Native Bees
Bee Family Survey

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Outline

- General native bee characteristics
- Early bee-flower work at UC Berkeley
- Statewide survey of bee-flower relationships in urban California gardens
- Survey of main bee families

Native Bee Diversity

- ~ 4,000 bee species native to the United States & Canada
- ~1,600 bee species are found in California
- 6,500+ flowering plant species (angiosperms) in California

Centris rhodopus

Ceratina spp.

Importance of Bee Pollination

- In the U.S. and Canada, about 100 crops are pollinated by bees
- Food from bee pollinated crops comprise ~30% of our daily diet
- Some crops that require bee pollinators are alfalfa, avocado, almond, apple, berries, cantaloupe, kiwi, plum, squash, sunflower, watermelon, ….
- Economic value of bees ~20 billion dollars annually

Native Bee Biology, Behavior & Ecology

- Much variation among bee species
- **Each bee species has its own story**
- Fertile ground for research and outreach

Native bees have evolved with native flowering plants in California and worldwide

Native Bee Ecology

- Most native bees are solitary nesters
- ~ 70% of bees nest in the ground, 30% in pre-existing cavities
- Nesting implications for habitat gardening. Mulch madness

Ground Nesters:

Digger bees and Ultra Green Sweat Bee

Pre-existing Cavity Nesters:

