# New Technologies for Surveillance

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USDA APHIS PPQ Science and Technology
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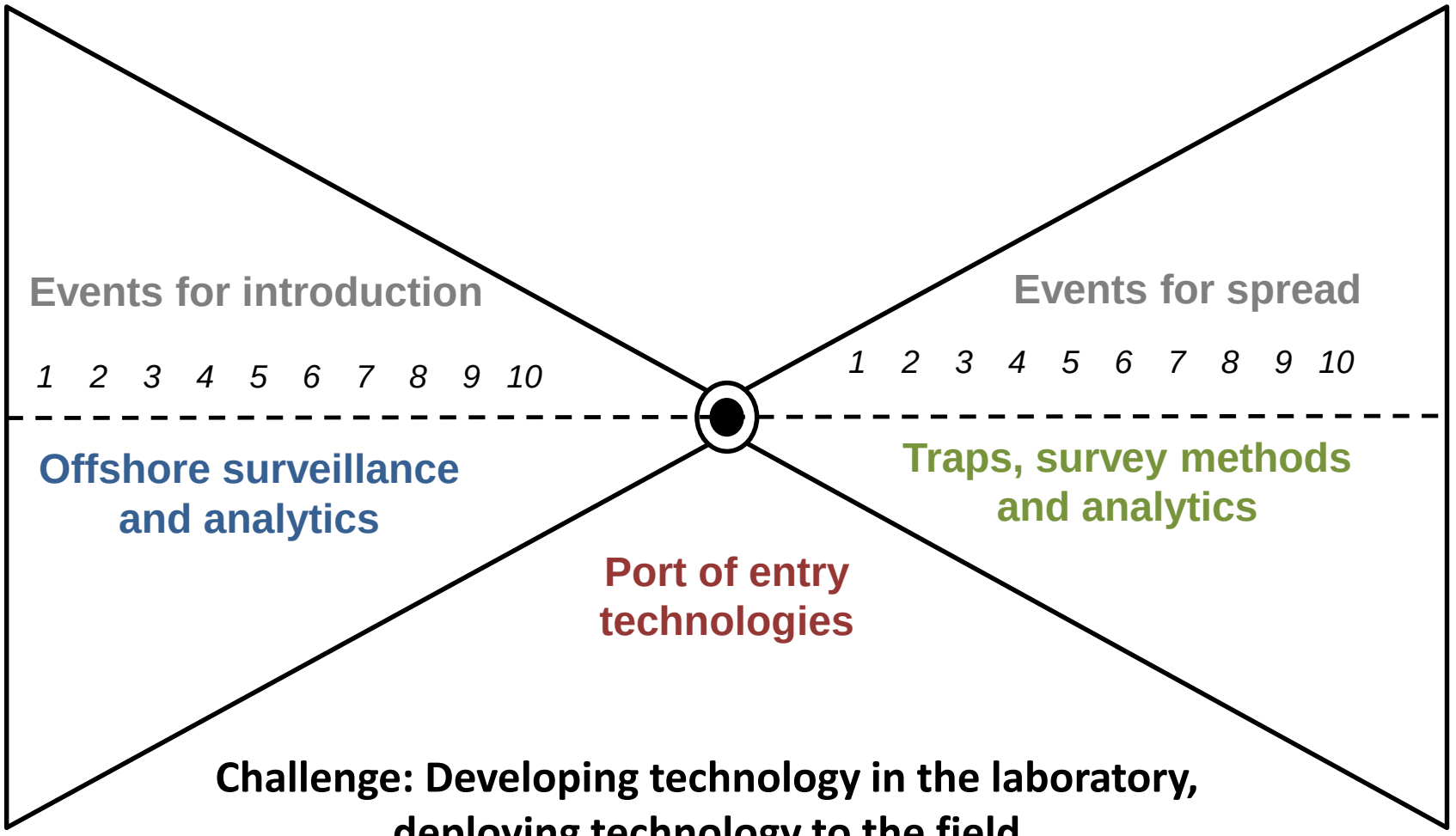
# Opportunities for Surveillance




**Challenge: Developing technology in the laboratory, deploying technology to the field**

# New Technologies

- Offshore survey methods
- Technologies for ports of entry
- Domestic surveys
  - Unmanned aircraft systems (UAS)
  - Canines
  - Chemical technologies
  - Molecular technologies
  - Analytics
  - Survey methods support

# Offshore surveillance

PestLens

**Thursday, August 31, 2017 Notification**

**First report of golden nematode, *Globodera rostochiensis* (Heteroderidae), in Egypt**
**Source:** Pakistan Journal of Nematology
**Event:** New Location

During a 2012 to 2016 survey, golden nematode, *Globodera rostochiensis* (Heteroderidae), was isolated from *Solanum tuberosum* (potato) plants in Egypt. This is the first report of *G. rostochiensis* in Egypt.

*Globodera rostochiensis* causes stunting and yield loss in economically important crops including *S. tuberosum, S. lycopersicum* (tomato), and *S. melongena* (eggplant). *Globodera rostochiensis* has been reported from parts of Europe, Africa, the Middle East, Asia, Oceania, Canada, Mexico, South America, and the United States. In the United States, it is restricted to New York and is under official control. *Globodera rostochiensis* is listed as reportable in the PEST ID database (queried 8/30/17) and is listed as a pest of concern on the 2015 PPQ Prioritized Offshore Pest List.

**References:**

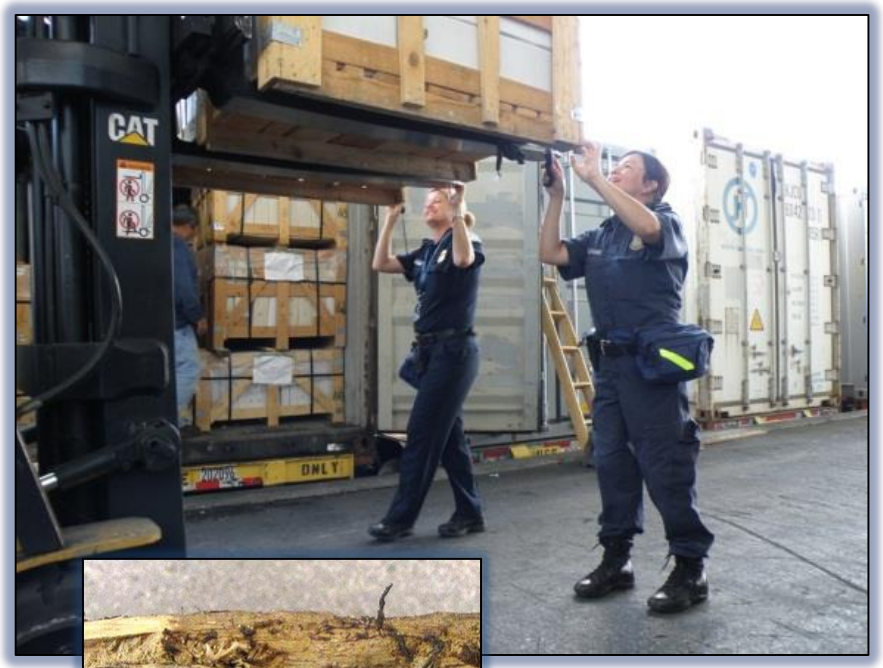
1. Ibrahim, I. K. A., Z. A. Handoo, and A. B. A. Basyony. 2017. The cyst nematodes *Heterodera* and *Globodera* species in Egypt. Pakistan Journal of Nematology 35(2):151-154. Last accessed August 31, 2017, from http://www.pjn.com.pk/old/files/vol%2035%20no.%202/2.Ibrahim%20et%20al.PDF.

