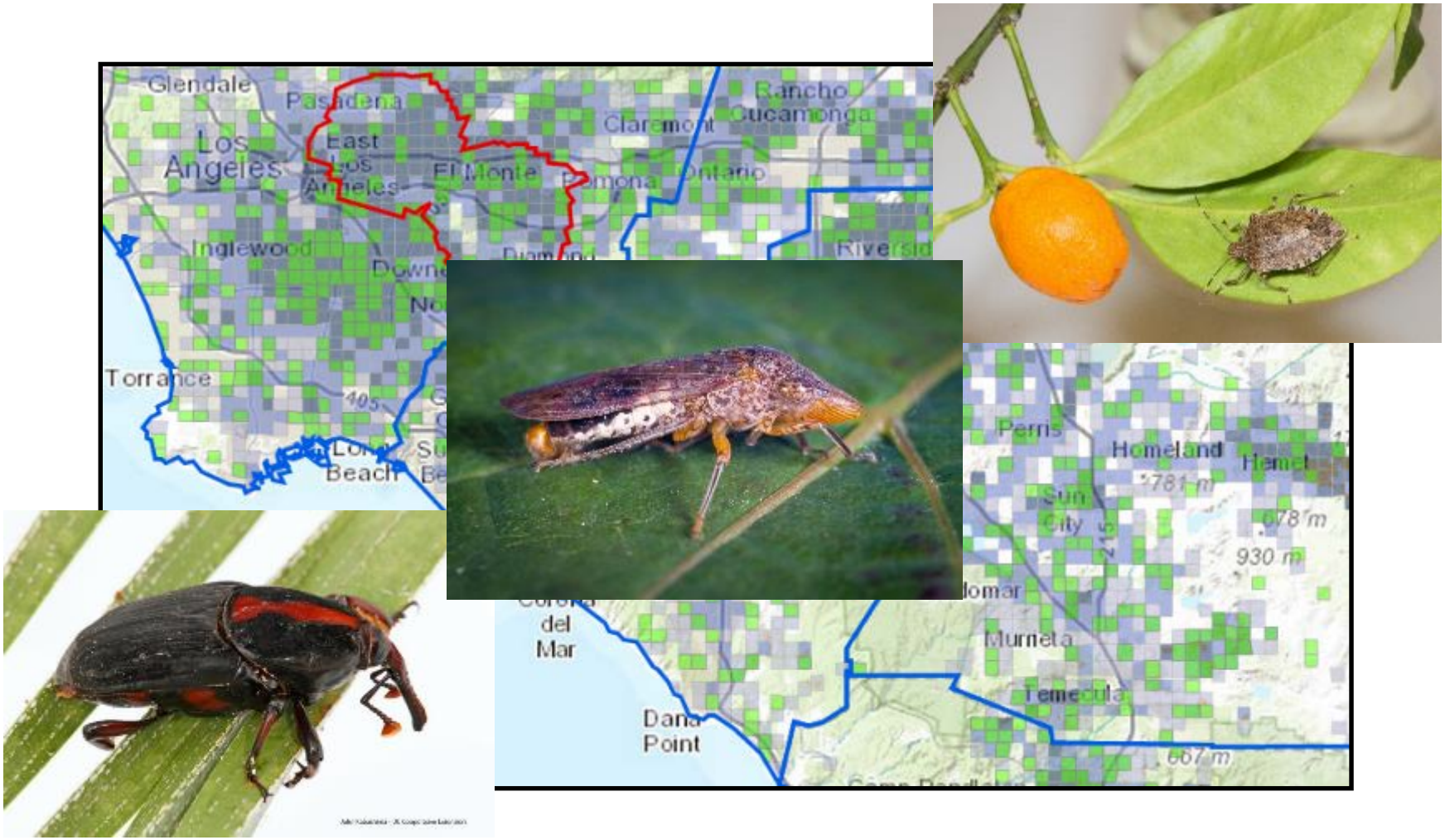
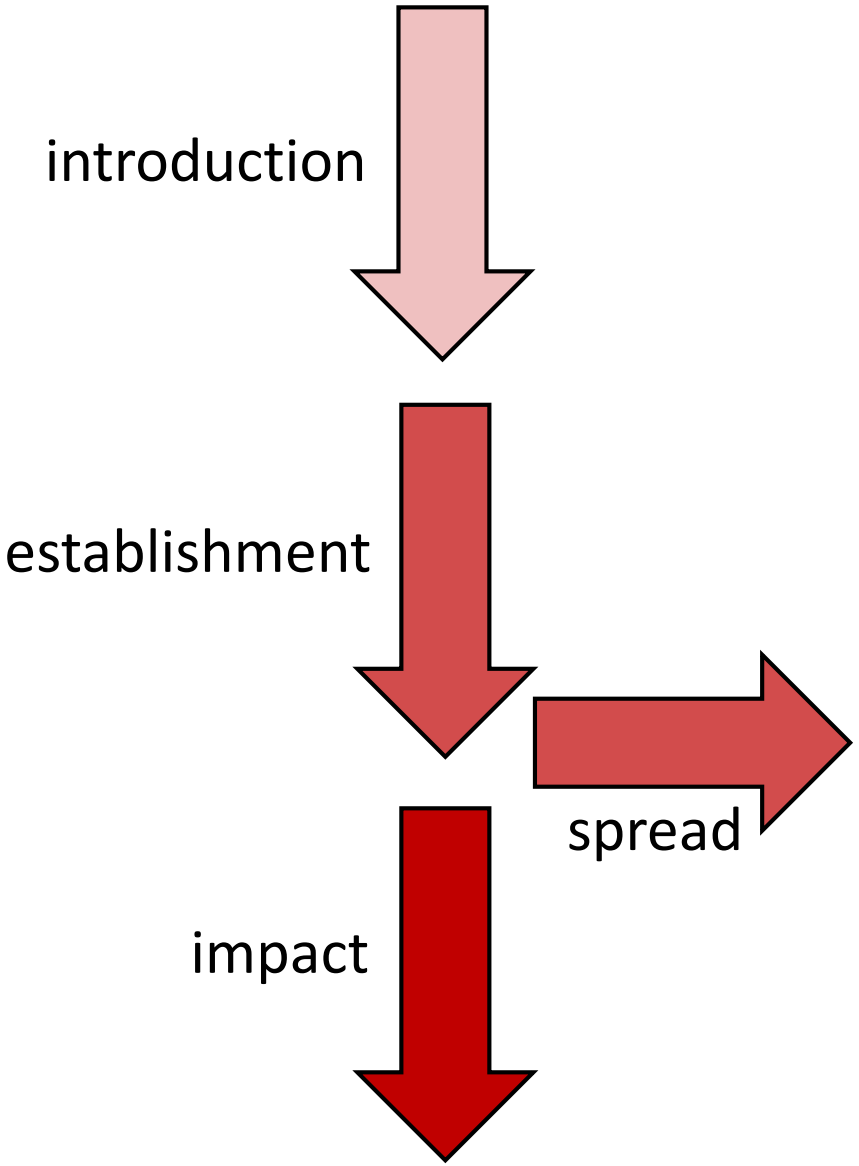
Invasive insects in California – an update



Matt Daugherty, Department of Entomology,
UC Riverside (mattd@ucr.edu)