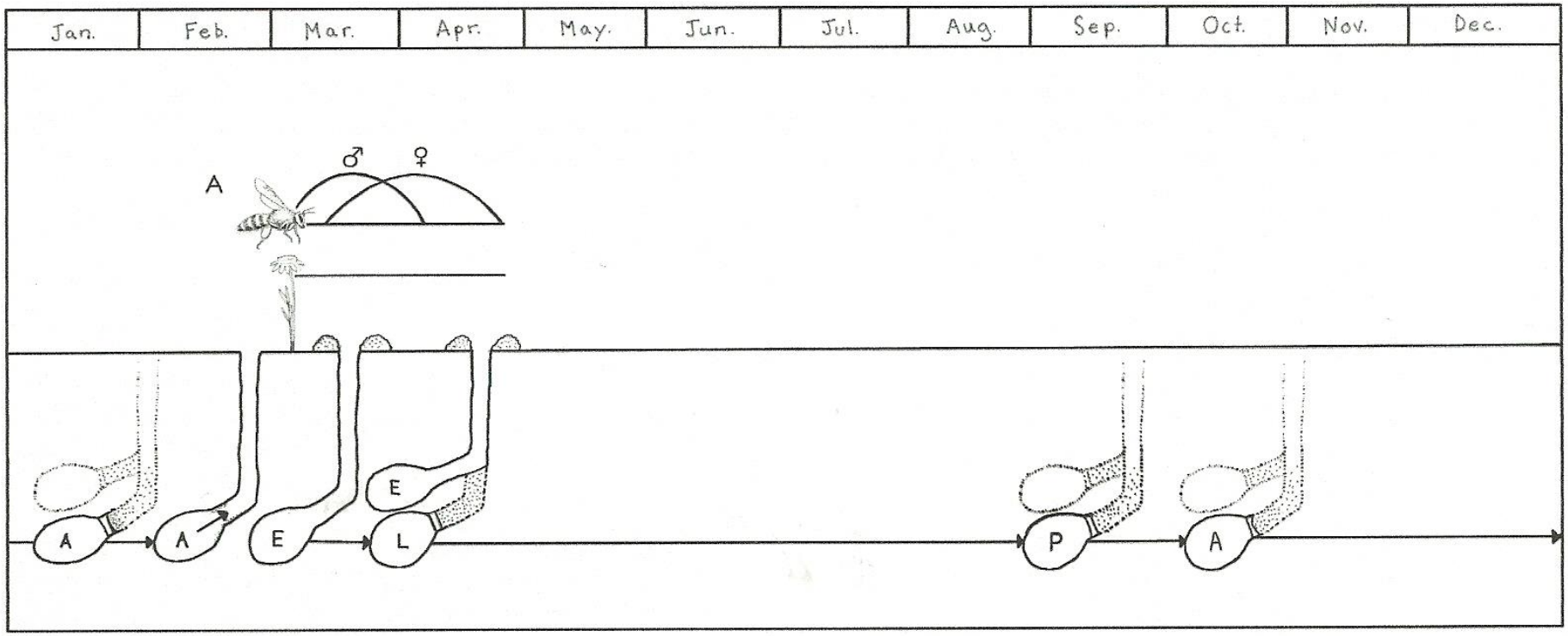
Leaf cutters in wooden trap nests

Native Bee Ecology

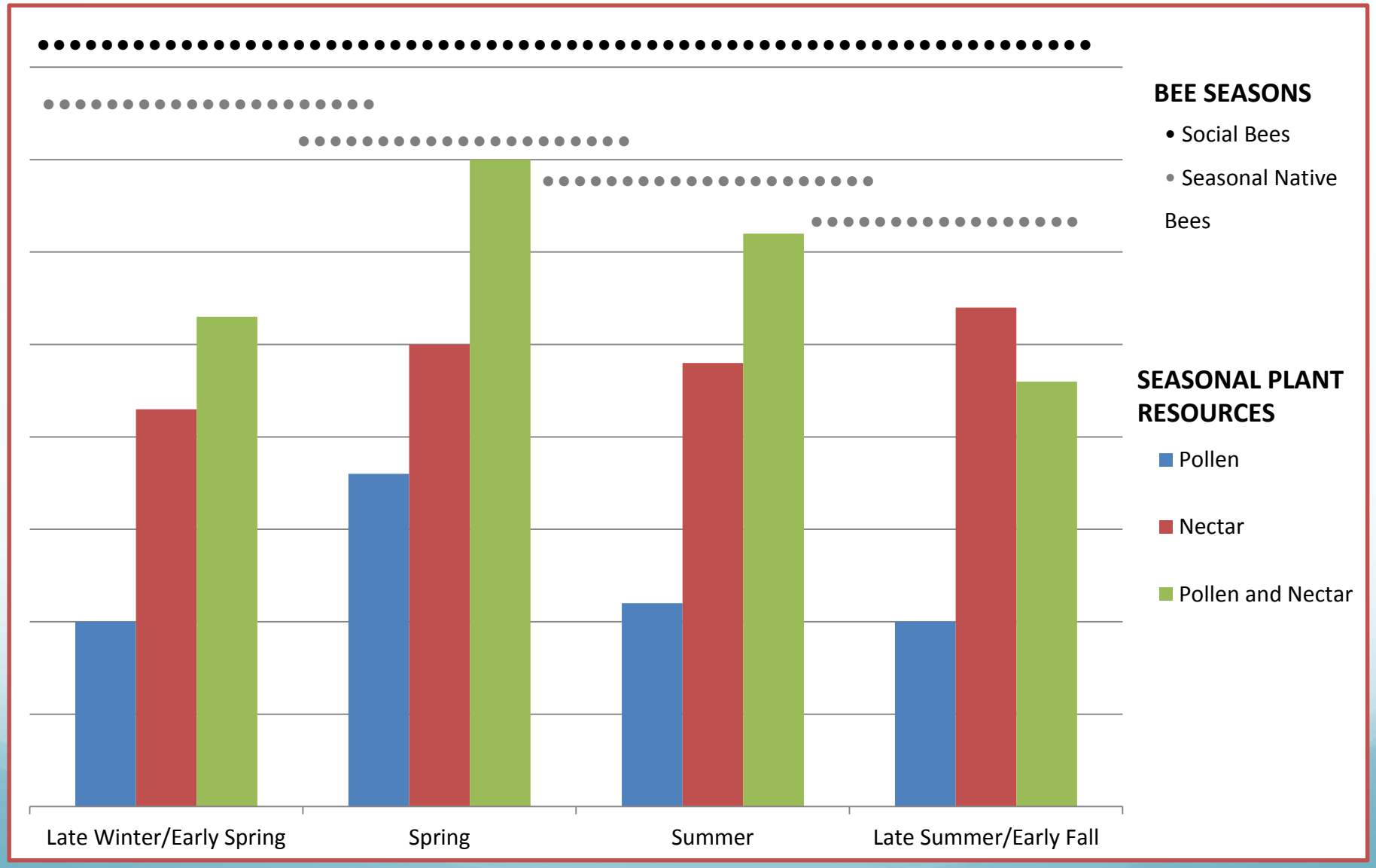
- Bees need: pollen, nectar, and mating
- Only females sting!
- Three types of pollen collection, depending on bee taxa

Xylocopa varipuncta male

Annual Cycle of single generation *Andrena* sp.