New Pest Advisory Group

NEW PEST ADVISORY GROUP (NPAG)
Plant Epidemiology and Risk Analysis Laboratory
Center for Plant Health Science & Technology

# Port Technologies

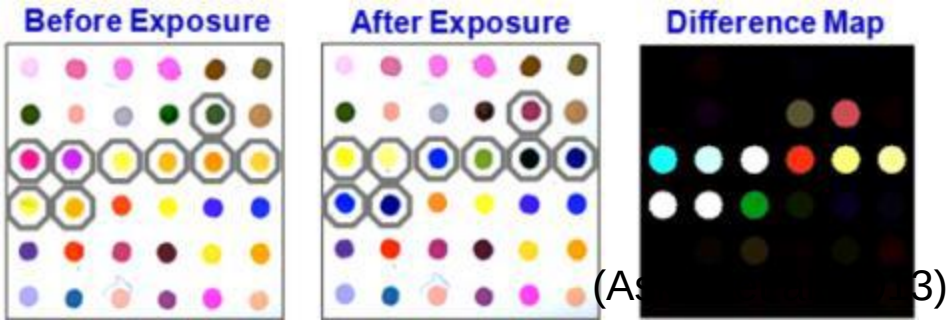
Better technology needed to improve our ability to detect exotic organisms at ports of entry



http://www.cbp.gov/archived/xp/cgov/newsroom/news_releas
/archives/2009_news_releases/

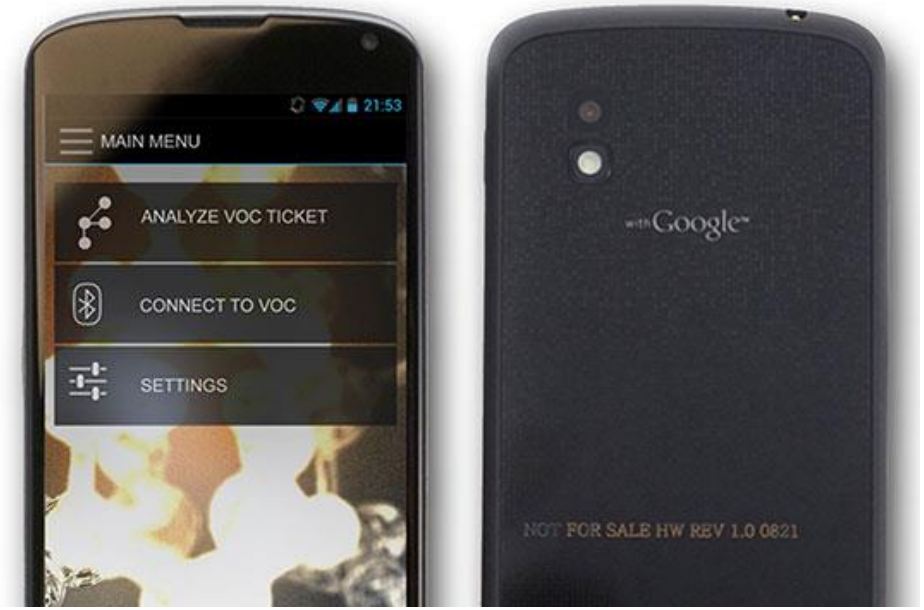
# Colorimetric Sensor Arrays (CSAs)

- 1x1” disposable sensor PVDF or cellulose membrane spotted with an array of colorimetric chemical indicator dyes
- Dyes change color in response to chemical stimuli. The color response is subtracted from a baseline to produce unique color “fingerprints.”




(As 3)

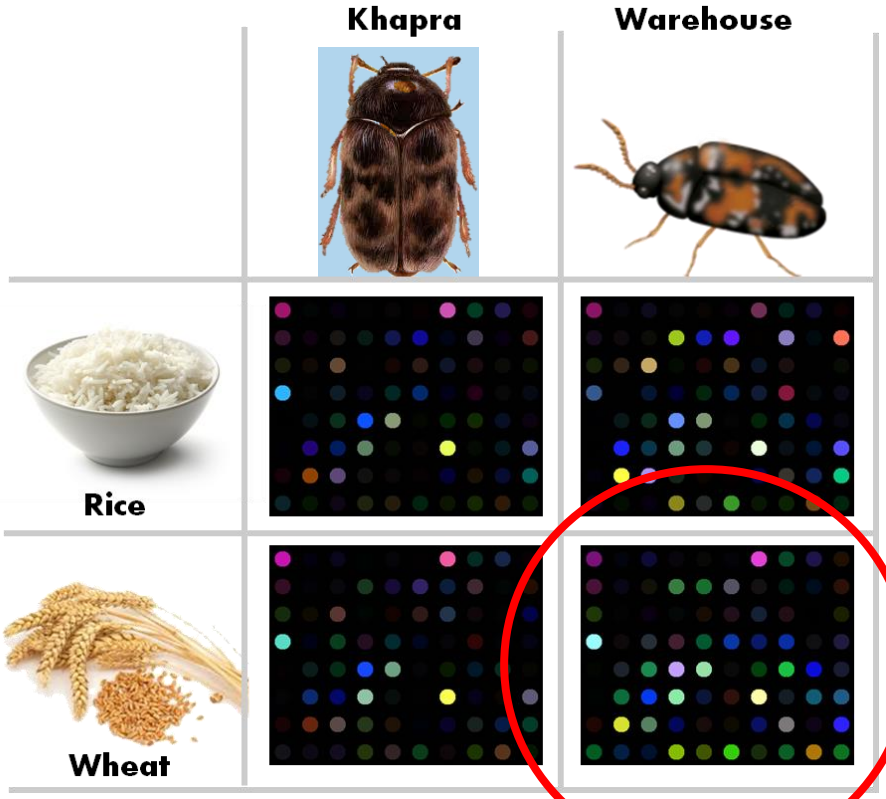
**Long term Goal:** Development of a disposable and inexpensive container-scanning technology to assist in the screening and monitoring of US imports.



