CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

OFFICIAL NOTICE
FOR MARIN COUNTY
PLEASE READ IMMEDIATELY

NOTICE OF TREATMENT FOR THE ASIAN CITRUS PSYLLID

On November 21, 2018, the California Department of Food and Agriculture (CDFA) confirmed the presence of Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama, a harmful exotic pest, in the city of Novato, Marin County. This detection indicates that a breeding population exists in the area. The devastating citrus disease Huanglongbing (HLB) is spread by the feeding action of ACP. The ACP infestation is sufficiently isolated and localized to be amenable to the CDFA's ACP treatment work plan.

A Program Environmental Impact Report (PEIR) has been certified which analyzes the ACP treatment program in accordance with Public Resources Code, Sections 21000 et seq. The PEIR is available at http://www.cdfa.ca.gov/plant/peir/. The treatment activities described below are consistent with the PEIR.

In accordance with integrated pest management principles, CDFA has evaluated possible treatment methods and determined that there are no physical, cultural, or biological control methods available to eliminate the ACP from this area. Notice of Treatment is valid until November 21, 2019, which is the amount of time necessary to determine that the treatment was successful.

The treatment plan for the ACP infestation will be implemented within a 50-meter radius of each detection site, as follows:

- Tempo® SC Ultra (cyfluthrin), a contact insecticide for controlling the adults and nymphs of ACP, will be applied from the ground using hydraulic spray equipment to the foliage of host plants; and

- Merit® 2F or CoreTect™ (imidacloprid), a systemic insecticide for controlling the immature life stages of ACP, will be applied to the soil underneath host plants. Merit® 2F is applied from the ground using hydraulic spray equipment. CoreTect™, which is used in place of Merit® 2F in situations where there are environmental concerns about soil surface runoff of liquid Merit® 2F, is applied by inserting the tablets into the ground and watering the soil beneath the host plants.

Public Notification:

Residents of affected properties shall be invited to a public meeting where officials from CDFA, the Department of Pesticide Regulation, the Office of Environmental Health Hazard Assessment, and the county agricultural commissioner's office shall be available to address residents' questions and concerns.

Residents are notified in writing at least 48 hours in advance of any treatment in accordance with the Food and Agricultural Code sections 5771-5779 and 5421-5436.

Following the treatment, completion notices are left with the residents detailing precautions to take and post-harvest intervals applicable to the citrus fruit on the property.

Treatment information is posted at http://cdfa.ca.gov/plant/acp/treatment_maps.html. Press releases, if issued, are prepared by the CDFA information officer and the county agricultural commissioner, in close coordination with the program leader responsible for treatment. Either the county agricultural commissioner or the public information officer serves as the primary contact to the media.

Information concerning the ACP/HLB program shall be conveyed directly to local and State political representatives and authorities via letters, emails, and/or faxes.

For any questions related to this program, please contact the CDFA toll-free telephone number at 800-491-1899 for assistance. This telephone number is also listed on all treatment notices.

Enclosed are the findings regarding the treatment plan, a November 22, 2017 UC and USDA briefing paper on the increasing detection rate of ACP/HLB, ACP/HLB work plan, map of the treatment area, integrated pest management analysis of alternative treatment methods, and a pest profile.

Attachments

FINDINGS REGARDING A TREATMENT PLAN FOR THE ASIAN CITRUS PSYLLID

On November 21, 2018, the California Department of Food and Agriculture (CDFA) confirmed the presence of Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama, in the city of Novato, Marin County. This detection indicates that a breeding population exists in the area. ACP is a harmful exotic insect pest and a vector of Huanglongbing (HLB) disease.

HLB is considered one of the most devastating diseases of citrus in the world. The bacterium that causes the disease, *Candidatus* Liberibacter asiaticus, blocks the flow of nutrients within the tree and causes the tree to starve to death within two to five years of infection. There is no cure. Symptoms of HLB include yellow shoots with mottling and chlorosis of the leaves, misshapen fruit, fruit that does not fully color, and fruit that has a very bitter taste, which makes it inedible for human consumption. These symptoms often do not appear until two years after infection, making this particular disease difficult to contain and suppress. These undesirable symptoms of HLB-infected trees result in the trees' loss of commercial and aesthetic value while at the same time such trees are hosts for spreading HLB.

ACP is native to Asia. It has appeared in Central and South America. In the United States, ACP has been found in Alabama, Arizona, Florida, Georgia, Hawaii, Louisiana, Mississippi, South Carolina, and Texas. In California, ACP has been found in twenty-six counties.

ACP feeds on members of the plant family Rutaceae, primarily on *Citrus* and *Murraya* species, but is also known to attack several other genera, including over forty species of plant that act as hosts and possible carriers. The most serious damage to the environment and property caused by ACP - the death and loss in value of host plants - is due to its vectoring HLB. In addition, the psyllids also cause injury to their host plants via the withdrawal of large amounts of sap as they feed and via the production of large amounts of honeydew, which coats the leaves of the tree and encourages the growth of sooty mold. Sooty mold blocks sunlight from reaching the leaves.

These pests present a significant and imminent threat to the natural environment, agriculture, and economy of California. For example, unabated spread of HLB would have severe consequences to both the citrus industry and to the urban landscape via the decline and the death of citrus trees. The value of California citrus production in the 2016-17 marketing year was $3.389 billion. The total economic impact of the industry on California's economy in 2016-17 was $7.1 billion. The California citrus industry added $1.695 billion to California's state GDP in 2016. Estimated full time equivalent jobs in the California citrus industry in 2016-17 totaled 21,674. Estimated wages paid by the California citrus industry income in 2016-17 totaled $452 million. A 20 percent 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.

Additionally, if unabated, the establishment of HLB in California would harm the natural environment as commercial and residential citrus growers would be forced to increase pesticide use. Also, the establishment of HLB could lead to enforcement of quarantine restrictions by the United States Department of Agriculture (USDA) and our international trading partners. Such restrictions would jeopardize California's citrus exports, which are valued at over $800 million per year.

The causative bacteria of HLB was first detected in Los Angeles in 2012. It has subsequently been detected in Orange, Riverside, and San Bernardino counties. Prior to November 2017, the level of HLB risk in California was thought to be relatively stable. However, on November 22, 2017, the University of California and the USDA released a briefing paper that indicates, beginning in June 2017, a sharp increase in HLB and HLB-positive ACP detections, cities containing HLB, and ACP nymphs.

With the release of the November 22, 2017 briefing paper, the CDFA became aware of the exponential intensification of the HLB epidemic, as demonstrated by the indicators contained in the paper.

Infected trees are destroyed as soon as they are discovered. However, due to the length of time it takes for symptoms to appear on infected trees, new infestations continue to be discovered. If the current ACP infestation is not abated immediately, ACP will likely become established in neighboring counties and could pave the way for a statewide HLB infestation.

CDFA has evaluated possible treatment methods in accordance with integrated pest management (IPM) principles. As part of these principles, I have considered the following treatments for control of ACP: 1) physical controls; 2) cultural controls; 3) biological controls; and 4) chemical controls. Upon careful evaluation of each these options, I have determined that it is necessary to address the imminent threat posed by HLB using currently available technology in a manner that is recommended by the HLB Task Force.

Based upon input from the HLB Task Force, the Primary State Entomologist, the Primary State Plant Pathologist, USDA experts on HLB and ACP, and county agricultural commissioner representatives who are knowledgeable on ACP and HLB, I find there are no physical, cultural or biological control methods that are both effective against ACP and allow CDFA to meet its statutory obligations, and therefore it is necessary to conduct chemical treatments to abate this threat. As a result, I am ordering insecticide treatments for ACP using ground-based equipment within a 50-meter radius around the ACP detection site and any subsequent sites.

The option selected is a chemical control measure that involves the use of insecticides targeting both the adult and immature stages of ACP. This option was selected based upon biological effectiveness, minimal public intrusiveness, cost, and minimal impacts to the environment.

