Lessons learned in California's effort to advance sustainable pest management

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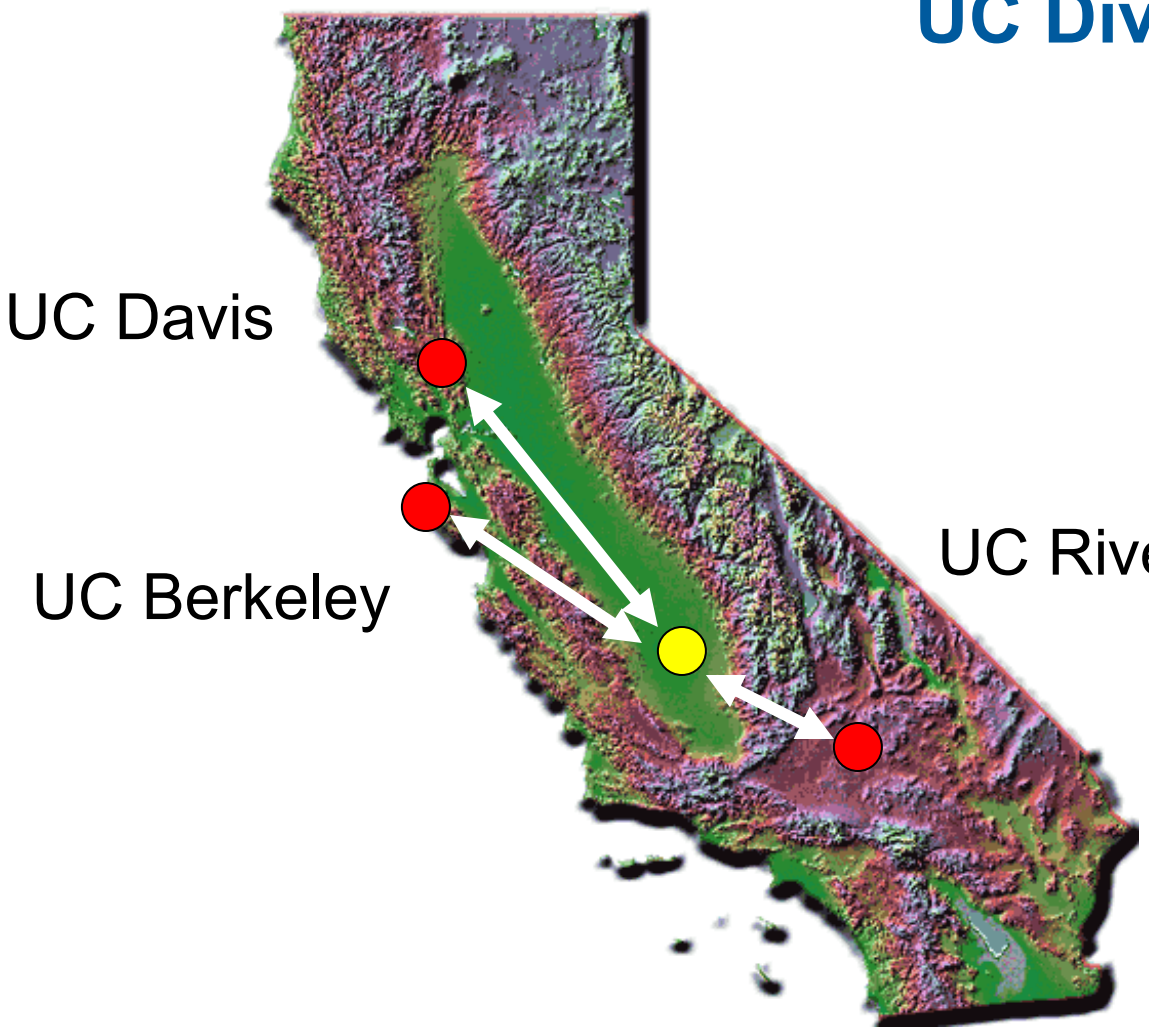
~50% Research,
~50% Extension



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Southern San Joaquin Valley

- Kern, Tulare, Kings, Fresno Counties
- Size: 300 x 150 km (Valley floor)
- 1.7 million hectares of ag production
- More than 300 crops grown
- >$27 billion ag value

Key products

Grape	109,000 ha	$4.1b
Citrus	113,000 ha	$3.2b
Almonds	262,000 ha	$2.2b
Pistachios	192,000 ha	$2.2b

