Risk based survey
De-emphasizing the core area

Science Sub-committee recommendations

11/08/2023

Executive Summary

1) Science advisory panel recommendation:

- *Split north and south California survey programs*
- *De-emphasize the core residential area.*
- *Focus on commercial-residential interphase*

2) Existing risk based survey:

- *The risk based formula to prioritize and identify STR incorporated weightings assigned to individual risks.*
- *Among the various risks, existing CLAS +ve and ACP density were weighed high.*
- *This caused a skewness towards prior detects.*

3) Recommendation:

- *5 acres as the minimum to be "protected" with a border survey*
- *1500m boundary around 5 acres*
- *Refer Slide 11 for allocation of effort*

Science Advisory Panel: Recommendations Re. RBS

- *Split RBS into 'Northern' and 'So-CAL' regions.*
- *Shift from historic finds, de-emphasize the core residential area and focus more capacity on residential/commercial interface.*

Outline: Review and proposed changes

- **RBS to date [Slide 5]:**
  - In the past decade, a risk based model was used to prioritize and identify STRs based on risk.
  - The formula used incorporated weightings assigned to individual risks.
  - Risks taken in account: population dynamics, ACP density, CLAS+ finds.
  - Among the various risks, existing CLas+ detections and ACP density were weighed high.
  - This caused a skewness towards prior detects and emphasized going back to the same areas.
- The historic RBS weightings are provided in Slide 5

Historic: Risk model factor weights --- Southern California

Risk factor	2013	2014	2015	2016	2017	2018	2019	2020	2021
Introduction risk (Census travel)	1	1	0.95	0.9	0.75	0.7	0.55	0.5	0.45
ACP density	1	1	0.6	0.85	0.9	0.8	0.85	0.8	0.9
CLas+ locations	1	1	0.85	0.95	0.9	0.95	0.95	1	1
Plant Nursery & Big Box Store	0.5	0.5	0.6	0.6	0.75	0.75	0.55	0.6	0.6
Citrus Road	0.5	0.5	0.5	0.5	0.8	0.8	0.6	0.75	0.75
Packinghouse		0.25	0.25	0.25	0.9	0.9	0.25	0.4	0.4
Farmers Market		0.25	0.75	0.75	0.85	0.8	0.8	0.8	0.8
Military and Native American Lands	0.5	0.5	0.5	0.5	0.25	0.1	0.01	0.01	0.05
Organic Citrus			0.1	0.1	0.1	0.1	0.1	0.1	0.1

The weight of each risk factor was adjusted annually.

Each risk factor is weighed by their actual predictive power in detecting the HLB.

Capacity of CDFA risk based survey program

Capacity of CDFA [Slide 7]:

- Considering the density of households and the spread, it is safe to estimate that at least 700 STRs can be surveyed in a year.
- Translates to approximately 9000 properties; includes mandatory multi pest commodity survey

Current: CDFA survey capacity and historical section township range (STRs) survey completed [STR = 1 sq mile]

YEAR	STRs surveyed in SoCal*
2019	1,730
2020**	1,095
2021	1,433
2022***	1,250
2023	260 (thru September)

*SoCal includes Santa Barbara and Ventura Counties
**COVID-19 limited ability to survey
***Survey capacity significantly dropped at the end of 2022 due to HLB detections and delimitation surveys

Current capacity: (Also encompasses the mandatory multi pest citrus commodity survey)

a) Properties: approx. 9000 (SoCal)
b) SoCal: 700 STRs
c) NorCal: 300 STRs

Commercial citrus interspersed with residential SoCal

- **STR numbers in SoCal [Slide 9]**
  - Total number of STRs located in each county in SoCal within the radius of ~1 mile of commercial citrus acreage, irrespective of acreage size are presented.
  - Majority of the STRs are located in San Diego, Riverside, Ventura and San Bernardino counties.
- **Slide 10** presents STRs to neighboring commercial citrus acreage larger than 1 acre.
- **The Subco recommendation:**

  *** 5 ac as the minimum to be "protected" with a border survey**

  *** 1500m boundary around 5 ac**
- Revisit: should the distance around 5 ac be reduced to 250m or 500m?

Number and percentage of section township and range (STRs) in each county that fall within the respective distance to commercial Citrus locations (considering all citrus acreage sizes)

County	<=250m	<=500m	<=750m	<=1000m	<=1250m	<=1500m	Total STR in County
San Bernardino	22 (1.77%)	42 (3.38%)	64 (5.14%)	91 (7.32%)	115 (9.24%)	138 (11.09%)	**1,244 (100%)**
Riverside	45 (3.58%)	74 (5.89%)	111 (8.84%)	151 (12.02%)	192 (15.29%)	246 (19.59%)	**1,256 (100%)**
San Diego	66 (5.48%)	143 (11.88%)	203 (16.86%)	253 (21.01%)	298 (24.75%)	331 (27.49%)	**1,204 (100%)**
Ventura	54 (13.47%)	94 (23.44%)	129 (32.17%)	149 (37.16%)	174 (43.39%)	199 (49.63%)	**401 (100%)**
Santa Barbara	11 (4.93%)	23 (10.31%)	30 (13.45%)	47 (21.08%)	60 (26.91%)	70 (31.39%)	**223 (100%)**
Los Angeles	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	**1,760 (100%)**
Orange	1 (0.16%)	2 (0.33%)	11 (1.81%)	26 (4.28%)	37 (6.09%)	46 (7.57%)	**608 (100%)**
Imperial	2 (1.41%)	2 (1.41%)	4 (2.82%)	4 (2.82%)	4 (2.82%)	4 (2.82%)	**142 (100%)**
Total	**201**	**380**	**552**	**721**	**880**	**1,034**	**6,838**

STRs census based on acreage and the corresponding distance

		----------Distance to commercial citrus----------					
		<=250m	**<=500m**	**<=750m**	**<=1000m**	**<=1250m**	**<=1500m**
Total commercial citrus acreage	**All Sizes**	201	380	552	721	880	935
	> 1 Acres	165	314	457	593	734	760
	> 5 Acres	**102**	**217**	**326**	**451**	**560**	**565**
	> 10 Acres	66	166	263	371	476	461
	> 25 Acres	21	95	177	241	331	326
	> 50 Acres	3	47	108	159	224	198

Summary: recommendation

Annual survey
(1000 STR: $6.1 M)
SoCal plus NorCal

Southern California
(700 STRs: ~$4.2M)

North/Central California
(300 STRs: ~$1.8M)

Commercial grove interface survey (350 STRs)

Rec 1: Survey boundary will be limited to 1 mile radius around groves which are larger than 5 acres. [50% of SoCal effort]

"Other" residential survey (350 STRs)

Rec 2: 25 percent effort will be within HLB quarantine (5 mile radius) and excluding delim. 25 percent effort will be on the outer perimeter of the quarantine with emphasis on the leading edges (southern orange county and east side of the Riverside county, NW of LA).

Residential survey

Rec 3: Focus survey in counties with historical detections.

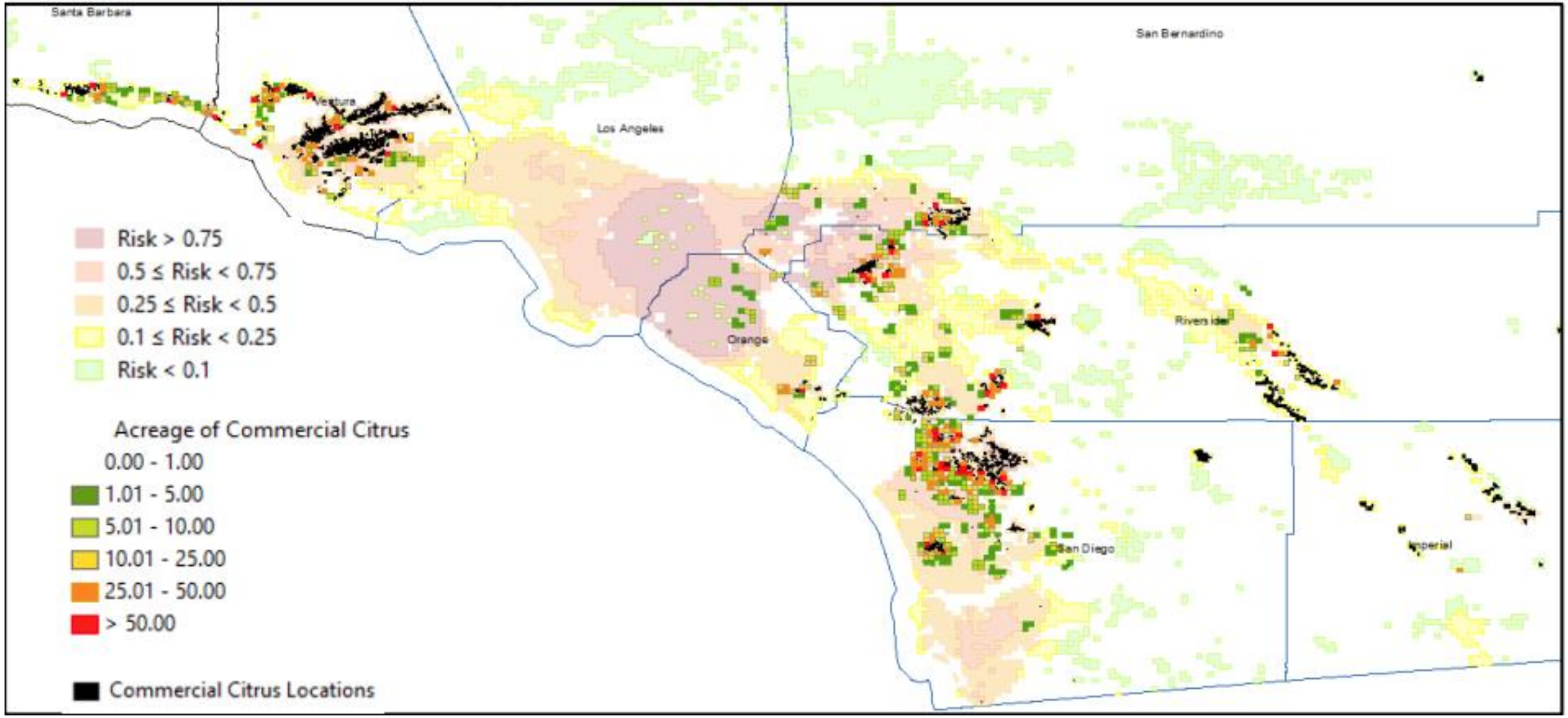
Rec 4: Weightage of ACP (adult and nymph) detection will be no less than 60% in the model.

Map depicting spread of STRs based on acreage of commercial citrus

Map of STRs in SoCal [Slide 13]:

- Majority of the STRs are located in San Diego, Riverside, Ventura and San Bernardino counties.
- No commercial citrus acreage present in Los Angeles county.
- In the past decade emphasis was made to survey this county.
- The “other” residential survey which accounts for 50% of the CDFA capacity in SoCal region will cover this region.