A Program Environmental Impact Report (PEIR) has been prepared which analyzes the ACP treatment program in accordance with Public Resources Code (PRC), Sections 21000 et seq. The PEIR was certified in December 2014, and is available at http://www.cdfa.ca.gov/plant/peir/. The PEIR addresses the treatment of the ACP at the program level and provides guidance on future actions against the ACP. It identifies feasible alternatives and possible mitigation measures to be implemented for individual ACP treatment activities. The ACP program has incorporated the mitigation measures and integrated pest management techniques as described in the PEIR. In accordance with PRC Section 21105, this PEIR has been filed with the appropriate local planning agency of all affected cities and counties. No local conditions have been detected which would justify or necessitate preparation of a site-specific plan.

Sensitive Areas

CDFA has consulted with the California Department of Fish and Wildlife's California Natural Diversity Database for threatened or endangered species, the United States Fish and Wildlife Service, the National Marine Fisheries Service and the California Department of Fish and Wildlife when rare and endangered species are located within the treatment area. Mitigation measures for rare and endangered species will be implemented as needed. The CDFA shall not apply pesticides to bodies of water or undeveloped areas of native vegetation. All treatment shall be applied to residential properties, common areas within residential development, non-agricultural commercial properties, and rights-of-way.

Work Plan

The proposed program area encompasses those portions of Marin County which fall within a 50-meter radius area around the property on which the ACP has been detected and any subsequent detection sites within the program boundaries. Notice of Treatment is valid until November 21, 2019, which is the amount of time necessary to determine that the treatment was successful. A map of the program boundaries is attached. The work plan consists of the following elements:

1. Treatment. Properties within 50-meters of each detection site shall be treated according to the following protocol. Treatments will be repeated, if necessary, as per label instructions.

   a. Tempo® SC Ultra, containing the contact pyrethroid insecticide cyfluthrin, will be applied by ground-based hydraulic spray equipment to the foliage of host plants for controlling the adults and nymphs of ACP. Treatment may be reapplied up to three times annually if additional ACPs are detected.

   b. Either Merit® 2F or CoreTect™, containing the systemic insecticide imidacloprid, will be applied to the root zone beneath host plants for controlling developing nymphs and providing long term protection against reinfestation. Merit® 2F is applied as a soil drench, while CoreTect™ tablets are inserted two to five inches below the soil surface and watered in to initiate tablet dissolution. CoreTect™ is used in place of Merit® 2F in situations where there are environmental concerns about soil surface runoff of the liquid Merit® 2F formulation. Treatment may be reapplied once annually if additional ACPs are detected.

Public Information

Residents of affected properties shall be invited to a public meeting where officials from CDFA, the California Department of Pesticide Regulation, the Office of Environmental Health Hazard Assessment, and the county agricultural commissioner's office shall be present to address residents' questions and concerns.

Residents shall be notified in writing at least 48 hours in advance of any treatment in accordance with the Food and Agricultural Code (FAC) sections 5771–5779 and 5421-5436.

After treatment, completion notices are left with the residents detailing precautions to take and post-harvest intervals applicable to the citrus fruit. Treatment information is posted at http://cdfa.ca.gov/plant/acp/treatment_maps.html.

For any questions related to this program, please contact the CDFA toll-free telephone number at 800-491-1899 for assistance. This telephone number is also listed on all treatment notices. Treatment information is posted at http://cdfa.ca.gov/plant/acp/treatment_maps.html.

Press releases, if issued, are prepared by the CDFA information officer and the county agricultural commissioner, in close coordination with the program leader responsible for treatment. Either the county agricultural commissioner or the public information officer serves as the primary contact to the media.

Information concerning the ACP program will be conveyed directly to local and State political representatives and authorities via letters, emails, and/or faxes.

Findings

ACP poses a significant and imminent threat to California's natural environment, agriculture, public and private property, and its economy.

The work plan involving chemical control of this pest is necessary to prevent loss and damage to California's natural environment, citrus industry, native wildlife, private and public property, and food supplies.

My decision to adopt findings and take action is based on sections 24.5, 401.5, 403, 407, 408, 5401-5405, and 5761-5764 of the FAC.

Karen Ross

Karen Ross, Secretary

12-6-18

Date

Asian Citrus Psyllid
Novato, Marin County
2018

0 0.25 0.5 0.75 1 mi

Proposed 50 Meter Treatment Area

Sensitive Environmental Area Treatment Mitigations in Place

N W E S

Asian Citrus Psyllid/ Huanglongbing Work Plan
November 2018

I. Trapping and Visual Survey

A. Urban and Rural Residential Detection Trapping and Visual Survey

This is a cooperative State/County trapping program for the Asian Citrus Psyllid (ACP) to provide early detection of an infestation in a county. Traps are serviced by agricultural inspectors. The trap used for ACP detection is the yellow panel trap, which is a cardboard panel coated with stickum on each side. ACP becomes entangled on the sticky surface and cannot move off of the trap. Yellow panel traps have proven successful at detecting infestations of ACP. At all locations where traps are placed, the host plant is visually inspected for ACP. If ACP is detected, the host will be visually surveyed for additional ACP and symptoms of huanglongbing (HLB).

- Trap Density: Five to 16 traps/square mile.
- Trap Servicing Interval: Every two to four weeks.
- Trap Relocation and Replacement: Traps should be replaced and relocated every four to eight weeks to another host at least 500 feet away, if other hosts are available.
- Visual surveys and/or tap sampling are conducted once at each trapping site when the trap is placed.

B. Delimitation Trapping and Visual Survey Outside of the Generally Infested Area

The protocols below are the actions in response to the detection of ACP in counties north of Santa Barbara County and the Tehachapi Mountains.

1. Response to the collection one or more ACP

a. Trapping

Density will be 50 traps per square mile in a four-square mile delimitation area centered on the detection site. Traps will be serviced weekly for one month. If no additional ACP are detected, the traps will be serviced monthly for one year past the identification date. Additional detections may increase the size of the delimitation survey area and will restart the one-year clock on the trap servicing requirement.

b. Visual Survey

All find sites and adjacent properties will be visually surveyed for ACP and HLB. Additional sites may be surveyed as part of the risk-based survey.

C. Commercial Grove Trapping

In counties with substantial commercial citrus production and are not generally infested with ACP, traps are placed within the groves at the density of one trap per 40 acres. Traps are replaced every month and submitted for screening.

In areas that are generally infested with ACP, agricultural inspectors visually survey commercial groves for plant tissue displaying symptoms of HLB and collect ACP which are tested for HLB.

II. Treatment

CDFA's treatment activities for ACP vary throughout the state and depend on multiple factors. Factors CDFA considers prior to treatment include:

- Determination if suppression of ACP is feasible;
- The proximity of the ACP infestation to commercial citrus;
- Whether growers are conducting coordinated treatment activities;
- The level of HLB risk;
- Consistency with the overall goal of protecting the state's commercial citrus production.

A. Treatment scenarios throughout the state in which treatment will occur:

- In areas with commercial citrus production that are generally infested with ACP, and where all growers are treating on a coordinated schedule; CDFA may conduct residential buffer treatments to suppress ACP populations.
- In areas with commercial citrus production that are not generally infested with ACP; CDFA will conduct residential treatments in response to ACP detections.
- In areas where HLB is detected, CDFA will conduct residential treatments to suppress ACP populations.
- In areas where ACP has not been previously detected, or where ACP has been detected at low densities, CDFA will conduct residential treatments to prevent ACP establishment or suppress populations.

CDFA's current policy is to not conduct treatments in areas that are generally infested if there is limited or no commercial citrus production in the area, or if all growers in the area are not treating.

1. Treatment Protocols

A Program Environmental Impact Report (PEIR) has been certified which analyzes the ACP treatment program in accordance with Public Resources Code, Sections 21000 et seq. The PEIR is available at http://www.cdfa.ca.gov/plant/peir. The treatment activities described below are consistent with the PEIR.

In accordance with the integrated pest management principles, the CDFA has evaluated possible treatment methods and determined that there are no physical, cultural, or biological control available to eliminate ACP from an area.