Native Bee Ecology



Decline in native and honey bees

- Causes for native and honey bee declines include:
  - pesticides (esp. neonics)
  - habitat destruction and fragmentation
  - global climate change
  - drought and other extreme weather events
  - Hb nutrition

Female *Centris* sp.,
Calif. Palm Desert

Early Urban Bee Work: UCB Oxford Tract

- Urban areas can serve as habitat for native and honey bees
- Research by our lab has found
  - 88 bee species in Berkeley
  - (83 native bee species)
  - ~60 bee species in Oxford Tract

Oxford Tract Garden 2005

Oxford Tract Evaluation Garden

- **Goal 1**: Evaluate basic **bee-flower relationships**
- **Goal 2**: **Monitor** diversity and abundance of bee species through time
- **Goal 3**: Evaluate optimal **plant mgt.** methods for vigorous flowering
- **Goal 4**: Use evaluations for **habitat gardens** statewide

Oxford Tract July 2003

Oxford Tract 2008

Oxford Tract Evaluation Garden Major Findings

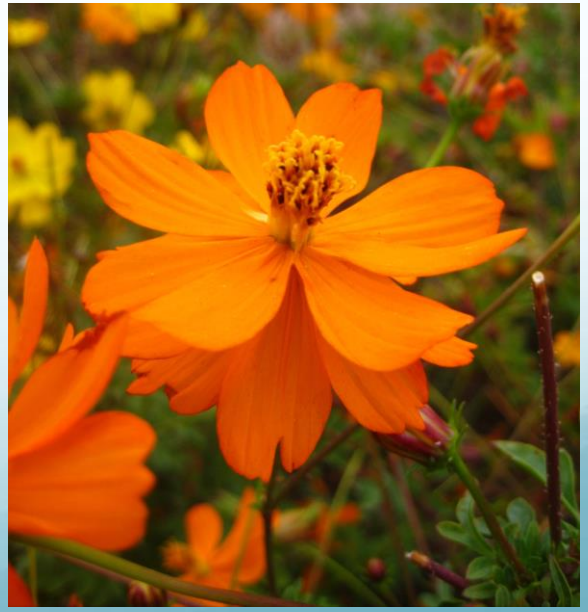
- Certain plant families highly attractive to bees
  - Asteraceae, Lamiaceae, Boraginaceae (Hydrophyllaceae)
  - Polygonaceae, Rosaceae

Osmia sp. on *Phacelia campanularia*

Anthophora urbana on *Phacelia campanularia*

Oxford Tract Major Findings

- Native bees foraged at **native plants** more often than non-native plant species
- Some non-native plants also important for native bees
  - For example: *Cosmos* spp.
  - *Salvia* spp.
  - *Lavandula* spp.
  - *Nepeta* spp.
  - *Vitex agnus-castus*
  - Some weeds



Statewide Survey

- 15 cities surveyed
- ~50 gardens throughout the state
- Variety of garden types: schools, botanical gardens, residential, and a cemetery

Ukiah

Sacramento

San Luis Obispo

Major Bee-Flower Findings

- **Aerial collections of bees on flowers:**
  - Current bee species count: 400+ bee species
  - Current host plant types: 500+ plant types
- Bee species, location, date, and plant host info added to Access database
- Relatively high bee species diversity in most cities

Bee Species from 5 Surveyed Cities

Location	Families	Genera	Species
Ukiah	5	28	95
Sacramento	5	23	82
Berkeley	5	25	88
San Luis Obispo	5	32	99
La Cañada Flintridge (near Pasadena)	5	34	112

Frequency Counts

- Frequency (visitation) counts on selected plant species statewide
- Frequency counts of bees on indiv. flower types for 3 minute intervals

Predictable Bee-Flower Relationships:

Bee plants attract certain bee taxa and rarely others

Bombus vosnesenskii

Halictus farinosus

Melissodes sp.

Svastra obliqua expurgata


Phacelia tanacetifolia
attracts 60+ bee spp.