# Objectives: Library Development

**Evaluate CSA color changes in response to quarantine insect pests associated with imported commodities.**

1. Incubation time required for interpretable response
2. Variability of response: commodity x insect species
3. Feasibility of identification from pattern recognition




*(Notional differential VOC response)*

- *Are there signatures of pest(s) infection regardless of food source?*
- *Can pest(s) be differentiated?*
- *Are pest(s) signatures differentiated by food source?*

# Port technologies

## zNOSE Technology

**PROGRAM OPERATION:**

- Developments in portable chemical technology provide a means to detect the presence/absence of concealed pests.
- Deployment of innovative technologies require objective and systematic performance evaluations.
- Performance evaluations include laboratory pre-demonstration studies and field demonstration studies.

High Speed GC

System Controller

**Electronic Sensor Technologies (EST) Model 4600 zNOSE™**

- Miniature High Speed Gas Chromatograph (GC)
- Acts as an Electronic Sniffing Tool
- Fast (5 to 60 seconds)
- Portable
- Small Footprint (32 pounds)
- Requires Minimal Training

# Port technologies

## CANARY

Cellular Analysis and Notification of Antigen Risks and Yields

**PCT Shredder**

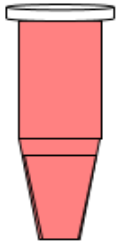
**Rotator**

**Magnetic Rack**

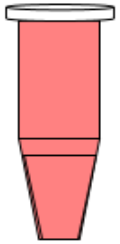
**Mini-centrifuge**

**Luminometer/ computer**

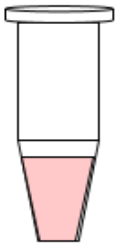
**Assay buffer**



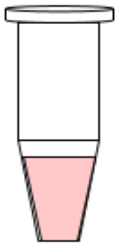
**CANARY cells**



**Magnetic capture bead**



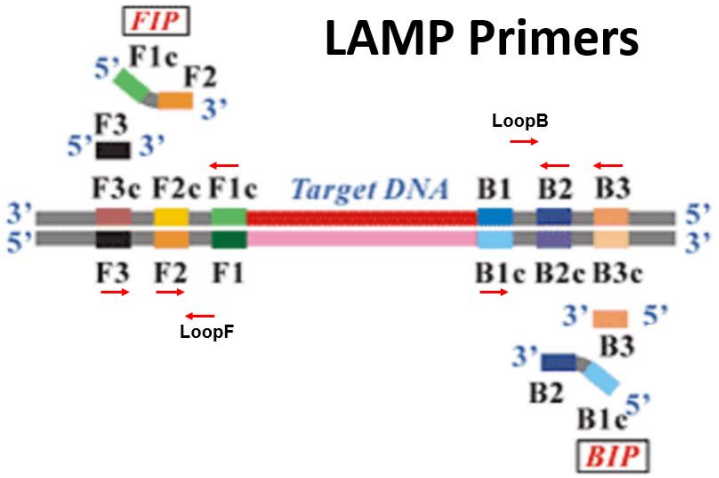
**Positive control**



# Port technologies

## Loop-Mediated Isothermal AMPlification (LAMP)

- Simple, rapid, specific
- Portable device & constant temperature
- multiple primers & isothermal DNA polymerase
- Results displayed in real-time
- Detection in 15-60 minutes



