Integrated Pollination Strategies:

Managed and Wild Bees for a Sustainable Future

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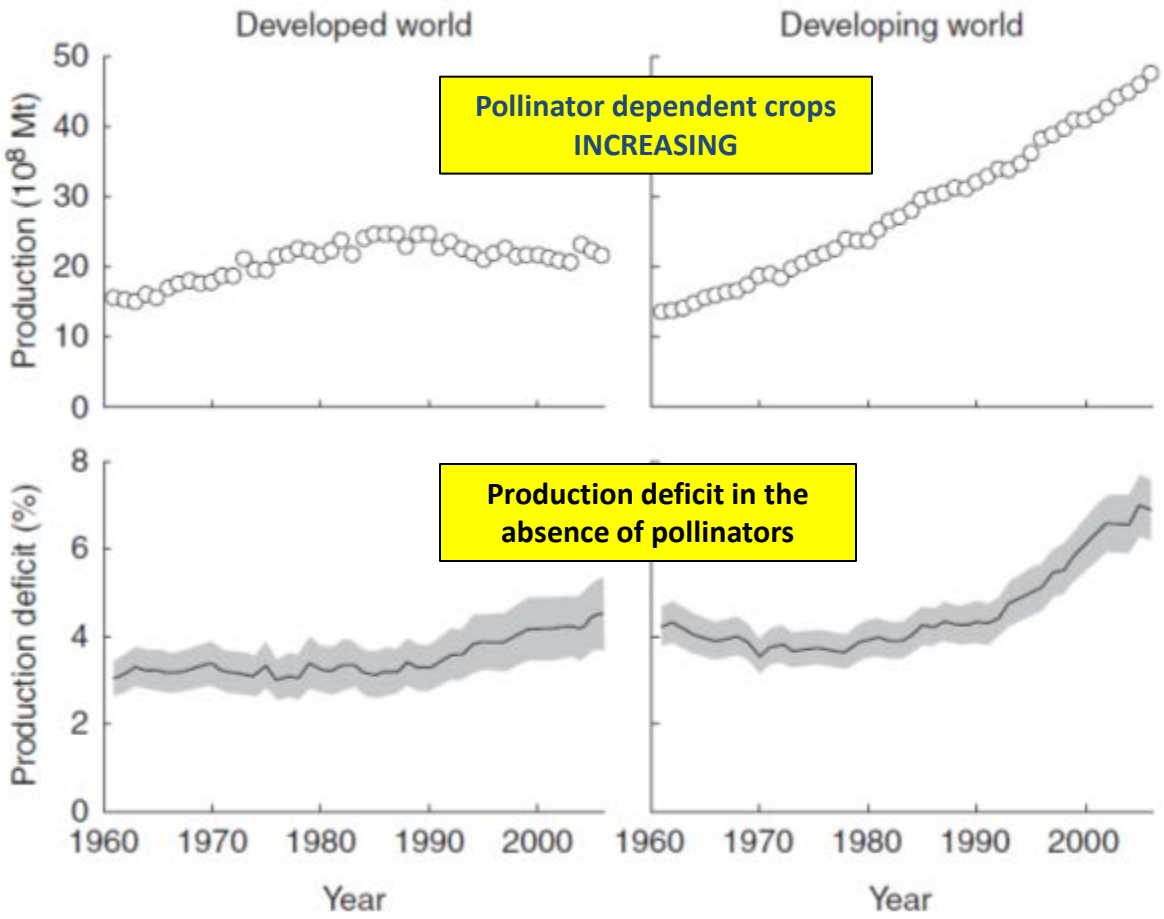
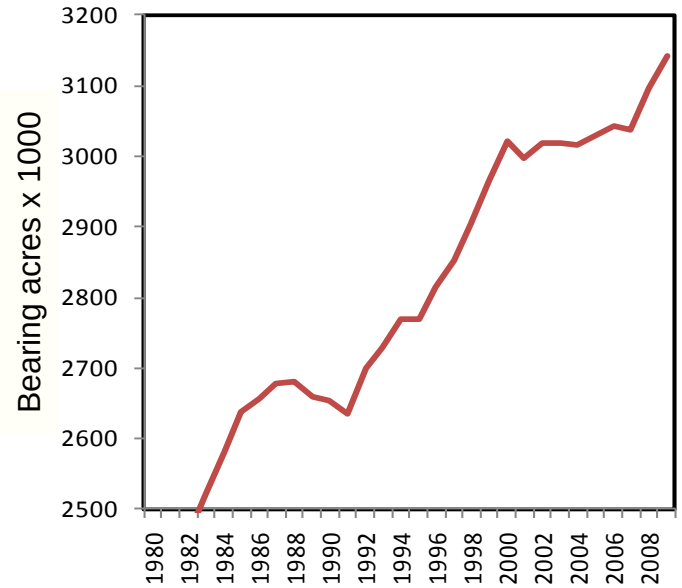
Managed pollinators