Stages of biological invasions



Not all exotic species become invasive

~20% of exotic insects in CA

Three (or 4) categories of stages are involved in biological invasions

Each stage introduces unique hurdles for an invader's success

For nurseries, try to avoid contributing to invader introduction and spread

European Grapevine Moth

Red Palm Weevil

-S. American Palm Weevil

Brown marmorated stink bug

Light brown apple moth

Glassy-winged sharpshooter

Asian citrus psyllid

STATE EXTERIOR QUARANTINES

3250 Citrus Pests (Updated 01-30-15) HTML- PDF
3251 Chestnut Bark and Oak Wilt Diseases (Updated 01-04-12) HTML- PDF
3252 Caribbean Fruit Fly (Updated 08-22-16) HTML- PDF
3254 Cotton Pest (Updated 04-21-04) HTML- PDF
3256 Cherry Fruit Fly (Updated 11-07-08) HTML- PDF
3257 Sweet Potato Weevil (Updated 07-09-08) HTML- PDF
3259 Peach Tree Diseases (Updated 04-26-83) HTML- PDF
3260 Nut Tree Pests (Updated 11-03-89) HTML- PDF
3261 Ozonium Root Rot (Updated 03-09-89) HTML- PDF
3262 Peach Mosaic Disease (Updated 07-10-15) HTML- PDF
3263 European Corn Borer (Updated 02-10-15) HTML- PDF
3264 Colorado Potato Beetle (Updated 09-22-06) HTML- PDF
3265 Persimmon Root Borer (Updated 02-15-91) HTML- PDF
3266 Plum Curculio and Blueberry Maggot (Updated 05-05-11) HTML- PDF
3271 Burrowing and Reniform Nematodes (Updated 04-15-15) HTML- PDF
3272 Cornstalk and Sugarcane Borers (Updated 10-24-13) HTML- PDF
3273 Walnut and Pecan Pests (Updated 08-02-07) HTML- PDF
3274 Cedar-Apple Rust (Updated 12-11-98) HTML- PDF
3275 European Pine Shoot Moth (Updated 09-19-03) HTML- PDF
3276 Peach Rosette Disease (Updated 12-11-98) HTML- PDF
3277 Cereal Leaf Beetle (Repealed 10-01-14)
3280 Japanese Beetle (Updated 09-01-15) HTML- PDF
3281 Hydrilla (Updated 10-28-98) HTML- PDF
3282 Lethal Yellowing of Palm (Updated 04-21-14) HTML- PDF
3286 Tomato Yellow Leaf Curl Virus (Repealed 08-14-11)

STATE INTERIOR QUARANTINES

3400 Peach Mosaic Disease (Updated 07-10-15) HTML- PDF
3401 Ozonium Root Rot (Updated 08-05-98) HTML- PDF
3406 Mediterranean Fruit Fly (Updated 12-22-14) HTML- PDF
3407 Citrus Tristeza Virus (Updated 05-20-14) HTML- PDF - MAP
3408 Gypsy Moth (Update 03-25-11) HTML - PDF
3409 Pink Bollworm (Updated 02-15-84) HTML- PDF
3410 Hydrilla (Updated 02-12-13) HTML- PDF
3414 Cherry Fruit Fly (Updated 12-06-90) HTML-PDF
3417 Mexican Fruit Fly (Updated 07-13-09) HTML- PDF
3419 Date Palm Disease (Updated 03-03-99) HTML- PDF
3423 Oriental Fruit Fly (Updated 12-18-14) HTML- PDF
3428 Chrysanthemum White Rust (Updated 03-03-99) HTML- PDF
3429 Sweet Potato Weevil (Updated 03-03-99) HTML- PDF
3430 Karnal Bunt (Updated 02-23-12) HTML- PDF
3431 Olive Fruit Fly(Updated 08-16-02) HTML- PDF
3432 Red Imported Fire Ant (Updated 08-16-99) HTML- PDF
3425 Melon Fruit Fly (Updated 06-03-11)HTML- PDF
3424 *Bactrocera zonata* (peach fruit fly) (Updated 10-16-06) HTML - PDF
3434 Light Brown Apple Moth (Updated 11-10-15) HTML - PDF
3435 Asian Citrus Psyllid (Updated 10-7-16) HTML - PDF - MAP
3436 *Bactrocera albistrigata* (white striped fruit fly) (Update 02-08-10) HTML - PDF
3437 European Grapevine Moth (*Lobesia botrana*) (Update 08-16-16) HTML – PDF – MAP
3439 Huanglongbing Disease (Update 05-25-16) HTML – PDF - MAP
3441 Guava Fruit Fly (Updated 05-20-15) HTML-PDF- MAP
3442 Malaysian Fruit Fly (Updated 02-04-16) HTML-PDF

STATE MISCELLANEOUS RULINGS

3559 Garlic Production in Mono County (Updated 07-22-98) HTML- PDF

European Grapevine Moth, *Lobesia botrana*

Native to S. Italy

Present in parts of Europe, Africa, Asia, and the Americas

Prefers grapevines, but feeds on a wide range of fruit and ornamental plants

- blackberry, currant, privet, rosemary, stone fruits

Larvae damage flowers and berry clusters

- feeding introduces rots

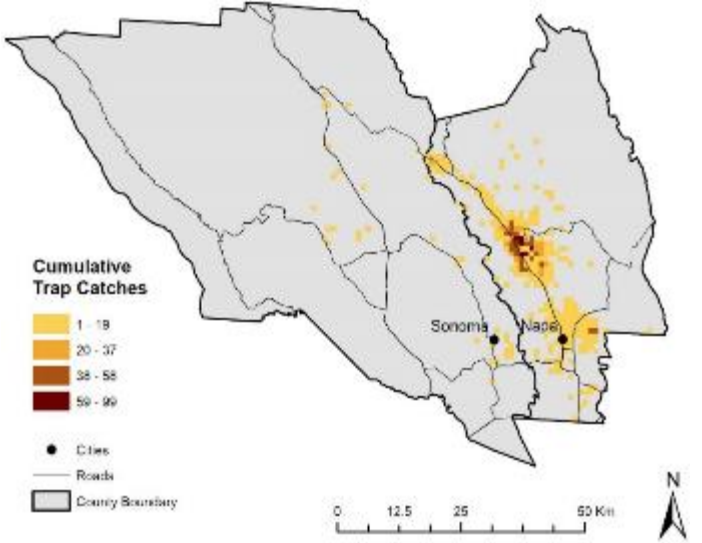
First detected in California in 2009

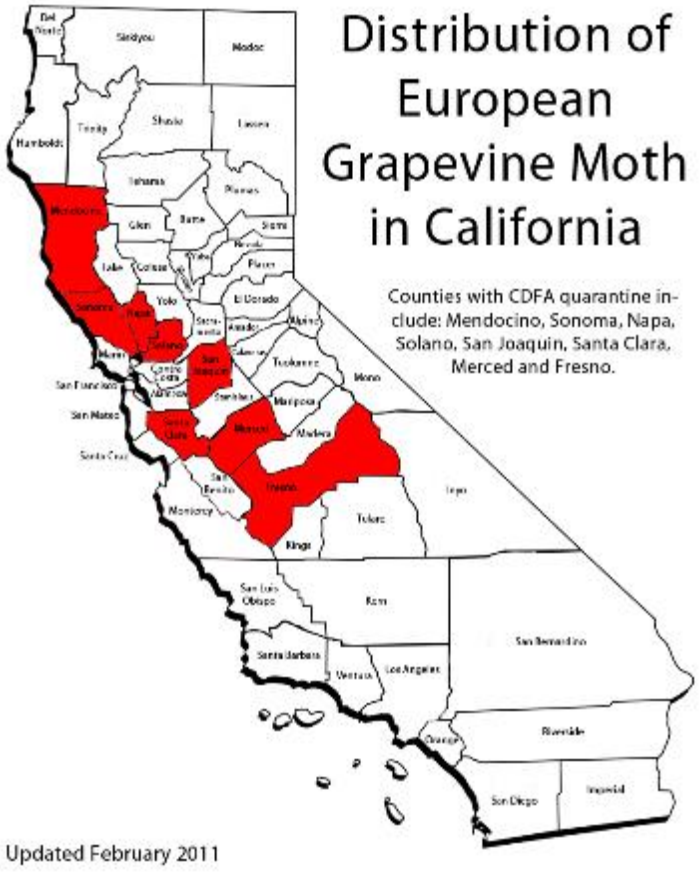
- Likely present for at least a few years

