#UNIDOS contra o GREENING

Fundecitrus
CIÊNCIA E SUSTENTABILIDADE
PARA A CITRICULTURA

Asian citrus psyllid and Huanglongbing in California, USA

II SIMPÓSIO INTERNACIONAL DE GREENING
Araraquara – SP
22 e 23 de maio de 2018

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cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

CITRUS RESEARCH BOARD

UNIVERSITY OF CALIFORNIA UC RIVERSIDE

Citrus Clonal Protection Program ... starting citrus correctly

University of California Agriculture and Natural Resources

05/22/2018

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California Citrus Nursery Board
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USDA United States Department of Agriculture
Start clean, stay clean NCPN National Clean Plant Network
University of California Agriculture and Natural Resources
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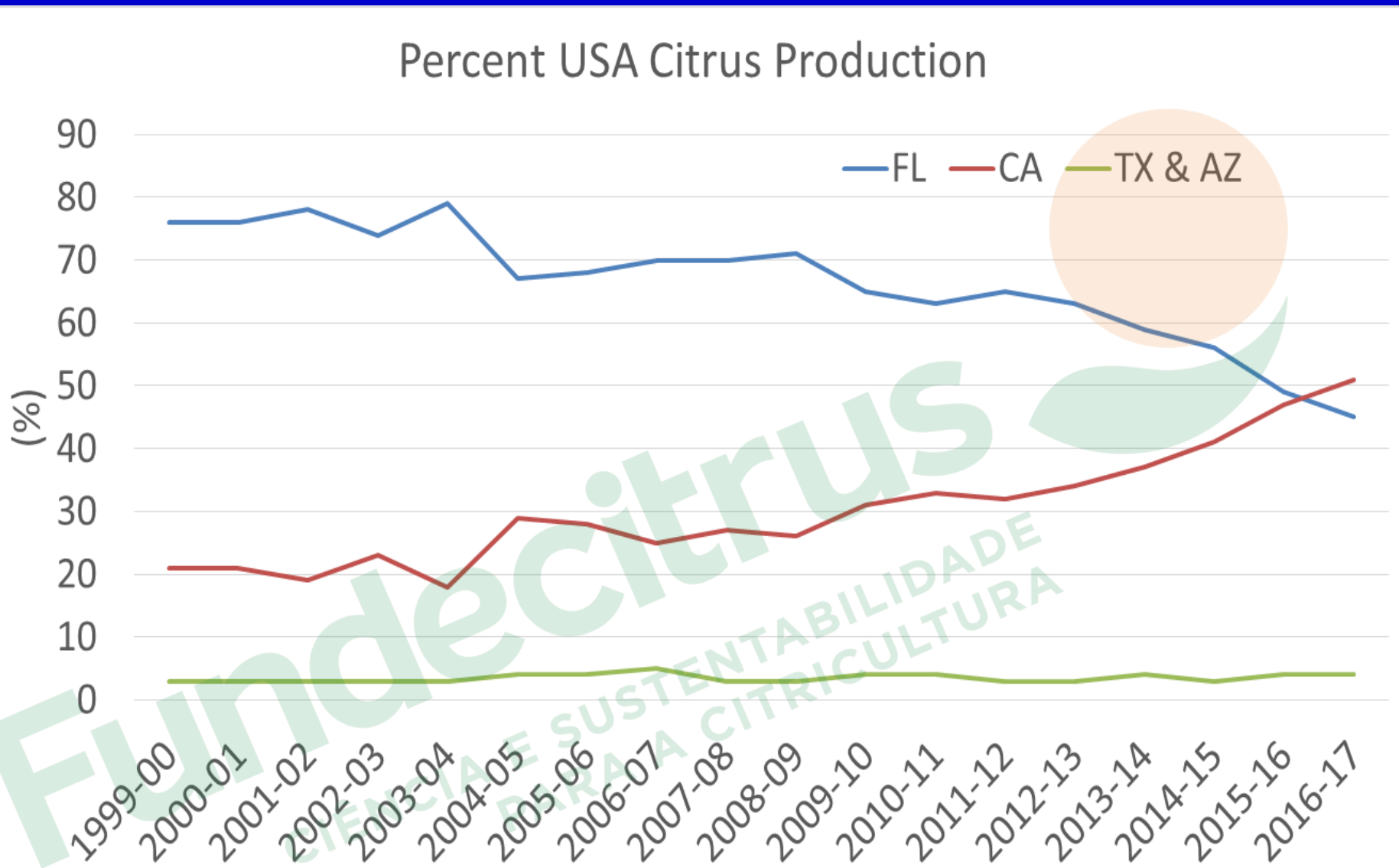
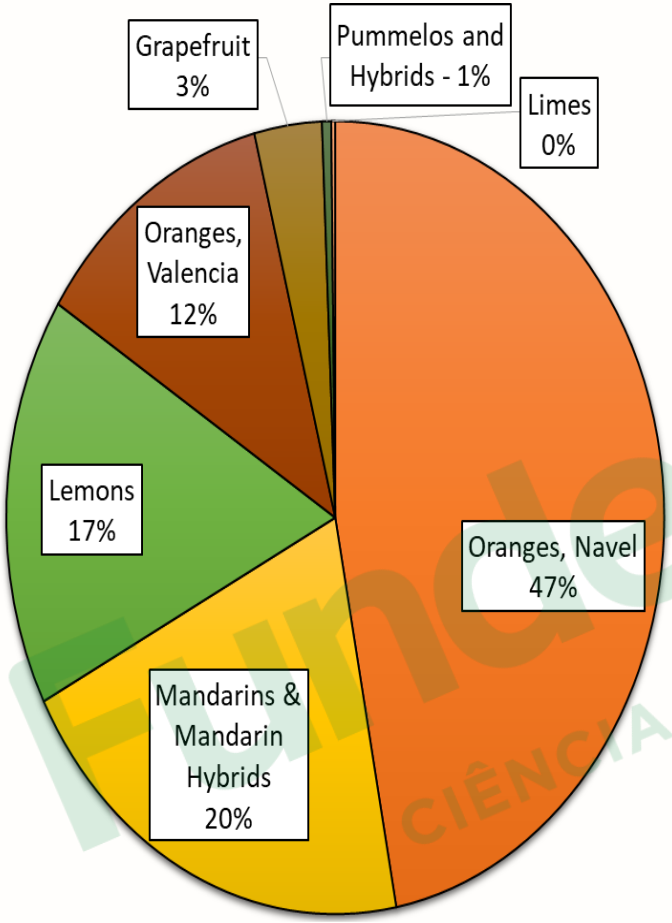
Today's Presentation

1. A brief introduction of citrus in California (size, characteristics, types of citrus, markets, ...)
2. HLB situation (historical and current distribution, ...)
3. Efforts to contain disease spread (ACP monitoring and control, diseased tree surveys .....)
4. Main research projects and perspectives.



USDA-NASS

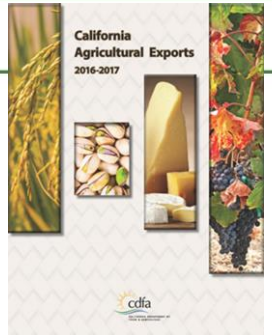
California Commercial Citrus Acreage-2016



Type	Bearing Acres	
	2014	2016
Oranges, Navel	122,882	116,672
Mandarins & Hybrids	44,347	50,387
Lemons	41,882	41,487
Oranges, Valencia	33,828	29,738
Grapefruit	8,316	8,218
Pummelos & Hybrids	1,312	1,117
Limes	451	482
TOTAL	253,018	248,101

2016 California Citrus Acreage Report, released August 6, 2016; CDFA & CASS cooperating with the USDA

California Agricultural Products Export Values and Rankings, 2014-2016



2016 Rank	Product	2014	2015	2016	Change in Value 2015 to 2016 (In Percent) [1]
			$1 Million		
1	Almonds	4,528	5,143	4,495	-12.6
2	Wine	1,392	1,480	1,494	0.9
3	Dairy and Products [2]	2,423	1,633	1,412	-13.5
4	Walnuts	1,446	1,485	1,339	-9.8
5	Pistachios	1,124	848	1,148	35.4
6	Table Grapes	890	766	800	4.4
7	Tomatoes, Processed [2]	784	814	743	-8.7
8	Rice	681	751	715	-4.8
9	Oranges and Products [2]	573	587	669	13.9
10	Strawberries	408	390	404	3.6
11	Seeds for Sowing	324	340	353	3.9
12	Hay	289	320	335	4.7
13	Cotton	377	229	325	41.8
14	Raisins	409	335	322	-4.0
15	Beef and Products [3]	404	309	312	1.0
16	Lettuce	338	315	290	-7.8
17	Lemons [2]	250	238	218	-8.6
18	Dried Plums	170	182	163	-10.1
19	Peaches and Nectarines	174	139	131	-5.9
20	Raspberries and Blackberries [2,4]	172	149	130	-12.5
21	Cauliflower	118	117	117	0.4
22	Broccoli	128	114	110	-3.9
23	Flowers and Nursery	96	86	97	13.1
24	Spinach	87	92	93	1.3
25	Onions [2,5]	83	84	88	5.8
26	Cherries [2]	51	94	81	-13.6
27	Celery	74	81	77	-4.5
28	Carrots	102	77	70	-9.6
29	Plums	65	56	58	3.5
30	Melons	63	60	58	-3.4
31	Dates	40	50	53	7.9
32	Tangerines and Mandarins	50	57	51	-10.3
33	Garlic	35	33	47	42.2
34	Blueberries	55	50	43	-12.5
35	Tomatoes, Fresh	51	48	41	-14.6
36	Olives and Olive Oil	37	36	38	6.8
37	Pears	43	39	37	-5.9
38	Sweet Potatoes	23	30	36	21.5
39	Grapefruit	33	32	32	1.6

2016 California Citrus Exports Total Value: $970 M

Major Destinations for California Agricultural Exports, 2015 and 2016 [1,2]

Commodities [1] and Destinations	Percent of Total by Destination	
Almonds (1)	**2015**	**2016**
European Union	38	36
China/Hong Kong	10	12
India	10	11
Canada	6	6
United Arab Emirates	7	5
Japan	6	5
Other destinations	22	25

Commodities [1] and Destinations	Percent of Total by Destination	
Rice (8)	**2015**	**2016**
Japan	37	33
Korea	18	15
Jordan	11	10
Canada	8	8
Papua New Guin	5	<5
European Union	<5	5
Other destinations	22	27

Commodities [1] and Destinations	Percent of Total by Destination	
Lemons (17)	**2015**	**2016**
Canada	28	33
Japan	27	27
South Korea	11	8
China/Hong Kong	10	9
European Union	9	5
Australia	5	5
Other destinations	9	13

Wine (2)	**2015**	**2016**
European Union	41	44
Canada	26	24
China/Hong Kong	10	11
Japan	7	5
Other destinations	16	16

Oranges and Products (9)	**2015**	**2016**
Korea	28	27
Canada	23	22
China/Hong Kong	16	20
Japan	12	13
Australia	5	<5
Other destinations	16	15

Dried Plums (18)	**2015**	**2016**
European Union	43	34
Japan	18	21
Canada	8	7
Other destinations	31	38

Peaches and Nectarines (19)	**2015**	**2016**

Melons (30)	**2015**	**2016**
Canada	87	83
Mexico	5	6
Japan	<5	5
Other destinations	8	6

Grapefruit (39)	**2015**	**2016**
Japan	36	37
European Union	26	26
Canada	18	20
Korea	10	10
Other destinations	9	7

Dates (31)	**2015**	**2016**
Australia	37	36
Canada	27	26
European Union	16	15
Other destinations	20	23

Potatoes (40)	**2015**	**2016**
Canada	45	43
Mexico	21	18
Japan	5	9
Taiwan	<5	9
Other destinations	25	21

Tangerines and Mandarins (32)	**2015**	**2016**
Canada	53	50
Japan	20	32
European Union	8	7
Other destinations	19	11

Avocado (41)	**2015**	**2016**
Canada	52	26
Japan	17	17
Korea	16	14
Singapore	8	6

2016-17- Economic Impact of California's Citrus Industry

Key findings

- The trends seem to favor continued health for California's citrus industry. The grower value of production expressed in constant 2016 dollars has increased 53% since 2007 from $1.5 to $2.3 billion.
- The value of citrus production in 2016-17 was $3.39 billion.
- The total economic impact on California's economy was $7.1 billion.
- The citrus industry added $1.70 billion to California's GDP.
- Estimated full time equivalent jobs in the California citrus industry totaled 21,674.
- Estimated wages paid by the California citrus industry income totaled $452 million.
- A 20% reduction in California citrus acreage would cause a loss of 7,350 jobs, $127 million in employee income, and reduce state GDP by $501 million.