Native pollinators

Long term trends in bee pollinated crops



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

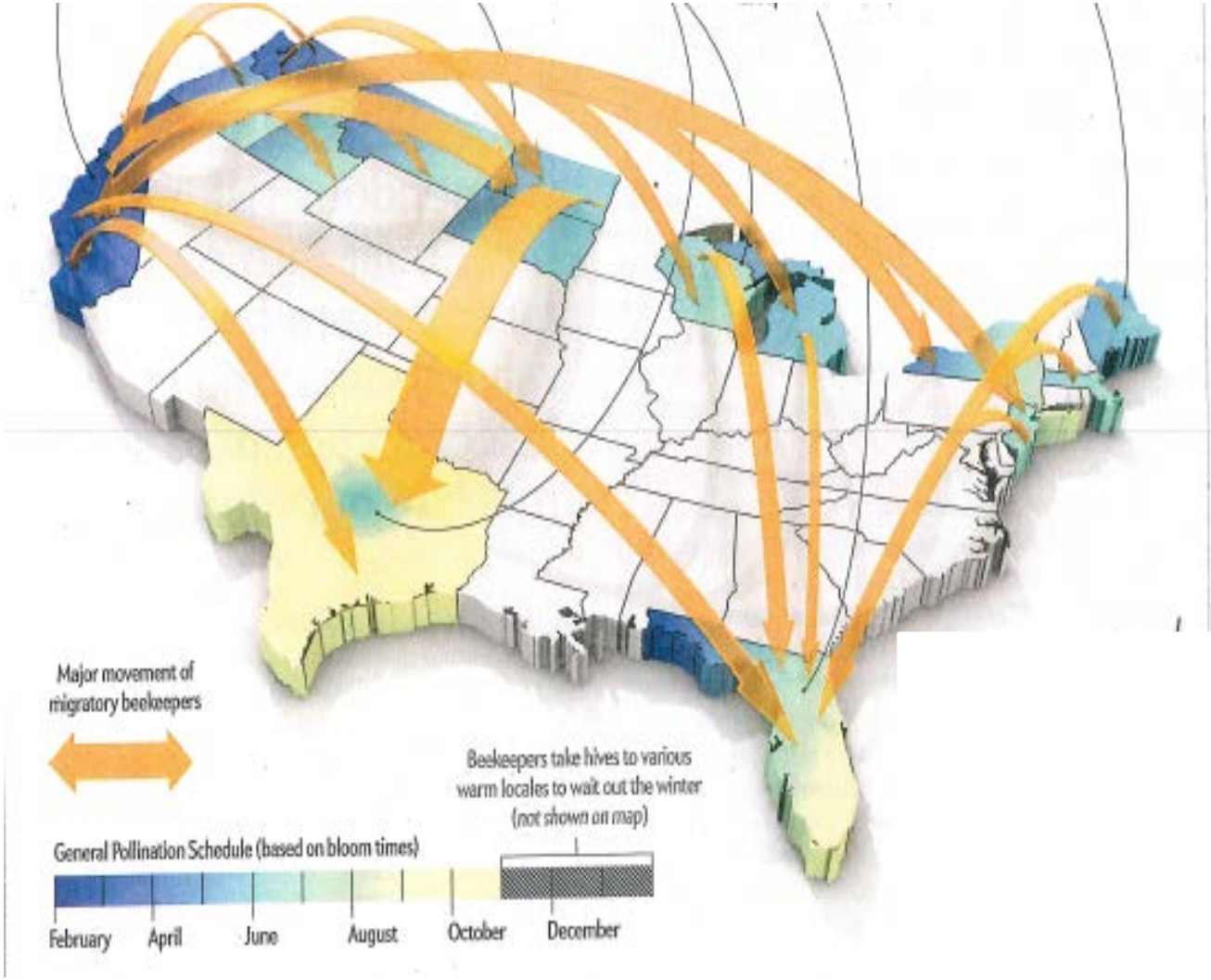


(USDA-ERS, 2009)

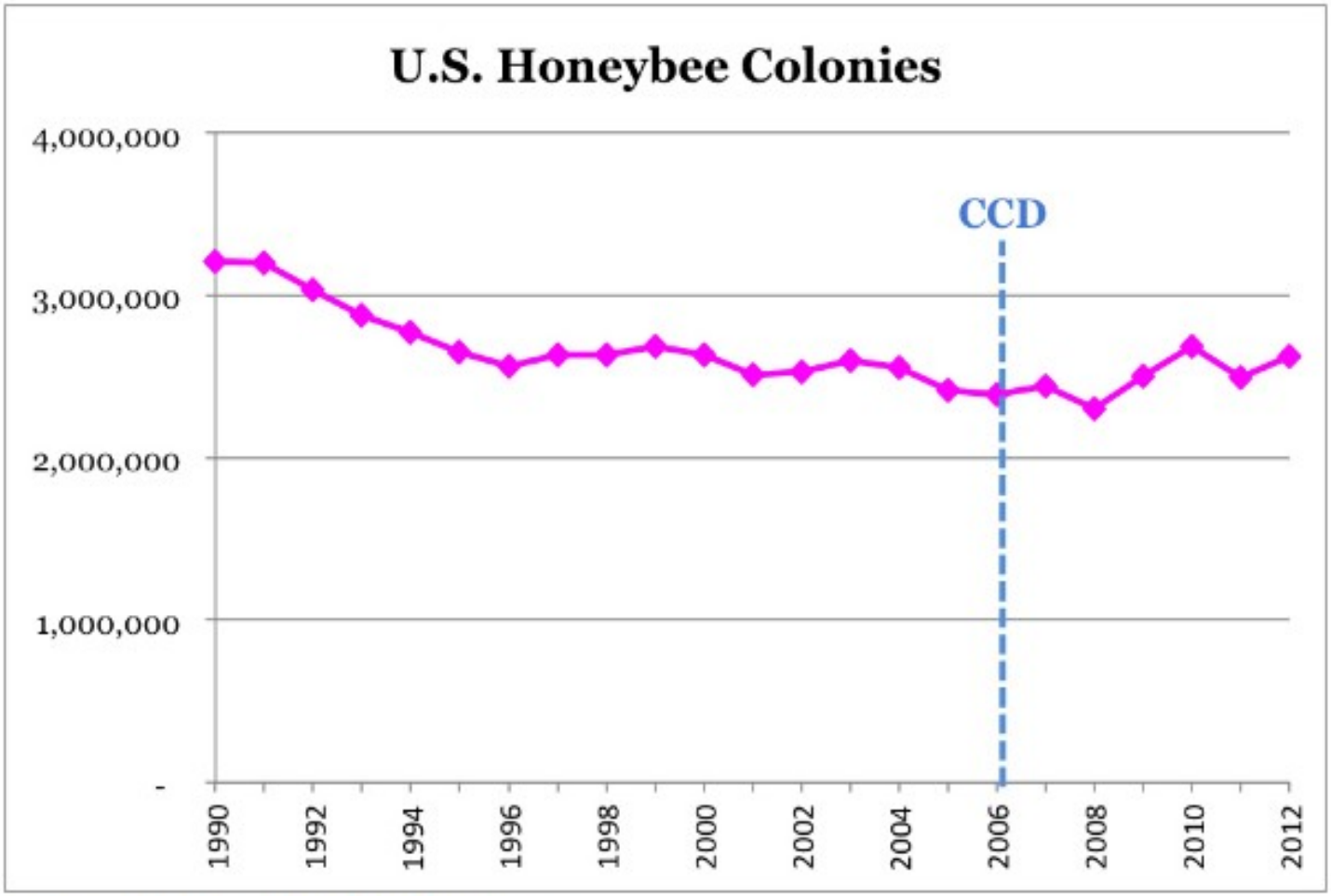
Aizen et al. (2009) How much does agriculture depend on pollinators? Lessons from long-term trends in crop production. Annals of Botany 103.

