Texas A&M University-Kingsville, Citrus Center
www.tamuk.edu

Area-Wide Integrated Management System (AIMS) for *Diaphorina citri* in Texas, USA

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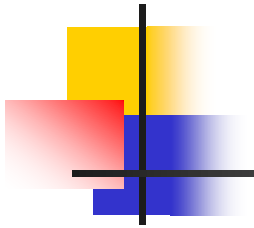
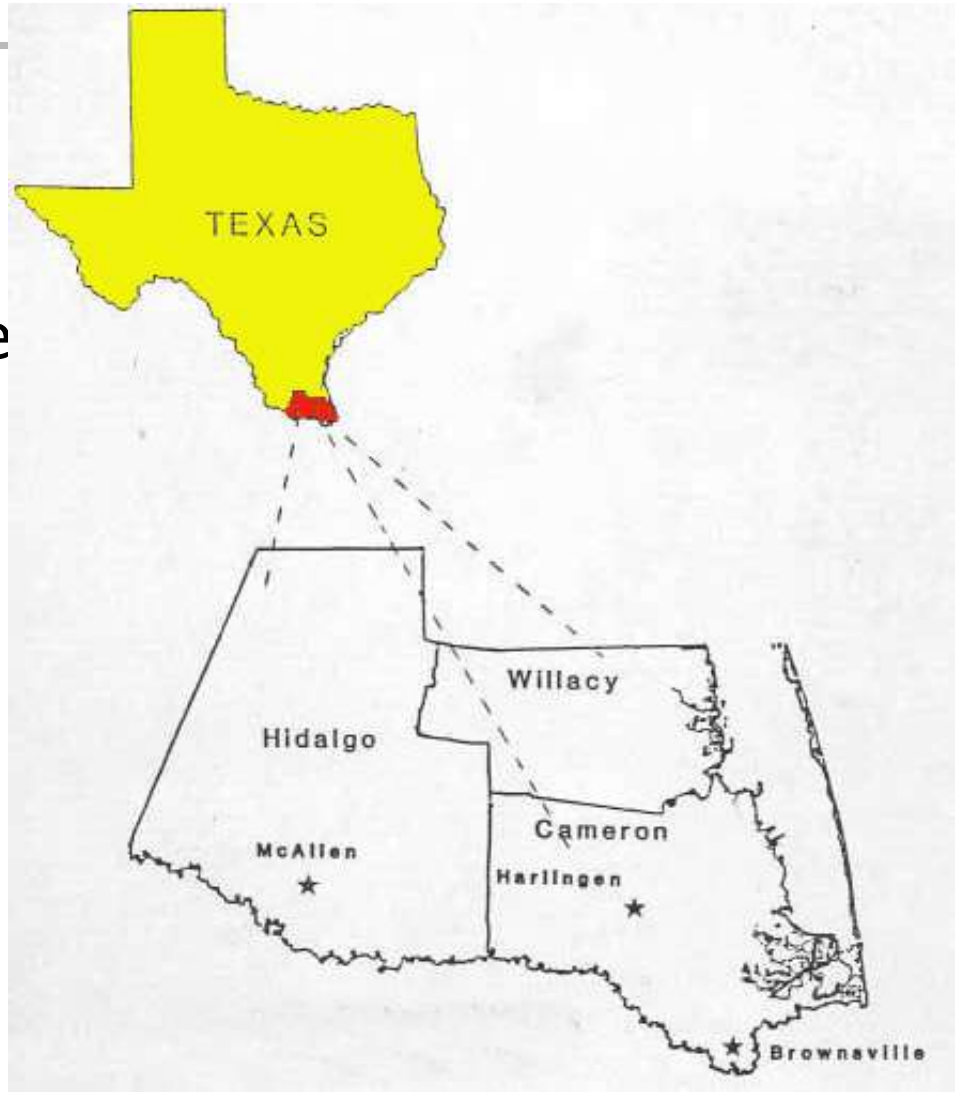
Outline



1. Development of ACP-AWM program
2. Specific components of Texas ACP-AWM program
3. Outreach & Implementation
4. Achievements
5. Challenges (costs, other pests, residential citrus)
6. Future outlook
7. Discussion

Texas Citrus Industry

- ✓ Texas citrus industry covers 28,000 acres; in the three southern-most counties of the state (LRGV)
- ✓ Texas ranks 3rd in citrus production in the U.S.
- ✓ Two major citrus spp.
  - ➢ Grapefruit-70%
  - ➢ Sweet oranges-28%