# Port technologies

## Using genomics to identify origin of AGM

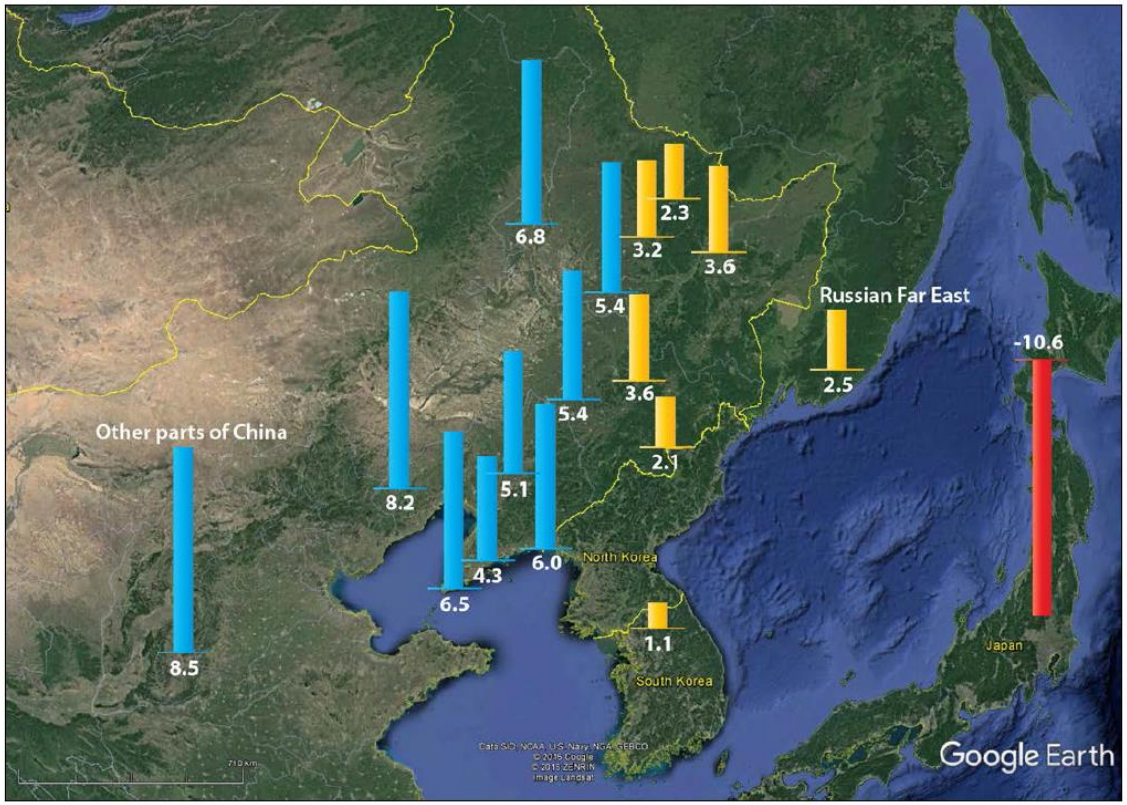
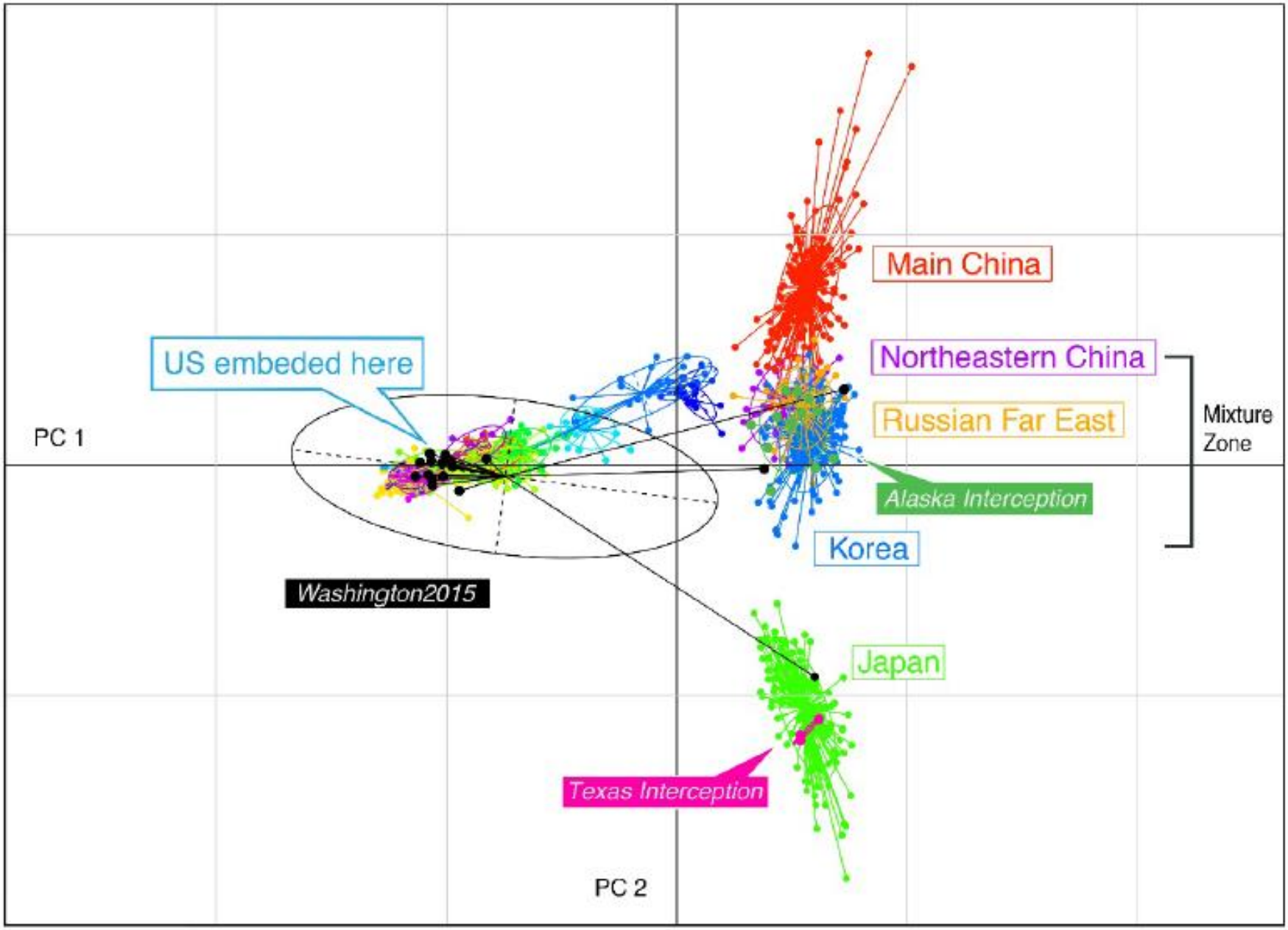



**Figure 1.** AGM populations have very different PC-2 values and can be separated into three genetic clusters.


US embeded here
Main China
Northeastern China
Russian Far East
Mixture Zone
Alaska Interception
Korea
Washington2015
Japan
Texas Interception
PC 1
PC 2

# Molecular technologies

- Genetic analysis of Asian longhorned beetle
- Investigating if this correlates to different origins

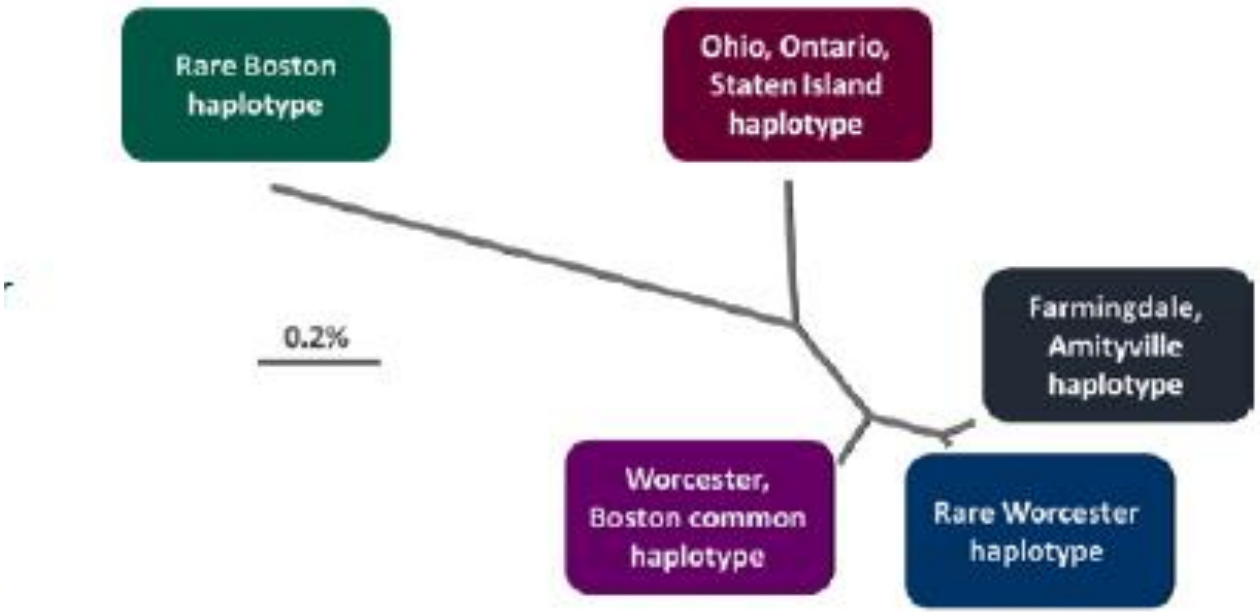
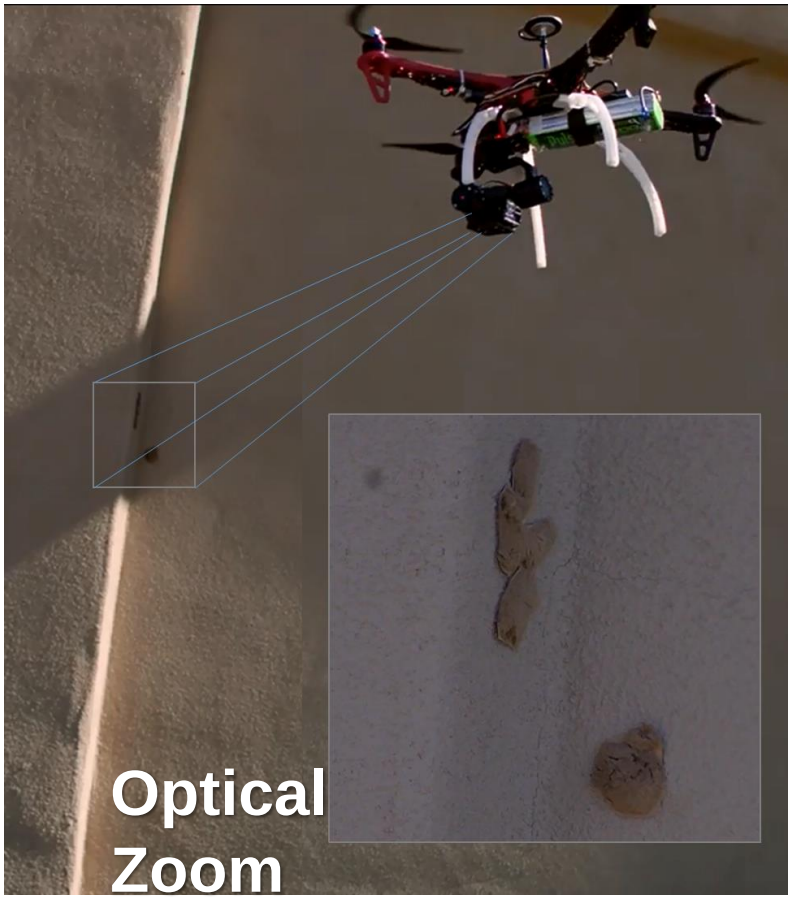



