Asian Citrus Psyllid and the Citrus Disease Huanglongbing

Huanglongbing

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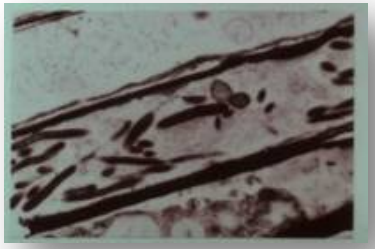
Agriculture and Natural Resources

The adult psyllid deposits eggs on new leaf flush, that then hatch into nymphs

Nymphs can only survive by living on young, tender leaves and stems (new flush)



Huanglongbing (HLB)

Bacterial disease:
***Candidatus* Liberibacter asiaticus *C*las**

As the disease progresses:

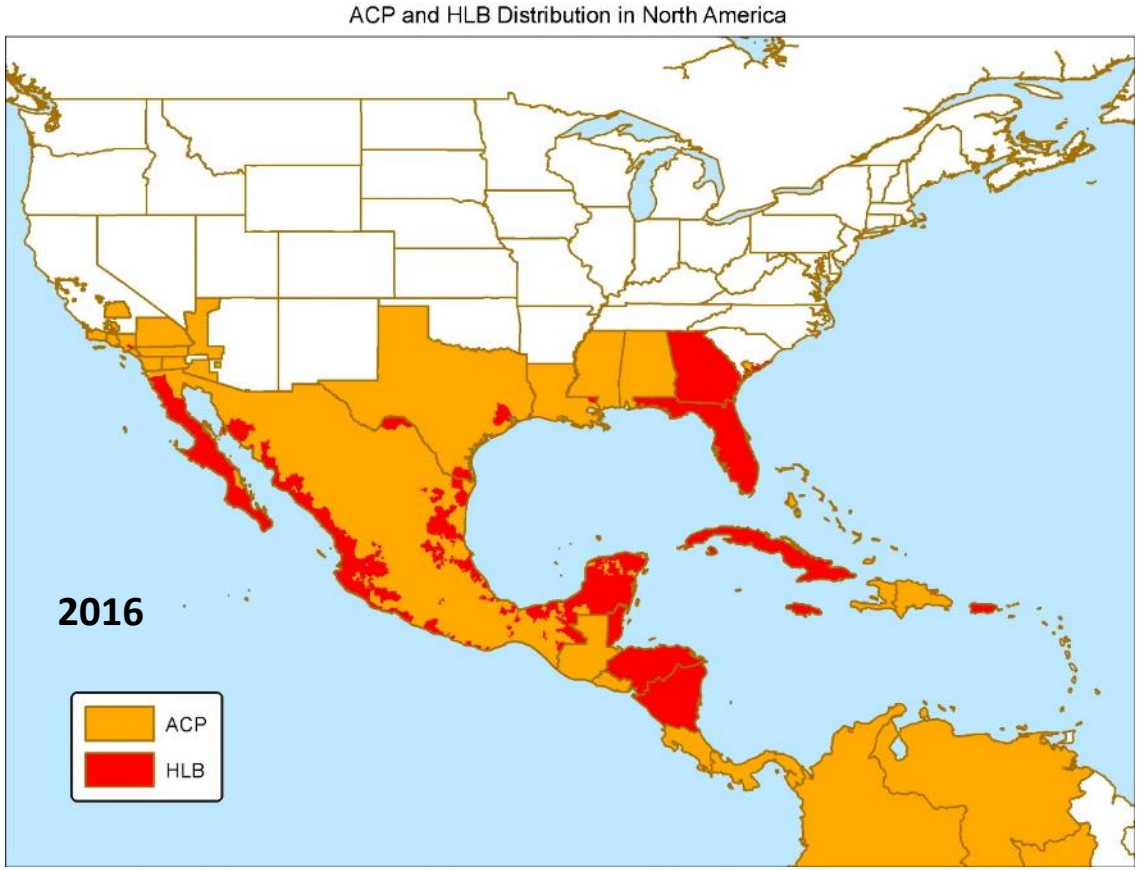
- ***Roots decline**
- **Leaves become yellow**
- **Foliage becomes thin**
- **Fruit drops off easily**
- **Fruit is smaller**
- **Juice is bitter**
- **Tree death (there is no cure)**

How did the psyllid get to California and where is the disease?

The psyllid was first found:
In Florida in 1998
in California in 2008

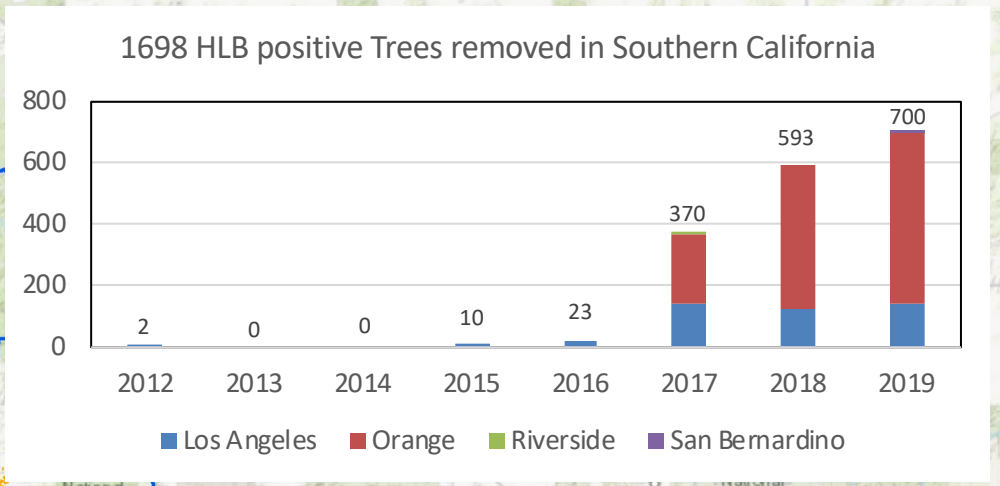
The psyllid most likely arrived in California from Mexico

The infected plants were likely already here (illegal grafting) and the psyllid spread HLB further