Movement of honeybees for pollination in USA

- November-Jan
  1.1 million colonies
  moved to CA.



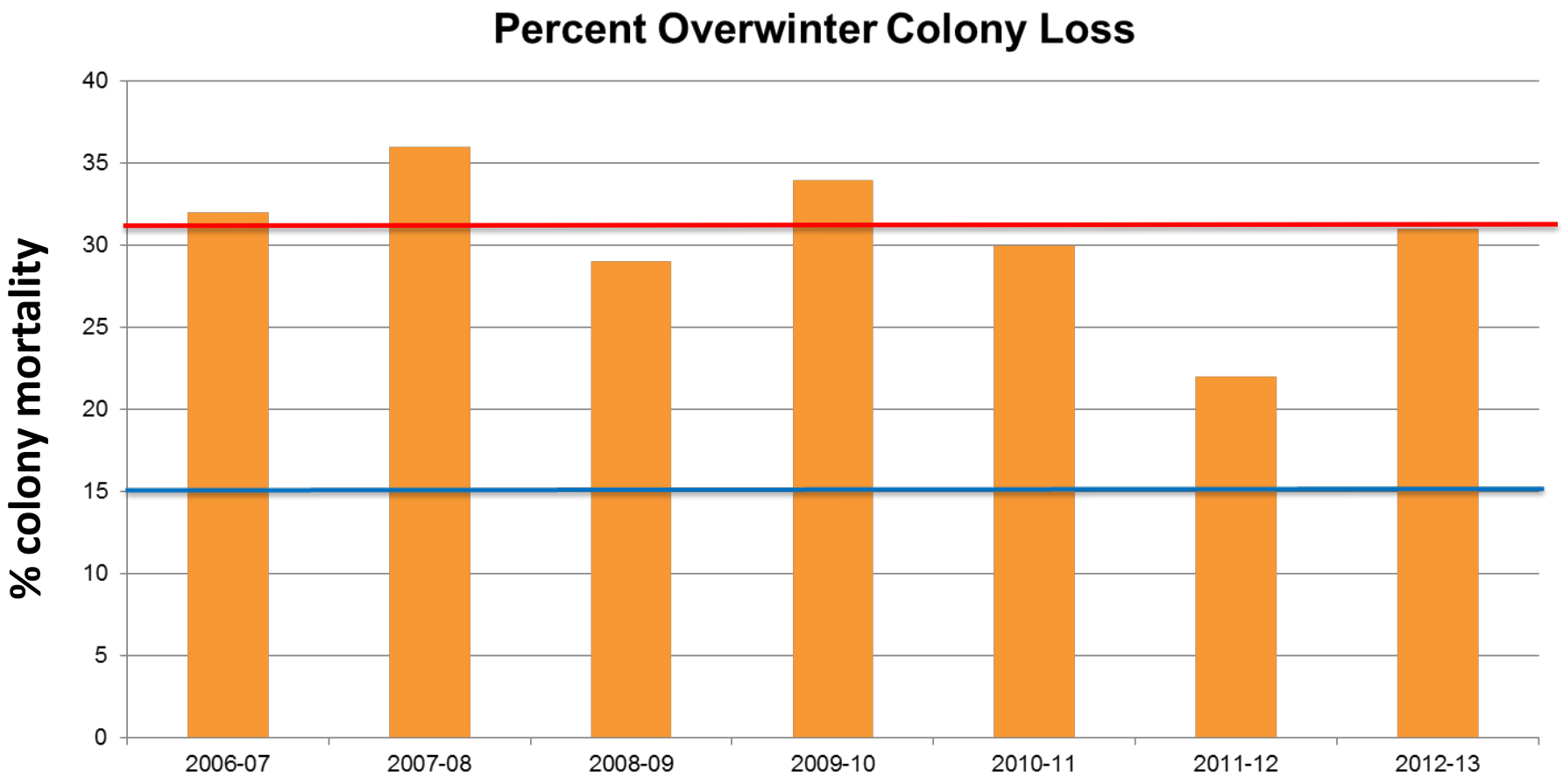