ACP and HLB in Texas

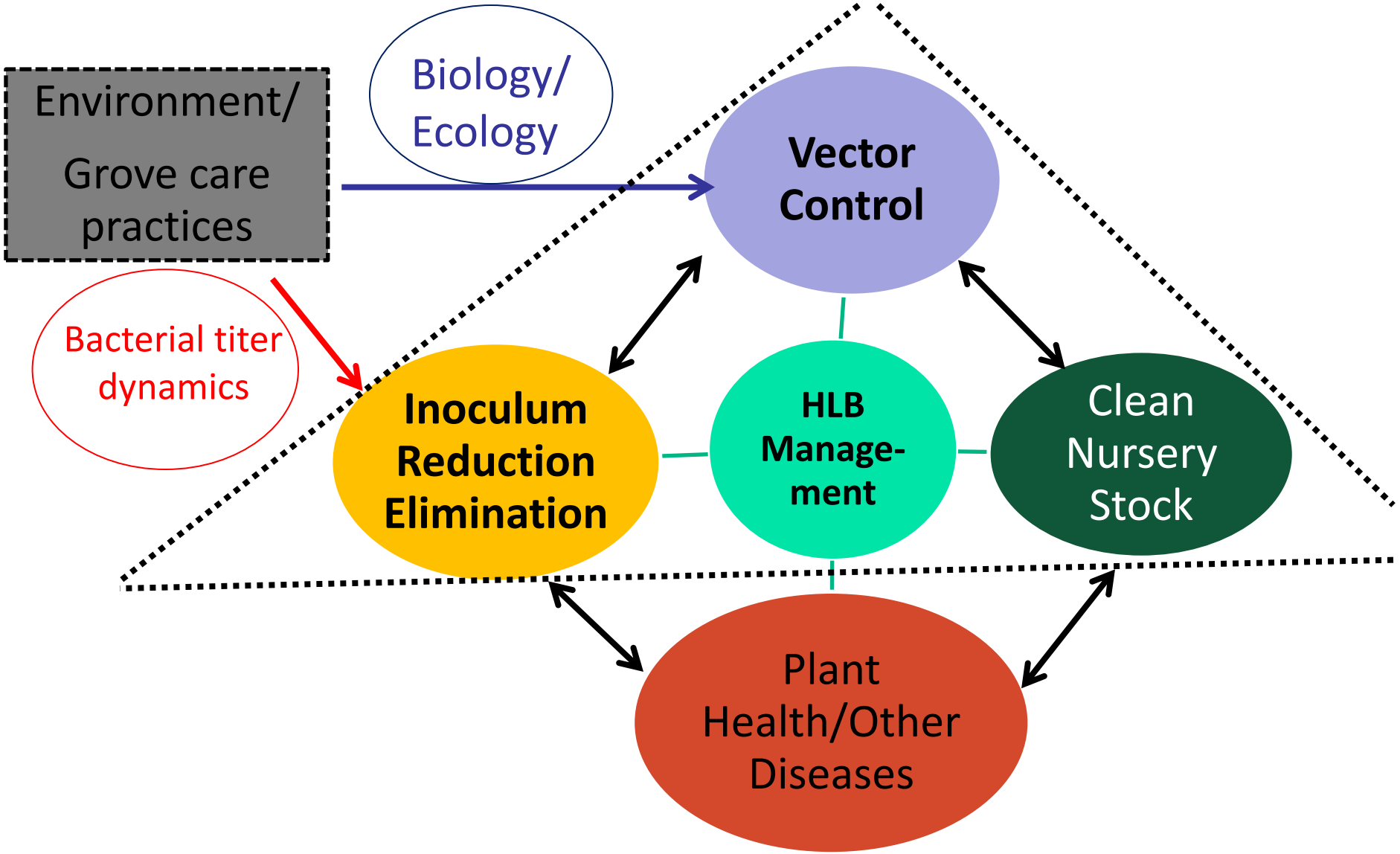
- **2001:** ACP was first reported in Texas
  - No "targeted" psyllid control program, but control of other insect pests provided some benefits
- **2007:** ACP monitoring initiated in sentinel groves
- **2008-2009:** Pilot project for the development of psyllid AWM (supported by APHIS-PPQ)
- **2010:** "Voluntary" grower implementation of AWM
- **2012:** Detection of HLB-intensification of ACP-AWM in quarantine and other mitigation efforts

Goal of ACP-AWM in Texas

- **To reduce ACP populations to very low levels and reduce the risk of CLas transmission and HLB spread**
  - Implement an aggressive area-wide control of psyllid in all settings where psyllid is found

