Honeybee and Pollination: Looking at the Big Picture

Chris Heintz
Almond Board of California

Neal Williams
UC Davis

Gordon Wardell
Paramount Farming Co.
Honey Bees and Pollination

Looking at the Bigger Picture

Christi Heintz
ABC Bee Task Force Liaison
Executive Director, Project Apis m.
Pollination: Looking at the Bigger Picture

TIME
A WORLD WITHOUT BEES

THE PRICE WE’LL PAY IF WE DON’T FIGURE OUT WHAT’S KILLING THE HONEYBEE
BY BRYAN WALSH

Bees are in crisis

Christi Heintz, executive director of Project Apis m., a nonprofit organization focused on enhancing honeybee health and colony sustainability (see “Costco bee-comes involved”)

Feeding the bees
Almond growers encouraged to plant floral seed mixes

Page 3

AgAlert
THE WEEKLY NEWSPAPER FOR CALIFORNIA AGRICULTURE
Factors Impacting Bee Health and Supply

- Pests and Diseases
- Queen Events
- Over-Wintering Losses
- Available Nutrition
Managed honey bee colony losses in the US

- Acceptable range: 0-15%
- +9.2 pt. mortality
Why should we care about honeybees?

Pollinators are responsible for $29 billion in farm income.

Nearly $20 billion directly or indirectly dependent on honey bees.

Calderone, PLoS ONE 5/22/12
The Importance of Bee Health to Almond Growers

- 2 colonies/ac = 1.62 million colonies vs. 2.62 in US and ~30% winter loss

Source: USDA Agricultural Statistics Service, Pacific Region (NASS/PR) 2012 Acreage Report
## Apiary Shipments to California

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Trucks</th>
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<tr>
<td>2010</td>
<td>2,713</td>
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<td>2011</td>
<td>3,475</td>
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<td>2012</td>
<td>3,409</td>
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<tr>
<td>Researcher</td>
<td>Project Description</td>
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<tr>
<td>----------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
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<tr>
<td>Sheppard/Cobey, WSU</td>
<td>Germplasm Importation, Preservation and Stock Improvement</td>
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<td>Spivak, U Minn</td>
<td>Enhancing Tech Transfer Teams for the Beekeeping Industry</td>
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<tr>
<td>Hooven, Oregon St U</td>
<td>Fungicide Effects on Honey Bee Development</td>
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<tr>
<td>Williams, UCD</td>
<td>Impact of Fungicide Application on Pollen Germination and Tube Growth</td>
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<td>CSBA</td>
<td>California Border Station Improvements</td>
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<tr>
<td>Ahumada, Ag Science Consulting</td>
<td>Varroa Treatments: Efficacy and Economic Impact</td>
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<td>DeGrandi-Hoffman, USDA Carl Hayden</td>
<td>Nutritional Effects of Protein Supplements vs. Natural Forage in Colonies Used for Almond Pollination</td>
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<td>Williams et al, UCD</td>
<td>Almond Integrated Crop Pollination</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
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ABC’s Collaborative Efforts
# Project Apis m. Funding

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Project Description</th>
<th>Funding</th>
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<tbody>
<tr>
<td>Ellis</td>
<td>UFL</td>
<td>Varroa Control-RNAi</td>
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<tr>
<td>Bromenshenk</td>
<td>Bee Alert</td>
<td>Virus and Nosema</td>
<td>$36,000</td>
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<tr>
<td>Flenniken</td>
<td>MSU</td>
<td>Virology and Immunology</td>
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<td>Martin</td>
<td>UK/HA</td>
<td>Virus-Pathogen Complex</td>
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<td>Wick</td>
<td>BVS, Inc.</td>
<td>Virus and Essential Oils</td>
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<td>Spivak</td>
<td>U MN</td>
<td>Landscapes and Nutrition</td>
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<td>Tarpy</td>
<td>NCSU</td>
<td>Nexcelom System</td>
<td>$29,480</td>
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<td>Eischen</td>
<td>USDA</td>
<td>Colony Density Almonds</td>
<td>$16,200</td>
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<td>Pettis</td>
<td>USDA</td>
<td>Amitraz</td>
<td>$33,140</td>
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<td>Frazier</td>
<td>PSU</td>
<td>Pesticide CostShare</td>
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<td>Johnson, R</td>
<td>OH State</td>
<td>Dimilin and IGRs</td>
<td>$134,640</td>
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<td>vanEngelsdorp</td>
<td>U MD</td>
<td>Midwest Tech Transfer</td>
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<td><strong>$398,781</strong></td>
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What You Can Do to Make a Difference

Plant Honey Bee Forage
...see Meg near poster session

POSTER SESSIONS

Sign up for free seed!!
What You Can Do to Make a Difference

Grower BMPs: Assure almonds continue to be a good and safe place for bees
Pollination Symposium: Next UP