B. Babcock, School of Public Policy, UC Riverside

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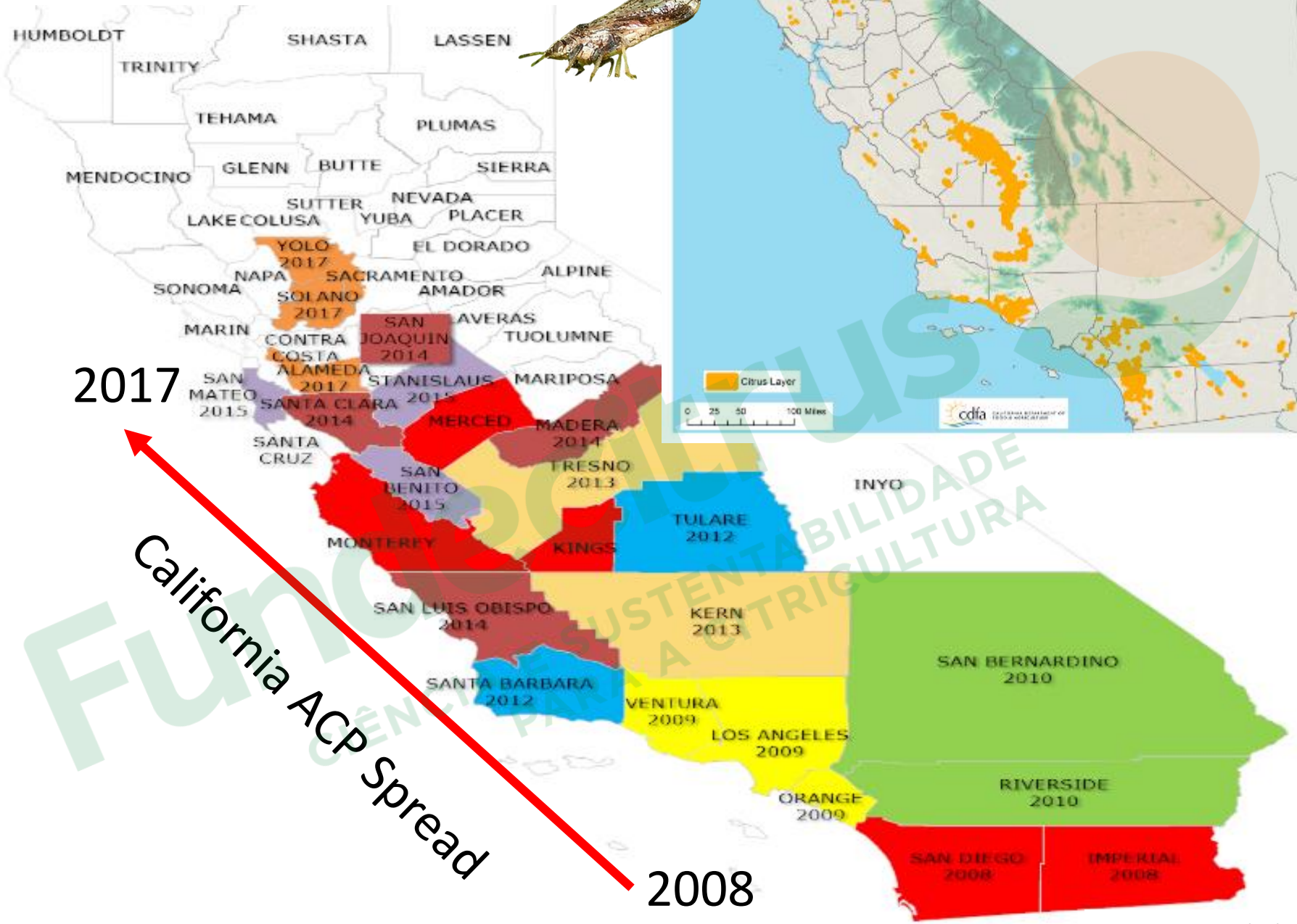
4. Main research projects and perspectives

August 2008 - Single Asian Citrus Psyllid Detected In San Diego, California



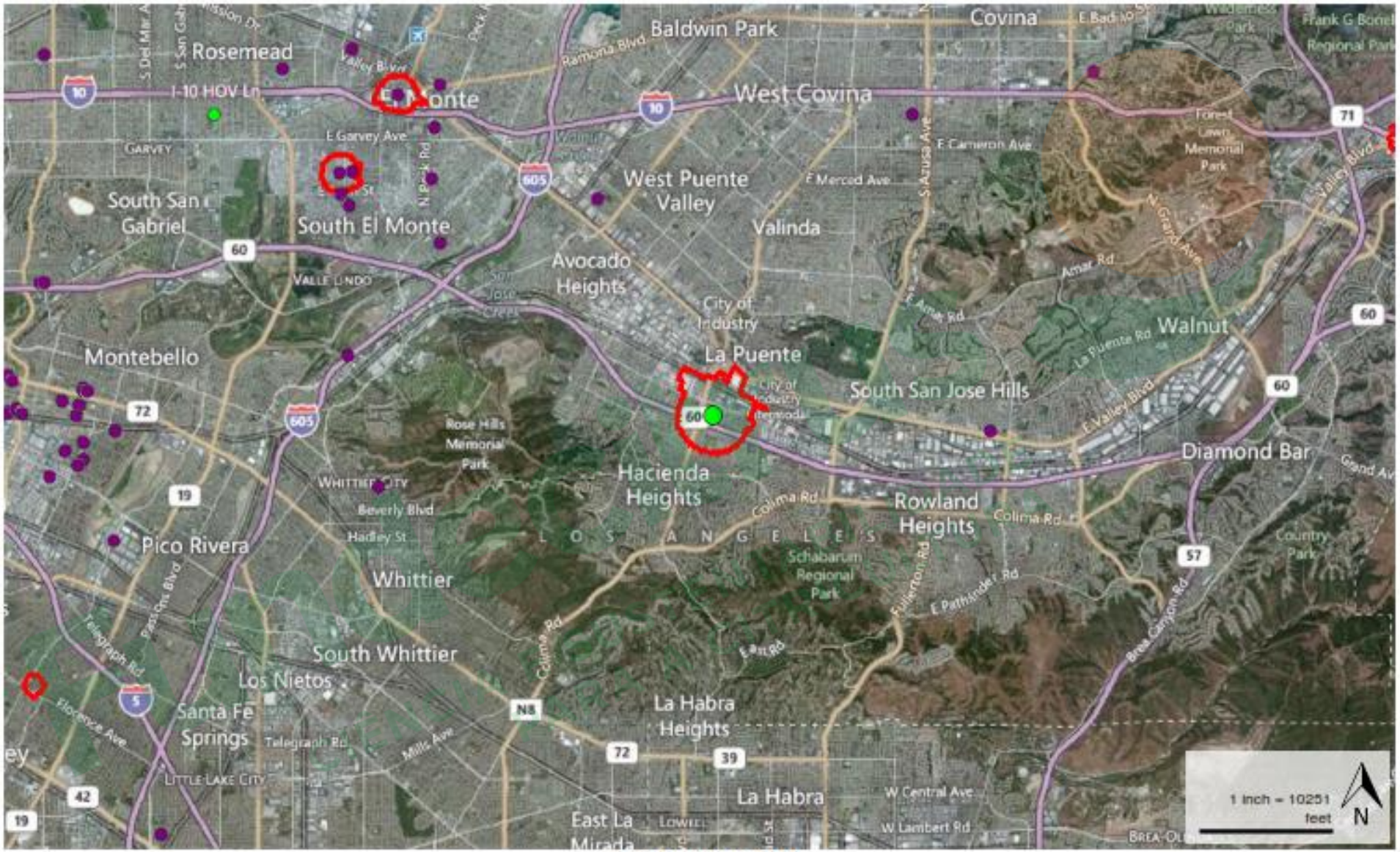
2017

California ACP Spread

2008

Victoria Hornbaker, CDFA

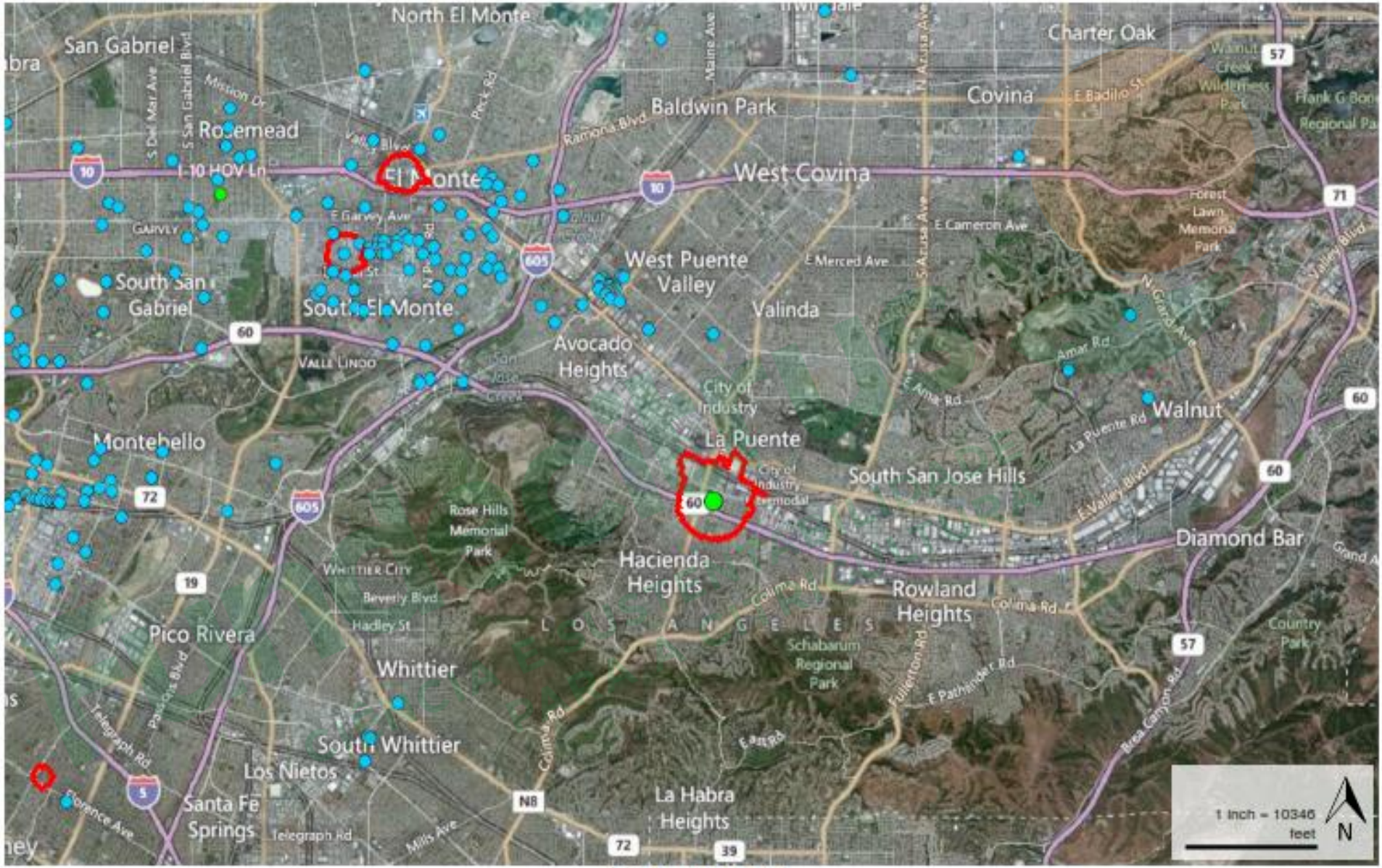
2009 ACP Detections Near Hacienda Heights, Los Angeles



