



2017

# THE ALMOND CONFERENCE

COMMITTED TO HEALTHY HIVES IN THE FIELD

Room 308-309 | December 7 2017



# AGENDA

- **Bob Curtis**, Almond Board of California, moderator
- **Matthew Smart**, U.S. Geological Survey Northern Prairie Wildfire Research Center
- **Billy Synk**, Project Apis m.
- **Elina L. Niño**, UC ANR/UC Davis
- **Neal Williams**, UC Davis

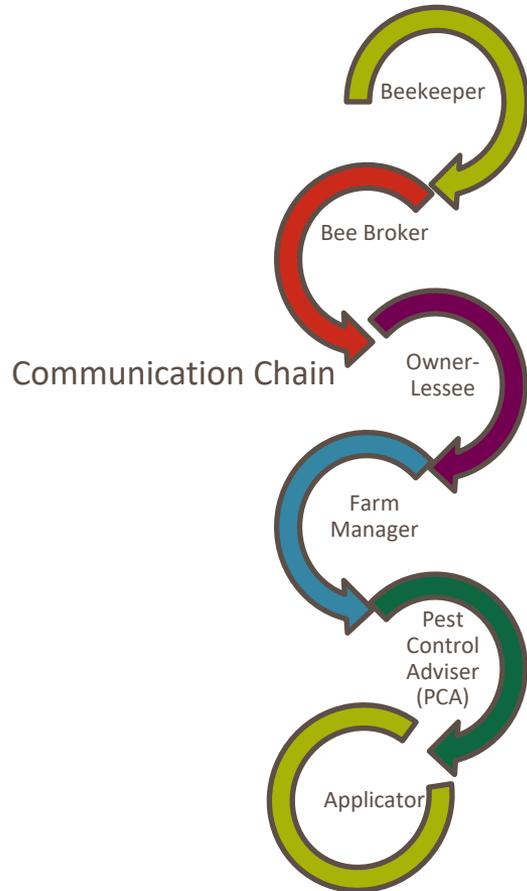




## **COMMITTED TO HEALTHY HIVES IN THE FIELD**

Bob Curtis  
The Almond Conference  
December 7, 2017  
9:15 – 10:30 a.m.

# Honey Bee Best Management Practices for California Almonds

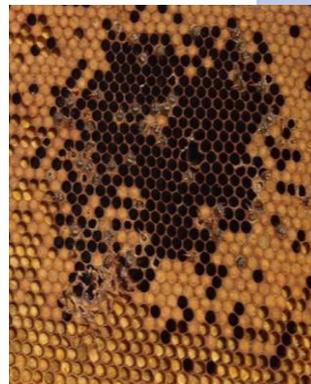


- Key BMP: Communication
  - Communication should occur between all pollination stakeholders along the communication chain about pest control decisions during bloom
  - Agreements/contracts should include a pesticide plan that outlines which pest control materials may be used
    - If treatment is deemed 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

# Honey Bee Best Management Practices for California Almonds

- Key BMP: Honey bees and insecticides
  - Avoid applying insecticides at bloom until more is known, particularly about their impact on bee brood
    - Newer insecticides safe for adult bees have been associated with immature bee brood loss
  - Avoid tank mixing insecticides with fungicides
  - There are alternative IPM insecticide timings. See UC IPM online: <http://www.ipm.ucdavis.edu/> > Agricultural Pests > Almonds
- 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 and spraying bees

*Impact  
on  
immature  
bees*



*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.*



# BE CAUTIOUS ABOUT ADJUVANTS

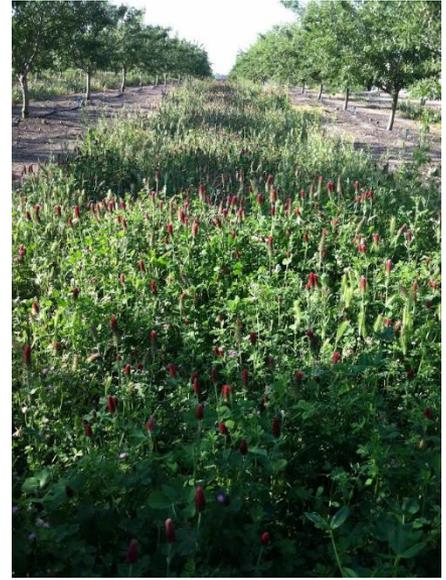
## UC RECOMMENDATIONS: ADJUVANTS SHOULD NOT BE USED WITH FUNGICIDES DURING BLOOM – UNLESS STATED ON THE LABEL

University of California publication Fungicide, Bactericide, and Biological Tables for Fruit, Nut, Strawberry, and Vine Crops

- Most fungicides are formulated with adjuvants including wetting agents, spreaders, and stickers
- With few exceptions, adjuvants do not statistically improve the efficacy of fungicides for managing diseases
- Although there is limited information on the interaction of adjuvants and fungicides with honey bees, it is best to follow a conservative approach. Because adjuvants may increase the wettability of bees and subsequently the potential toxicity of fungicides.

# CONSIDER PLANTING SUPPLEMENTAL FORAGE

- Supplemental forage provides bees natural nutrition before and after almond bloom, when there is a dearth of pollen
- On going ABC-funded research demonstrates
  - After almond bloom, hives with access to supplemental forage have higher survivorship and perform better
  - Forage does not compete with almond blossoms -- bees go to almonds first
- Contracts are emerging that discount hive rental price if forage is planted
- More information at [Almonds.com/BeeBMPs](https://Almonds.com/BeeBMPs) and at [Project Apis m.](https://Project Apis m.)
- [www.projectapism.org/forage-home.html](https://www.projectapism.org/forage-home.html)



# OVERALL OBJECTIVE: ENSURE THAT ALMONDS CONTINUE TO BE A GOOD AND SAFE PLACE FOR BEES

- Resources
  - “Honey Bee Best Management Practices for California Almonds”
    - With 3 “Quick Guides”: general, applicator-specific, and supplemental forage –
  - 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 agricultural producers to ensure both honey bee health and the best possible production.

1. Communication should occur between all pollination stakeholder organizations, as outlined in the Honey Bee BEE Communication Plan. Stakeholders include beekeeper, the Inland County Agricultural Commissioner, grower, other POC and pesticide applicator.
2. Agreements should include a pesticide plan that outlines when grower and beekeeper should agree on which products may be applied, when necessary, growers should give beekeepers 48-hour notice to avoid insecticides with fungicides.
3. If applying pesticides, contact your local county agricultural commissioner (Call for California) or the website to get an approved list.
4. Avoid applying insecticides during almond bloom and avoid a new honey beekeeping bees in the field. If treatment is necessary, use spot insecticides with fungicides.
5. Any fungicide application deemed necessary during bloom should be applied before and after the bloom. This helps avoid contact with the flowering or water. Grower should use fungicides before and after a treatment is made. Check water levels throughout bloom and re-apply.
6. Do not directly spray hives with any pesticide spray application inside or near hives. Spray applications should be done in contact with the position of the crop.
7. Do not hit flying bees with any spray application materials. Use will not be able to tolerate the weight of heavy droplets on their wings.
8. Report suspected pesticide-related bee incidents to the county agricultural commissioner or the website for more information for California Almonds on the website for reporting detail.
9. Beekeeper and grower should agree on the removal timing. It is recommended that the beehive on the insect spraying zone are placed, and bees that forage outside the orchard up to 4-miles, wearing higher level of warning in contact with beekeepers' treated zones.

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

Pesticide applications should follow these precautions to ensure and the best possible pollination of the California Almonds crop.

1. Read labels carefully and follow directions. Do not use pesticides that read "highly toxic to bees," "toxic to bees," "moderately toxic."
2. Before applying pesticides at any time of year, contact commissioner to notify beekeepers with nearby managed for pollination products with "toxic to bees," "moderately toxic" or "moderately toxic" pesticides, especially during almond bloom.
3. Water should either be covered or removed before a pesticide is applied and refilled after the treatment is made. Pesticide should not be applied until they are more time pollinating the crop.
4. Do not directly spray hives with any pesticide spray application. Do not spray near hives or for pollination products in contact with bee hives could adversely affect bee health.
5. Do not hit flying bees with spray applications. Bees that are hit will not be able to fly because of the weight of heavy droplets in contact with their wings.
6. Report suspected pesticide-related bee incidents to the county agricultural commissioner. Bee health concerns can be reported from these incidents.

**FORAGE YOUR WAY TO BETTER HONEY BEE HEALTH**

Studies show that planting forage provides honey bees with better nutrition, and healthy honey bees mean better pollination! Although planting forage may not be the best fit for all growers, it can provide a number of benefits when combined with other best practices.

The benefits of planting forage

As almond tree average grows, so does the need for pollinators. Besides the numerous pollen and nectar that almond trees provide for honey bees, one of the ways almond growers can support pollinator populations is to provide an alternate source of honey bee nutrition before and after almond bloom.

Supplemental feeds are often used to support honey bee nutrition while pollen and nectar are unavailable. However, forage plantings provide a robust source of nutrition that nurtures more vigorous foragers.

Continuing Almond Board-Almonds studies have examined the health, growth and survival of honey bees colonies that were fed supplemental feeds and forage. The results indicate that planting forage could increase queen and colony survival, as well as provide healthier colonies.

Should you plant forage?

In addition to providing robust food resources to honey bees, growers who plant forage may benefit from a number of other improvements to their orchards, including:

- improved soil health
- improved water infiltration
- improved soil moisture conservation
- faster drainage
- increased organic material
- increased beneficial insects
- soil stabilization and erosion control

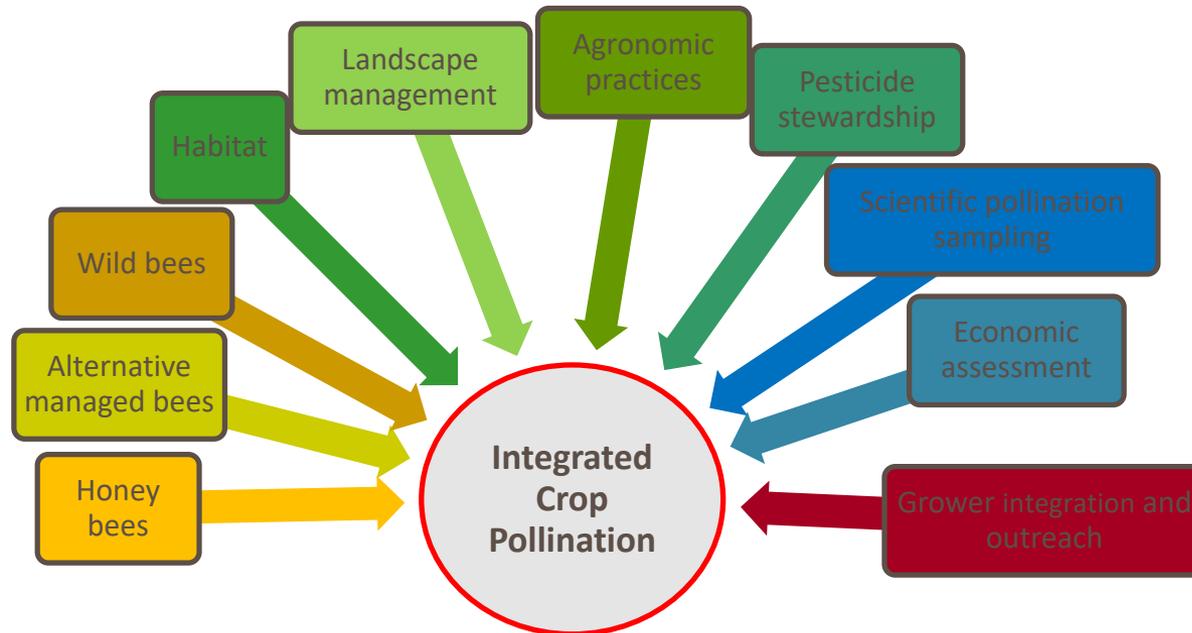
Whether it's young orchards needing soil stabilization, or reducing erosion in older orchards, cover crops between tree rows are appropriate for all orchards. If new plantings are not an option for your orchard, consider planting forage along orchard margins or in open fields nearby. Hedgerows, with their long bloom periods, are also an option to provide bee forage, beneficial insects and soil benefits to the grower.