Current status of colonies in USA



Source: USDA NASS Honey Production Report

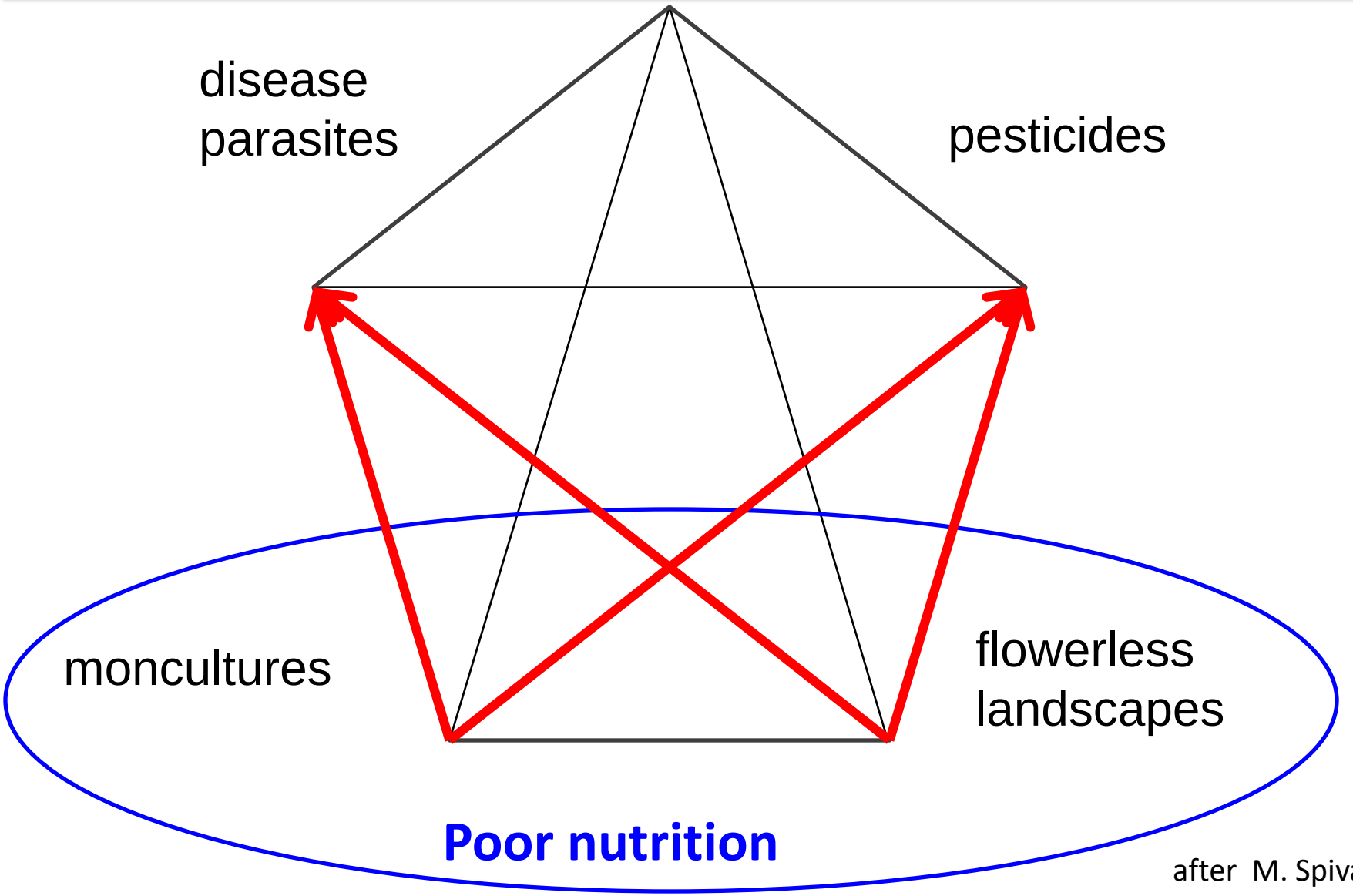
Pollination Supply vs. Demand: Overwinter Colony Loss