Napa County most severely affected

>100,000 moths captured in 2010

By 2012 had spread to additional 10 counties, as far as Fresno County





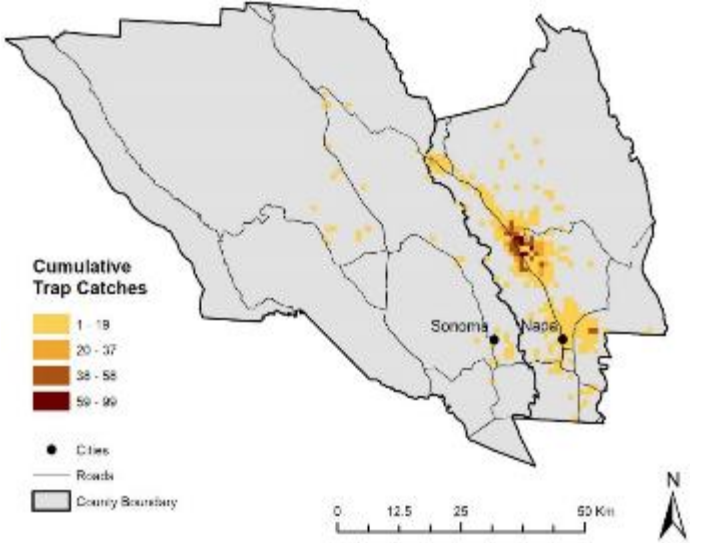
Extensive monitoring in vineyards, nearby residential areas

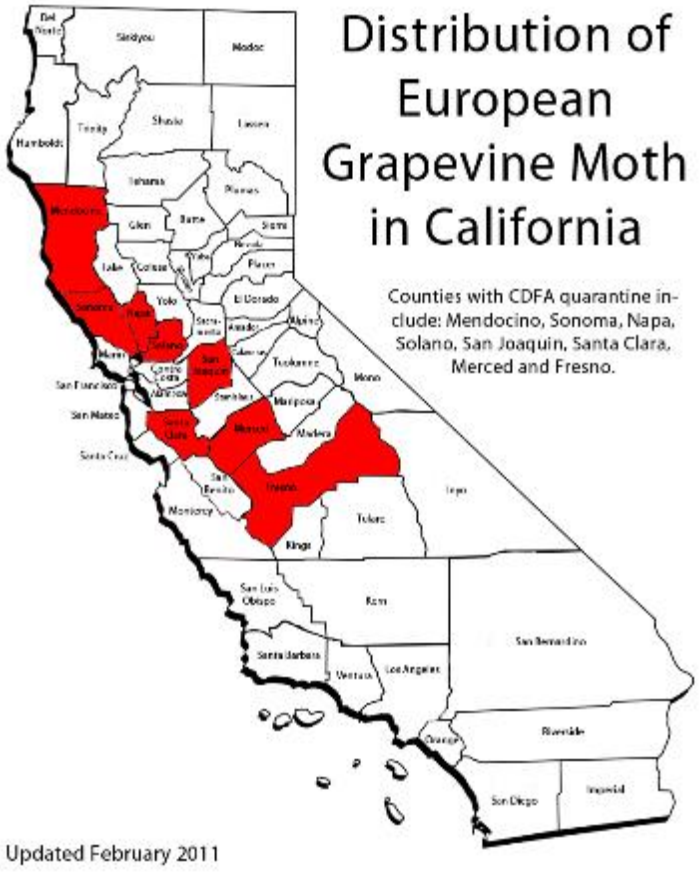
Fruit removal around affected areas

Regulated movement of nursery stock and farm/winery equipment

Insecticide applications around finds

Mating disruption (pheromone lures)



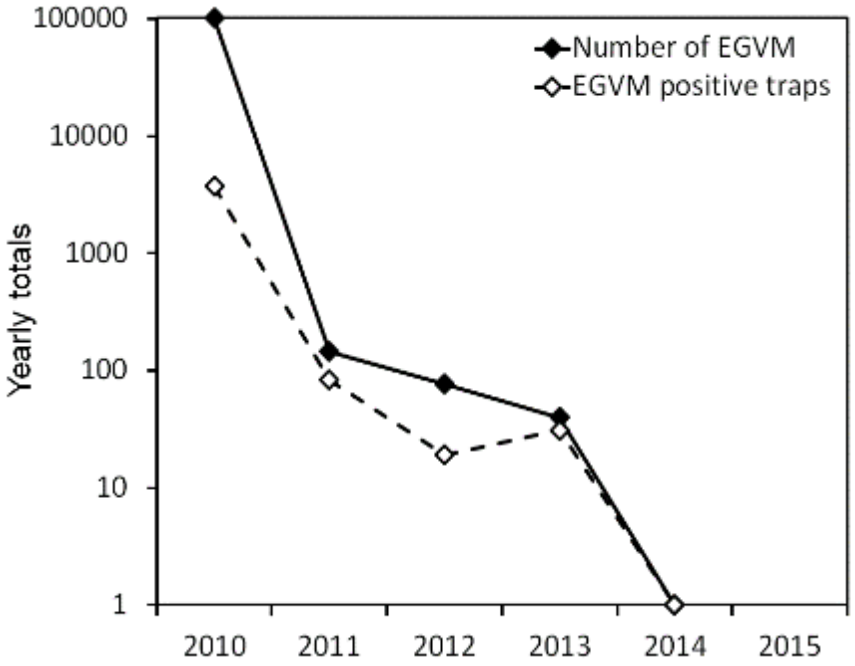


By 2014, detections had dropped to 1 moth in total

Officially declared eradicated in 2016

Has emerged as a model of an effective response to invasive species

- cooperation among growers, county officials, and extension personnel in affected areas
- effective early detection of new infestations



Red Palm Weevil, *Rhynchophorus ferrugineus* (more likely *R. vulneratus*)

Native to SE Asia, widespread in Middle East, Africa, S. Europe

Attacks common landscape palms

- attracted to stressed trees
- dieback of apical fronds
- frass/“oozing” from feeding tunnels, fermented smell
- fractured trunks, risk of toppling

Found in Laguna Beach, CA in 2010

1. Monitoring:

   - pheromone baited traps (detect small populations)
   - visual surveys

2. Control measures

   - insecticide treatments
   - mass trapping of weevil adults
   - removal of infested trees

Last trapped in January 2012

Officially declared eradicated in 2015

Good example of early detection contributing to a successful outcome

And the next invasive weevil is…

South American palm weevil (*Rhynchophorus palmarum*)

Similar feeding damage as RPW

Transmits plant nematode

- red ring nematode, *Bursaphelenchus cocophilus*

Known to be present in Tijuana since 2010

Repeated detections in San Diego and Imperial Counties

Brown marmorated stink bug, *Halyomorpha halys*

Native to eastern Asia

Wide host range

- fruits and vegetables (apple, pear stone fruit, berries, tomato, beans)
- ornamental trees and shrubs (holly, redbud, magnolia, Catalpa)