HLB mitigation and sustainable citrus production are the ultimate goal of the psyllid control that must be integrated to all other strategies in a **system approach**

Sustainable citrus production in the presence of ACP/HLB: the 4-pronged approach



Strategies for HLB Mitigation

- **The fight against HLB is an industry-wide effort**. No single grower can successfully combat HLB alone
- **No single strategy will also be able to provide effective control- All approaches must be integrated and implemented together**
  - **Psyllid control** (Avoid spread of pathogens, protection of new planting and non-infected groves)
  - **Clean and certified nursery plants**
  - **Improved tree health** (nutrition and control of other diseases)
  - **Reduction of inoculum** (Where possible-Early detection is key for inoculum reduction)

Strategies for HLB mitigation in Texas

Prior to January 13, 2012:

1. Production of “clean” nurseries plants
2. Vector control
3. Early detection
4. Maintaining good tree health (nutrient, control of other diseases)

Post January 13, 2012:

5. Destruction of inoculum & Aggressive vector control in all commercial groves and residential areas within quarantine

Development of Psyllid Control Program

- Psyllid control has been **the major proactive step** we've taken for HLB mitigation in Texas
- Sustainable psyllid management strategies need to be designed to fit particular pest ecology and production systems
- The ***'one-size fits all'*** approach appears to be unsustainable in psyllid control (e.g Brazil: 12-24 sprays a year, Florida: 12 sprays, will be hardly adopted by growers in TX)

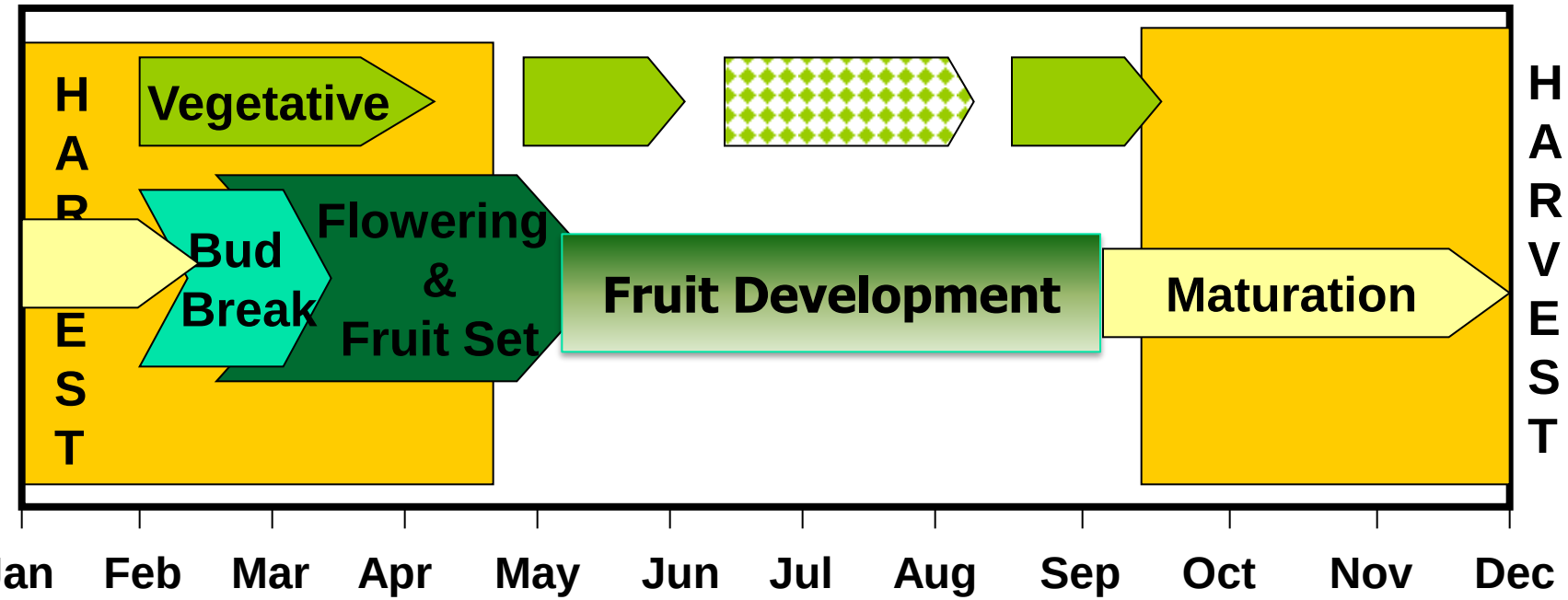
Development of Psyllid Control Program

- Growers generally spray 3 to 4 times a year, and pest and disease control accounts for 35-50% of production costs
- Spray decisions are based on mite or scale insect threshold, and psyllid population would not have driven spray decision-at least during active growing season
- Design a program that is ***efficacious*** yet ***cost-effective*** and that could ***easily fit into their ongoing programs***