Map depicting STRs with commercial citrus groves with ~1500 m



EcoData

DATOC Consulting Update for CPDPC Science Subcommittee

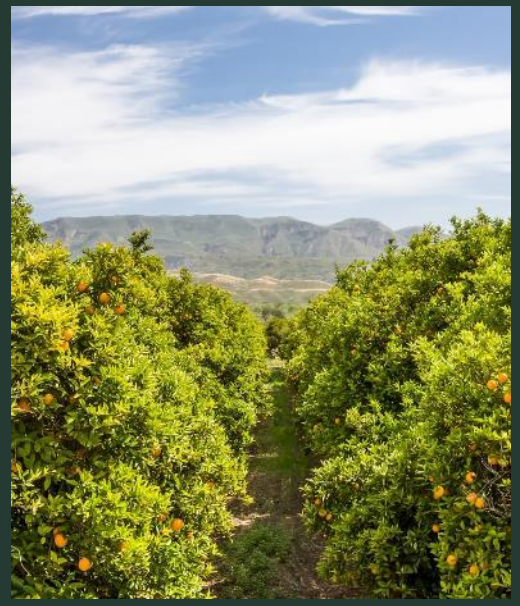
December 6, 2023

Today’s objective

Provide an overview of completed and in-progress work as part of consulting activities for DATOC

Core Issue: practices implemented without a way to audit progress and determine completion

“Practices are working because there are no large outbreaks in commercial groves.”



“Practices are not necessary because there are no large outbreaks in commercial groves.”

Practices and assessments

1. At what time points are CLas+ trees and vectors increasing?
2. Are HLB+ tree surveys & removals working as intended?
3. How does the rate of HLB spread relate to quarantine zone size?

Practices and assessments

1. At what time points are CLas+ trees and vectors increasing?
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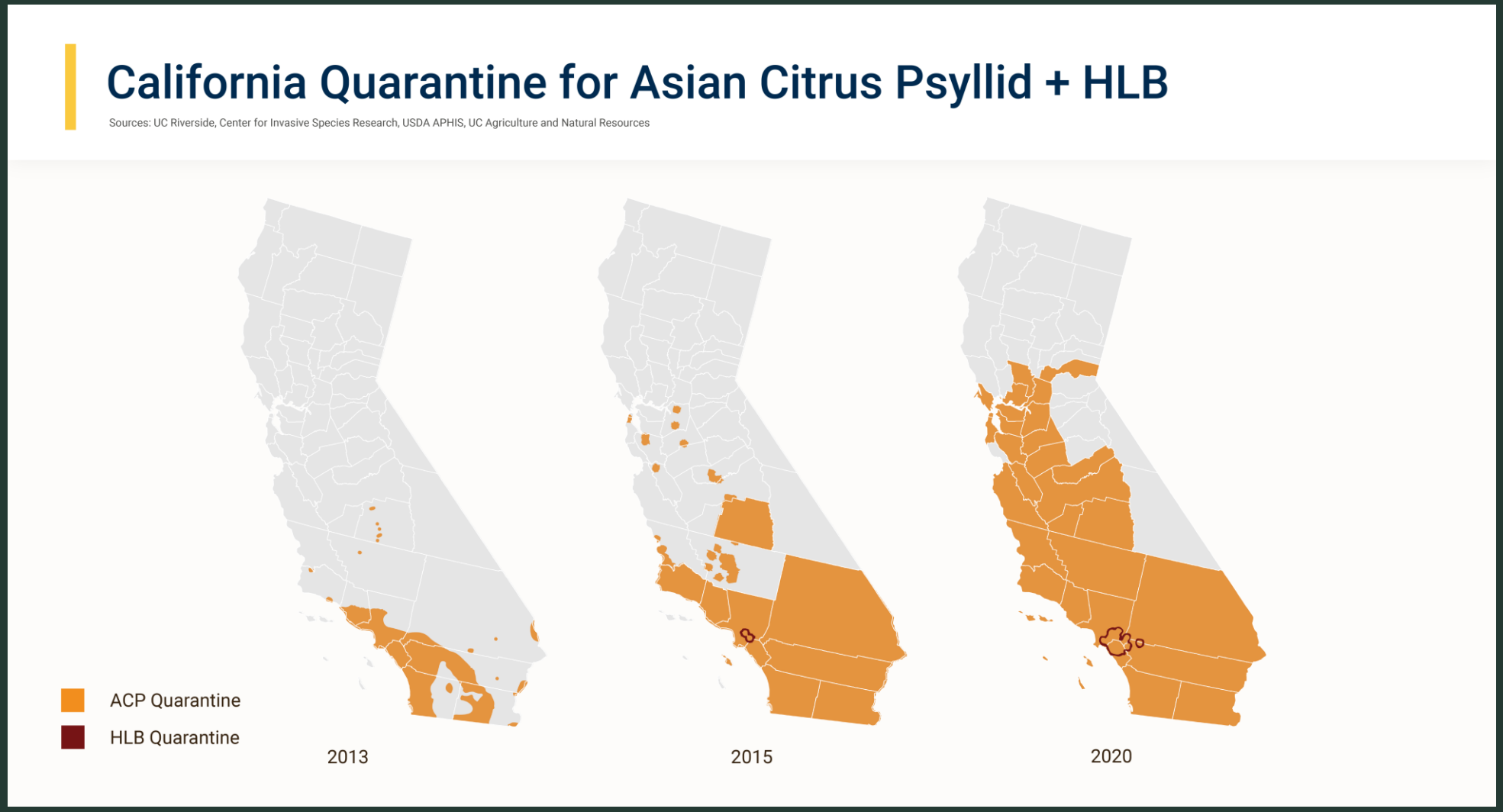
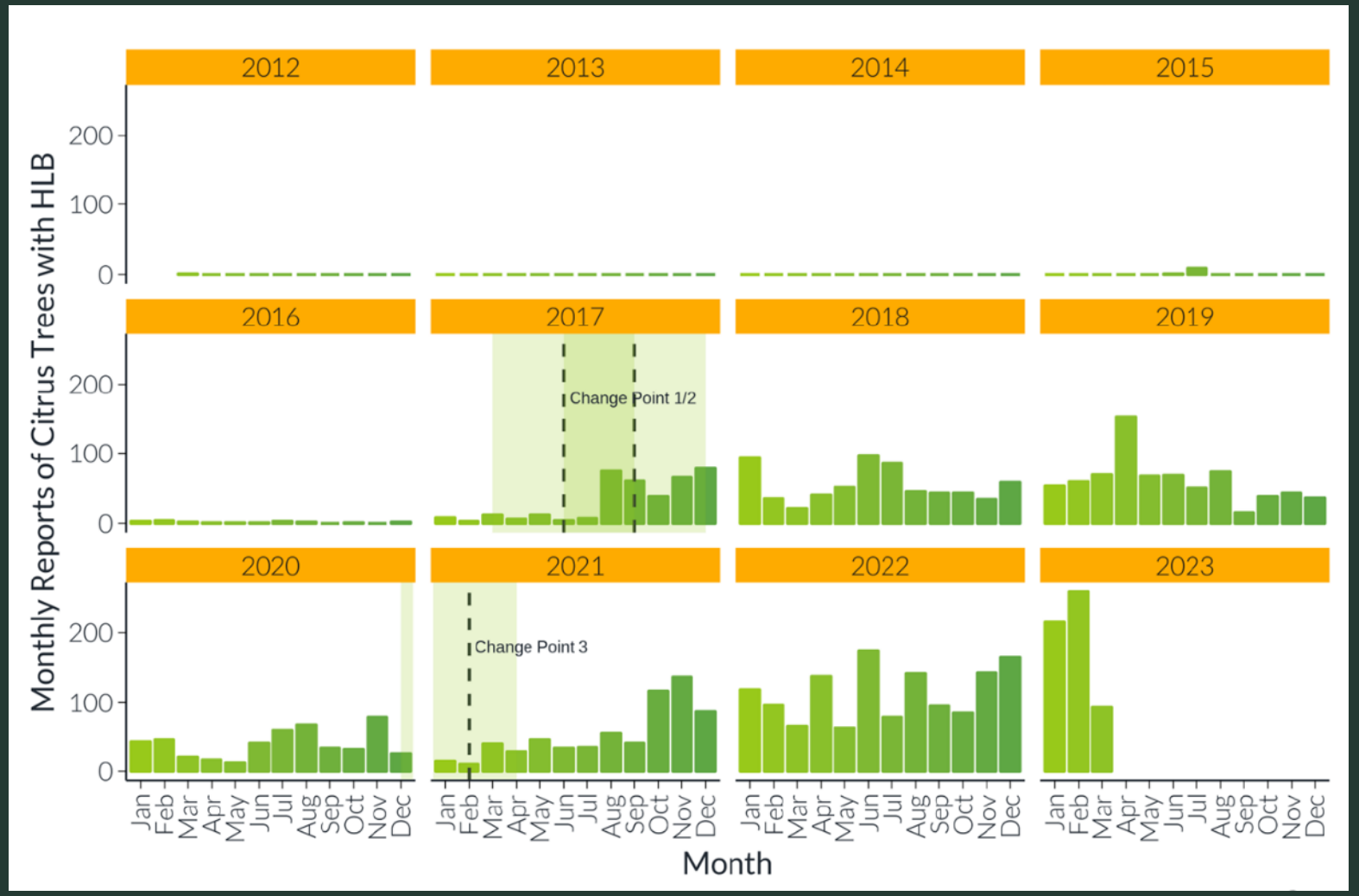
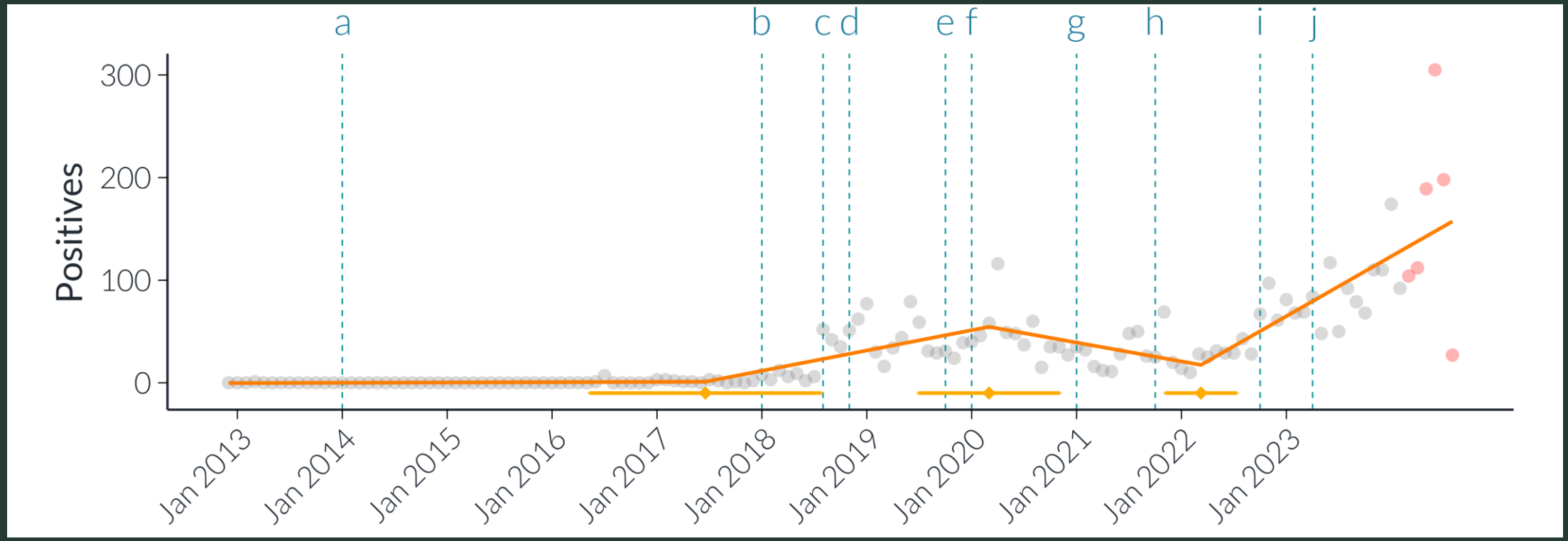
Both ACP and trees with CLas+ have rates of discovery that varied significantly over time