Invaded the eastern US in 2001

First detected in Pasadena in 2006

Brown marmorated stink bug, *Rhynchophorus*

Feeding damages fruits and seed pods

- necrosis, deformation

Significant nuisance pest

- moves seasonally from orchards, shade trees into homes
- form high density aggregations in crevices or inside homes

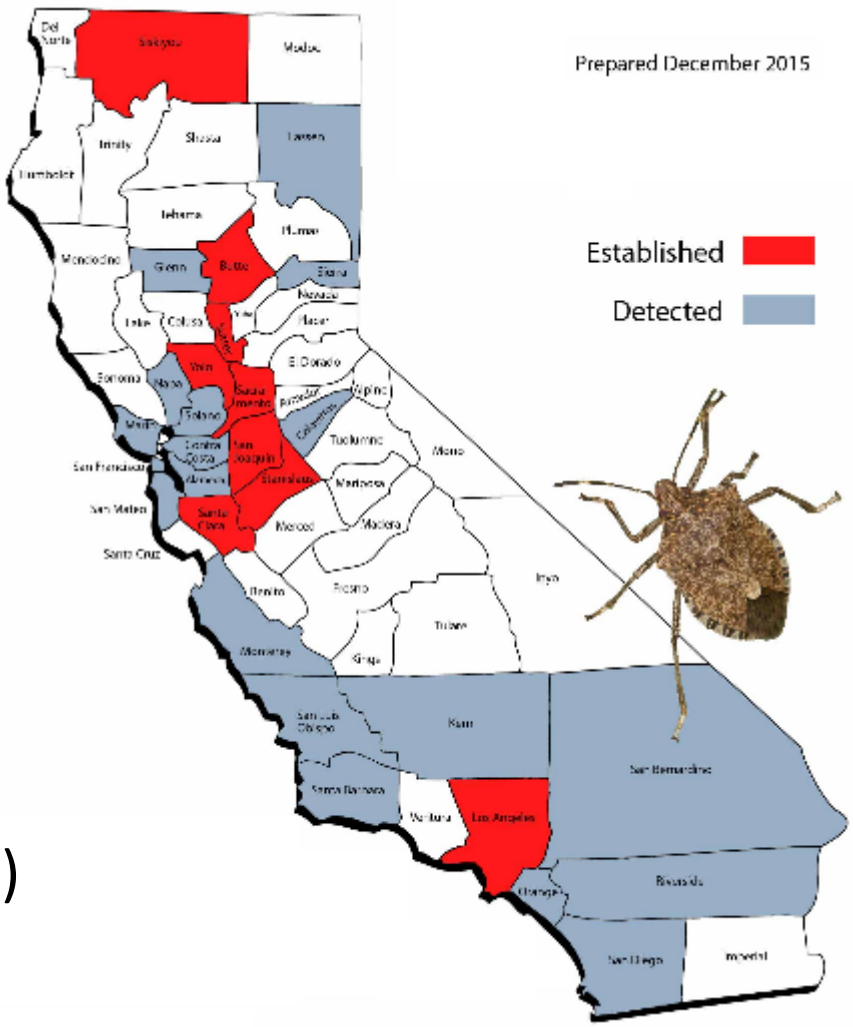
BMSB has been detected in many locations throughout California

- almost exclusively in urban/suburban areas
- few finds in commercial agriculture

No reports of major damage

- localized infestations
- more significant as a nuisance?

Exotic that is not very invasive (so far)



Light Brown Apple Moth (LBAM), *Epiphyas postvittana*

Tortricid leafroller, ¼ inch in length

Native to Australia

Extreme generalist

- 350+ genera, 500+ species of plants
- berries, tree fruits, native trees/shrubs, ornamentals, weeds

First found in CA in 2007

LBAM eradication program established for Bay Area

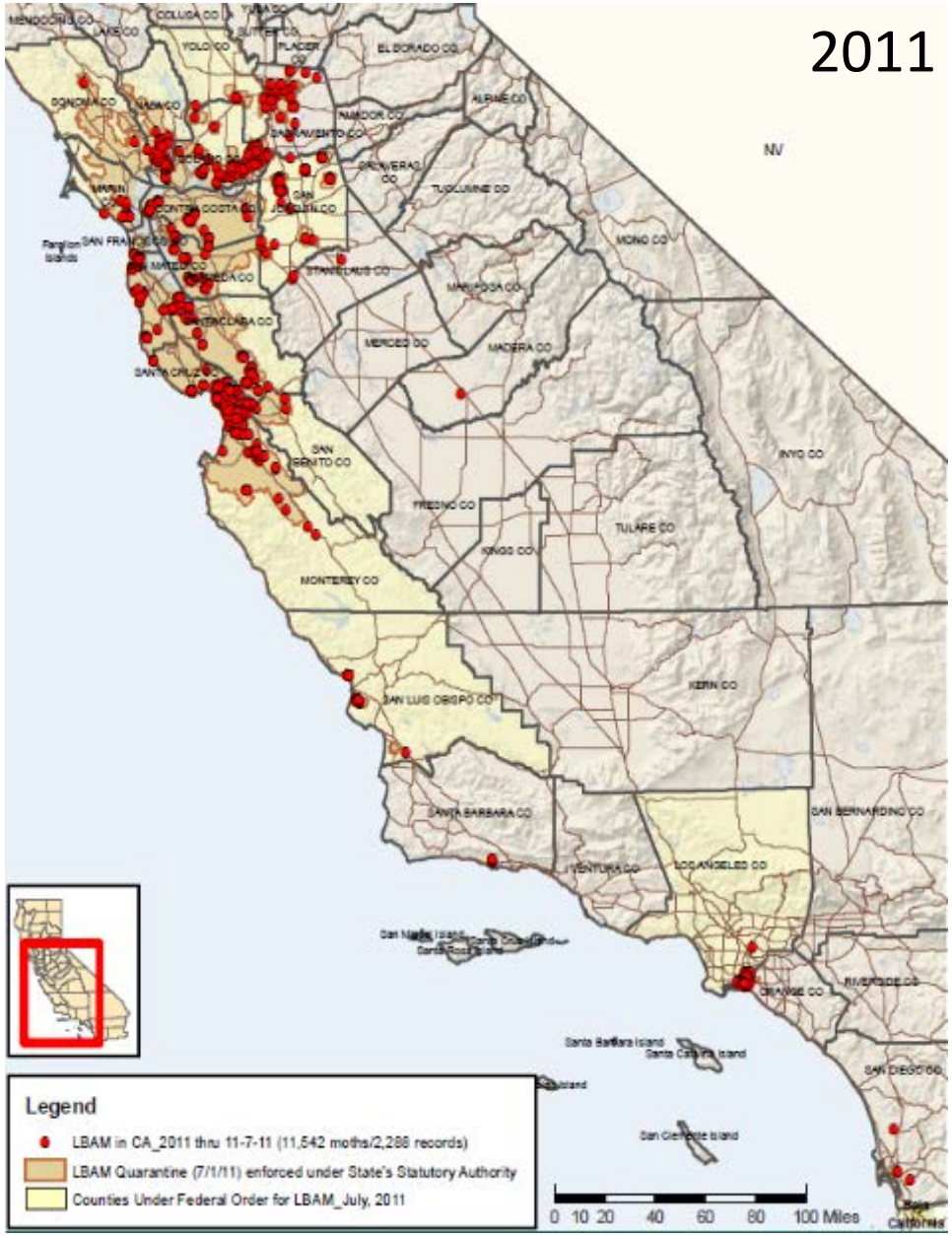
- mating disruption via pheromone sprays