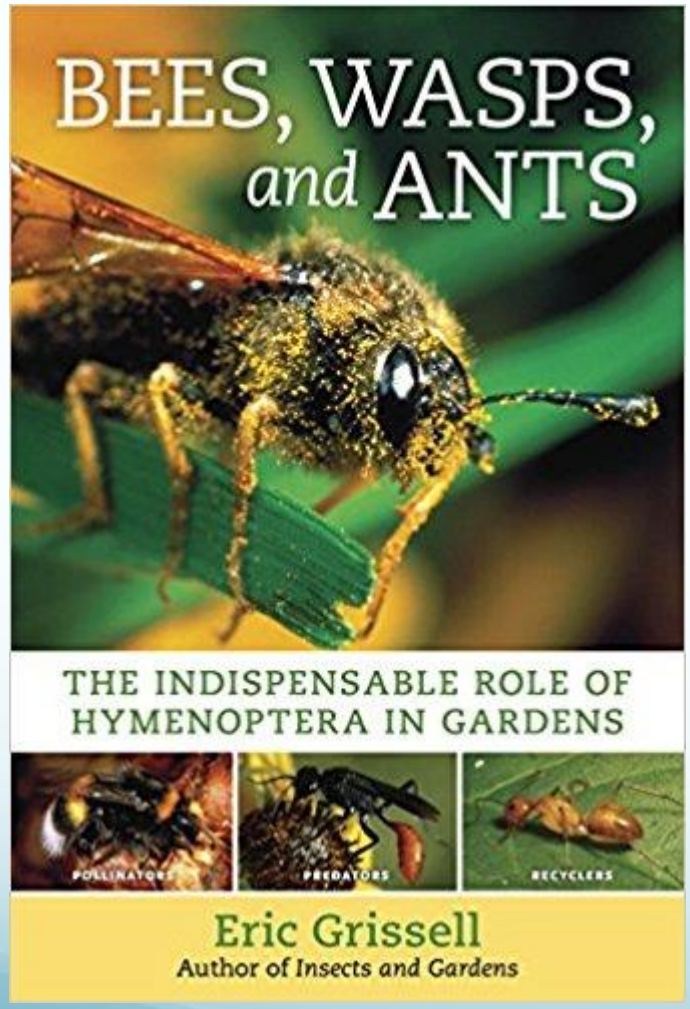
Sonoma Bee Count

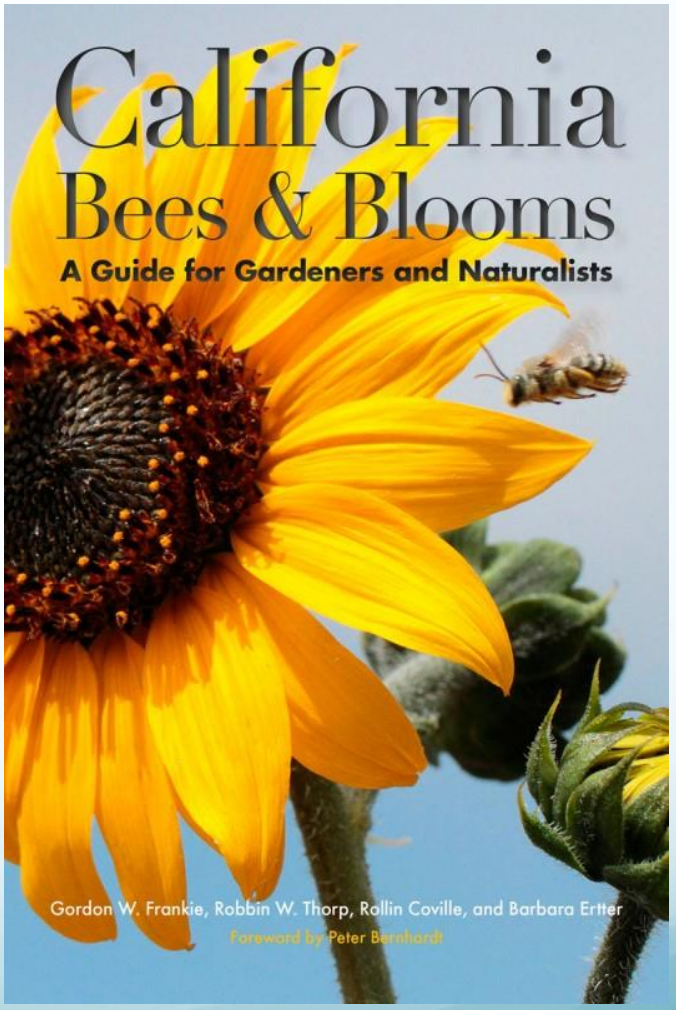
Annual Citizen Science Project 2010 – 2020

Sonoma Bee Count

Citizen-scientists at work processing bees

Survey of Bee Families





Families in N. America	No. Spp. In World	No. Spp. In N. America	Larval Feeding Type	Hosts
Apidae	**5636**	**1622**		
Subfam. Apinae digger bees, honey bees, bumble bees	**3441**	**931**	Pollen, digger bees solitary; honey bees eusocial; bumble bees mostly social	Larval cells in soil (digger bees), others constructed nests either underground or in cavities
Subfam. Nomadinae Cuckoo bees	**1207**	**581**	Pollen, solitary; all cleptoparasitoids of other bees	Larval cells in soil
Subfam. Xylocopinae Carpenter bees	**988**	**110**	Pollen, mostly solitary, some gregarious, some subsocial	Larval cells in wood or plant stems

