



growing  
ADVANTAGE  
The Almond Conference

A close-up photograph of several green almonds on a branch, with vibrant green leaves. The background is softly blurred, showing more of the tree and some out-of-focus figures of people, suggesting an outdoor setting like a farm or orchard.

**Eric Mussen**  
**UC Davis Emeritus**



# Challenges Facing Beekeepers and Bees

Eric Mussen  
Extension Apiculturist Emeritus  
UC Davis

# U.S. Annual Colony Losses

- Up to late 1980s – Five to ten percent – Economically replaced with “splits” or “divides”
- Invasions of exotic mites – Tracheal mite (*Acarapis woodi*) arrived from Europe in 1984 and Varroa mite (*Varroa destructor*) arrived from Asia in 1987
  - Both species spread across the country in five years, killing half of our managed colonies
  - Tracheal mites eventually became much less of a problem
  - Varroa mites also killed nearly all of our feral (unmanaged, “wild”) colonies
  - Varroa mite remains a damaging parasite that is very difficult to subdue
  - U.S. annual colony losses climbed to 15-20 percent when mites became established
  - This is the upper limit of financial ability to replace colonies with splits and divides
- U.S. annual colony losses have continued to increase to an average range of 26-35 percent
  - Not all beekeepers suffer these losses, but many lose between 50 and 90 percent of their colonies
  - This is not sustainable for the beekeeping industry – the loss rate has to be reduced

# Colony Collapse Disorder

- The name “colony collapse disorder” or “CCD” was coined in 2006 in response to a sudden increase in inexplicable increased losses and colonies across the nation and around the northern hemisphere
- Afflicted colonies simply lose their adult bee populations over a period of a few days
  - The bees simply fly away, individually, leaving behind:
    - substantial stored honey and pollens
    - all stages of brood that require incubation and feeding
    - and the queen and a few newly emerged bees that will quickly perish
- Practically no dead bees are seen in the hive or on the ground surrounding the hive

# Increased Federal Support for CCD Research

- The federal government appropriated \$4.3 million for focused research on possible causes of CCD
  - Federal “bee labs” and universities across the country shared the funding to focus on their areas of expertise to try to determine the cause or causes
  - Mountains of data were generated and analyzed
  - No specific cause or causes were identified, so the conclusion was that the bees were being overwhelmed by too many stresses
- The federal government appropriated \$5 million additional for an epidemiological approach to finding common management procedures or common exposures of colonies to factors that might be causing the problem
- Recently the federal government appropriated nearly \$8 million for enhancing habitat for honey bees in various states, especially by supporting planting of seeds for bee forage plants

# Colony Stresses

- Malnutrition – Loss of historic bee foraging locations, particularly loss of Conservation Reserve Program acreage, to increased acreages of agricultural crops, extensive use of herbicides, urban sprawl, airports, and encroachment of non-native plants
  - Malnutrition leads to suppression of the bees' immune and detoxification systems
- Parasitism – Feeding by *Varroa*, in particular, reduces the amount of protein in a bee's blood, decreases its life expectancy, causes bees to start foraging too early in life, and vectors disease to the bees
- Infectious Diseases – Presently, there are 25 named RNA viruses found associated with honey bees – the most damaging to the bees are: deformed wing virus; acute bee paralysis virus; Israeli acute paralysis virus; Kashmir bee virus; chronic bee paralysis virus; black queen cell virus; and a series of five Lake Sinai viruses
- *Nosema ceranae*, an exotic fungal intestinal disease from Asia, usually is found in abundance in collapsing colonies, however control using an antibiotic is unpredictable

# Pesticides

- Historically have severely damaged or killed ten percent of California commercial honey bee colonies since the 1960s
- Classes of bee-toxic pesticides have changed over the decades:
  - Arsenicals; chlorinated hydrocarbons; organophosphates; carbamates; pyrethroids; neonicotinoids; ryanoids (?)
  - Changes in chemistries followed development of resistance
  - Each class is more toxic, requiring less pesticide per acre to accomplish the goal
- Recently, pesticides historically not toxic to honey bees are causing adult honey bee, and especially bee brood, losses when tank-mixed as fungicides, insect growth regulators and newer adjuvants
  - A lack of a bee warning on a product label does not mean that an application will be benign to bees, especially if the products are tank-mixed



# Sustainability of Bees and Beekeeping

- Elevated honey bee colony losses noted across the country cannot continue if we expect to have honey bees available for pollinating the 100 or so crops for which they are used nationwide (1.72 million colonies for almonds in 2015)
- Managing key stressors by:
  - Improving control of varroa mite and other pests and diseases
  - Increasing forage for bees
  - Reducing exposure of honey bees to pesticides
    - this is one facet over which we do have some control; we should try to do it
- Our next speakers will emphasize specific things that are being done to help in our efforts to enhance bee health

# Christi Heintz Project Apis m.





# Honey Bee Forage Efforts

Christi Heintz



# Honey Bee Forage Efforts

- Why is honey bee forage important to the almond grower?
- What are some of the efforts that are underway?
- Where are these forage projects located?
- Who is involved in building diverse honey bee forage?