**Figure 1.** Genetic distances among the five haplotypes recovered from the 111 beetles.

# Unmanned Aircraft Systems – Offshore Application

Survey for Asian Gypsy Moth egg-masses that may be on containers or ship superstructures.

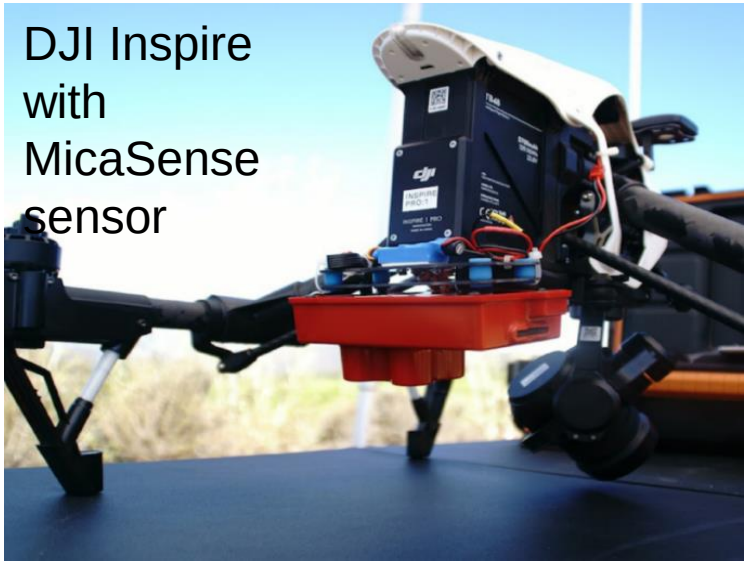


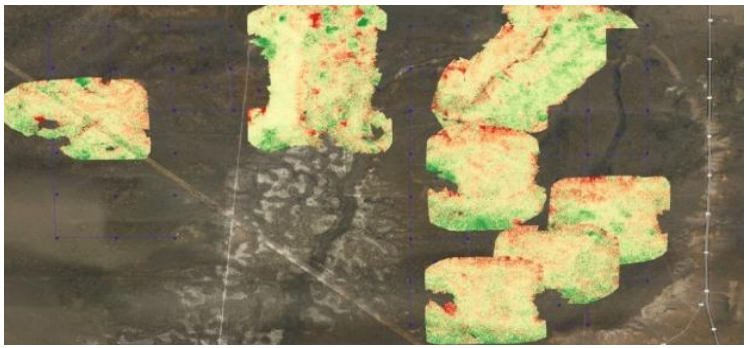
# Unmanned Aircraft Systems – Domestic Application

## Remote sensing

Monitoring Rangeland Health

- Testing the use of multispectral imagery
- To assess rangeland forage in relation to grasshopper densities following the treatment of aerially applied insecticides.



# Unmanned Aircraft Systems – Domestic Application

Asian Longhorned Beetle

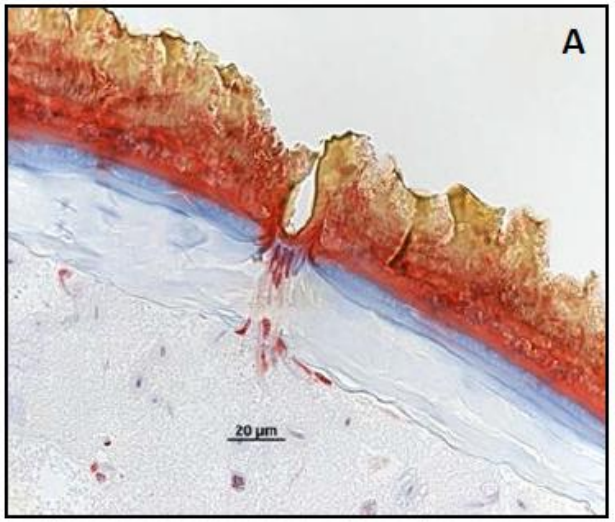
- Use quadcopter and camera to capture insect damage to trees
- Assist visual ground survey
- Currently improving systems – better camera, increase flight time, and better portability.