Dr. Neal Williams, UC Davis
Dr. Gordon Wardell, Paramount Farming, Inc.
Bee forage and sustainable pollination for almonds

Neal M. Williams
UC Davis
nmwilliams@ucdavis.edu
Almond context

- Large fields
- High density of flowers
Honey bees for crop pollination

- Colonial
- Social foraging
- Perennial

LARGE NUMBERS OF POLLINATING BEES
Challenges facing honeybees

• Overwinter mortality 30%
• Must build back colonies
• Almond pollination demands vigorous hives
• Low forage resource levels preceding almond bloom
• Hives are supplemented
• Could benefit from diverse pollen sources
• Integration of other pollinators??
Challenges facing honey bees

- disease parasites
- pesticides
- monocultures
- flowerless landscapes
- Poor nutrition

after M. Spivak
Synergies of honey bees and native bees for almond pollination

- The presence of wild bees

- Honey bee pollination effectiveness and fruit set are greater when wild bees are present
Wild bees make honey bees better pollinators

Fruit set data from 5 trees per orchard for 7 orchards with WBs and 7 without WBs

**Single visit pollination by honey bees**

<table>
<thead>
<tr>
<th>Orchard</th>
<th>% Visits successful pollination</th>
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<tbody>
<tr>
<td>without WBs</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>with WBs</td>
<td><img src="image2.png" alt="Image" /> 21%</td>
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**Fruit set**

<table>
<thead>
<tr>
<th>Orchard</th>
<th>% fruit set per orchard</th>
</tr>
</thead>
<tbody>
<tr>
<td>without WBs</td>
<td><img src="image3.png" alt="Image" /> 16%</td>
</tr>
<tr>
<td>with WBs</td>
<td><img src="image4.png" alt="Image" /></td>
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</table>

Wild bees make honey bees better pollinators.
Almond pollination “in a nutshell”

- Multiple varieties
- One per row of the orchard
- Varieties are SELF STERILE
Forage plants for honey bees in almond and beyond . . .

- Testing honeybee use of wildflowers pre/post almond bloom
- Testing new plants for honey bees
- *Honey Plants of California 1940s* in digital format @ Laidlaw website

K Garvey

Project Apis m.

Paramount farming
Tailored mix for almond

Almond Mix (round 1)
- Five spot
- Baby blue-eyes
- Chinese houses
- California poppy
- California bluebells
- Miniature lupine
- Great Valley Phacelia
Testing establishment methods (2013)

Two mixes: Mix 1—45 seeds/ft²; Mix 2—90 seeds/ft²

N

Irrigated

Non-Irrigated

18 ft

20 ft

6 ft

6 ft

6 ft

272 ft

Broadcast Early

Broadcast Early

Broadcast Late

Broadcast Late

Mix 2

Mix 1

Mix 2

Mix 1

Mix 2

Mix 1

Mix 2

Mix 1

Weeded

No weed control
Almond mix planting trials

Lost Hills
Modesto
Lockeford

- Pre-almond bloom
- Mid-bloom
- Post-bloom

- Wildflower timing
- Bee visitation
Almond mix performance

Pre-almond bloom
Almond mix performance

Post-almond bloom
Bee visits to almond mix

![Graph showing bee visits to almond mix with data points for Honey Bees and Wild Bees.](image)

<table>
<thead>
<tr>
<th>Date</th>
<th>Number of Honey Bees</th>
<th>Number of Wild Bees</th>
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<tbody>
<tr>
<td>2/22/2013</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>3/22/2013</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>4/22/2013</td>
<td>15</td>
<td>10</td>
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Lost Hills
Honey Bee: 1017
Native Bee: 515
Honey bee use by plant

Number of bees per plot

- Great valley phacelia
- Five spot
- Baby blue eyes
- California blue bells
- California poppy
- Chinese houses

B L O O M

Broadening the range of plants for honey bees

**Trial sites**
- Central Valley
- Coast
- Foothills
Tools for producers and land managers

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### Honey Plants of California