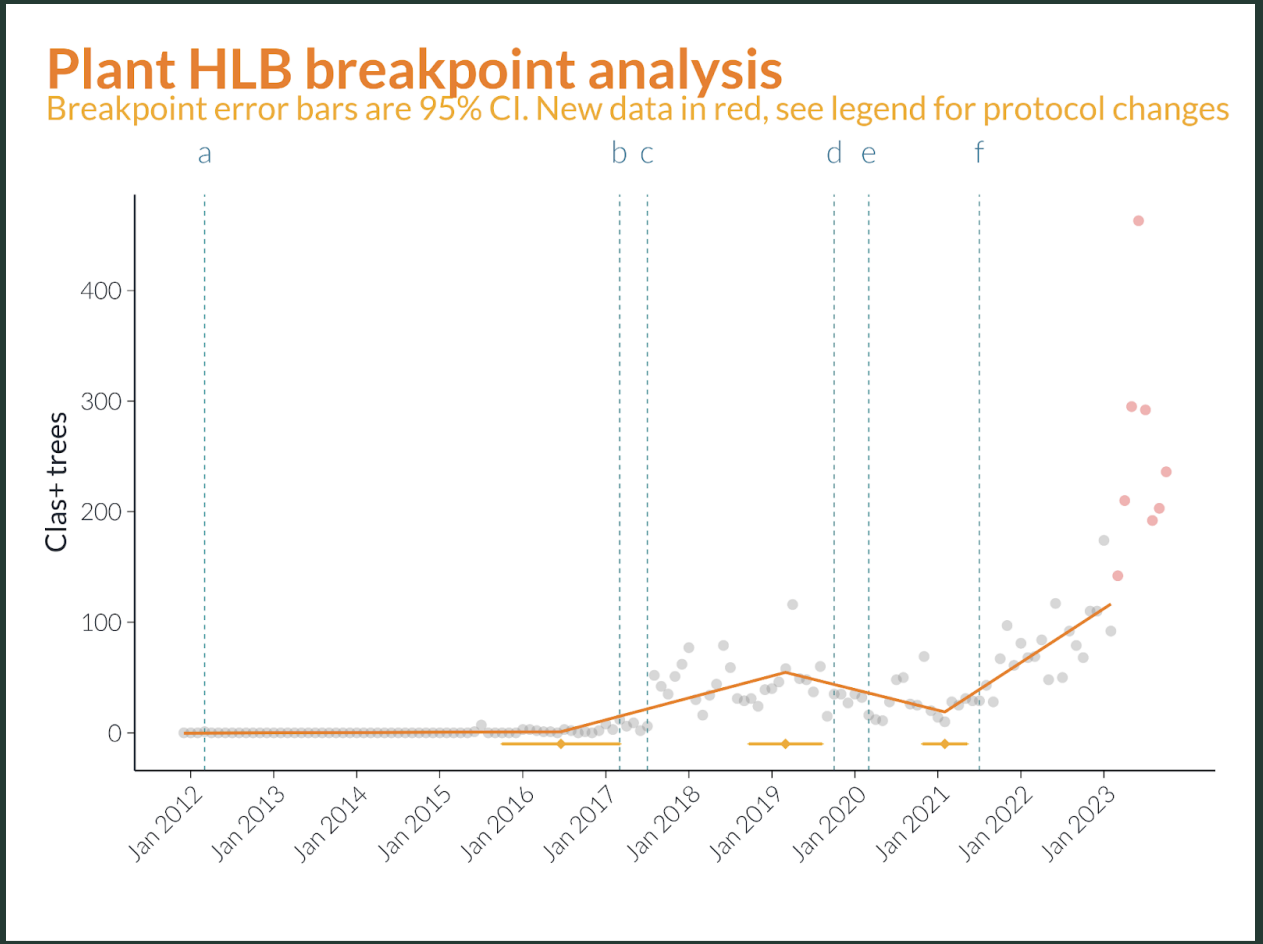
I have continually updated a change-point detection analysis every few months (May 2023 below)



I have continually updated a change-point detection analysis every few months (August 2023 below)



I have continually updated a change-point detection analysis every few months (Nov 2023 below, in progress)



Everyone has hunches about why and when certain trends have changed – we need to know if these hunches are supported or not to evaluate HLB management practices

Hunches	Supported or not?
A1. HLB+ tree cases have been increasing steadily since 2021	A2. All my analyses point to 2021 as being an important turning point for more HLB+ tree detections
B1. Increase in HLB+ trees is due to changes in sampling efforts or testing capacity	B2. While sampling practices impact total numbers, the net increase in HLB+ trees is not explained by methodology changes

Practices and assessments

1. At what time points are CLas+ trees and vectors increasing?
2. Are HLB+ tree surveys & removals working as intended?
3. How does the rate of HLB spread relate to quarantine zone size?

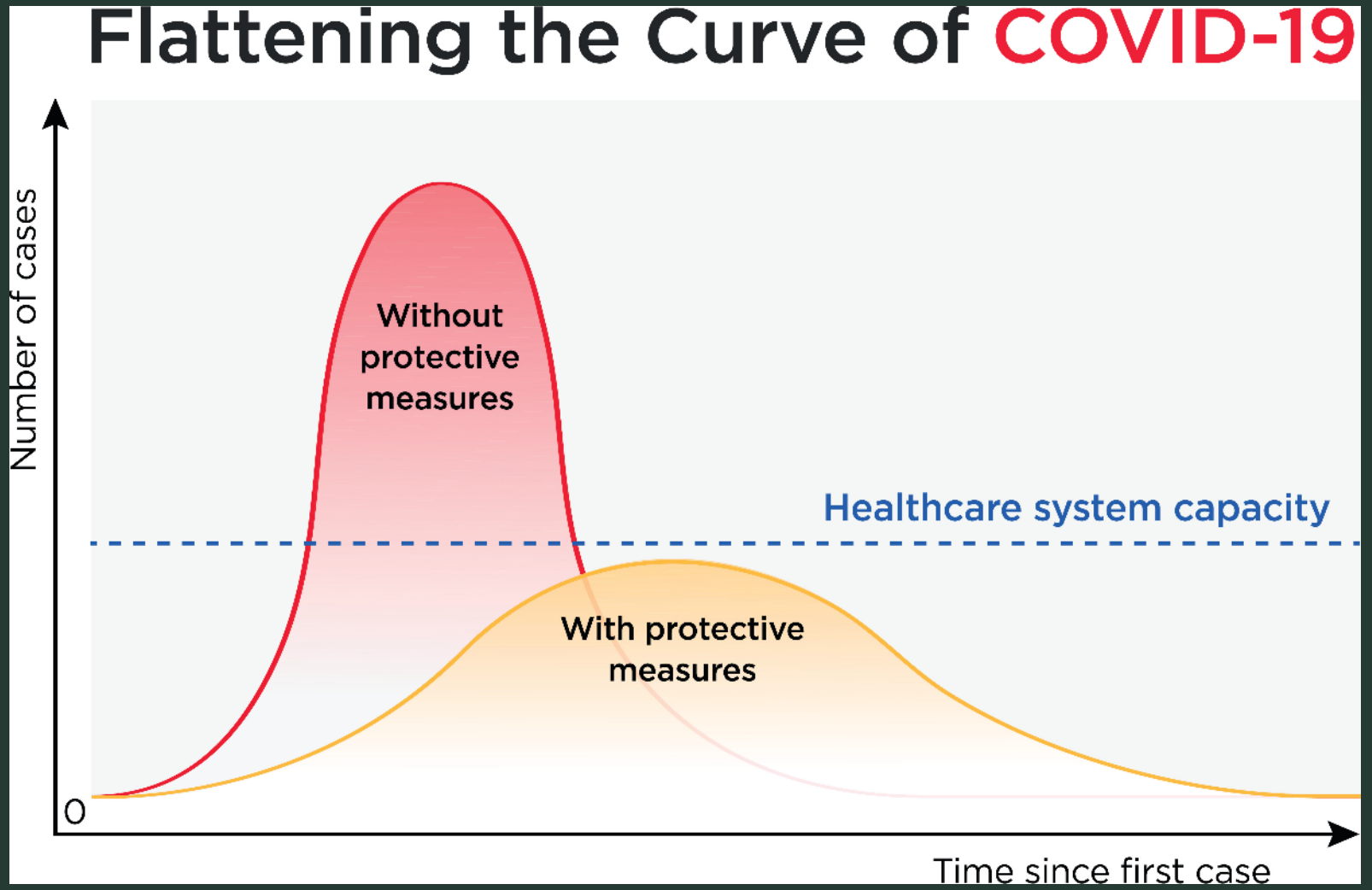
This debate is not unique to the citrus industry. Residential tree removals in response to invasive pathogens or insects are controversial everywhere they've been implemented

"The key is the beetle's slow rate of spread. They don't tend to move on from a tree between generations until it is dead… then they don't go very far as they are so big and heavy. So as long as you catch it reasonably early you are ok."