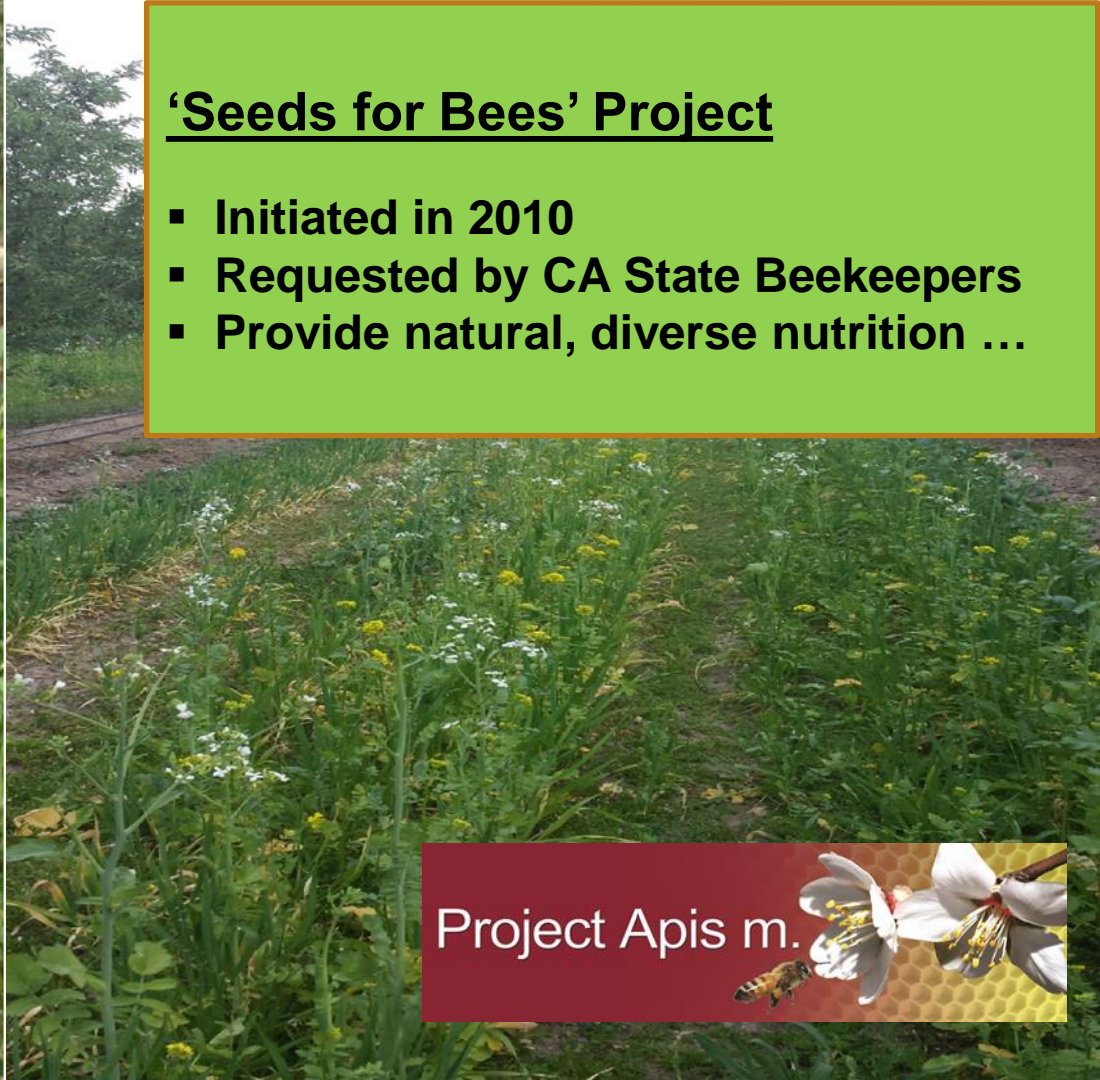
# HONEY BEE FORAGE

“SEEDS FOR BEES”



## 'Seeds for Bees' Project

- Initiated in 2010
- Requested by CA State Beekeepers
- Provide natural, diverse nutrition ...



Project Apis m.



...Pre - almond bloom



... and Post - almond bloom

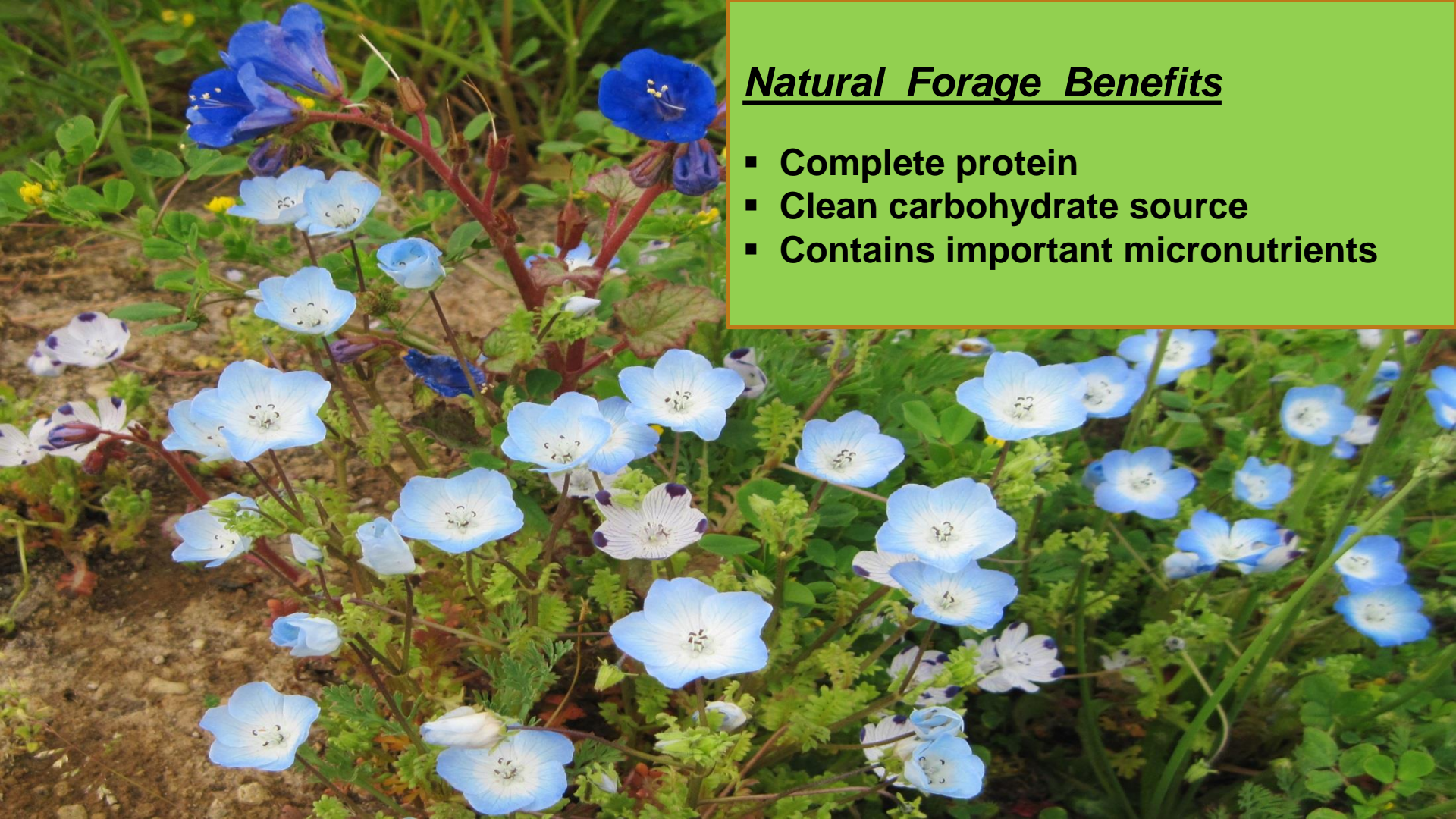






## *Honey Bee Forage Benefits*

- Healthier bees
- Increased over-wintering success
- Greater supply of foragers
- Longer life span
- Better immune system
- Increased resistance to pathogens



## **Natural Forage Benefits**

- **Complete protein**
- **Clean carbohydrate source**
- **Contains important micronutrients**

## *Grower Benefits*

- Improve soil structure
- Alleviate soil compaction
- Reduce erosion
- Increase water infiltration
- Nitrogen fixation
- Suppress weeds
- Adds organic matter
- Nematode suppression



A photograph of a field of purple and yellow flowers, likely a cover crop, with several bees flying in the air. In the background, there is a blue metal structure, possibly a greenhouse or a shed, and a white vertical post. The scene is brightly lit, suggesting a sunny day.