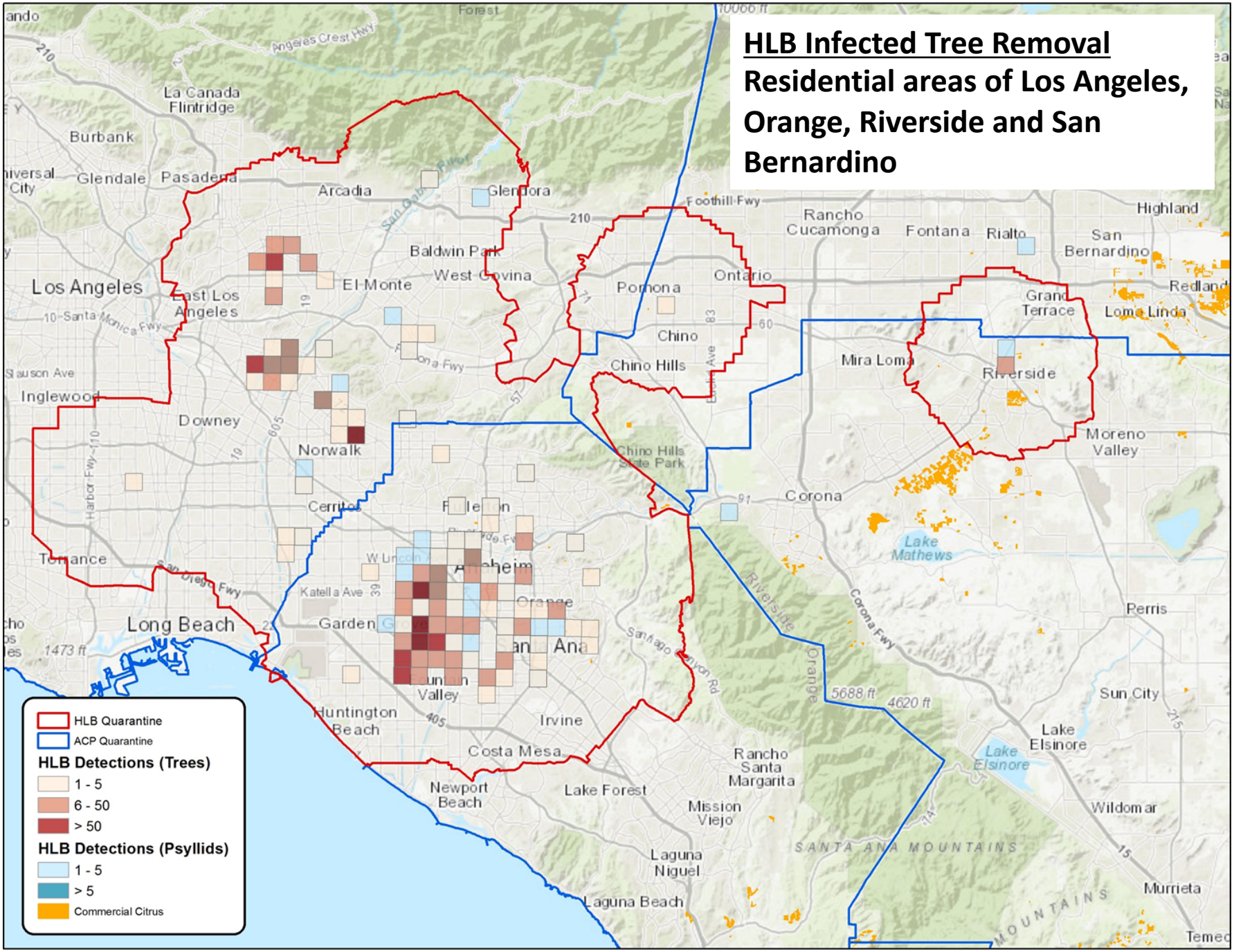
Florida has lost 50% of its citrus production due to this disease!

https://ucanr.edu/acpmap



1698 HLB-infected tree removals from residential citrus

HLB Quarantine
ACP Quarantine
HLB Detections (Trees)
1 - 5
6 - 50
> 50
HLB Detections (Psyllids)
1 - 5
> 5
Commercial Citrus


HLB Infected Tree Removal
Residential areas of Los Angeles, Orange, Riverside and San Bernardino
HLB Quarantine
ACP Quarantine
HLB Detections (Trees)
1 - 5
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> 50
HLB Detections (Psyllids)
1 - 5
> 5
Commercial Citrus
Los Angeles
Long Beach
Anaheim
Santa Ana
Irvine
Huntington Beach
Newport Beach
Costa Mesa
Lake Forest
Mission Viejo
Laguna Niguel
Laguna Beach
Rancho Santa Margarita
Lake Elsinore
Corona
Riverside
Moreno Valley
Perris
Sun City
Wildomar
Murrieta
Temecula
Mira Loma
Chino
Chino Hills
Ontario
Pomona
Rancho Cucamonga
Fontana
Rialto
San Bernardino
Highland
Redlands
Grand Terrace
Loma Linda
Baldwin Park
West Covina
El Monte
East Los Angeles
Arcadia
Glendora
Pasadena
Glendale
Burbank
La Canada Flintridge
Inglewood
Downey
Norwalk
Torrance
Garden Grove
Orange
Lake Mathews
Lake Elsinore
SANTA ANA MOUNTAINS

In March 2012, HLB was found in a residential tree in Southern California. How did it get there?

Most likely an HLB-infected tree or infected budwood was brought illegally into California and planted or grafted onto a residential tree. The disease just sits inside the plant, until a psyllid arrives and picks it up and moves it.

It is very important to obtain disease-free trees and budwood from reputable nurseries rather than trading plant material of unknown origin

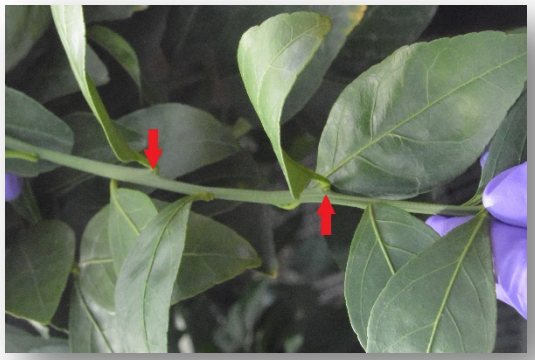
How does the bacterium spread? – Two ways

When the insect feeds it takes up the bacteria and passes it on when it feeds on the next citrus tree or 'citrus-like' plant

The psyllid can pick up the bacteria as a nymph or adult and then it carries the bacteria in its body for the rest of its life (weeks to months).

The bacteria can be spread by grafting infected plant material

Most Citrus trees are grafted



Budwood

Rootstock grown from seed with good disease resistance

+

Scion plant material with good fruit qualities

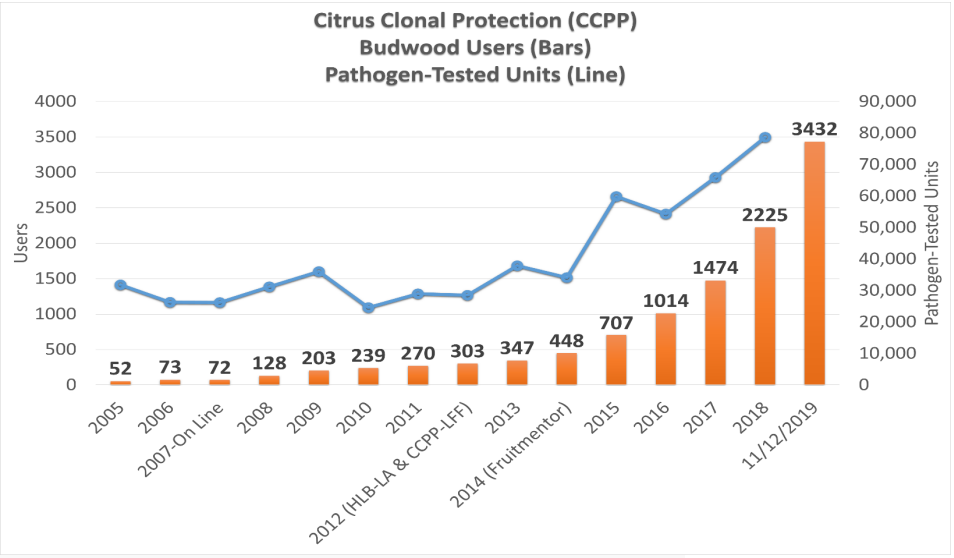
Citrus Clonal Protection Program
... starting citrus correctly

https://ccpp.ucr.edu

Disease-free budwood is shipped to the nurseries, who then make the trees that are sold to growers and retail stores

Fruit Mentor - Dan Willey

Videos teach how to graft citrus and recommend Citrus Clonal Protection Program Budwood

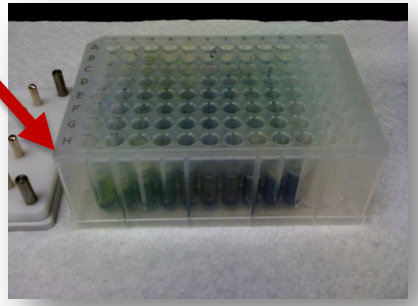


Why is this disease so quick to spread and so hard to detect?

