Risk-based survey for decision making in the management of Huanglongbing: Phase II

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Year 3 of 5 (65% Complete)

Objectives

1. Continuous refinement, validation and quality assurance of data-driven risk model
2. Survey design and deployment in California
3. Ad hoc analyses using data collected via risk-based surveillance

Problem and Significance

The key to control of huanglongbing (HLB) is early detection. Since Phase I of the risk-based survey implementation, the model has predicted high-risk areas to target, leading to >2800 '*Candidatus* Liberibacter asiaticus' (*C*Las)+ trees and Asian citrus psyllids (ACP) detected, as of October 2021, in Southern California. In Phase II, we continue to refine the early detection/prediction model of HLB for residential and commercial citrus and develop survey protocols to improve decision-making for ACP/HLB management. This targeted, evidence-based approach allows us to predict, and regulatory agencies to combat, HLB outbreaks (fires) not only where we see the flames but also where the burning embers are most likely to establish new HLB outbreaks (optimizing proactive resource allocation).

Benefit to Industry

We produce ACP/HLB early detection/prediction surveys for urban and commercial citrus as well as delimitation response protocols. Statewide risk maps are implemented by California Department of Food and Agriculture (CDFA) each survey cycle with guidance on efficient deployment (Figure 1). These model predictions and risk maps are continuously valuable and effective approaches in finding *CLas* early (i.e. in a manageable phase), prior to severe spread and invasions into commercial citrus. With exceedingly early model-directed surveillance, regulatory agencies in combination with growers can effectively target eradication/management efforts, maintaining low incidence and suppressing outbreaks. Additional spatiotemporal analyses using data collected can further inform decision makers on the current ACP/HLB situation throughout California.

Progress Summary

Residential risk-based surveys are constructed and refined regularly to provide evidence-based decision-making tools that guide surveillance efforts to maximize early detection of new HLB infections. Following HLB detections, we design high-intensity targeted surveys to maximize detection of additional *CLas*+ trees to prevent further spread, e.g. delimiting survey for new epicenters outside existing quarantine regions (San Gabriel, Pico Rivera, Whittier, Anaheim, Garden Grove, Riverside, and Oceanside). These rapid response protocols aid in reallocating sampling efforts to increase the probability of suppressing outbreaks.

The sampling prioritization is determined via calculated risk with consideration of resource availability and current survey capabilities (e.g. sampling effort and efficiency, detection technique). Total risk and proximity to commercial citrus groves were used to determine Section-Township-Range (STR) grid selection and sampling density to accommodate CDFA suggestions, such as:

- 25% more sampling effort for STR grids with close proximity to commercial citrus

- increasing the sampling effort toward major commercial citrus areas in the Central Valley
- removing statewide survey STR grids with more than 20% overlapping area with delimitation surveys
- reducing the likelihood of STR selection if surveyed in the previous cycle (50%)

We used retrospective longitudinal analysis to evaluate the prediction power of each risk factor in the model. Figure 2 shows the predictive power of individual risk factors in finding new HLB+ locations (up to 2020) in Southern CA. Introduction risk is very powerful in predicting the first HLB detections for each Southern CA County, except San Diego (*CLas*+ ACP). The greatest risk areas from ACP density (risk value >0.75) have consistent coverage of all confirmed HLB finds. That is, there is a strong indication that high ACP density levels will result in increasing numbers of new HLB finds nearby. In addition, general ACP population dynamics can uncover detection through propagation/movement pathways particularly as more survey data is collected. As to previous *CLas*+ locations, HLB detections are typically clustered and a strong indicator of risk for follow-up delimited detections in all areas. The effect of other risk factors (i.e., plant nursery, citrus road, packinghouse, farmers market) are not as consistent and require further investigation when more data are collected. No obvious relationship between HLB detection and adjacent military installations and Indian Reservations (i.e., Native American Lands) has been determined. The predictive power is continuously investigated to evaluate and determine proper weightings of all risk model factors for future survey design.