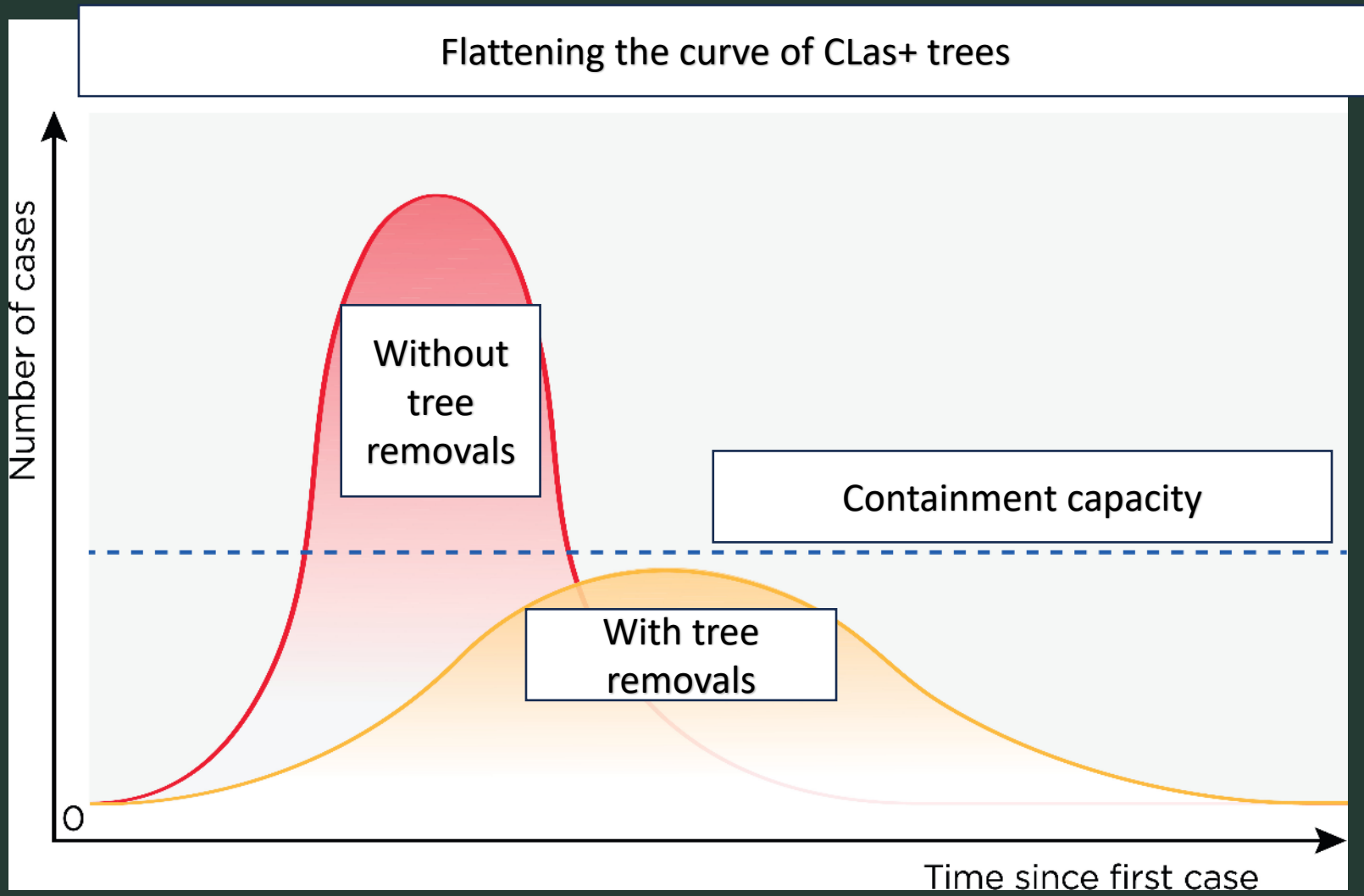
-Conversation about Asian Longhorn Beetle with a state entomologist in the northeastern US

In Spring & Summer 2023, I completed interviews with Citrus Division staff, CRB, and members of the CPDPC to understand the tree removal debate

“Reservoir management” is similar to the “flatten the curve” discussion during COVID19

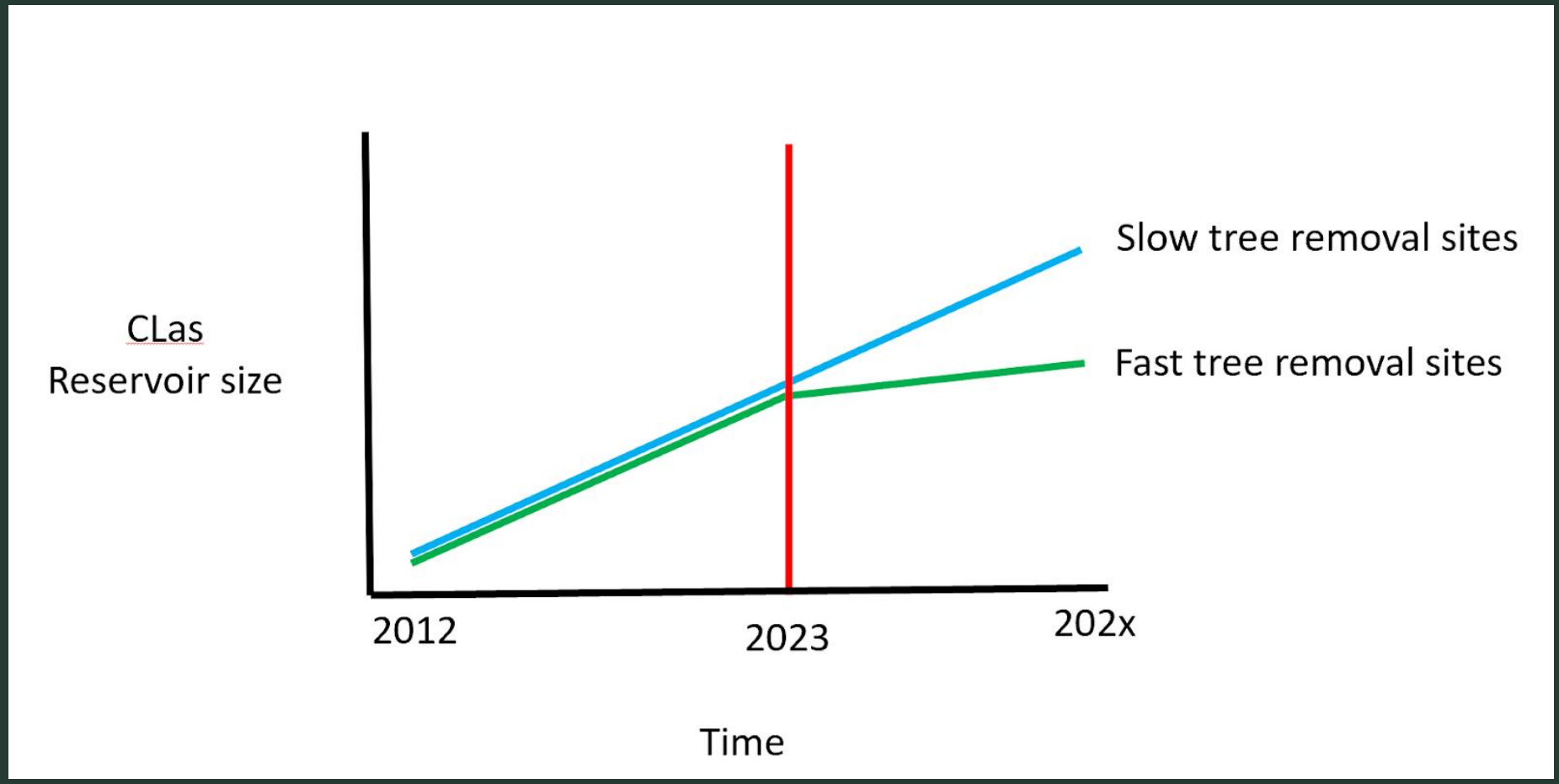


“Reservoir management” provided the strongest argument in favor of continuing to remove HLB+ trees in residential areas, but it is not yet well-supported by data



Some locations have fast tree removal (1 week), while others have slower tree removal (6 months) simply due to logistical challenges

If “Reservoir management” is effective, roughly speaking, locations with fast tree removal should have less CLas



Current support for or against reservoir management as part of tree removals

For

A1. In locations where tree removals progress slowly, CT values are lower (more inoculum)

B1. No large-scale outbreaks of CLas in commercial setting near urban areas have been reported yet

C1. In locations where tree removals progressed quickly, slightly fewer Clas+ trees are found in nearby gridded locations

Against

A2. However, the difference in CT values is extremely small (some have argued too small to be relevant)

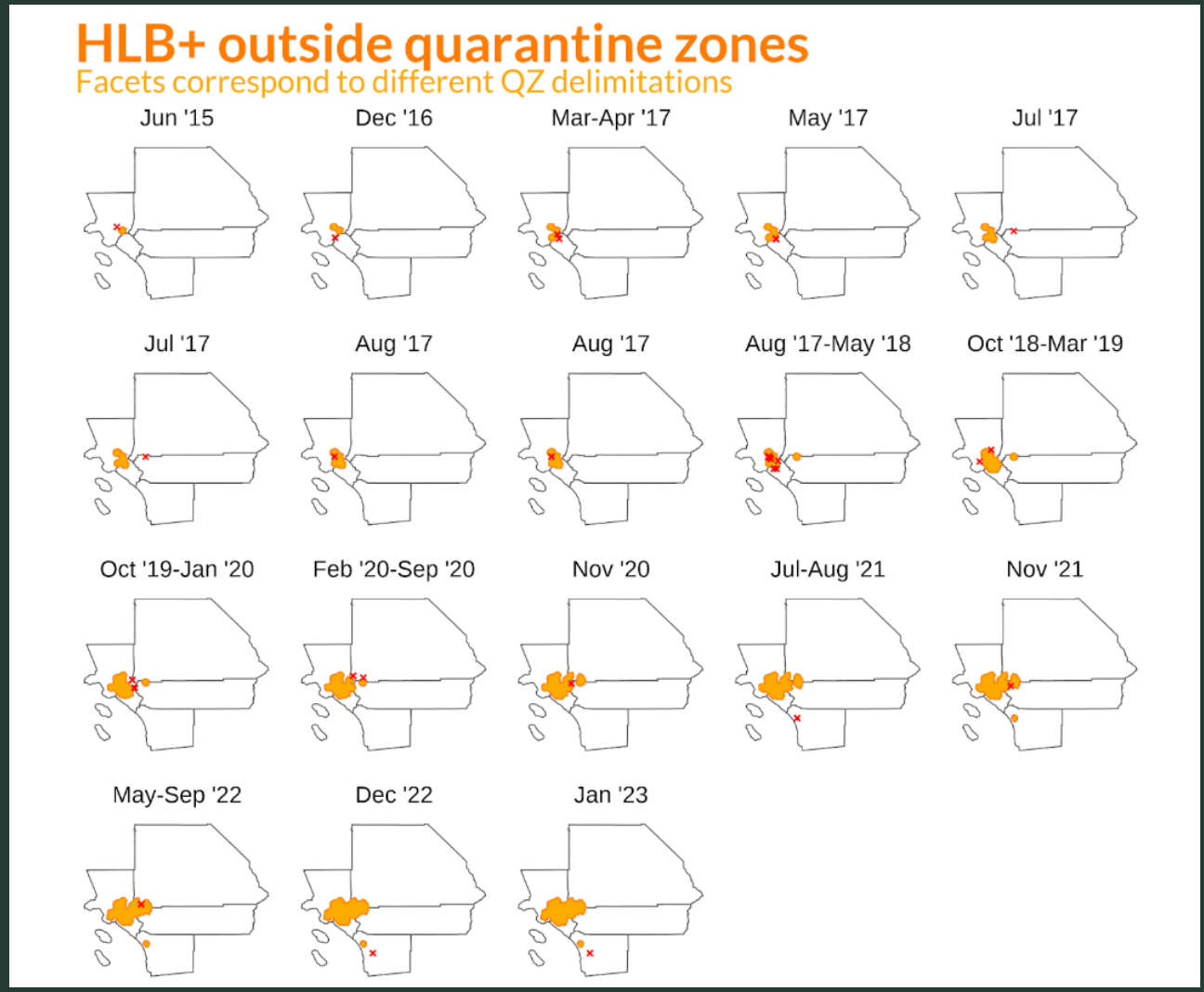
B2. Only a small proportion of potential residential trees are tested, and the quarantine areas continue to expand