The nymphs hatch and immediately pick up the bacterium and spread it when they molt and fly away 4-6 weeks later.

The eggs are laid on new flush next to the where the psyllid injects the bacterium.

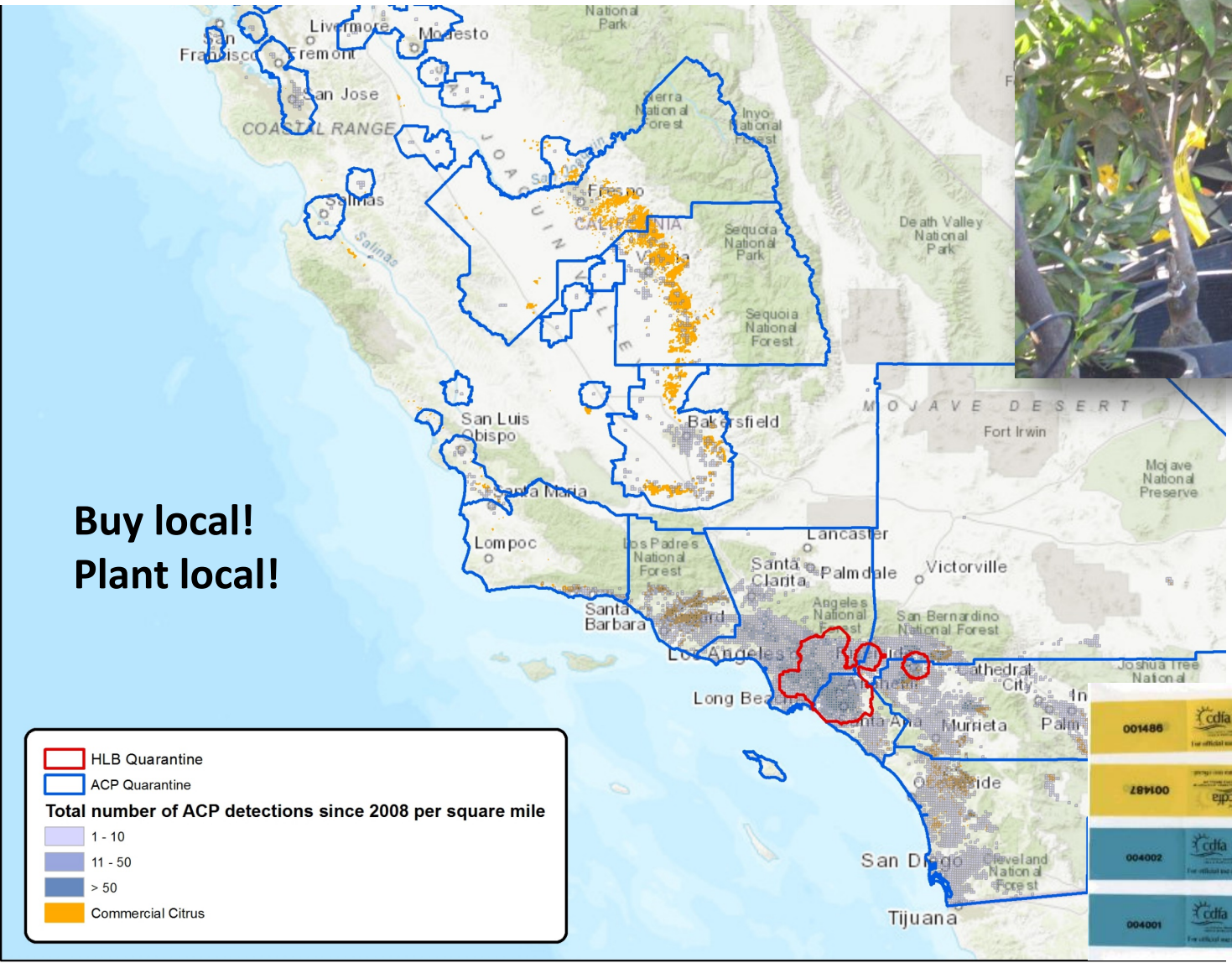
When leaves are sampled, they must have the bacteria for PCR to detect it.
It takes 9 months to 2 years for the bacteria to spread throughout the tree for sampling to pick the right leaf.



Citrus trees in retail nurseries in the ACP quarantine areas have a tag on them to keep plants local and retail citrus in HLB Q areas is destroyed

The tag explains that the tree should not be moved out of the quarantine area.

Buy local!
Plant local!