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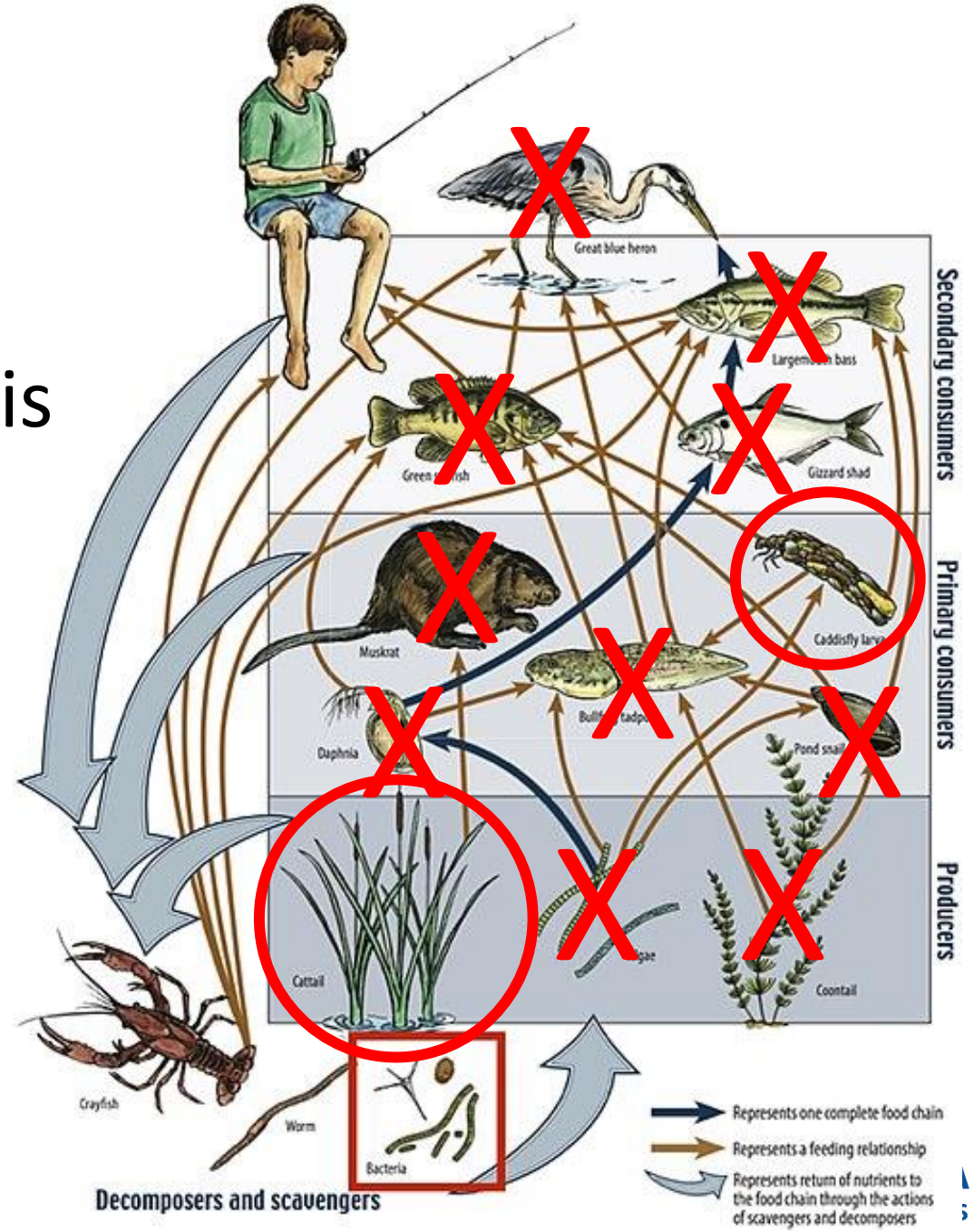
Mother nature always provides equilibriums

- Everything eats, everything is eaten
- Balance is inherent
- In agriculture, in order to increase yields and quality
  - We promote monoculture
  - We break food webs



What is sustainability? Restoring equilibriums

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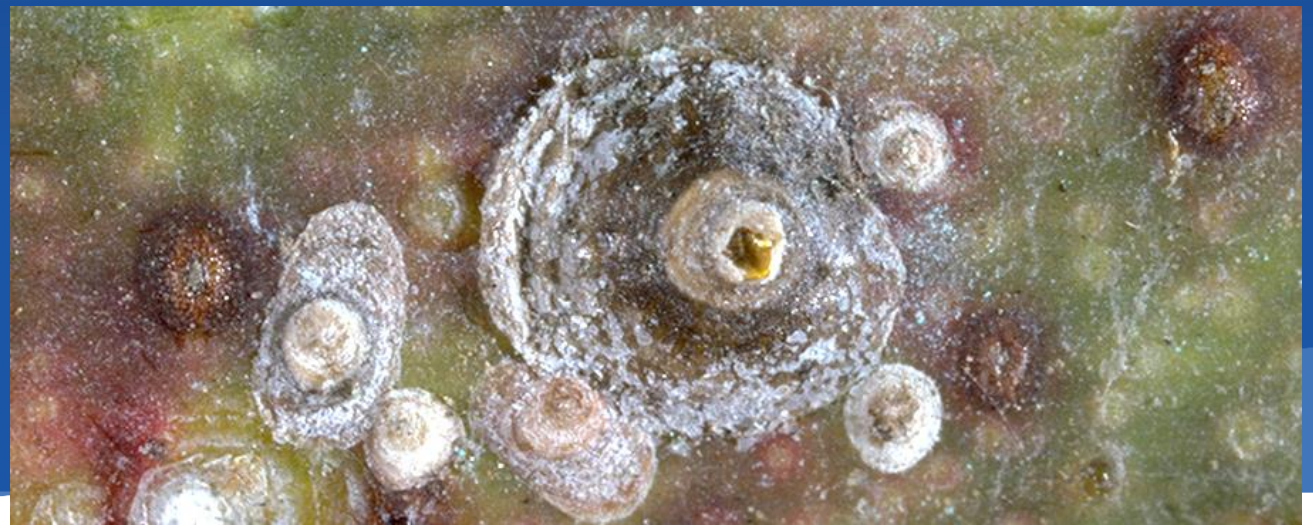
Almond in California

Almonds are…

- #1 crop by California acreage (>500k ha)
- #1 exported commodity
- #2 most valuable California crop
- #1 specialty crop exported from the US
- Grown by more than 7,600 growers
- Currently there are more than 120 million trees in CA
- Ca produces >1.1 million metric tons of almonds annually
- Valued at more than $6 billion US dollars annually
- Anything done in California almonds has a big footprint