# INTEGRATED CROP POLLINATION II

Adaptive decision support to integrate pollinator and pest management for sustainable production of specialty crops



**UC DAVIS**  
UNIVERSITY OF CALIFORNIA



# SUMMARY

- **Mustard and wildflower** mixes provided the **most bloom** and wildflower flowering persisted longer after almond flowering
- **Mustard and wildflower mix attracted** the **most honeybees**
- **Wildflower** mix, then mustard **attracted** the **most wild bees**
- Mixes **did not** attract honey bees away from the orchard flowers





# The Northern Great Plains: Land use, forage and contribution to almond pollination services

Matthew Smart, Clint Otto  
USGS Northern Prairie Wildlife Research Center

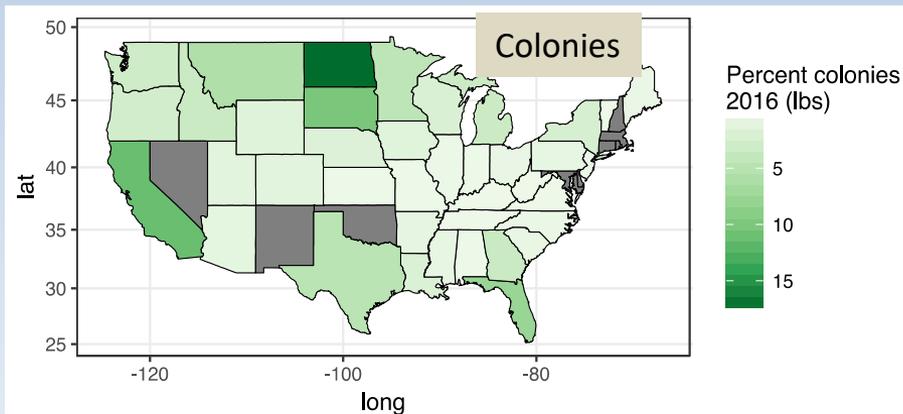


U.S. Department of the Interior  
U.S. Geological Survey

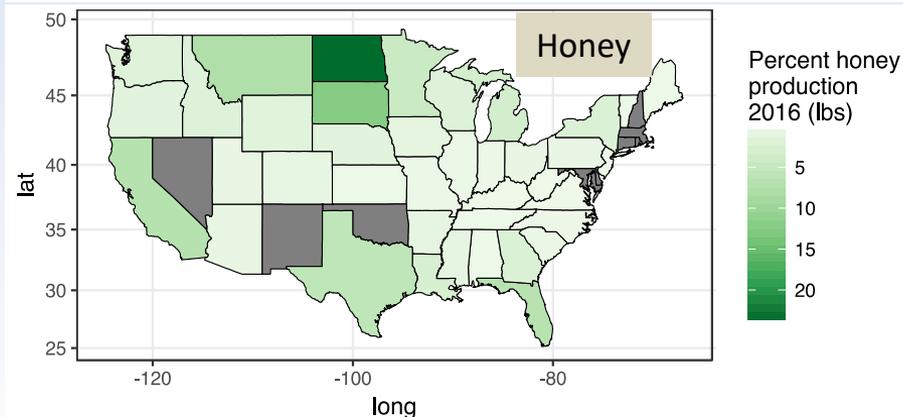


# Bees and honey in the US and NGP

- Approx. 2.7 million colonies nationwide:
  - ND: 485,000
  - SD: 280,000
  - MT: 159,000
  - MN: 124,000
- Approx. 40% in NGP
- CA: 310,000; FL: 215,000; TX: 133,000



- Approx. 161 million lbs nationwide:
  - ND: 38M
  - SD: 20M
  - MT: 12M
  - MN: 7M
- Approx. 48% from NGP
- CA: 11M; FL: 11M; TX: 9M



# Research & Monitoring Questions

1. How has land-use change affected bee habitat in the Northern Great Plains?
2. What flowering plants do honey bees and native bees visit when collecting nectar and pollen?
3. What is the effect of land use and forage availability on honey bee colony health, productivity, and pollination services?

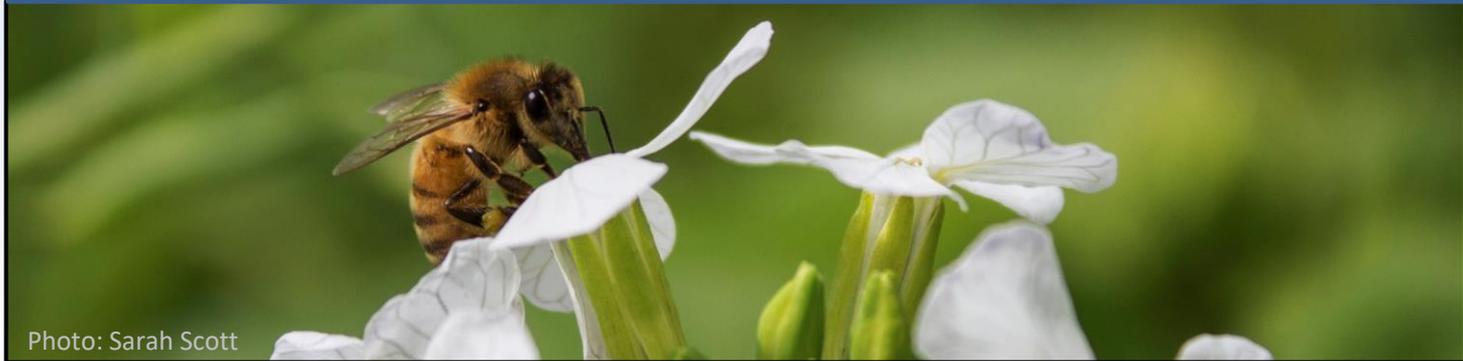
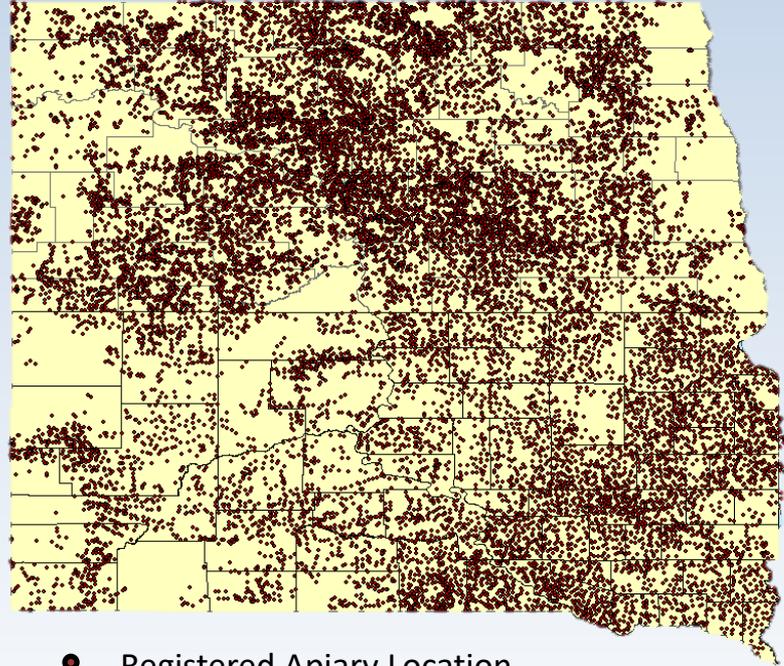


Photo: Sarah Scott

# Apiary locations

State	# of Reg. Apiaries in 2015
North Dakota	11,700
South Dakota	6,800



- Registered Apiary Location



<http://www.nd.gov/ndda>



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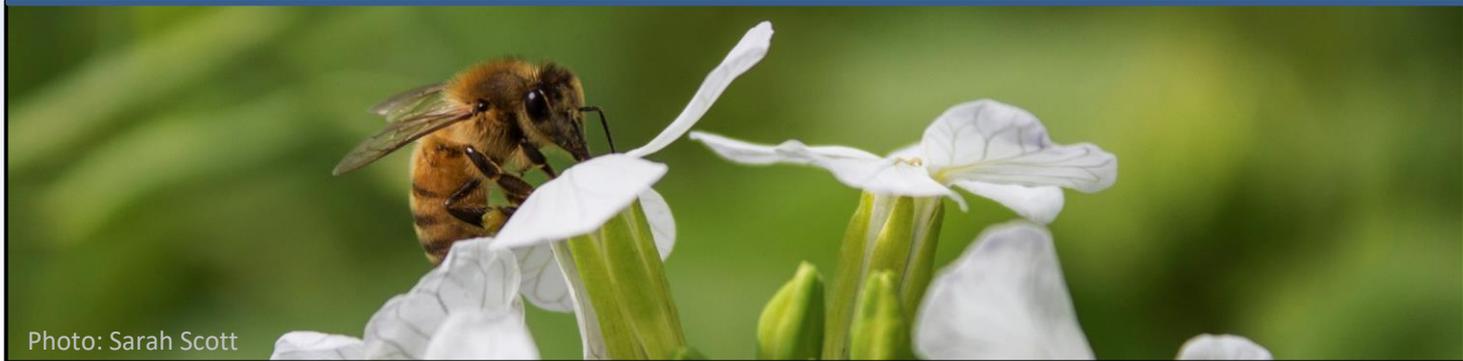