Response to psyllids

Goal: reduce psyllids to reduce the spread of disease

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

Central/Northern CA:
Eradicative/ Coordinated Treatments

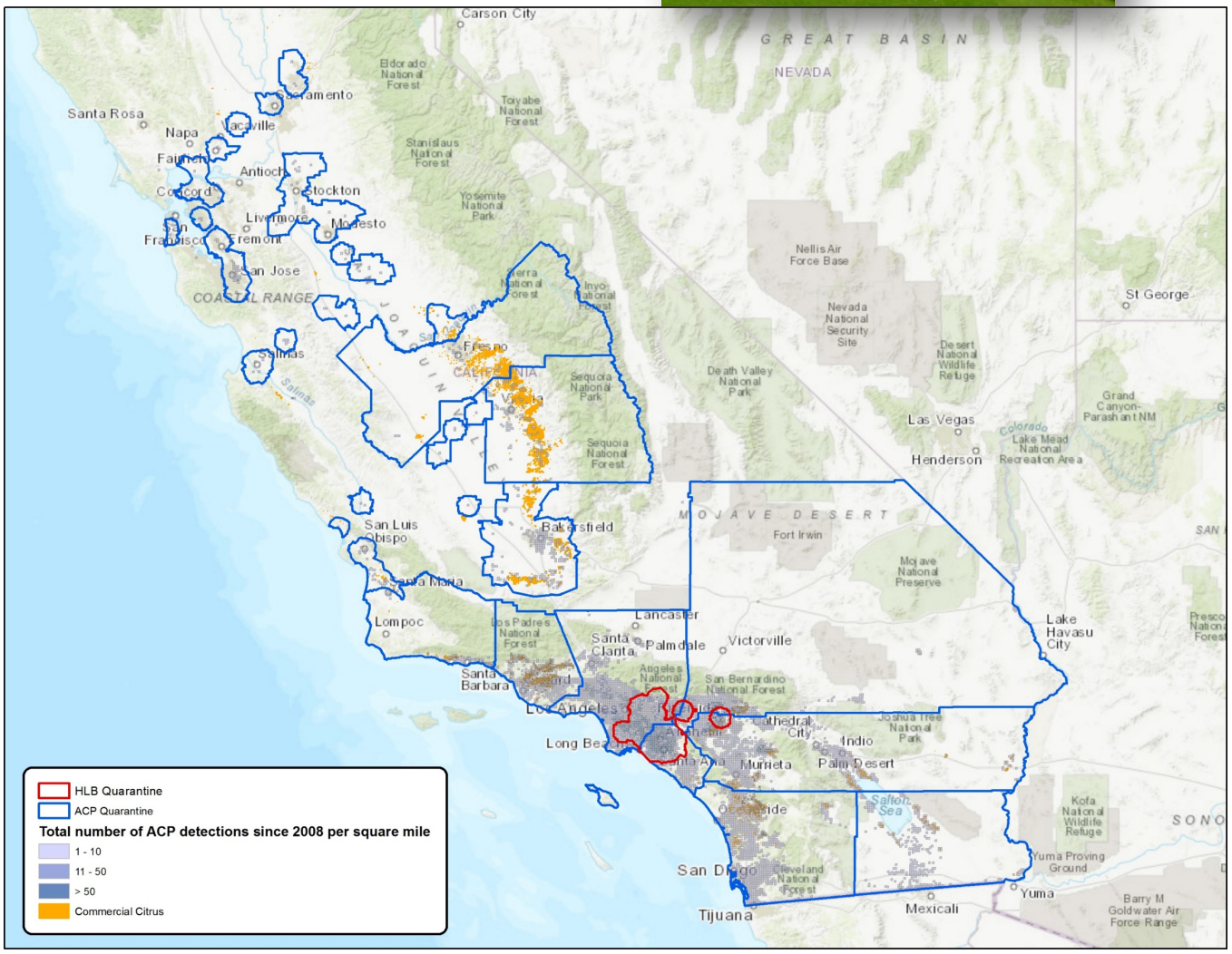
Commercial citrus: coordinated treatments

Urban: find site and neighbors

Southern California:
Area-wide treatment program

Commercial citrus: Growers treat together over a 2-3 week window (fall and winter)

Urban: parasites released



Action Steps for Homeowners in areas where psyllids are not known to have established (generally north of the grapevine)

- Examine citrus trees whenever there is young leaf flush
- If you find psyllids, call the hotline or the local Ag Commissioners office
- If the psyllid is found in or near your home, support CDFA-applied insecticide treatments to help locally eradicate the pest

Locally eradicate the psyllid!

How do I look for the psyllid?

Look at new leaves for adult and nymphs that produce the waxy tubules

If you find it north of the grapevine, call your county ag commissioner
Or the CDFA hotline – either way act fast to contact the authorities

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What actions does CDFA take to locally eradicate the psyllids?

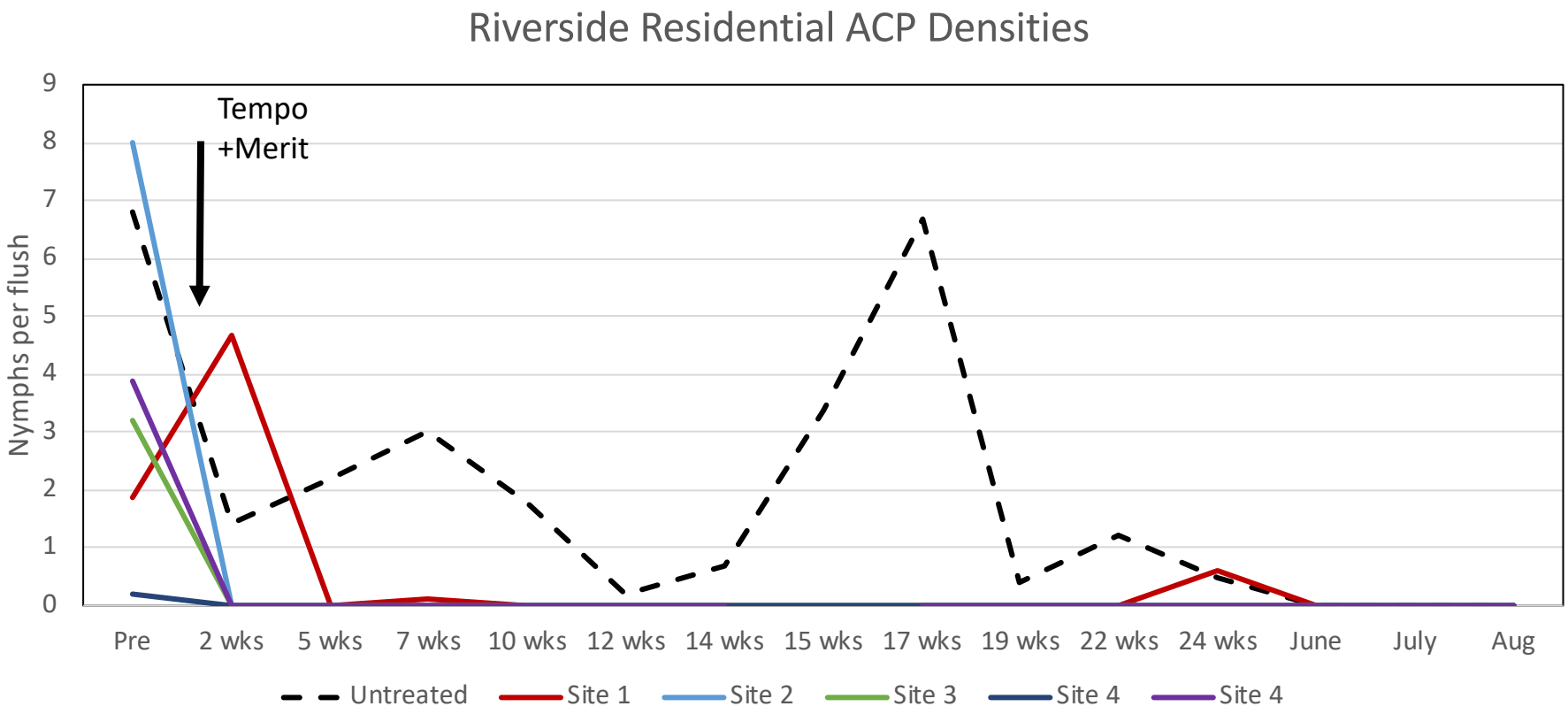
All of the host plants in that yard and neighboring yards, are treated with a foliar and a systemic insecticide.

A professional applicator treats the backyard citrus trees and closely related plants with insecticides

-cyfluthrin (Tempo) a foliar pyrethroid

-imidacloprid (Merit) a systemic neonicotinoid

Treatments are very effective



<u>Conclusions</u>

Tempo + Merit rapidly eliminated psyllids in 4 out of 5 sites

Protection lasted for at least 4 months and in some areas of CA eradicates the pest

5 flushes examined (when available) on 2-5 trees at each site

What about bees?

