Multi-Pest Surveillance Program Design
July 21, 2026

Attendance:
TAC Members: Dr. Georgios Vidalakis, Jim Gorden, Dr. Ray Yokomi, Dr. Weiqi Luo, and Dr. Sandra Olkowski.
Grower Liaison: Judy Zaninovich
Grower/BOC: Milo Gorden, Jeffrey Steen
Fresno County Ag: Libby Ouellette
APCD Staff: Dr. Subhas Hajeri, Dr. Dhiraj Gautam, Dr. Saurabh Gautam, Mia Neunzig, Ron Carter, Kevin Howerton, Hailey Penix, Tony Patino, and Tina Acevedo.

This recap summarizes the Technical Advisory Committee discussion on APCD's multi-pest surveillance program design, including model customization, pest prioritization, operational risk factors, laboratory capacity, and next steps for developing a TAC-recommended operational plan.

Key Takeaways
- Weiqi presented a multi-model framework for HLB/ACP surveillance, covering introduction risk (census travel model), and risk-based survey design.
- The existing international travel-based introduction risk model is well-developed but lacks domestic movement data, which is now the primary pathway of concern for ACP/HLB in California.
- The group agreed to customize the international model for the APCD service area and to initiate development of a domestic movement risk model.
- Sandra and Neil will collaborate with Weiqi to assess existing tools, identify data gaps, and propose a targeted pilot project for APCD.
- The committee worked through pest/disease prioritization weightings and risk factor weightings for the multi-pest survey design, with ACP/HLB receiving the highest allocation (~65%).
- Key bottlenecks identified: domestic travel data integration, trap-reading capacity (human screeners), and the need for a machine-learning-based trap image analysis tool.
- A written TAC-recommended operational plan will be drafted as a shared Google Doc for TAC review and recommendation to the APCD Board of Commissioners.

Discussed Topics

1. Overview of the Three-Model Framework for Pest Surveillance
Weiqi presented a high-level summary of three interconnected models: (1) disease introduction and risk-based survey, (2) epidemic simulation, and (3) feedback loop for survey refinement.
- **Details**
  - Weiqi: The framework links introduction risk prediction, survey design, and management strategy simulation. Survey results feed back into the model to improve future predictions.
  - Georgios: Asked whether the work is published; Weiqi confirmed at least two publications are available and references were shared.
- **Conclusion**
  - The three models are designed to work iteratively, with each cycle improving survey targeting and resource allocation.

2. HLB Background and Florida Case Study

Weiqi provided background on HLB, emphasizing the importance of early detection, and illustrating the devastating impact on Florida's citrus industry.

- **Details**
  - Weiqi: Florida citrus acreage has been nearly wiped out since HLB detection in 2005. California and other states have maintained production, which is a positive indicator. Early detection is critical to effective control.
- **Conclusion**
  - The Florida example underscores the urgency of proactive surveillance in California.

3. Census Travel-Based Introduction Risk Model

Weiqi detailed the international travel model, which uses data from the US Census (American Community Survey), Homeland Security, and the Department of Commerce to predict where exotic pests/pathogens are most likely to be introduced.

- **Details**
  - Weiqi: The model covers 176 of ~196 countries (approximately 99.9% of relevant citrus-producing nations). It integrates airport-to-airport flight data, traveler demographics (visa class, gender, age), and destination patterns. Output can be generated at county, census tract, or section/township/range level.
  - Ray: Asked about the 20 missing countries; Weiqi confirmed these are very small Pacific island nations with negligible citrus risk and no direct US flights.
  - Subhas: Raised the issue of underreporting by foreign countries; Weiqi agreed this is a valid concern and the model accounts for adjacent-country travel as a proxy.
  - Georgios: Noted that the CCPP (Citrus Clonal Protection Program) has intercepted diseases from budwood up to a year before the source country officially reported them, suggesting this data could be fed into the model.
  - Weiqi: Confirmed the model predicted San Gabriel and Hacienda Heights as high-risk introduction zones before the first California HLB detections in 2012–2015, validating the approach.
  - Ray: Asked about the model's ability to track website usage and data updates; Weiqi confirmed the model is validated through 2023 travel data, with 2024–2025 data pending resource availability.
- **Conclusion**
  - The international travel model is robust for predicting initial introduction points but becomes less relevant once secondary spread dominates.
  - The model can be customized for the APCD service area and specific pest/disease combinations.