C2. This result (C1.) is only marginally statistically significant (I currently have low confidence in this result)

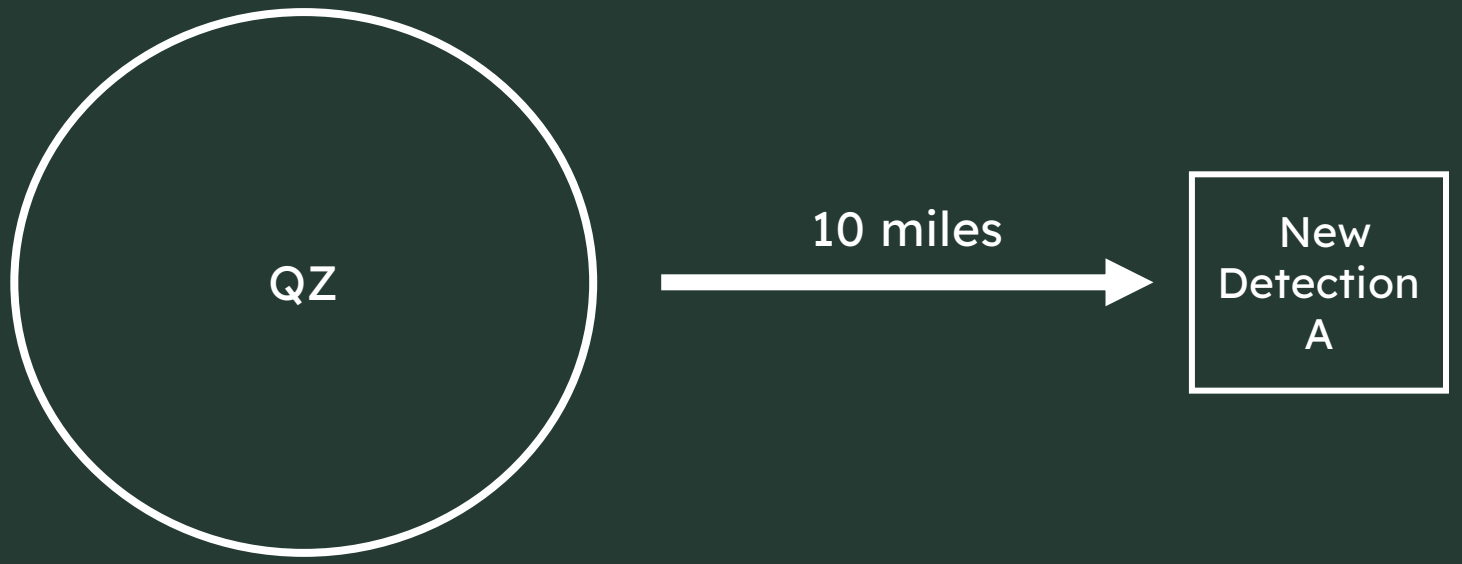
Practices and assessments

1. At what time points are CLas+ trees and vectors increasing?
2. Are HLB+ tree surveys & removals working as intended?
3. How does the rate of HLB spread relate to quarantine zone size?

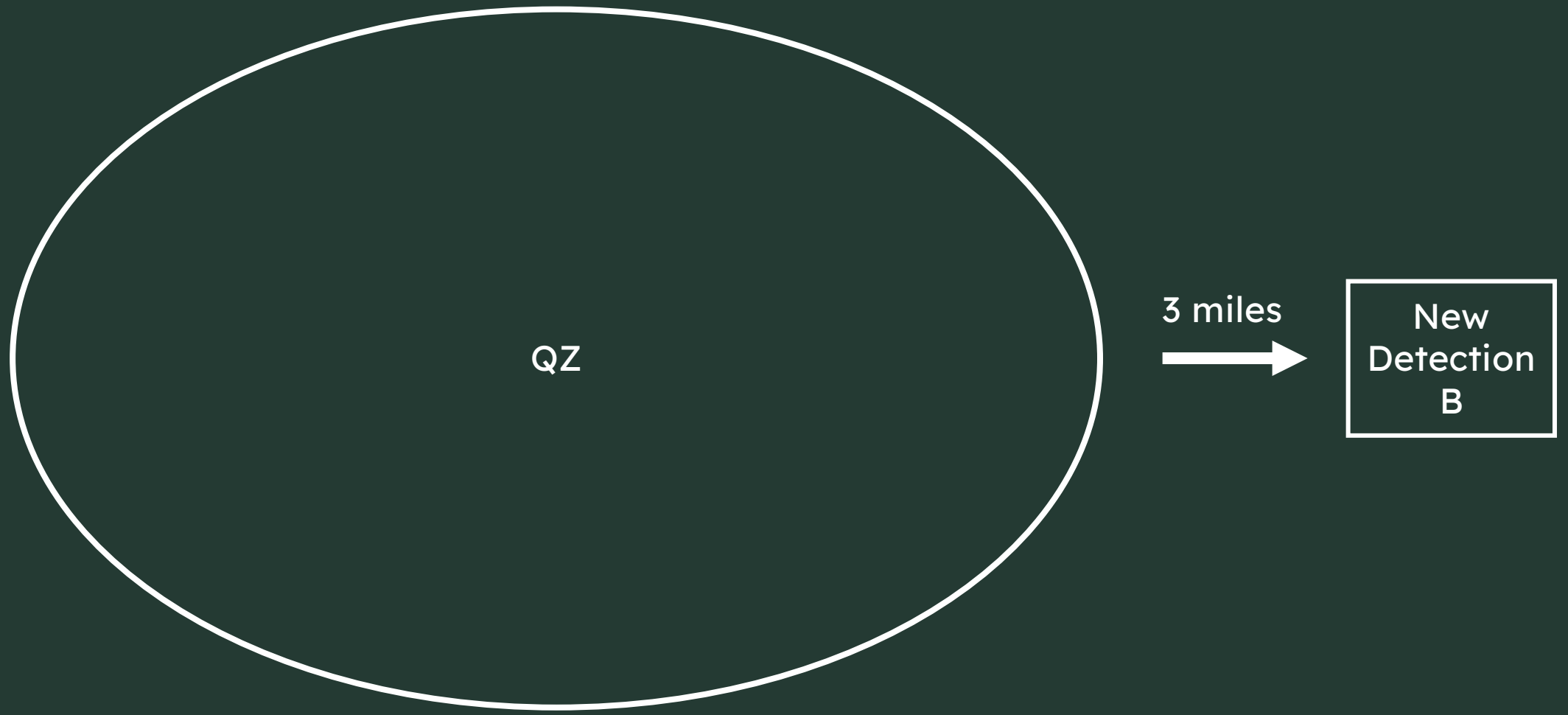
Since 2015 there have been regular reports of new HLB+ trees outside quarantine zones – this information is being used to evaluate spatial spread



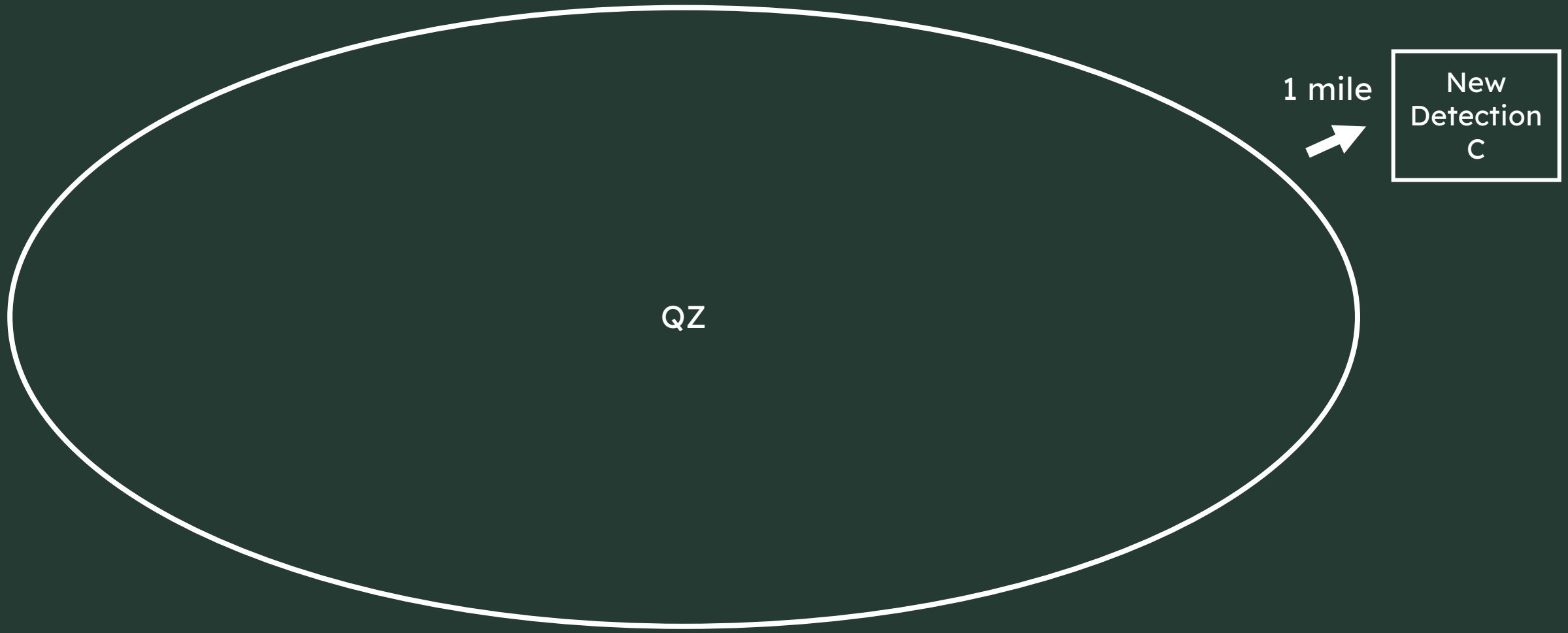
How the analysis works: “new detections” are areas outside quarantine zone where a new HLB+ tree is found