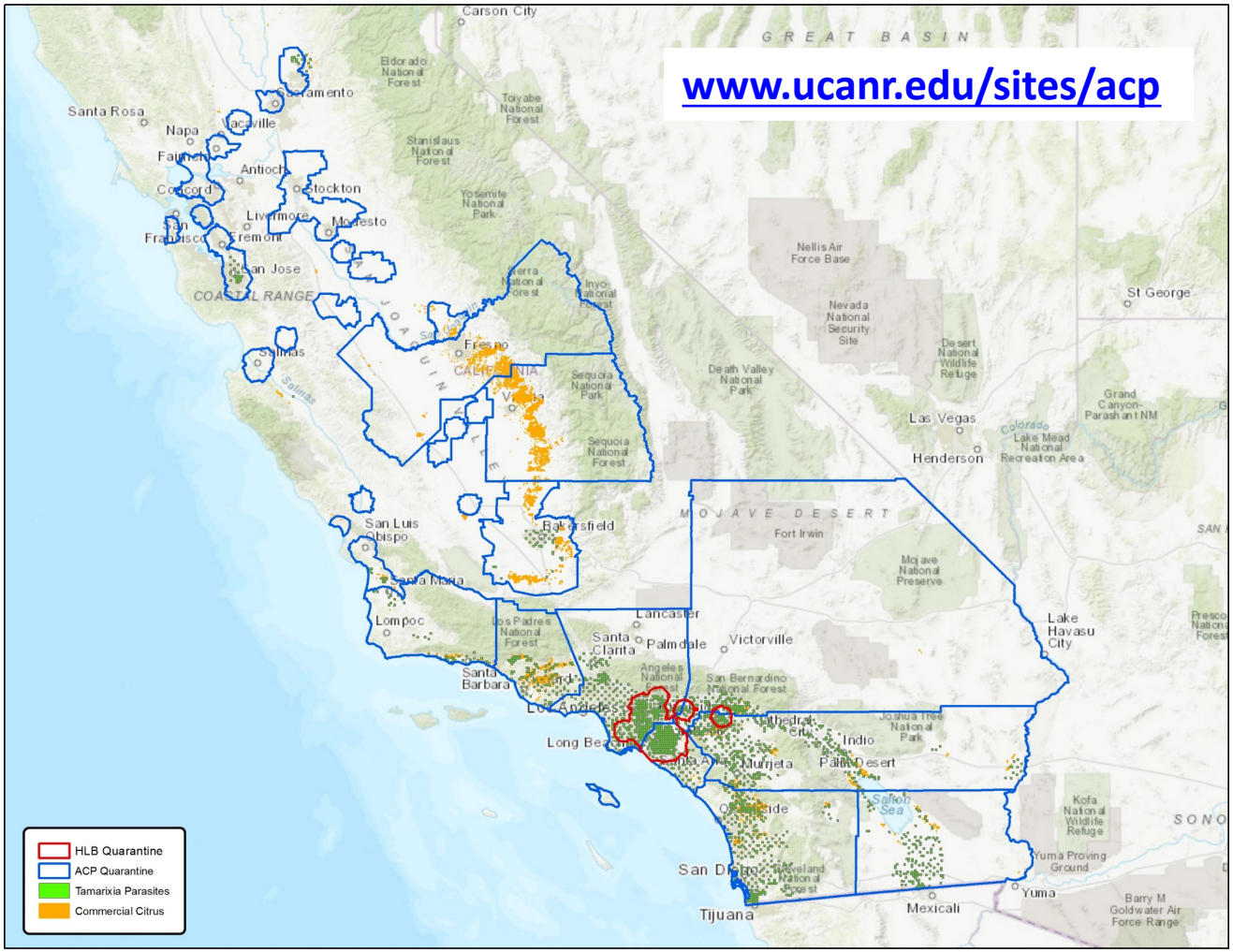
- CDFA does not treat with the foliar pyrethroid pesticide if bloom is present
- The neonicotinoid is applied to the soil
- Most citrus trees only bloom in April. Bees are not attracted to citrus the rest of the year. So treatments applied outside of April do not affect them.
- Bees are not feeding just on citrus flowers, but other plants in the yard as well and that reduces the effect of pesticides.
- Citrus is self-pollinating, which means that it doesn't need bees to produce fruit.

Action Steps for Homeowners in southern California where the psyllid is well-established, but not near HLB-infected trees

- Protect your trees from psyllids
  - Control ants to help biological control
  - Pesticides
  - Bags
  - Kaolin clay
- Examine your trees for HLB-leaf symptoms and if you see something suspicious, call the CDFA hotline

Protect your trees from psyllids and be on the lookout for HLB!

Tamarixia radiata parasite releases



USDA/UC Releases have been successful in establishing the parasites and releases continue, however, the *Tamarixia* are very expensive ($.50/wasp) and parasitism levels are not high enough to prevent disease spread.

Control ants to promote natural enemies (parasites, lacewings, syrphid flies)

All Ants:

- **Stickem band on the trunk**
- **Surface treatments: pyrethroids**

Sugar Feeders (grey and black ants)

- **Liquid baits: boric acid**
- **Gel baits: arsenic, boric acid**

Protein Feeder (red ants)

- **Corn cob grit baits: hydramethylnon, fipronil, sulfuramid**

Ants protect psyllids from natural enemies

The nymphs produce sugary honeydew as waste and the ants protect the psyllids from parasites and predators (natural enemies) in order to farm that honeydew

Insecticide treatments available to homeowners – treatments to apply when CDFA does not treat

Type of treatment	Pesticide Name	Effectiveness against ACP	Duration of control	Application timing
Professional treatment	Tempo & Merit	High	Months	Foliar: when psyllids are present Systemic: summer or fall
Homeowner-applied broad-spectrum foliars	Sevin, Malathion	Moderate	Weeks	When psyllids are observed
Homeowner-applied soil drench	Bayer Advanced Fruit, Citrus & Vegetable	Moderate	Months	When psyllids are observed in summer or fall
Homeowner-applied soft foliars	Insecticidal soaps, oils and pyrethrins	Low to moderate	Days	Every 7-10 days especially during *leaf flushing

*Flushing: when new leaves are first developing until they expand and harden

Surround at Home© Crop Protectant

- ¼ to ½ lb per gallon, premix in a bucket and spray on the plant
- Be sure to shake the sprayer and clean the nozzles when done

The trick is to keep the new flush protected because that is where the psyllid wants to lay the eggs

Mesh bags or screenhouses to prevent psyllids reaching the trees

- Mesh must be small enough to keep psyllids out
- Bags for individual trees
- Screen houses for community gardens

The TREE DEFENDER
CREATED BY GROWERS FOR GROWERS

http://thetreedefender.com

4, 5, 7 and 12 foot bags
($8 -25 + shipping)

**Its critical to make sure there are no insects on the tree to begin with and to check periodically, or you will create an insectary of scales, whiteflies, mealy bugs, psyllids etc inside the bag.

