



The importance of pollinators and their conservation

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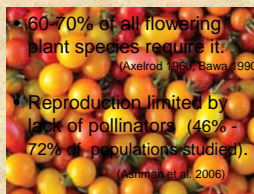
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Overview

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

Pollinators - key ecosystem function



• 60-70% of all flowering plant species require it.
(Axelrod 1995, 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

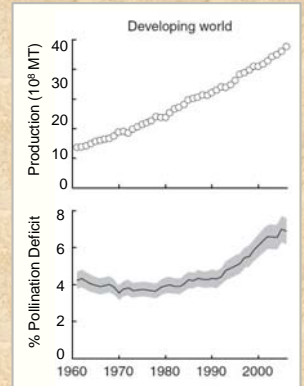
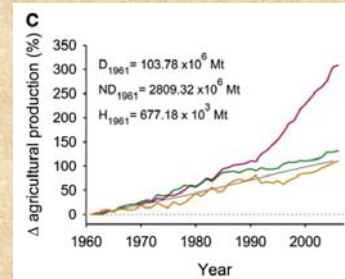


Without bees, crop production and yields suffer

- 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

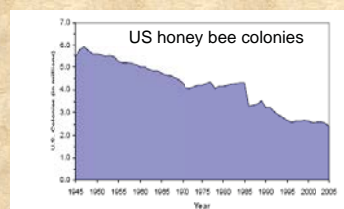


Pollinator declines

- Lost of once common species
National Research Council (2007)
- Long term decline in managed honeybees
- New and persistent diseases
 - Varroa
 - Colony Collapse Disorder



Bombus occidentalis



Threats to native bees



Habitat loss



Tillage

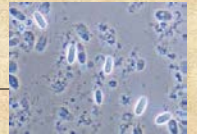


Disease

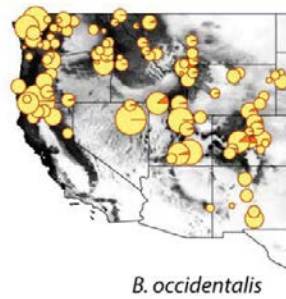


Pesticide

Disease



Historic & Current range



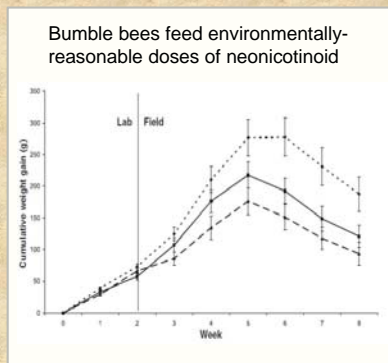
B. occidentalis

Incidence of Nosema

- *B. vosnesniskii* 1.3%
- Common within historic range
- *B. occidentalis* 37.2%
- Regionally extinct
- (or nearly so)

Pesticides

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



March 2012- Science

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



- 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
 - Williams and Kremen

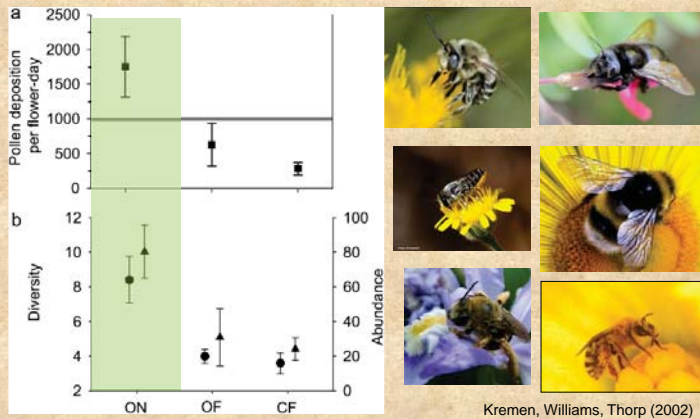


1 km

Local loss

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

Where habitat and resource needs are met native bees provide substantial pollination



Total estimated pollen deposition by native bees \pm SE

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

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



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
<i>Lupinus succulentus</i>	Spring
<i>Phacelia tanacetifolia</i>	Spring
<i>Trifolium wildenovii</i>	Late Spring - Summer
<i>Trifolium fucatum</i>	Late Spring
<i>Trichostema lanceolatum</i>	Summer late summer
<i>Eschscholzia californica</i>	Spring
<i>Phacelia californica</i>	Early summer
<i>Lupinus formosus</i>	Late Spring-Summer
<i>Lotus scoparius</i>	Summer
<i>Grindelia camporum</i>	Summer-Fall