Each new detection means a larger quarantine zone, so subsequent analyses take that larger qz into account



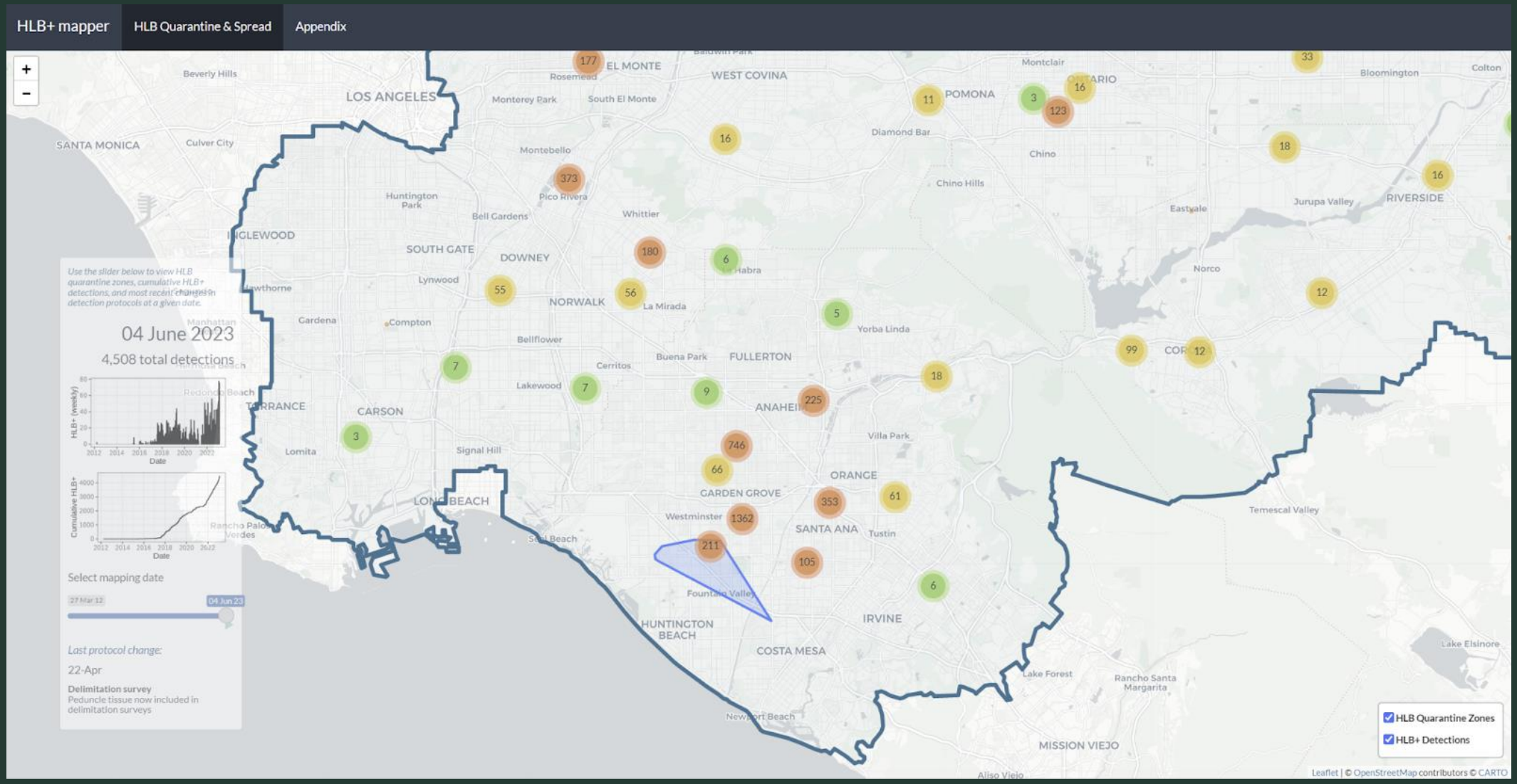
This continues across all detections through the most recent discoveries of HLB+ trees



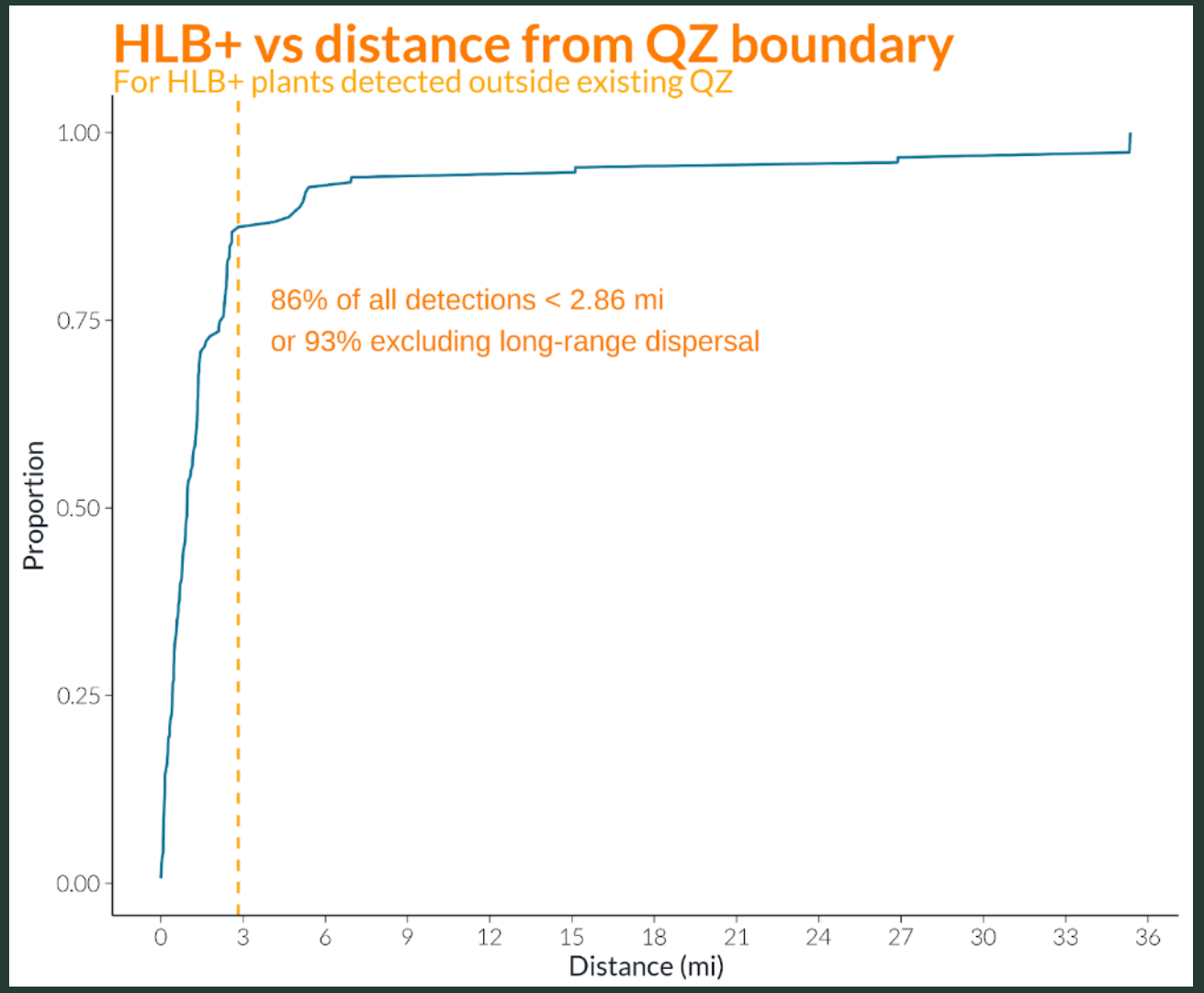
The average distance is taken across all new detections to find the average distance from a quarantine zone new trees are found

In this example the average “rate of spread” is 4.66 miles over a single year

Such an analysis is complex because QZ boundaries change over time and surveys are for new HLB+ trees are non-random



86% of new detections outside quarantine zones are occurring at less than 3 miles from border



Thanks for your time!

HLB Prevalence and positivity rate Estimation in Southern CA

USDA NC STATE UNIVERSITY

Weiqi Luo

UCDAVIS UNIVERSITY OF CALIFORNIA

Neil McRoberts

Support: CRB #5300-199

Citrus population in Southern CA (Residential vs commercial)

County	Total number of STRs	Number of STRs with Residential Properties	Total Number of Residential Properties	Percent of Residential Properties with Citrus	Estimated Number of Residential Citrus Properties	Average number of citrus tree planted per property	Residential tree population	Total commercial citrus (acres)
LA	4,129	2,447	1,589,829	63.25%	1,005,544	1.90	**1,910,534**	**0**
Orange	873	621	563,373	41.61%	263,914	2.17	**572,693**	**567**
Riverside	7,622	1,942	611,347	55.97%	342,167	3.04	**1,040,188**	**16,473**
San Diego	4,373	1,804	590,277	77.91%	459,897	3.06	**1,407,285**	**10,078**
Imperial	4,499	538	36,706	62.71%	23,017	2.39	**55,010**	**7,224**
San Bernardino	20,457	2,277	485,689	68.19%	331,169	2.42	**801,429**	**2,710**
Ventura	1,952	572	174,682	62.71%	109,539	2.40	**262,893**	**26,049**