Average 30.6% vs. Acceptable 15%



Source: Apiary Inspectors of America and USDA-ARS Beltsville Lab

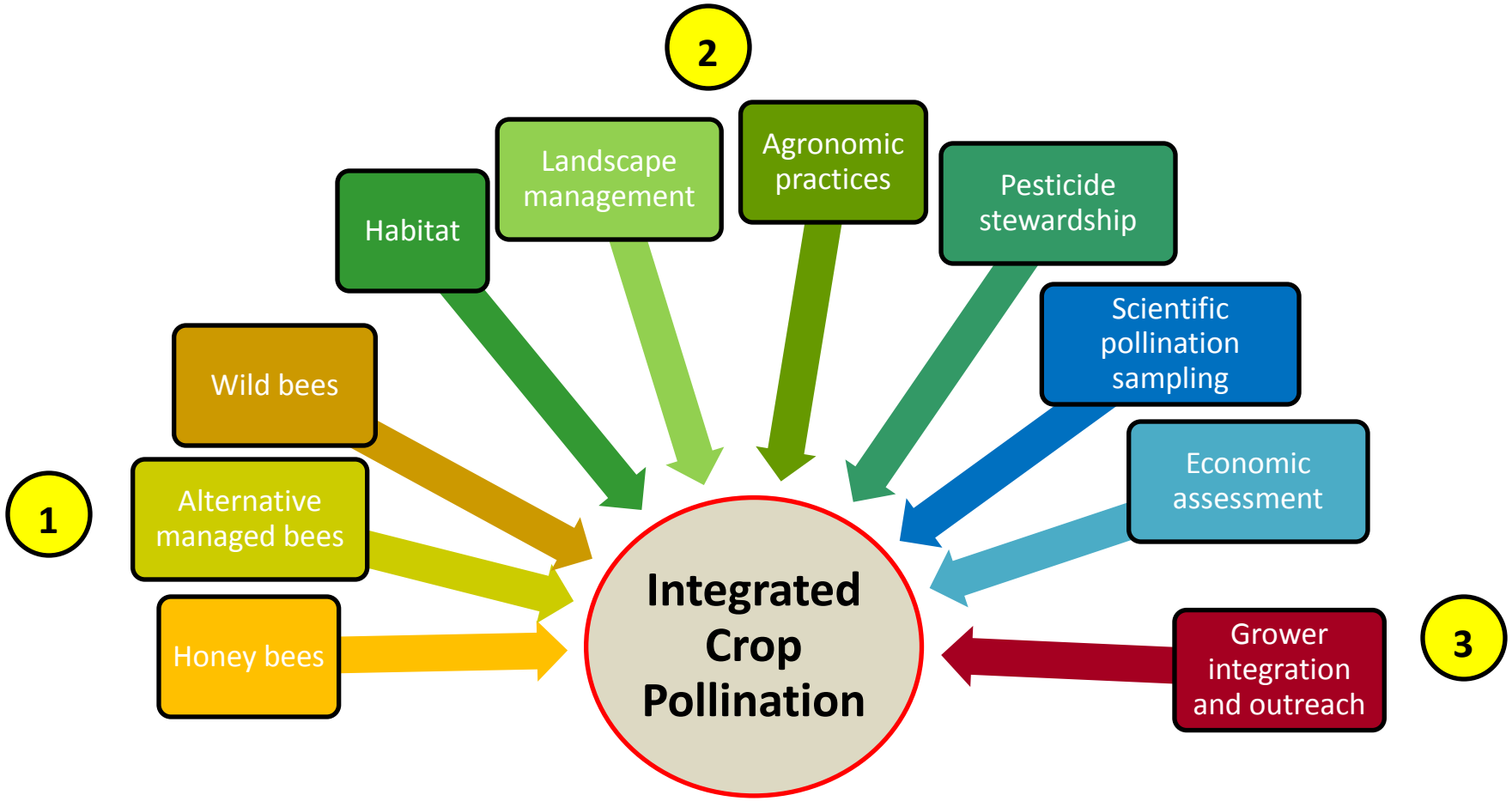
Challenges facing honey bees



after M. Spivak

Integrated Crop Pollination

- Strategy to bolster pollinators and support sustainable yield



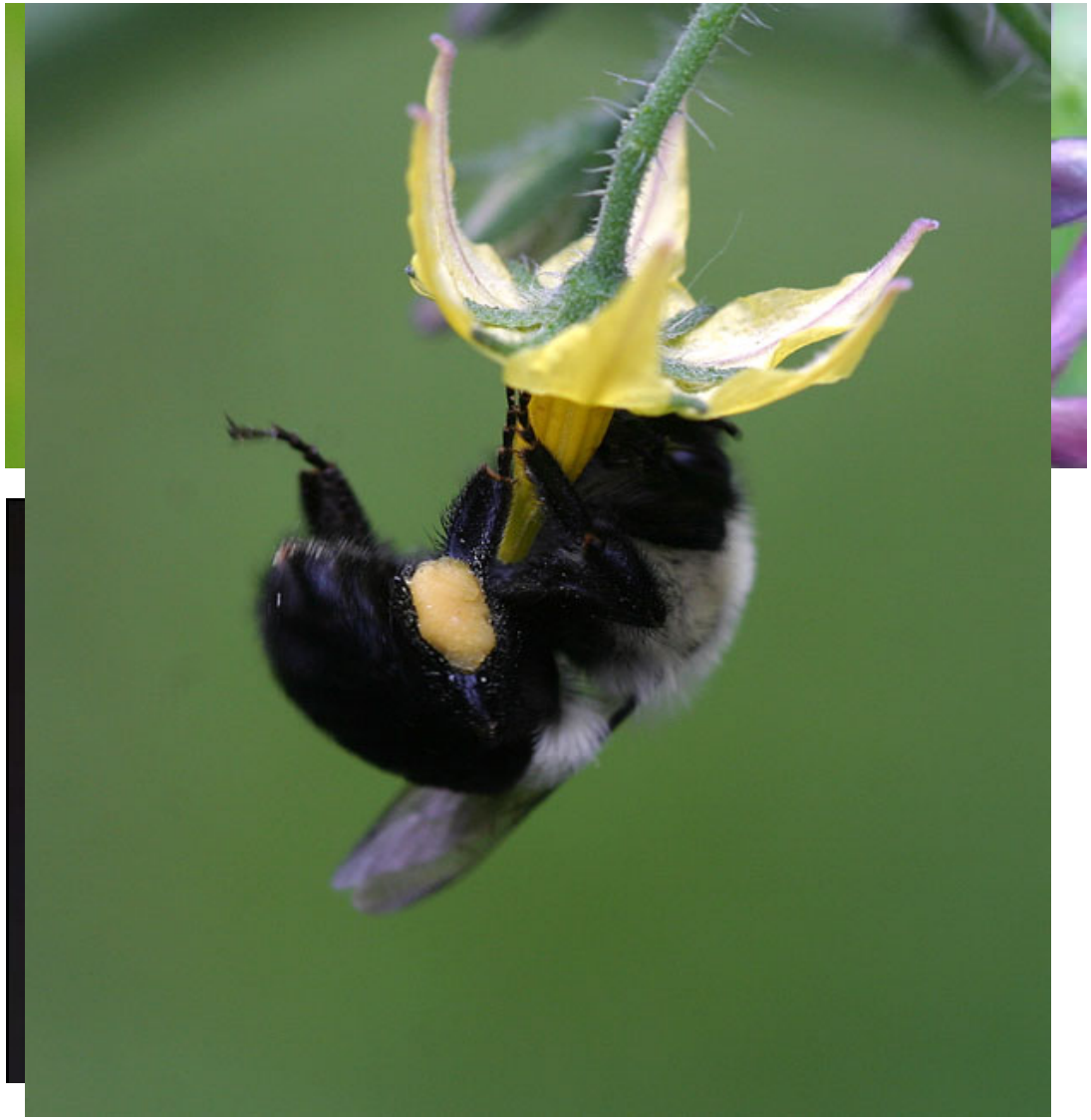
Integrated approaches

Wild pollinators

Alternative managed bees

Wild bees contribute to crop and other pollination

- Many native species are very efficient crop pollinators
- Often more effective than honey bees **on a per visit basis**
- BUT numbers of individuals are also key!



Alternative managed pollinators