Photo: Sarah Scott

# Quantifying Forage

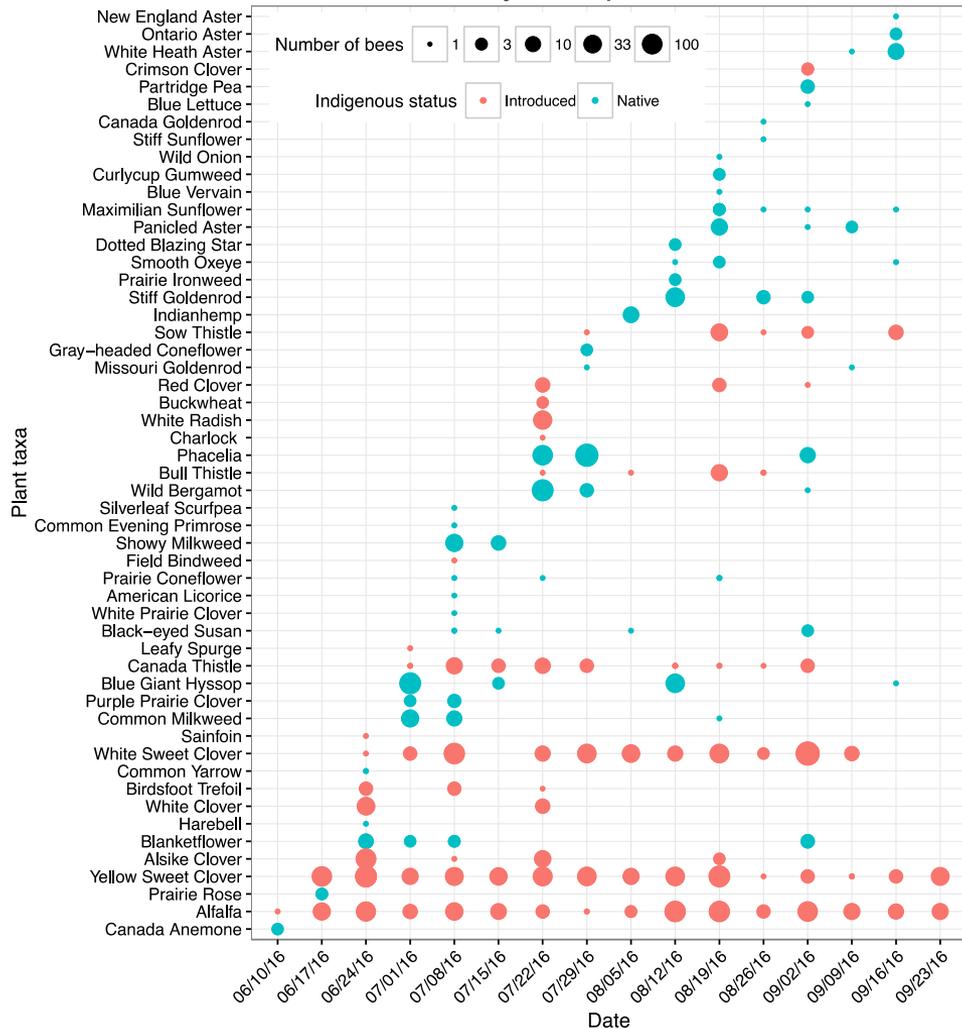
## Observing Flower Visits



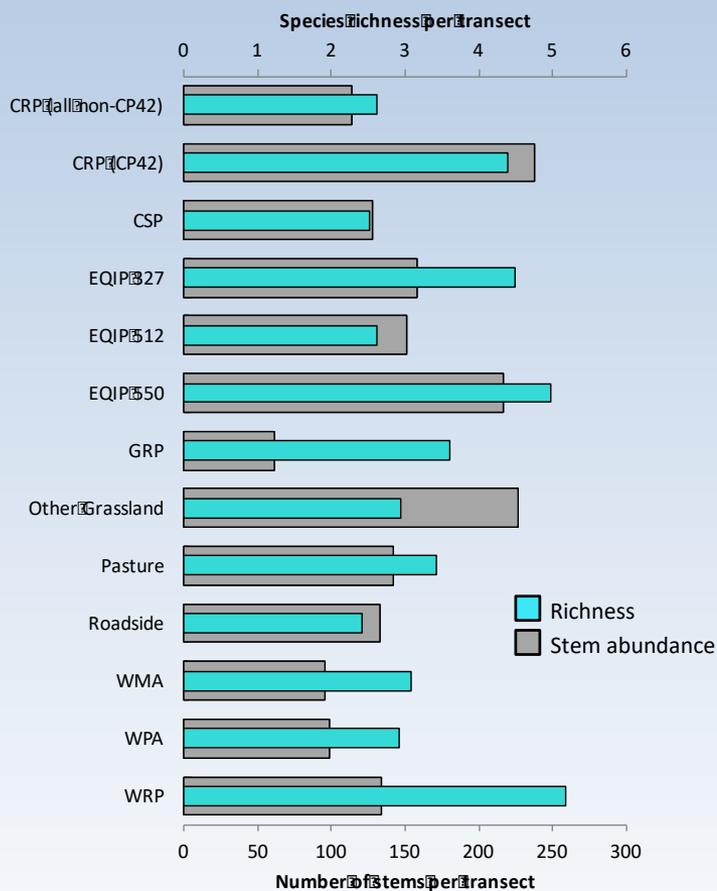
## Identifying Bee-Collected Pollen



## 2016 Honey bee—plant observations

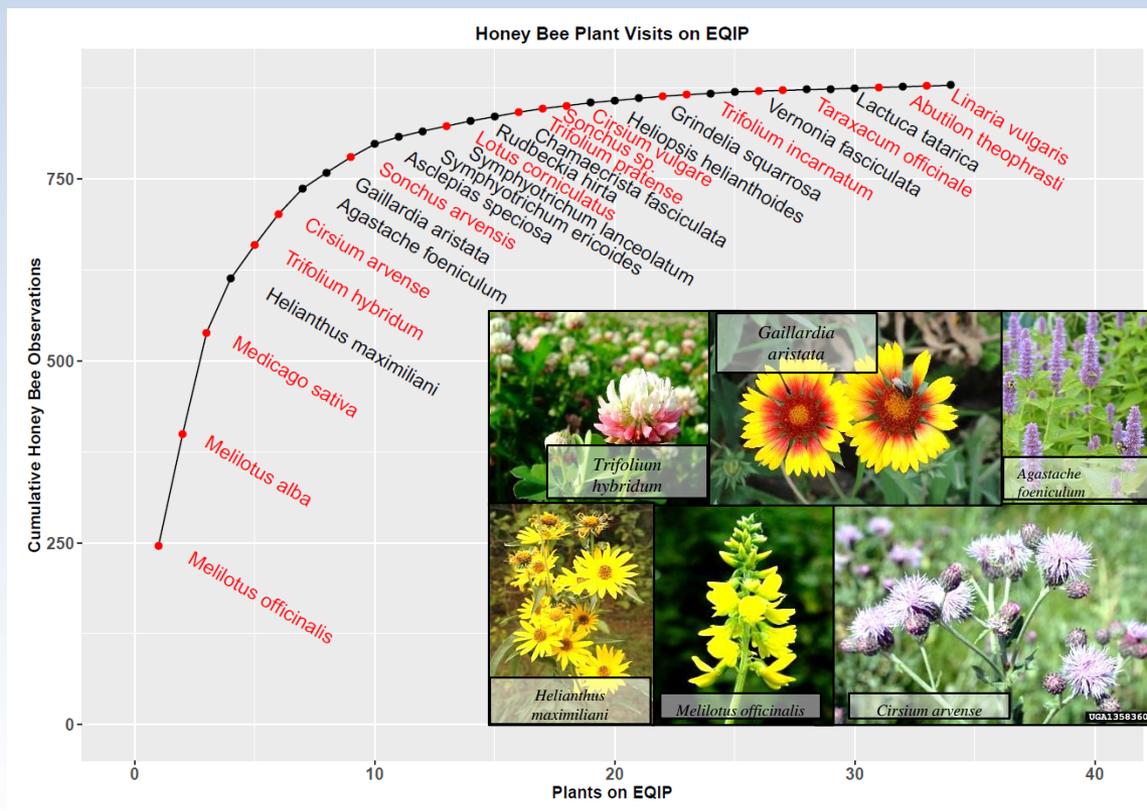


- All plant taxa with at least 1 observed bee visitation in 2016 based on transects conducted on CRP, EQIP, pasture, and roadside ditches.
- Pattern of **introduced** “staples” (e.g. sweet clover, alfalfa), punctuated by attractive, but relatively ephemeral, native taxa.



**CRP** = Conservation Reserve Program; **CP42** = Pollinator habitat; **CSP** = Conservation Stewardship Program;  
**EQIP 327** = Environmental Quality Incentives Program, Conservation cover;  
**EQIP 512** = Forage and biomass planting; **EQIP 550** = Range planting;  
**GRP** = Grassland Reserve Program;  
**WMA** = Wildlife Management Area; **WPA** = Waterfowl Production Area; **WRP** = Wetlands Reserve Program

What plants do honey bees visit on EQIP enrollments?



Native  
Status

Introduced  
Native

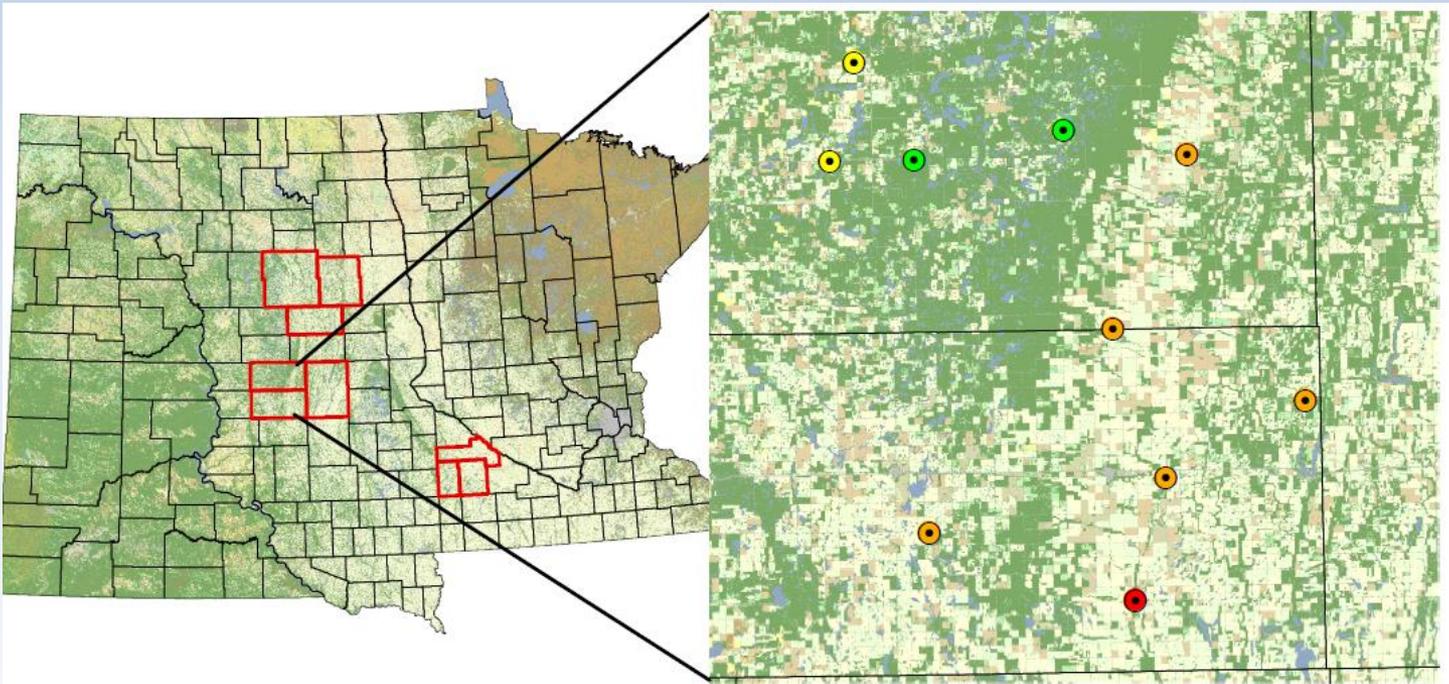
# Research & Monitoring Questions

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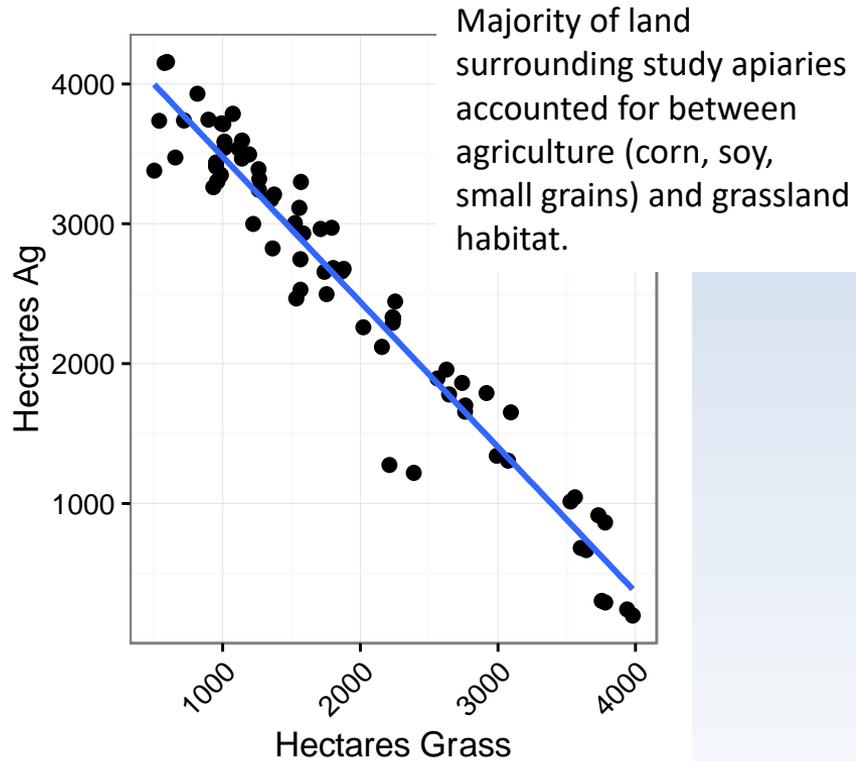
Photo: Sarah Scott

# Study region



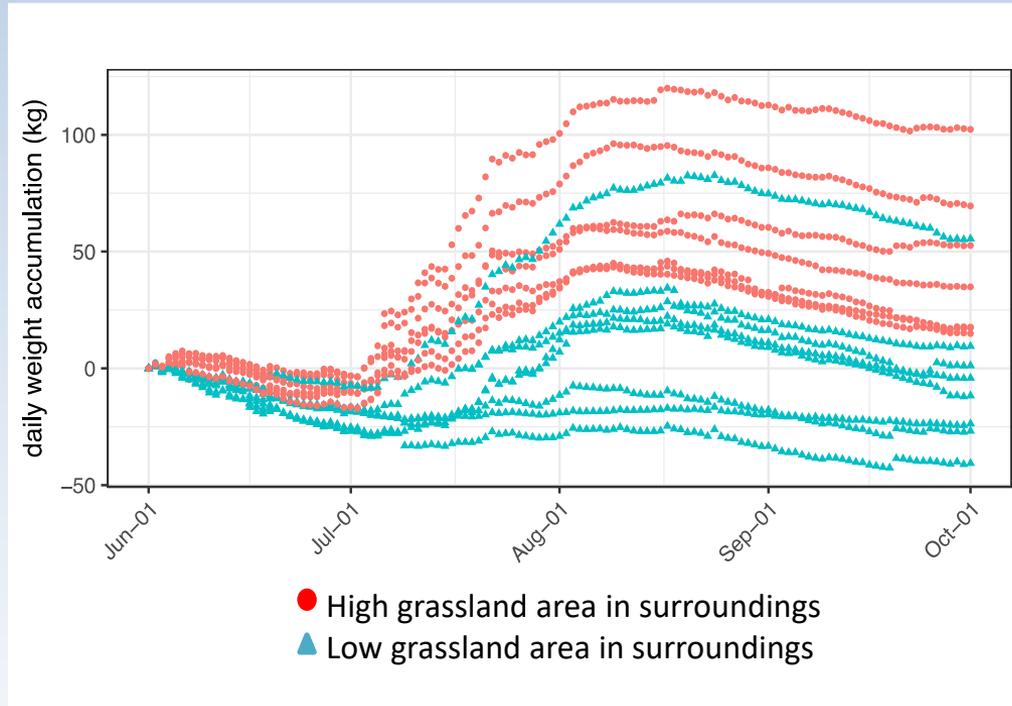
Low  High  
Expected habitat quality

# Land use around apiaries



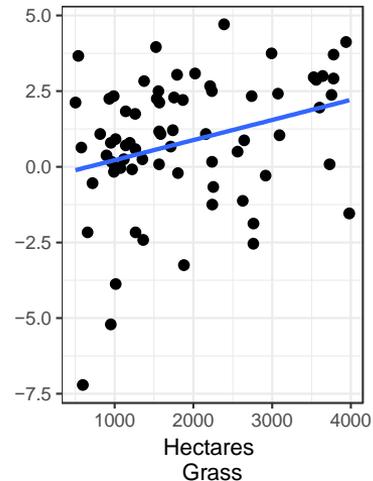
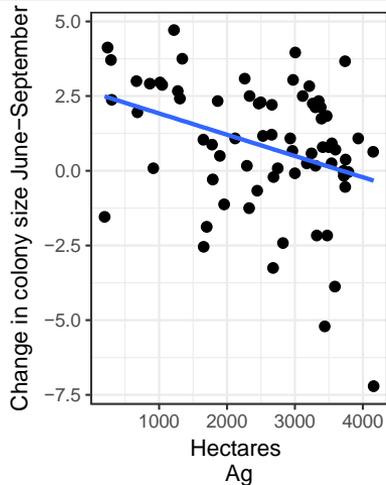
- Land use quantified within 2 mi radius of each apiary.
- Dot = a single apiary.