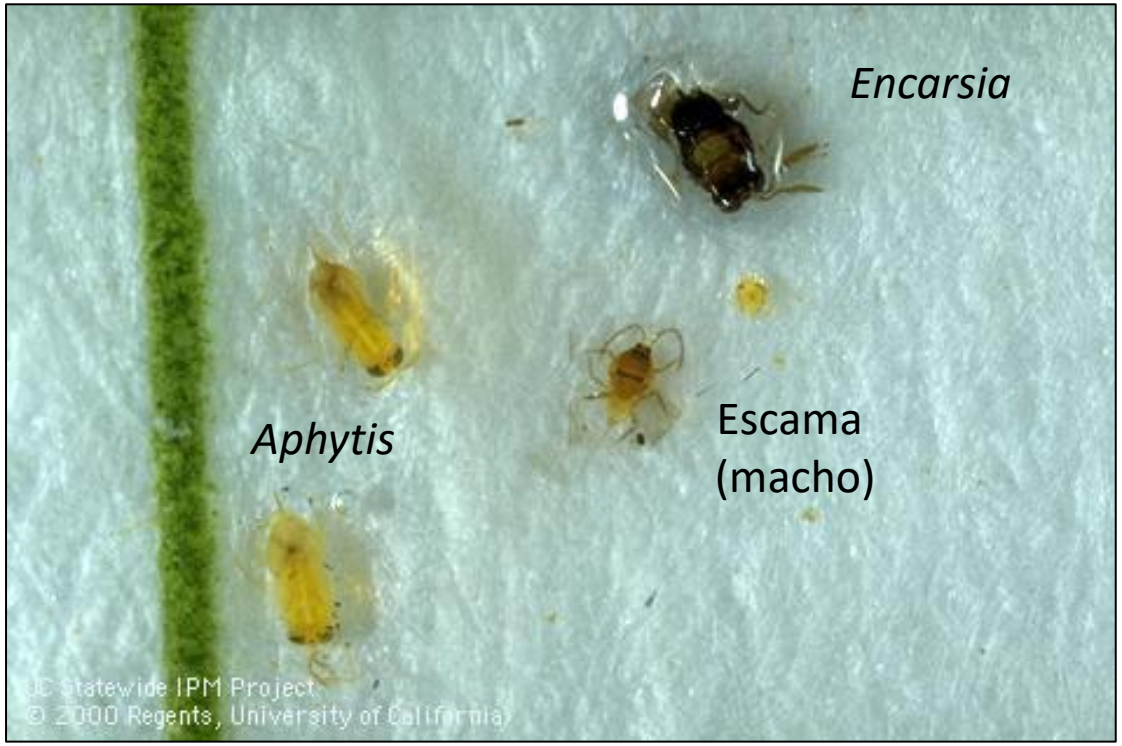
Case study: San Jose Scale

- A significant pest of almonds in the early 2000s
- Injects a toxin that kills scaffolds
- Controlled with dormant applications of organophosphates
- Significant environmental concerns
- Management not sustainable
- Management ineffective



San Jose Scale: Sampling + biocontrol

- Developed pheromone traps
  - Males
    - To determine flights
    - To time treatments with growth regulators instead of organophosphates
  - Parasitoids
    - *Encarsia* sp. and *Aphytis* sp.
    - Document levels of parasitism
- Dormant spur sampling
  - Sequential sampling plan
  - Developed thresholds
    - Do not treat
    - Treat with oil
    - Treat with oil and growth regulator



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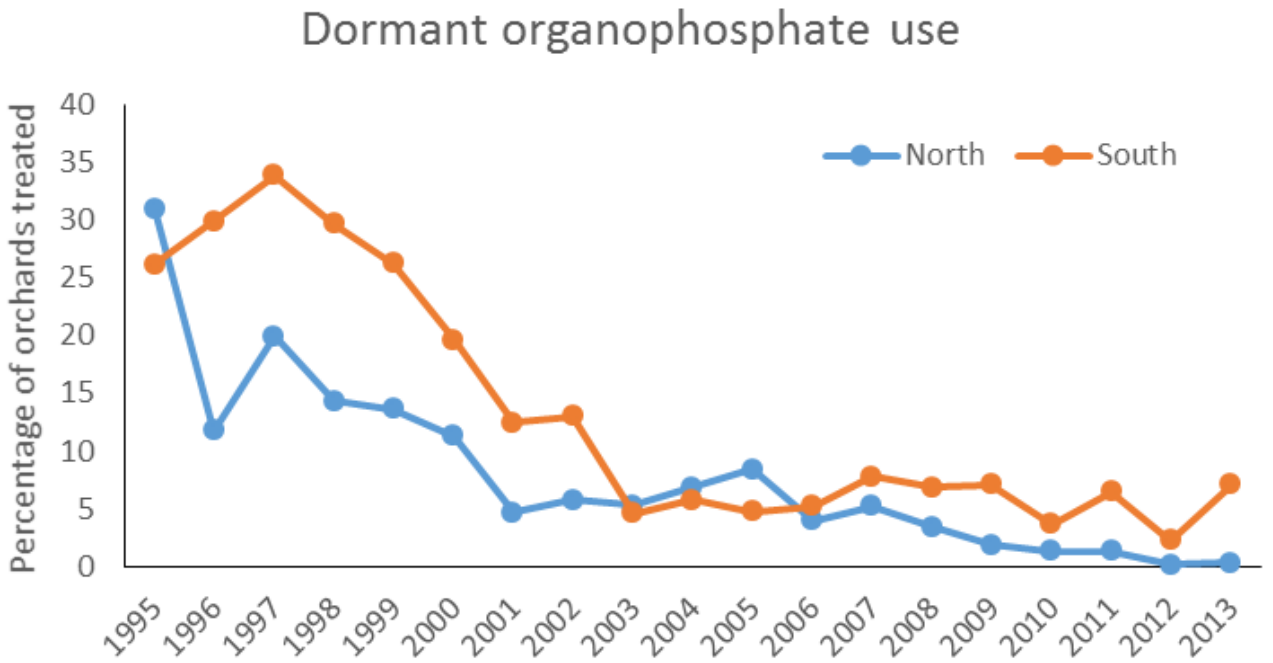
San Jose Scale: Results

- Growers stopped killing natural enemies
- Biocontrol increased
- Treatments extremely rare
- San Jose scale no longer a relevant pest
- Dormant organophosphate use gone
- Sustainability advanced



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Case study: navel orangeworm

- The arch nemesis of nut growers
- Pest of almond, pistachios and walnuts
- Feeds exclusively on kernels
- Predisposes kernels to fungi that produce aflatoxins
- Routinely costs $800-$1,000 per hectare to control
- On average 1-2% of all California almonds are eaten by NOW

Case Study:
Navel orangeworm

- Organophosphates banned
- Winter sanitation
- Timely harvest
- Insecticide programs
  - Only three options available
  - Some have environmental concerns
  - Some kill natural enemies
- Mating disruption