Regulated nursery stock
https://www.cdfa.ca.gov/Plant/lbam/rpts/LBAM_BMP-Rev_3.pdf

- substantial monitoring costs

- increased insecticide use

Regulated movement of bulk green waste

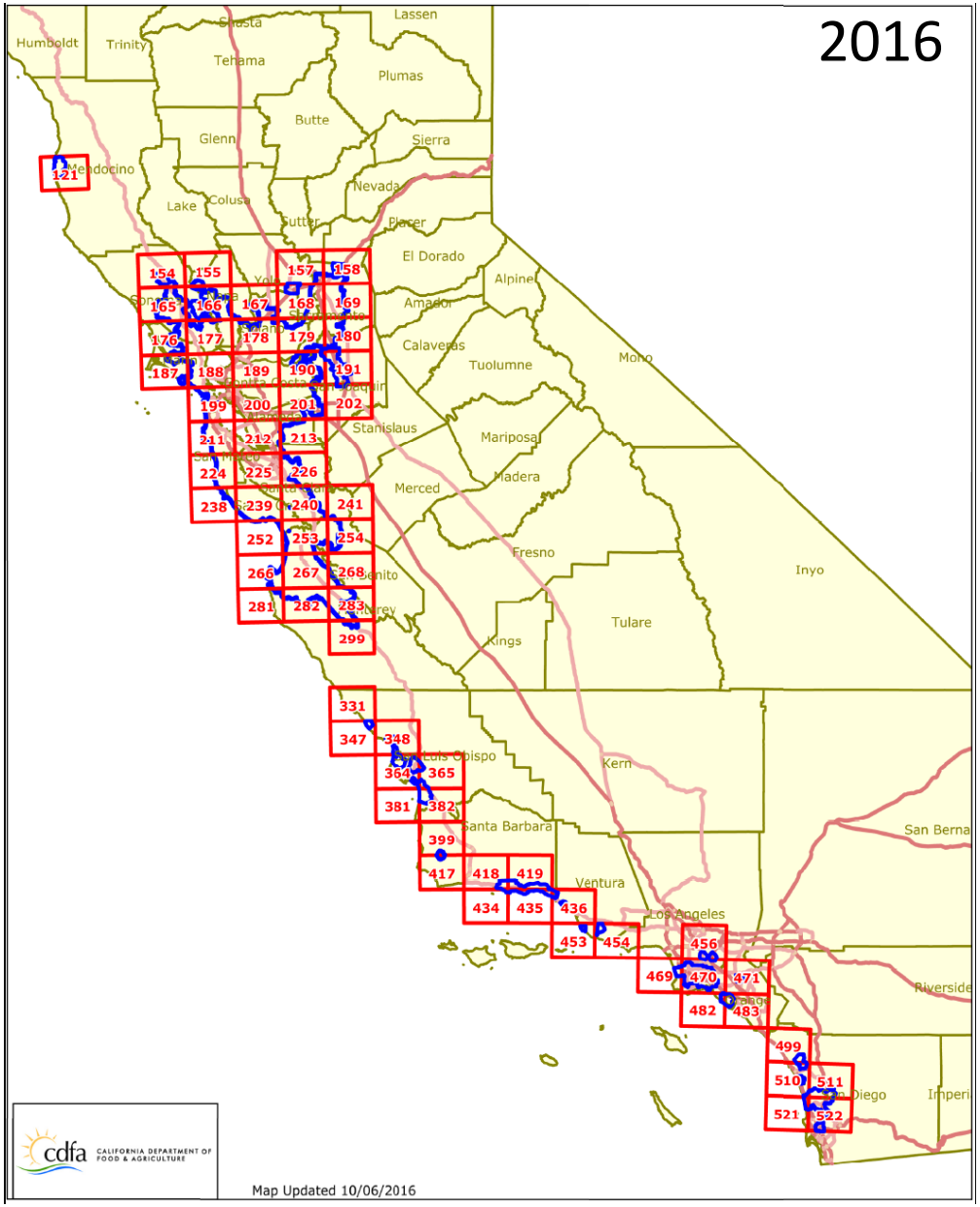


Widespread

Prevalent in cooler, coastal areas, relatively rare inland

Present in natural areas, residential areas

No documentation of major damage?



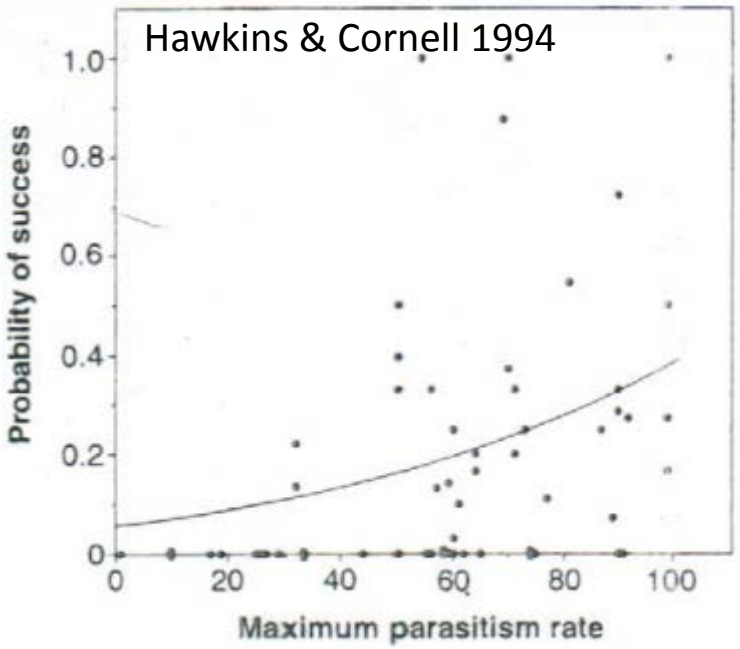
Continues to spread

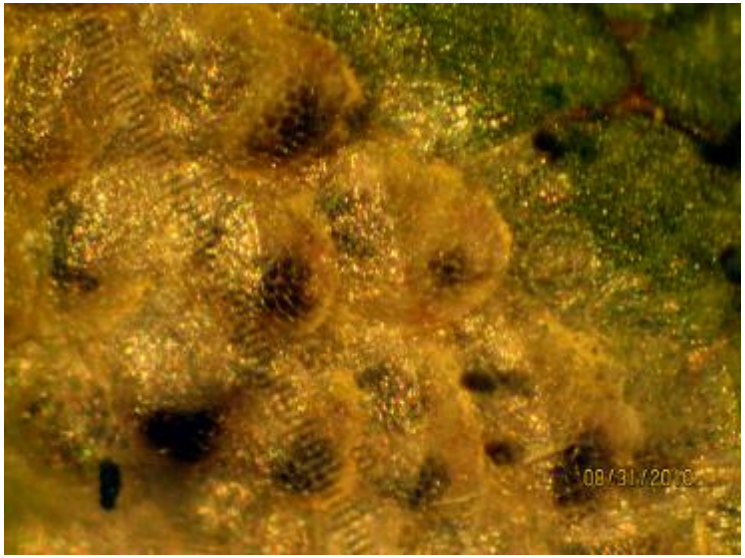
Prevalent in cooler, coastal areas, relatively rare inland

Present in natural areas, residential areas

No documentation of major damage?