# Colony productivity through time



- By week 2, colonies in the high grassland apiary had already gained sig. more weight.
- This separation continued throughout the remainder of the growing season.
- Final avg. weight change: High grass: 34kg, Low grass: -2kg

# Colony population growth



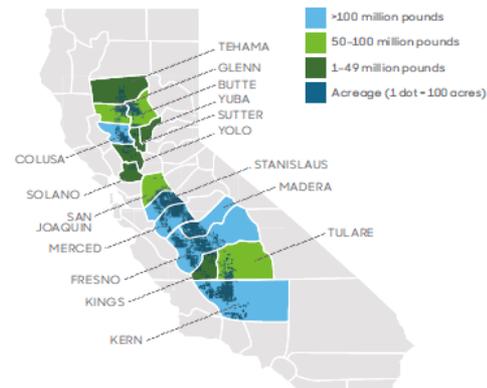
- Dot = change in colony size from June-September for a single apiary.
- Overall, approx. 2 frames of bees avg. population size difference across gradient.

# Almond pollination



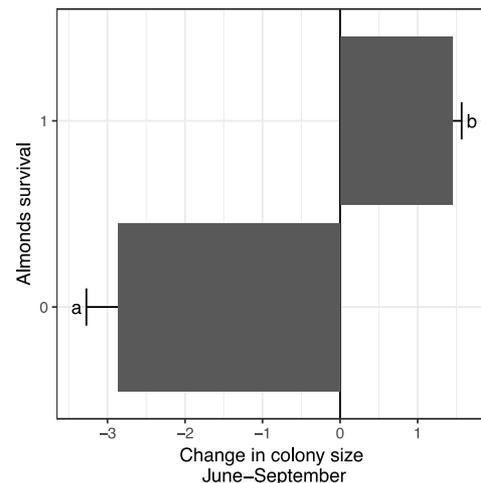
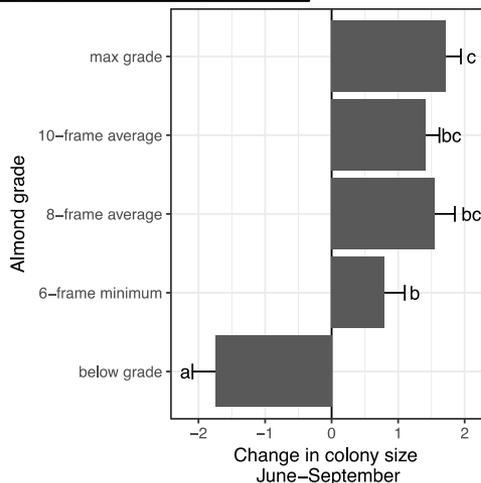
## WHERE ALMONDS ARE GROWN

PRODUCTION BY COUNTY 2015/16



Summer change in population size influences almond pollination grade and survival.

6-frame avg: \$140;  
8-frame avg: \$160;  
10+ frame avg: \$180+



# Spring colony splits

- After colonies moved out of almond orchards.
- Divide bees and food frames from strong colonies into a number of smaller colonies and provide each with a new queen.



Scientificbeekeeping.com

Strong colonies in almonds. Solid bees top to bottom. I'll add a third deep in the orchard for later March splits.

# Bee benefits of grassland habitat

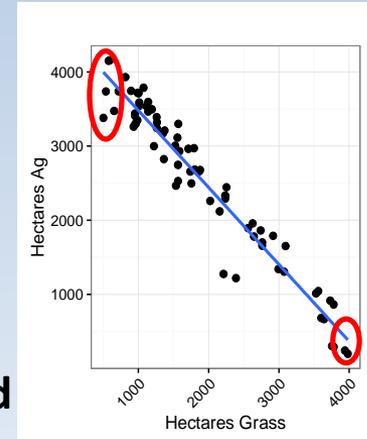
- Beek-onomics:
  - 2 frames of bees difference for almonds across land use gradient.

## ALMOND POLLINATION

- Approx. \$20 difference per colony.
- Approx. **\$1000 more per high-end grassland apiary** (\$20 x 48 colonies) **in almonds.**

## SPRING COLONY SPLITS

- 96 additional frames per high-end apiary.
- Additional **\$2400 per high-end grassland apiary in splits.**
- Estimate for 10,000 colonies at 48 colonies per apiary = 200 apiaries netting an additional \$3000 per apiary = **\$600,000 annually in additional almond pollination fees and splits for high-end grassland apiaries.**



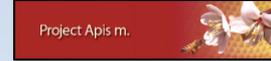
# Multiple benefits of grassland habitat in the NGP

- Grasslands, and multi-use grassland-agroecosystems, provide numerous ecosystem services while maintaining a productive agricultural economy, including:
  - Pollinator habitat, colony growth, honey production
  - Carbon sequestration
  - Habitat for wildlife
  - Promotion of biodiversity
  - Maintaining or increasing beneficial insects and natural enemies
  - Improving soil health
  - Reducing and preventing soil erosion
  - Reducing greenhouse gas emissions

# Acknowledgments

## Research Collaborators

- Beekeepers
- Haochi Zheng; UND
- Rufus Isaacs; MSU
- Jon Lundgren; Ecdysis Foundation



## USGS Research Team

- R. Scott Cornman; FORT
- Deb Iwanowicz; LSC
- Alisa Gallant, EROS
- Clint Otto, Ben Carlson; NPWRC

## Supporting Agencies and Organizations

- USDA-FSA
- USDA-NRCS
- Project Apis m
- USGS-Ecosystems Mission Area



Matthew Smart, [msmart@usgs.gov](mailto:msmart@usgs.gov); Clint Otto, [cotto@usgs.gov](mailto:cotto@usgs.gov)

# HOW PROJECT APIS M. IS INCREASING FORAGE WHERE IT IS NEEDED MOST

Billy Synk

Project Apis m.



# WHY IS HIGH QUALITY FORAGE ESSENTIAL TO BEE HEALTH?

- Colony health
  - Long term health
- Individual health/vigor
  - Pollination and short term health



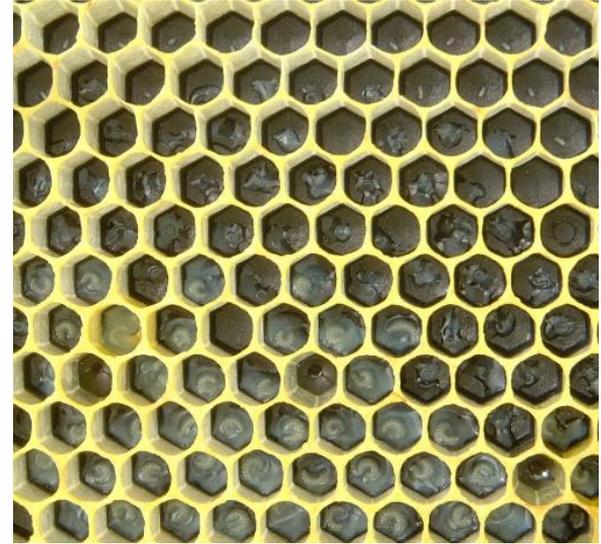
# LONG TERM COLONY HEALTH / IMMUNOCOMPETENCE



- Colonies have a better chance of winter survival when they have access to adequate forage (Degrandi-Hoffman et al. 2015)
- The abundance and diversity of resources can have a direct impact on pollinator's health. Alaux et al. (2010b)
- Polyfloral diets enhanced some immune functions better than monofloral diets...meaning that the diversity in floral resources provides better in-hive antiseptic protection. Alaux et al. (2010b)
- If nutrition is a critical factor in immune response, then **“malnutrition is probably one of the causes of immunodeficiency in honeybee colonies.”** Alaux et al. (2010b)

# INDIVIDUAL HEALTH / VIGOR

- Poor nutrition weakens bee fitness, colony growth and pollination ability
  - Workers reared under conditions of pollen limitation had reduced weight (Pernal and Currie 2000)
  - 62% of workers who were reared in pollen-limited colonies were observed foraging compared to 81% and 80% of workers reared in the abundantly supplied control colonies (Scofield and Mattila 2015)
  - 9% of workers reared in pollen limited colonies were observed dancing compared to 24% and 21% of workers reared in pollen abundant colonies (Scofield and Mattila 2015)
  - Precision of dances were also affected



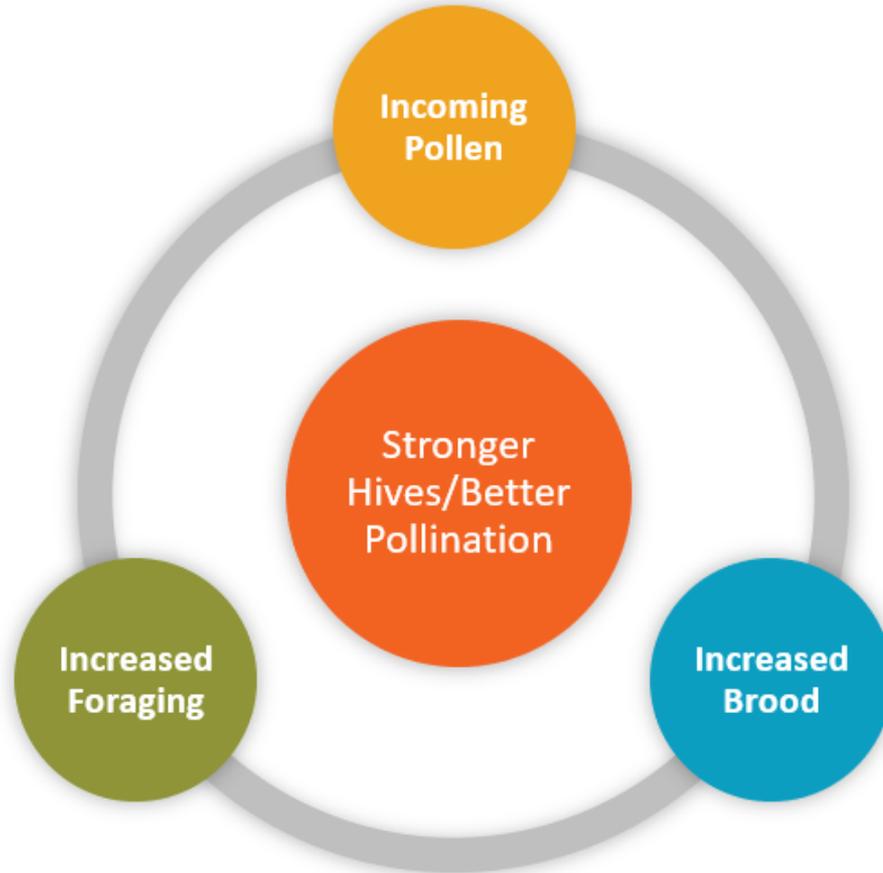
**THIS WILL ALWAYS BE BETTER...**



**...THAN THIS**



# Create a positive feedback loop!



# SEEDS FOR BEES

Specialty designed seed mixes maximize bee health for almond growers by providing a natural source of food for bees before and after almond bloom.

**A win-win for honey bees, beekeepers, growers, and soil and water quality!**

## Did you know?

Contracts are emerging that discount hive rental price if forage is planted.

**6,225**

acres of pollinator habitat planted last year



# SEEDS FOR BEES

- Seed mixes extend diversity, duration and density of bloom before and after almonds in California
  - PAm Mustard mix
  - PAm Clover mix
  - Lana Vetch
  - All almond growers are eligible
- Free seed! Free shipping!
- Enough seed to cover 75-125 acres.