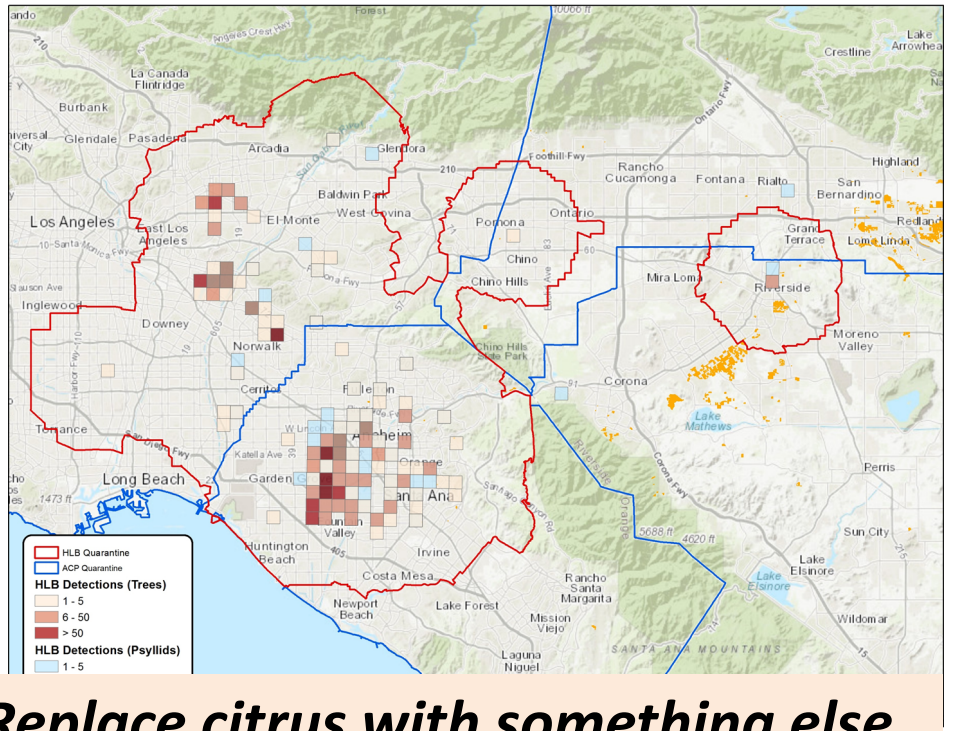
How do I look for the disease?

Leaves with HLB disease have a blotchy yellow pattern that is not the same on both sides of the leaf.

Leaves with nutrient deficiencies (Zinc is an example) have the same yellow pattern on both sides of the leaf.

Action Steps for Homeowners near HLB-infected tree removals or infected psyllids

- Support CDFA treatment of your citrus (mandatory treatments)
- Parasitic wasps are being released outside the treated yards
- Protect your trees from psyllids
  - Pesticides
  - Bags
  - Kaolin clay
- Examine your trees for HLB-leaf symptoms and if you see something suspicious, call the CDFA hotline
- Consider replacing your citrus with non-citrus or keeping it covered with a mesh bag



Replace citrus with something else until a cure is found!

If You Find it: Act Fast, Time is Critical

Call 800/491-1899

Think you found the Asian citrus psyllid or HLB symptoms on your tree.

- Time is critical.
- Secure psyllids and leaf samples in a clear, locked sandwich bag, jar or plastic container.
- Contact your local Agricultural Commissioner's office or call the California Department of Food and Agriculture hotline immediately.

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Homeowner Messaging in the HLB Quarantine Area

https://ucanr.edu/hlbapp

Should I replace my citrus tree with a non-citrus fruit tree?

The Asian citrus psyllid is spreading a bacterial disease called huanglongbing (HLB) that kills citrus trees. Trees that are known to have the disease are treated and removed by the California Department of Food and Agriculture (CDFA). HLB quarantines have been set up in areas where diseased trees have been found. Unhappily, not all trees with disease test positive, but they can still provide a home for the psyllids and the disease.

If you are close to or within the HLB quarantine, you may need to replace your citrus tree with a non-citrus fruit tree to help prevent the spread of HLB. See the graphic below to find out more.

Use the web link ucanr.edu/hlbapp or the QR code to determine how close you are to an infected tree.

HLB detected 0-2 miles: replace your tree

Remove and replace your tree with a non-citrus fruit tree.

Your tree is likely to be infected with HLB even if it is not showing symptoms or a positive test.

When removing the tree:

Treat with the tree with insecticide and/or dry out the tree before disposing of it so that you don't move psyllids.

Alternative fruit trees

There are lots of great choices for southern California planting: apples, figs, jujube, loquat, persimmon, pomegranate, avocado, and many more!

HLB detected 2-5 miles: consider replacing your tree!

Support regular treatment and testing for HLB by CDFA. Regularly check the map and intensify the protection of your citrus trees by additional treatments to kill ACP or a tree covering to block ACP reaching the foliage.

HLB detected greater than 5 miles

Regularly check the map and protect citrus trees with pesticide treatments for ACP and control ants to promote natural enemies.

Resources

UC ANR ACP and HLB Distribution and Management: ucanr.edu/acp

UC IPM *Pest Notes* for ACP: ucanr.edu/pnacp

Call CDFA hotline with ACP/HLB questions in Spanish and English: **(800) 491-1899**

E-mail photos of insects, damage, or disease concerns to: pesthotline@cdfa.ca.gov