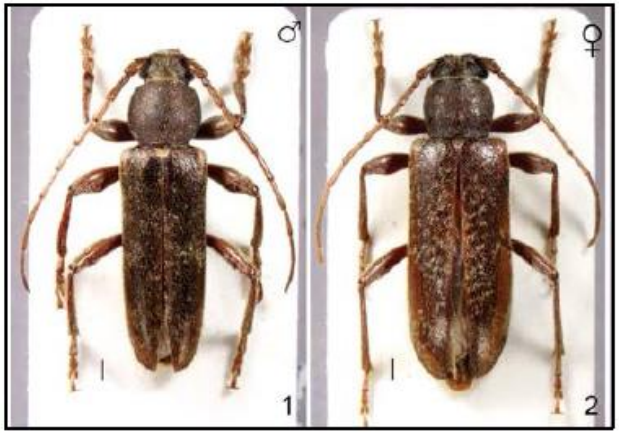
DJI Inspire with X3 Camera

M3 Aegis with 10x optical zoom sensor

# Chemical technologies

- Isolation of attractant pheromone for Velvet Longhorn Beetle

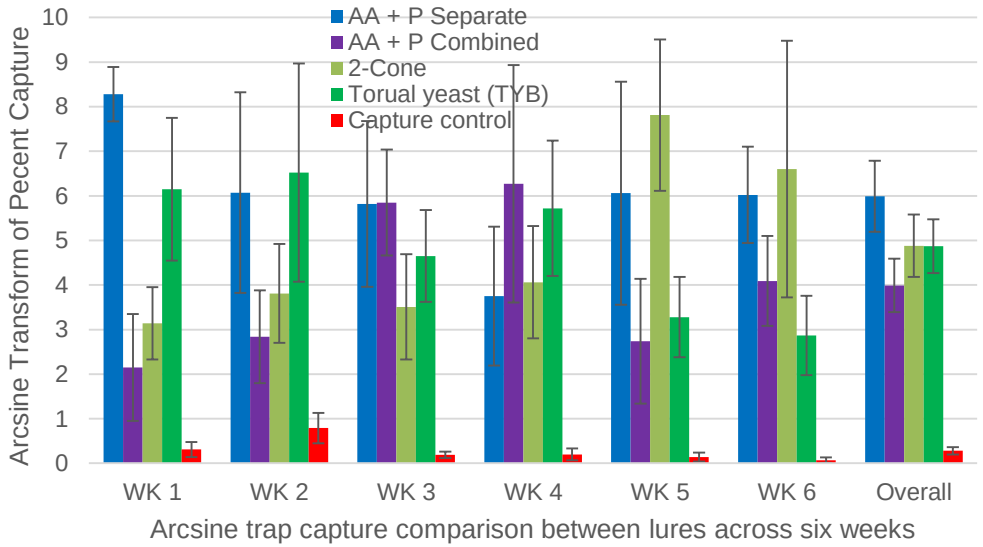


# Chemical technologies

## Fruit fly lure testing

Separate 2-component (ARS)
Combined (ARS)
2-component cones
Torula yeast borax
Capture solution control



2- component patches

2 component cones

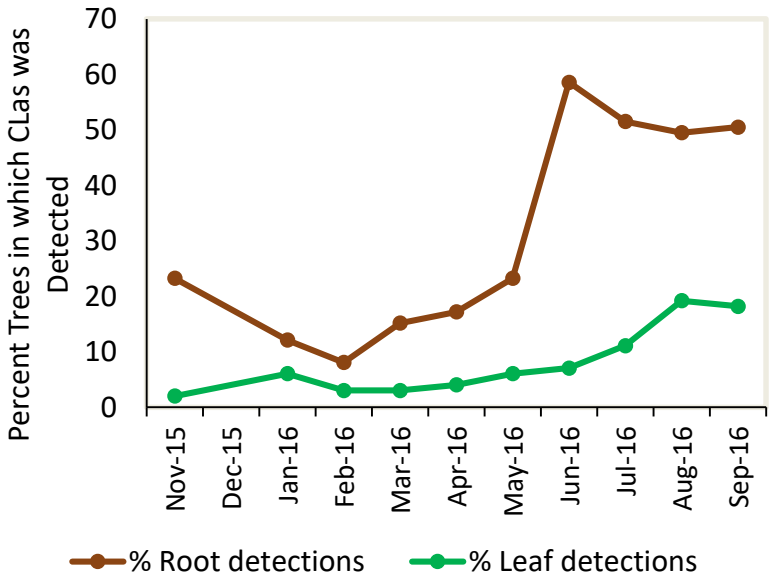
Torula Yeast Borax tablets

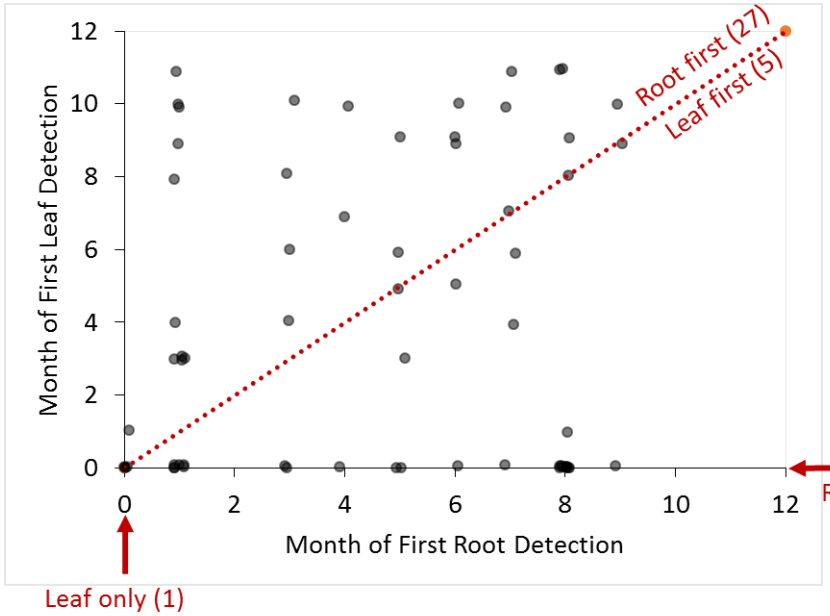
# The ultimate VOC sensor…

# Canines

- Currently in routine use for international air passengers
- Developed or in development/proof of concept
  - ALB
  - Coconut rhinoceros beetle
  - Giant African snail, Brown marmorated stinkbug, Plum pox virus, Citrus canker, HLB, wood-boring beetles in SWPM, Phytophthora ramorum

# Improved detection of *Candidatus* Liberibacter asiaticus using root tissue




**Total detections: 89**
**Root detections: 88 (99%)**
**Leaf detections: 38 (43%)**

**First detection: Roots: 78 (88%); Leaves: 7 (7%)**
**Detected in both tissues: 37 (42% of detections)**
**Detected in both tissues simultaneous: 4**