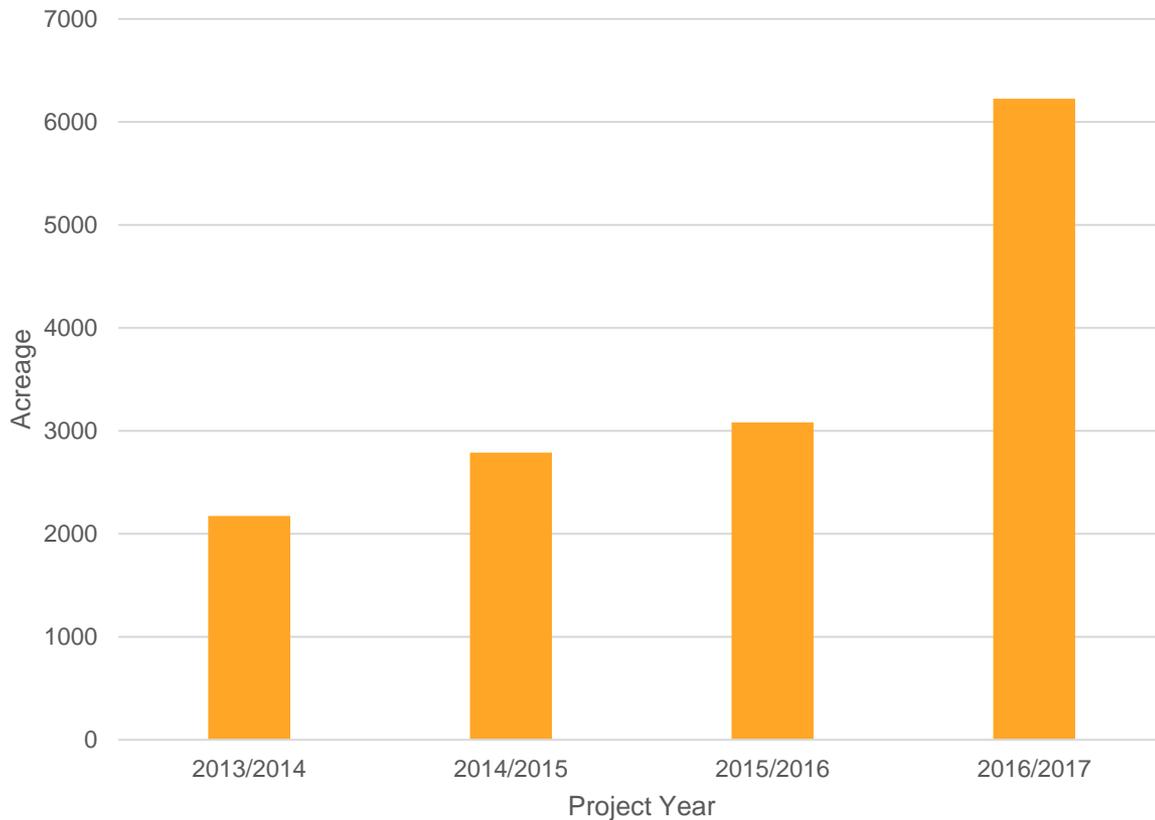
Project Apis m.



Seed for Bees is a valued program growers appreciate.

- 3,082 acres in 2015
- 6,225 acres in 2016

## Seeds for Bees Acres



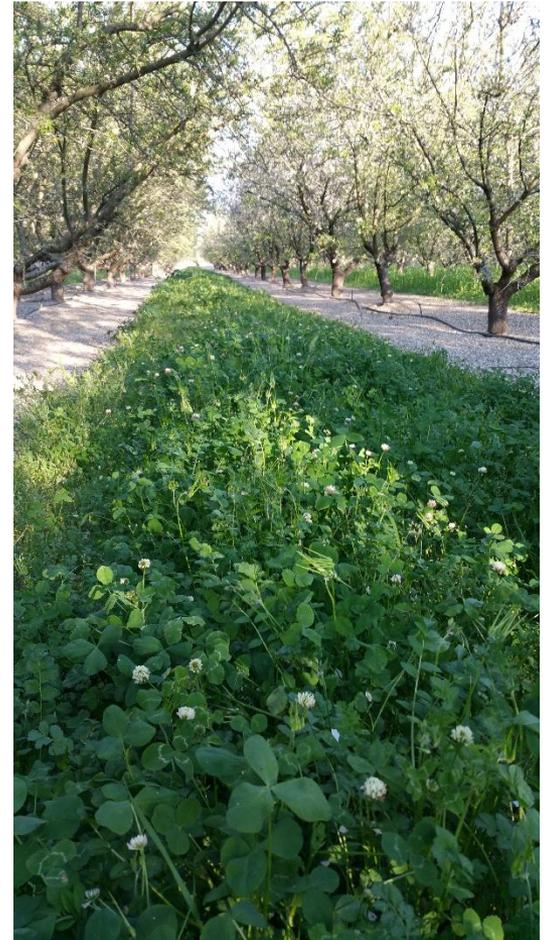
# IN ADDITION TO STRONGER COLONIES, BEE FORAGE COVER CROPS BENEFITS INCLUDE:

- Increased **organic matter**
- Prevents erosion
- Increase **water infiltration**
- Increase nitrogen
- Suppress weeds
- Suppress nematodes
- Decomposition of mummy nuts
- Many pollinators benefit





**1% organic matter =  
19,000 gallons per  
acre of water  
holding capacity!**



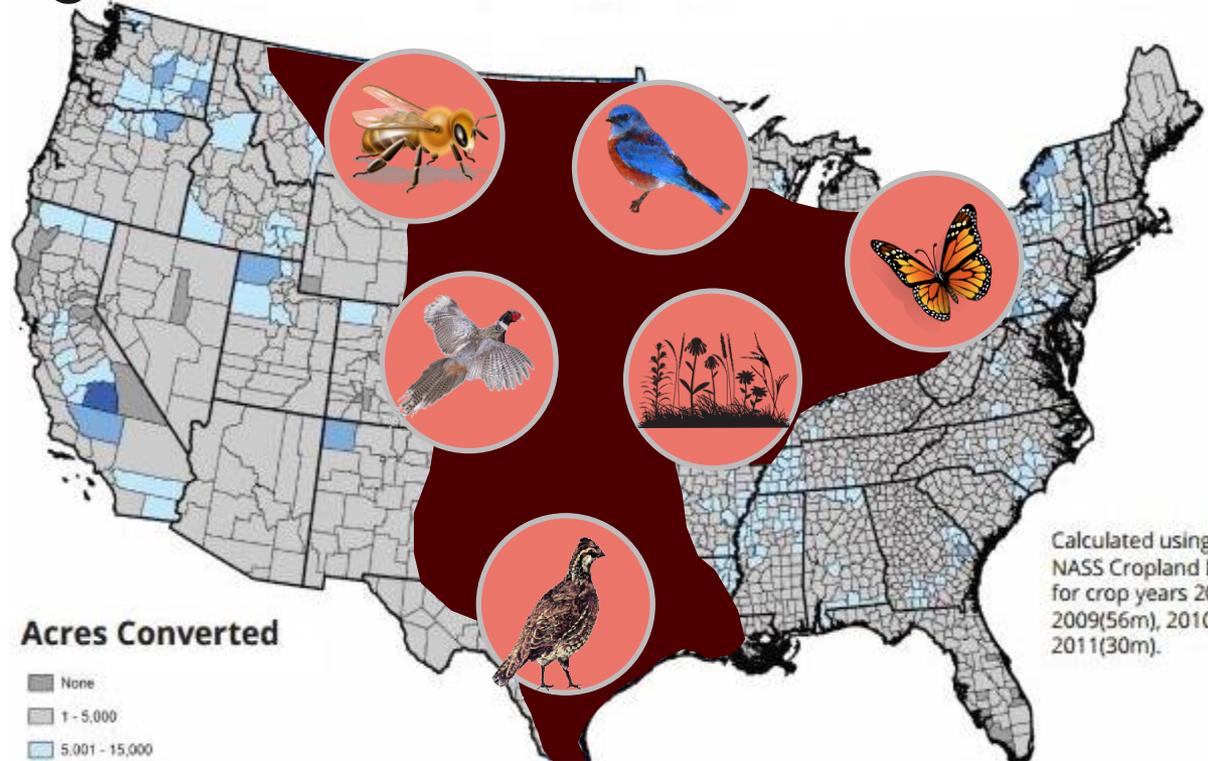
# WHERE DO HIVES GO NOW?



# Disappearing forage...

**Acres of  
Grassland/Wetlands/  
Shrub Land  
Converted to All  
Crops**

*By county, 2008-2011*



**Acres Converted**



Calculated using the USDA-NASS Cropland Data Layer for crop years 2008 (56m), 2009(56m), 2010(30m), & 2011(30m).

**Total Acres Lost: 23,681,611**

# STRATEGIC SOLUTIONS WHERE HONEY BEES BENEFIT MOST.

Bee and Butterfly Habitat Fund  
-25% ND, 75% 8 state region  
~30 weeks



Seeds for Bees  
-2 million hives  
~6 weeks

# BEE AND BUTTERFLY HABITAT FUND

## Forage program focused in the Upper Midwest

Supports beekeepers and landowners to replant habitat in agricultural landscapes that no longer support healthy bees. Honey bees benefit, and so do Monarch butterflies and other native pollinators such as song and game birds.

**Did you know?**  
120 landowners are combating habitat loss by participating in NextGen Habitat projects.



The Bee & Butterfly  
Habitat Fund

*A Unique Conservation Solution.*



Project Apis m.



**Contact us!**

Billy Synk

Director of Pollination Programs

[Billy@projectapism.org](mailto:Billy@projectapism.org)

[www.projectapism.org](http://www.projectapism.org)





# **LONGITUDINAL EVALUATION OF COLONIES WITH ACCESS TO TWO DIFFERENT FORAGE PLANTINGS**

Elina L. Niño

UC ANR/UC Davis



## Goals of the E. L. Niño Bee Lab

**Continue characterizing biotic and abiotic stressors affecting colony health in order to inform development of immediate and long-term solutions for bees, beekeepers and growers.**

# Many stressors affecting colonies

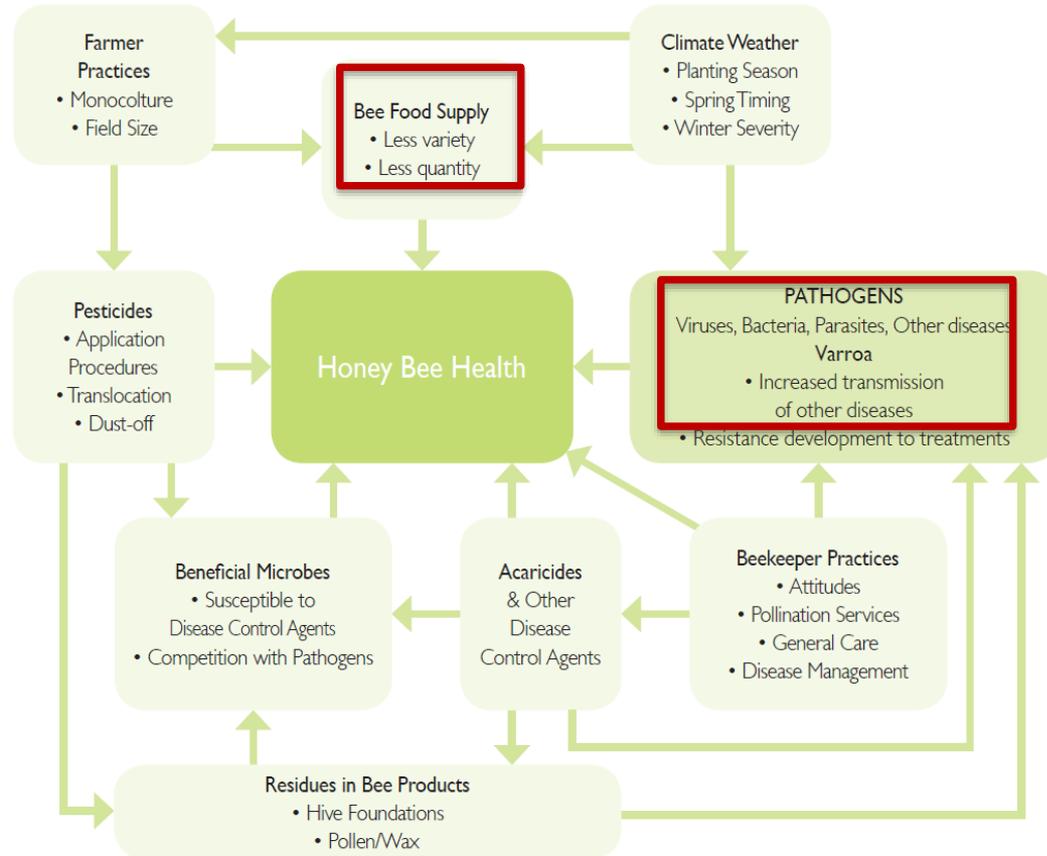


Figure 6. Interrelationship of bee health stressors Adapted from Le Conte *et al.*, 2010,

## Value of optimal nutrition

- Honey bees require diverse forage for better health



- **Better nutrition improves immune/detox response → helps bees better withstand pathogen infections even pesticides (e.g., Alaux et al. 2009; Di Pasquale et al. 2013; Schmehl et al. 2014)**

Project Apis m.