Why isn't LBAM more invasive?





LBAM is attacked by several resident generalist parasitoids

- ~~enemy release~~

Rule of thumb: effective biocontrol requires >30% parasitism

Observed average parasitism:

- 84.4% for eggs,
- 43.6% for larvae,
- 57.5% of pupae

High biotic resistance

Glassy-winged sharpshooter, *Homalodisca vitripennis*

Xylem-sap feeder

Native to southeastern U.S.

Wide host range (200+ species)

- crops, ornamental trees and shrubs, weeds

Causes little direct damage

Transmits pathogenic bacterium, *Xylella fastidiosa*


almond
pecan
oleander
olive
oak
coffee
plum
elm
sweet gum

Detected in S. California ~25 yr ago

- by 2000, “100s” of per grapevine in vineyards
- widespread in S. California, parts of Central Valley

Response to GWSS invasion:

- area-wide control
- within-vineyard management
- restrictions on movement of nursery stock

Over the next 10 years GWSS populations declined

- > 20/day in 1999 vs. <0.01/d in 2012
- disease prevalence <1% in S. CA vineyards

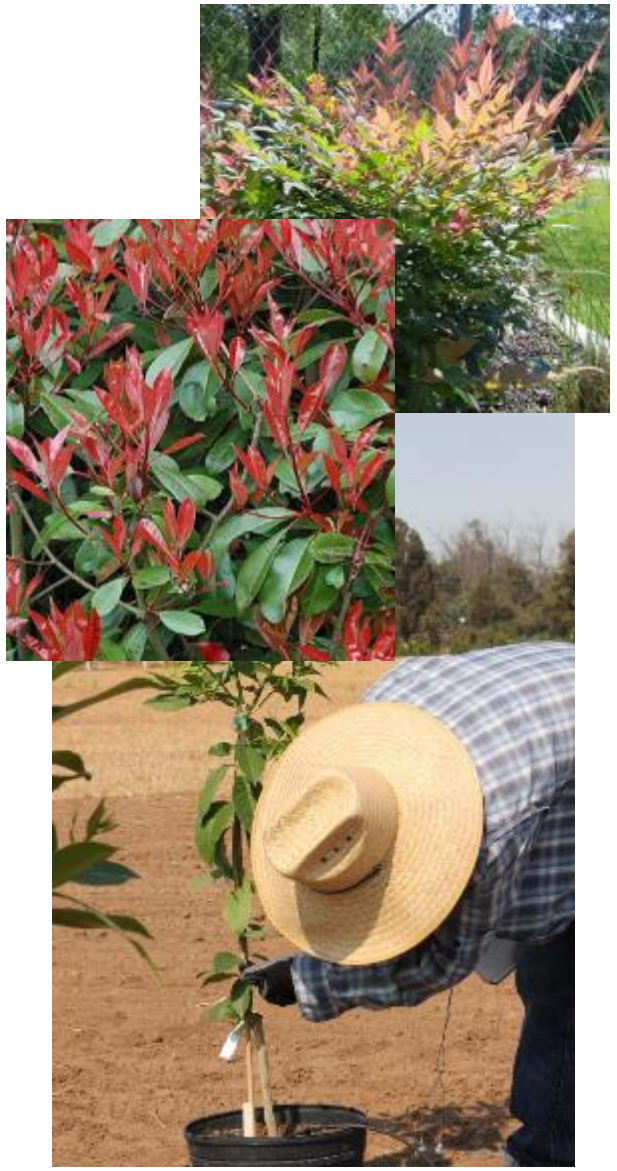
GWSS has not expanded its range substantially

- prevalent in S. CA and parts of Kern, Tulare Co.
- localized, management infestations further north

Nursery shipments and the Approved Treatment Program

Movement of GWSS hosts may require:

- plant inspection prior to shipping and at receiving location; insecticide treatment; certification of shipment;
- to date, <0.1% of 863,600 shipments had viable GWSS; just 6 of 38,000 last year



The ATP relaxes inspection requirement if select GWSS-effective insecticides (Sevin, Tame) are applied

- to date, no viable GWSS have been found on ATP shipments

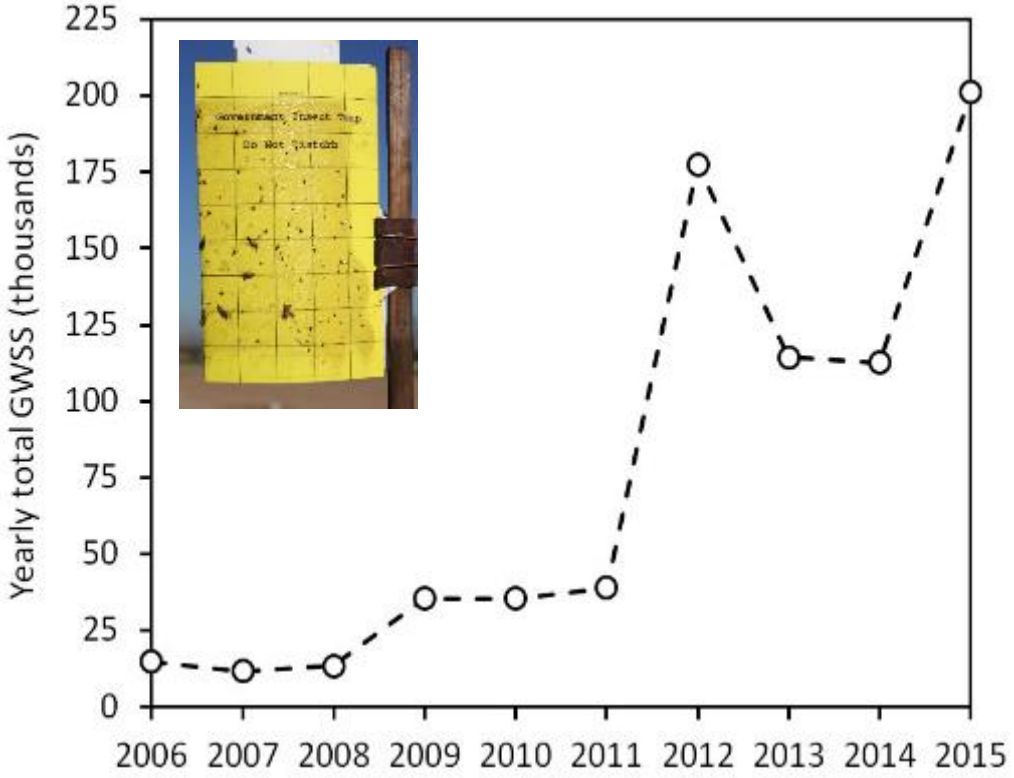
GWSS population resurgence in vineyards

After years of low densities, GWSS populations are starting to rebound

- in Southern California, GWSS trap catch is the highest since 2009
- In Kern Co., GWSS catch increased more than 5-fold since 2011

Explanation isn't known

- temperate winters
- insecticide resistance



Asian citrus psyllid (*Diaphorina citri*)

Native to Southern, Southeast Asia

Highly invasive in the Americas

Attacks all varieties of citrus and some relatives (Rutaceae)

- dynamics tied to flush cycles

Feeding can damage new shoots

Transmits bacteria (Candidatus *Liberibacter* spp.) associated with huanglongbing disease

Huanglongbing (Citrus greening)