ACP Detections 2009

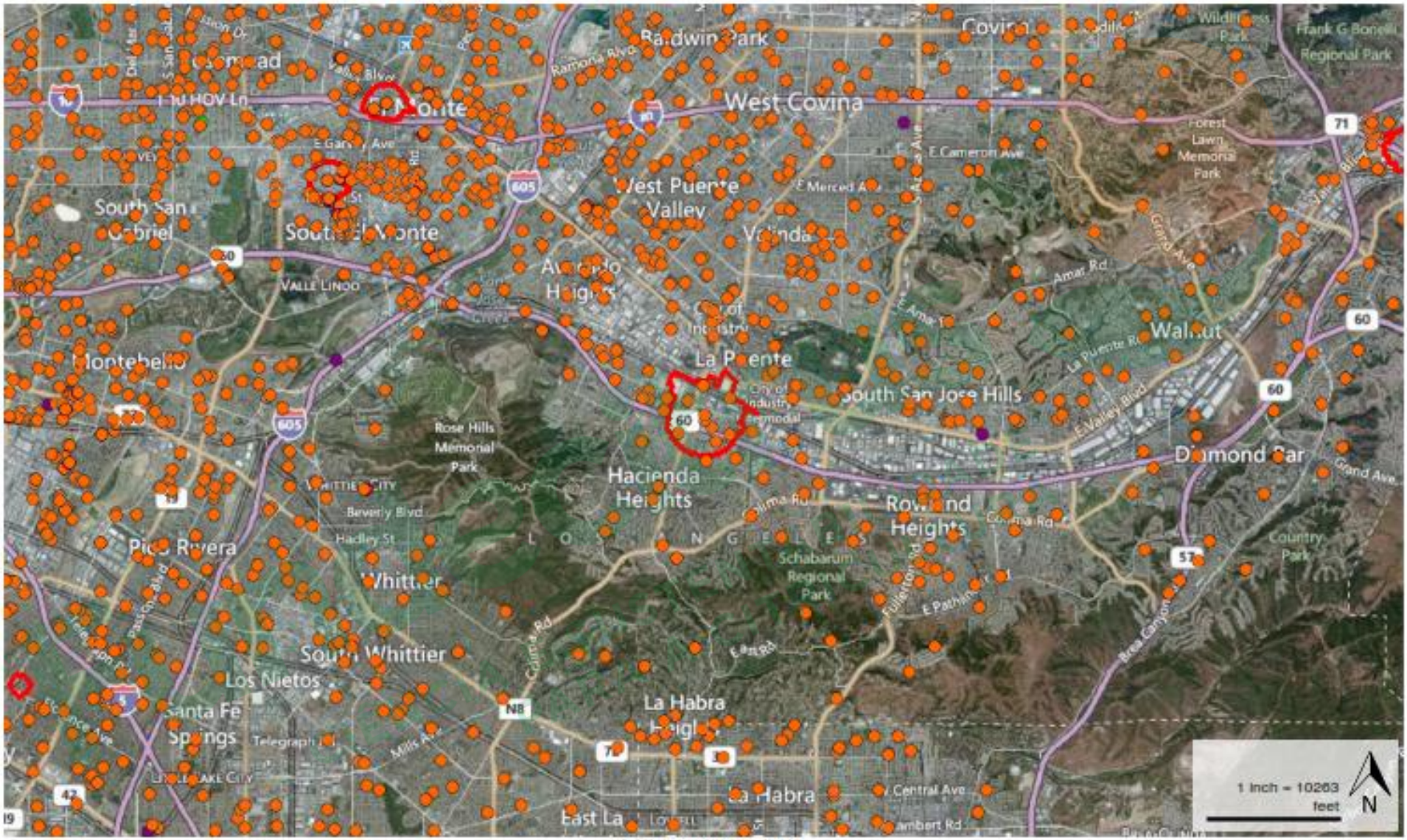
Celestina Galindo, CDFA

2010 ACP Detections Near Hacienda Heights, Los Angeles



ACP Detections 2010

2011 ACP Detections Near Hacienda Heights, Los Angeles



ACP Detections 2011

2012 ACP Detections Near Hacienda Heights, Los Angeles

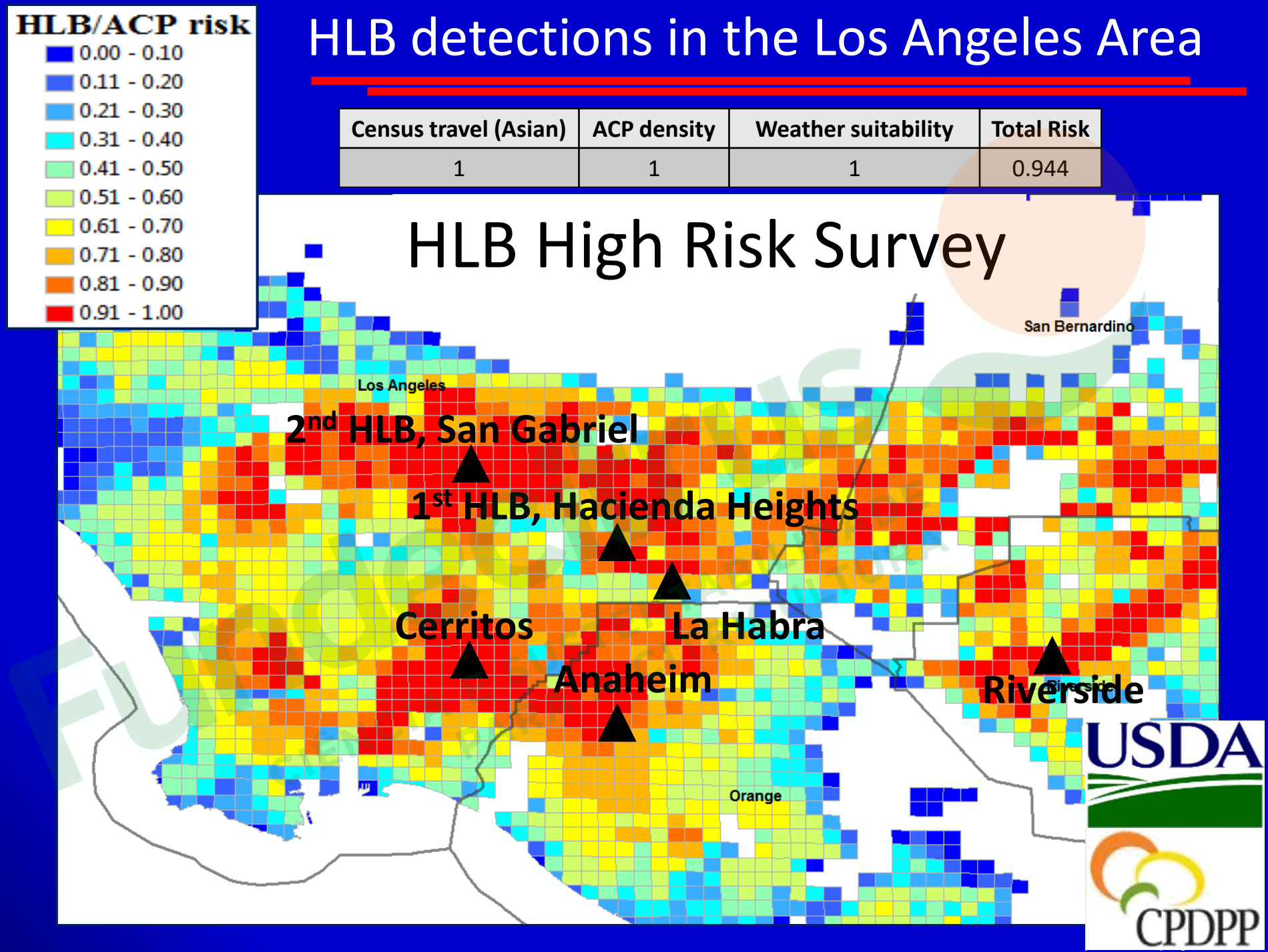
ACP Detections 2012

2012-1st HLB Tree-Hacienda Heights, Los Angeles

- April 2012
- Lemon/Pummelo
- Tree had 23 grafts
- Budwood used – Unknown Origin

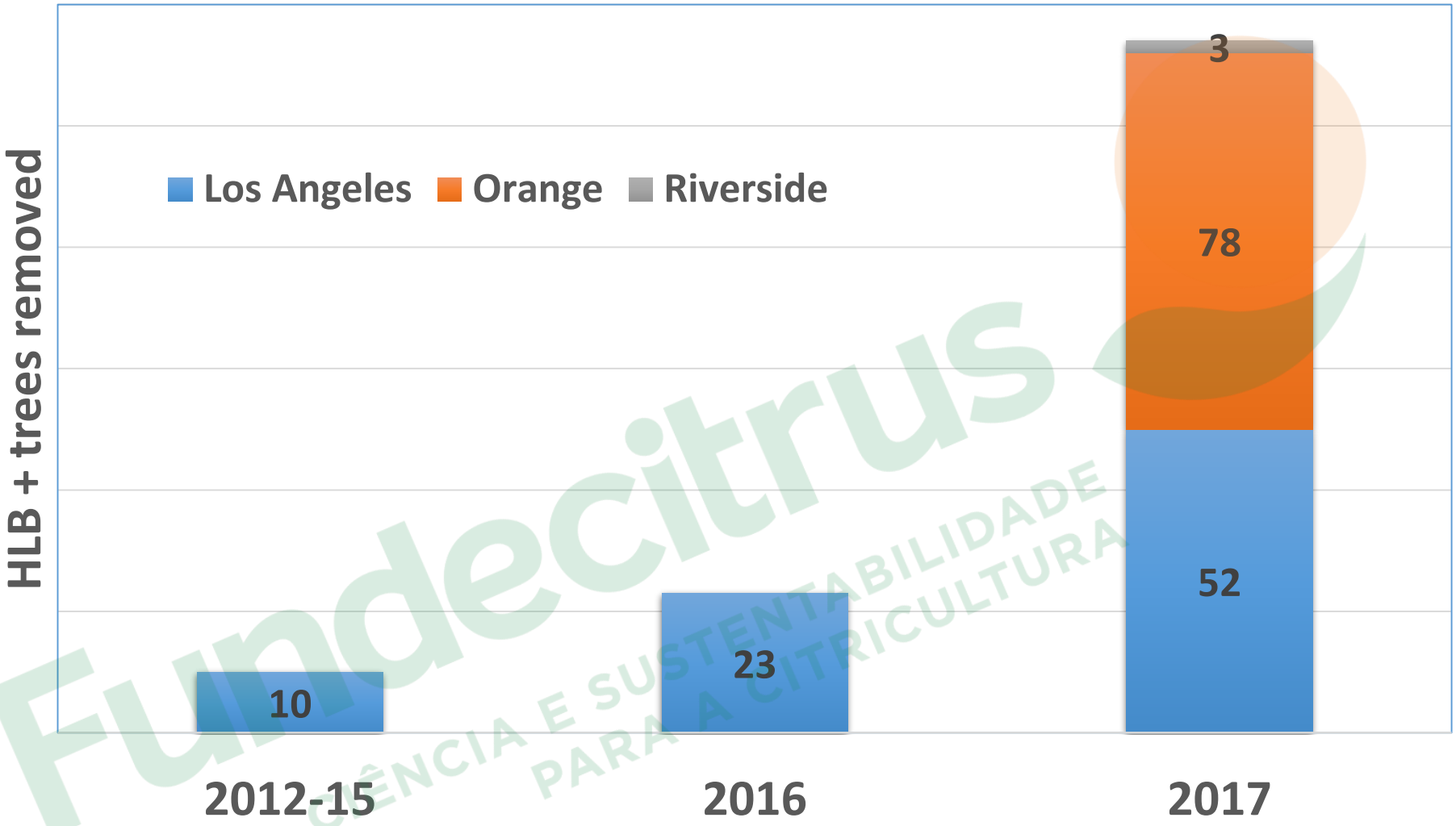
HLB detections in the Los Angeles Area

Census travel (Asian)	ACP density	Weather suitability	Total Risk
1	1	1	0.944



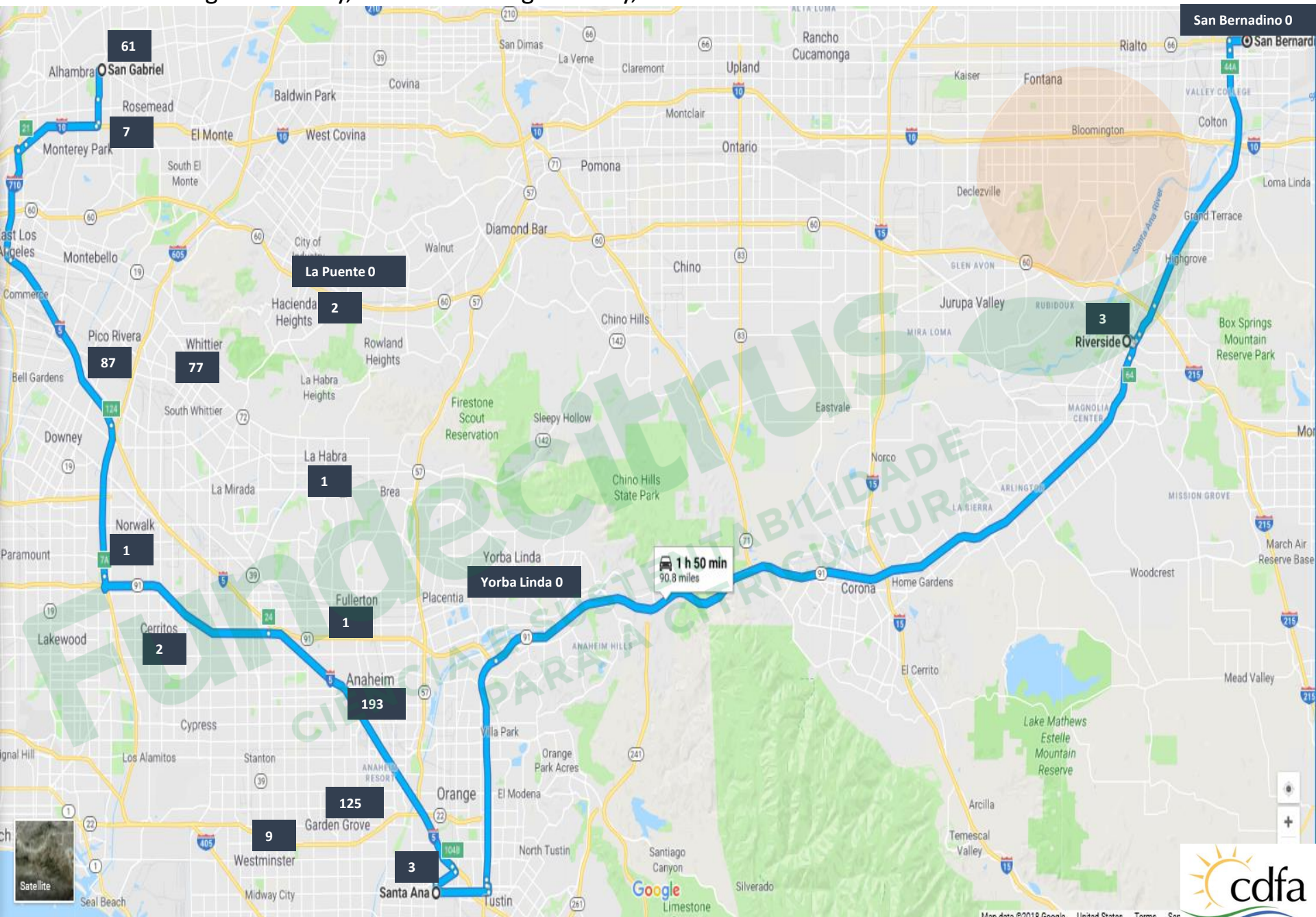
HLB+ trees California

166 in October 2017…



Beth Grafton-Cardwell, UC Riverside

California HLB+ Trees April 2018. A total of **587 HLB+** trees have been detected and removed.
241 from Los Angeles County, **343** from Orange County, and **3** from Riverside.



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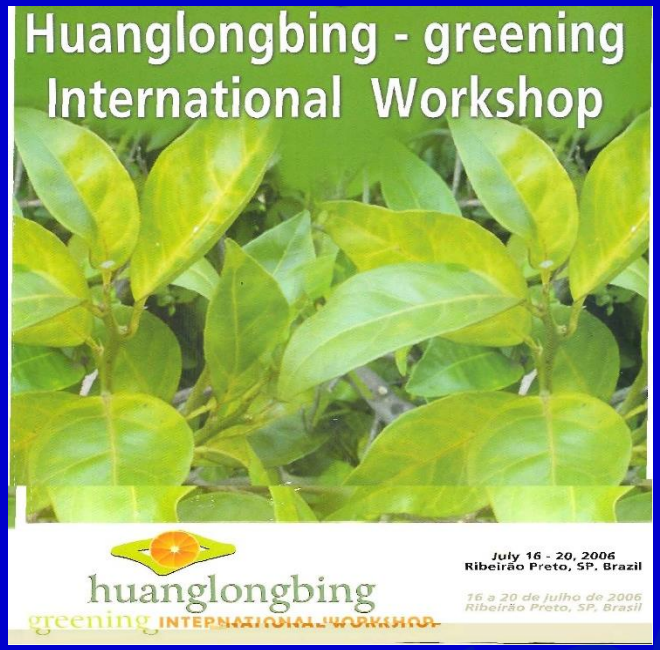
2006 - Californians Visit Brazil



July 13

- Fundecitrus, Juliano Ayres
- Cambuhy Farms, Luiz Rodrigues and Fernando Tersi
- Columbia, Nelson Wullf

July 14

- Fiorese Citrus Nursery, Henrique Fiorese
- Bebdouro Citraculture Experiment Station, Eduardo Stuchi

HUANGLONGBING PRE-CONFERENCE TOUR - SAO PAULO, BRAZIL

Suggested Action Plan for the detection of Huanglongbing (HLB) and/or *Diaphorina citri* in California. It is recommended that a statewide task force be formed to develop appropriate regulations and implement an action plan. On all levels, launch an extensive educational and training program as soon as possible as a means to exclude and/or achieve the early detection and eradication of HLB and the citrus psyllid in California. Engage the 3 "P"s; prepare, prevent, and partnership.