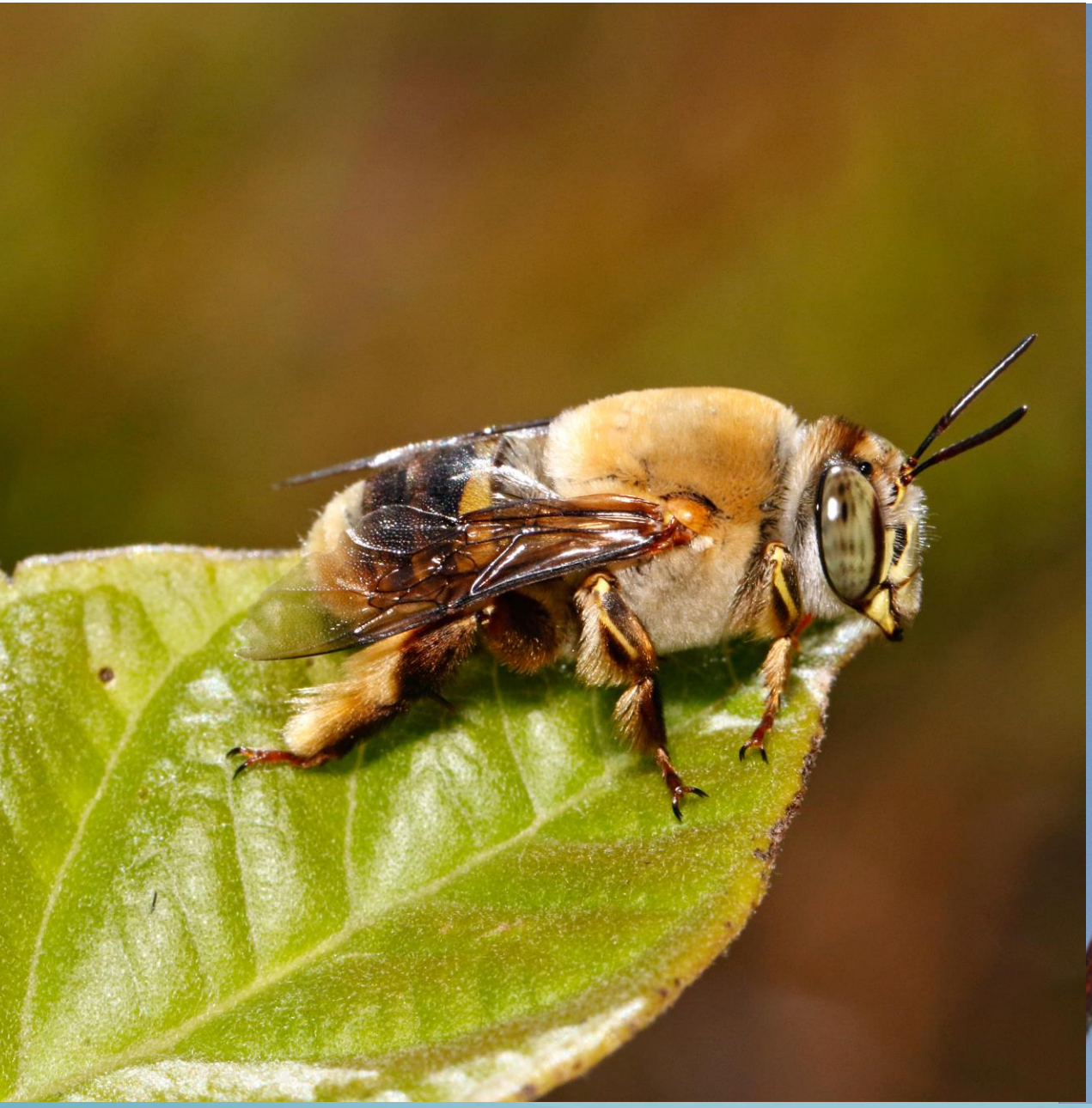
Families in N. America	No. Spp. In World	No. Spp. In N. America	Larval Feeding Type	Hosts
Colletidae Yellow-faced bees; plasterer bees	**2498**	**320**	Pollen, solitary	Larval cells in soil or hollow stems
Halictidae Sweat bees	**4084**	**828**	Pollen, solitary, rarely communal or primitively eusocial; some cleptoparasitoids	Larval cells in soil or rotting wood
Megachilidae Leafcutter bees, mason bees, resin bees, carder bees	**3952**	**861**	Pollen, solitary, rarely cleptoparasitoids	Larval cells in soil, pithy stems, preformed cavities or formed on rocks, stems or leaves (from resin, mud, pebbles)
Andrenidae Mining bees	**2869**	**1473**	Pollen, mostly solitary, some communal nesters	Larval cells in soil

