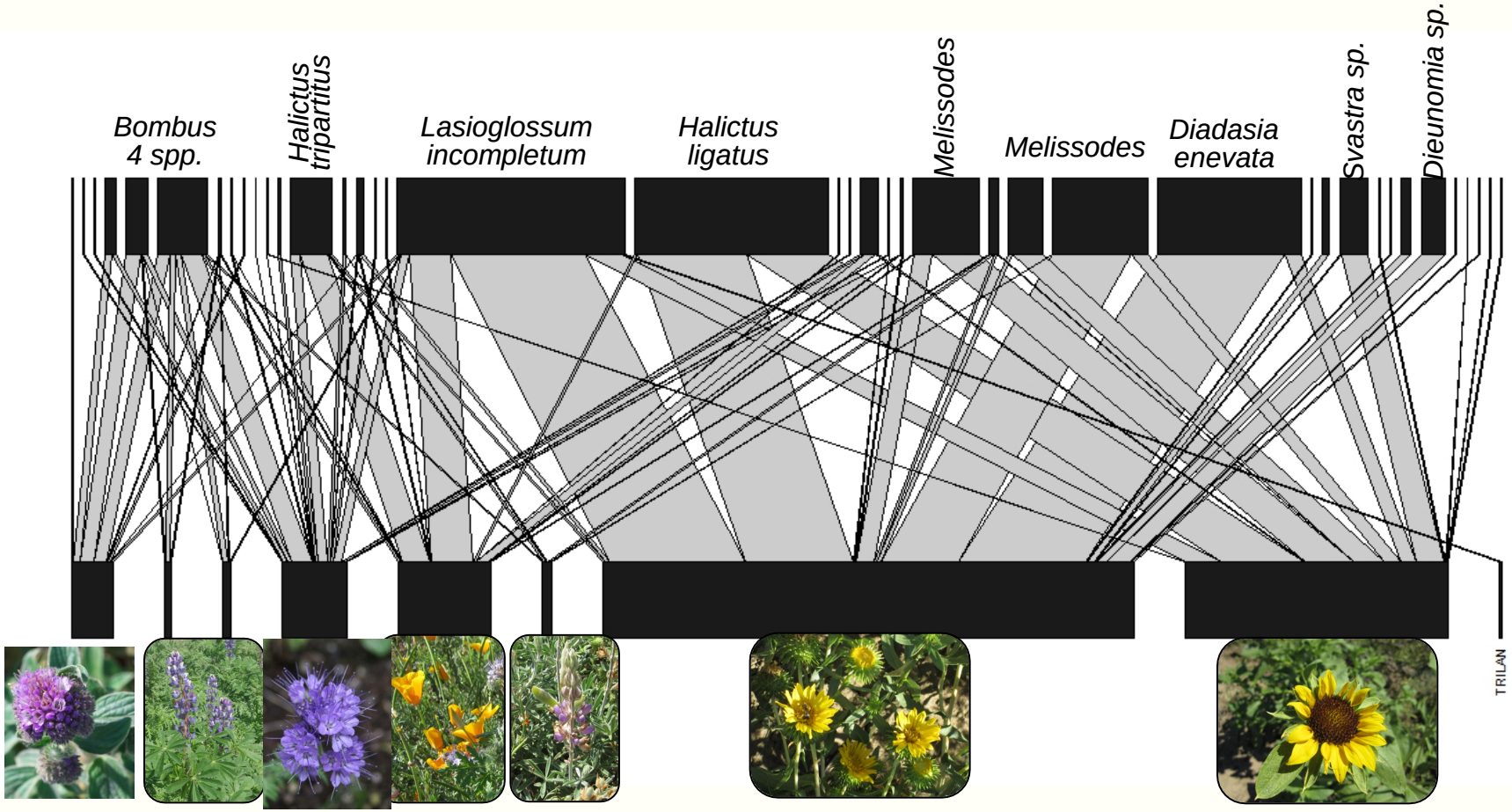
Scaling up 5 x 600m

Biodiversity value of restorations

- Wildflower strips increased
  - Richness over 6-fold
  - Abundance over 13-fold
- 47 total bee species
- 32 unique to enhanced borders



Patterns of interaction

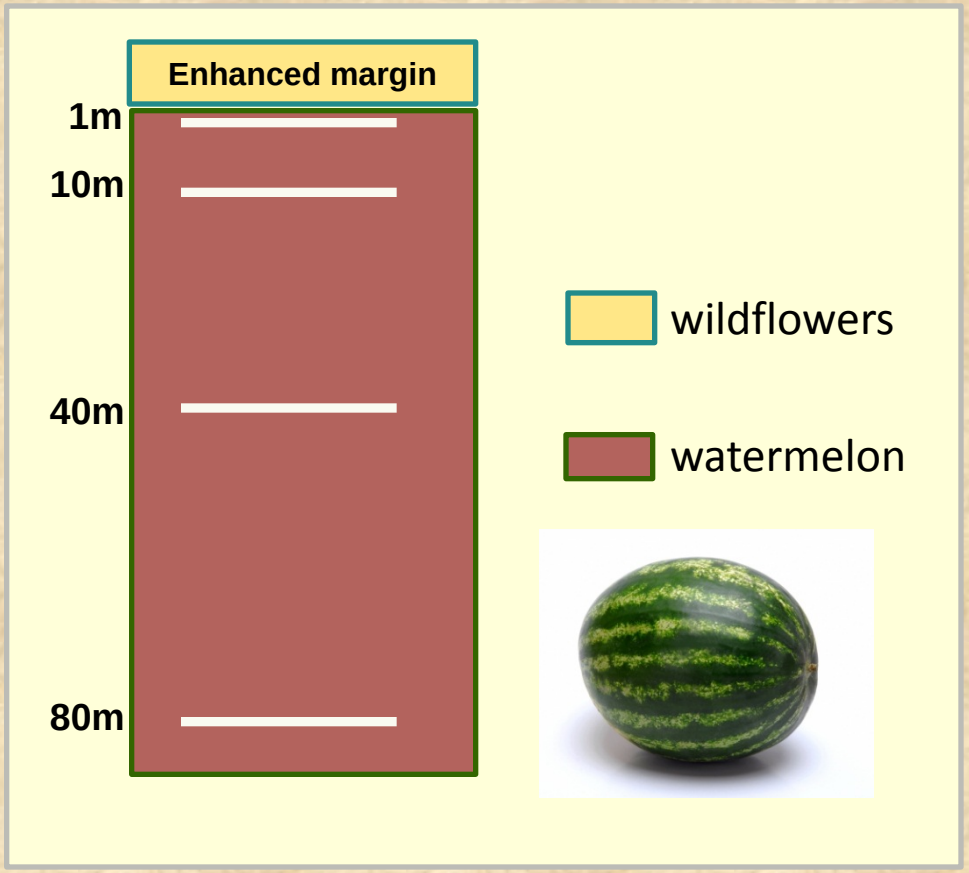


spring → summer → autumn

Pollination service value of restorations

Do wildflower plantings increase crop pollination and yield

- Paired Design
  - Enhanced field
  - Control field
- 10-30 acres
- Assess visitation and yield at different distances into the crop.
- All fields have managed honeybees.

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