Annual a perennial mix



Testing establishment



Data collection



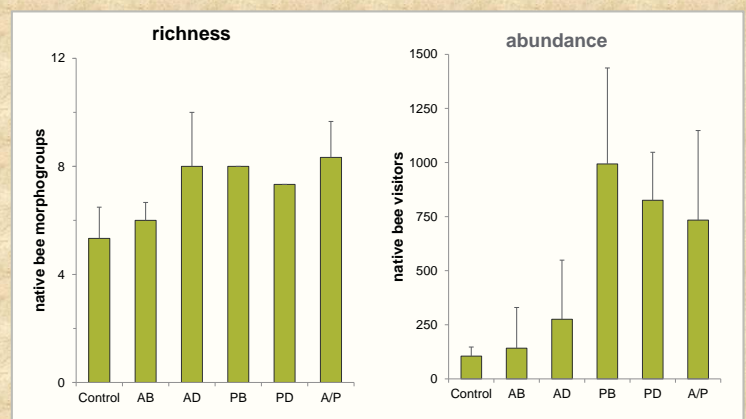
Pollinator visitation

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



Native bee visitors



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



April 2012

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



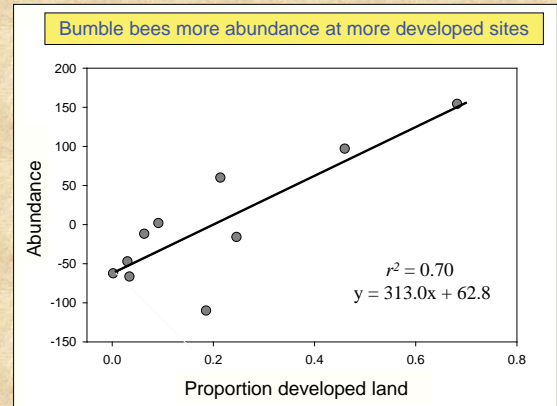
Thank You

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 bee abundance in restored meadows in Philadelphia



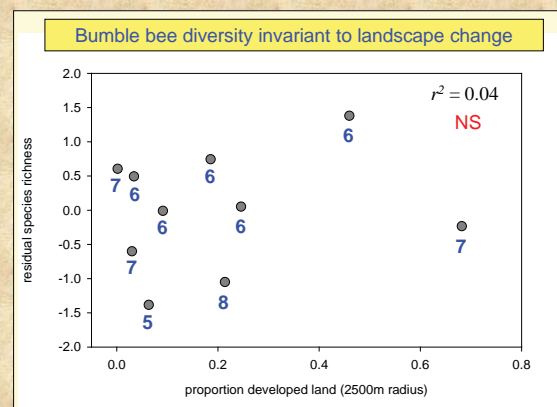
Honeybee Haven UC Davis

- Also supports non-Apis bees
- In ½ acre:
 - 40 bee species
 - 22 genera
- All common bee groups (families)



Robbin Thorp is monitoring bees

Bombus spp. richness



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



Implications of life history for conservation in urban landscapes

Simple rules of thumb

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

Developing recommendations of floral resources for bees

- Surveying use and preference
 - asking bees
 - 6770 specimens
 - Multiple habitat types
 - Base list
- Use versus preference
 - Accounting for plant abundance
- Native plants to region
 - Does this matter for urban gardens?
- Check for adaptation to local conditions or conditions of interest
- Bloom duration
- Reward type offered
- Human attraction too.