To improve decision-making, we estimate the proportion of trees infected with HLB using the risk-based model and data collected via surveys (sampling density, detections, etc.). Figure 3 shows our updated estimates of the actual HLB incidence in each STR grid with sufficient sampling density. It is important to note that HLB risk is the probability of HLB establishment in each STR calculated from all risk factors, whereas HLB incidence is the estimated proportion of infected trees in each STR. Knowing the possible HLB incidence in each STR will enable better assignment of sampling effort for HLB detection.

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Publications and Presentations

Luo. W., Posny, D., & McRoberts, N. (2021) Evaluation of risk-based model for residential citrus HLB survey in Southern CA. 2021 APS Annual Virtual Meeting. August 02-06, 2021.

Manuscript in Progress:

Luo, W., Posny, D., McRoberts, N., Gottwald,T. Risk-based residential survey design for early HLB detection in Southern CA

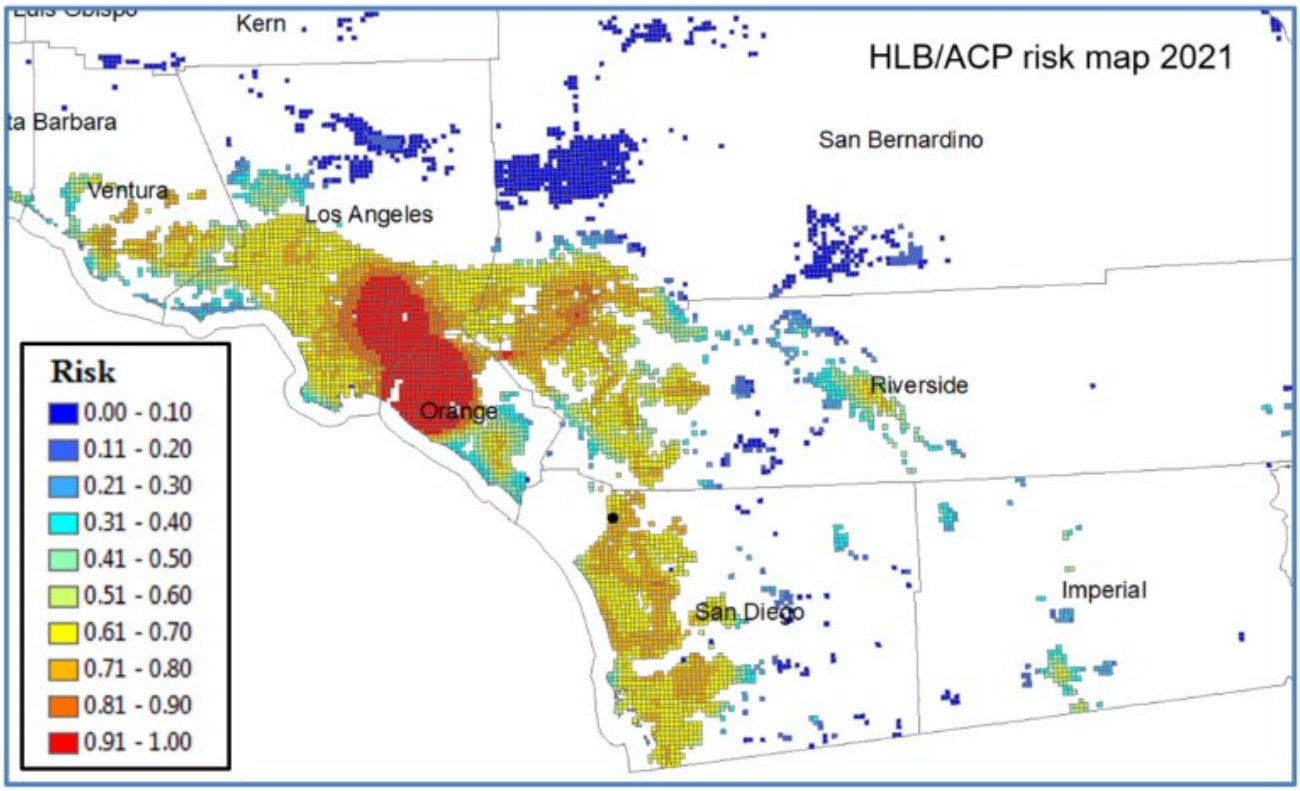

Figure 1. HLB/ACP residential risk map for 2021.