HONEY BEE  
HEALTH  
COALITION



The Bee & Butterfly  
Habitat Fund

*A Unique Conservation Solution.*



## Supplemental forage mixes

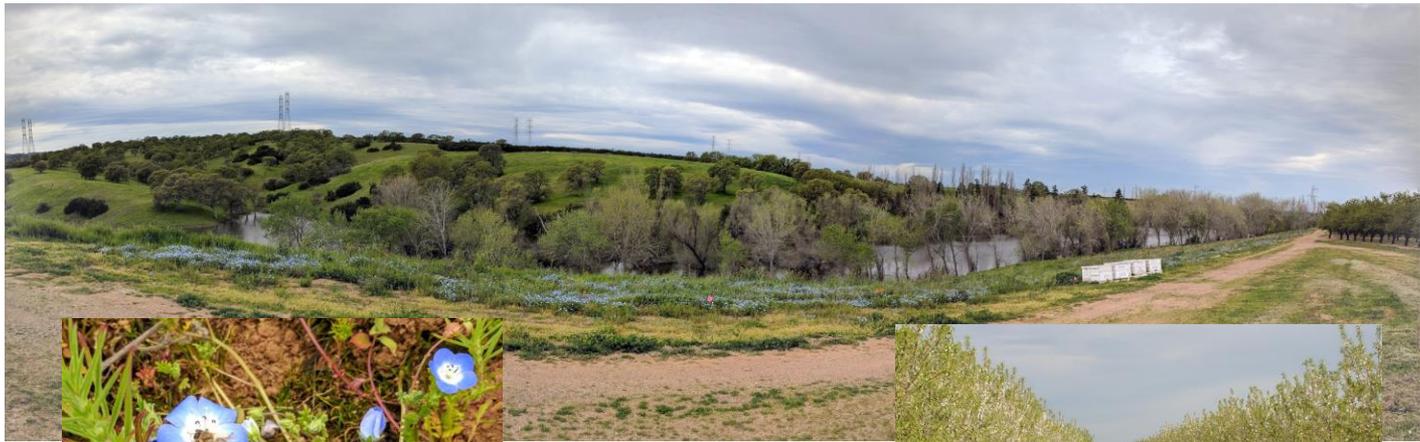


- **Seven annual plant species native to CA**
  - *Calandrinia ciliata*
  - *Collinsia heterophylla*
  - *Eschscholzia californica*
  - *Nemophila maculate*
  - *Nemophila menziesii*
  - *Phacelia campanularia*
  - *Phacelia ciliata*



- **35% Canola, *Brassica napus***
- **15% 'Bracco' White Mustard, *Sinapis alba* or *Brassica hirtum***
- **15% 'Nemfix' Yellow Mustard, *Brassica juncea***
- **20% Diakon Radish, *Raphanus sativus***
- **15% Common Yellow Mustard, *Brassica hirtum* or *Sinpais alba***

**Matching controls with no planed supplemental forage**

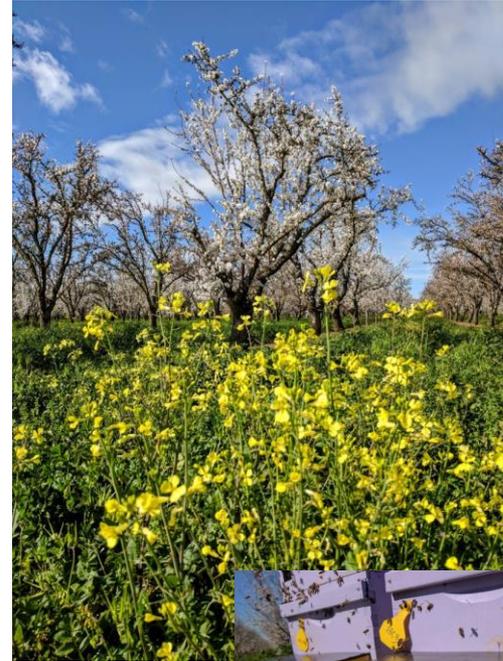




**X 4 treatments/4 sites**

**Total of 32 colonies**

- **Colonies tracked before, during and after almond bloom for various parameters.**
- **After bloom, colonies moved to a stationary site and monitoring continued once per month.**
- **Colonies are being tracked for overwintering survival.**



## Parameters tracked

- Resource use (Williams)
- Colony growth = adults and brood, weight
- Varroa mite infestation
- Pathogen load and bee gut microbiome (McFrederick)
- Immune competence (Anderson)



## Some challenges this season



# Resource utilization

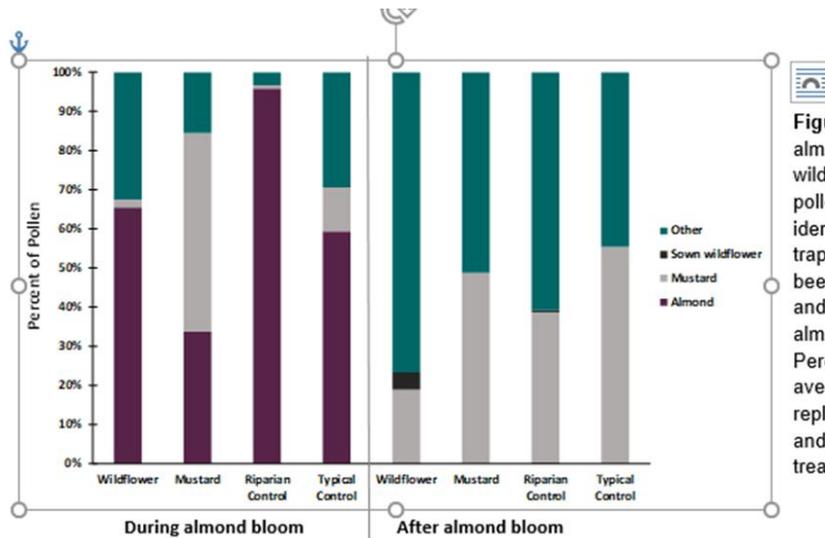


Figure 5. Percent of almond, mustard, sown wildflower, and other pollen that was identified from pollen traps placed on honey bee hives both during and after the 2017 almond bloom. Percentages represent averages over two replicate hives per site, and four sites per treatment.

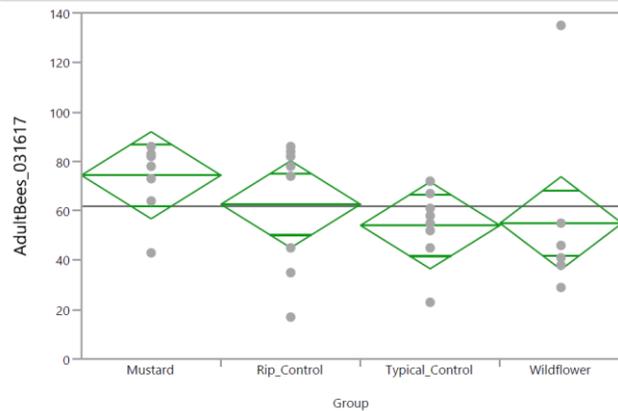
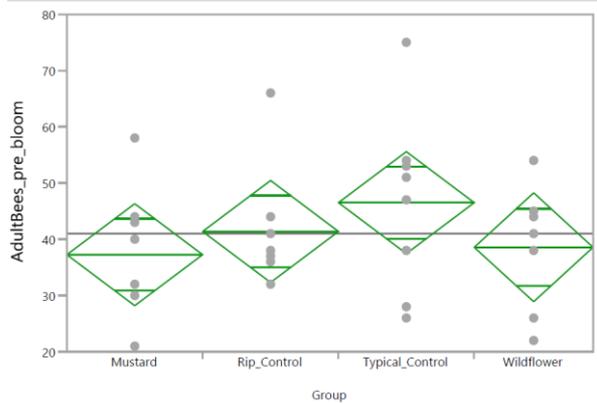
S. Cibotti, K. Ward, N. Williams

Poster: 17-POLL13-Williams; 1:30-2:30 PM

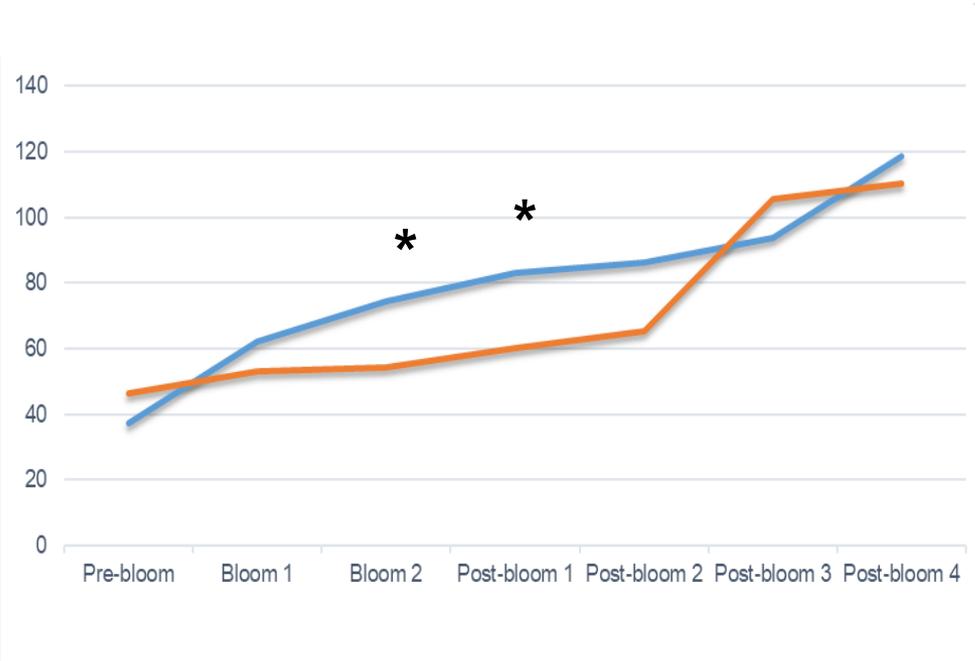
- Sampling showed diversity of pollen collected
  - However, wildflower collected only after bloom and colonies had to be moved out