4. Limitations of the International Model for Current California Situation

A significant discussion emerged around the shift in primary risk from international introduction to domestic movement for ACP and HLB.

- **Details**
  - Jeffrey: Asked whether the bigger risk for APCD is international introduction or domestic spread? (e.g., psyllids moving north from Ventura/Southern California). Subhas confirmed that for ACP and HLB, domestic movement is now the dominant pathway; international models remain more relevant for exotic diseases not yet present.
  - Judy: Asked whether the model captures mail/shipment detections (e.g., HLB-positive trees shipped from Florida to Fresno via FedEx/UPS/USPS); Weiqi confirmed this is not currently incorporated but is a recognized gap.

- Subhas: Highlighted citrus yellow vein clearing virus (CYVCV) in Tulare County as an example of a likely domestic introduction with no plausible international travel link.
- Weiqi: Acknowledged the domestic travel gap and noted a proposal with Sandra and Neil is in development to address this.

- **Conclusion**
  - The international model needs to be complemented by a domestic movement model for the current California context.
  - Domestic data sources exist (Department of Transportation truck movement samples, county ag commissioner interception records, CDFA/USDA commodity inspection data) but require significant data processing effort.

5. Multi-Pest Survey Capability

Weiqi demonstrated that the model can simultaneously assess introduction risk for multiple pests/diseases and generate combined risk maps.

- **Details**
  - Weiqi: Users can weigh the relative importance of different diseases (e.g., HLB, citrus canker, black spot) and generate individual and combined risk maps. The interactive map allows users to click on a grid and see the risk breakdown by pest.
  - Subhas: Confirmed that the model could guide inspectors to look for specific pests in specific sections based on risk profiles.
- **Conclusion**
  - The multi-pest survey feature is directly applicable to APCD operations and can guide targeted deployment of field inspection.

6. Proposal to Develop a Customized Domestic Risk Model for APCD

The group discussed the feasibility and pathway for developing a domestic movement risk model tailored to the APCD service area.

- **Details**
  - Georgios: Proposed a focused pilot project: customize the international model for the APCD service area and develop a domestic model covering interstate movement from citrus-producing states (primarily Florida, Texas) into the Central Valley.
  - Weiqi: Confirmed this is feasible; approximately 80% of the modeling framework already exists. The main gap is domestic travel data integration.
  - Sandra: Noted that UC Davis has prior work on risk-based survey design for CDFA (including transportation corridors, proximity to citrus, environmental conditions) that can be leveraged. Proposed an action item for herself, Neil, and Weiqi to meet and assess what is already in place.
  - Georgios: Suggested the board of directors could fund a part-time or full-time data analyst to mine domestic databases, framing it as an insurance policy for the district.
  - Judy: Noted that county ag commissioners have real interception data on bulk citrus movement between states, which could serve as a domestic data source.
  - Sandra: Confirmed that the UC Davis team has a workflow for targeted, specific tool development (e.g., CDFA winter trapping program optimization) and is well-positioned to execute this.
- **Conclusion**
  - Sandra and Neil will meet with Weiqi to assess existing tools, identify outstanding data needs, and prepare a proposal (personnel requirements, data sources) to bring back to Subhas and APCD leadership.

- The TAC will act as reviewers rather than authors of this proposal.
- Reporting chain: Sandra/Weiqi/Neil → Subhas → TAC/Board.

7. Pest and Disease Prioritization Weightings

The group worked through a prioritization table assigning relative weights to target pests and diseases for the multi-pest surveillance program.

- **Details**
  - Subhas: Proposed ACP/HLB as the top priority (~65% of effort), given ACP's role as vector for both HLB and CYVCV.
  - Judy: Advocated for elevating CVC (Citrus Variegated Chlorosis) and Glassy-Winged Sharpshooter (GWSS) on the priority list, citing high GWSS populations throughout the Central Valley, reduced treatment coverage, and the risk of CVC explosion if introduced.
  - Georgios: Noted that leprosis should be elevated and brown citrus aphid (no vector present) should be reduced; suggested switching their relative weights.
  - Weiqi: Recommended using ranges rather than fixed values and noted that the model will optimize weightings after the first year of survey data.
  - Weiqi: Proposed a minimum of 5% for any pest to keep it on the list; items assigned 0% can be moved to a "future candidates" category.
  - The group discussed Spiroplasma citri (stubborn disease): present in California but lacking an efficient tree-to-tree vector; flagged as a watch item if ACP is ever shown to transmit it.
  - Sweet orange scab (SOS) and Bot Gummosis were discussed and tentatively assigned low or zero weight due to primer validation issues and manageable impact, respectively.
  - Fruit flies were removed from the active list as CDFA, and county programs already cover them.
  - A "triangle" framework was proposed: score each pest/disease by how many of the three elements (host, vector, pathogen) are present in California (1–3), to justify weightings.
- **Conclusion**
  - ACP/HLB: ~65% of effort.
  - CYVCV: second priority (all three triangle elements present).
  - CVC/GWSS: elevated priority (vector present, pathogen absent).
  - Leprosis: elevated above brown citrus aphid.
  - Items with 0% weight moved to a watch list for field inspectors.
  - Final weightings to be refined by Sandra, Weiqi, and Neil and circulated for review.