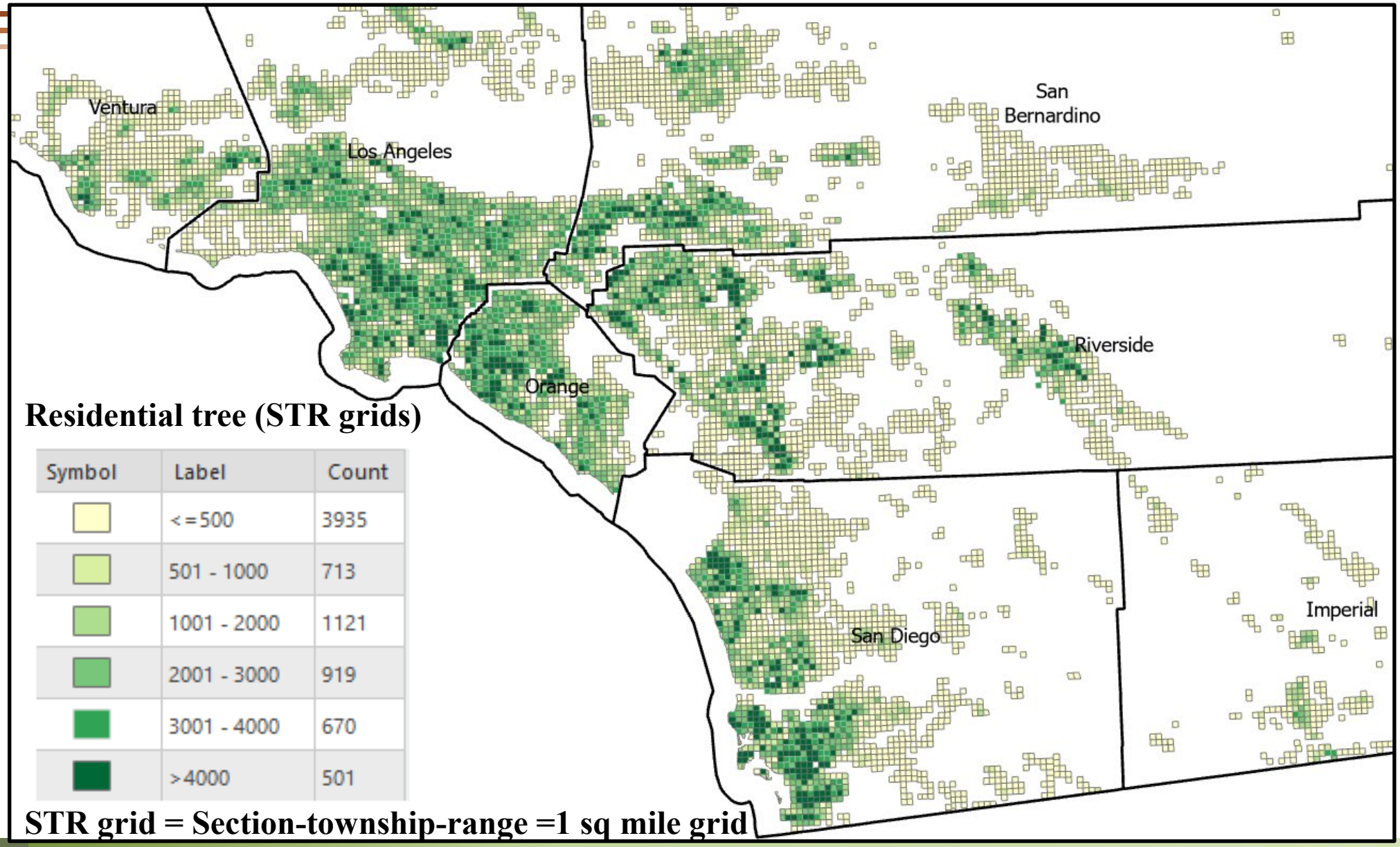
Total residential citrus trees in Southern CA = 6,050,032

Total commercial citrus trees in Southern CA = 6,310,100

Assuming typical 100 trees/acre

Refined residential citrus population and distribution are also available for Coastal, Central and Central North CA

Residential Citrus distribution in Southern CA



Residential tree (STR grids)

Symbol	Label	Count
	<=500	3935
	501 - 1000	713
	1001 - 2000	1121
	2001 - 3000	919
	3001 - 4000	670
	>4000	501

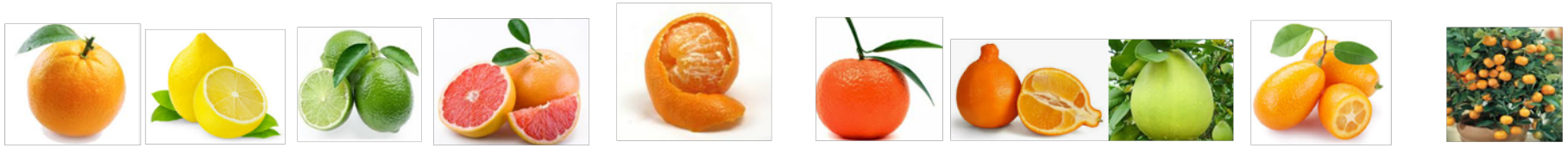
STR grid = Section-township-range =1 sq mile grid

Number of Citrus tree/property & citrus type preference

County	Total Properties Sampled (2013, 2019, 2020)	Mean Trees	1 Tree	2 Trees	3 Trees	4 Trees	5+ Trees
Los Angeles	43,524	1.90	24,512 (56.3%)	10,018 (23.0%)	4,467 (10.2%)	2,114 (4.9%)	2,413 (5.5%)
Orange	13,673	2.17	7,120 (52.0%)	3,018 (22.0%)	1,511 (11.0%)	775 (5.7%)	1,249 (9.1%)
Riverside	12,841	3.04	4,769 (37.1%)	2,801 (21.8%)	1,798 (14.0%)	1,143 (8.9%)	2,330 (18.1%)
San Diego	20,916	3.06	8,267 (39.5%)	4,540 (21.7%)	2,597 (12.4%)	1,633 (7.8%)	3,879 (18.5%)
Imperial	1,017	2.39	452 (44.4%)	245 (24.0%)	124 (12.1%)	64 (6.3%)	132 (12.9%)
San Bernardino	3,920	2.42	1,884 (48.0%)	851 (21.7%)	439 (11.1%)	279 (7.1%)	467 (11.9%)
Ventura	12,319	2.40	5,428 (44.0%)	2,948 (23.9%)	1,679 (13.6%)	935 (7.6%)	1,329 (10.7%)

Number of Citrus tree/property & citrus type preference

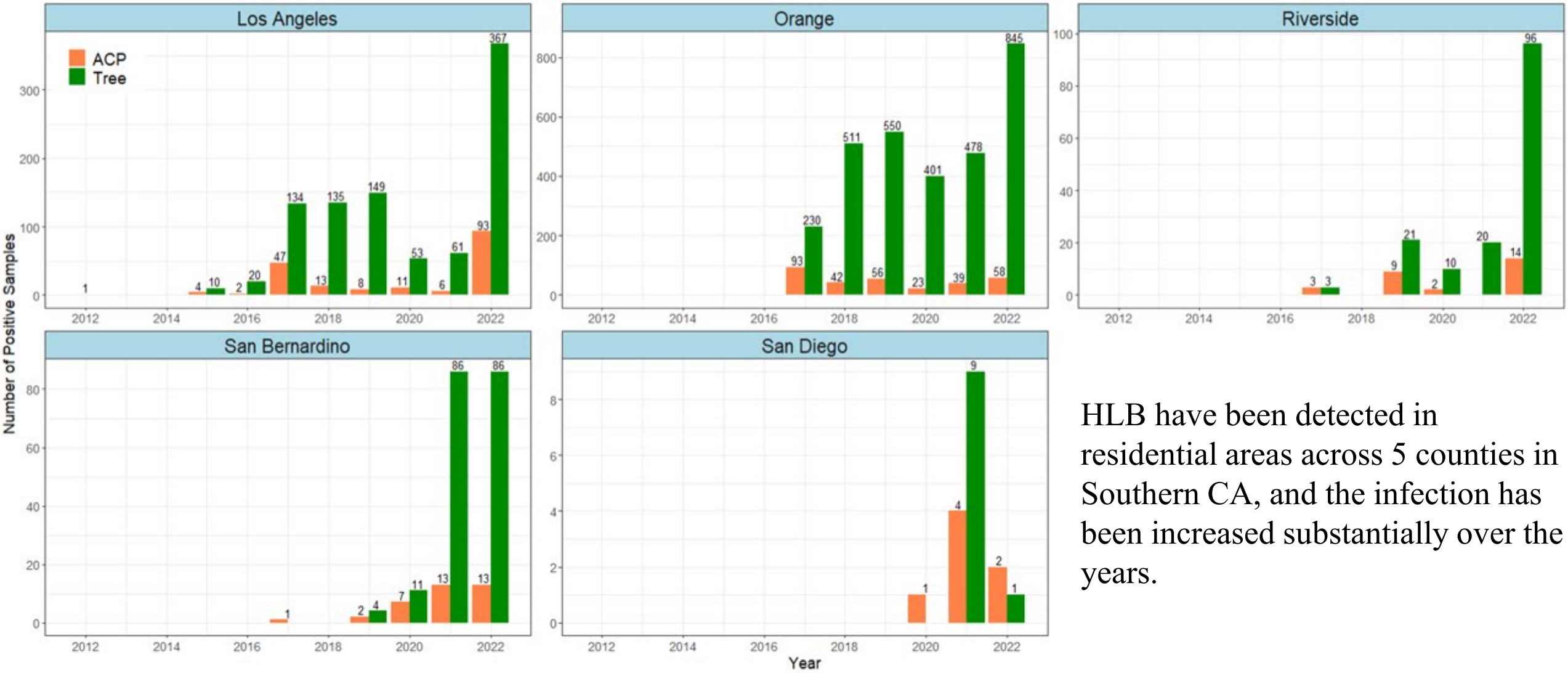
Dooryard citrus type distribution (%) by county



County	Orange	Lemon	Lime	Grapefruit	Mandarin	Tangerine	Tangelo	Pomelo	Kumquat	Calamondin	Other
LA	25.0	28.7	14.5	6.8	7.1	4.7	1.1	3.3	6.3	1.6	0.9
Orange	26.7	27.7	15.0	6.2	6.2	5.9	1.1	2.4	5.8	1.8	1.2
Riverside	31.4	30.3	12.7	9.7	4.7	3.8	1.9	1.0	3.2	0.9	0.3
San Diego	34.1	31.2	11.3	6.5	4.3	5.1	2.4	0.5	2.5	1.9	0.2
Imperial	21.0	38.3	15.1	13.7	4.0	3.1	3.6	0.2	0.5	0.3	0.0
San Bernardino	29.6	30.3	14.9	7.5	5.4	4.1	1.7	1.1	3.8	1.3	0.3
Ventura	35.8	37.6	8.1	6.8	4.1	5.1	0.8	0.3	1.0	0.5	0.0

Lowest Highest

HLB detections in Southern CA, 2012 - 2022



HLB have been detected in residential areas across 5 counties in Southern CA, and the infection has been increased substantially over the years.