- High quality
- Pesticide Free

- Bumble bee pollinated

Alternative managed pollinators

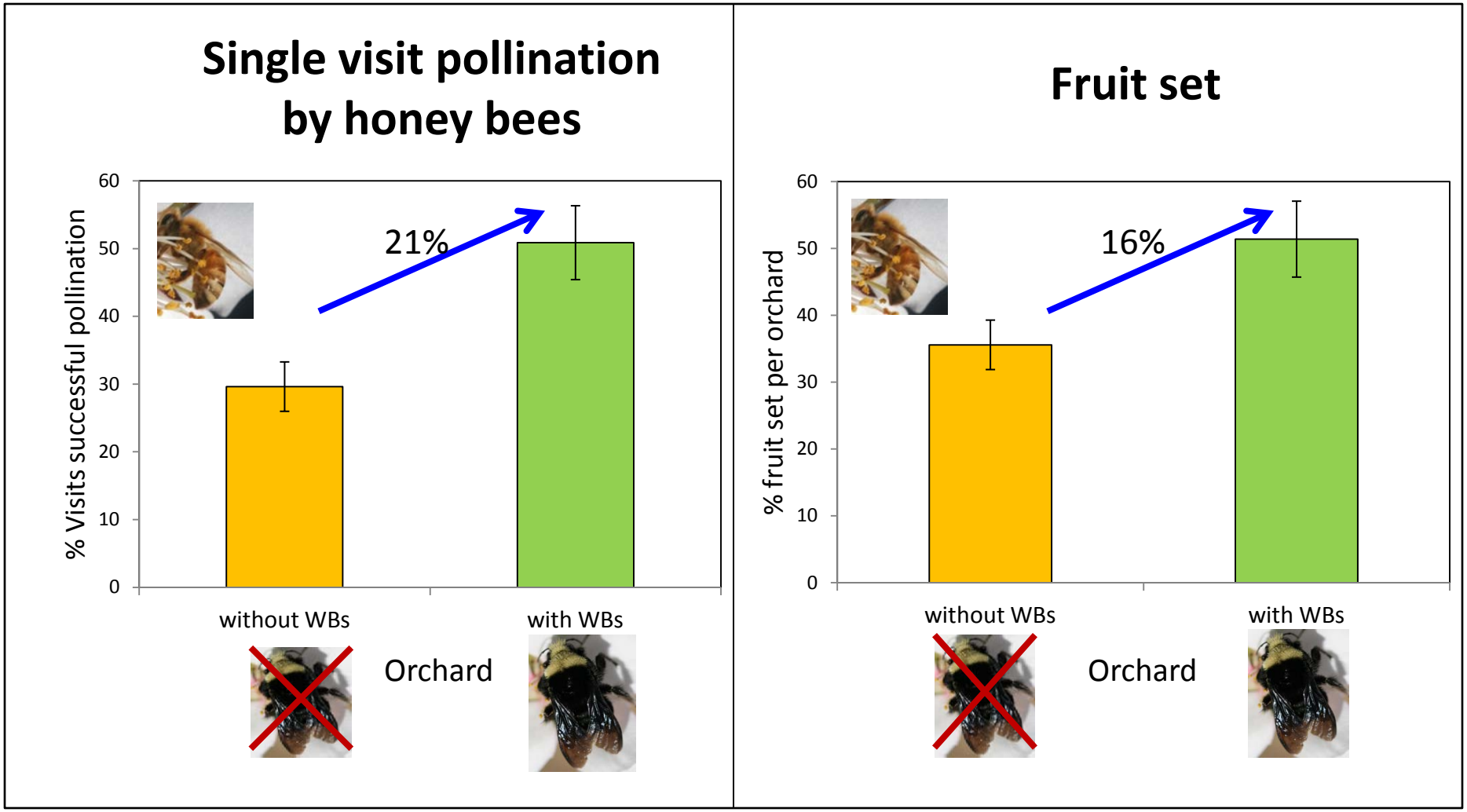
Alternative managed pollinators

Combining native bees and honey bees

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

Dr. Claire Brittain

Wild bees make honey bees better pollinators



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

Enhancing habitat for bees wild and managed alike

- The Irony of intensive agriculture and pollination
- Intensive agriculture challenges bees
- Forage (flowering plants)
- Nutrition (diverse pollen and nectar)
- Pesticides (mortality and physiological stress)
- Nesting sites