## *Grower Benefits*

- **Attracts beneficials**
- **Anchors bees in your orchard**
- **BUILDS BEES for better nut set**

# Brassicas - Mustards

**FALL BLOOM: Mustard Mix**



**Canola** *Sinapis rapa*  
**Braco White Mustard** *Sinapsis alba*  
**Nemfix Mustard** *Brassica juncea*  
**Daikon Radish** *Raphanus sativa*



# Mustards are cost effective on a large scale!

- \$2.31 per pound
- Seed rate: 12 lbs/acre
- Cost per acre of honey bee forage \$27.72

Project Apis m.



## Legumes



## SPRING BLOOM: Clover Mix





Project Apis m.



**Clovers are cost effective on large-scale too!**

- **\$3.11 per pound**
- **Seed rate 15 lbs/acre**
- **Cost per acre of honey bee forage  
\$46.65**

# Legumes

## SPRING BLOOM – Vetch



**Purple Vetch**  
*Vicia bengbalensis*



**Lana & Hairy  
Vetch**  
*Vicia villosa*

# Time to Sow

In the Fall, while the soil is still warm and before the 1<sup>st</sup> germinating rains.





## Honey Bee Forage



Along access roads



## Honey Bee Forage



**In the middles.**





## Honey Bee Forage

Along waterways





## Honey Bee Forage



**In a young, non-bearing orchard**



## Honey Bee Forage



Extra land strips





**Fallow, or unused adjacent land**





## Honey Bee Forage



**Orchard margins or borders**



## Honey Bee Forage



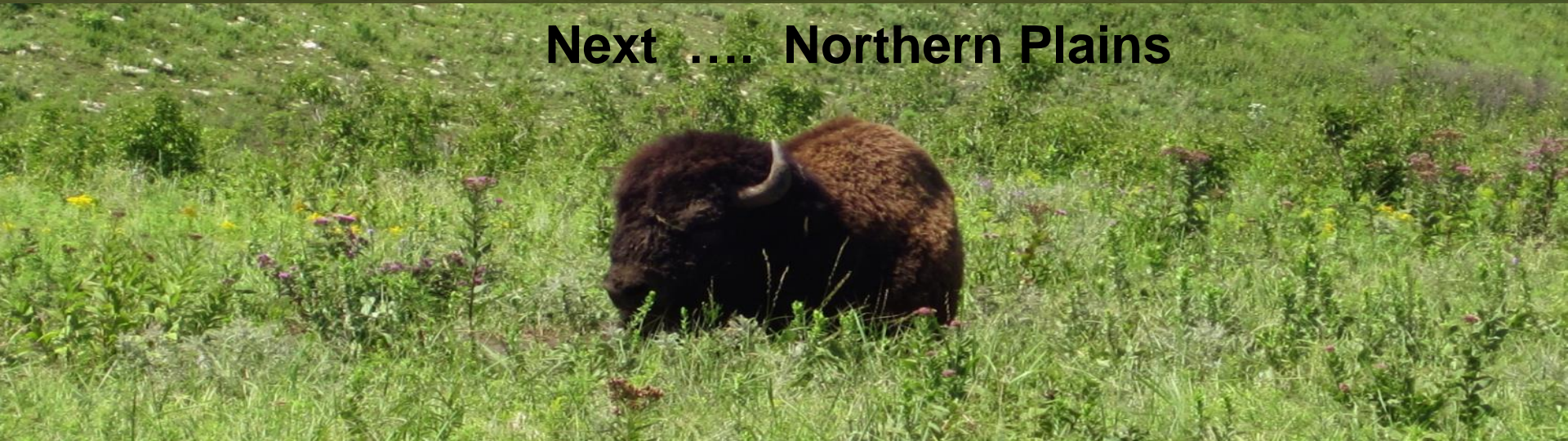
**Cover crop between rows**



**First .... California**

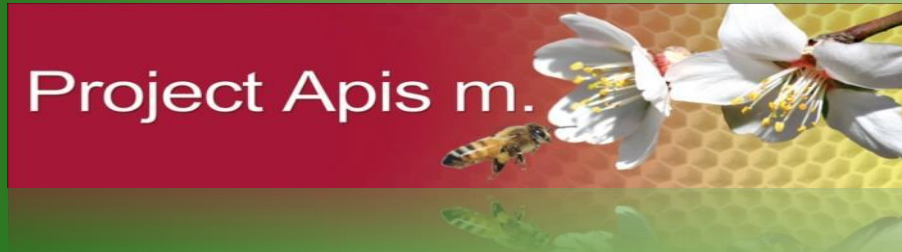


**Next .... Northern Plains**



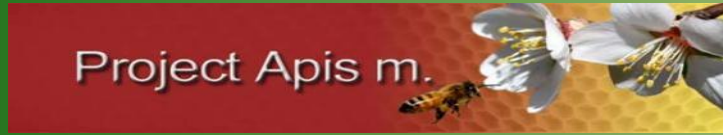
# HONEY BEE HABITAT PARTNERSHIP

*A Unique Conservation Initiative*



**To promote, establish, enhance & protect honey bee habitat.**

# GOALS OF THE HBHP



- **Develop** and fund programs designed to provide **high quality foraging** opportunities for honey bees
- Design habitat that is consistent with needs for **monarch butterflies** and other wildlife
- Develop **cost-effective** forage mixtures for a variety of situations and locations
- Improve domestic **honey production**
- Create a more sustainable honey **bee supply** and agricultural system

Project Apis m.



## Partners in Building Honey Bee Forage







**Gabriele Ludwig, ABC**



# Almond Board's Engagement in Honey Bee Health Issues

Gabriele Ludwig, Ph.D.  
Associate Director,  
Environmental Affairs

## Bees - Keeping ABC Busy!

Almond Board has been engaged in:

- Research
- Education/Outreach
- Policy

Working with:

Universities around the country

Government agencies: EPA, CDPR

USDA/ARS, /NIFA, /OPMP, /NRCS

Non-profit groups: Project Apis m, NAPPC, Honeybee Health Coalition

Beekeeping groups: CSBA, AHPA, ABF



# Federal and State Governments Seeking Advice on Pollinator Health



*CA State Assembly Hearing on Honey Bee Health (November 2013)*



*Webinar Presentation to Canadian Senate Committee (September 2014)*

*California State Board for Food & Agriculture (April 2014)*



*World Food Prize Conference (October 2015). Panel re bees and global food security* →



*White House (Office of Science Policy & Technology) (April 2014)* ↑  
→ *White House Directive to Federal Agencies to work together to improve pollinator health*



## Research Priorities in Honey Bee Health

- USDA Varroa Mite Summit (February 2014)
  - 1.5 day mtg re research needs to improve Varroa mite control
- USDA Honey Bee Forage & Nutrition Summit (October 2014)
  - 2 day mtg re policy and research needs to improve honey bee forage options and nutrition
- Bee-Informed Partnership (January 2014 &15)
  - USDA-NIFA funded research project that is seeking honey bee best management practices
- Integrated Crop Pollination Project (Jan 2015)
  - USDA-SCRI funded research project that is focused on improved forage for native and honey bees.