	Nursery Level	Commercial	Regulatory	Residential
HLB Only **Murraya spp. are of concern especially those originating from Florida.** **It is necessary to locate illegally introduced material from Asia, Brazil, Florida, and other infected areas.**	Eradicate infected plants; place a hold on the nursery; determine the Liberibacter species. Conduct a trace forward and trace backward. Implement a survey program of surrounding area (citrus, Murraya spp) Set out traps; monitor for psyllid; conduct training for the identification of psyllid and HLB symptoms.	Eradicate infected plants; determine the Liberibacter species; implement a survey program; train and partner with industry for long-term survey.	USDA & CDFA: Conduct a delimitation survey; increase survey; Implement and enforce regulations regarding inter- and intra-state plant movement; strengthen nursery regulations such as mandatory enclosed production; consider the possibility of eradicating all Murraya plants Prepare the diagnostic lab in Sacramento for confirmation of bacterium	Survey Murraya plants for HLB symptoms and test by PCR; focus on plants that have entered California from Florida within last 4 years. Survey backyard citrus in high-risk areas. Eradicate infected plantings of Murraya and backyard citrus trees.
D. citri only **Texas, Florida, Mexico, and Hawaii are major concerns because the vector is present.**	Apply additional systemic pesticides; set out traps to monitor for psyllid; release bio-predators; conduct training on identifying the psyllid and HLB symptoms.	Apply additional pesticides Release bio-predators Conduct training for the identification of psyllid and HLB; set out insect traps to monitor for psyllid	Implement a statewide psyllid monitoring program – set out traps, identify Murraya plantings and survey for psyllid and HLB symptoms; Test psyllids for HLB	Conduct a delimitation survey for psyllid
Both HLB and D. citri	Apply additional systemic pesticides; implement survey and eradication programs; release bio-predators	Apply additional pesticides; implement survey and eradication programs, release bio-predators	USDA & CDFA: Conduct a delimitation survey; increase survey; Implement a psyllid monitoring program – set out traps, survey Murraya	USDA & CDFA: Conduct a delimitation survey; increase survey; Implement a psyllid monitoring program – set out traps, survey Murraya
Neither HLB or D. citri[1]	Launch an extensive education and training program; survey for psyllid	Launch an extensive education and training program; survey for psyllid	Release biological predators; training to identify D. citri and HLB symptoms	Conduct sentinel survey of dooryard citrus & Murraya trees for psyllid and HLB symptoms

2009-Citrus Budwood & Citrus Nurseries Protection

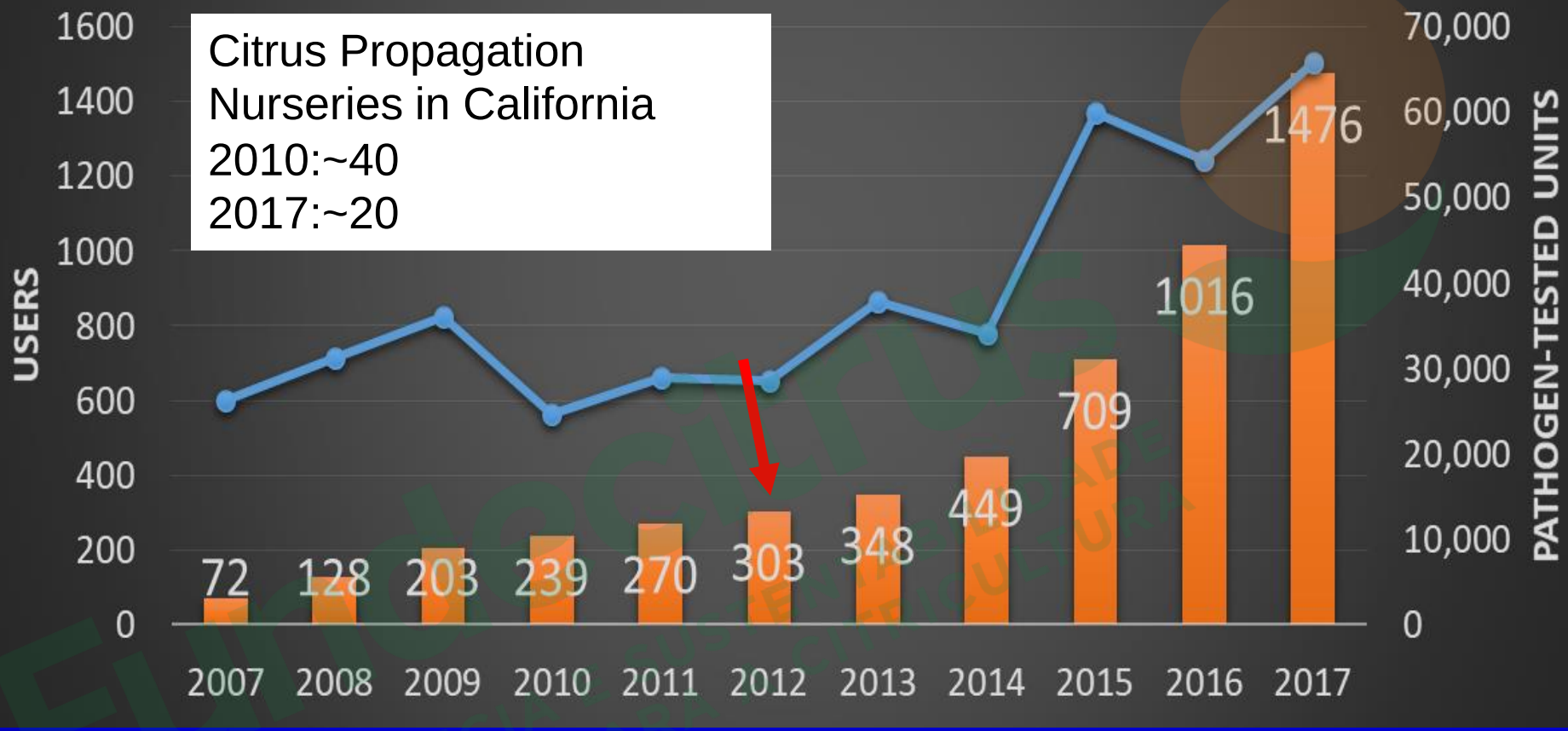
- California Citrus Nurseries Production Under New Conditions/Systems
- Senate Bill No. 140 Citrus Nursery Stock Pest Cleanliness Program Mandatory pathogen testing for mother nursery trees

2010-Budwood & Nursery Protection & Innovation
Pre-HLB & ACP Testing & Inspections

Citrus Clonal Protection Program
... starting citrus correctly

CCPP Budwood Users (Bars)
Pathogen-Tested Units (Line)

Citrus Propagation
Nurseries in California
2010:~40
2017:~20



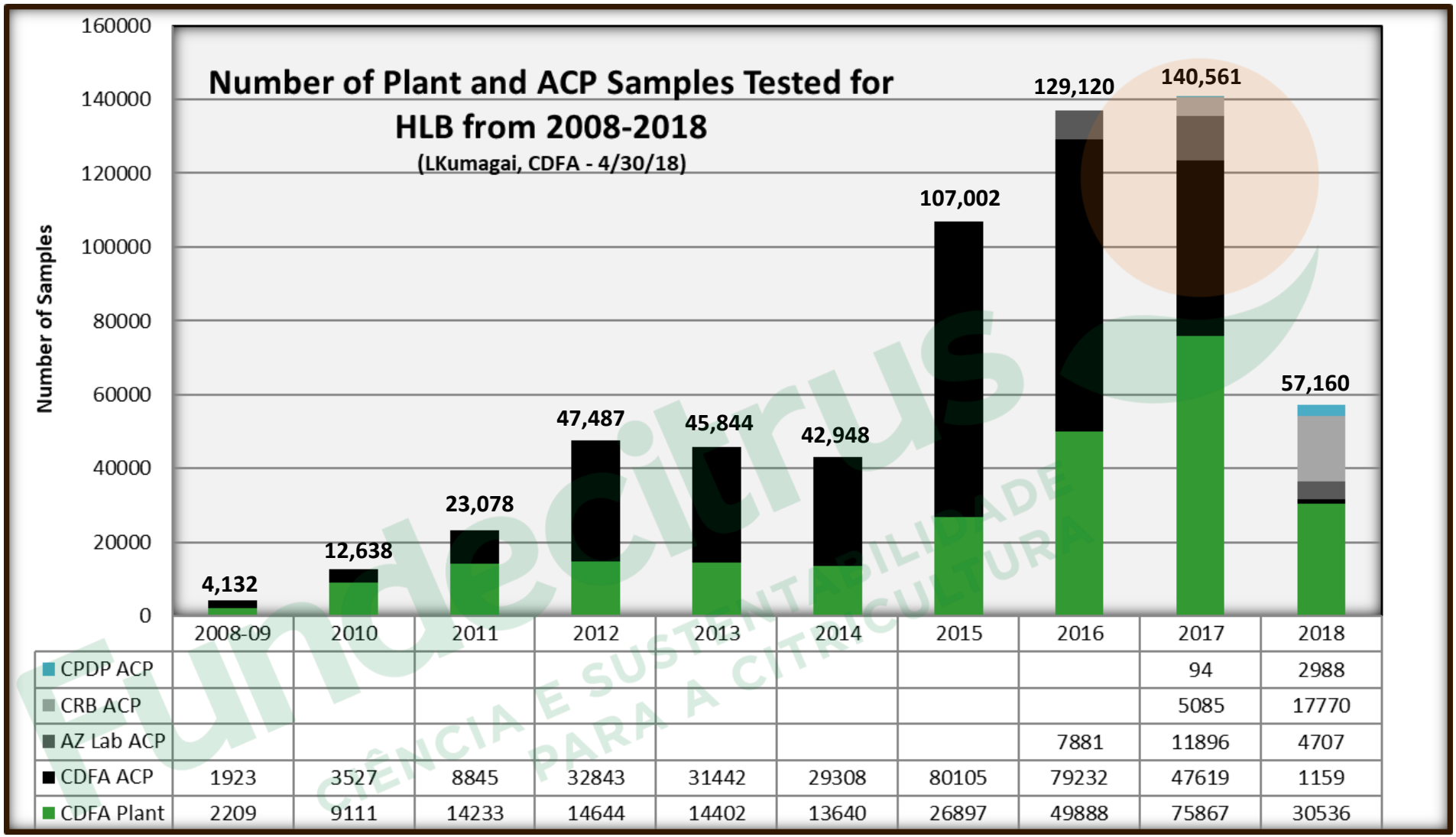
05/20/2018: 1916 customers
404 Orders
279 Accessions
29,979 Buds

2010-CPDPC: California HLB-ACP Program Partners

- Federal
  - USDA
- State
  - California Department of Food & Agriculture
  - University of California
- Local
  - County Agricultural Commissioners
- Industry
  - California Citrus Research Board
  - Growers & Nurseries
- CA Residents

California HLB-ACP Program Activities: $41.5M

- Detection Trapping
- Visual Survey
- Residential & Area wide Treatments
- Environmental Monitoring
- Neglected and Abandoned Groves
- ACP & Plant Testing
- Biocontrol
- Quarantine
- Outreach
- Research



	2008-09	2010	2011	2012	2013	2014	2015	2016	2017	2018
CPDP ACP									94	2988
CRB ACP									5085	17770
AZ Lab ACP								7881	11896	4707
CDFA ACP	1923	3527	8845	32843	31442	29308	80105	79232	47619	1159
CDFA Plant	2209	9111	14233	14644	14402	13640	26897	49888	75867	30536

Figure 2. Number of samples submitted for HLB testing per year from 2008 to 2018. Combined total of plant and ACP samples tested from 2008 –2018 is 617,851.

ACP Detection/Delimitation

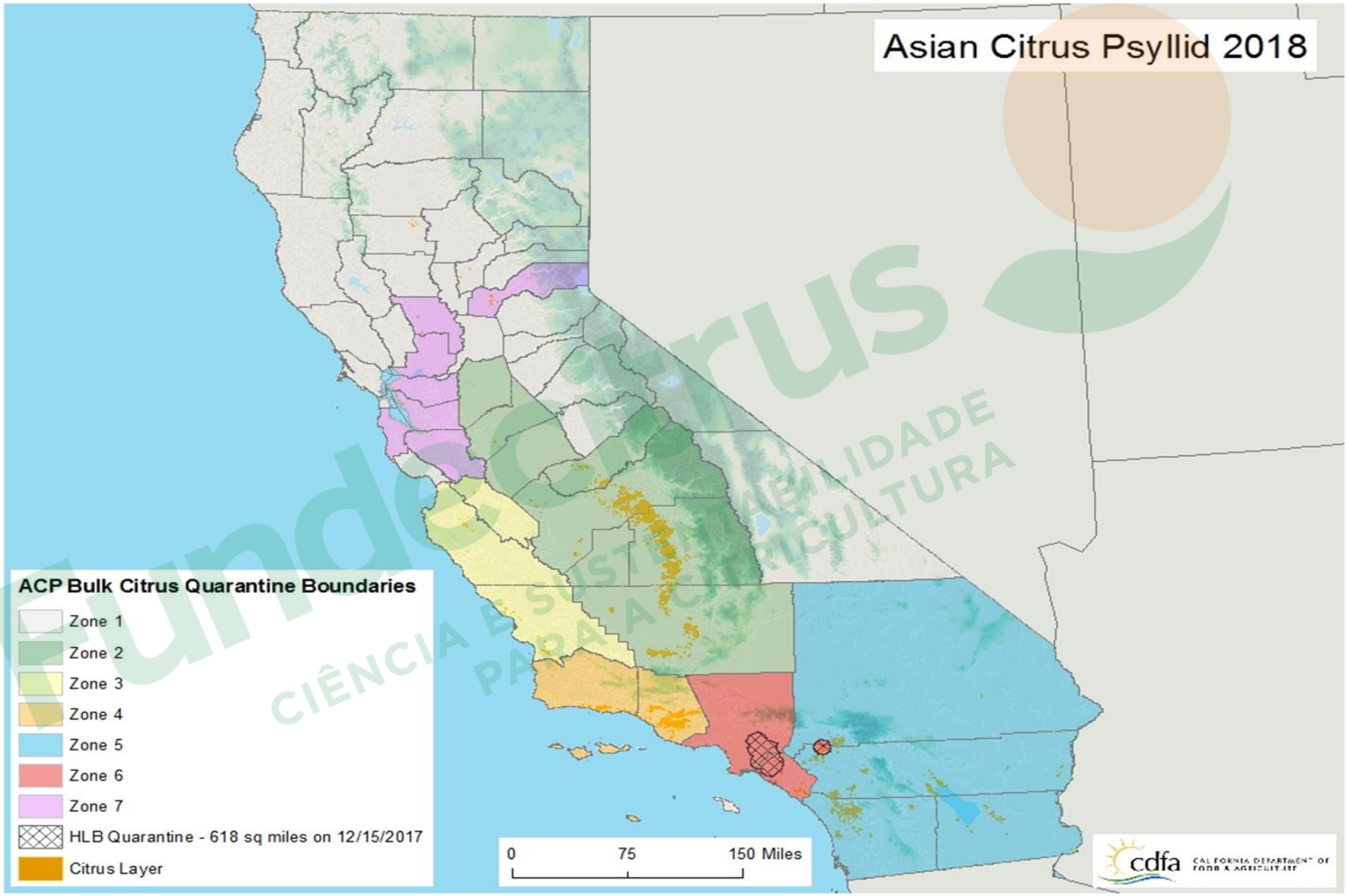
- Residential Trapping throughout the State
- Commercial Grove Trapping in the Central Valley.
- Visual Surveys around the delimitation area

Trap Servicing Interval: Traps will be serviced bi-weekly for one month and monthly after that for two years past the identification date.