Development of Psyllid Control Program

- Effective ACP management requires great understanding of spatial and temporal distribution of ACP population in agro-ecosystems (***nurseries vs groves vs residential trees***)
- Several factors affect ACP population dynamics
  - ✓ Tree phenology (**flush cycle**)
  - ✓ Host plant species and varieties
  - ✓ Irrigation type
  - ✓ Tree location
  - ✓ Time of year
  - ✓ Other grove care practices (leading to flush shoot production)

Citrus phenology and psyllid population biology in TX

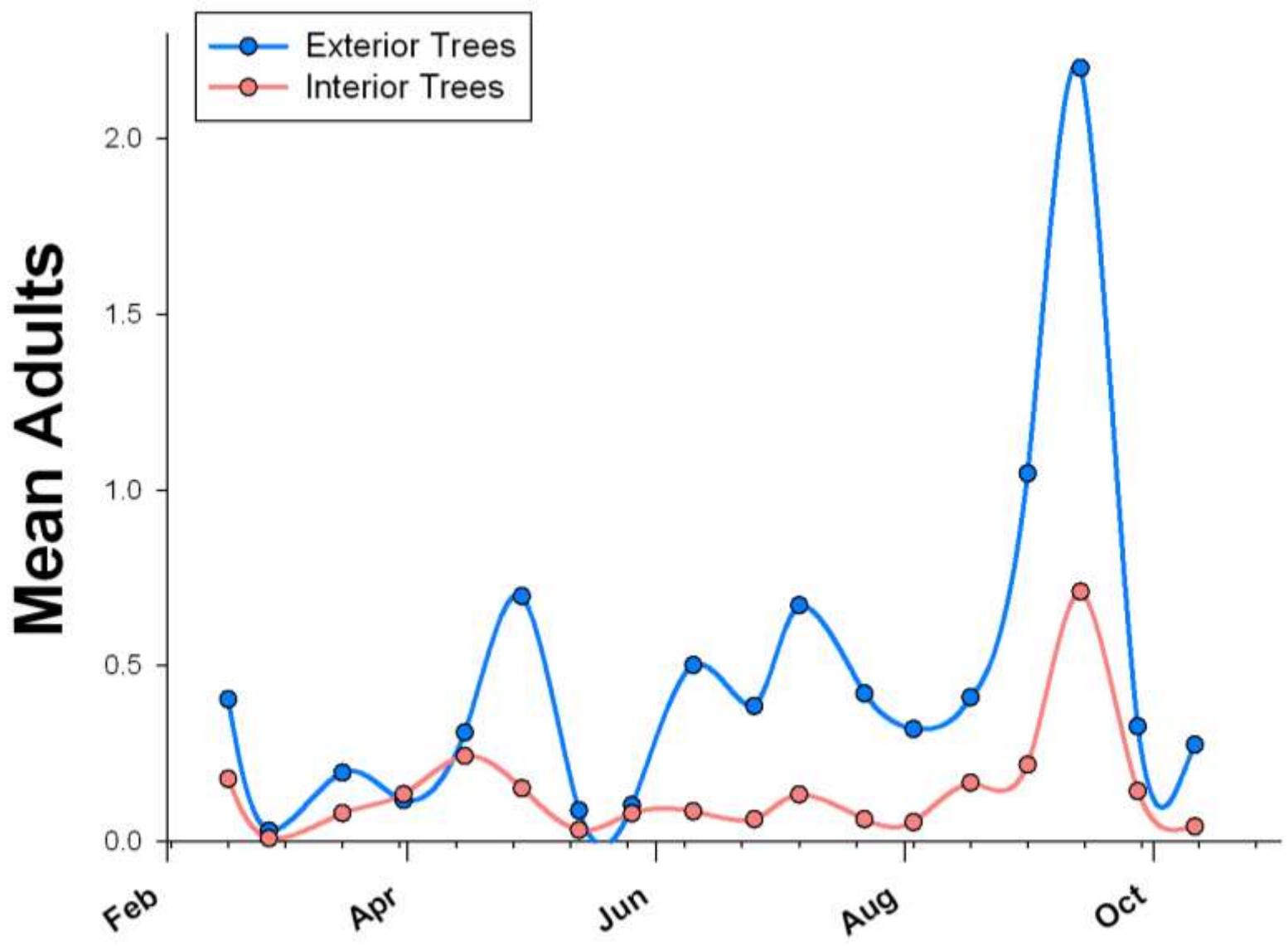


Variance component analysis of factors affecting ACP dynamics in Texas

Variance Component	ACP developmental stage		
	Eggs	Nymphs	Adults
Grove Location (Proximity to Residential areas, outer of block clusters)	0.2	0.15	0.5