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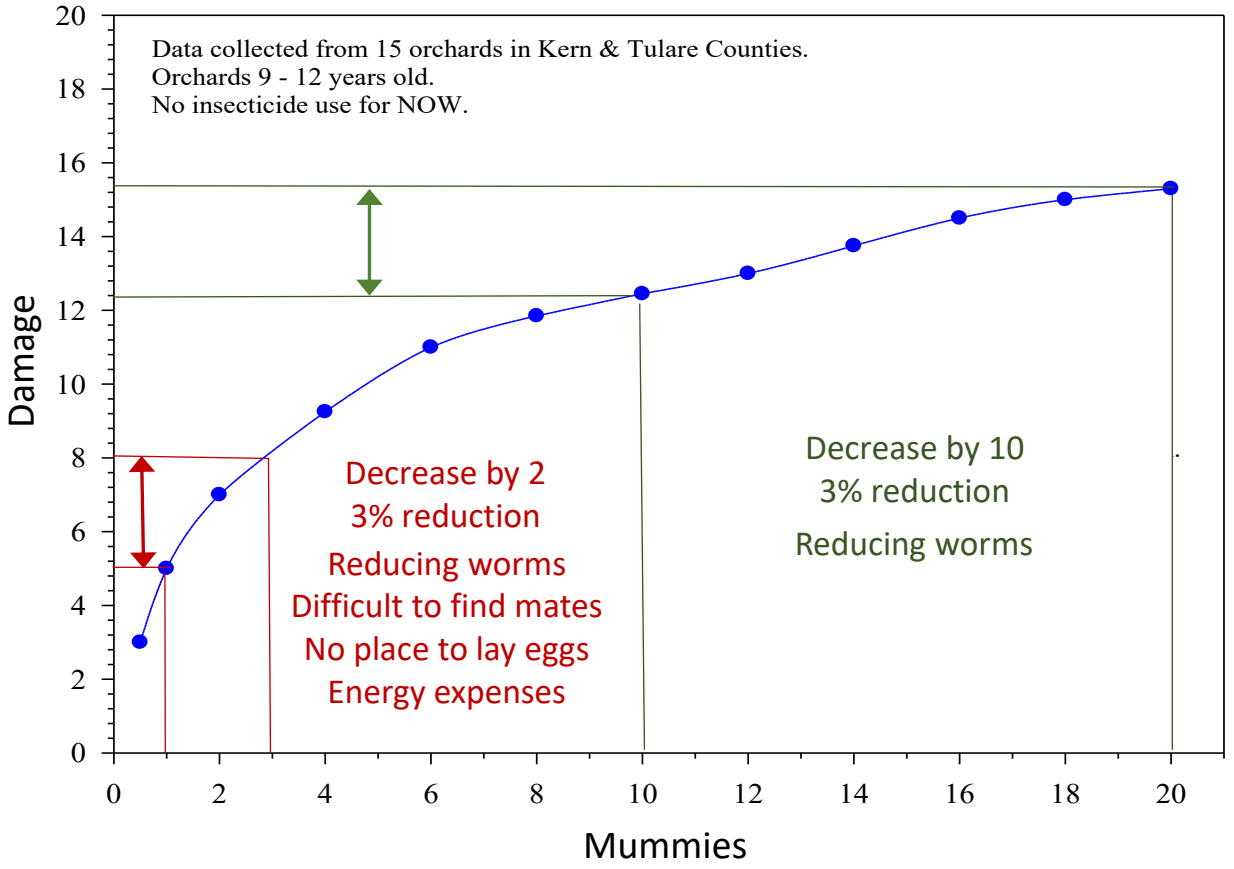
Sanitation

1. Shaking
2. Poling
3. Blowing
4. Mowing

All are needed



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Sanitation’s best friends in Australia

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Case Study: Navel orangeworm

- Mating disruption developed
- Do don’t have to kill what isn’t born in the first place
- Extremely safe to people
- No impacts to biological control
- Environmentally friendly
- Can be organic

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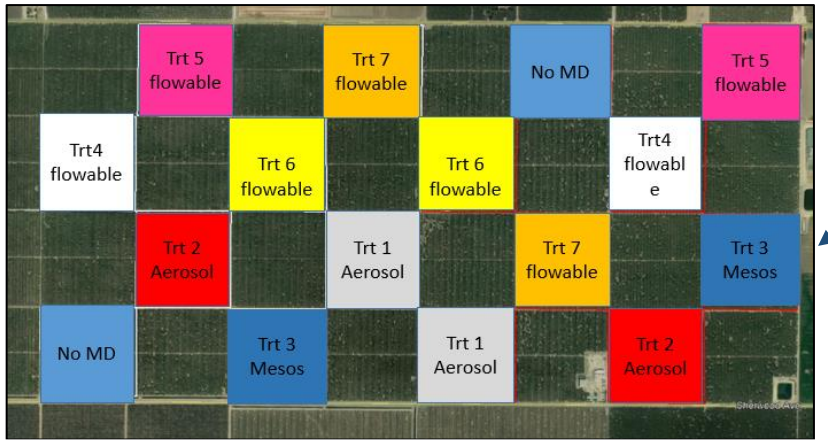
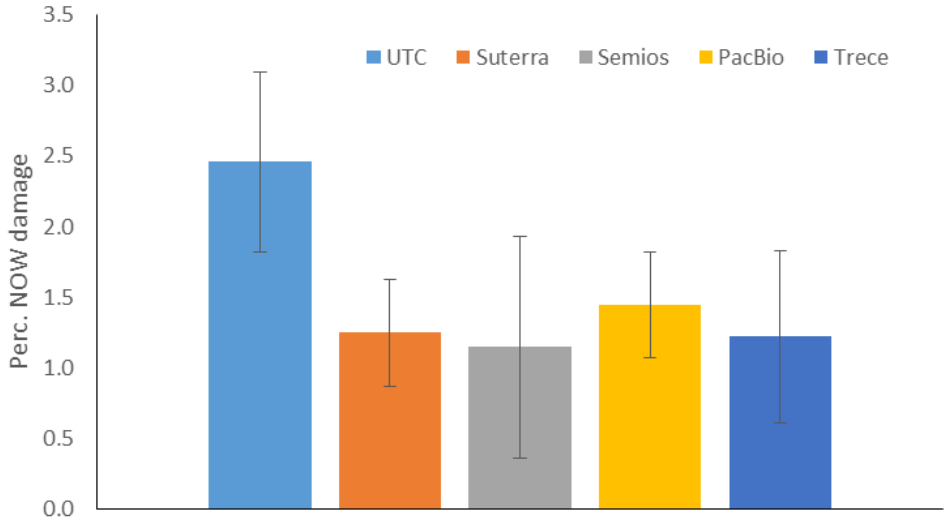
What was done

1. Determine if it works
2. Assess the consistency of results on commercial scale
3. Determine costs and benefits
4. Deliver the information