# Pesticides and Honey Bees



- US-EPA *Pesticide Program Dialogue Committee*, Bee Task Force
- *Pollinator Partnership's* Pesticide Education Workgroup
- *Minor Crop Farmer Alliance* – Pesticide Labelling Workgroup
- AAPCO – Pesticide State Management Plans
- *Honey bee Health Coalition* - includes forage, bee BMPS, pesticide BMPs, Varroa mite control

## Honey Bee Best Management Practices for California Almonds

Outreach in CA and beyond (30+ presentations, with the help of many) to all involved in the pollination communication chain – beekeepers, growers, PCAs applicators, Ag Commissioners



# Overview of Honey Bee Best Management Practices for California Almonds

Bob Curtis

Associate Director, Agricultural Affairs

Almond Board of California

# Why should all pollination stakeholders care?

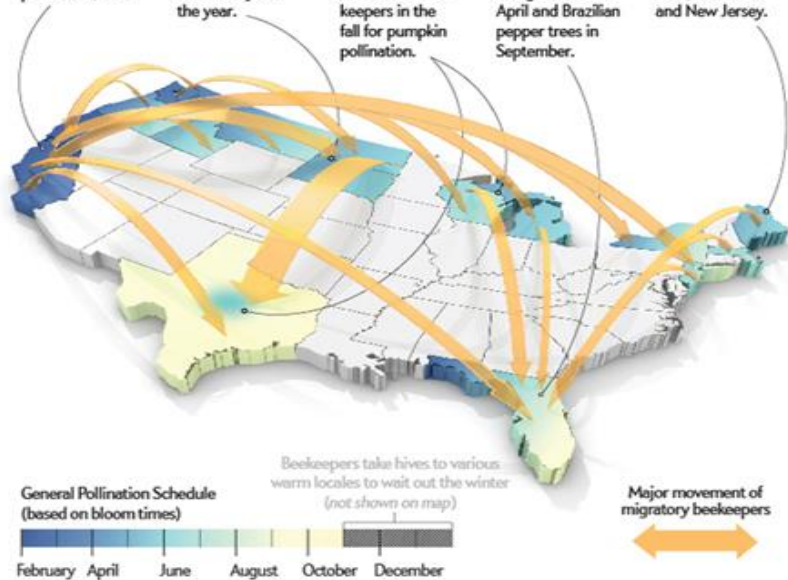
Each February most migratory beekeepers converge in the Central Valley to pollinate more than 800,000 acres of almonds. Apples, plums and cherries in California and nearby states require honeybee pollination, too.

In summer months, many commercial beekeepers head to North and South Dakota, where they allow their bees to gorge on fields of alfalfa, clover and sunflowers and to produce the bulk of their honey for the year.

In the spring and summer, some beekeepers travel to blooming blueberry fields in Michigan and cranberry bogs in Wisconsin. Others opt for watermelons, cantaloupes and cucumbers in Texas, which also draws beekeepers in the fall for pumpkin pollination.

Because Florida's climate varies from subtropical to tropical, some plant or other is always flowering in the Sunshine State. Florida depends on honeybees to pollinate blueberries as early as February, tupelos and gallberries in April and Brazilian pepper trees in September.

Migratory beekeepers travel up and down the East Coast year-round as well, visiting apples, cherries, pumpkins, blueberries, cranberries, lettuces, and various veggies in Maine, Pennsylvania, Massachusetts, New York and New Jersey.



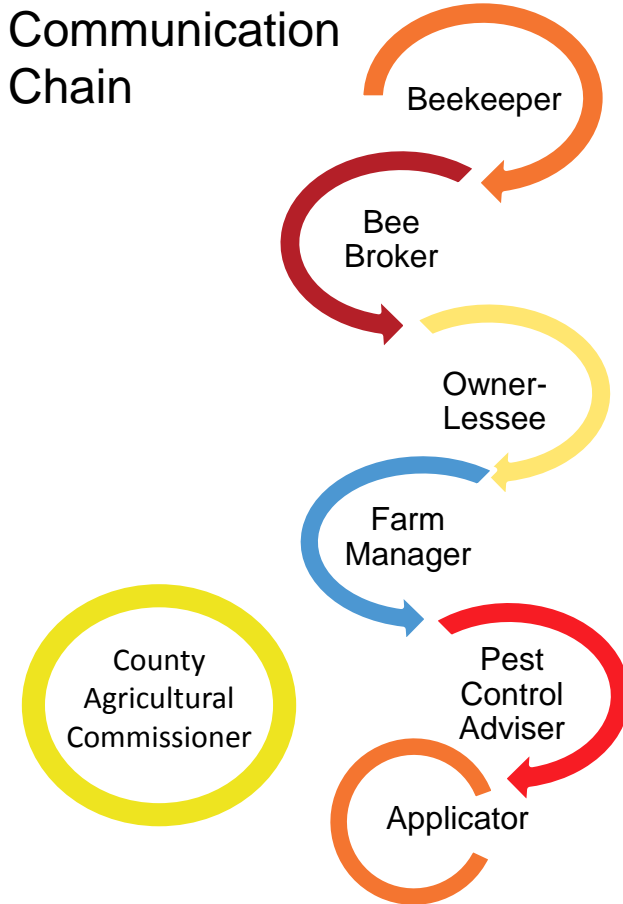
- Honey bees are essential for almond production
- Bees are a valuable resource and almond production input
- The time bees spend in almonds impacts hive health throughout the year until they return the next season



## Key BMPs: Communication

- Communication should occur between all pollination stakeholders along the communication chain about pest control decisions during bloom
- Agreements/contracts should include a pesticide plan that outlines which pest control materials may be used
- If treatment is deemed necessary, growers/PCAs/applicators should contact county ag commissioners so that beekeepers with near by managed hives are notified 48 hours in advance
- As well, beekeepers should register their hives with county agricultural commissioner offices and request notifications for pesticide applications
- Report suspected pesticide related incidences to county ag commissioners. Bee health concerns cannot be addressed without data from potential incidents