Variety	-	0.2	0.2
Irrigation	0.2	0.3	0.3
Time (fall)	1.5	3.1	4.4
Tree location (Perimeter vs Adj vs Interior)	1.0	4.7	3.8
Flush Cycle	76.7	68.2	61.3
Error	20.4	23.35	29.5

Total of 53 groves sampled twice a month for 24 months

Strong Edge Effects in ACP Distribution



Development of Psyllid Control Program: Factors affecting Psyllid population

- ✓ Densities of ACP mostly determined by new flush shoots
- ✓ Psyllids are more abundant on perimeter trees in groves (edge effects)
- ✓ Grove close to residential areas or unmanaged habitats w/ACP host plants are more at risk for ACP infestations
- ✓ ACP is very mobile, thus the necessity of AWM of psyllid

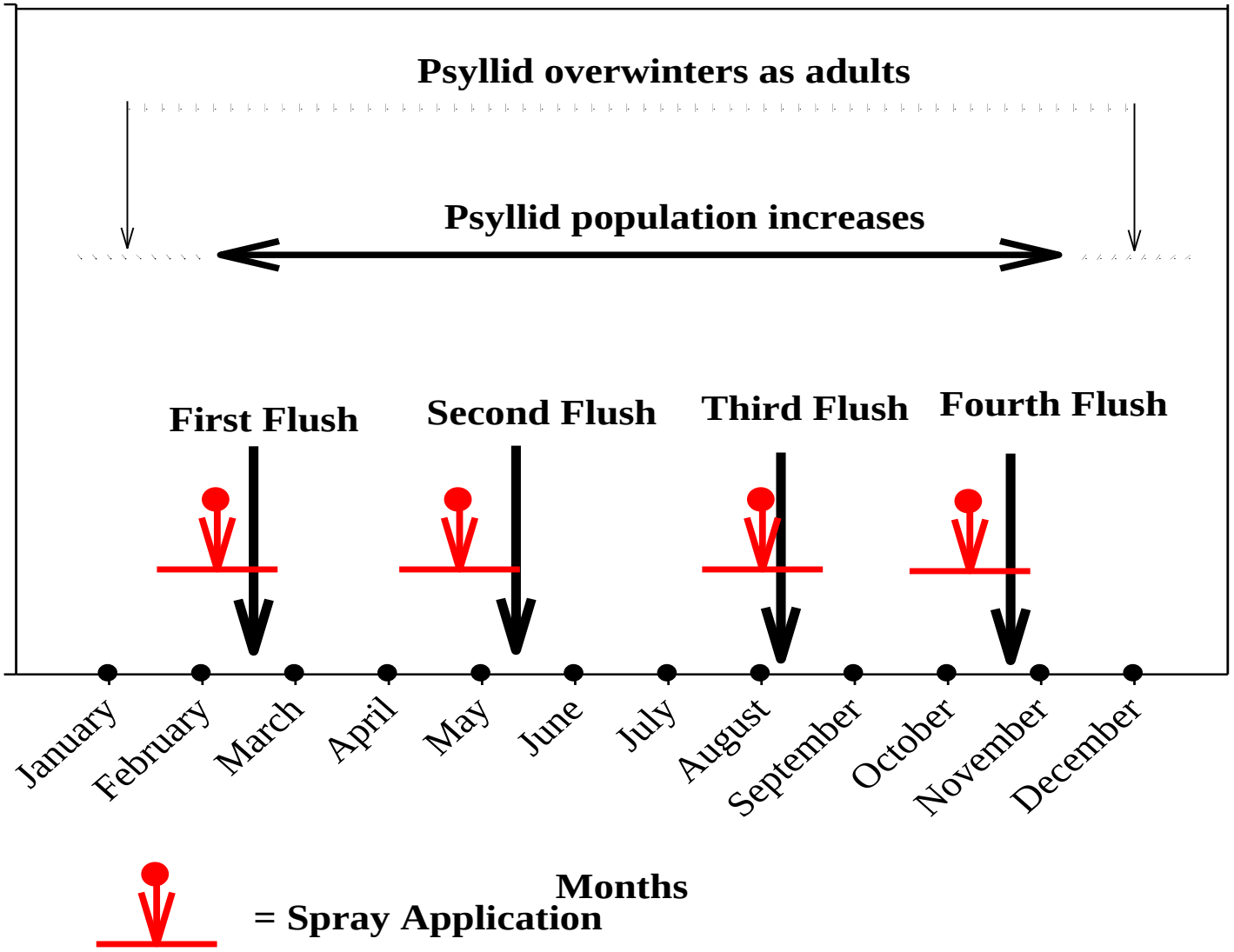
Consequences for management:

- ✓ Chemical sprays **must target** adults during dormant period of just before a new flush cycle
- ✓ **Perimeters** sprays between flush cycles

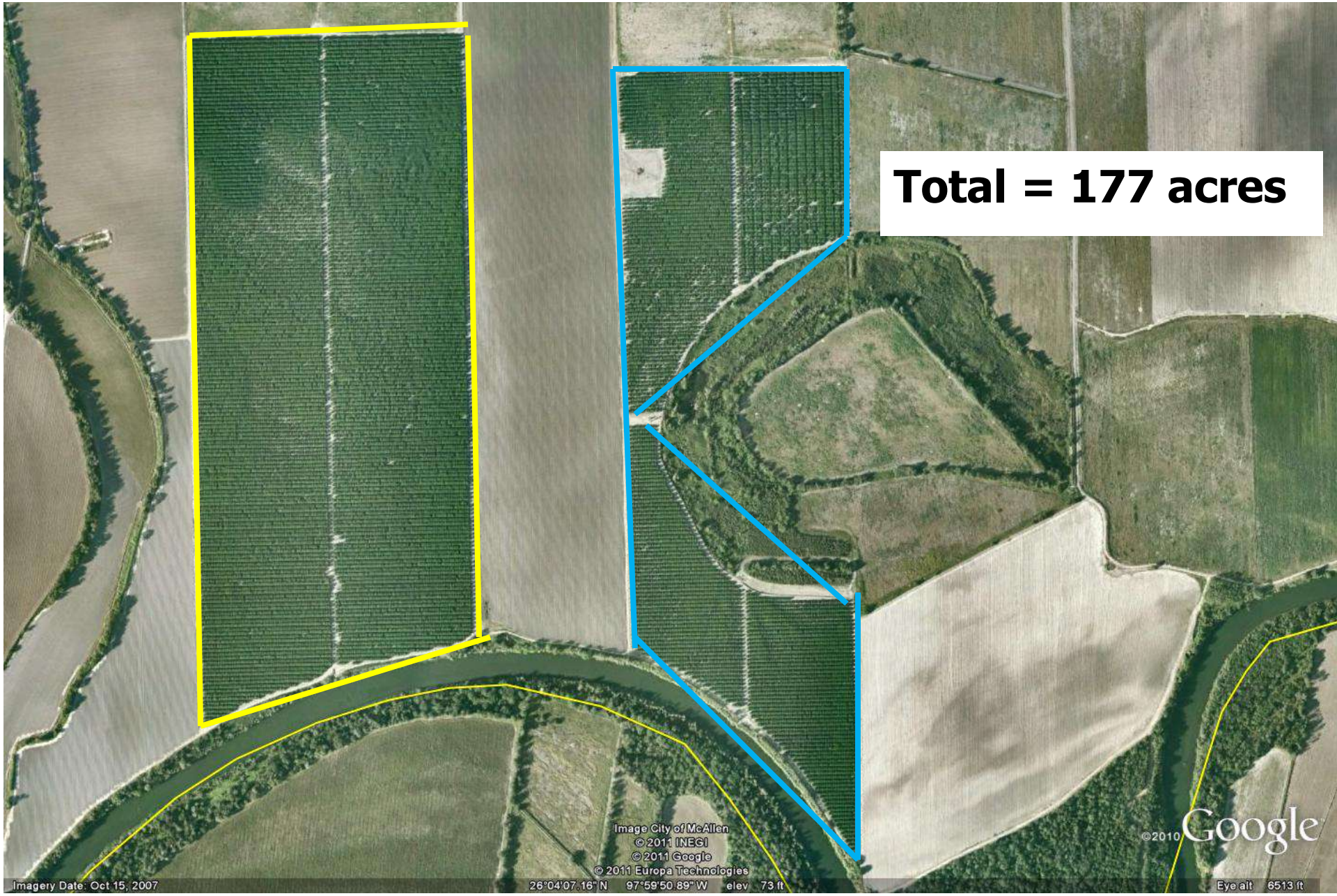
Development of Psyllid Control Program: Local *vs* Regional Control