8. Risk Factor Weightings for ACP/HLB Survey Design

The group reviewed and adjusted a table of risk factors (columns) for guiding APCD field operations for ACP/HLB.

- **Details**
  - Weiqi: Recommended increasing the weight for "previous finds" based on Southern California data showing strong spatial clustering.
  - Subhas: Noted that packing houses have been a major find location historically (e.g., Tulare County); proposed keeping packing houses as the top category but reducing slightly to redistribute to other factors.
  - Jeffrey: Flagged transportation corridors as a significant concern; others noted that tarping requirements since ~2017 have reduced this risk somewhat, and that previous finds already capture much of the corridor risk.

- Subhas: Proposed adding a "local activity knowledge" category (5%) to capture swap meets, flea market, farmer's markets, harvester/hauler, farm labor movement, private truck yards, and citrus nurseries.
- Ron Carter: Highlighted that harvest crews brought from Southern California represent a significant domestic introduction risk, particularly in southern Kern County.
- Sandra: Raised the question of whether sampling should be optimized by cost (e.g., drive time); the group agreed this is less critical given the focused geography and efficient routing already in place.
- The group discussed nursery risk: CDFA and county programs heavily cover licensed propagation nurseries; APCD should note nursery type (Type 1–3) and add traps in the perimeter of higher-risk open/staging nurseries not already covered.
- Weiqi: Confirmed that the initial weightings are a starting point; the model will self-optimize after the first year of survey feedback.

- **Conclusion**
  - Agreed that top risk factors for ACP/HLB: packing houses (30%), previous finds (20%), proximity to residential (20%), transportation corridors (10%), organic citrus (10%), local activity knowledge (5%), and abandoned citrus (5%).
  - Nursery risk to be categorized by type; APCD to coordinate with CDFA to avoid duplication.
  - Swap meets, flea market, farmer's markets, harvest crew staging areas, and private truck yards near citrus to be included under "local knowledge."

9. Risk Factor Weightings for Other Target Pests (CYVCV, CVC, Leprosis)

The group briefly reviewed risk factor columns for secondary target pests.

- **Details**
  - Subhas: For CYVCV, proximity to residential and previous finds are the dominant factors; lemon orchards should receive disproportionate attention as the primary symptomatic host.
  - Subhas: For CVC, the risk is primarily an introduction risk (no pathogen present); residential proximity and introduction risk are the top factors; GWSS testing on existing traps is the primary detection method.
  - Subhas: For leprosis, the vector (flat mites) is difficult to monitor directly; inspectors should flag circular ring symptoms on leaves/stems and refer to CDFA or county ag for official sampling.
- **Conclusion**
  - Risk factor columns for secondary pests to be finalized by Weiqi and Sandra with input from Subhas.

10. Laboratory Capacity and Multiplexing

Discussion of lab screening bottlenecks and opportunities for multiplexing PCR assays.

- **Details**
  - Ron: Trappers are servicing 70–80 traps per day; the bottleneck is now in the lab (screeners cannot keep up). An extra hour per day has been added to lab shifts.
  - Jeffrey: Noted that human screeners struggle to read more than two or three pest types per trap accurately.
  - Subhas: Proposed developing a universal/multiplex PCR primer set covering at least 3–4 pathogens (HLB, CYVCV, CSD, CVC) to improve screening efficiency and reduce cost.
  - Dhiraj: Confirmed that multiplexing is feasible; the lab currently tests for two pathogens and is working toward expanding.

    - Georgios: Discussed potential use of hyperspectral cameras to automate trap reading, noting that insect-specific chemical signatures may be detectable beyond the visible spectrum, potentially eliminating the need for anatomical AI identification.
- **Conclusion**
    - Multiplex PCR development is a priority lab action item.
    - Machine-learning/camera-based trap reading proposal (previously submitted to Specialty Crop program) to be revisited; hyperspectral imaging to be explored as an alternative approach.