# Molecular technologies

## *Helicoverpa armigera* trap sampling

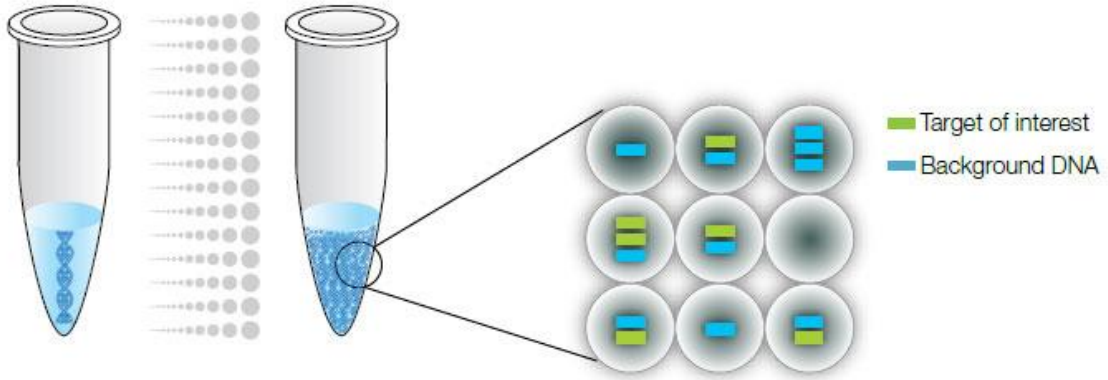
- Old World bollworm (OWB)
- "One of the world's worst insect pests"
- Trapping protocol for OWB – up to 500 moths per trap (primarily non-targets = *H. zea*)
- Identification by genitalia dissection or DNA analysis of individual specimens
- Lots of time to identify potential targets

(Photo from Brambila et al. 2014)

# Molecular technologies

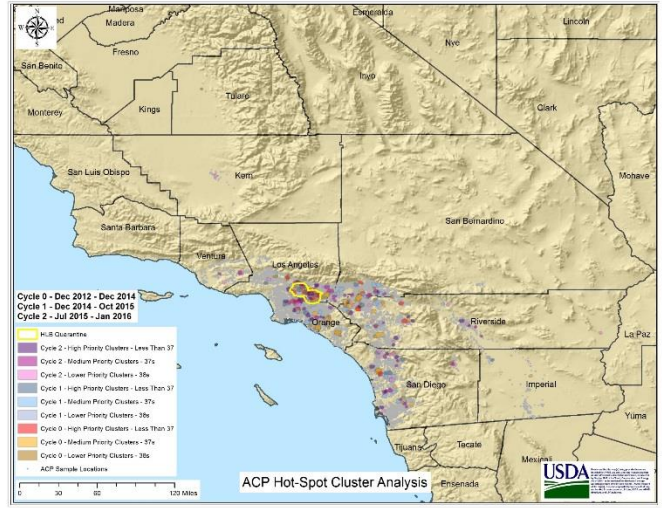
## Droplet digital PCR (ddPCR)

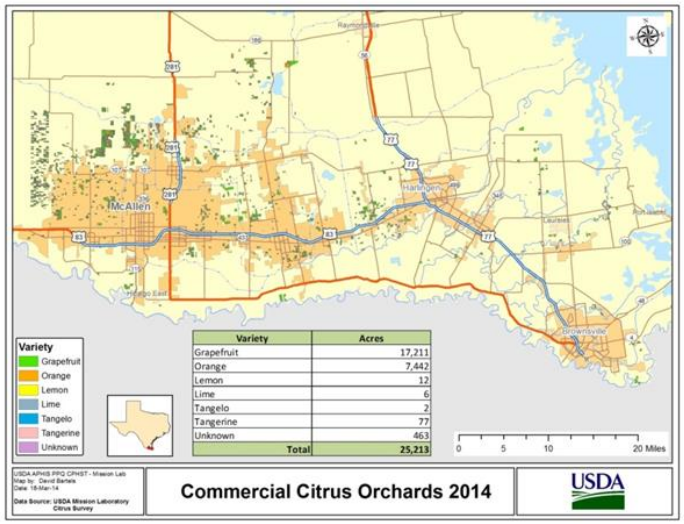
- Droplet digital PCR
  - Ideal for “rare event” detection – detection of rare targets in complex backgrounds
  - Increased sensitivity and precision over real-time PCR
  - No standard curve is needed for quantification
  - Provides thousands of discrete measurements (droplets) in a single tube/well – approx. 20,000 per 20 µl reaction
  - Demonstrated sensitivity of 0.00005%

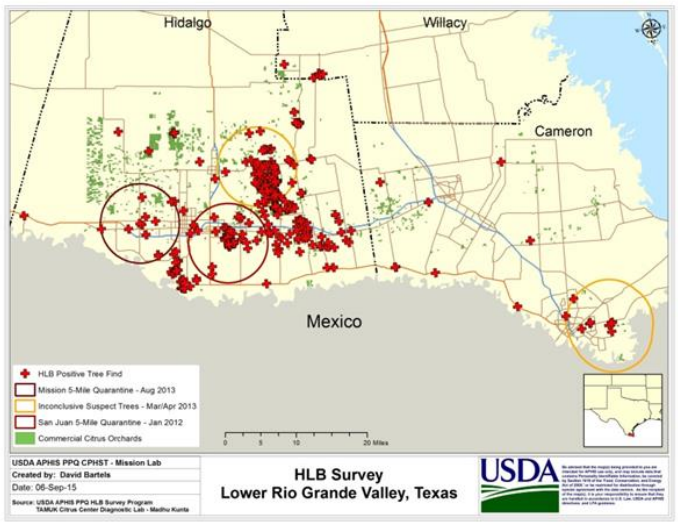


# Geospatial Technology / Quantitative Analysis

- Spatial Analysis of survey data and diagnostic information
- Development of geospatial data layers and visualization products
- Development and testing of simulation spread models and risk-based survey models