Earliest symptoms include blotchy, irregular yellowing of leaves

Fruit don’t develop properly; small, deformed, poor flavor

Lack of tree vigor, stunting; excessive fruit drop

Tree mortality in as little as 5 years

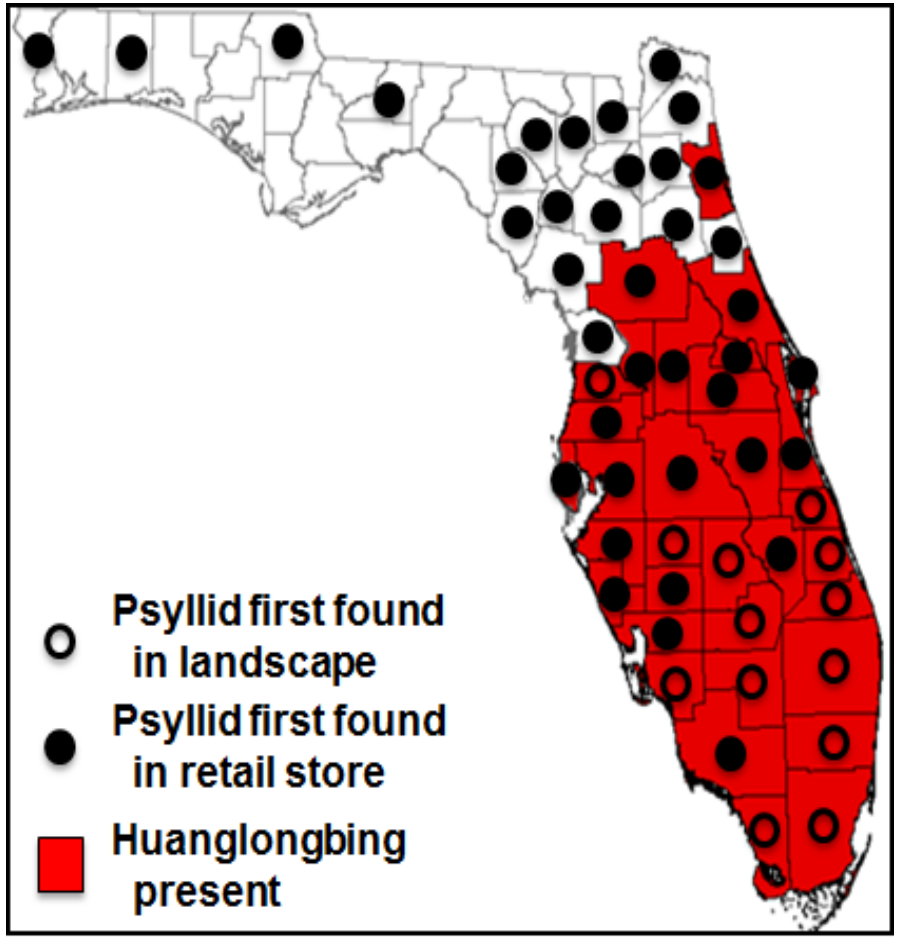
ACP and HLB in Florida: How bad it can get

ACP first detected in 1998, after which it spread throughout the state.

- assisted by nursery shipments

Within 3 years the disease spread to all citrus growing regions

- citrus production <1/2 of what it was
- production costs >50% higher



ACP invasion in California

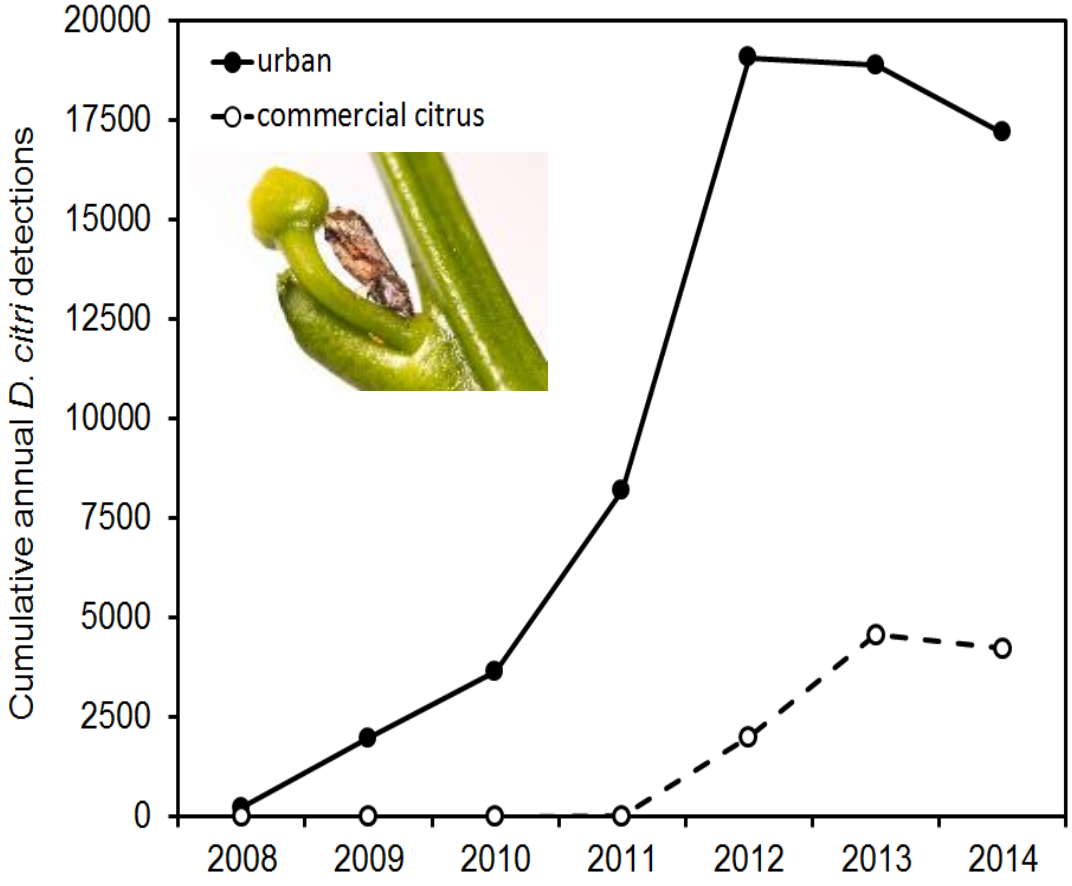
ACP was found in a residential area in San Diego in 2008. It then spread throughout Southern California