## Communication Chain

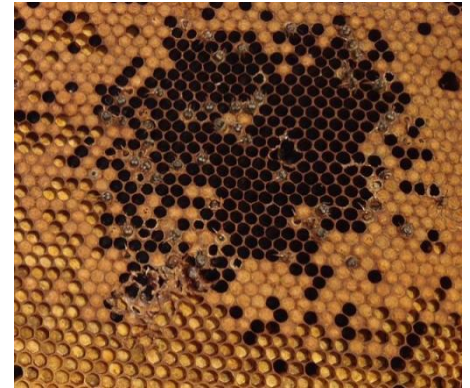


# Key BMP: Honey Bees and Insecticides

- Avoid applying insecticides at bloom until more is known, particularly about their impact on bee brood (immature bees )and avoid tank mixing insecticides with fungicides
  - Bee losses have occurred as a result of tank mixing insecticides with bloom time fungicides
  - The term 'insecticide' includes insect growth regulators, also known as IGRs
  - Currently most bee label warnings are only based on acute adult toxicity
- There are alternative IPM insecticide timings



Newly emerged, wingless bees pulled from the combs by other bees, and empty cells of brood that failed in their attempts to emerge as adults



## Key BMP: Honey Bees and Fungicides

- Any fungicide application deemed necessary during bloom should occur in the late afternoon and evening when bees and pollen are not present
- This avoids contaminating pollen with spray materials



# Almond Board of California Resources

- “[Honey Bee Best Management Practices for California Almonds](#)” with general and applicator-specific “[BMP Quick Guides](#)”
- Also available on line at [www.Almonds.com/BeeBMPs](http://www.Almonds.com/BeeBMPs)



## HONEY BEE BEST MANAGEMENT PRACTICES QUICK GUIDE FOR ALMONDS

All parties involved in honey bee pollination of California Almonds and/or applying pesticides should follow these precautions to ensure both honey bee live health and the best possible pollination of the almond crop:

- 1. Communication should occur between all pollination stakeholders about pest control decisions.** These stakeholders, as illustrated in the “Honey Bee BMP Communication Chain for California Almonds” on the reverse, can include beekeeper, bee broker, county agricultural commissioner, grower (owner/lessee), farm manager, pest control adviser (PCA) and pesticide applicator.
- 2. Agreements should include a pesticide plan that outlines which pest control materials may be used.** Grower and beekeeper should agree on which products may be applied. If a treatment is deemed necessary, if deemed necessary, growers should give beekeepers 48-hour notice before treatment.
- 3. If applying pesticides, contact your local county agricultural commissioner** as specified in “Honey Bee BMP Communication Chain for California Almonds” on the reverse to give advance notification to beekeepers with nearby managed hives.
- 4. Avoid applying insecticides during almond bloom until more is known, particularly about their impact on bee brood (young developing bees in the hive).** If treatment is necessary, only apply fungicides and avoid tank-mixing insecticides with fungicides.
- 5. Any fungicide application deemed necessary during bloom should occur in the late afternoon or evening, when bees and pollen are not present.** This timing avoids contaminating pollen with spray materials.
- 6. Provide clean water for the bees to drink.** This will ensure that they spend more time pollinating the crop than searching for water. Either cover or remove water sources before a pest control treatment, or empty and refill water after a treatment is made. Check water levels throughout bloom and refresh as necessary.
- 7. Do not directly spray hives with any pesticide spray application.** Ensure that the spray-rig driver turns off nozzles when near hives. Spray applications that come in contact with bee hives could adversely affect bee health and the pollination of the crop.
- 8. Do not hit flying bees with any spray application materials.** Bees that come in contact with agricultural sprays will not be able to fly because of the weight of spray droplets on their wings.
- 9. Report suspected pesticide-related bee incidents to the county agricultural commissioner's office.** Bee health concerns cannot be addressed without the data from these incidents. See “Honey Bee BMP Communication Chain for California Almonds” on the reverse for reporting detail.
- 10. Beekeeper and grower should agree on hive removal timing.** The University of California recommends bee removal when 90% of the flowers on the latest blooming variety are at petal fall. Past this point, no pollination is taking place, and bees that forage outside the orchard (up to 4 miles) seeking alternate food sources and water will have a higher risk of coming in contact with insecticide-treated crops.

Curtis, Blev, Catherine Ludwig and Danielle Hernandez, eds. 2014. Honey bee best management practices for California almonds. Almond Board of California.



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A digital version of this publication is available at [Almonds.com/BeeBMPs](http://Almonds.com/BeeBMPs)  
Also available:  
Honey Bee Best Management Practices for California Almonds  
Applicator/Driver Honey Bee Best Management Practices Quick Guide for Almonds



## APPLICATOR/DRIVER HONEY BEE BEST MANAGEMENT PRACTICES QUICK GUIDE FOR ALMONDS

Pesticide applicators should follow these precautions to ensure both honey bee hive health and the best possible pollination of the California Almond crop:

- 1. Read labels carefully and follow directions.** Do not use pesticides at bloom with label cautions that read “highly toxic to bees,” “toxic to bees,” “residual times” or “extended residual toxicity.”
- 2. Before applying pesticides at any time of year, contact the county agricultural commissioner to notify beekeepers with nearby managed hives.** This is mandatory for pesticide products with “toxic to bees” label statements and recommended for all other applications, particularly during almond bloom.
- 3. Water should either be covered or removed before a pest control treatment is made, or emptied and refilled after the treatment is made.** Providing clean water for bees to drink will ensure that they spend more time pollinating the crop than searching for water.
- 4. Do not directly spray hives with any pesticide spray application.** Spray-rig driver should turn off nozzles when near hives for all materials applied. Spray applications that come in contact with bee hives could adversely affect bee health and the pollination of the crop.
- 5. Do not hit flying bees with spray applications.** Bees that come in contact with agricultural sprays will not be able to fly because of the weight of spray droplets on their wings.
- 6. Report suspected pesticide-related bee incidents to the grower, beekeeper and county agricultural commissioner.** Bee health concerns cannot be addressed without the data from these incidents.

When a pesticide to be applied bears “toxic to bees” statements on its label, beekeepers with hives within 1 mile of the application must be notified if they have requested notification by the applicator at least 48 hours before the planned application.