- ✓ Comparison of the efficacy of **regional spray program** *vs* **local spray program** (treatment of selected groves)
  - ➢ Program 1 (Regional): all orchards sprayed in the area
  - ➢ Program 2 (local): spayed orchards surrounded by unsprayed ones
- ✓ Spray applications were made 4 times during the year, just before each major flush cycles, the first one as a dormant spray

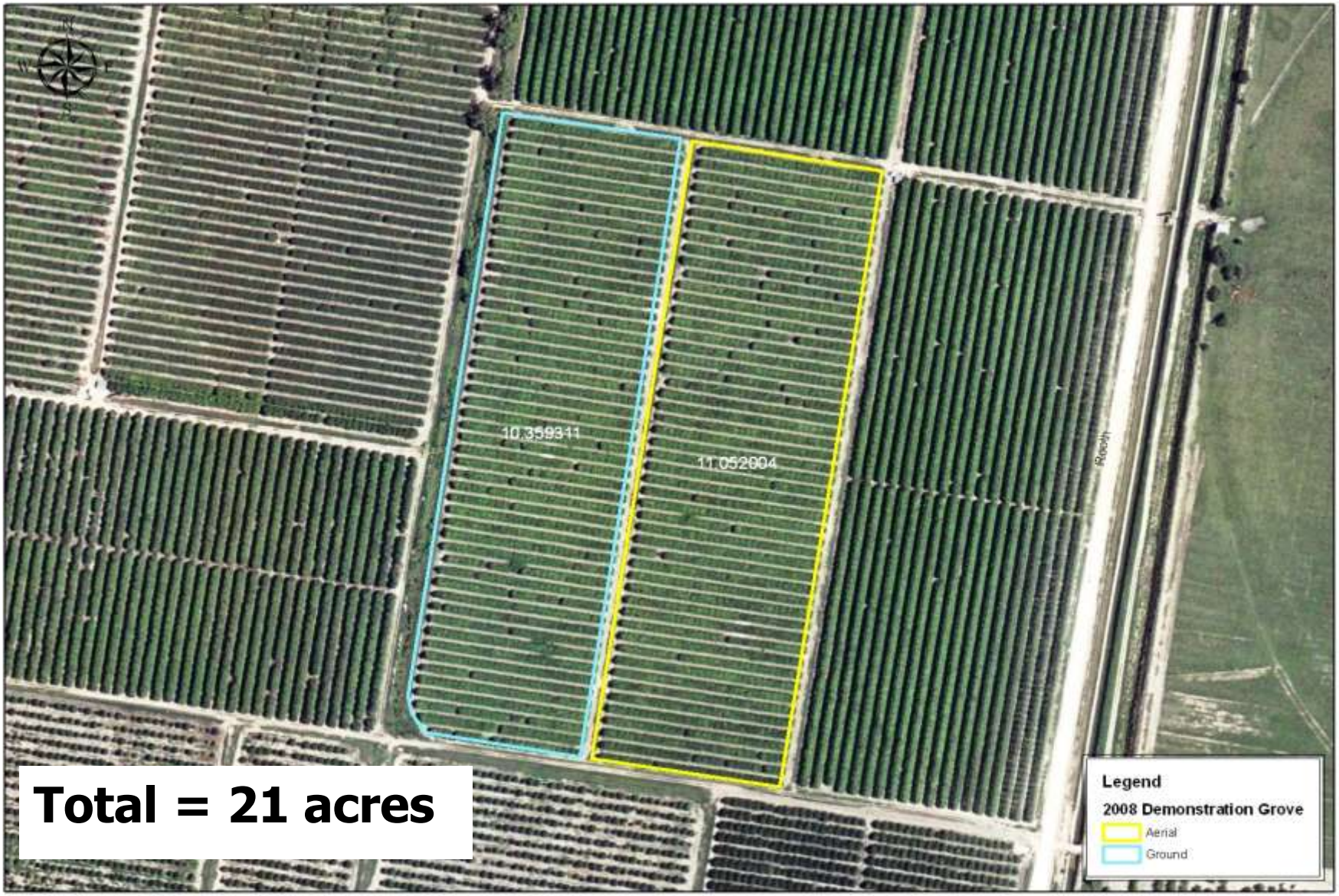
Development of Psyllid Control Program:
Local *vs* Regional Control