Apidae Family-Apinae

Nomadinae

Xylocopinae

Apidae-territorial behavior



Squash bee

Colletidae Family

Halictidae Family

Megachilidae Family

Andrenidae Family

Thank you!

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Transition to Agricultural: Brentwood

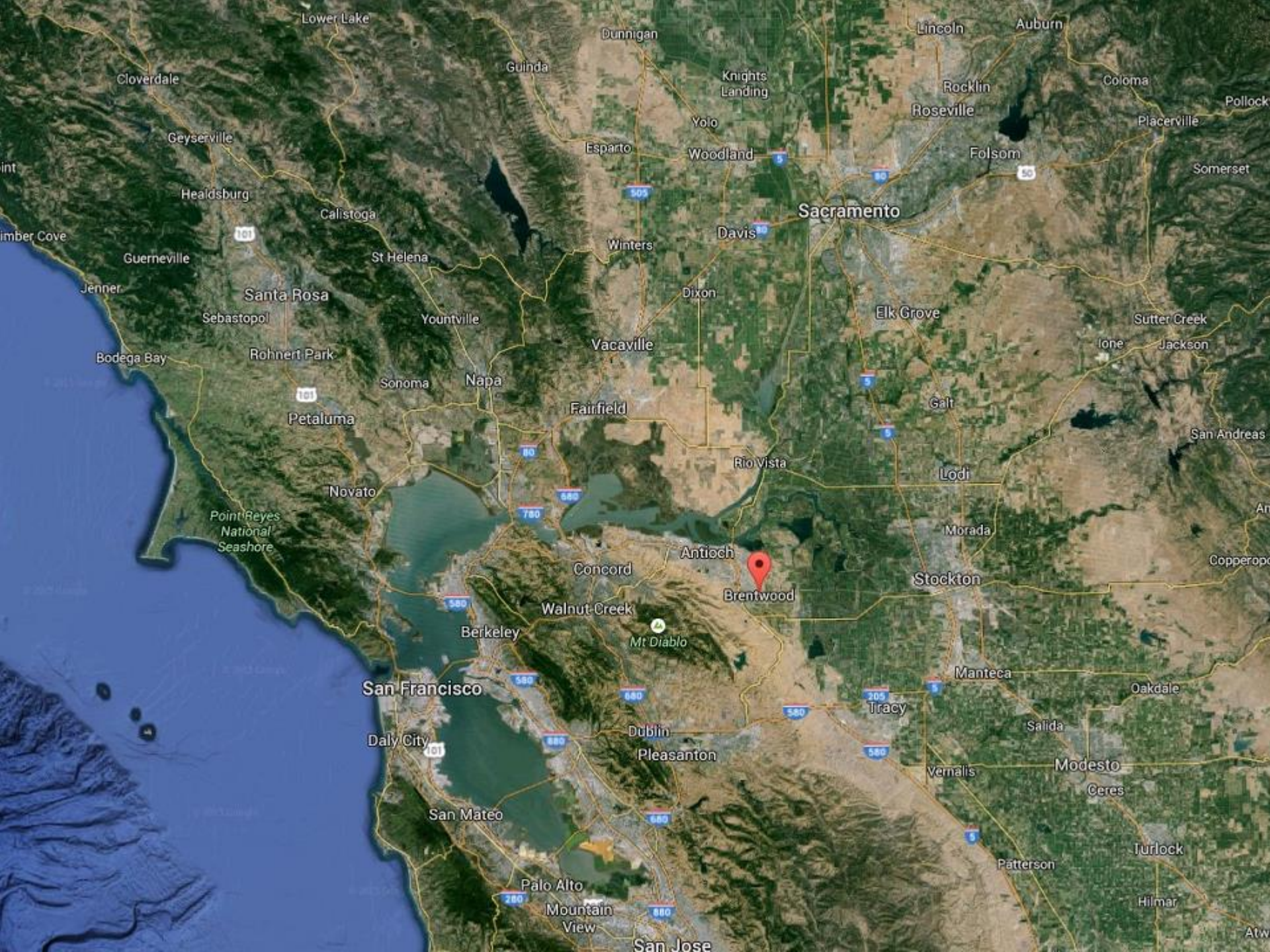
- Invitation* in 2009: To bring urban bee-plant knowledge to Frog Hollow farm to:
  - Construct habitat in orchards to attract native bees to **supplemen**t honey bee pollination
  - **Monitor populations** of native bees through time
  - **Partner with farmers** to **outreach** info to agr. professionals, USDA-NRCS, UCCE, Brentwood Agr. Land Trust, schools, and CNPS