11. Operational Plan, Review Process, and Governance

The meeting concluded with discussion of how to formalize the surveillance program design into an official document.

- **Details**
    - Subhas: The ultimate goal is a written TAC-recommended operational plan to present to the APCD Board of Commissioners for adoption.
    - Georgios: Proposed using a shared Google Doc so all committee members can contribute simultaneously.
    - Sandra: Confirmed she will report back to Subhas directly; Subhas will distribute to TAC and BOC.
- **Conclusion**
    - Subhas to circulate a draft operational plan as a Google Doc for TAC review.
    - TAC members to act as reviewers; Sandra/Weiqi/Neil to act as primary authors of the modeling/data components.

Challenges

- **Domestic movement data gap**: No comprehensive database exists for intrastate/interstate movement of people, harvest crews, and agricultural commodities. Available data (Department of Transportation truck samples, county ag commissioner records) are partial samples requiring extrapolation.
- **Model update lag**: The international travel model is validated through 2023; 2024–2025 data has not yet been incorporated due to resource constraints.
- **Lab screening bottleneck**: Human screeners cannot keep pace with the volume of traps being serviced; adding hours is a short-term fix, not a sustainable solution.
- **Nursery coverage gaps**: Not all nursery types are covered by existing CDFA/county trapping programs; open/staging nurseries represent an unmonitored risk.
- **Spiroplasma/ACP transmission unknown**: If ACP is ever shown to transmit *Spiroplasma citri*, the risk profile for stubborn disease would change dramatically; this remains an unresolved scientific question.
- **Underreporting by foreign countries**: The international model cannot fully account for diseases present but unreported in source countries; CCPP interception data could partially address this but raises diplomatic sensitivities.

Action Items

- **Weiqi**
    - Collaborate with Sandra and Neil to assess what modeling components are already in place and what additional data/refinement is needed for the APCD-focused tool.
    - Finalize and circulate the updated pest prioritization weighting table and risk factor weighting tables, incorporating group feedback, to Subhas.

    - Explore feasibility of customizing the online model interface for APCD-specific output (district boundaries, TRS level, etc).
- **Sandra**
    - Meet with Neil and Weiqi to review existing modeling tools, identify data gaps, and prepare a proposal (personnel needs, data sources, scope) for a customized domestic risk model for the APCD service area.
    - Share the UC Davis risk-based survey tool developed for CDFA (transportation corridors, environmental conditions, proximity to citrus) with the APCD group.
- **Subhas**
    - Receive the proposal from Sandra/Weiqi/Neil and distribute it to TAC and APCD Board of Commissioners.
    - Circulate a draft TAC-recommended operational plan as a shared Google Doc for committee review.
    - Coordinate with CDFA to obtain a full map of existing trap locations and identify nurseries not currently covered by state/county programs.
    - Work with Weiqi to finalize pest/disease prioritization and risk factor weightings for the multi-pest survey model.
- **Georgios**
    - Present the case to the APCD Board of Commissioners for funding a part-time or full-time data analyst to develop the domestic movement risk model.
    - Provide Weiqi with CCPP interception data (disease detections from budwood programs) to incorporate as an additional input layer in the international model.
- **Dhiraj Gautam / Lab Team**
    - Develop a multiplex PCR assay covering at least 3–4 target pathogens (HLB, CYVCV, CSD, CVC) to improve screening efficiency and reduce per-sample cost.
    - Optimize DNA extraction protocol for Glassy-Winged Sharpshooter (GWSS) samples (testing pool sizes of 1–5 insects per extraction).
    - Continue GWSS trap processing; prioritize traps with more than 5 insects for pathogen testing.
- **Ron Carter / APCD Field Team**
    - Document local knowledge inputs (swap meets, flea market, farmer's markets, harvest crew staging areas, private truck yards near citrus, open nurseries) for inclusion in the "local activity knowledge" risk factor category.
    - Evaluate current trap network coverage relative to CDFA trap locations to identify gaps, particularly around nurseries and packing houses.
- **All TAC Members**
    - Review the draft operational plan (Google Doc) once circulated by Subhas and provide written feedback.
    - Individually complete the pest prioritization weighting exercise (assigning ranges rather than fixed values) and submit to Weiqi/Sandra for aggregation.