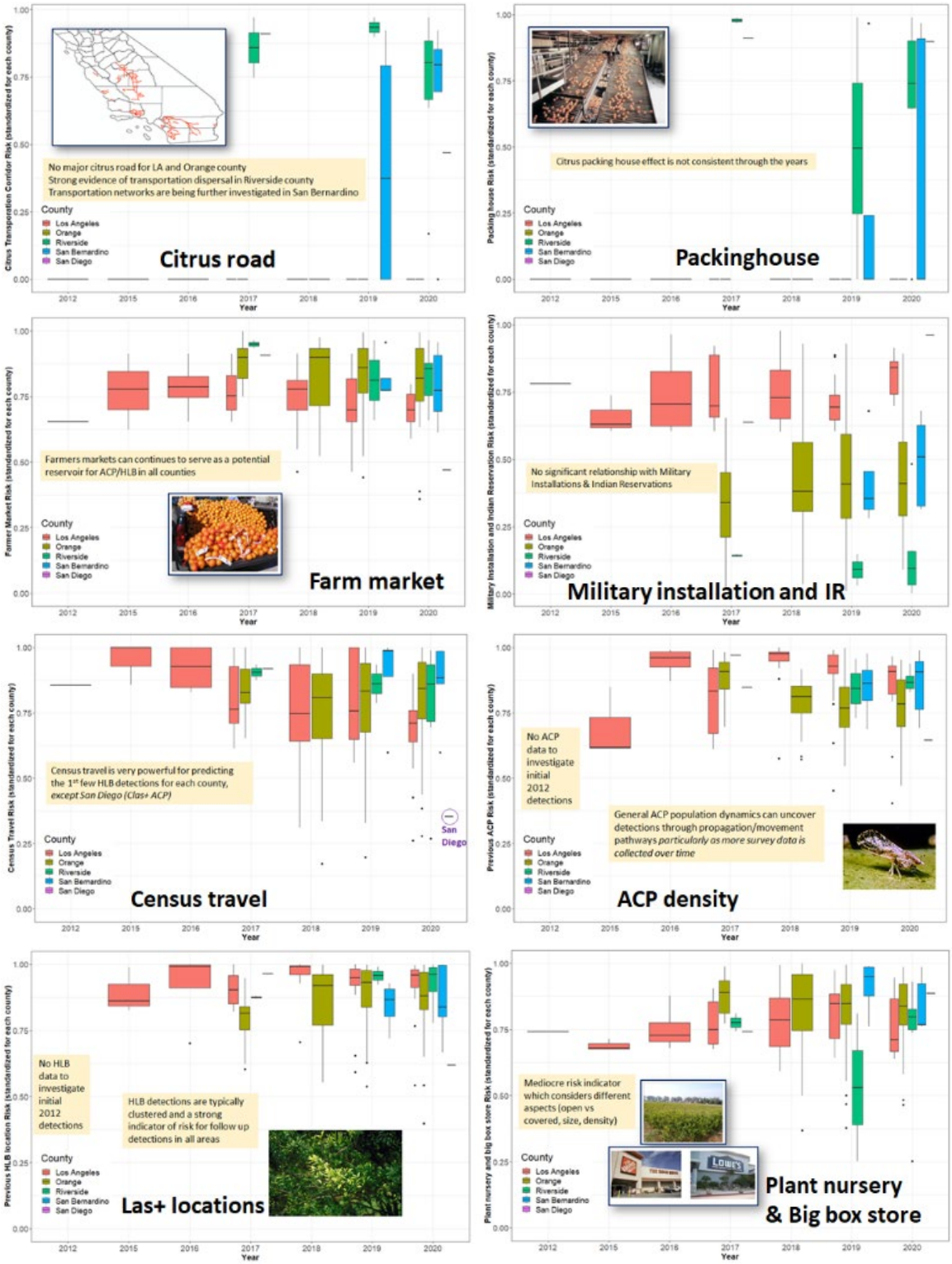

Figure 2. Evaluation of each risk factor on new HLB detections between 2012 and 2020. Over time, higher weightings were assigned for risk factors if similar spatiotemporal patterns/effects were observed across multiple years and regions.