Plot size = 4,000 trees



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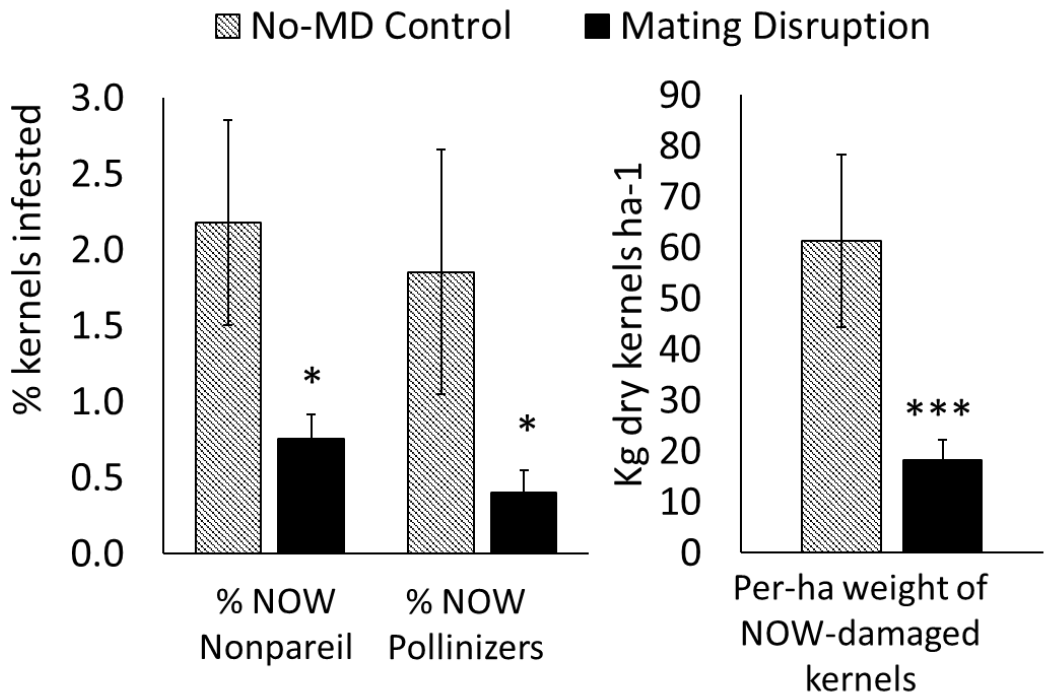

12 demonstration sites
4 counties over 2 years
Committee-defined demonstrations

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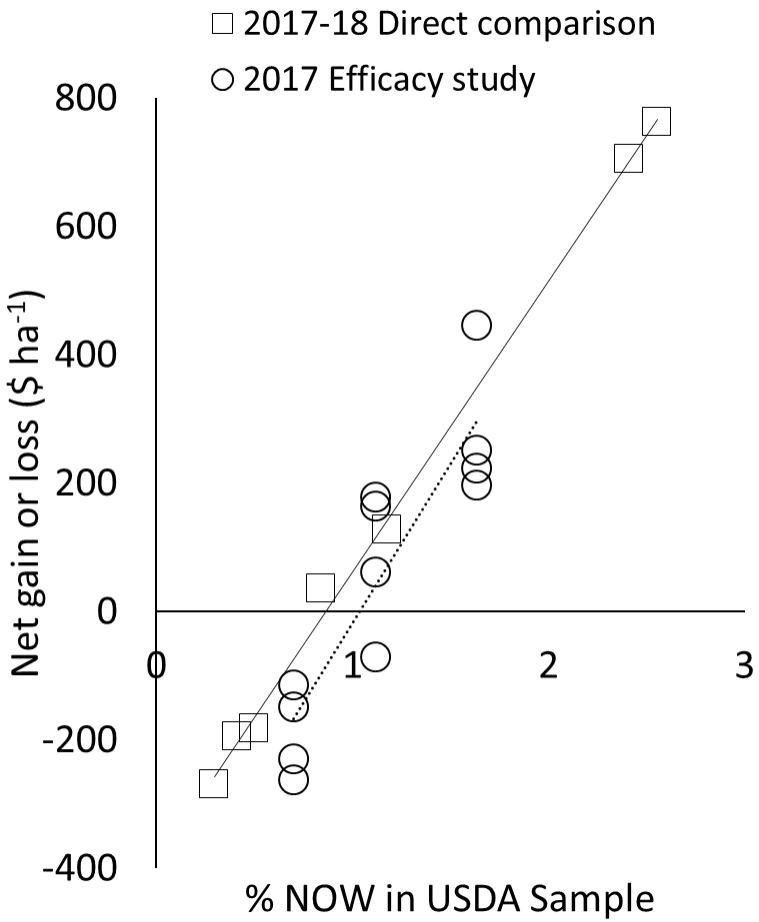

Break even points

1% if you DID NOT use MD

0.5% if you DID use MD

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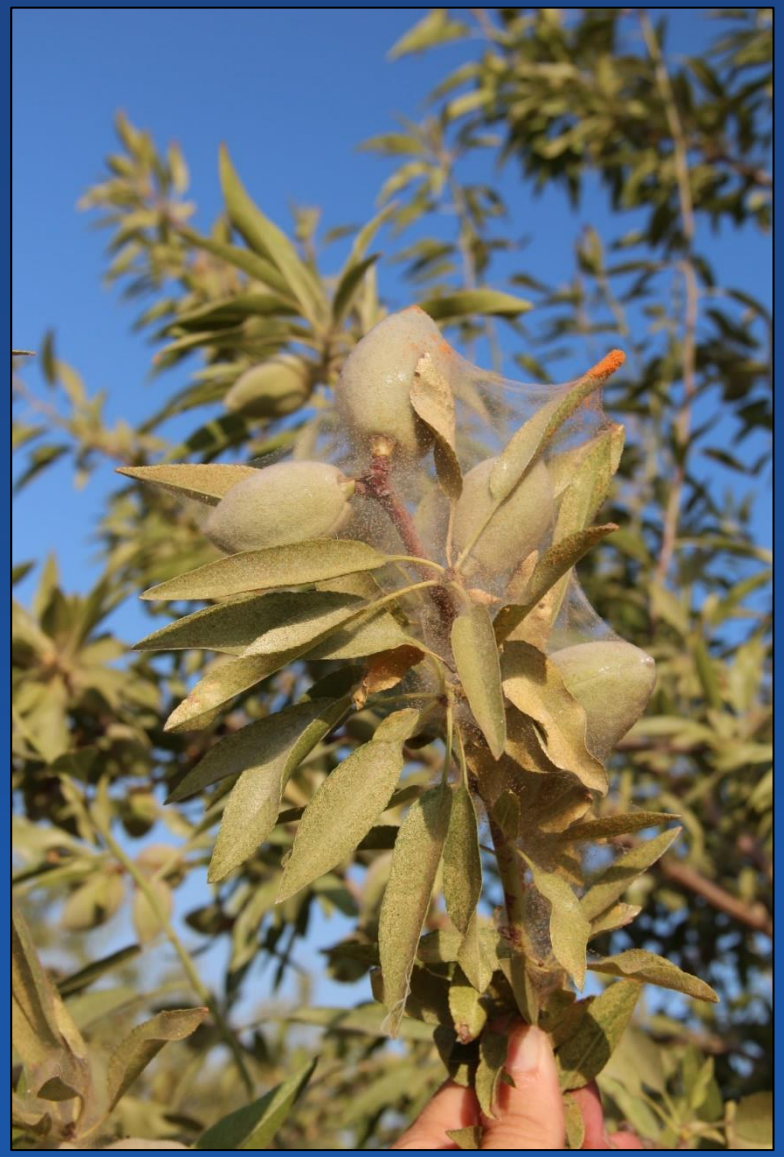
What was done