In general, when treatment has been deemed appropriate, CDFA applies insecticides to host trees in the residential (urban) areas in a 50 to 400-meter radius around each detection site. Only ACP host plants are treated.

a. Within two miles of International Border with Mexico

- CDFA will treat the residential area within a 400-meter buffer of the border.
- A Notice of Treatment (NOT) will be issued.

b. Within a Generally Infested Area With Commercial Citrus Production

- CDFA will treat the residential area within a 400-meter buffer surrounding commercial citrus groves if the growers are conducting coordinated treatments.
- A NOT will be issued.

c. Outside of the Generally Infested Area

The actions below are in response to the detection of one or more ACP in counties north of Santa Barbara County and the Tehachapi Mountains.

- Detection of one or more ACP - All properties with hosts within a 50-meter radius of the detection site will be treated.
- A NOT will be issued.

The actions below are in response to the detection of two or more ACP in Fresno, Madera, Kern, Kings, and Tulare counties.

- Detection of two or more ACP on one trap or one or more ACP detected on separate traps within 400 meters of each other within a six-month period – All properties with hosts within an 800-meter radius will be treated.
- In a commercial citrus environment, where there are few residences in the area, CDFA will treat the residential area within an 800-meter buffer surrounding commercial citrus groves if the growers are conducting coordinated treatments.
- A NOT will be issued.

d. In response to an HLB Detection

- All properties within a 400-meter radius of the detection site will be treated.
- A NOT will be issued.
- All host plants found to be infected with HLB shall be destroyed. Infected host plants shall be removed and destroyed by mechanical means.
- A Proclamation of an Emergency Program (PEP) will be issued.

2. Treatment Methodology

The treatment protocol consists of both a foliar and a systemic insecticide. The foliar insecticide is used for immediate reduction of the adult population in order to prevent the adults from dispersal. The systemic insecticide is a soil treatment used to kill the sedentary nymphs and provide long term protection against reinfestation. Treatment frequency is dependent on the insecticide applied and severity of the infestation. Treatments will end no later than two years after the last psyllid detection in the treatment area.

CDFA uses registered pesticides and follows the label directions. The treatment protocol may be adjusted to use only the foliar or the systemic insecticide to allow for mitigations in special situations.

a. Foliar Treatment

Tempo® SC Ultra (cyfluthrin) is a pyrethroid contact insecticide. Treatment will initially occur once, and subsequent applications may occur for up to three times annually if additional psyllids are detected. This material will be applied to the foliage of all host plants using hydraulic spray or hand spray equipment.

b. Soil Treatment

A systemic soil application will be made using either Merit® 2F or CoreTect™.

- Merit® 2F (imidacloprid), is a neonicotinoid systemic insecticide. Treatment will initially occur once, and a subsequent application may occur once on an annual basis if additional psyllids are detected. This material will be applied to the soil within the root zone of host plants.

- CoreTect™ (imidacloprid) is a neonicotinoid systemic insecticide. It is used in place of Merit® 2F in situations where there are environmental concerns about soil surface runoff of the liquid Merit® 2F formulation, such as host plants growing next to ponds and other environmentally sensitive areas. Treatment will initially occur once, with a subsequent application once on an annual basis if additional psyllids are detected. This material is a pelletized tablet and is inserted into the soil and watered in within the root zone of host plants.

INTEGRATED PEST MANAGEMENT ANALYSIS OF ALTERNATIVE TREATMENT METHODS FOR CONTROL OF THE ASIAN CITRUS PSYLLID AND HUANGLONGBING
May 2018

The treatment program used by the California Department of Food and Agriculture (CDFA) for control of the Asian citrus psyllid (ACP), *Diaphorina citri* (Hemiptera: Psyllidae), and the disease it transmits, namely Huanglongbing, *Candidatus* Lilberibacter asiaticus, targets multiple life stages. A contact insecticide is used for an immediate control of ACP adults in order to prevent spread, and a systemic insecticide is used to control developing ACP nymphs and to give the plant long term protection from re-infestation. The contact insecticide preferentially used contains the synthetic pyrethroid cyfluthrin, while the systemic insecticide contains the synthetic neonicotinoid imidacloprid. Both products have been shown to be effective against ACP elsewhere, particularly in Florida. In addition, HLB-infected plants are removed in their entirety and destroyed, in order to remove a reservoir for the disease. The California Huanglongbing Task Force, a joint government, university, and industry group formed in 2007 to provide guidance to the CDFA on matters pertaining to ACP and HLB has endorsed the use of these chemicals in the CDFA's treatment program.

Below is an evaluation of alternative treatment methods to control ACP and HLB which have been considered for treatment programs in California.

A. PHYSICAL CONTROL

Mass Trapping. Mass trapping of adults involves placing a high density of traps in an area in an attempt to physically remove them before they can reproduce. The current available trapping system for ACP relies on short distance visual stimulus, and is not considered effective enough to use in a mass trapping program.

Active Psyllid Removal. Adult ACPs are mobile daytime fliers, and adults could theoretically be netted or collected off of foliage. However, due to their ability to fly when disturbed, and the laborious and time-prohibitive task of collecting minute insects from several properties by hand, it would be highly unlikely that all adults could be captured and removed. Nymphs attach themselves to developing leaves and stems via their proboscis. Therefore, physical removal of the nymphs would entail removal of the growing shoots which will stunt the tree and reduce fruit production. For these reasons, mechanical control is not considered to be an effective alternative.

Host Removal. Removal of host plants for ACP would involve the large-scale destruction of plants and their roots by either physical removal or phytotoxic herbicides. Additionally, host removal could promote dispersal of female psyllids in search of hosts outside of the treatment area, thus spreading the infestation. For these reasons, host removal is considered inefficient and too intrusive to use over the entirety of the treatment areas used for ACP. However, physical host removal of HLB-infected plants in their entirety is used for HLB control, because it is limited in scope to just the infected tree and it is effective at eliminating the disease reservoir, thereby preventing further spread of the disease by ACP.

B. CULTURAL CONTROL

Cultural Control. Cultural controls involve the manipulation of cultivation practices to reduce the prevalence of pest populations. These include crop rotation, using pest-resistant varieties, and intercropping with pest-repellent plants. None of these options are applicable for ACP control in an urban environment, and may only serve to drive the psyllids outside the treatment area, thus spreading the infestation.

C. BIOLOGICAL CONTROL

Microorganisms. No single-celled microorganisms, such as bacteria, are currently available to control ACP.

Nematodes. Entomopathogenic nematodes can be effective for control of some soil-inhabiting insects, but are not effective, nor are they used, against above ground insects such as psyllids.

Parasites and Predators. There have been two parasites released in Florida against ACP, but only one of these are considered somewhat successful there, namely *Tamarixia radiata* (Hymenoptera: Eulophidae). This insect has been released into the environment in southern California. The CDFA is working with the citrus industry to pursue options for incorporating this parasite into treatment programs statewide. In addition, a second wasp has been recently released by the University of California Riverside, *Diaphorencyrtus aligarhensis.*

Sterile Insect Technique (SIT). SIT involves the release of reproductively sterile insects which then mate with the wild population, resulting in the production of infertile eggs. SIT has neither been researched nor developed for ACP, nor has it been developed for any species of psyllids, and is therefore unavailable.

D. CHEMICAL CONTROL

Foliar Treatment. A number of contact insecticides have been researched for use against ACP elsewhere, particularly in Florida. Contact insecticides are more effective against adult ACPs than the sedentary nymphs because adults actively move around on plants, thereby coming into contact with residues, whereas nymphs have to be directly sprayed in order for them to come into contact. The following product has been identified for use by the CDFA, based on a combination of effectiveness against ACP, worker and environmental safety, and California registration status.

Tempo® SC Ultra is a formulation of cyfluthrin which is applied to the foliage of all host plants. Tempo® SC Ultra is a broad-spectrum synthetic pyrethroid insecticide which kills insects on contact. Tempo® SC Ultra has no preharvest interval, which makes it compatible with residential fruit-growing practices.

Soil Treatment. A number of systemic insecticides have been researched for use against ACP elsewhere, particularly in Florida. Systemic insecticides are particularly effective against psyllid nymphs because nymphs spend much of their time feeding, thereby acquiring a lethal dose. The following products have been identified for use by the CDFA, based on a combination of effectiveness against ACP, worker and environmental safety, and California registration status.