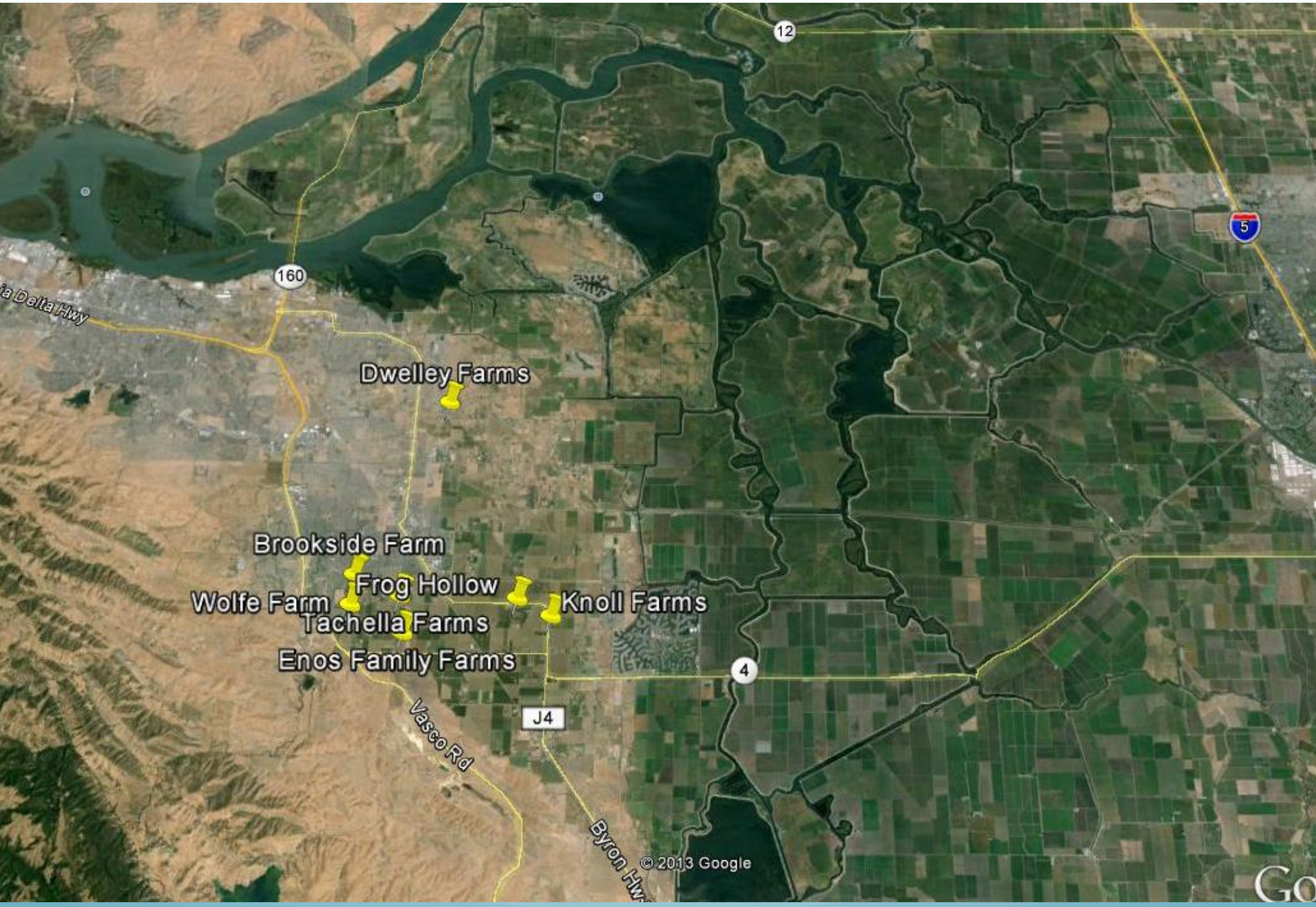
NRCS
Natural Resources Conservation Service