1. Determine if it works
2. Assess the consistency of results on commercial scale
3. Determine costs and benefits
4. Deliver the information

- >150 presentations in 36 cities, 20 counties, to more than 20,000 people
- >50 extension publications on almond IPM
- Demonstration videos and workshops

Mating disruption adoption

1. Annual increases in adoption for 5 straight years
2. Adoption by almond, pistachio and walnut growers
3. Currently adopted on ~45 million trees
4. 2+ million kg of kernels saved annually
5. 1.7 billion kernels eaten annually by people, not worms
6. At no added cost to growers
7. Using a green, sustainable technology



Secondary impacts…
Spider mite management

- Thrive in hot climates
- Feed on the leaves
- Defoliates trees
- Reduces carbohydrates that define yield capacity
- Can affect bud differentiation
- Early 2000s, 2-3 miticide sprays standard

Conservation Biological Control Expectations

20 years ago

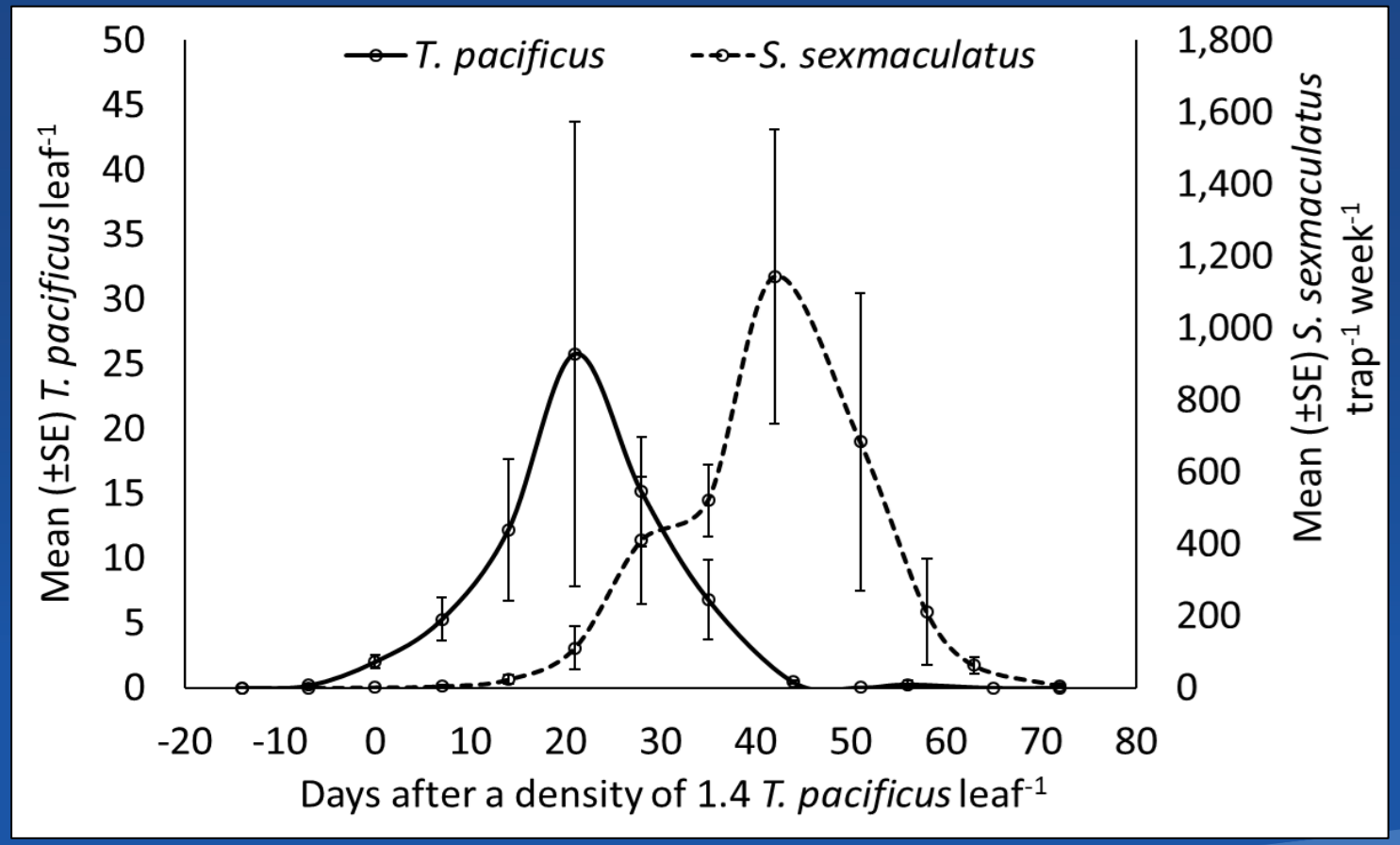
- Phytoseiids the primary predator
- Resistant to most OPs
- M. Hoy in BC in the Western US

Current

- Expectation: massive increases in phytoseiid activity
- Observations: phytoseiids absolutely disappeared
- Phytoseiids replaced by a predator (sixspotted thrips) that eats spider mites and predatory mites

Thrips studies

- Developed a trap
- Studied biology
- Evaluated predator-prey relationships



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IPM paradigm shift….