Merit® 2F is a formulation of imidacloprid which is applied to the root system of all host plants via a soil drench. Imidacloprid is a synthetic neonicotinoid insecticide which controls a number of other phloem feeding pests such as psyllids, aphids, mealybugs, etc.

CoreTect™ is a formulation of imidacloprid which is applied to the root system of all host plants via insertion of a tablet into the soil, followed by watering. It is used in place of Merit® 2F in situations where there are environmental concerns about soil surface runoff of the liquid Merit® 2F formulation, such as host plants growing next to ponds and other environmentally sensitive areas.

E. RESOURCES

Grafton-Cardwell, E. E. and M. P. Daugherty. 2013. Asian citrus psyllid and huanglongbing disease. Pest Notes Publication 74155. University of California, Division of Agriculture and Natural Resources Publication 8205. 5 pp. http://www.ipm.ucdavis.edu/PDF/PESTNOTES/pnasiancitruspsyllid.pdf.

Grafton-Cardwell, E. E., J. G. Morse, N. V. O'Connell, P. A. Phillips, C. E. Kallsen, and D. R. Haviland. 2013. UC IPM Management Guidelines: Citrus. Asian Citrus Psyllid. Pest Notes Publication 74155. University of California, Division of Agriculture and Natural Resources. http://www.ipm.ucdavis.edu/PMG/r107304411.html.

PEST PROFILE

Common Name: Asian Citrus Psyllid

Scientific Name: *Diaphorina citri* Kuwayama

Order and Family: Hemiptera, Psyllidae

Description: The Asian citrus psyllid (ACP) is 3 to 4 millimeters long with a brown mottled body. The head is light brown. The wings are broadest in the apical half, mottled, and with a dark brown band extending around the periphery of the outer half of the wing. The insect is covered with a whitish waxy secretion, making it appear dusty. Nymphs are generally yellowish orange in color, with large filaments confined to an apical plate of the abdomen. The eggs are approximately 0.3 millimeters long, elongated, and almond-shaped. Fresh eggs are pale in color, then, turn yellow, and finally orange at the time of hatching. Eggs are placed on plant tissue with the long axis vertical to the surface of the plant.

History: Asian citrus psyllid was first found in the United States in Palm Beach County, Florida, in June 1998 in backyard plantings of orange jasmine. By 2001, it had spread to 31 counties in Florida, with much of the spread due to movement of infested nursery plants. In the spring of 2001, Asian citrus psyllid was accidentally introduced into the Rio Grande Valley, Texas on potted nursery stock from Florida. It was subsequently found in Hawaii in 2006, in Alabama, Georgia, Louisiana, Mississippi, and South Carolina in 2008. ACP was first found in California on August 27, 2008 in San Diego County. Subsequent to this initial detection in San Diego County, the ACP has been detected in Fresno, Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Luis Obispo, Santa Barbara, Tulare, and Ventura counties. The ACP has the potential to establish itself throughout California wherever citrus is grown.

Distribution: ACP is found in tropical and subtropical Asia, Afghanistan, Saudi Arabia, Reunion, Mauritius, parts of South and Central America, Mexico, the Caribbean, and in the U.S. (Alabama, Arizona, California, Florida, Georgia, Hawaii, Louisiana, Mississippi, South Carolina, and Texas).

Life Cycle: Eggs are laid on tips of growing shoots; on and between unfurling leaves. Females may lay more than 800 eggs during their lives. Nymphs pass through five instars. The total life cycle requires from 15 to 47 days, depending on environmental factors such as temperature and season. The adults may live for several months. There is no diapause but populations are low in the winter or during dry periods. There are nine to ten generations a year, with up to 16 noted under observation in field cages.

Hosts and Economic Importance: ACP feeds mainly on *Citrus* spp., at least two species of *Murraya*, and at least three other genera, all in the family Rutaceae. Damage from the psyllids occurs in two ways: the first by drawing out of large amounts of sap from the plant as they feed and, secondly, the psyllids produce copious amounts of honeydew. The honeydew then coats the leaves of the tree, encouraging sooty mold to grow which blocks sunlight to the leaves. However, the most serious damage caused by ACP is due to its ability to effectively vector three phloem-inhabiting bacteria in the genus *Candidatus* Liberibacter, the most widespread being *Candidatus* Liberibacter asiaticus. These bacteria cause a disease known as huanglongbing, or citrus greening. In the past, these bacteria have been extremely difficult to detect and characterize. In recent years, however, DNA probes, electron microscopy, and enzyme-linked

immunosorbent assay tests (ELISA) have been developed that have improved detection. Symptoms of huanglongbing include yellow shoots, with mottling and chlorosis of the leaves. The juice of the infected fruit has a bitter taste. Fruit does not color properly, hence the term "greening" is sometimes used in reference to the disease. Huanglongbing is one of the most devastating diseases of citrus in the world. Once infected, there is no cure for disease and infected trees will die within ten years. The once flourishing citrus industry in India is slowly being wiped out by dieback. This dieback has multiple causes, but the major reason is due to HLB.

Host List

SCIENTIFIC NAME	**COMMON NAMES**
Aegle marmelos	bael, Bengal quince, golden apple, bela, milva
Aeglopsis chevalieri	Chevalier's aeglopsis
Afraegle gabonensis	Gabon powder-flask
Afraegle paniculata	Nigerian powder-flask
Amyris madrensis	mountain torchwood
Atalantia monophylla	Indian atalantia
Atalantia spp.	
Balsamocitrus dawei	Uganda powder-flask
Bergia (=*Murraya*) *koenigii*	curry leaf
Calodendrum capense	Cape chestnut
X Citroncirus webberi	
Choisya arizonica	Arizonia orange
Choisya ternate	Mexican or mock orange
Citropsis articulata	Katimboro, Muboro, West African cherry orange
Citropsis gilletiana	cherry-orange
Citropsis schweinfurthii	African cherry-orange
Citrus aurantiifolia	lime, Key lime, Persian lime, lima, limón agrio, limón ceutí, lima mejicana, limero
Citrus aurantium	sour orange, Seville orange, bigarde, marmalade orange, naranja agria, naranja amarga
Citrus hystrix	Mauritius papeda, Kaffir lime
Citrus jambhiri	rough lemon, jambhiri-orange, limón rugoso, rugoso
Citrus limon	lemon, limón, limonero
Citrus madurensis (=X *Citrofortunella microcarpa*)	calamondin
Citrus maxima	pummelo, pomelo, shaddock, pompelmous, toronja
Citrus medica	citron, cidra, cidro, toronja
Citrus meyeri	Meyer lemon, dwarf lemon
Citrus × nobilis	king mandarin, tangor, Florida orange, King-of-Siam
Citrus × paradisi	grapefruit, pomelo, toronja
Citrus reticulata	mandarin, tangerine, mandarina
Citrus sinensis	sweet orange, orange, naranja, naranja dulce
Citrus spp.	
Clausena anisum-olens	anis
Clausena excavata	clausena
Clausena indica	clausena
Clausena lansium	wampi, wampee
Clymenia polyandra	a-mulis

Eremocitrus glauca	Australian desert lime
Eremocitrus hybrid	
Esenbeckia berlandieri	Berlandier's jopoy
Fortunella crassifolia	Meiwa kumquat
Fortunella margarita	Nagami kumquat, oval kumquat
Fortunella polyandra	Malayan kumquat
Fortunella spp.	
Limonia acidissima	Indian wood apple
Merrillia caloxylon	flowering merrillia
Microcitrus australasica	finger-lime
Microcitrus australis	Australian round-lime
Microcitrus papuana	desert-lime
X *Microcitronella* spp.	
Murraya spp.	curry leaf, orange-jasmine, Chinese-box, naranjo jazmín
Naringi crenulata	naringi
Pamburus missionis	
Poncirus trifoliata	trifoliate orange, naranjo trébol
Severinia buxifolia	Chinese box-orange
Swinglea glutinosa	tabog
Tetradium ruticarpum	evodia, wu zhu yu
Toddalia asiatica	orange climber
Triphasia trifolia	trifoliate limeberry, triphasia
Vepris (=*Toddalia*) *lanceolata*	white ironwood
Zanthoxylum fagara	wild lime, lime prickly-ash