#### Alameda County

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Common Name</th>
<th>Genus</th>
<th>Species</th>
<th>Drought Tolerance</th>
<th>Honey Value</th>
<th>Honey Color</th>
<th>Pollen Value</th>
<th>Flower Color</th>
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<tr>
<td>FORBS</td>
<td>Alfalfa</td>
<td>Medicago</td>
<td>sativa</td>
<td>Perennial</td>
<td>Major</td>
<td>Variable, mostly light amber</td>
<td>Minor</td>
<td>ND</td>
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<tr>
<td></td>
<td>Arroyo lupine</td>
<td>Lupinus</td>
<td>acutiloba</td>
<td>Annual</td>
<td>Questionable</td>
<td>Questionable</td>
<td>Questionable</td>
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<td></td>
<td>Bluebelle</td>
<td>Gilia</td>
<td>capillata</td>
<td>Annual</td>
<td>ND</td>
<td>Minor</td>
<td>Amber</td>
<td>Minor</td>
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<tr>
<td></td>
<td>Bolander's sunflower</td>
<td>Helianthus</td>
<td>bolanderi</td>
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<td>Moderate</td>
<td>Minor</td>
<td>White</td>
<td>Minor</td>
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<tr>
<td></td>
<td>Bunchleaf penstemon</td>
<td>Penstemon</td>
<td>heterophyllus</td>
<td>Perennial</td>
<td>Moderate</td>
<td>Fairly important</td>
<td>White</td>
<td>Minor</td>
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<td></td>
<td>California bee plant</td>
<td>Seropallaria</td>
<td>californica</td>
<td>Perennial</td>
<td>Low</td>
<td>Fairly important</td>
<td>White to light amber</td>
<td>Minor</td>
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<tr>
<td></td>
<td>California gilia</td>
<td>Gilia</td>
<td>achillefolia</td>
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<td>Low</td>
<td>Minor</td>
<td>Light amber</td>
<td>Minor</td>
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<td>californica</td>
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<td>ND</td>
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<td>Light amber, greenish</td>
<td>Minor</td>
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<td>California poppy</td>
<td>Eschscholzia</td>
<td>californica</td>
<td>Annual or perennial</td>
<td>Moderate</td>
<td>Minor</td>
<td>Light amber</td>
<td>Major</td>
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<td>Corisops</td>
<td>tomentosa</td>
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<td>High</td>
<td>Major</td>
<td>Orange yellow</td>
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<td>Lupinus</td>
<td>micranthus</td>
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<td>Minor</td>
<td>Questionable</td>
<td>Questionable</td>
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<td>ND</td>
<td>Minor</td>
<td>Light amber</td>
<td>Important</td>
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<td>Common verbena</td>
<td>Phyla</td>
<td>nodiflora</td>
<td>Perennial</td>
<td>ND</td>
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<td>White to light amber</td>
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<td>Common sunflower</td>
<td>Helianthus</td>
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<td>Moderate</td>
<td>Minor</td>
<td>Amber</td>
<td>Minor</td>
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<td>Coyote mint</td>
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<td>ND</td>
<td>Minor</td>
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<td>Variable</td>
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<td>Important</td>
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<td>imbricata</td>
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<td>Important</td>
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<td>Meadow foam</td>
<td>Limnanthes</td>
<td>douglasii</td>
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<td>ND</td>
<td>Fairly important</td>
<td>Light amber to amber</td>
<td>Important</td>
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<td>Red maidens</td>
<td>Calandrinia</td>
<td>cauliflora var. Many</td>
<td>Annual</td>
<td>ND</td>
<td>Fairly important</td>
<td>Light amber to amber</td>
<td>Important</td>
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</table>
Getting the Most Out of Your Bees and Your Trees

Pollination from a Grower’s Perspective and a Bee’s Perspective

Gordon Wardell
Bee Biologist
Paramount Farming Company
Chairman: Project Apis m
Honey Bee Basics
Three Distinct Populations in a Honey Bee Colony

• The Immature Bees (Brood)
  Eggs, Larvae, Pupae

• The Hive Bees
  Nurse Bees, Hive Cleaners, Wax Builders, Honey and Pollen Processers, Undertakers and Guards

• Field Bees (Foragers)
  Pollen Foragers, Nectar Foragers, Water Foragers, Propolis Foragers
Honey Bee Brood
Foragers
Washboarding Behavior
Bees have a choice.
They have wings.
Honey Bee Dance Language

Outside the hive
50 to 150 Meters
> 150 Meters

• Direction and Distance to the flowers
• Scent of the flowers
• Taste of the nectar
If Orchards Must Be Treated

• Spray only if you must
• Spray in the late afternoon or evening
• Spray the Safest Materials Around Bees
• Resist the “Free Ride” during bloom
• Avoid Direct Spraying of the Colonies
• Dump and replace water in bee water buckets
• Instruct Equipment Operators to make wide turns around colonies at the ends of rows
Herbicide Bee Kill - Tank Mix:
A generic Roundup
A second herbicide
Spray Oil
Liquid AMS (ammonium sulfate)
Hand Held Data Recording

• Hand Held Data Recorder plus GPS

• Colonies randomly select
• GPS coordinates
• Immediate access to data
• No transcription from paper
Almond Yield vs. Frames of Bees, 2010
2011 Colony Strength VS. Yield
2012 Colony Strength vs Yield
Thank You