A digital version of this publication is available at [Almonds.com/BeeBMPs](http://Almonds.com/BeeBMPs)

Also available:  
Honey Bee Best Management Practices for California Almonds  
Honey Bee Best Management Practices Quick Guide for Almonds

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Key Objective:

Assure almonds continue to be a good and safe place for bees





**Gordon Wardell**  
**Paramount Farming Co**

# Protecting the Pollinators Protects Your Crop

Gordon Wardell, Ph.D.  
Paramount Farming Company



# Protecting the Pollinators Means Protecting the Crop

- We Pay a Lot for Bees,  
Why Kill Them or Chase Them Away?
- Keeping the Orchard Attractive
- Protecting the Flowers
- Keeping the Bees Working for You









## Three Populations of Bees in a Colony

1. The Brood
2. The House Bees
3. The Field Bees

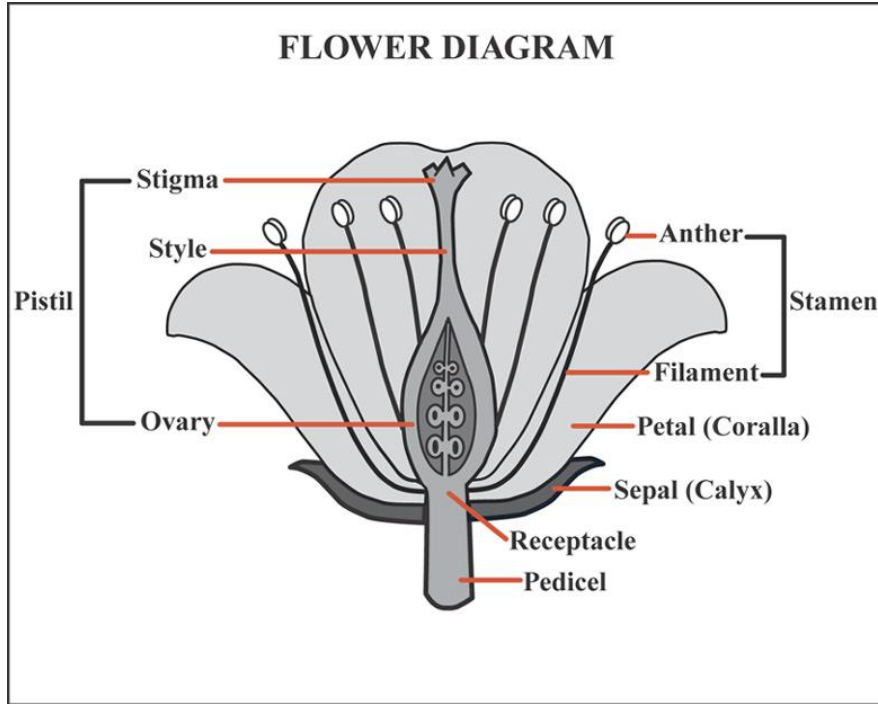


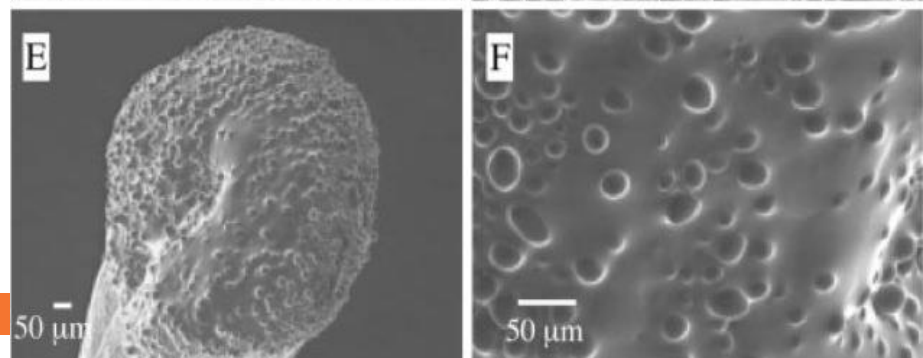
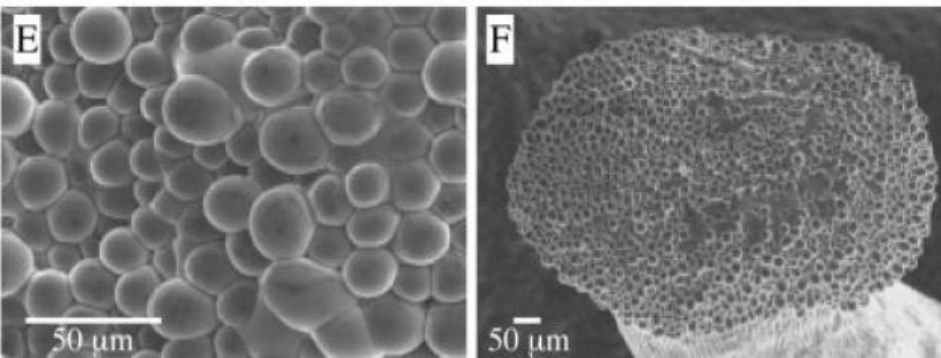
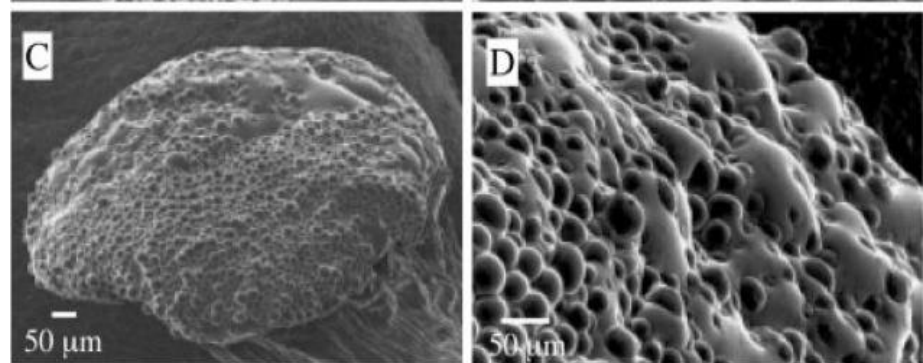
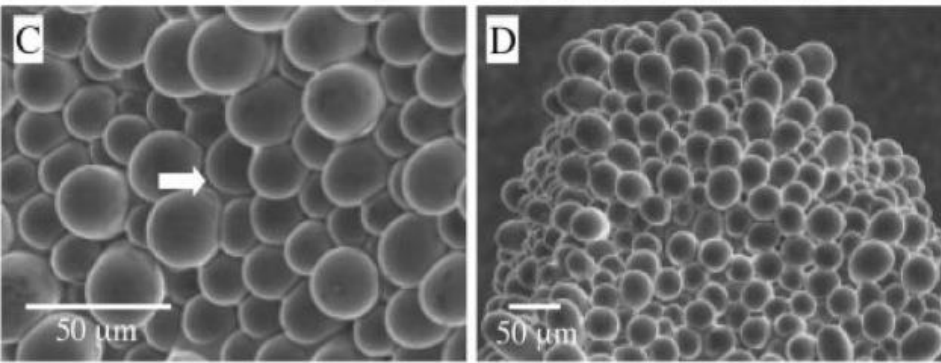
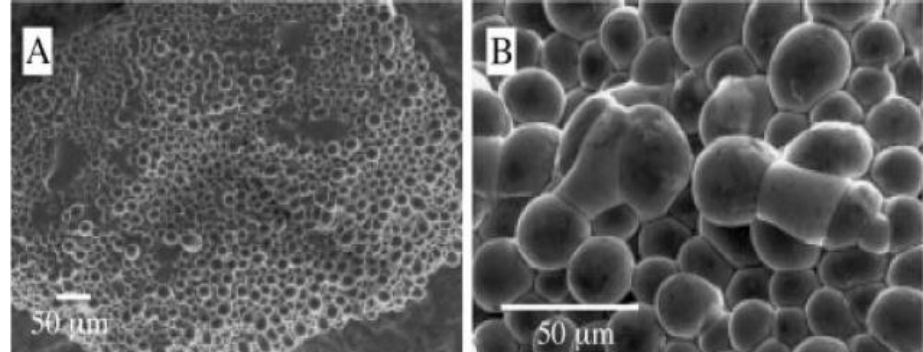
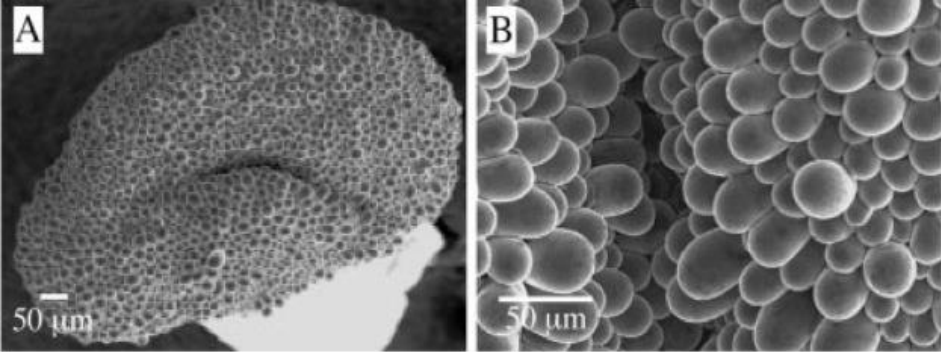