Briefing Paper: Recent changes in the ACP/HLB invasion in California and implications for regional quarantines

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State-wide background risk level for HLB

Since 2012, a background risk level for HLB in both residential and commercial citrus in each square mile of interest has been calculated 2-3 times per year using a risk model developed in Florida and adapted for use in California (Gottwald et al., 2014). The model uses a range of risk variables including census data, topography, land use, and known incidence of both HLB and Asian Citrus Psyllid (ACP) to produce a risk value ranging from 0 (extremely low risk) to 1 (very high risk) that applies to each square mile. Figure 1 shows the current risk status across the state at a county level, where the risk level applied to the county is the highest value for any individual square mile within that county

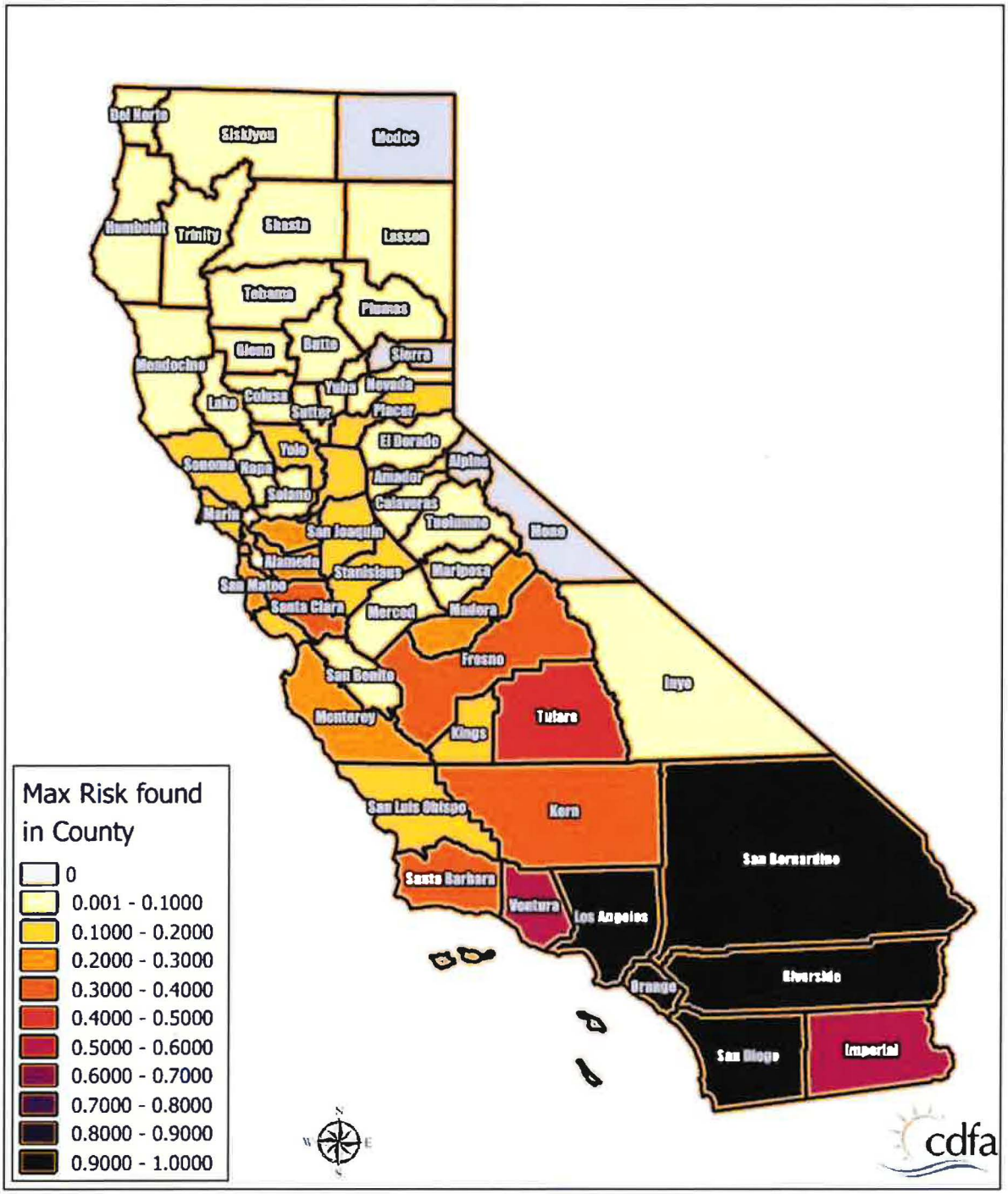

Figure 1. Maximum HLB risk level by county across California as estimated by the USDA-ARS HLB risk model.

In Figure 1 note that the risk level is generally higher in the south than north, because of the known presence of HLB and large ACP population in the southern counties. Note also that in northern California even counties with only a few ACP detections – for example Santa Clara County – may still have

relatively high risk levels because of population census data that indicate the background risk of the presence of infected citrus in private yards is relatively high. To illustrate this point further, Figure 2 shows the San Francisco Bay Area in more detail.

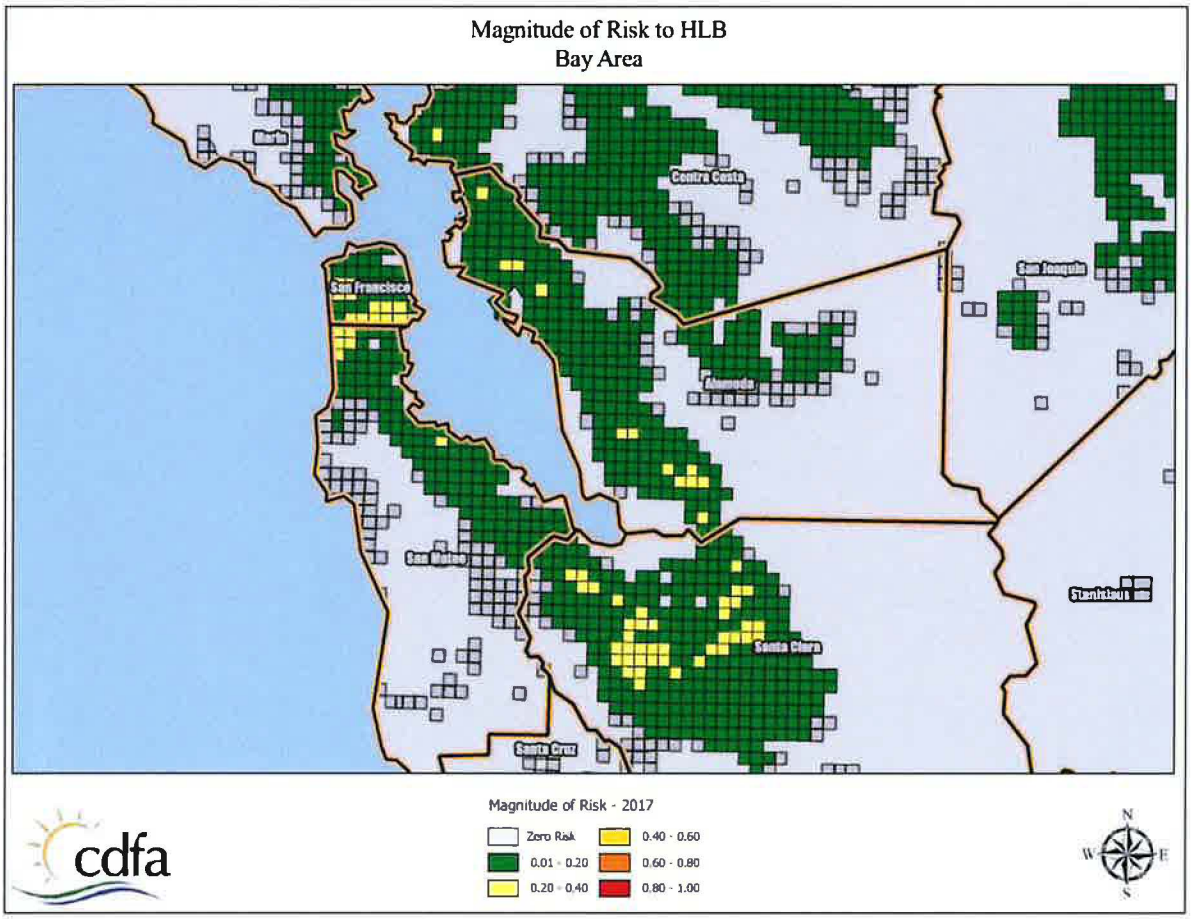

Figure 2. Individual square mile HLB risk levels for the San Francisco Bay Area. Note that the general risk level is low, but there are pockets of moderately high risk in San Francisco itself, and more noticeably in San Jose, associated with population census risk factors; ACP detections in this area is still low and sporadic.