If you want to know how many mites there are… count the mites!

If you want to know how many mites there are going to be… count the thrips!

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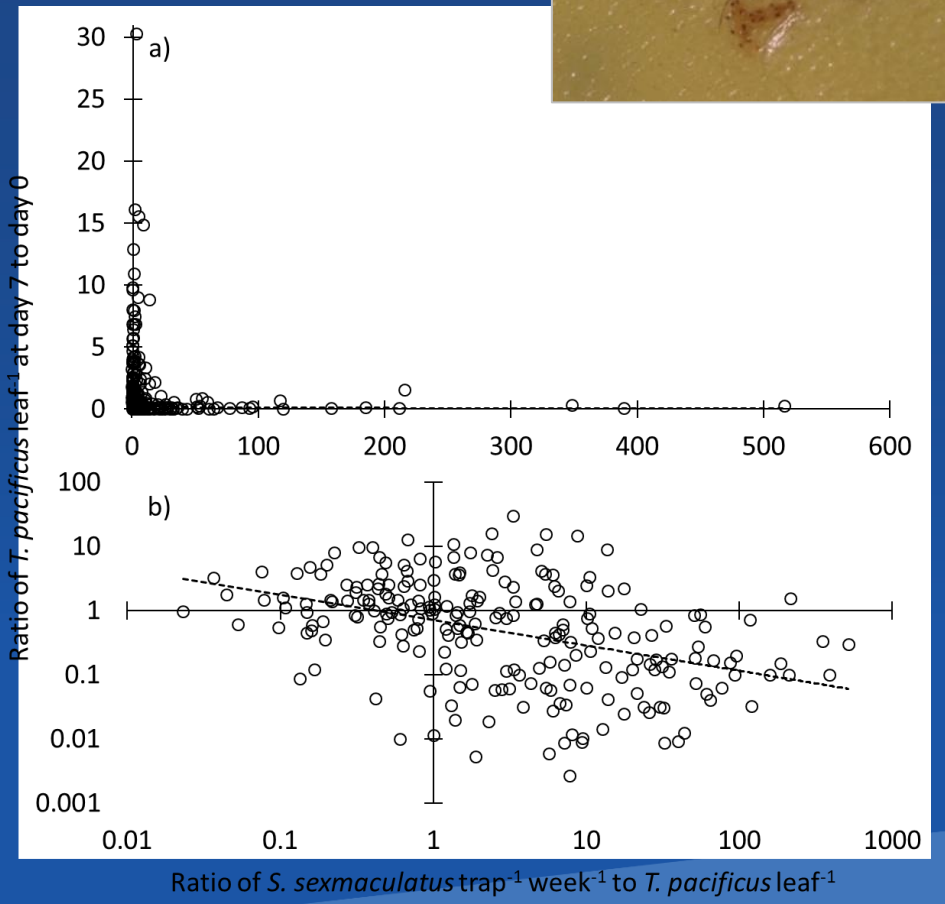
Biocontrol-based thresholds

- Correlated thrips:mite ratio today to proportional mite increase in 7 days
- 3 thrips/trap/week equals
  - No mite change in 14 days
  - 70% probability of decrease in 7d
  - 77% probability of decrease in 14d
- 5 thrips/trap/week equals
  - No change in mites in 7 days



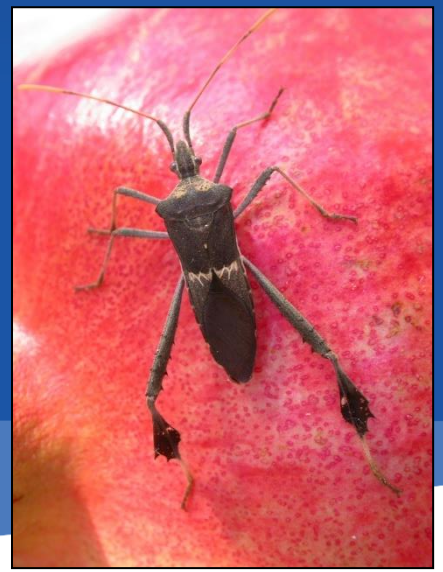
Cumulative sustainability results

- San Jose scale- OPs gone, no longer a pest (parasitoids)
- Navel orangeworm- aged sustainably with sanitation, mating disru d-risk insecticides
- Fire ants- OPs gone, managed with selective baits
- Peach twig borer- No longer a problem (biocontrol by good ants)
- Spider mites- Mites greatly reduced (biocontrol), defoliation no longer seen, prophylactic spring sprays obsolete, one hull split spray (if needed) made using thresholds and reduced-risk miticides

But...

Unintended consequences, Secondary pests

- Pests historically controlled by OPs (secondarily) have returned
- Tend to be pests with limited biocontrol
- Stink and leaffooted bugs in almonds are great examples



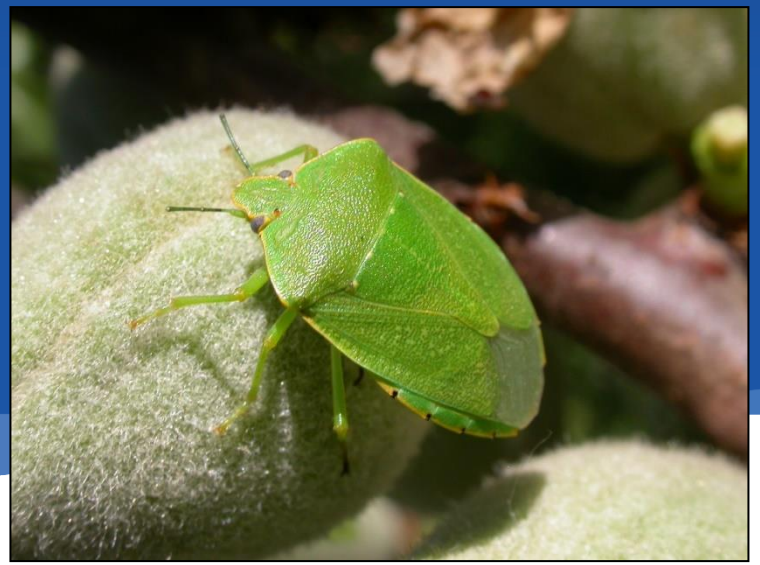


Photo ~ June 1 (Dec 1 in Australia)