* USDA-NRCS and Farmer Al Courchesne of Frog Hollow

Brentwood Farms

- By 2012 project participants grew to 8 farms (organic and conventional) for comparisons
- 4 control farms with no plants added
- 4 treatment farms with added plants


Lower Lake
Dunnigan
Lincoln
Auburn
Cloverdale
Guinda
Knights Landing
Rocklin
Coloma
Roseville
Pollock
Placerville
Geyserville
Yolo
Esparto
Woodland
Folsom
Somerset
Healdsburg
Sacramento
Calistoga
Davis
Winters
Guerneville
St Helena
Jenner
Santa Rosa
Dixon
Elk Grove
Sebastopol
Yountville
Sutter Creek
Vacaville
Ione
Jackson
Bodega Bay
Rohnert Park
Sonoma
Napa
Galt
Petaluma
Fairfield
San Andreas
Rio Vista
Lodi
Novato
Point Reyes National Seashore
Morada
Antioch
Concord
Stockton
Brentwood
Walnut Creek
Berkeley
Mt Diablo
Manteca
San Francisco
Oakdale
Tracy
Dublin
Salida
Daly City
Pleasanton
Vernalis
Modesto
Ceres
San Mateo
Turlock
Patterson
Palo Alto
Hilmar
Mountain View
San Jose


12
5
160
Dwelley Farms
Brookside Farm
Frog Hollow
Wolfe Farm
Knoll Farms
Tachella Farms
Enos Family Farms
4
J4
Vasco Rd
© 2013 Google


legendary fruit
FROG HOLLOW FARM
organically grown

Dwelley Farm

Halictid on Bristly Ox-tongue (*Picris echioides*)

Honey Bee on Bristly Ox-tongue (*Picris echioides*)

East Contra Costa Hills

Where native bees come from

Brentwood Farm Results: Bees

- Numerous bee plants (**80 types**) added in 2010-2015 attracted **127 species** of bees

- Main bee groups moving between bee plants and crop flowers
  - 2 species of *Bombus* (Bumble bees)
  - 2 species of *Ceratina* (Small carpenter bees)
  - >4 halictid species (Sweat bees)
  - Several *Osmia* species (Mason bees and Leaf Cutter bees)
  - Several *Andrena* species (Mining bees)
  - Apids (*Anthophora* and *Habropoda)* species (Digger bees)



Additional Results

- New information on managing bee plants in Ag systems
- Bee plants also provide pollen and nectar for resident honey bees
- Interfacing **bee ecology** info with **farming ecology**
- **Partnering** with farmers to share and exchange knowledge

New bee condo nesting work

Beyond Brentwood: 2014-2017

- Avocado orchards in Ventura Co.

Avocado Orchards (SoCal)

J. Lloyd-Butler Orchard – Saticoy, CA (Jan. 2016)

Lloyd-Butler Ranch, SoCal Spr. 2017

Goals of Brentwood Project

- 1. **Construct** native bee floral habitat that is sustainable
- 2. **Monitor** native bees through time in treated and control farms
- 3. **Record** native bee species visiting installed bee flowers and crop flowers

What's Next in Brentwood?

1. Need **more space** to create more floral habitat
2. Need more information on **nesting**
3. Native bees in vicinity of Brentwood Ag
   Urban, wildlands, and creeks
4. Farmer adoption; Pollinator Habitat Advisor (PHA)

Conclusions

1. **Can attract** diverse native bees to urban and Ag areas.
2. Can **synchronize** flowering of crop plants with bee plants.
3. **Can attract** native bees to crop flowers.
4. New partnerships with farmers can guide implementation. **Pollinator Habitat Advisor (PHA)**
5. Analysis of **business/economics** of implementation of ecological data

Thank you to our funders!

- Funding for this project provided in part by Contra Costa Department of Fish and Wildlife, University of California Agriculture and Natural Resources, UCB-Agricultural Experiment Station, Mary A. Crocker Trust, Western Sustainable Agriculture Research and Education Program and NRCS-USDA.
- This material is based upon work supported by the Natural Resources Conservation Service, U.S. Department of Agriculture, under award # 69-3A75-12-252. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture.

THANK YOU!

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