While the background risk of HLB is strongly dependent on factors which are either static (e.g. topography) or change only slowly (e.g. human socio-economic factors) the presence of the ACP vector of the pathogen introduces a large dynamic component into the risk level across the state. To illustrate the impact of the vector population on changing risk status for HLB Figure 3 shows changes in HLB risk for the proposed quarantine areas 5 (San Diego, Imperial and Eastern Riverside) and 6 (LA. Western Riverside, San Bernardino and Orange). The risk level is shown as a blue-to-red heat map with higher risk indicated by darker red color and lower risk indicated by darker blue color; a time series of six periods is shown for each area.

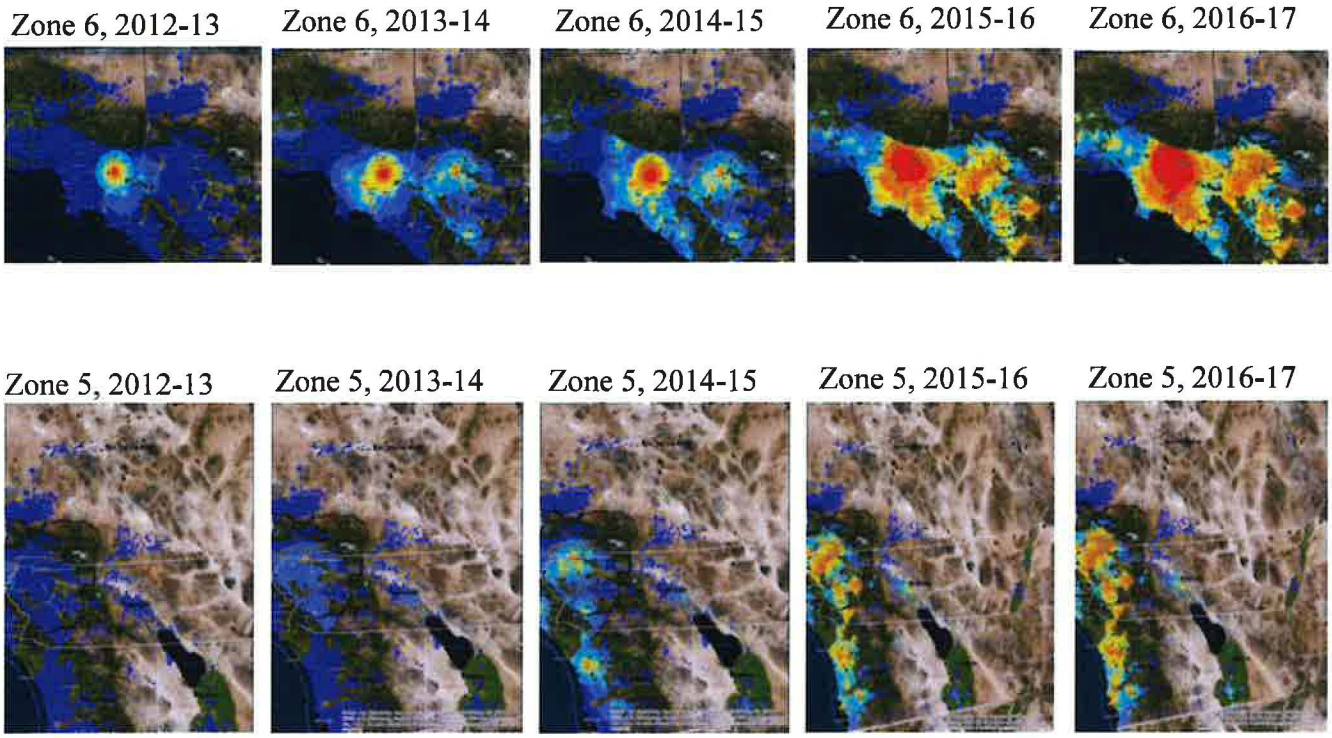

Figure 3. Changes in background risk of HLB in proposed quarantine areas 5 and 6 from 2012 to present. Red color indicates high risk, blue indicates low risk. Note that the location of the early HLB detections in Hacienda Heights and San Gabriel falls inside the single high-risk area predicted in 2012. The progressive increase in risk in both areas is apparent with the passage of time. All known cases of HLB are in proposed Quarantine Area 6.

Figure 3 tells us at least two useful things about HLB risk. First, note that in 2012-13 the only area of predicted high risk was centered on Hacienda Heights and San Gabriel, the locations of the first HLB discoveries in California; in other words, the risk model correctly anticipated the presence of HLB. Also note that the model also highlighted the focus of high risk in the city of Riverside as early as 2013-14; this outbreak emerged in 2017. These results are important for interpreting the presence of areas of elevated risk in places such as San Jose. Second, the pattern of change in risk in both areas 5 and 6 is a steady increase, spreading out from the original high risk area in LA, but also with additional foci developing at locations quite distant from the original focus. These changes are associated mainly with the spread of ACP through the region and the patterns of population density of the insect recorded in the risk-based surveys.

Taken together the results presented in this section highlight two important aspects of HLB risk that are relevant to quarantine regulations:

1. Because HLB-affected citrus plant material can be propagated and spread by human activity, the risk of HLB and ACP are to some extent independent, particularly in areas that are not generally infested with ACP.
2. **The risk of HLB can exist before the arrival of the vector** in an area because HLB-affected plant material is often brought to an area by human activities.

After ACP infests an area with pre-existing infected trees present, the vector population eventually comes into contact with the infected trees and foci of disease begin to build around them. This is because ACP acquires the pathogen from the infected trees and establishes a recurring cycle of infection and acquisition. Because trees remain asymptomatic for a long period of time, spread in the absence of detection and tree removal can occur.

Reducing disease spread by quarantines

The basic principle of underlying the use of quarantines is to restrict the spread of disease by sub-dividing an area into smaller regions and limiting the opportunities for disease to spread from one region to another. In the case of invasive and highly mobile diseases, quarantines should be applied early and rigorously to have the largest effect on disease spread. Importantly, quarantines do not have to be 100% effective to be worth imposing. If the incursion of the disease into generally uninfected areas can be limited to a low rate, and psyllid populations can be kept low, local eradications can be achieved when new incursions are detected.

The basic idea of setting up quarantine regions within the state is an ecological analogue of the idea of constructing a ship using multiple watertight compartments; even if one compartment is flooded, as long as the flow of water is negligible to the other compartments the ship won't sink. In instituting a quarantine policy, the aim is to limit the flow of vectors and disease throughout the state and thus safeguard the industry and homeowners as a whole.

Recent changes in the dynamics of HLB/ACP detections

Until recently, the rate of accumulation of new positive ACP and tree detections had been relatively stable. Over the last 6 months there has been a dramatic increase in the rate of new detections of HLB infections in both ACP and citrus trees. In addition, there has been a recent increase in the number of cities in which positive finds have been reported and a sharp increase in the number of ACP nymph detections. These results are summarized in Figures 4 through 7.

Taken together the results indicate an exponential increase in the intensity of the HLB epidemic at multiple scales. The pathogen is becoming more prevalent in the vector population and in the tree population. At the same time, the upswing in nymphal detections indicates that the transmission rate is increasing and the increase in the number of cities with positive detections indicates that the geographic extent of the epidemic is increasing rapidly.

