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Commercial risk-based survey for HLB and implications for efficacy of Citrus Health Management Areas (CHMAs)

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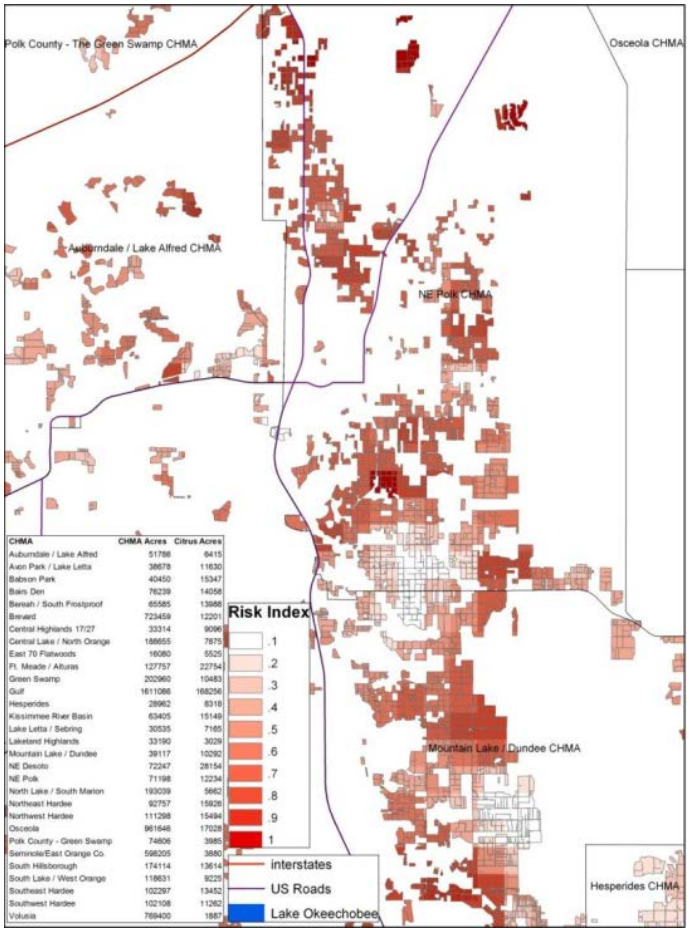
The USDA, APHIS, PPQ has been conducting a risk-based multi-pest survey (MPS) for the past two years. The initial 6 statewide survey cycles were conducted on a 6 week basis, whereas the subsequent 20 cycles have been conducted on a 3-week basis. HLB and ACP are the two main pests addressed by the MPS but other citrus pests and diseases, i.e., Asiatic Citrus Canker (ACC), Citrus Leprosis Virus (CLiV), Citrus Black Spot (CBS) and Citrus Variegated Chlorosis (CVC) were also given lesser emphasis during the survey.

Commercial Survey model design and implementation

a. For the commercial citrus survey, similar risk factors are calculated as used for the residential survey (See Gottwald et al., 2013 IRCHLB III abstract) and the risk reversed to reflect the impact of urban populations and activities on commercial plantings. The MPS is used to assess incidence, to predict future spread and disease increase, and for commercial citrus management and regulatory decision-making.

b. *Stratification:* To apply the MPS statewide, the citrus industry is first parsed into strata and sampled based on a risk-bias algorithm previously designed and deployed in Florida (Parnell et al.). A stochastic algorithm is then used to prioritize sample locations (individual blocks) within each strata. Thus there is a weighted stratified sampling applied across the entire citrus industry. The prioritization of individual blocks



within each strata is via a risk calculation as described immediately below.

c. *Individual risk factors*: Risk factors considered are cultivar susceptibility, planting size (in hectares or acres), planting age, proximity to ACP populations (both residential and commercial citrus), proximity to HLB infections (if and when discovered), risk from Asian populations, proximity to abandon citrus if any, and proximity to residential citrus. The model already exists for the state of Florida and is being adapted to and amended for California and Texas. A risk index factor (also known as a biasing factor) is calculated based upon the sum of all criteria listed above. This risk factor is calculated for each commercial block which takes into account the relative importance or weighting of each factor.

d. *Additional risk factors:* Other risk factors includes proximity to nurseries, home centers, military installations, Indian reservations, transportation corridors, and collection of other factors used in residential risk survey.

e. *Statewide HLB risk model validation and improvement*: The initial survey was used for model validation of the existing predictive model within the Florida, California, and Texas environments. As data are collected from each state, post-survey analyses are used for adjustment of weighting of individual risk factors. Subsequent surveys will then have the benefit of an improved model. Thus, the model is dynamic and can be continuously improved until it approaches a steady state, where subsequent analyses add little or no significant benefit in changing risk factor weightings.

f. Output from the model can be used for overall risk mapping such as the map (See above) which was generated for commercial citrus blocks in central Florida. The output can portray ACP population density, HLB population density, and combinations of other risk factors to generate a cadre of overall risk maps.

g. When a sufficient number of surveys have been conducted through time, spatiotemporal predictions can also be generated such that the maps can be predictive estimates of future ACP/HLB risk areas as well as evaluation of the overall efficacy of the CHMA program (See figure to left). These efficacy and predictive maps can be utilized by production managers and regulatory agencies as an attempt to offset emerging ACP and HLB hot spots. Such maps can also be utilized to aid in optimizing CHMA size, location, and number of CHMAs needed. Although CHMAs have been set for Florida, these data can aid in CHMA development for other citrus producing states.