Integrated Pollination Strategies: Managed and Wild Bees for a Sustainable Future

Neal M. Williams
nmwilliams@ucdavis.edu
Long term trends in bee pollinated crops

Pollinator dependent crops INCREASING

Production deficit in the absence of pollinators

Bearing acres of U.S. non-citrus fruit and nut crops 1980-2009

Movement of honeybees for pollination in USA

- November-Jan
- 1.1 million colonies moved to CA.
Current status of colonies in USA

U.S. Honeybee Colonies

Source: USDA NASS Honey Production Report
Pollination Supply vs. Demand: Overwinter Colony Loss

Average 30.6% vs. Acceptable 15%

Source: Apiary Inspectors of America and USDA-ARS Beltsville Lab
Challenges facing honey bees

- Disease
- Parasites
- Pesticides
- Flowerless landscapes
- Monocultures

Poor nutrition

(after M. Spivak)
Integrated Crop Pollination

- Strategy to bolster pollinators and support sustainable yield

Diagram:
- Integrated Crop Pollination
  - Habitat
  - Landscape management
  - Agronomic practices
  - Pesticide stewardship
  - Scientific pollination sampling
  - Economic assessment
  - Grower integration and outreach
- Wild bees
- Alternative managed bees
- Honey bees
Integrated approaches

Wild pollinators

Alternative managed bees
Wild bees contribute to crop and other pollination

- Many native species are very efficient crop pollinators

- Often more effective than honey bees on a per visit basis

- BUT numbers of individuals are also key!
Alternative managed pollinators

- High quality
- Pesticide Free

- Bumble bee pollinated
Alternative managed pollinators
Alternative managed pollinators
Combining native bees and honey bees

- The presence of wild bees
- Honey bee pollination effectiveness and fruit set are greater when wild bees are present

Dr. Claire Brittain
Wild bees make honey bees better pollinators

**Single visit pollination by honey bees**

- Without WBs: 30% 
- With WBs: 50%

**Fruit set**

- Without WBs: 16% 
- With WBs: 21%

Fruit set data from 5 trees per orchard for 7 orchards with WBs and 7 without WBs
Enhancing habitat for bees wild and managed alike

- The Irony of intensive agriculture and pollination
- Intensive agriculture challenges bees
- Forage (flowering plants)
- Nutrition (diverse pollen and nectar)
- Pesticides (mortality and physiological stress)
- Nesting sites
Restoring floral resources for Pollinators in Agricultural Landscapes
Selecting & evaluating flowering plants for bee conservation

### Plant material
- Regionally relevant
- Seed available
- Cost effective
- Perennial/annual
- Reliable growth
- Bloom period
- Pest neutral
- Site suitability

### Pollinator response
- Attractive
- Rewarding
- Abundance
- Diversity
- Species of interest

### Technology transfer
- Demonstration sites
- Early adopters
- Economics
- Agronomic expertise
- Cost-sharing options
- Success stories

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Bee habitat establishment by farmers

Increased yields
Higher crop quality
More stable yields
Plant selection tools

1. **List of interactions**
   - Bees x Plant
   - Which plants do the bees visit

2. **Bees flight seasons**
   - When are different bee species active?

3. **Flowering seasons**
   - When do the different plants flower?
Selection approach → Results

• 69 candidate plant species in the data set.
• Select number of plants species 5, 10, 15, etc.
• Maximize bee richness for that number of plants
• Genetic “optimization” algorithm
• Non-linear response
  – 10 plants – 88 spp. 70%
  – 15 plants – 94 spp. 74%

Questions:

If cost limited choice to 10 plant species, which 10 would support greatest bee diversity?

Our best starting guess

How many plant species are required to achieve 80% of total bee species in the regional pool?

Results
Best performing plants

**LACY PHACELIA:**
- **Season:** Spring
- **Type:** Perennial

**ARROYO LUPINE:**
- **Season:** Early spring
- **Type:** Annual

**CHICK LUPINE:**
- **Season:** Late spring/summer
- **Type:** Annual

**CALIFORNIA POPPY:**
- **Season:** Spring-summer
- **Type:** Perennial

**BOLANDER’S SUNFLOWER:**
- **Season:** Summer
- **Type:** Annual

**SUMMER LUPINE:**
- **Season:** Summer-fall
- **Type:** Perennial

**VINEGAR WEED:**
- **Season:** Late summer
- **Type:** Annual

**VALLEY GUM PLANT:**
- **Season:** Summer - fall
- **Type:** Perennial
Evaluating function of wildflower plantings

- 6 x 400 m strips adjacent watermelon fields
- Control margins

1. Quantify flower density

2. Sample flower visitors over the season for diversity and abundance

3. Measure fruit set on the crop
Testing plant benefits for bees
Wildflower strips enhance native pollinators

- Wildflower strips increased
  - Species 6 times higher
  - Abundance 13 times higher
- 47 total bee species
- 32 unique to enhanced borders

- **Natural floral-diverse border**
- 26 unique to enhanced borders
Tools for producers and land managers

ASSESSING THE POLLINATION OF YOUR PROPERTY

2. Calculations

Once you have completed ten 1 minute observations and collected data in the table:

- For each bee type, add up the numbers in each column to get a total for each type of bee in the “TOTAL visits” row A. This provides a simple way to calculate the flower visitation rate by each type of bee in your study area.

- In each column in row C “% pollen deposition”, multiply the numbers in each column in row A “TOTAL visits” by the numbers in row B “Single visit % pollen deposition” to get the number of pollen grains each bee type is depositing on flowers. This computation shows you the percent of the pollen necessary for a flower to set fruit within a given group, given how often they visit the watermelon flower.

<table>
<thead>
<tr>
<th></th>
<th>Honey bee</th>
<th>Native bee large</th>
<th>Native bee small</th>
<th>Native bee green</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation 1</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Observation 2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Observation 3</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>6</td>
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<tr>
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<td>2</td>
<td>4</td>
<td>1</td>
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<tr>
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<td>1</td>
<td>8</td>
<td>1</td>
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<tr>
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<td>Observation 9</td>
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<tr>
<td>Observation 10</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

A = sum Obs 1-10: “TOTAL visits” (sum of Obs 1-10 for each column)

B: “Single visit % pollen deposition” (% of pollen deposition per visit needed to produce a fruit)

C = AxB: “Group % pollen deposition” (% of pollen deposition needed to produce a fruit by each bee group)

D = sum of C: “Farm level pollination” % pollen deposition needed to produce a fruit provided by pollinators in your farm (≥100% means each flower receives sufficient pollination to set a fruit)

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<tbody>
<tr>
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<td>0.69</td>
<td>1.13</td>
<td>0.26</td>
<td>1.13</td>
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<tr>
<td>Native bee small</td>
<td></td>
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<tr>
<td>Native bee green</td>
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89.69
Tools for producers and land managers
Integrated Crop Pollination

- Recognizing farming context where alternatives are valuable
  - Honey bees
  - Managed alternative bees
  - Wild populations

- Capitalizing on interactions among bee species

- Enhancing habitat to support bees
  - Diverse, robust populations Managed and Wild bees
Questions?

UC DAVIS
UNIVERSITY OF CALIFORNIA

nmwilliams@ucdavis.edu