Most of these changes have become apparent only in the last 6 months. Given the very sharp increase in the intensity of the epidemic, a rapid response is needed to implement additional measures to slow the rate of spread of HLB beyond its current range before the opportunity is lost.

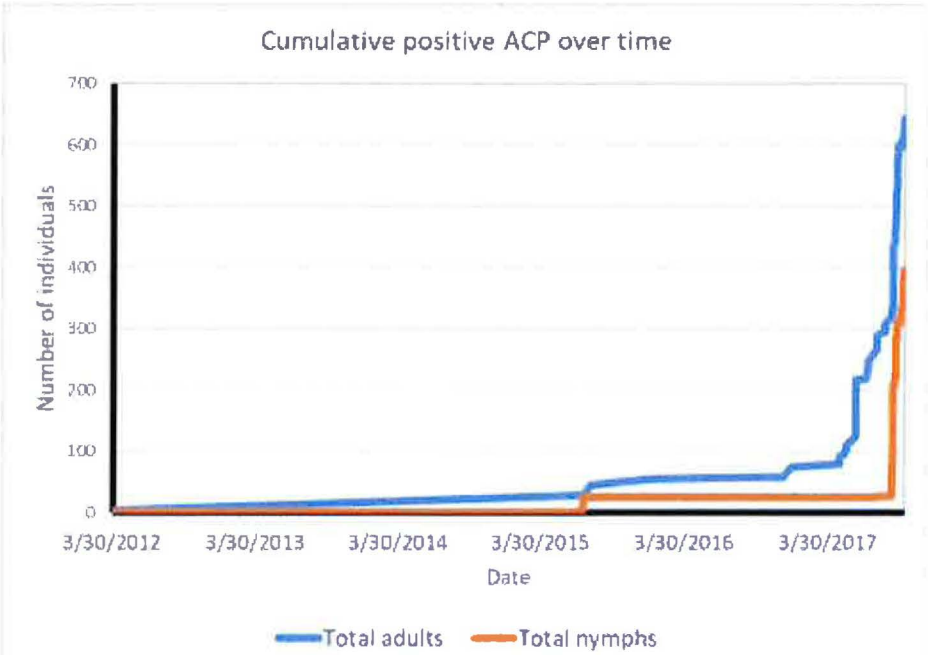

Figure 4: Cumulative counts of PCR-positive ACP samples collected in California over time since 2012. Note the sharp increase in the rate of accumulation from mid-2017 onwards.

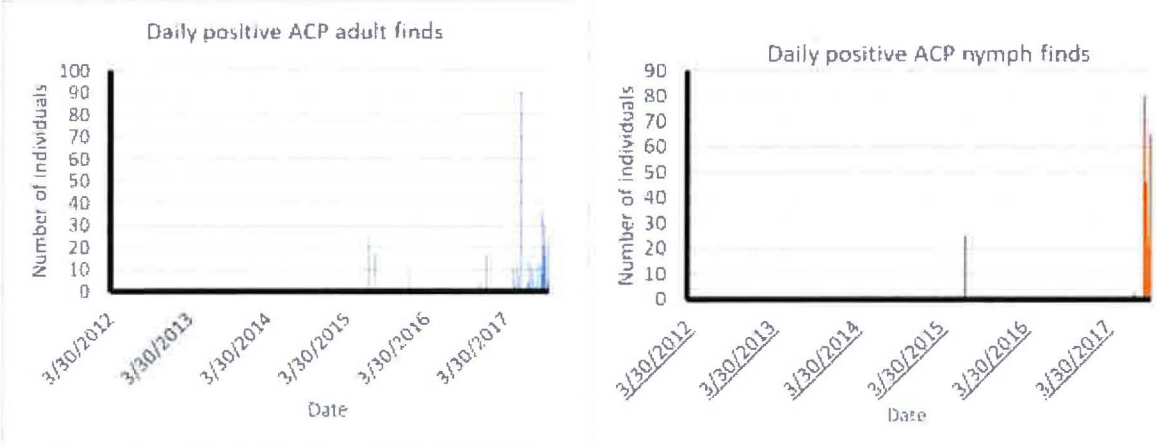

Figure 5: Daily discovery rate for PCR-positive ACP (adults and nymphs are shown separately). Note the sharp increase in finds toward the end of 2017, particularly for nymphs which had largely been absent from positive samples until recent detections.

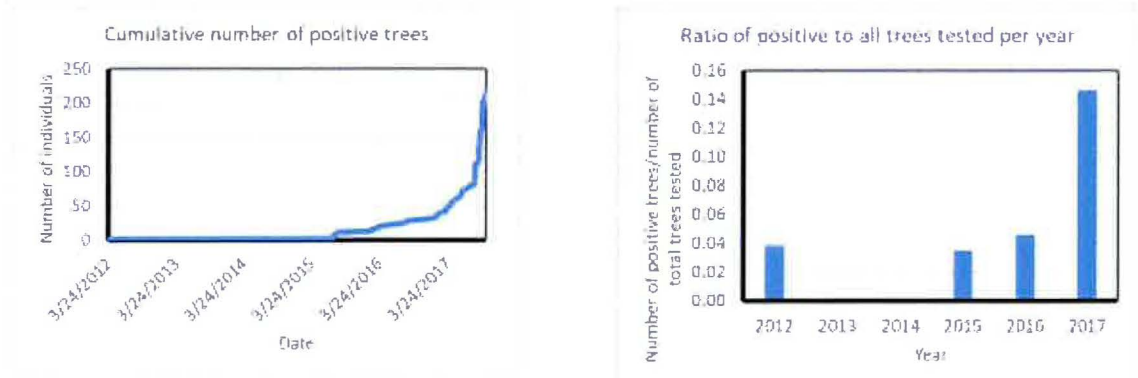

Figure 6: PCR-positive tree detections over time. In the left panel the cumulative number of detections is shown, highlighting the exponential increase in 2017. In the right panel the ratio of positive trees to all trees tested per year is shown. Note that until 2017 the ratio had been more or less stable at approximately 5%, but has nearly tripled in 2017 to just under 15%.

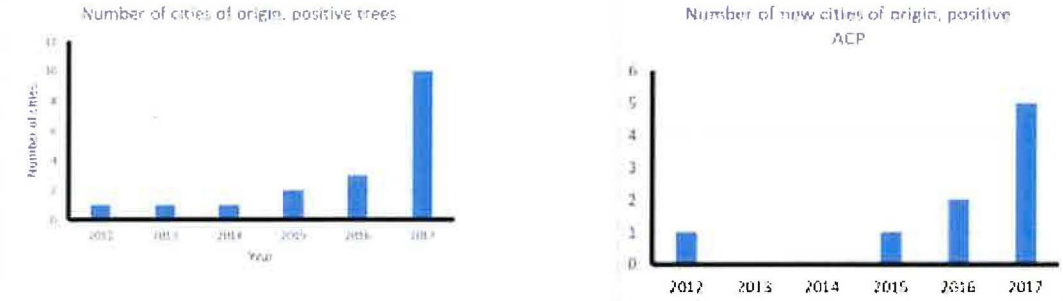

Figure 7: Numbers of citites with PCR-positive ACP detections over time. The left panel shows the cumulative figure, the right panel shows the number of new cities per year. Mirroring the results for trees and for ACP, note the sharp increase in 2017. These results indicate that the epidemic is intensifying across several spatial scales at a very high rate.

Changes in diagnostic results on tested Asian Citrus Psyllids

The previous section detailed the recent sharp increases in PCR detections for ACP and trees. These increases indicate that the pathogen population is growing and this can be seen directly by considering the Ct values in qPCR tests. Results highlighting the increase in the pathogen population are shown here in Figures 8 and 9.

Figure 8 shows the data for qPCR Ct values obtained from psyllid samples collected in different sampling cycles of the survey program. The data are sub-divided into samples obtained from inside and outside the existing HLB quarantine areas. It can be seen that the Ct values obtained from ACP samples inside the quarantine areas are showing a much faster increase in the proportion of low values (CT <32 to 33), indicating an intensification of the pathogen population in the vector population.