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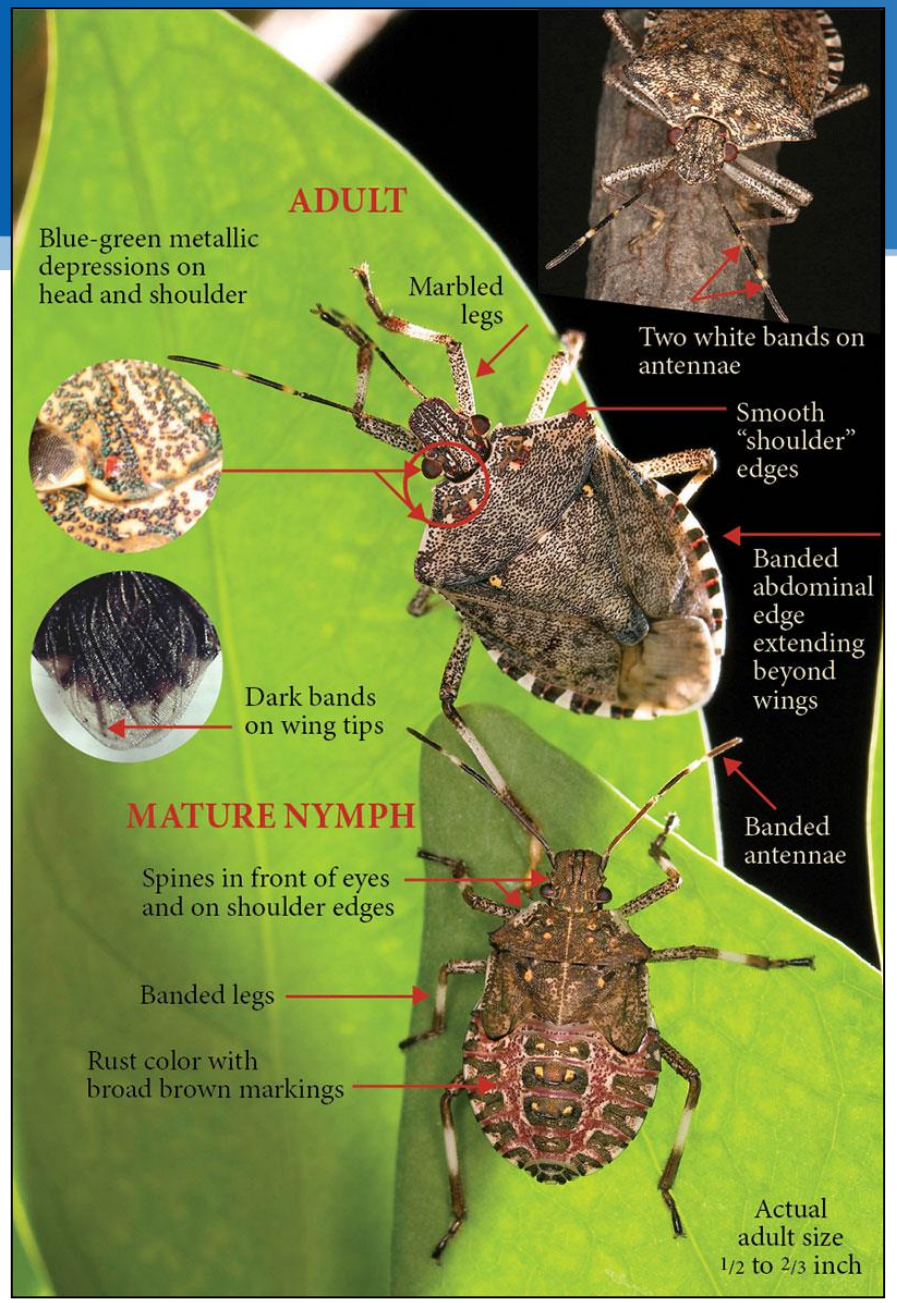
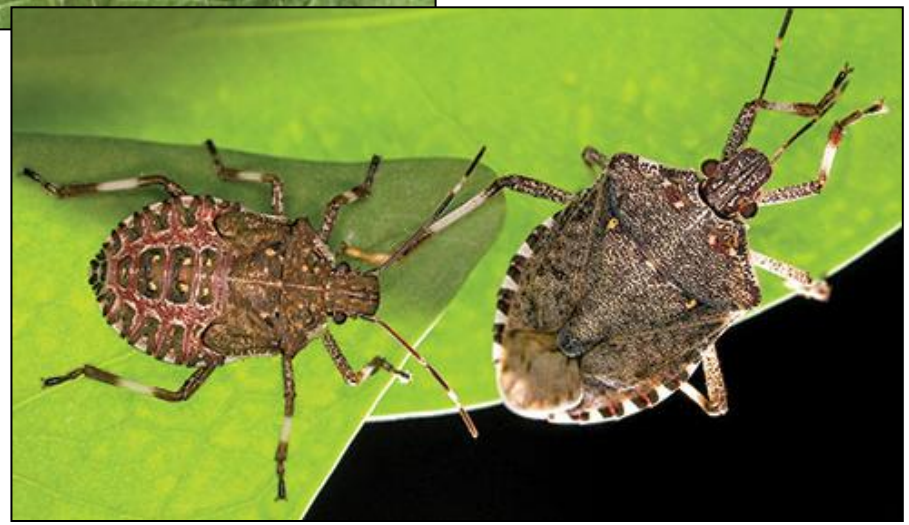
Brown marmorated stink bug





http://www.ipm.ucdavis.edu/pestalert/pabrownmarmorated.html

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Threats to sustainability, Invasive species

- New pests often arrive without effective biological control
- They often behave differently than in their host country
- Impacts can go beyond yield and quality to include quarantines, export restrictions
- Immediate responses are not based on IPM and sustainability
- Immediate response is usually to spray
- Broad-spectrum products are common

Invasive species response

- Proper identification
- Trap development
- Pest biology
- Local phenology
- Crop susceptibility
- Expanded host crop interactions
- Cultural controls (sanitation)
- Chemical controls

Conclusions

- Sustainability is an attainable goal
- Requires significant investment in biological control
- Requires technological advances
- Requires significant education efforts
- Requires public-private partnerships
- The Almond Board of California, UC/USDA researchers, and UC Cooperative Extension have proven that these partnerships can absolutely drive IPM adoption/sustainability

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