UCCE Master Gardener Hotlines

Los Angeles County
mglosangeleshelpline@ucdavis.edu
(626) 586-1988

Desert/Indio area
anrmgindio@ucanr.edu
(760) 342-2511

Orange County
ucceocmghotline@ucanr.edu
(949) 809-9760

San Bernardino County
mgsanbern@ucanr.edu
(909) 387-2182

City of Riverside area
anrmgriverside@ucanr.edu,
(951) 683-6491 ext. 231

Ventura County
mgventura@ucdavis.edu
(805) 645-1455

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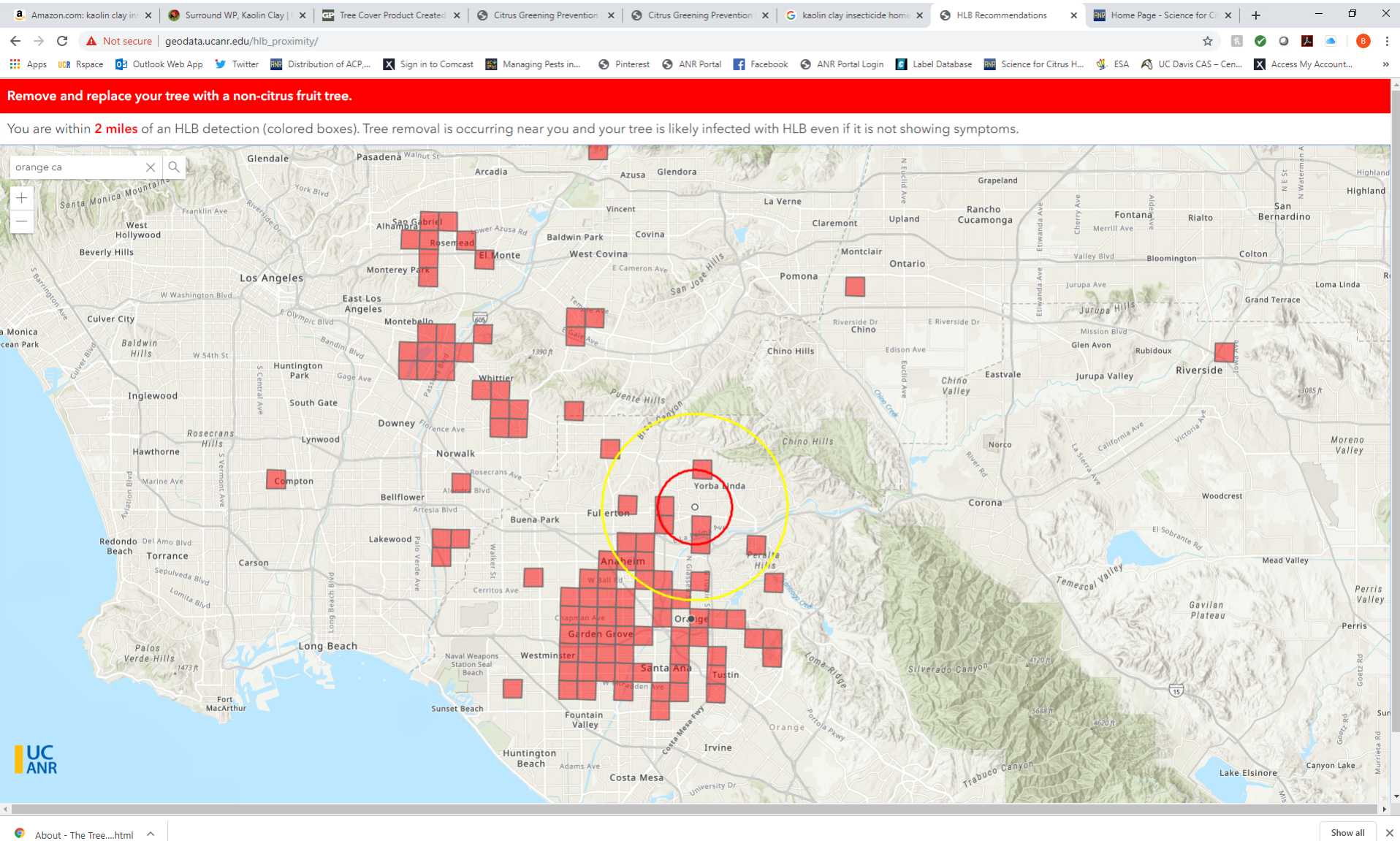
https://ucanr.edu/hlbapp

2 to 5 miles from an HLB-infected tree removal – recommend intensifying protection of the tree and consider replacing the tree with noncitrus

<2 miles from an HLB-infected tree removal – recommend replacing citrus with noncitrus



If I am in the HLB quarantine area, is it safe to pick fruit from my tree and give it to my friends?

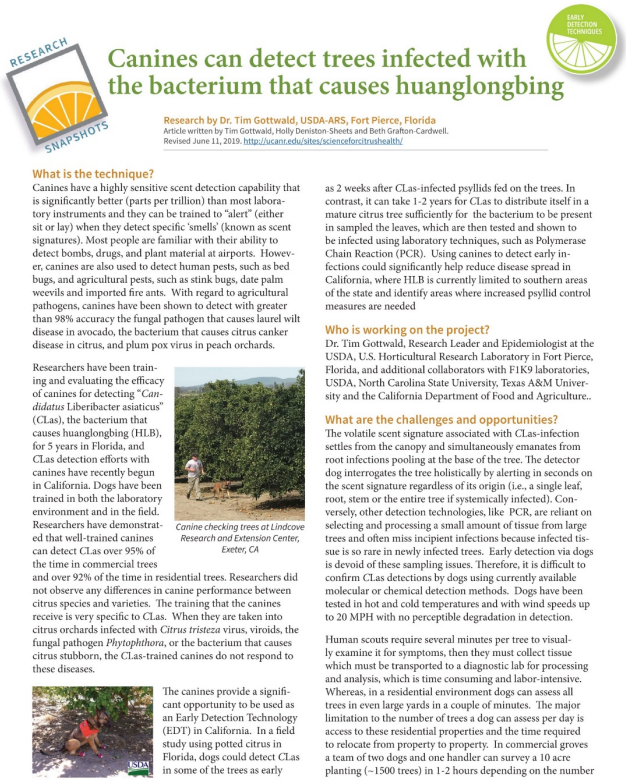
The immature psyllids can't live on citrus fruit, so as long as you brush or wash the fruit to remove the adults and make sure it is free of leaves and twigs that could harbor eggs and nymphs before transporting it, it is ok to move it.

What about bactericides?

- **Though bactericides (oxytetracycline and streptomycin) are registered, they are not currently being used by California growers**
- **In Florida, where 80% of the trees have HLB, some growers use the antibiotics to lower the titer of the bacteria in trees so that they produce better**
- **Bactericides for plants are formulated very differently than for humans and can not select for antibiotic resistance in micro-organisms, animals or humans.**
  - **Plant bactericides formulated as a very low concentration**
  - **They are applied to the surface of the plant**
  - **They are broken down very rapidly and naturally by micro-organisms in the environment**
- **The micro-organism and human effects have been studied extensively**
- **The products are registered with rate, frequency and timing restrictions (both Federal and State) that protect consumers from any effect whatsoever**

The Future of California Citrus Production

- Using **early detection techniques** to rogue out infected trees
  - Machines that measure changes in the volatiles (smells) of sick trees
  - Tests that measure defense proteins in the leaves of sick trees
  - Measure changes in the organisms that live on the surface of leaves
  - Canines that can detect the bacterium
- Growing **tolerant varieties**
- Growing trees in **higher densities** with a shorter lifespan
- Applying **bactericides** to the trees
- Utilizing **genetic engineering** to create a protected tree
  - Altering the tree and replanting the new trees
  - Using Citrus tristeza virus as a carrier for HLB resistance to protect planted trees
- Spray trees with chemicals (**interference RNAs**) that prevent psyllid from picking up the disease
- CUPS- grow citrus under a **protective structure**



RESEARCH SNAPSHOTS

Canines can detect trees infected with the bacterium that causes huanglongbing

Research by Dr. Tim Gottwald, USDA-ARS, Fort Pierce, Florida
Article written by Tim Gottwald, Holly Deniston-Sheets and Beth Grafton-Cardwell.
Revised June 11, 2019. http://ucanr.edu/sites/scienceforcitrushealth/

What is the technique?

Canines have a highly sensitive scent detection capability that is significantly better (parts per trillion) than most laboratory instruments and they can be trained to "alert" (either sit or lay) when they detect specific 'smells' (known as scent signatures). Most people are familiar with their ability to detect bombs, drugs, and plant material at airports. However, canines are also used to detect human pests, such as bed bugs, and agricultural pests, such as stink bugs, date palm weevils and imported fire ants. With regard to agricultural pathogens, canines have been shown to detect with greater than 98% accuracy the fungal pathogen that causes laurel wilt disease in avocado, the bacterium that causes citrus canker disease in citrus, and plum pox virus in peach orchards.

Researchers have been training and evaluating the efficacy of canines for detecting "*Candidatus* Liberibacter asiaticus" (CLas), the bacterium that causes huanglongbing (HLB), for 5 years in Florida, and CLas detection efforts with canines have recently begun in California. Dogs have been trained in both the laboratory environment and in the field. Researchers have demonstrated that well-trained canines can detect CLas over 95% of the time in commercial trees and over 92% of the time in residential trees. Researchers did not observe any differences in canine performance between citrus species and varieties. The training that the canines receive is very specific to CLas. When they are taken into citrus orchards infected with *Citrus tristeza* virus, viroids, the fungal pathogen *Phytophthora*, or the bacterium that causes citrus stubborn, the CLas-trained canines do not respond to these diseases.