Restoring floral resources for
Pollinators in Agricultural Landscapes

Selecting & evaluating flowering plants for bee conservation

Plant material

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

Pollinator response

- Attractive
- Rewarding
- Abundance
- Diversity
- Species of interest

Technology transfer

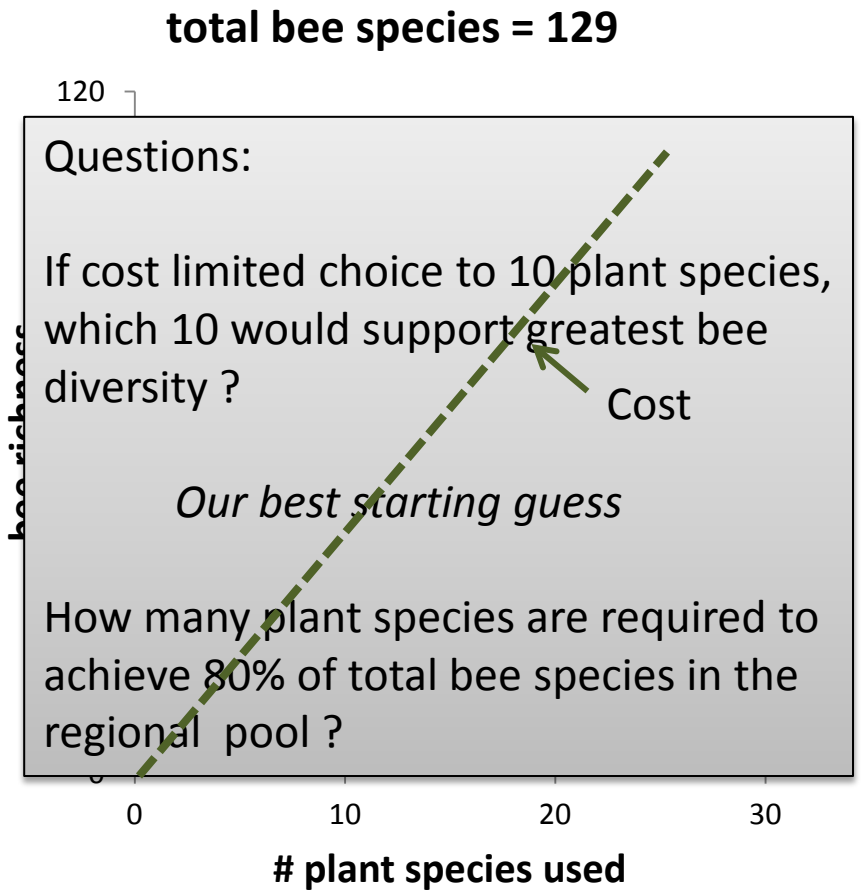
- Demonstration sites
- Early adopters
- Economics
- Agronomic expertise
- Cost-sharing options
- Success stories

Plant selection tools

1. <u>List of interactions</u>
   - Bees x Plant
   - Which plants do the bees visit
2. <u>Bees flight seasons</u>
   - When are different bee species active?
3. <u>Flowering seasons</u>
   - When do the different plants flower?