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Annual a perennial mix



Hedgerow/ forb-strip restoration



Spring



Late Summer

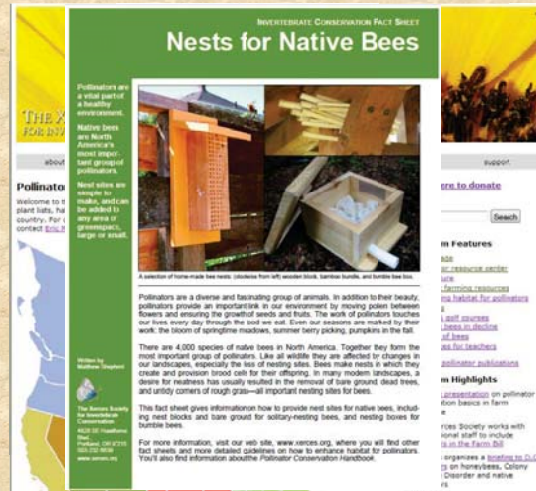
Plant Scientific Name		Plant Common Name (Perennial, Annual)	Visiting Bees	Bees Preference	Flowering Season						
					April	May	June	July	Aug	Sept	
1.	<i>Cirsium discolor</i> ¹	Field thistle (P)	Ap, B, X	**							
2.	<i>Eriogonum strigosum</i>	Daisy fleabane (A)	Ap, Au, C, H, L	*							
3.	<i>Scutellaria integrifolia</i>	Helmet flower (P)	B	***							
4.	<i>Apocynum cannabinum</i>	Indian hemp (P)	An, Ap, Au, B, L	**							
5.	<i>Prunella vulgaris</i>	Common selfheal (P)	Ap, Au, B, L	**							
6.	<i>Verbena hastata</i>	Swamp verbena (P)	C	***							
7.	<i>Asclepias syriaca</i>	Common milkweed (P)	Ap, B, X	***							
8.	<i>Euthamia graminifolia</i>	Flat-top goldenrod (P)	Ap, Au, C, H, L, X	**							
9.	<i>Lobelia spicata</i>	Pale purple lobelia (P)	B, C	***							
10.	<i>Agalinis purpurea</i>	False foxglove (A)	Au	***							
11.	<i>Pyrolanthus tenuifolius</i>	Narrowleaf mountainmint (P)	Ap, Au, B, C, H, L	**							
12.	<i>Solidago odora</i>	Antiseptic goldenrod (P)	Ap, Au, C, H, L, X	**							
13.	<i>Potentilla norvegica</i>	Norwegian cinquefoil (AP)	Au, H, L	***							
14.	<i>Eupatorium maculatum</i>	Spotted joe pye weed (P)	B, C, H	***							
15.	<i>Veronica noveboracensis</i>	Broadleaf ironweed (P)	Au, C, H, L	***							

References for gardeners



<http://nature.berkeley.edu/urbanbeegardens/gbt.html>

<http://www.xerces.org/pollinator-resource-center/>



Simple rules of thumb

- A diversity of flower types supports a diversity of bees
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- Flowers must be available throughout the season
- Nest sites are as likely as flower resources to limit bees
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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



Sampling Methods

Sampling plots

- Half-hectare plots in target meadows

Bees

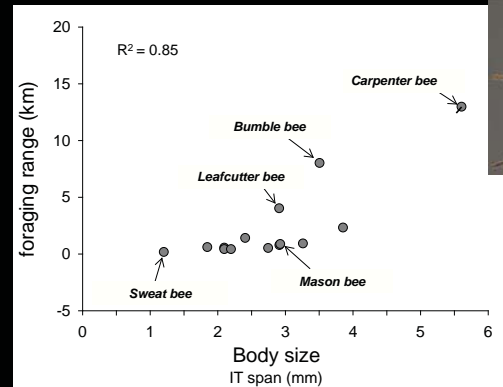
- Net collected off flowers for 2 hour-long periods

Floral Resources

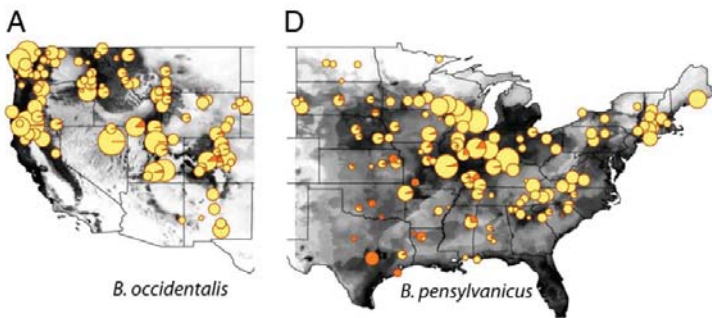
- Floral counts & diversity using quadrates



Body size and foraging distance



Threats



Conservation of bees and their habitats informed by bee biology

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