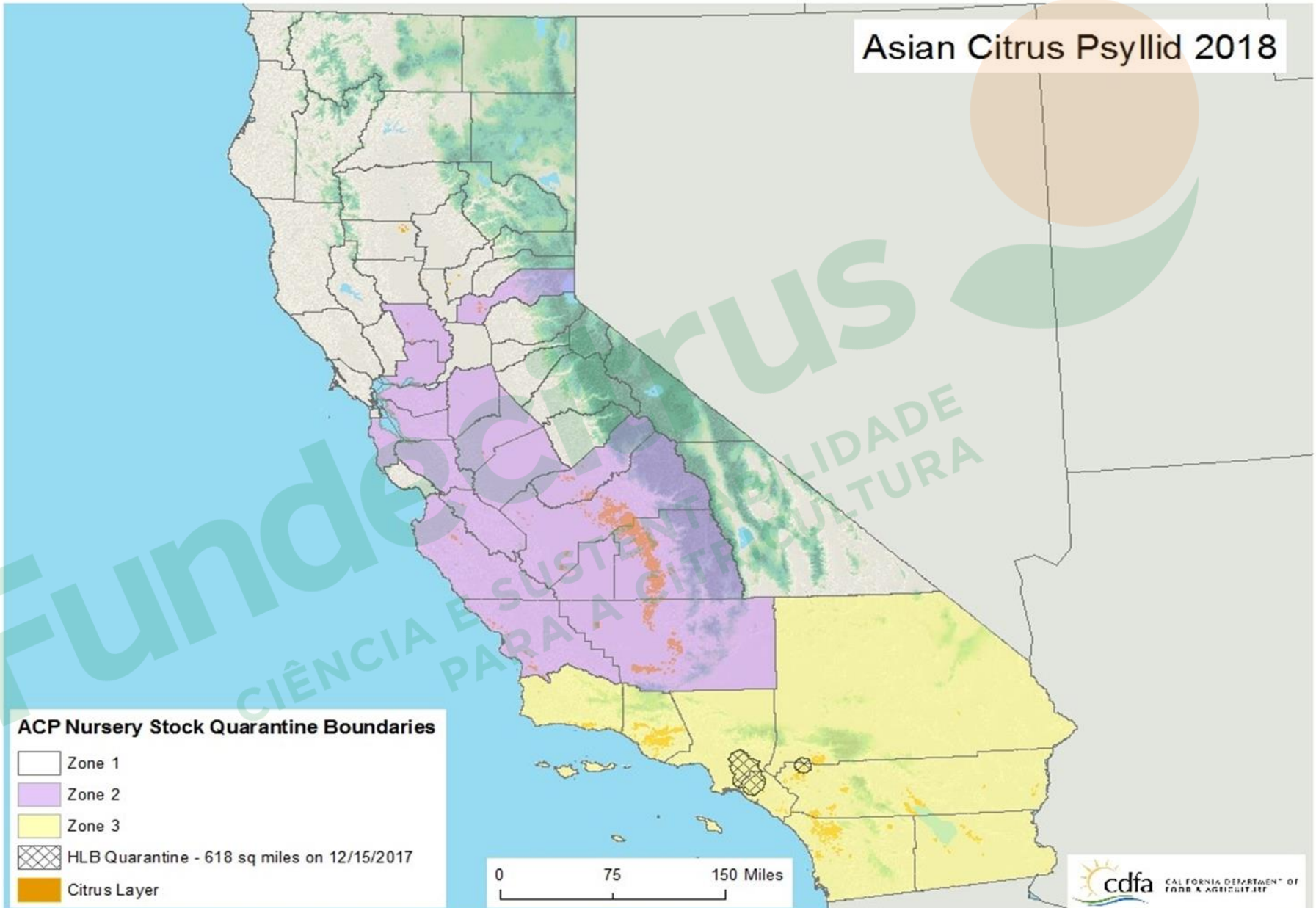
HLB Detection/Delimitation

- Intensive ACP trapping in the HLB detection core
- State-wide risk based survey
- Cluster survey
- 800 meter delimitation survey
- ACP live collection for HLB testing in commercial citrus in Southern California
- Testing plants and ACP for HLB

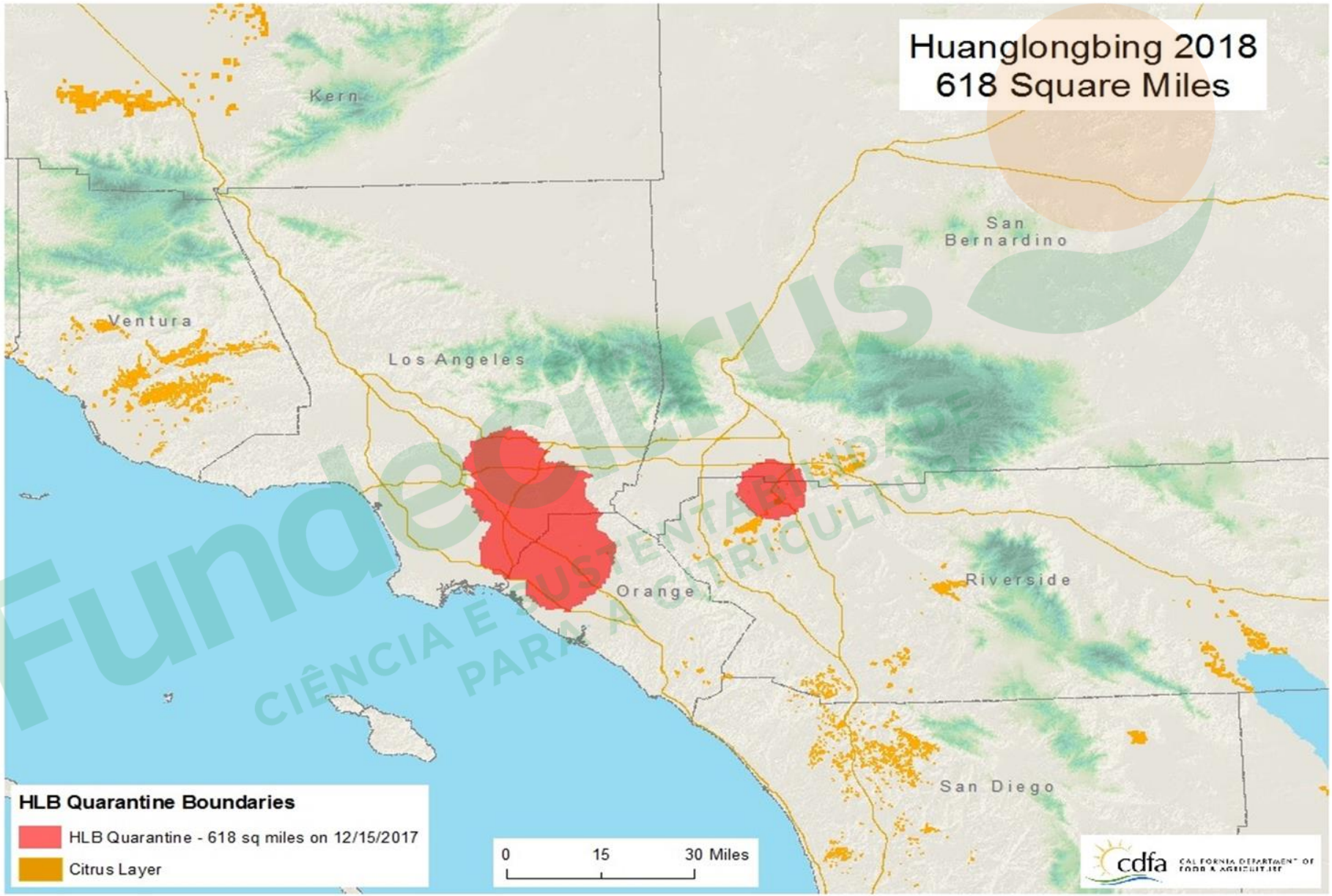
Regional Quarantine – Bulk Citrus Zones



Regional Quarantine - Nursery Zones



HLB Quarantine Area



http://ucanr.edu/sites/ACP/

Quarantines restrict movement

Eradicative/ Coordinated Treatments

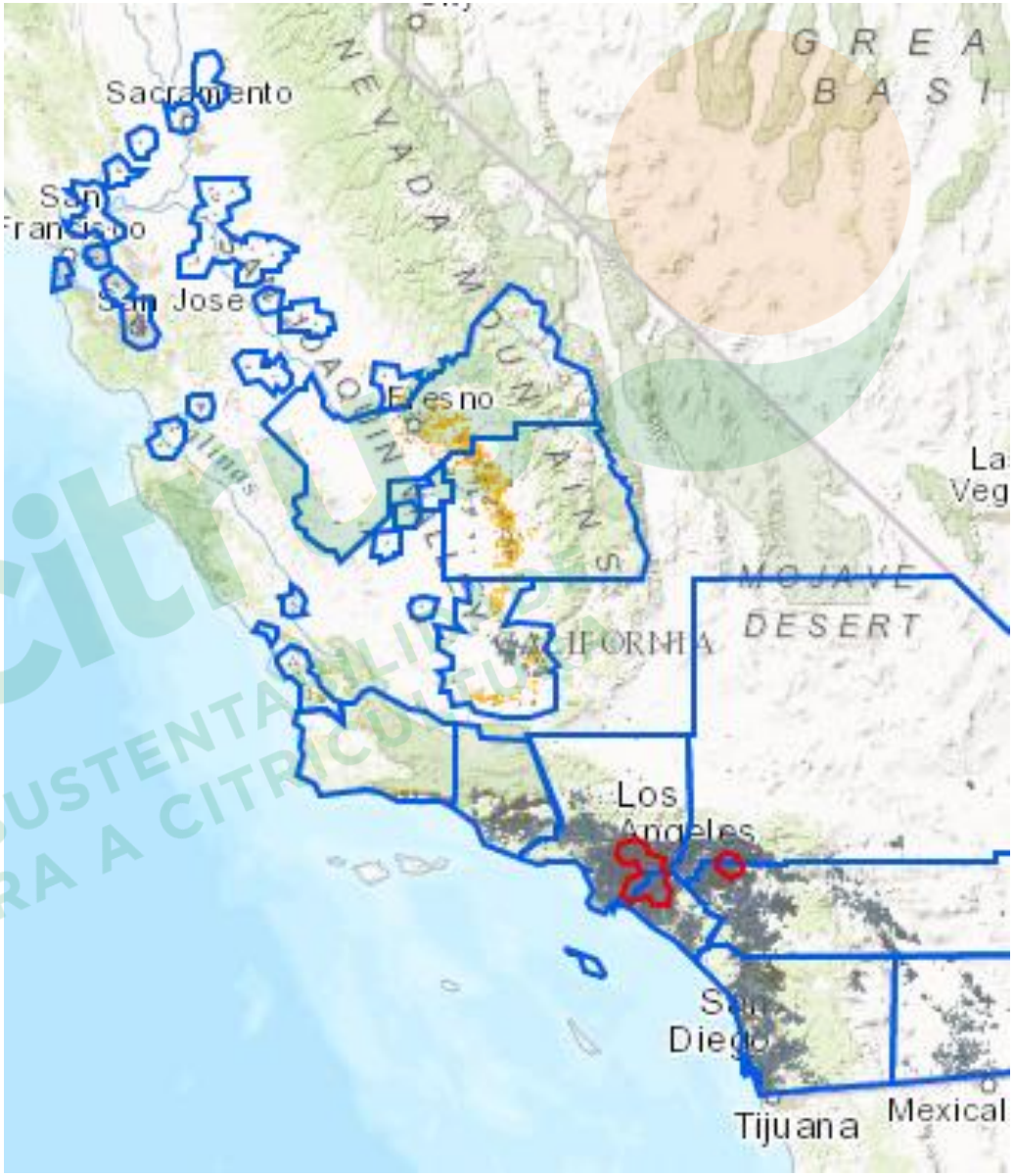
Commercial citrus: Growers treat together over a 2-3 week window

Urban: treated in a 400 meter area whenever psyllids are found

Areawide treatment program

Commercial citrus: PMAs treat together over a 2-3 week window (spring & fall) + additional treatments

Urban: parasites released



http://ucanr.edu/sites/ACP/

University of California, Division of Agriculture and Natural Resources

Asian Citrus Psyllid Distribution and Management

Home | Growers | Homeowners | Map of Psyllids, HLB and Parasites

- Home
- Online Course
- Grower Options
- Grower Management
  - Monitoring
  - ACP Effective Insecticides
  - Residual Activity of Insecticides
  - Eradication Strategy
  - Area-Wide Treatment Programs
- Grower Costs
- Grower Resources
- Homeowner Options

Grower Management

If psyllid is new to an area, then the **eradication strategy** is the best approach to managing the psyllid. If the psyllid is established in an area, then the growers shift to a **management strategy** of treating year-round with ACP-effective insecticides, focusing on overwintering adults and protecting new flush from egg laying. To determine if you are in eradication or management mode, consult the **interactive mapping tool** for the current distribution of ACP and HLB.

Not all insecticides are effective against ACP and some are short-lived, some only affect nymphal stages and some are quite toxic to natural enemies.

- Focus on overwintering adults and protecting new flush
- Rotate between chemistries to avoid selecting for resistance
- Use selective insecticides for the in-season treatments to allow natural enemies to survive and assist with control
- Be aware of MRLs to ensure export

http://ucanr.edu/sites/ACP/

ACP Effective Synthetic Insecticides			
Chemical group	Pesticides	Mode of Action	Selectivity
Organophosphate	Lorsban, Supracide, Dimethoate, Imidan	1a	Broad spectrum
Carbamate	Sevin, Lannate, Carzol	1b	Broad spectrum
Pyrethroids	Baythroid, Danitol, Mustang, Tombstone	3	Broad spectrum
Neonicotinoids foliar	Provado and generics, Actara	4a	Broad spectrum
Neonicotinoids systemic	Admire and generics, Platinum		Broad spectrum
Butenolide	Sivanto	4d	Broad spectrum
Pyrethroid + neonicotinoid	Leverage	3+4a	Broad spectrum
Neonicotinoid + abamectin	Agri-Flex	4a +6	Broad spectrum
Neonicotinoid + chlorantraniliprole	Voliam Flexi	4a + 28	Broad spectrum
Spinosyns	Delegate	5	Soft
Benzylureas	*Micromite	15	Soft
Meti insecticide	Fujimite	21	Soft
Tetronic acid	*Movento (foliar systemic)	23	Soft
Anthranilic Diamide	Altacor, Exirel, Verimark (systemic)	28	Soft
Anthranilic diamide + abamectin	Minecto Pro	28 + 6	Soft

http://ucanr.edu/sites/ACP/

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Riverside/San Bernardino Pest Management