Selection approach ➡ Results

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



Best performing plants

LACY PHACELIA:
annual
Spring

ARROYO LUPINE:
annual
Early spring

CHICK LUPINE:
annual
Late spring/summer

CALIFORNIA POPPY:
perennial
Spring-summer

CALIFORNIA PHACELIA:
perennial
Early summer

BOLANDER'S SUNFLOWER:
annual
Summer

SUMMER LUPINE:
perennial
Summer -fall

VINEGAR WEED:
annual
Late summer

VALLEY GUM PLANT:
perennial
Summer - fall

Evaluating function of wildflower plantings

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

1. Quantify flower density

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

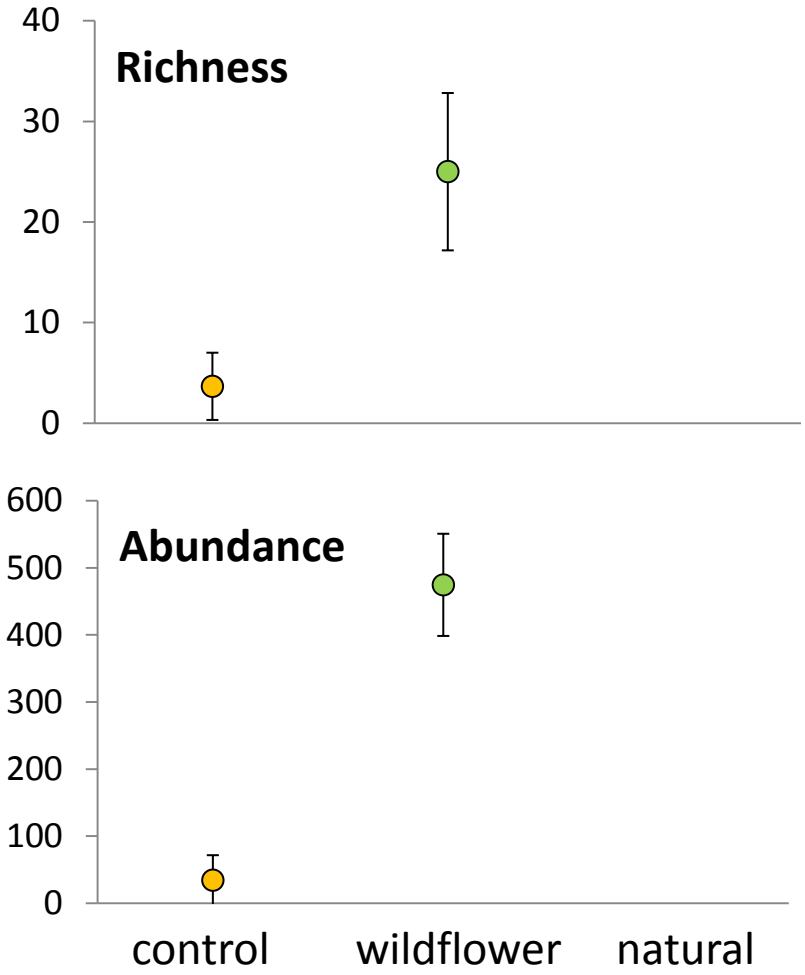
3. Measure fruit set on the crop

Testing plant benefits for bees

Wildflower strips enhance native pollinators

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

- Natural floral-diverse border
- 26 unique to enhanced



Tools for producers and land managers

ASESSING THE POLLINATION OF YOUR

2.) Calculations

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

- For each bee type, add up the numbers in each column
total for each type of bee in the "TOTAL visits" **row A** u
of the flower visitation rate by each type of bee in your
- In each column in **row C** "% pollen deposition", multi
column in row A "TOTAL visits" and row B "Single visit
you the percent of the pollen necessary for a flower to
group, given how often they visit the watermelon flowe

DATA SHEET : WESTERN U.S.A.

Site Name Smith Farms Date July-15-2013

Start Time 10:15 End Time 10:35 Observer M Smith

Each row below is for a 1 minute observation of a group of 5 flowers	Total visits during 1 minute observation by each bee type			
	Honey bee	Native bee large	Native bee small	Native bee green
Observation 1	3	5	5	2
Observation 2	2	3	3	5
Observation 3	5	0	3	6
Observation 4	0	2	4	1
Observation 5	6	1	8	1
Observation 6	1	1	3	3
Observation 7	3	3	1	7
Observation 8	5	0	0	0
Observation 9	0	5	4	4
Observation 10	5	2	4	2
A= sum Obs 1-10: "TOTAL visits" (sum of Obs 1-10 for each column)	30	22	35	31
B: "Single visit % pollen deposition" (% of pollen deposition per visit needed to produce a fruit)	0.69	1.13	0.26	1.13
C=AxB: "Group % pollen deposition" (% of pollen deposition needed to produce a fruit by each bee group)	20.70	24.86	9.10	35.03

D= sum of C: "Farm level pollination" % pollen deposition needed to produce a fruit provided by pollinators in your farm (≥100% means each flower receives sufficient pollination to set a fruit)	89.69

Tools for producers and land managers

od	Drought Tolerance	Honey Value	Honey Color	Pollen Value	Flower Color	Drought Tolerance	Honey Value	Honey Color
	ND	Major	Variable, mostly light amber	Minor	ND	ND	Major	Variable, mostly ligh amber
	low	Questionable	.....	Questionable	ND	low	Questionable	.....
	low	ND	ND	ND	blue	low	ND	ND
	moderate	Minor	Amber	Minor	ND	moderate	Minor	Amber
	moderate	Fairly important	White	Minor	ND	moderate	Fairly important	White
	low	Fairly important	White to light amber	Minor	red	low	Fairly important	White to light ambe
	low	Minor	Light amber	Minor	purple	low	Minor	Light amber
	ND	Fairly important	Light amber, greenish	Minor	ND	ND	Fairly important	Light amber, greeni
	moderate	Minor	.....	major	Orange	moderate	Minor	.....
	high	ND	ND	ND	yellow	high	ND	ND
	low	Questionable	.....	Questionable	ND	low	Questionable	.....
nber	ND	Minor	Light amber	Important	ND	ND	Minor	Light amber
	ND	Fairly important	White to light amber	Negligible	ND	ND	Fairly important	White to light ambe
	moderate	Minor	Amber	Minor	ND	moderate	Minor	Amber
	ND	Fairly important	Dark	Minor	ND	ND	Fairly important	Dark
	moderate	Minor	Water white	Minor	pink	moderate	Minor	Water white
	ND	Minor	.....	major	ND	ND	Minor	.....
	low	Minor	White	Variable	purple	low	Minor	White
	ND	Fairly important	Light amber, greenish	Minor	ND	ND	Fairly important	Light amber, greeni
	high	ND	(blank)	ND	yellow	high	ND	(blank)
	ND	Fairly important	Light amber to amber	Important	ND	ND	Fairly important	Light amber to amb

Integrated Crop Pollination

- Recognizing farming context where alternatives are valuable
  - Honey bees
  - Managed alternative bees
  - Wild populations
- Capitalizing on interactions among bee species
- Enhancing habitat to support bees
  - Diverse, robust populations Managed and Wild bees

Questions?

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