Canine checking trees at Lindcove Research and Extension Center, Exeter, CA

The canines provide a significant opportunity to be used as an Early Detection Technology (EDT) in California. In a field study using potted citrus in Florida, dogs could detect CLas in some of the trees as early as 2 weeks after CLas-infected psyllids fed on the trees. In contrast, it can take 1-2 years for CLas to distribute itself in a mature citrus tree sufficiently for the bacterium to be present in sampled the leaves, which are then tested and shown to be infected using laboratory techniques, such as Polymerase Chain Reaction (PCR). Using canines to detect early infections could significantly help reduce disease spread in California, where HLB is currently limited to southern areas of the state and identify areas where increased psyllid control measures are needed

Who is working on the project?

Dr. Tim Gottwald, Research Leader and Epidemiologist at the USDA, U.S. Horticultural Research Laboratory in Fort Pierce, Florida, and additional collaborators with F1K9 laboratories, USDA, North Carolina State University, Texas A&M University and the California Department of Food and Agriculture..

What are the challenges and opportunities?

The volatile scent signature associated with CLas-infection settles from the canopy and simultaneously emanates from root infections pooling at the base of the tree. The detector dog interrogates the tree holistically by alerting in seconds on the scent signature regardless of its origin (i.e., a single leaf, root, stem or the entire tree if systemically infected). Conversely, other detection technologies, like PCR, are reliant on selecting and processing a small amount of tissue from large trees and often miss incipient infections because infected tissue is so rare in newly infected trees. Early detection via dogs is devoid of these sampling issues. Therefore, it is difficult to confirm CLas detections by dogs using currently available molecular or chemical detection methods. Dogs have been tested in hot and cold temperatures and with wind speeds up to 20 MPH with no perceptible degradation in detection.

Human scouts require several minutes per tree to visually examine it for symptoms, then they must collect tissue which must be transported to a diagnostic lab for processing and analysis, which is time consuming and labor-intensive. Whereas, in a residential environment dogs can assess all trees in even large yards in a couple of minutes. The major limitation to the number of trees a dog can assess per day is access to these residential properties and the time required to relocate from property to property. In commercial groves a team of two dogs and one handler can survey a 10 acre planting (~1500 trees) in 1-2 hours depending on the number

http://ucanr.edu/sites/scienceforcitrushealth/

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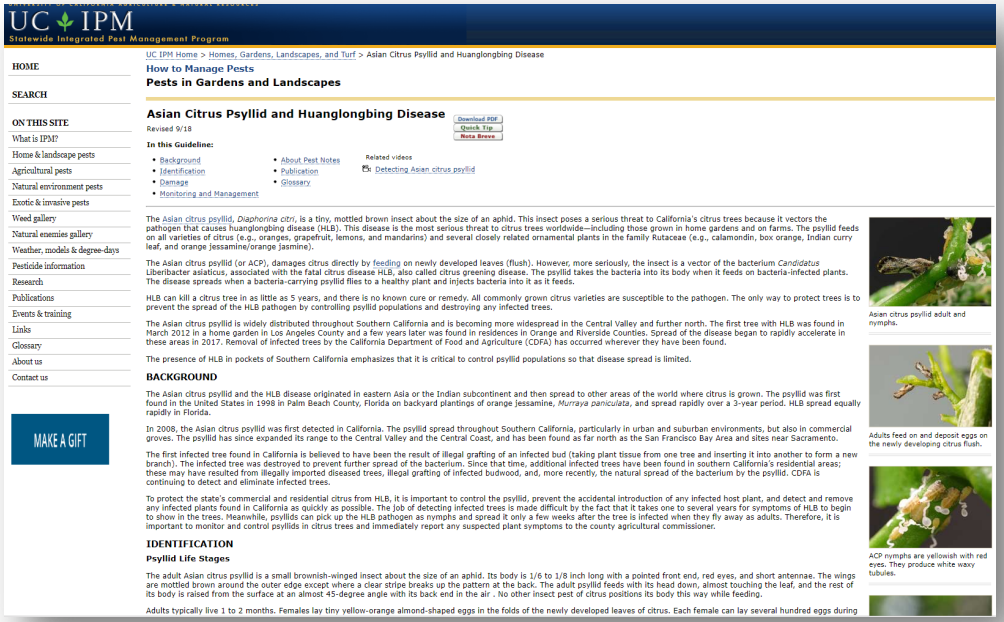
A great resource for sharing information about the pest and disease with friends

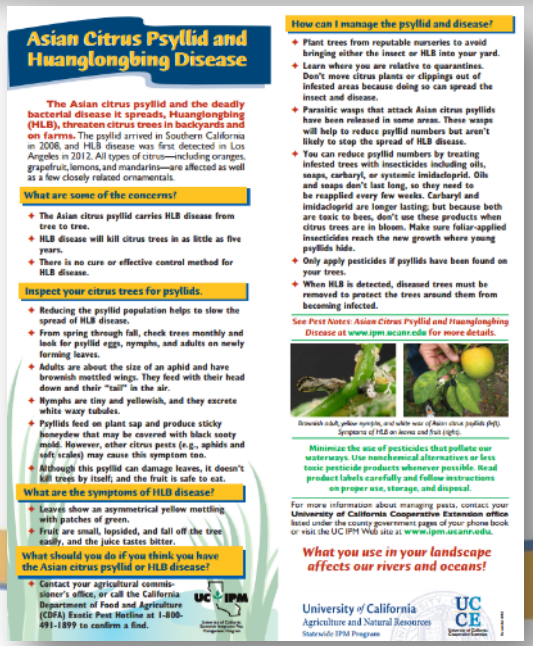
www.CaliforniaCitrusThreat.org
www.PeligranCitricosenCalifornia.com

This web site, funded by the citrus industry provides users with basic information about the psyllid and disease and how to respond.

Where can I get more University of California information?

- **ACP HLB Website:** www.ucanr.edu/sites/ACP
- **UC IPM Pest note for homeowners** http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74155.html
- **UCIPM Quick tip for homeowners** http://www.ipm.ucdavis.edu/QT/asiancitruscard.html





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Master Gardeners can help with messaging about how homeowners can protect their citrus

- If you graft citrus, use only disease-free budwood from the Citrus Clonal Protection Program (CCPP.ucr.edu)
- Plant only disease-free citrus plants obtained from a reputable nursery.
- Do not move citrus trees around the state
- Learn to recognize the pest and disease.

All of these steps buy time for the scientists to find a cure for the disease!

- Call the Department of Food and Agriculture hotline if you think you might have the psyllid (central and northern CA) or the disease (southern CA).
- Allow officials to inspect and test your citrus for the disease – if HLB is found, the tree must be destroyed
- Allow officials to treat your citrus trees if HLB is found near you
- If you live near an HLB-infected area in southern California, consider removing your citrus tree in advance of it becoming infected with the disease or covering it with a bag.
- Follow the Science for Citrus Health website to learn what scientists are doing to fight this disease