# Preliminary results for adult bee population

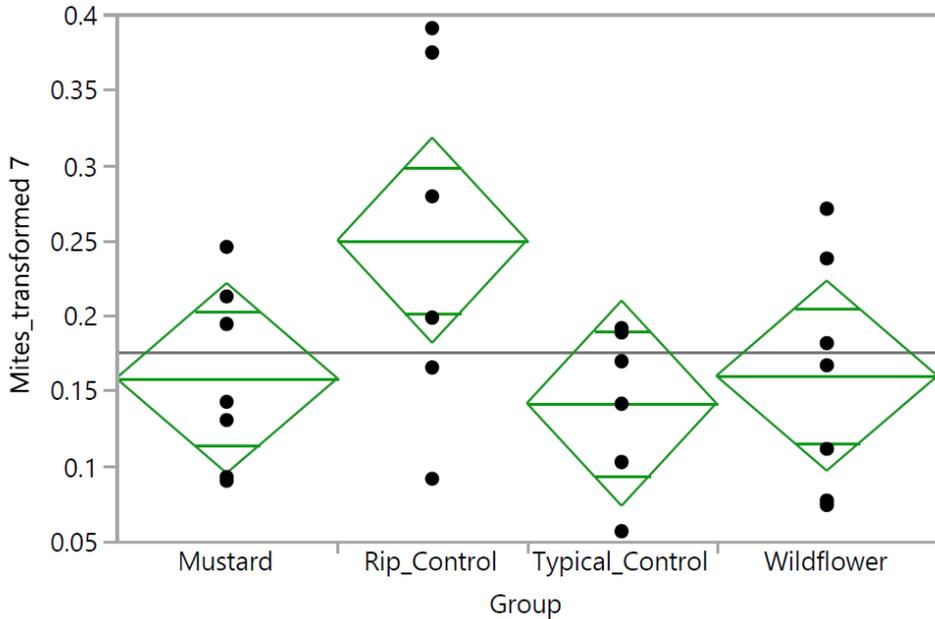


# Preliminary results for adult bee population

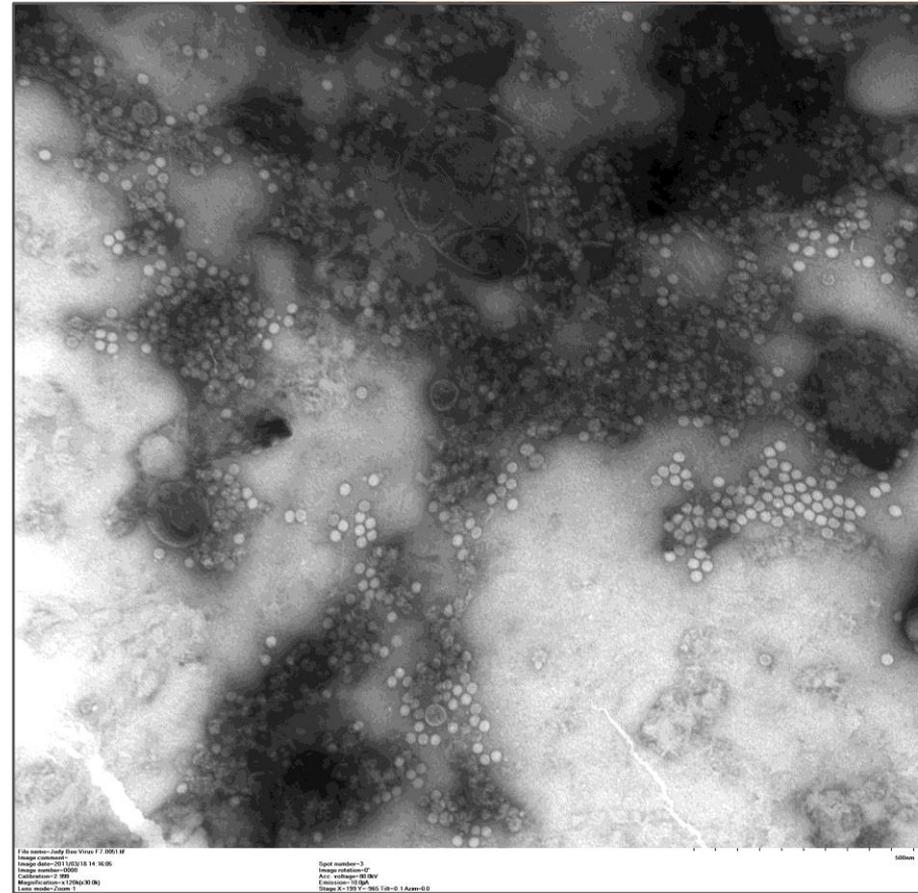


Adult bee population was significantly higher for colonies with access to mustard plantings in comparison to control groups at two timepoints. (T-test: Bloom 2:  $p=0.0084$ ; Post-bloom 1:  $p=0.0256$ ).

# How about those mites?



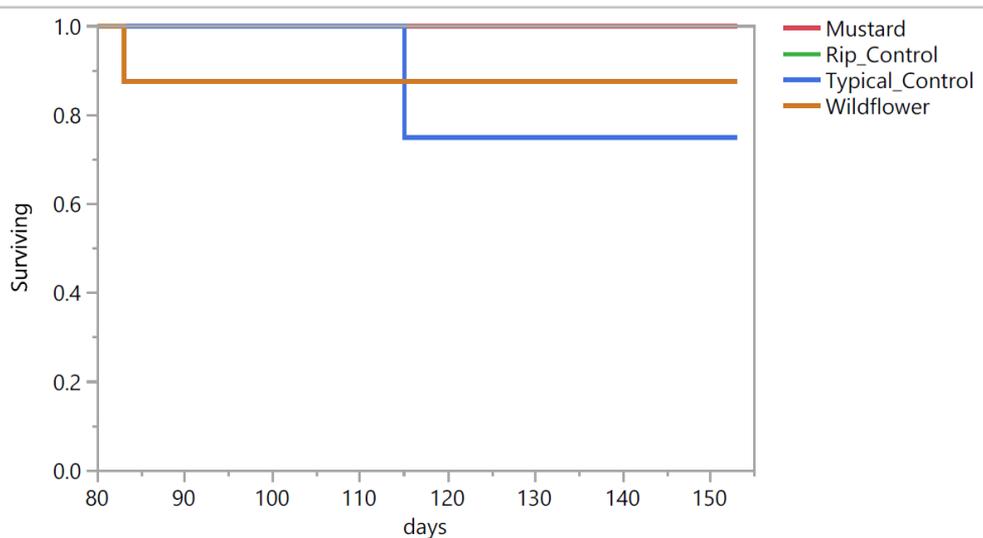
Poster: 17-POLL14-McFrederick/Anderson; 1:30-2:30 PM



## High varroa mite pressure



# What about survival?



- **Preliminary data confirms potential immediate and long term benefits of supplemental plantings.**
  - Beneficial for beekeepers and growers
  - Contracts with bonuses
    - Beekeeper – grower
    - Grower - customer
- **Complete analysis of immunity and pathogen load data (Q. McFrederick and K. Anderson)**
- **Replicate next year to confirm benefits and characterize wildflower effects.**

# ACKNOWLEDGEMENTS

## The Niño Bee Lab

Bernardo Niño

Many students

Joe Tauzer

Rae Purrington

## Bee facility manager

Charley Nye



## Collaborators

Neal Williams Lab (UCD)

Quinn McFrederick Lab (UCR)

Kirk Anderson Lab (USDA-ARS)

Beekeepers and growers

Funding sources, donors,  
volunteers





# HEALTHY BEES AND SUSTAINABLE POLLINATION

Dual goals of successful forage  
in almond landscapes

Neal M. Williams  
University of California, Davis

# CHALLENGES FOR BEES

- **Overwinter mortality**
  - Must build back colonies
  - Almond pollination demands vigorous hives
- **Low forage resource levels preceding almond bloom**
  - Hives are supplemented
- **Bees could benefit from diverse pollen sources**



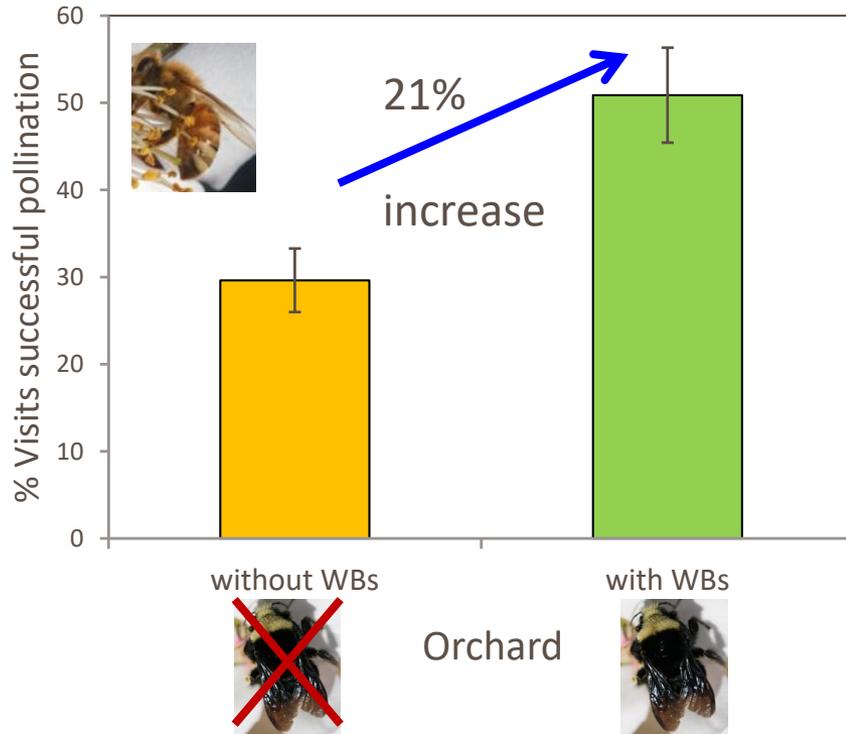
# CHALLENGES FOR POLLINATION



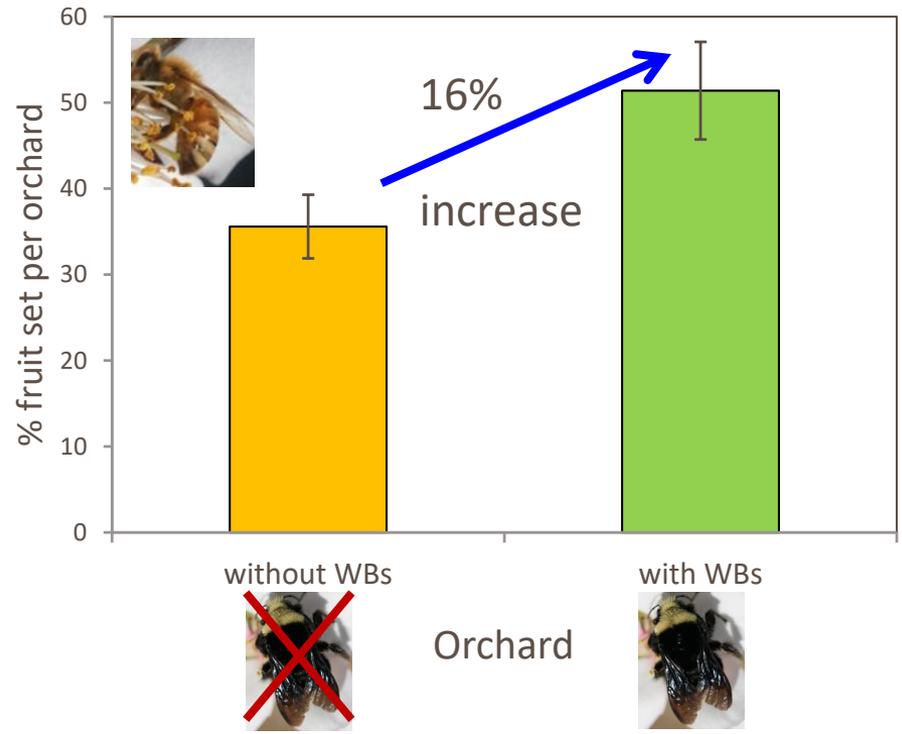
- **Reliable visitation to orchard during short bloom window**
  - Grower needs bees pollinating orchard
  - Highest quality pollination visits
- **Integration of other pollinators**
  - Wild bees make honey bees better pollinators

# POTENTIAL BENEFITS OF INTEGRATING WILD BEES - POLLINATION SYNERGY

## Single visit pollination by honey bees



## Single visit fruit set by honey bees



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

# WHAT WE ARE RESEARCHING

## 2016 - 2018

- Bloom of flower mixes in Northern/Central growing region
  - comparison of Wildflower/ Mustard Mixes (PAm)
- Honey bee use of forage mixes, visits and pollen analysis (UC Davis)
- Verify lack of competition between forage mixes and orchard for pollination
- Quantify impacts of forage mixes on almond pollination
- Assess impact of forage mixes on honey bee colony performance
  - collaboration with E. Niño lab, Q. McFredrick lab

# MIX COMPOSITIONS

- **Almond wildflower mix**



**Great valley phacelia**



**Five spot**



**Baby blue eyes**



**Lupine**



**Chinese houses**



**California poppy**

- **Mustard Mix**

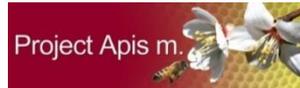


**Rapini mustard**

**Braco White Mustard**

**Nemfix Mustard**

**Radish**



# STUDY LOCATIONS AND SITE TYPES



**Mustard mix**



**Typical border**



**Wildflower mix**



**Riparian border**



# MEASUREMENTS

- **Flower abundance for forage mixes and other borders**

Impacts on bees

- Bee use of forage mixes
  - Visitation to mixes
  - Pollen samples for honey bee hives

Impacts on pollination

- Bee visitation to orchard
- Nut Set



# MEASUREMENTS

- Flower abundance for forage mixes and other borders

## Impacts on bees

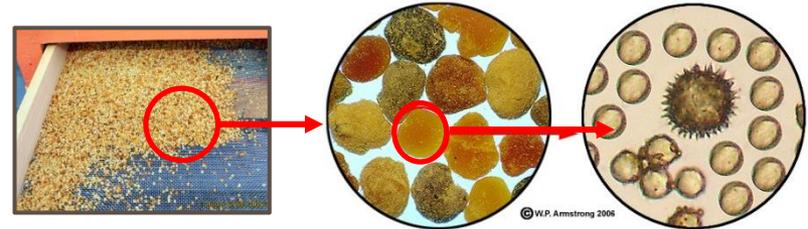
- **Bee use of forage mixes**
  - Visitation to mixes
  - **Pollen samples for honey bee hives**