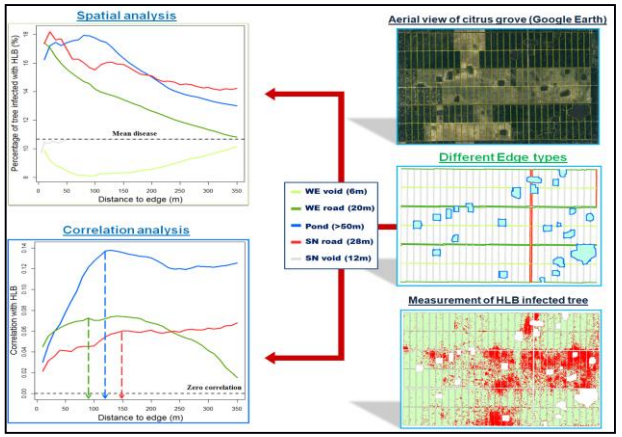


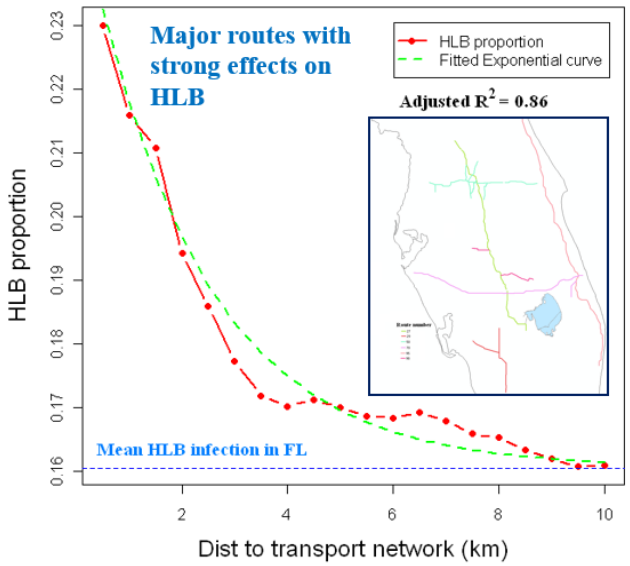



# Spatial analysis

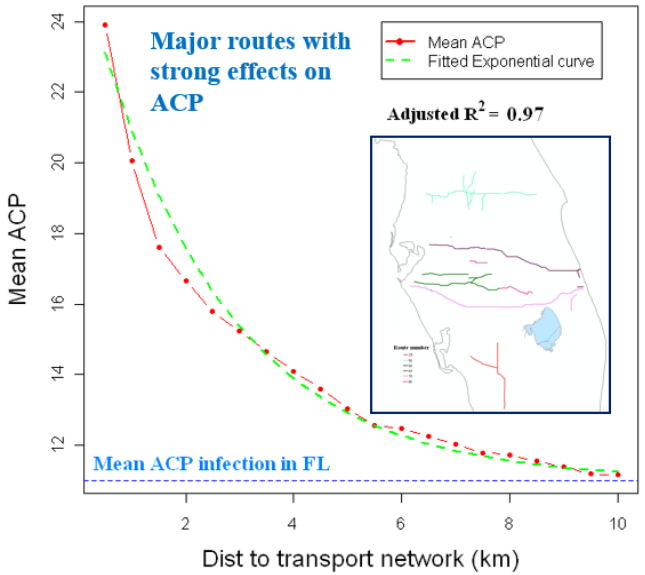
- Multi-pest survey models
- ACP/HLB spread associated with transportation corridors

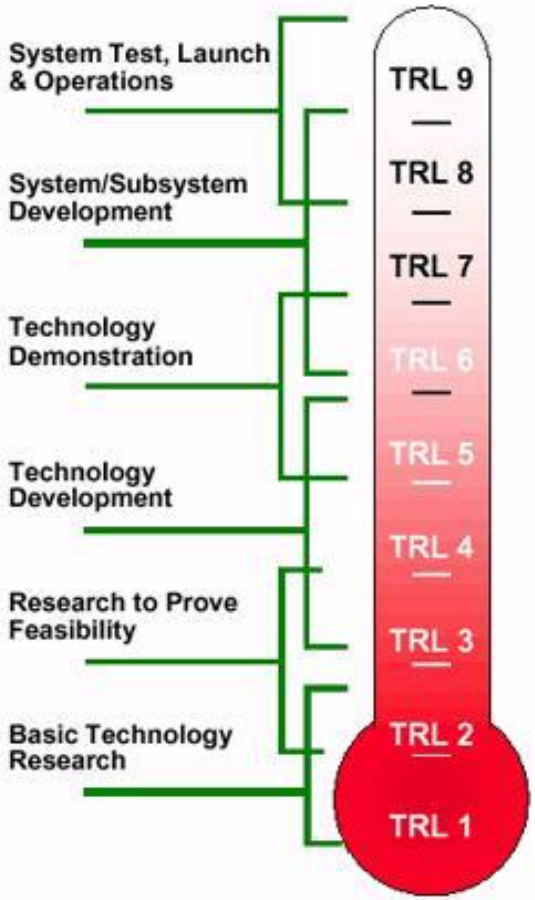


Route 27, 29, 50, 70, 95, 98




Route 29, 50, 60, 64, 70 ,98



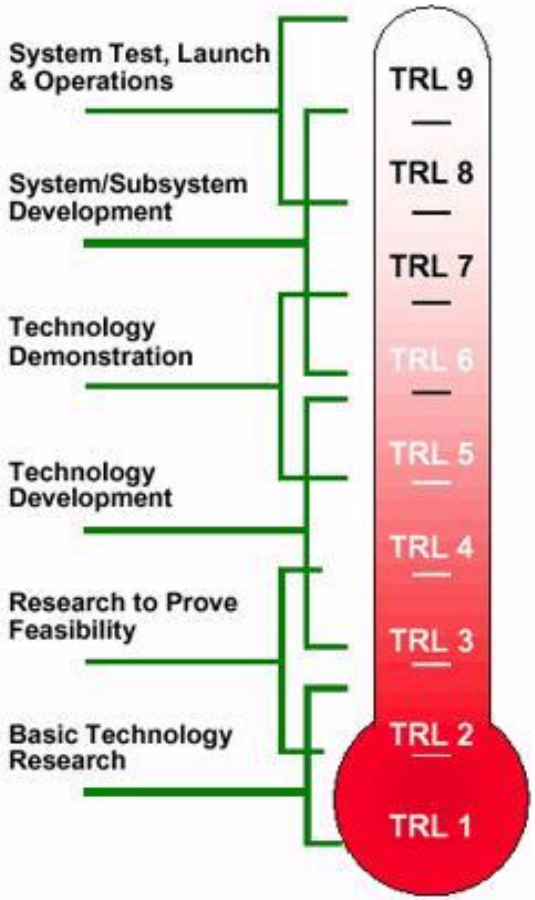



The Technology Valley of Death

Adapted from NASA

# How do we avoid the Technology Valley of Death???

- Engage the customer(s)/end-user(s)/partners etc. from the very beginning
- Engage international stakeholder/collaborators early on
- Have a plan for operationalizing the technology
- Have a plan for commercializing (if appropriate) the technology




The Technology Valley of Death

The Technology Mountain of Opportunity

Adapted from NASA

# Acknowledgements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