The presence of some ACP with low qPCR Ct values outside the existing quarantine areas highlights the risk of ACP moving the disease around and the need for quarantine regulations that apply at a larger scale than the current radius around confirmed HLB-positive trees.

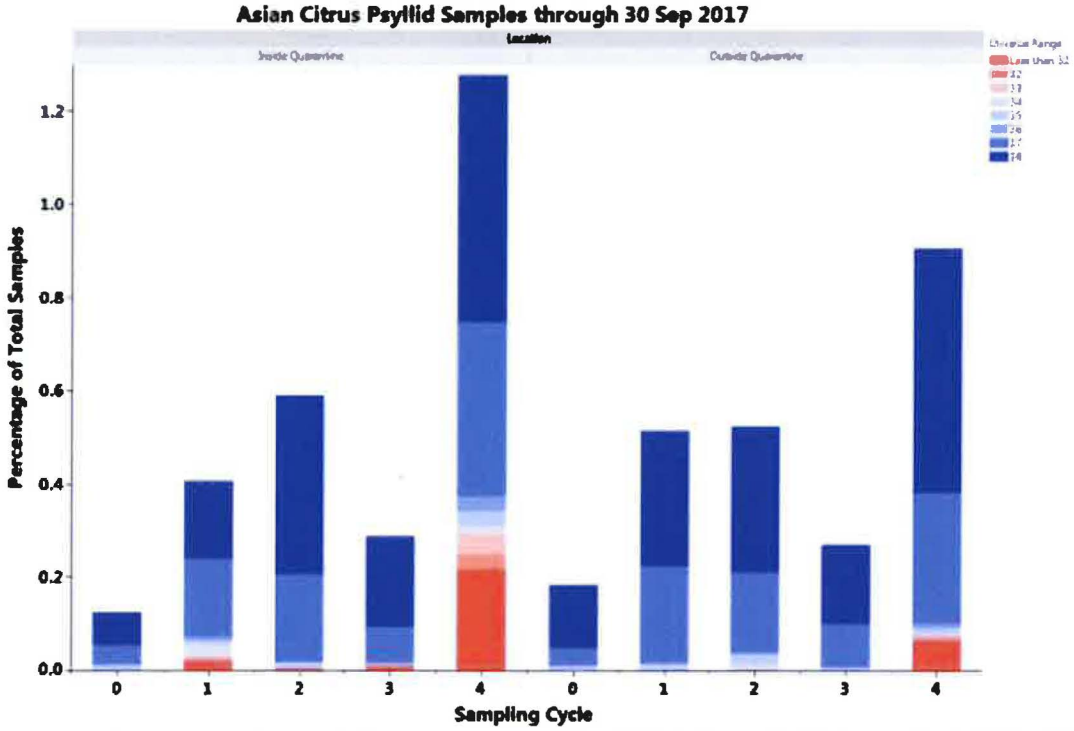

Figure 8: qPCR test results on ACP samples tested by CDFA through 30 September 2017. Note that the proportion of light blue and red (indicating presence of the HLB pathogen) in the samples from inside the quarantine areas (left panel) has increased over time, whereas no corresponding change is apparent in samples outside the quarantine areas (right panel).

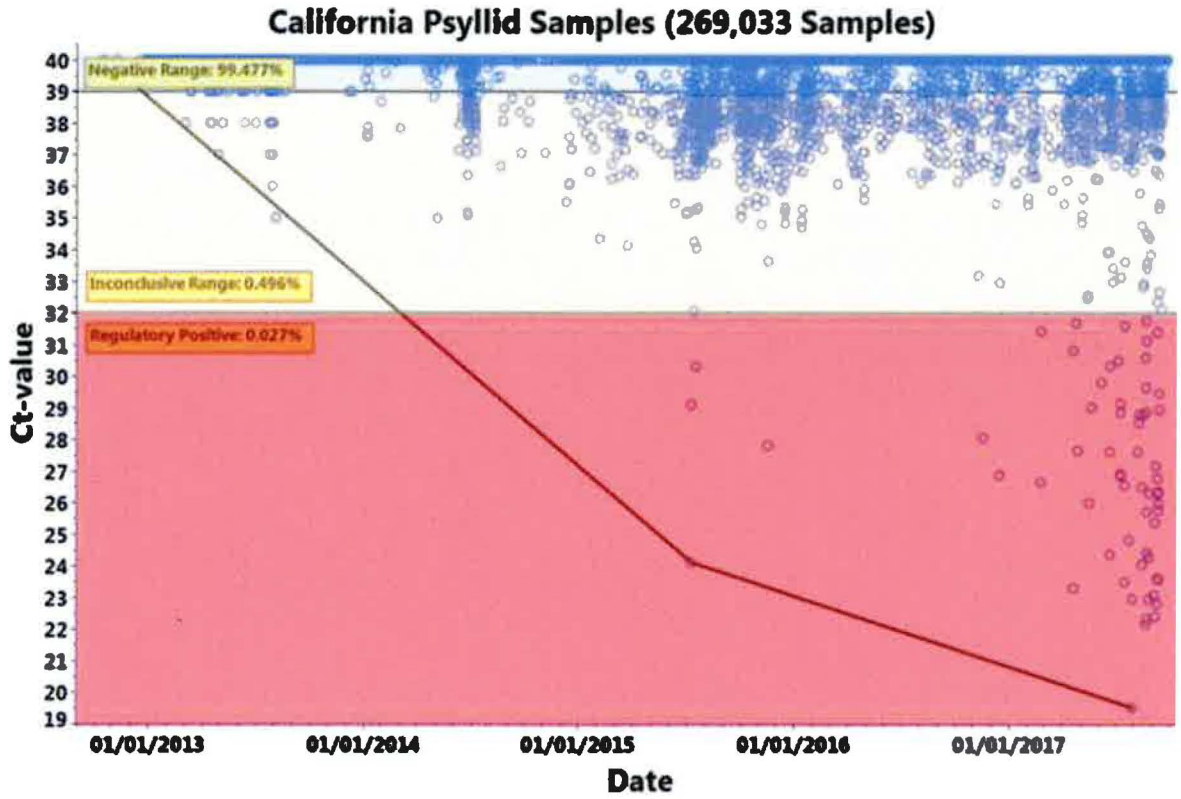

Figure 9: qPCR regulatory results recorded since the detection of HLB in California over time compared to the concentration of the pathogen in the sample (Ct < 32.1= HLB positive (red zone), Ct 32.1-38.9 = suspect (yellow zone), Ct > 38.9=HLB not detected (green zone)). The lower the Ct value, the higher the concentration of the HLB bacterium. Note the trend towards lower Ct values over time and the increase in numbers of HLB positive psyllids starting in 2015 and continuing through 2017 indicating that the titre (concentration) of HLB DNA in the psyllids is increasing.

Implications of changes in the dynamics and recommendations

To summarize the recent changes in the dynamics of HLB/ACP detections in trees and psyllids:

1. The number of HLB positive citrus trees detected has increased exponentially in the last 4 months as compared to the previous 6 years.
2. The number of HLB positive and infectious Asian citrus psyllids has increased exponentially in the last four months as compared to the previous 6 years.
3. These HLB infectious psyllids are spreading to new communities in the LA basin at a significantly escalated rate compared to the previous 6 years.
4. These infectious psyllids can be spread by movement of ACP-host nursery stock, bulk citrus, and other possible carriers of ACP.

Given the above developments in the California HLB epidemic it is of the utmost urgency to further compartmentalize the state using quarantine zones defined by HLB risk to commercial citrus (rather than 5 mile and county wide quarantines). This will help to reduce the potential for spread of HLB to zones where HLB has not been detected in citrus trees, nor has Asian citrus psyllid become established in some cases. The proposal to divide the state into 7 zones for bulk citrus movement and three zones for nursery stock, will serve to restrict the dispersal of HLB and its ACP vectors. Currently all known HLB infected trees are inside a single quarantine zone – zone 6. However, with the exponential escalation of the number of infected ACP and citrus trees requires an immediate regulatory response to restrict spread before the opportunity for such measures to be effective is lost.