- widespread in urban and suburban areas

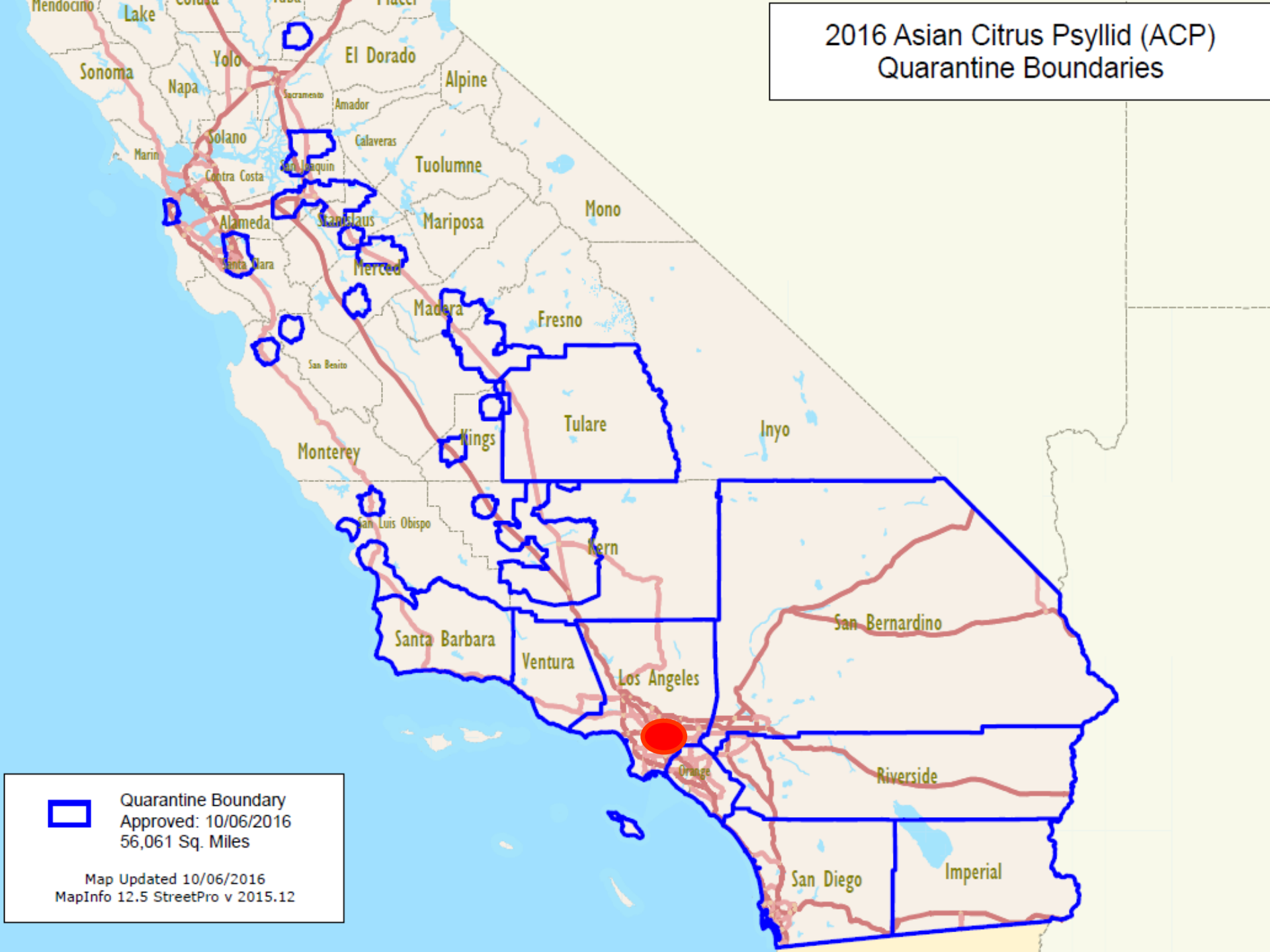
Detected in commercial citrus in 2011, Central Valley in 2012

HLB first documented in 2012

- ~25 total residential cases to date
- more cases expected



2016 Asian Citrus Psyllid (ACP) Quarantine Boundaries



Quarantine Boundary
Approved: 10/06/2016
56,061 Sq. Miles

Map Updated 10/06/2016
MapInfo 12.5 StreetPro v 2015.12

Limiting the risk of spreading ACP on nursery stock

Insecticide treatment of plants prior to shipment

- systemic (neonicotinoid) and foliar (OP)
- 90 day limit on treatments

Tagging of all ACP/HLB host plants

- ACP/HLB host plants can't leave quarantined area

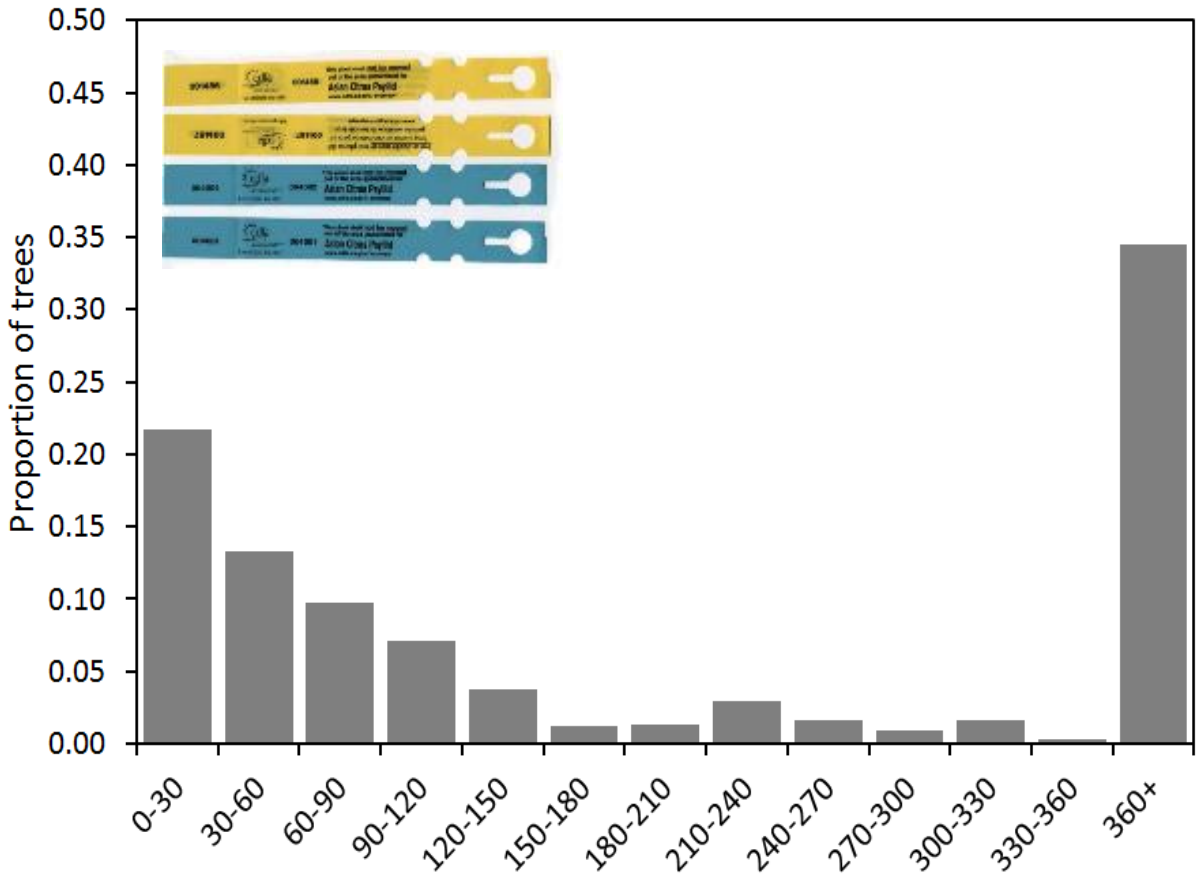
Inspections by CDFA personnel

- infested plants must be retreated or destroyed

Studies show treatments can effectively protect trees for approximately 3 months

Trees can reside for long periods at retail sites

- 55% > 3 mo
- 35% > 1 yr



BMPs at retail sites should include attempts to encourage turnover in citrus nursery stock

Information on invasives in California

UC Riverside Center for Invasive Species Research:
http://cisr.ucr.edu/

UC IPM:
http://ipm.ucanr.edu/

CDFA quarantine information pages:
https://www.cdfa.ca.gov/plant/pe/interiorexclusion/quarantine.html

UC ANR online classes:
http://class.ucanr.edu/