HLB **situations** in Southern CA, 2012 - 2022

Estimated HLB Prevalence (% areas/STRs infected with HLB)

County	2015	2016	2017	2018	2019	2020	2021	2022
Los Angeles	0.4%	0.5%	2.4%	3.6%	4.0%	2.6%	2.9%	13.5%
Orange	--	--	16.2%	13.7%	20.5%	14.9%	17.9%	26.5%
Riverside	--	--	0.9%	--	0.8%	2.0%	2.0%	5.8%
San Bernardino	--	--	--	--	3.0%	3.4%	5.6%	4.9%
San Diego	--	--	--	--	--	0.2%	0.2%	0.6%

Estimated HLB Positivity Rate (% trees infected with HLB)

County	2015	2016	2017	2018	2019	2020	2021	2022
Los Angeles	0.6%	0.3%	0.7%	0.5%	0.6%	0.7%	1.4%	2.6%
Orange	--	--	1.3%	0.7%	1.8%	1.1%	3.9%	7.5%
Riverside	--	--	0.2%	--	0.6%	0.4%	0.7%	1.8%
San Bernardino	--	--	--	--	0.6%	0.5%	1.1%	2.7%
San Diego	--	--	--	--	--	1.3%	3.3%	0.8%

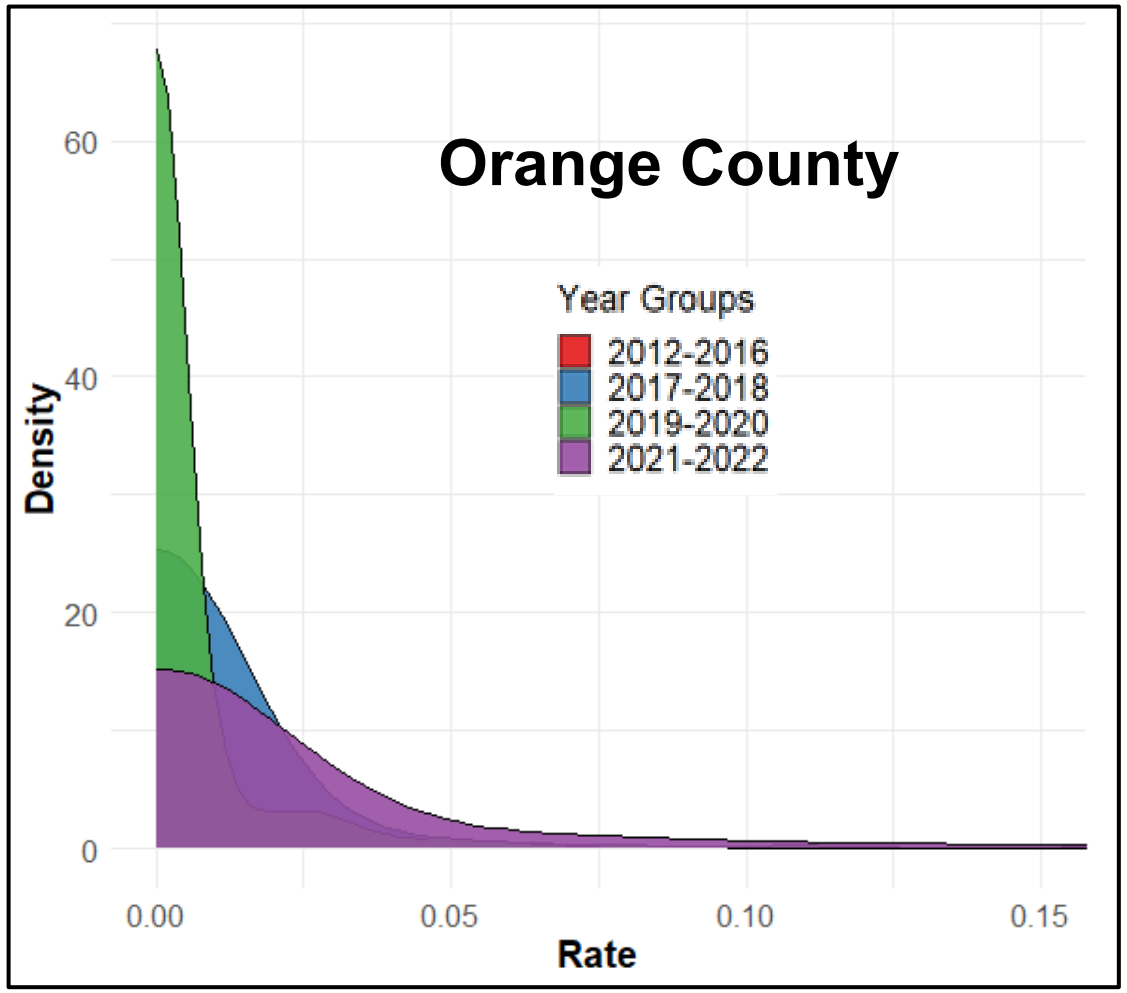
-- Year without HLB tree finds or insufficient sampling

Example: the total HLB+ trees (estimated) in **Orange and Riverside county in 2022**

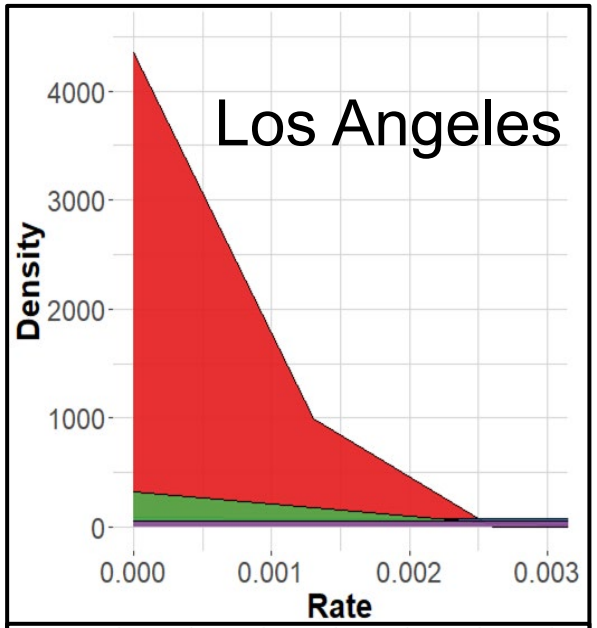
Orange: Dooryard Tree population * Prevalence * Positivity Rate = **572,693 * 0.265 * 0.075 = 11,382**

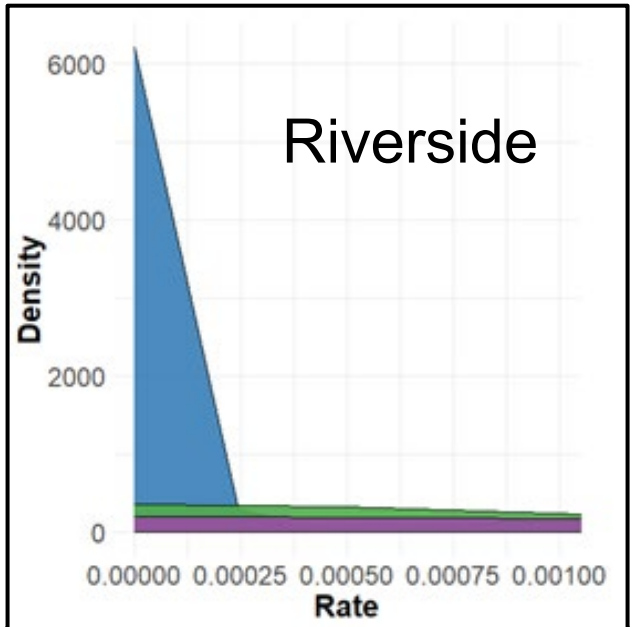
Riverside: Dooryard Tree population * Prevalence * Positivity Rate = **1,040,188 * 0.058 * 0.018 = 1,085**

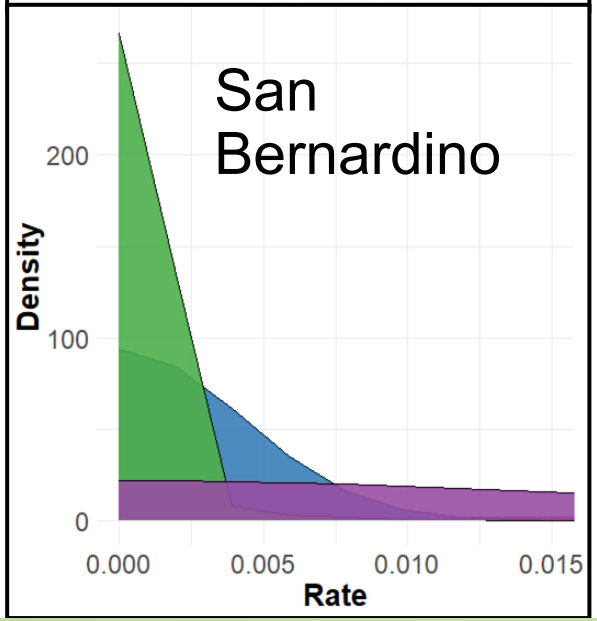
Estimated HLB positivity rate at STR level for each County by Year

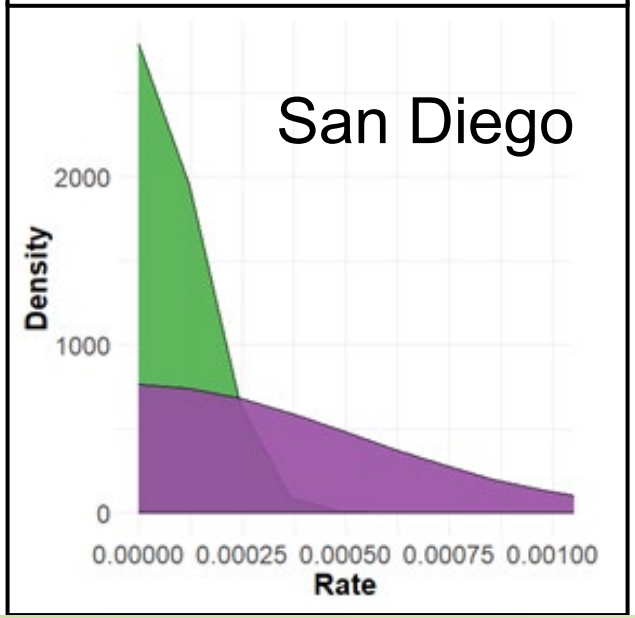


Years without any positive HLB findings were removed









Method & References

Method: We use the binomial probability law to estimate HLB prevalence *f* and the STR level positivity rate *p*. Here, *q=1-p*.

$$P(x|f,p) = (1-f)0^x + f\binom{n}{x}p_{\text{pool}}^x(1-p_{\text{pool}})^{n-x}$$

$$= (1-f)0^x + f\binom{n}{x}(1-q^m)^x q^{m(n-x)}$$

Terms:

x: The number of positive pooled samples for a specific STR

n: The total number of pooled samples for a specific STR

f: The overall prevalence of HLB within a County

p: The probability of an individual sample testing positive from an infected STR group, in other words, the positivity rate of HLB within each STR

m: The number of individual samples combined into one pooled sample

Reference:

Comparison of methods for estimation of individual-level prevalence based on pooled samples

David W. Cowling[a,*], Ian A. Gardner[a], Wesley O. Johnson[b]

Estimation of animal-level prevalence from pooled samples in animal production

Eric G. Evers[*], Maarten J. Nauta