## Foragers



# Protecting the Flowers







Bees have wings  
They have a choice

Other consequences of daytime spray application

# Honeybees' ability to find flowers could be hampered by a chemical in diesel exhaust, say scientists.

Tests showed that exhaust degraded some floral scent chemicals the bees "home in on" when they are foraging. The study, published in *Scientific Reports*, also revealed that a specific group of chemicals found in diesel exhaust, known as NO<sub>x</sub>, diminished the insects' response to floral scents. They say the results are evidence that air quality should be improved.

"We got into this, because we were aware of the impacts of airborne pollutants on human health, so it didn't seem so wild that there may be impacts that extended beyond human health," said University of Southampton neuroscientist Dr Tracey Newman, who was involved in the work.







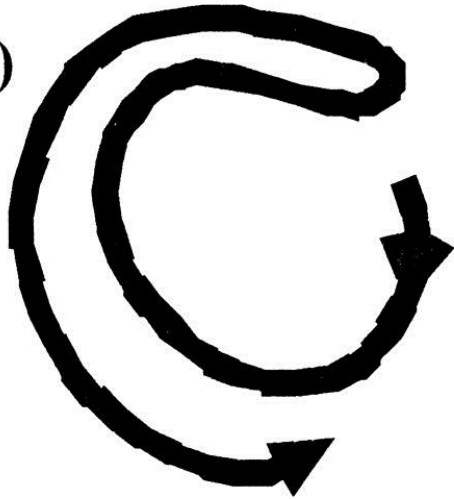
# Honey Bee Dance Language

Outside the hive