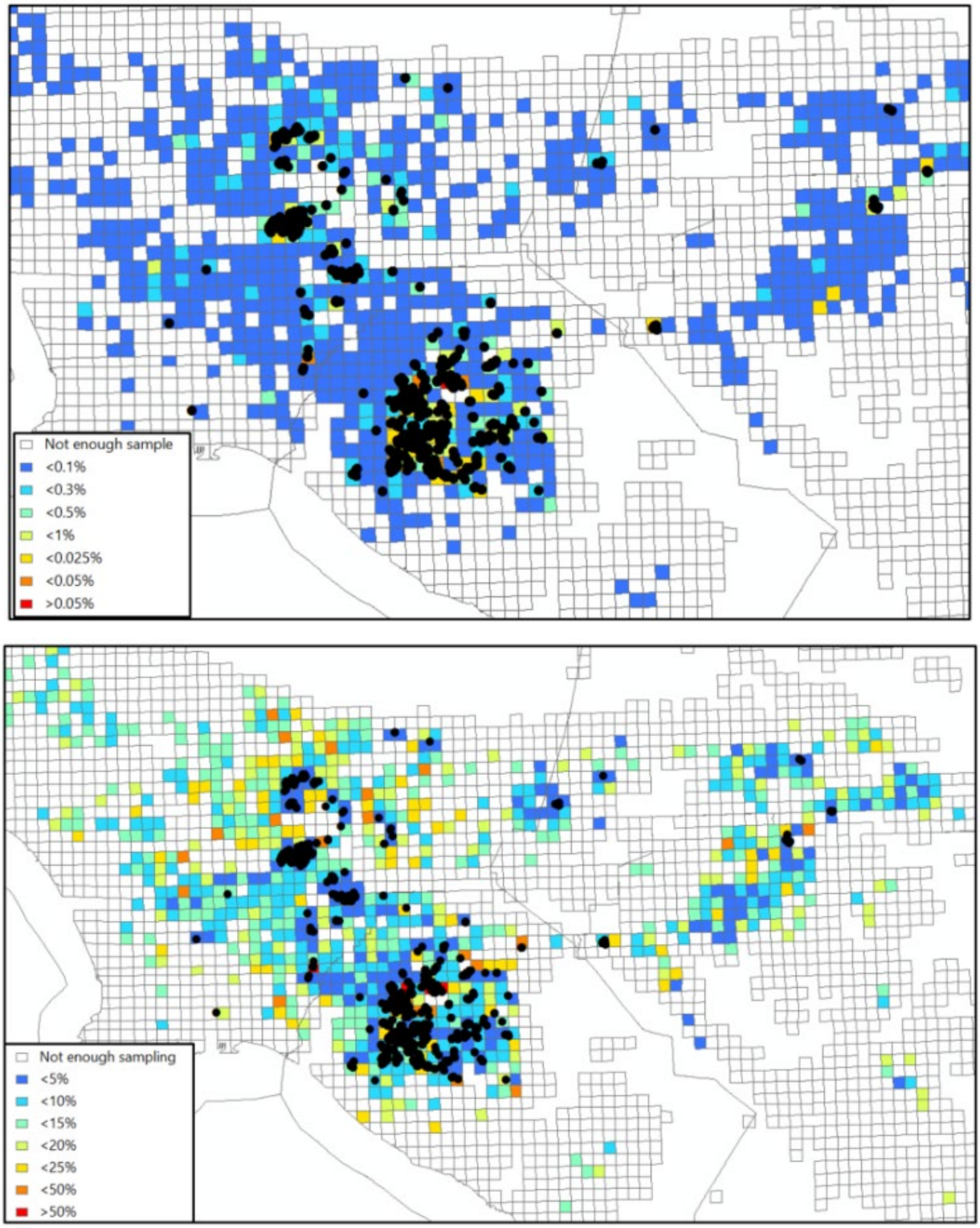

Figure 3: Estimates of minimum and maximum HLB incidence for each STR in Southern California.