Miticides, Fujimite

Yuma mite on young trees, Texas mite

Citrus thrips

Success, Delegate

Mealy bug in grapefruit — Cryptolaemus predators

Argentine ants — Lorsban

Aphytis, Lorsban, Movento — California red scale

Black scale, mostly grapefruit

Asian citrus psyllid

Treatments in red are ACP effective

Grower choice foliar

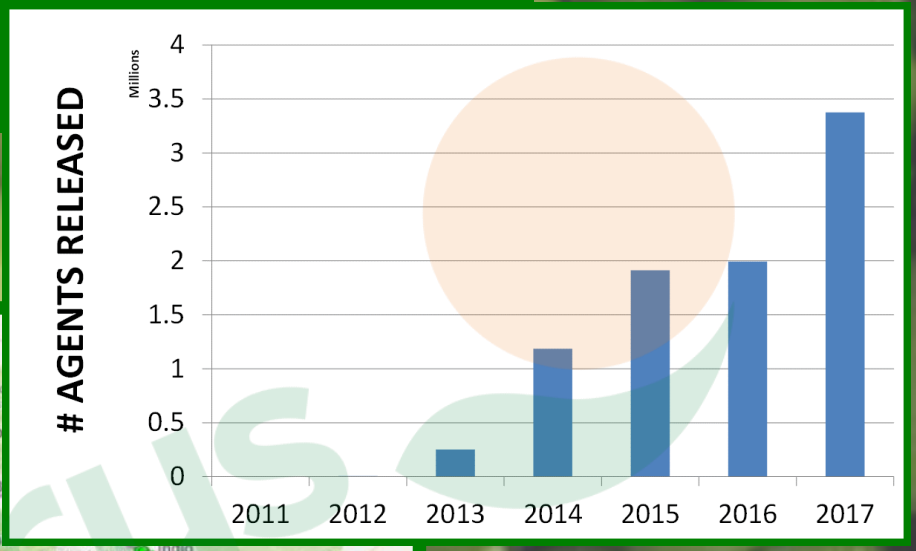
Coordinated treatment: Fall foliar

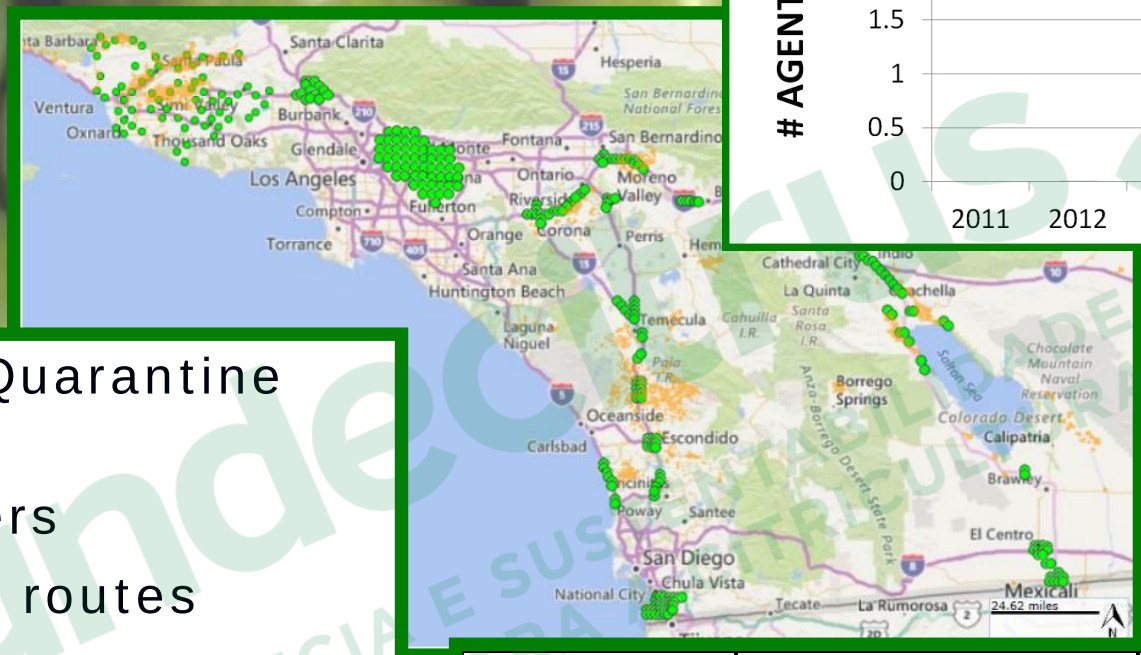
Coordinated treatment: Late fall foliar

Environmental Monitoring

- To ensure protection of human health and the environment, the CDFA has contracted with DPR to oversee environmental monitoring of treatment projects.
- Sampling media include air, leaf, soil, tank, and water.

Biological Control Agent Releases

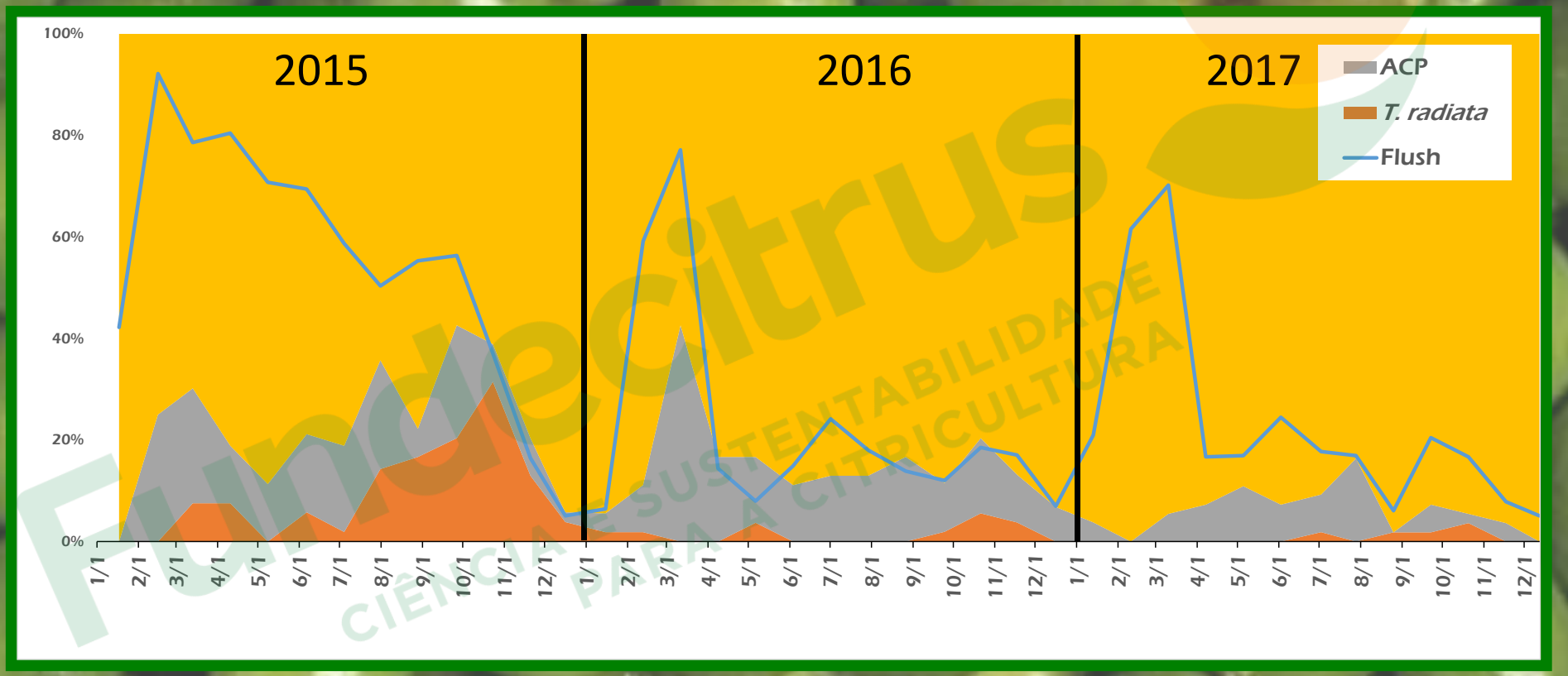




1. HLB Quarantine areas
2. Borders
3. Trade routes
4. Area-wide management
5. Newly established ACP

Release Type	2016		2017	
	# Agents	%	# Agents	%
Borders	472,960	24	592,483	18
HLB	634,503	32	1,972,984	59
New	26,733	1	56,013	2
Other	858,560	43	723,249	22

Monitoring Results
2015 – 2017



Today's Presentation

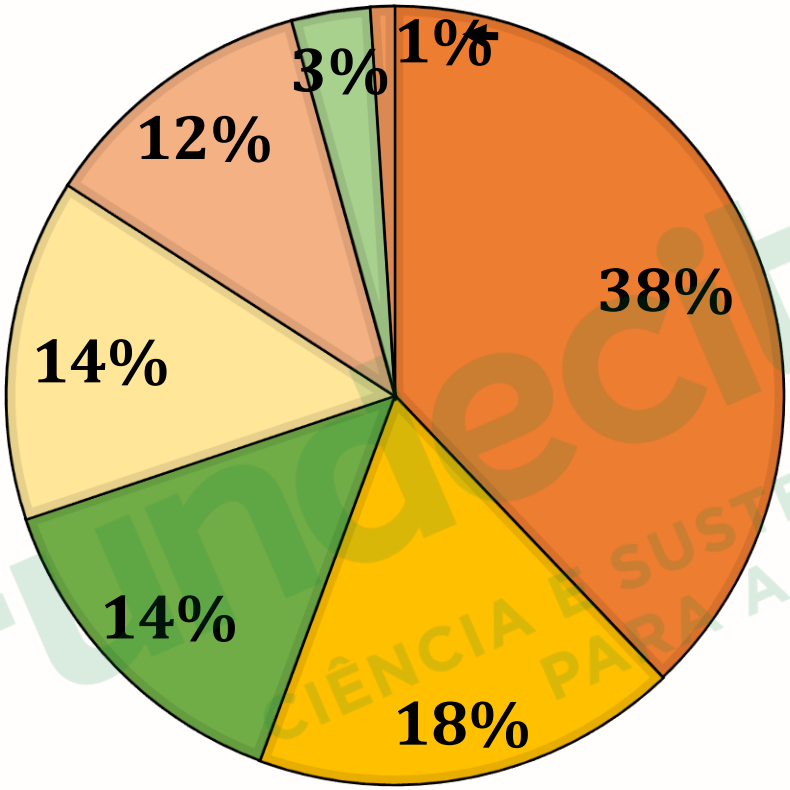
1. A brief introduction of citrus in California (size, characteristics, types of citrus, markets, ……)
2. HLB situation (historical and current distribution, …)
3. Efforts to contain disease spread (ACP monitoring and control, diseased tree surveys ……)
4. Main research projects and perspectives.

Over $50 million are invested every year in HLB/ACP research nationally from government & growers. Myriads of projects in a long list of subjects. Impossible to cover today...Focus on California.

California Citrus Research Board HLB/ACP Projects

- 5.3 cents/box= $9.7 million assessment (2017-18).
- $4 million of additional state & federal research dollars to augment grower assessment dollars.
- 75% of Research Budget goes to ACP/HLB research. Partnerships with NIFA, CRDF & HLB MAC.
- Since 2008 the CRB has invested $33 million in ACP/HLB Research:
  - HLB Resistant/Tolerant Scions & Rootstocks
  - Early Detection Technologies (EDTs)
  - Vector Control
  - Anti-microbial Therapies
  - Biocontrol (IPM)
  - Citrus Clonal Protection Program (CCPP)

ACP/HLB PROJECTS



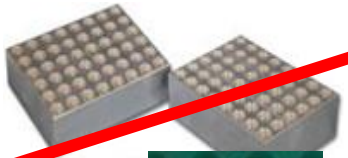
UC Riverside-CCPP Research Projects - Collaborations

1. **High throughput pathogen detection**
   a. **qPCR based**
   b. **Non-PCR based**
2. **Huanglongbing**
   a. **Secreted proteins-W. Ma**
   b. **Host small RNAs-H. Jin**
   c. **Culturing-D. Gabriel**
   d. **K9 screening-USDA-ARS**
3. **Use of viroid RNA as a citrus dwarfing agent – CUPS- P. Rolshausen**
4. **Citrus germplasm management – CCPP & Nurseries**
5. **Citrus Cryopreservation-USDA-ARS- M. Polek & G. Volk**
6. **Citrus phytobiome-C. Roper & P. Rolshausen**
7. **Breeding for resistance-M. Roose & C. Ramadugu**

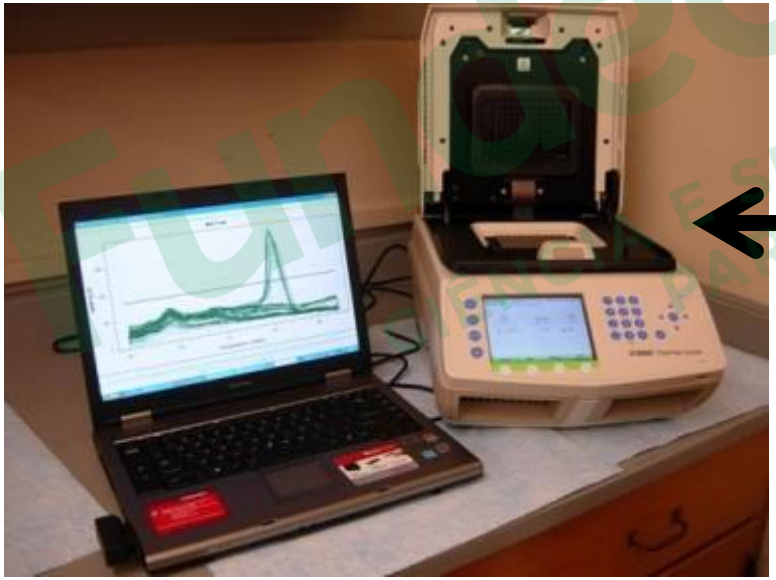
From 17-20hours per sample to 2-5min per sample