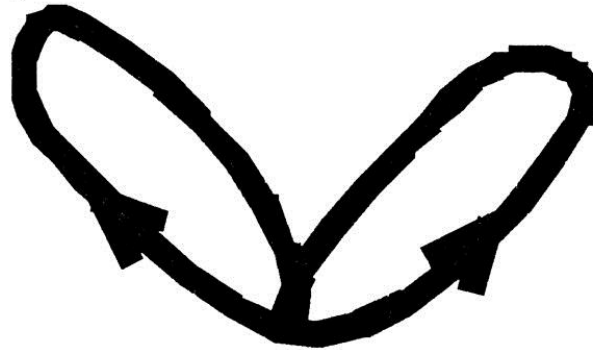
50 to 150 Meters

> 150 Meters

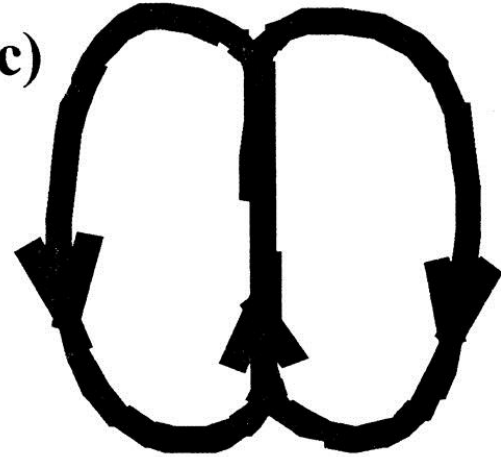
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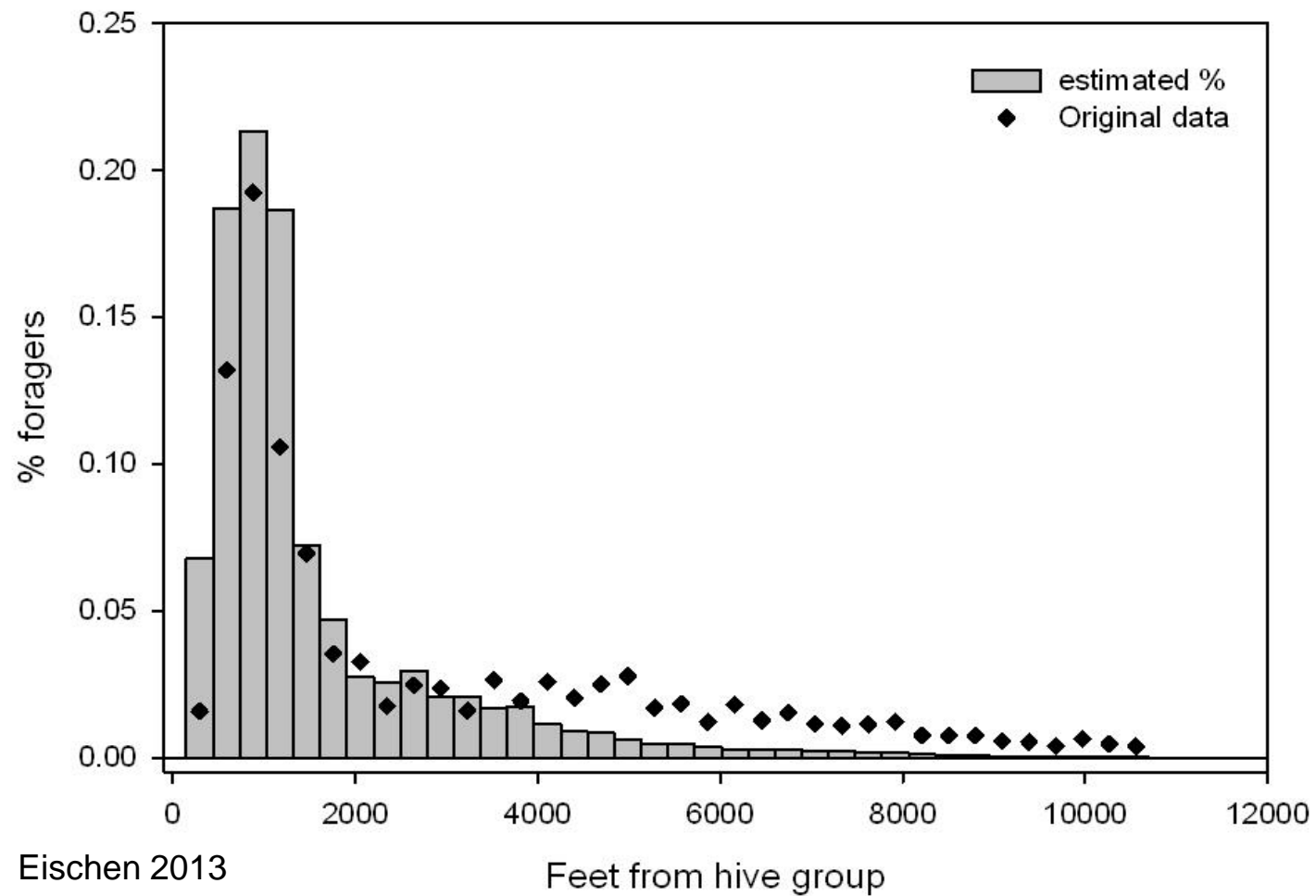
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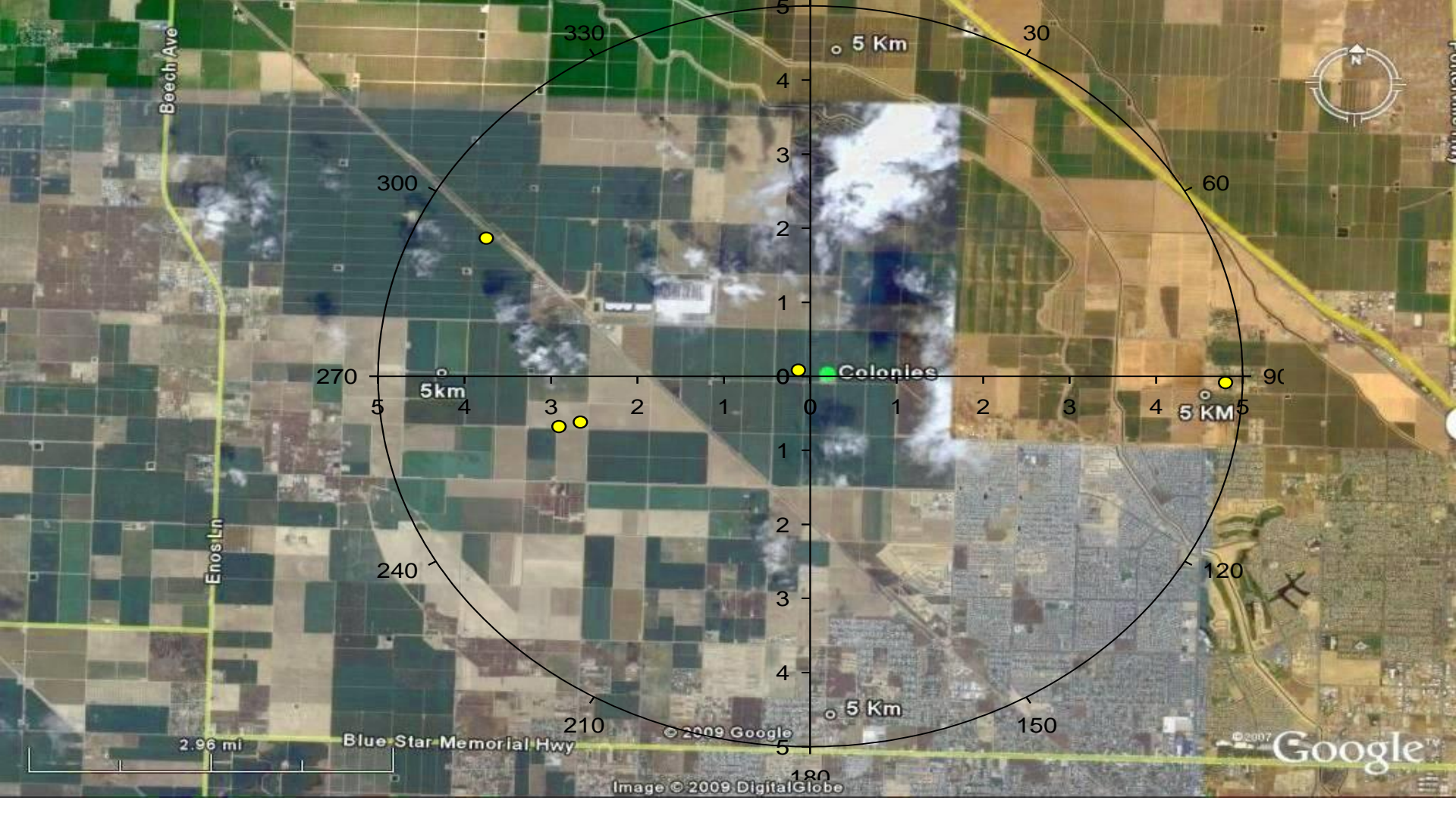
c)



- Direction and Distance to the flowers
- Scent of the flowers
- Taste of the nectar



Eischen 2013



Beech Ave

Enos Ln

Blue Star Memorial Hwy

Colonies

2.96 mi

Image © 2009 DigitalGlobe

Google



270

5

4

3

2

1

0

1

2

3

4

5

300

330

5

4

3

2

1

0

1

2

3

4

5

5 Km

5km

60

90

120

150

180

5 Km

5 KM

© 2007





growing  
ADVANTAGE  
The Almond Conference

The logo features a stylized tree with a brown trunk and branches. The leaves are colored in shades of green and blue. The text 'growing' is in a light blue, lowercase font, 'ADVANTAGE' is in a green, uppercase font, and 'The Almond Conference' is in a blue, uppercase font.