## Impacts on pollination

- Bee visitation to orchard
- Nut Set



Analysis hive use



# MEASUREMENTS

- Flower abundance for forage mixes and other borders

## Impacts on bees

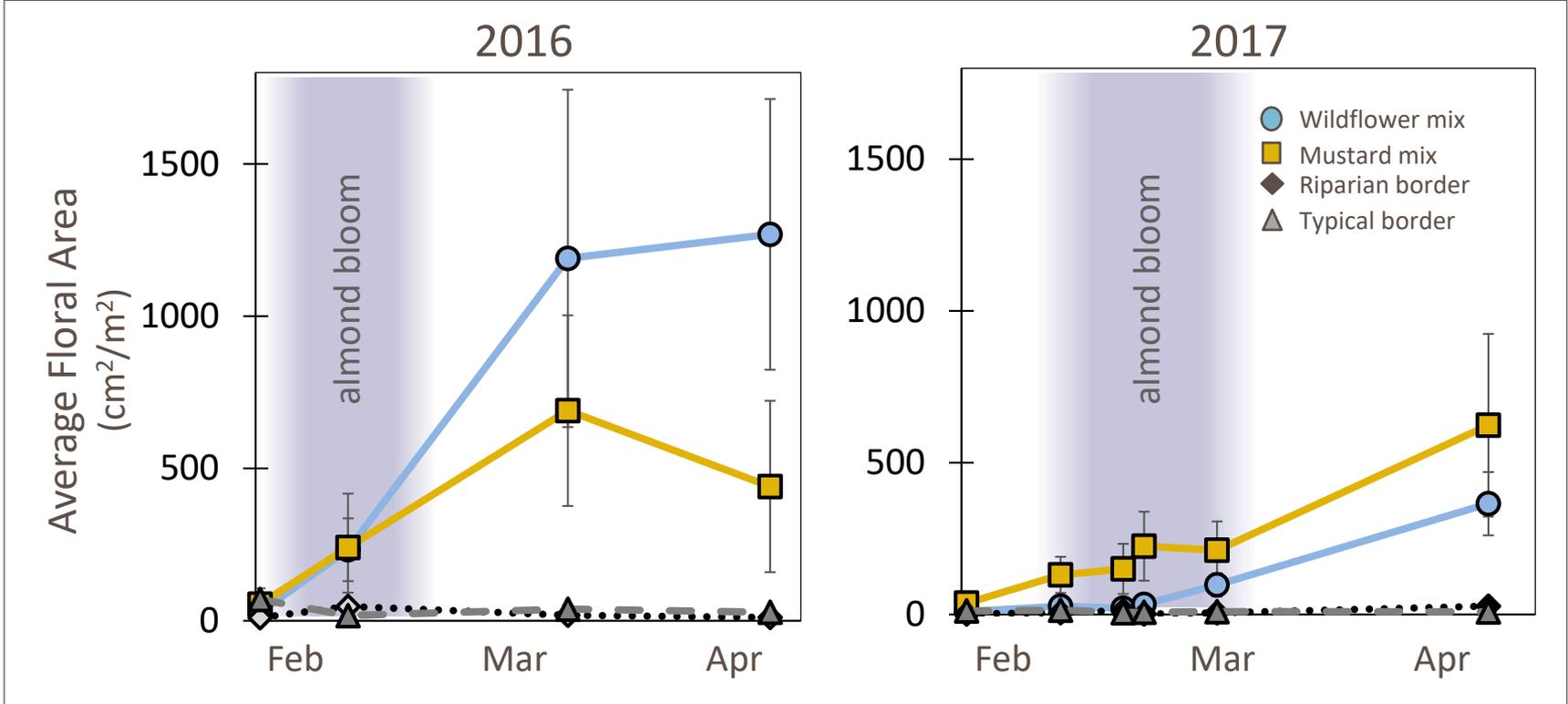
- Bee use of forage mixes
  - Visitation to mixes
  - Pollen samples for honey bee hives

## Impacts on pollination

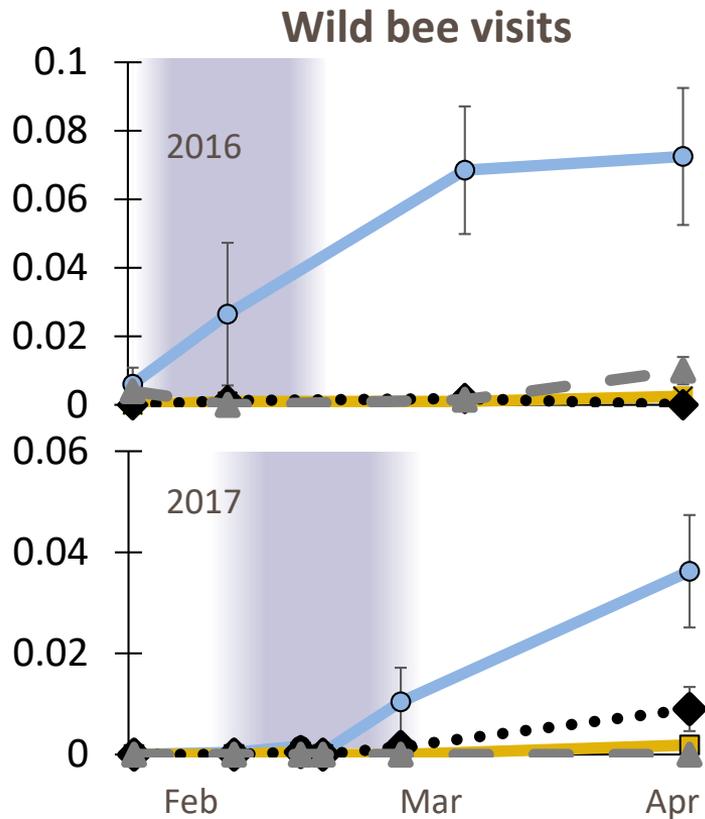
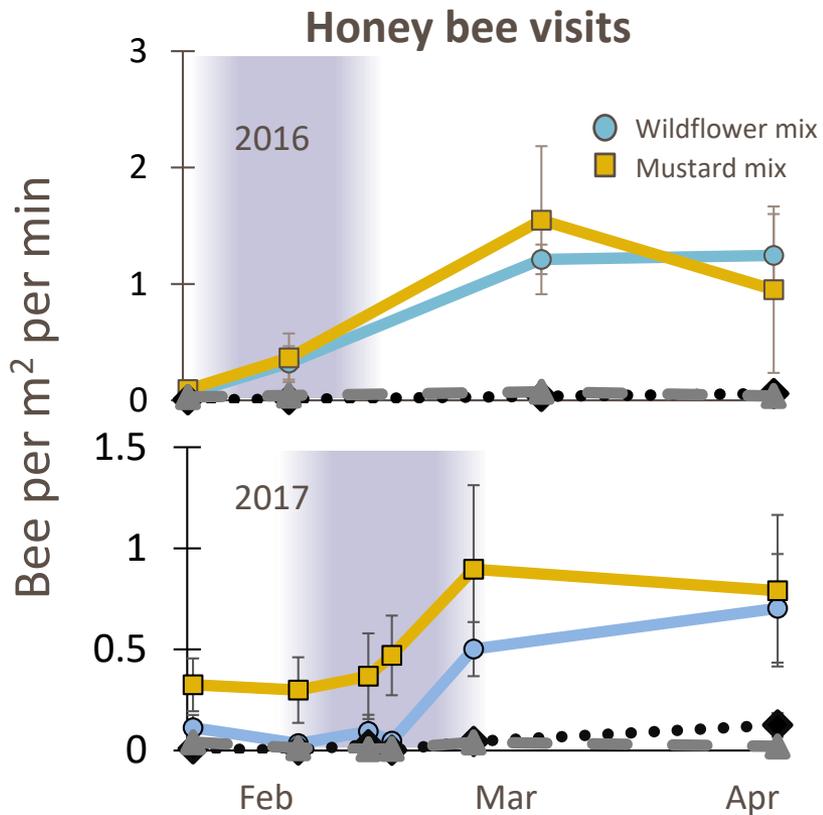
- **Bee visitation to orchard**
- **Nut Set**



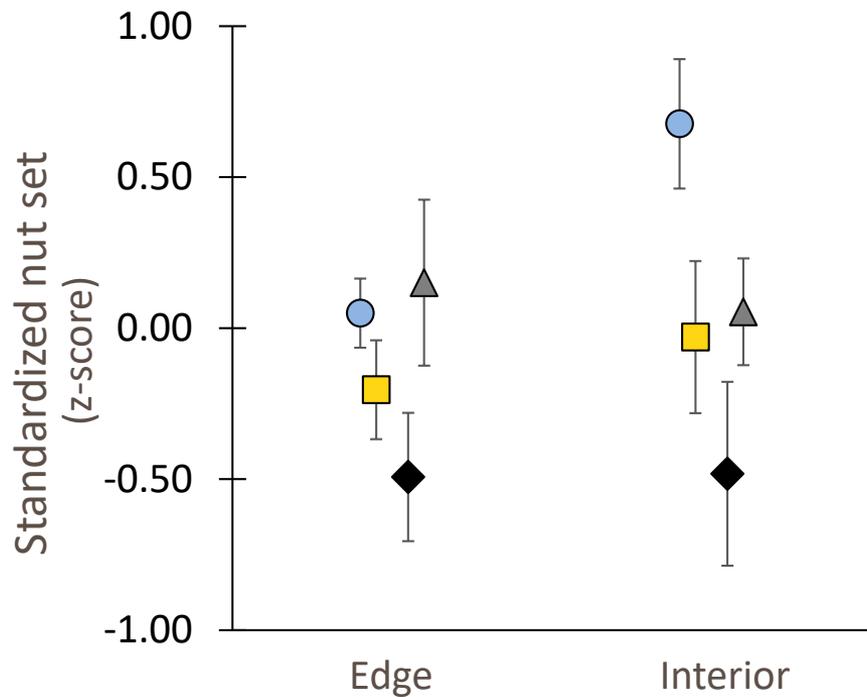
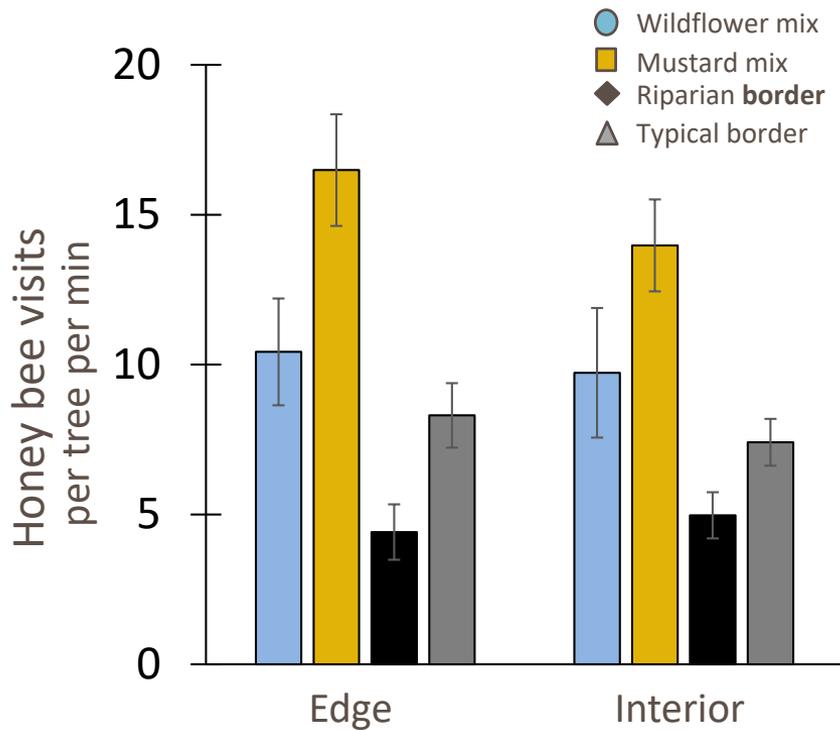
# MIX FLOWERING PERFORMANCE



# BEES USE OF FORAGE MIXES



# IMPACTS ON POLLINATION



# DUAL GOALS OF HEALTHY BEES AND SUSTAINABLE POLLINATION

## Good for bees

- Mixes provide consistent forage for bees after almond
- Mixes do not appear to compete for pollinator visits

## Good for pollination

- **Mixes increase visitation to neighboring orchards !**
- **Mixes can support increased nut set within the orchard**
- **Wildflowers may provide particular pollination benefit**



# What's Next

**Thursday, December 7 at 10:45 a.m.**

- Insect Pest Management Update – Room 308-309
- ABC Partners Addressing Bee Health – Room 312-313
- India: Celebrating Traditions – Room 306-307
- Surveying the Legal Risk Landscape – Room 314
- Unified Services for Solar Construction and Maintenance in the Almond Industry, Almond Stage in Hall A+B, presented by Sunworks, Inc.