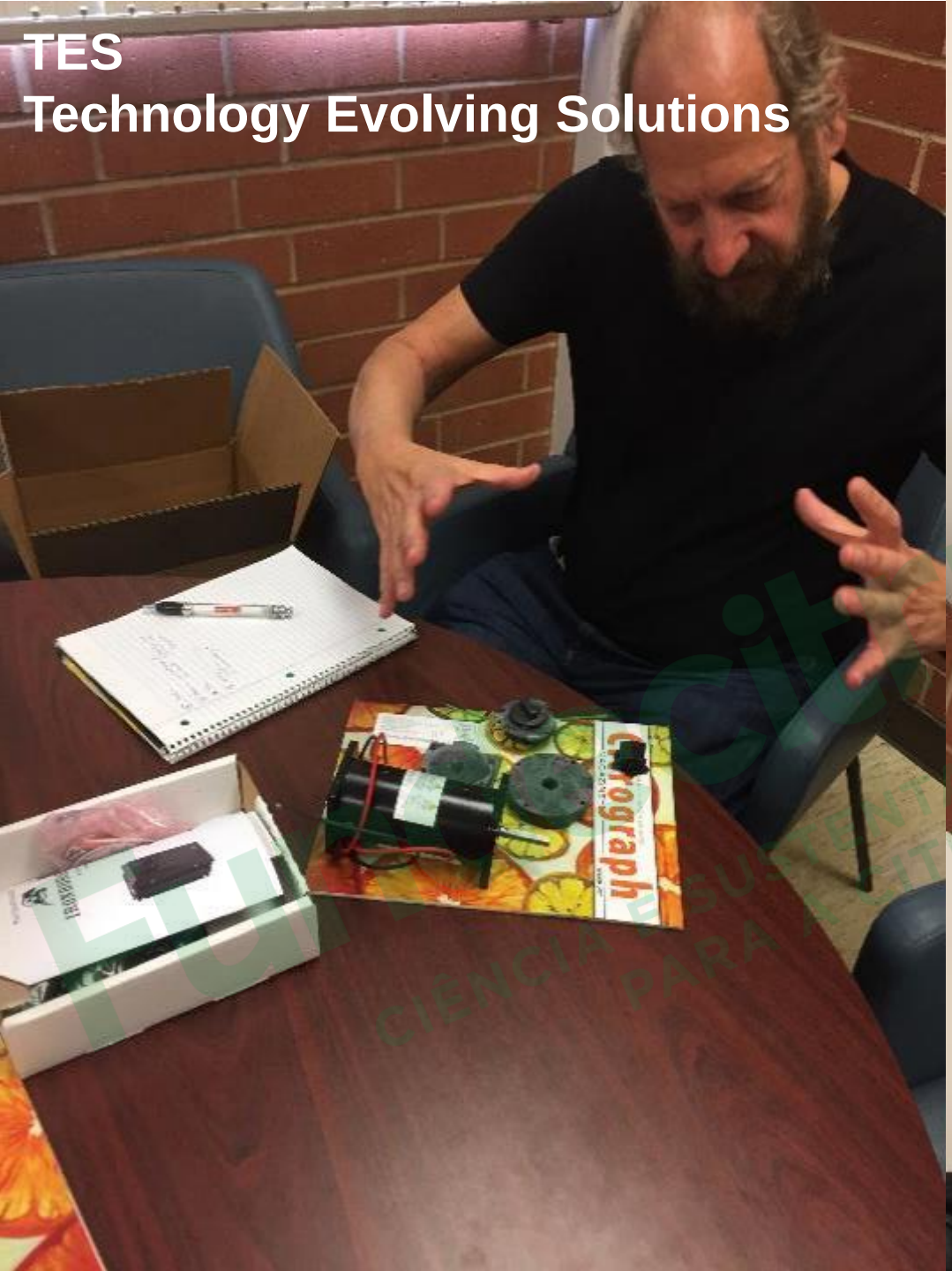






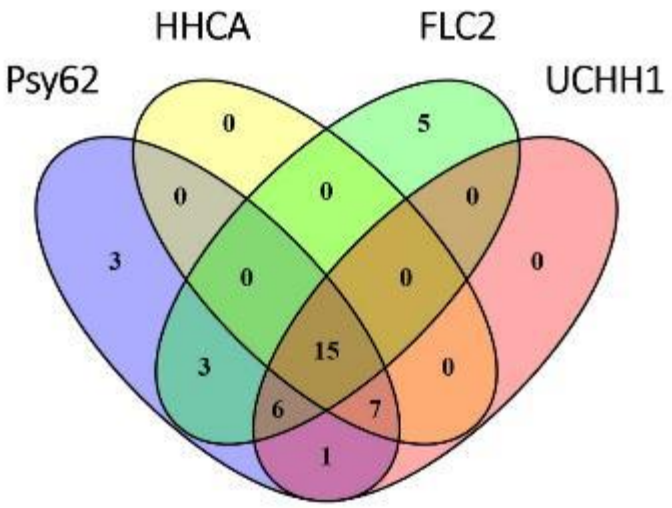


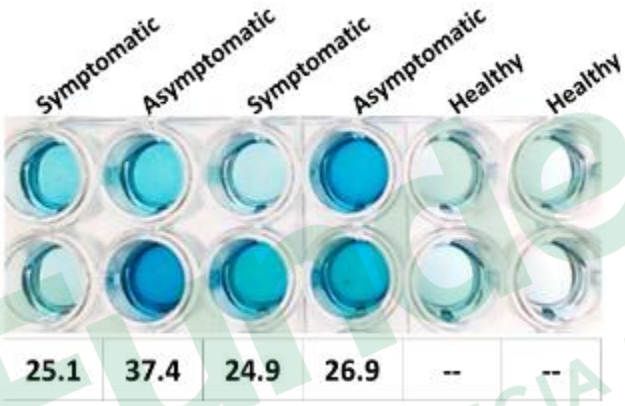
TES
Technology Evolving Solutions



TES
Technology Evolving Solutions

Wenbo Ma





Ct=	25.1	37.4	24.9	26.9	--	--

Marker	Expression in Citrus vs. Psyllids
SDE1	40.75

Predict Sec-secreted proteins using genome sequences of CLas

↓

Identify core SDEs that are unique to CLas

↓

Confirm the expression of the SDEs in HLB-infected citrus tissues

↓

Generate antibodies against selected SDEs for HLB detection

Identify SDE targets in citrus for modification using genome editing

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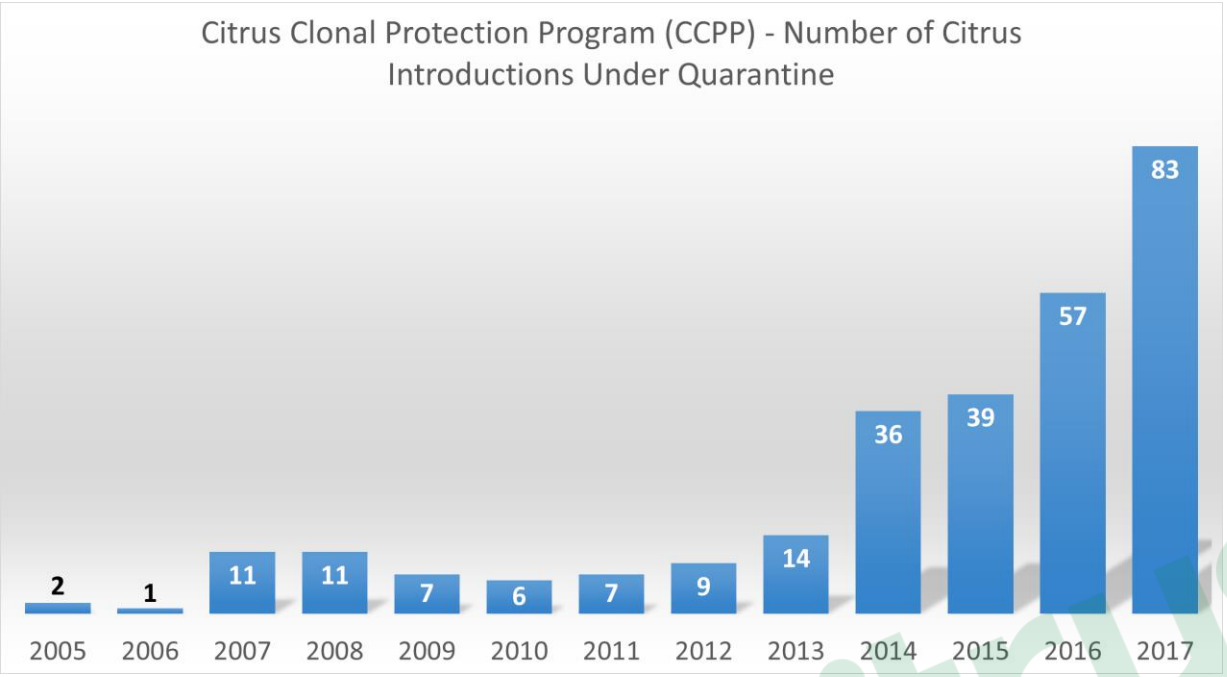
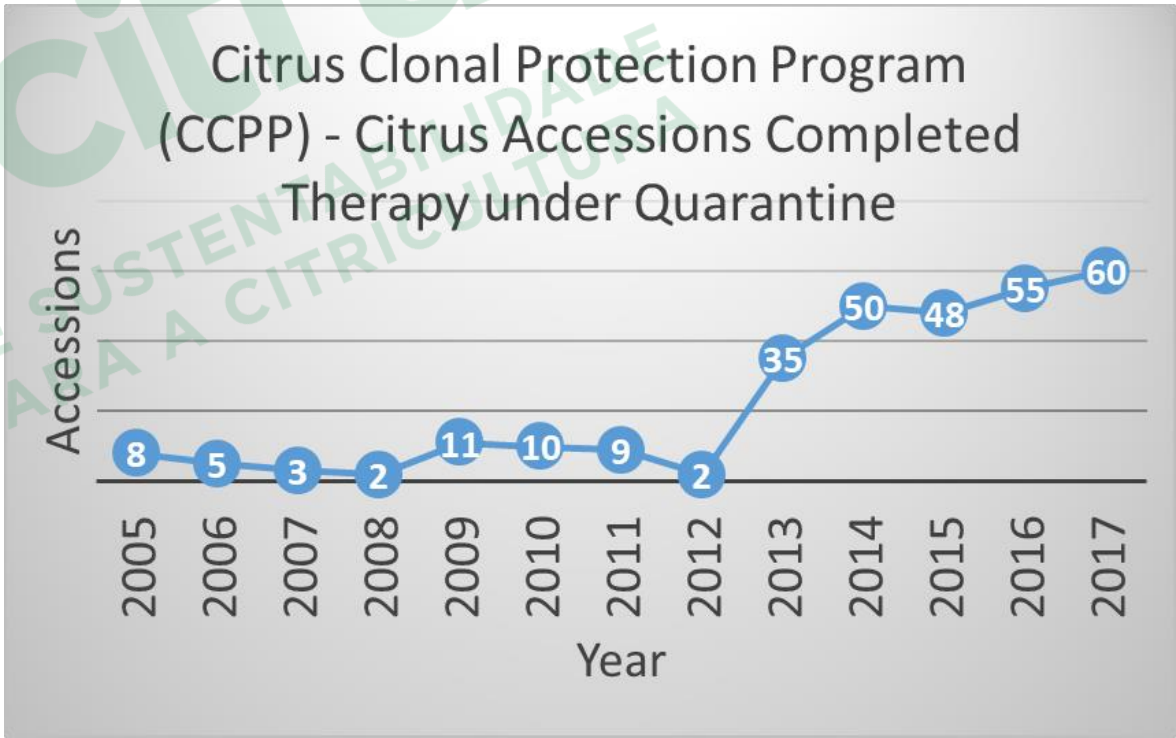
8. Breeding for resistance-M. Roose & C. Ramadugu

Citrus Germplasm & HLB
Broad Collaboration with CCPP – UC Riverside

1. University of California, Riverside
2. University of Florida, Lake Alfred
3. Florida Department of Agriculture & Consumer Services
4. California Department of Food & Agriculture
5. California Citrus Research Board
6. USDA-ARS
7. USDA-APHIS
8. Citrus Nurseries & Growers





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Valencia on *Poncirus trifoliata* + TsnRNA-IIIb

The Original Observation-Reduced Canopy Volume

20 Years Old Valencia on Trifoliate Rootstock (1984-2003)

Control TsnRNA-IIIb

Parent Navel on *P. trifoliata* + TsnRNA-IIIb

Reduced Canopy Volume

18 Years Old Navel on Trifoliate Rootstock

Control TsnRNA-IIIb

High Density 3 x 6.7m

Standard Density 6 x 6.7m

- **Increased production per land surface unit**
- **CUPS: Citrus Under Protective Structures – P. Rolshausen**

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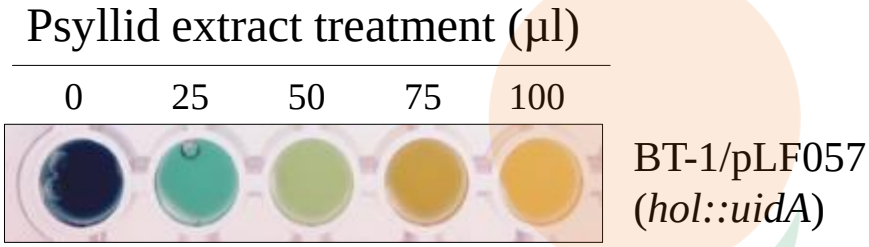
Las SC1 holin promoter is strongly repressed by psyllid extract

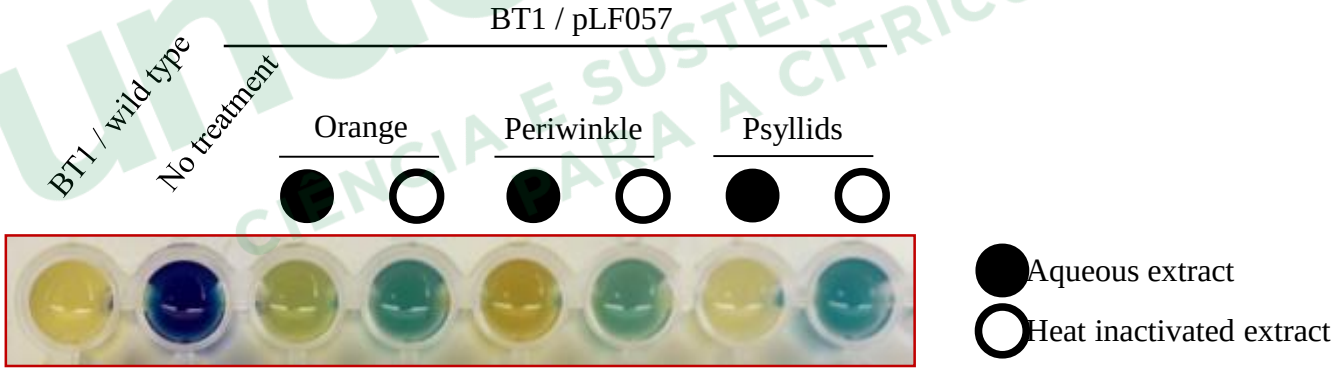
- Holin expression is lethal
- Inhibition is dose dependent
- Inhibitor is heat labile and sensitive to protease



- A Wolbachia (bacterial endosymbiont) protein found in psyllids was identified as capable of repression of the Las holing

L. crescens genome gives clues on important genes for culturing.

Inhibitory effect on GUS activity in BT1/pLF057 by plant leaf and psyllid extracts is heat labile



-Gabriel lab, 2016, including unpublished

---Fleites et al. 2014. AEM 80:6023-6030.

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Caroline Roper & Philippe Rolshausen

Sampling Design: Disease Rating

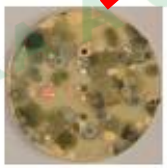
HLB+ Survivor tree

Sampling Design: Tissue Processing

Culture Independent Analysis

Culture Dependent Analysis

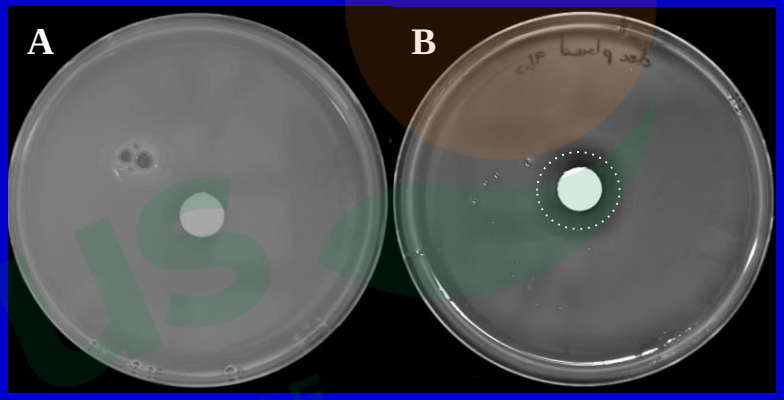
Culture Bacteria and Fungi

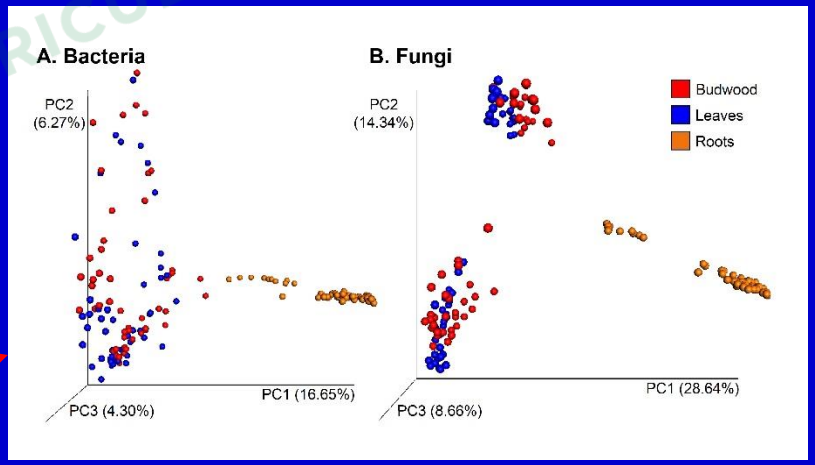


DNA & RNA extraction + sequencing

DNA extraction + sequencing

Liberibacter crescens in vitro inhibition assay





Ginnan et al. 2018. PBIOMES-08-17-0032-A

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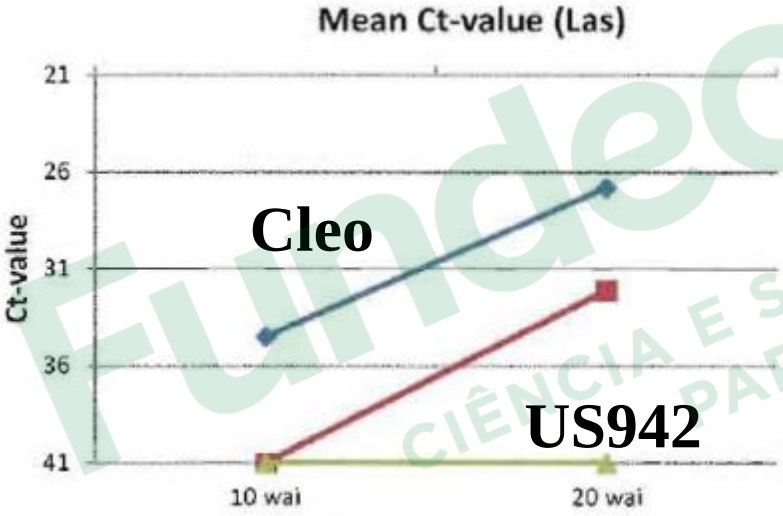
Hailing Jin & Kim Bowman / Michael Roose & Chandrika Ramadugu

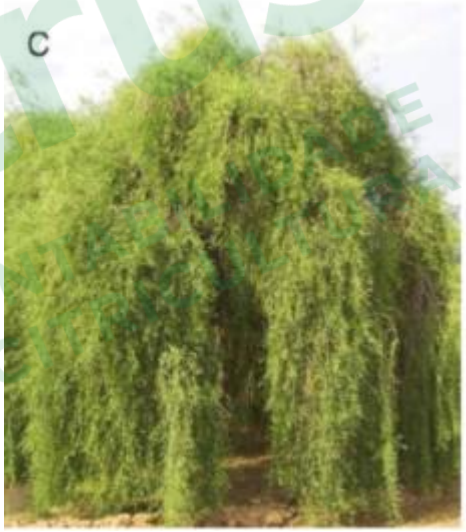
Identification of natural defense regulators against HLB

Small RNA profiling of HLB-tolerant/resistant hybrids (e.g. US942) identified a set of defense regulators against *C*Las infection.



US942 P. trifoliata hybrid

These identified regulators showed similar regulation in another HLB-resistant/tolerant hybrids, Citrus sp. x Eremocitrus



Ramadugu & Roose

Rapid Screening


Fundecitrus
CIENCIA E SUSTENTABILIDAD PARA LA CITRICULTURA

Citrus Huanglongbing (HLB) - My Prediction

- I am optimistic that California will make history.
- 10 years since the ACP introduction and we do not have an HLB epidemic in commercial citrus-Thank you Brazil and Florida for sharing your knowledge!
- Growers start feeling fatigue from the rapid developments and the cost of assessments for various programs.
- Research has developed plethora of information but we need to look for commercialization of technologies.

- Short term
  - ACP control & HLB eradication will not protect California for very long time.
- Medium term
  - Horticultural practices & treatments (tristeza virus & other vectors and antimicrobials for use in existing trees).
- Long term
  - Breeding & editing for resistance tolerance (classical and engineering) & Integrated pest management.

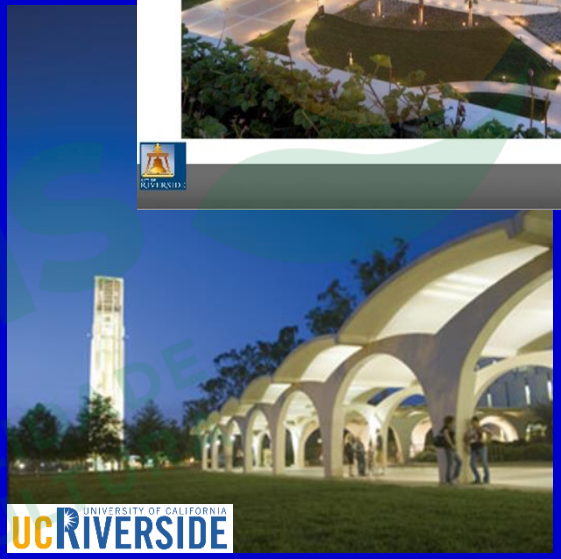
Thank You - vidalg@ucr.edu

See you All in 2019-March at Riverside, CA

- International Huanglongbing Conference
- International Organization of Citrus Virologists Conference

INTERNATIONAL ORGANIZATION OF CITRUS VIROLOGISTS

Journal of Citrus Pathology



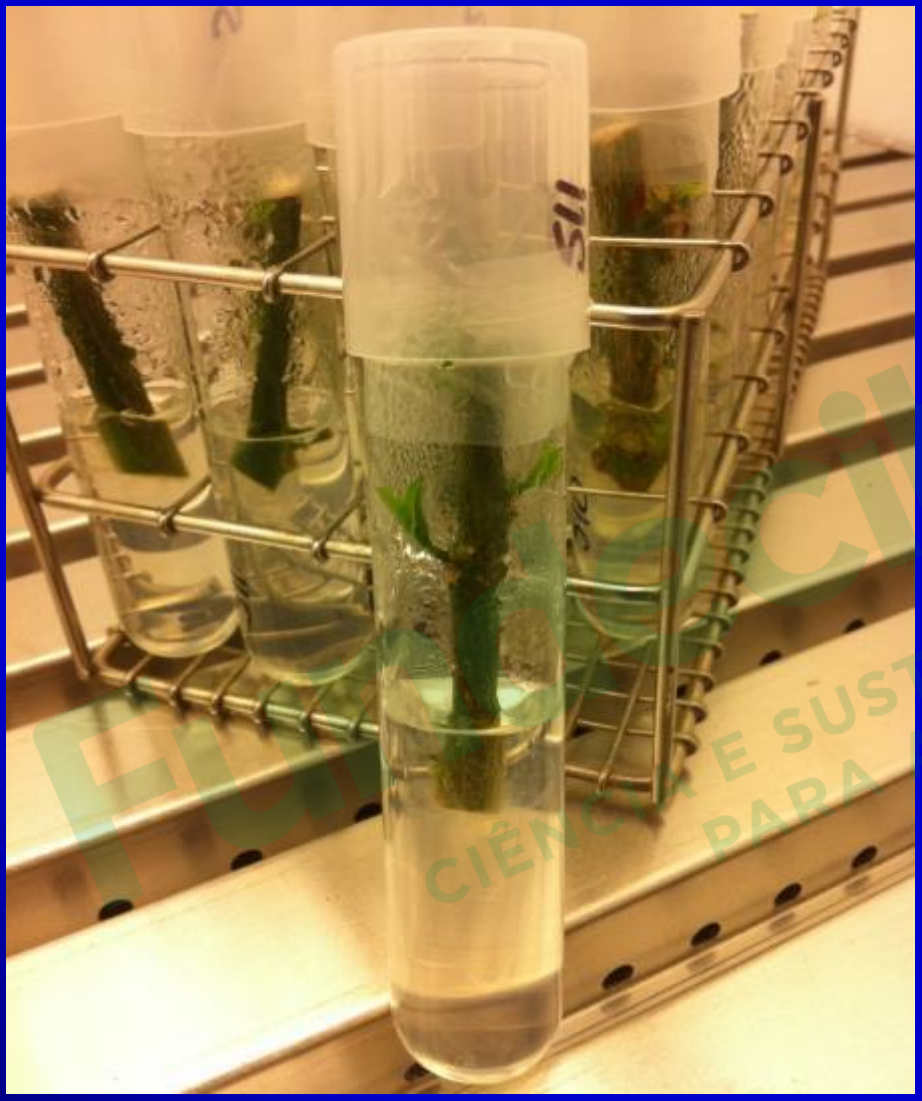
1873-Parent Navel Tree Introduced to Riverside, California from Bahia, Brazil

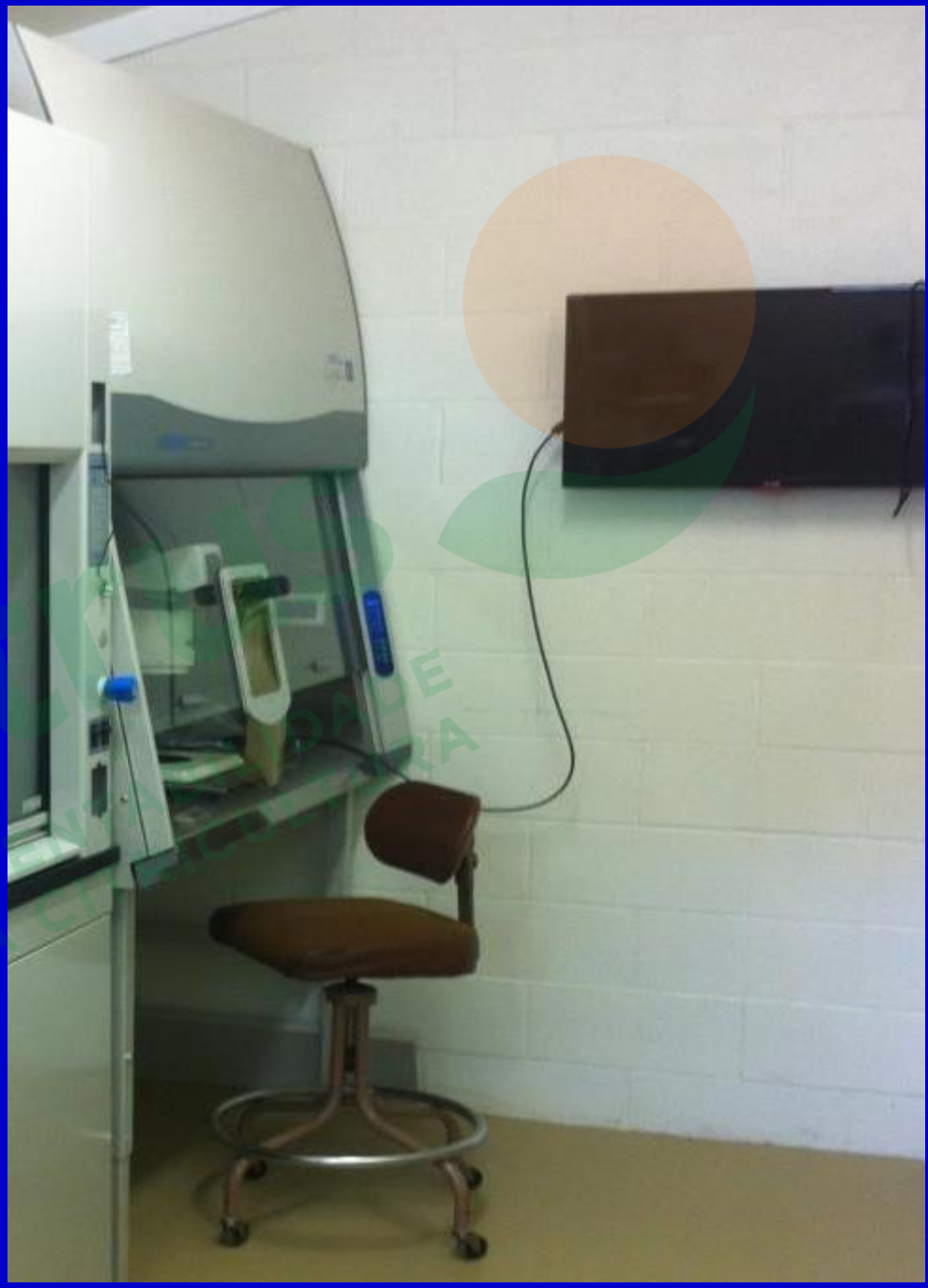
May 2014

May 2018

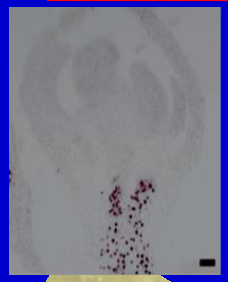
Time for citrus shoot-tip grafting video for pathogen (including CLas) elimination?

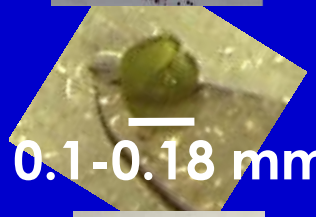
Therapy – Mandatory – HLB/ACP Regulations





Citrus Therapy-Shoot-Tip Micrografting





0.1-0.18 mm

Magnification 16-20x

Therapy