Regional Spray Program



Local Spray Program

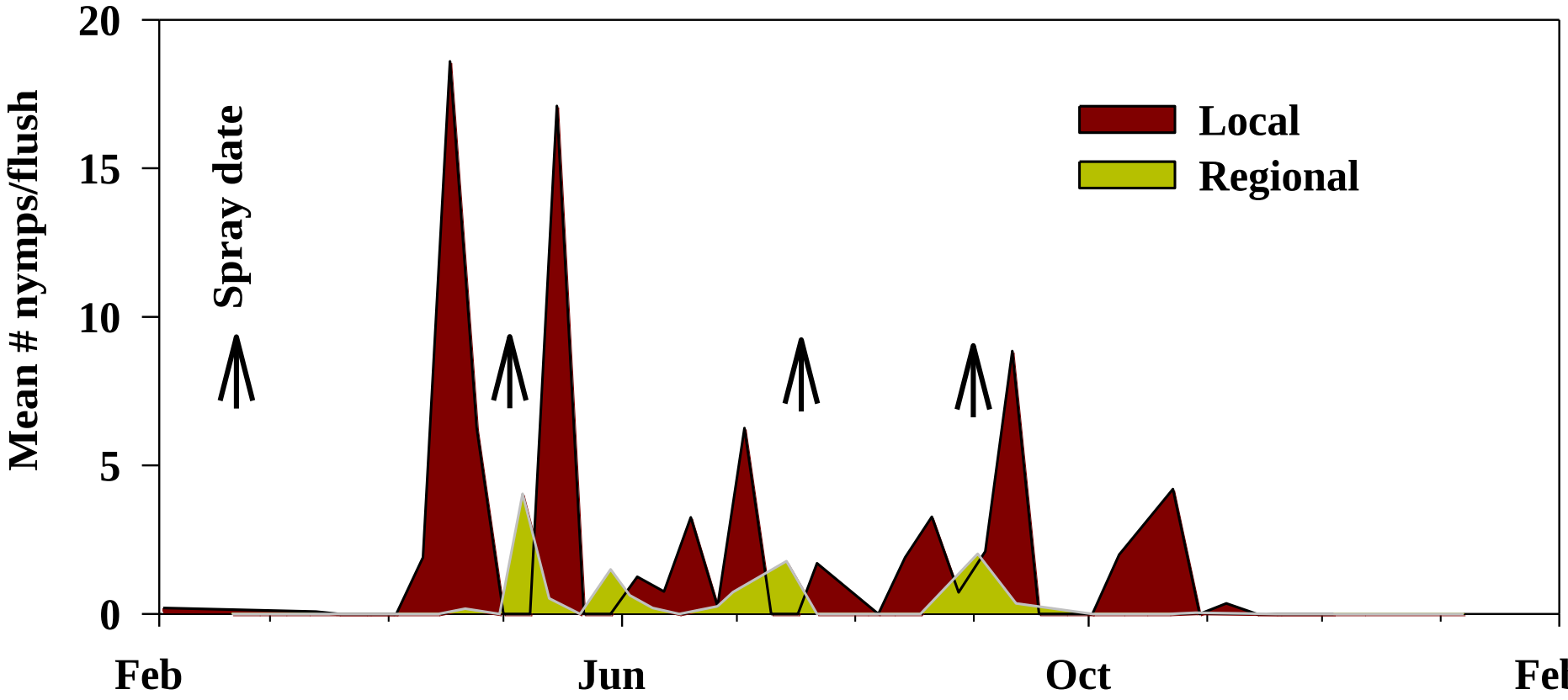


Total = 21 acres

0 0.025 0.05 0.1 Miles

Healds Valley Farms Upper Valley Site - Rooth & Monte Cristo
Grove Manager - Don Longwell - mobile # 330-7716

Development of Psyllid Control Program:
Local *vs* Regional Control



- Very low ACP pop in regional *vs* local control
- Dormant spray provided 3-4 months of effective control

Development of Psyllid Control Program: Local *vs* Regional Control

- ✓ Most insecticides provide short residual control, and frequent applications may be required for effective control due to ACP re-infestation
- ✓ Coordinated regional spray provided long term control of ACP with fewer sprays because ACP is controlled over a larger area, thus preventing re-infestation
  - ❖ the larger the area covered, the better is the control

Development of Psyllid Control Program

Key Concept in ACP and HLB Management

- ACP is not difficult to kill, but is extremely hard to control!!!!!
- Effective control requires coordination between growers and all stakeholders, thus the concept of **area-wide management**

Development of Psyllid Control Program

Key Components of Program

- Psyllid control is implemented as an Area-Wide Integrated Management System (**AIMS**)
- Area-wide psyllid control
  - ***Coordinated dormant sprays*** (goal is to target psyllid overwintering populations)
  - ***Coordination is difficult*** during active growing seasons but psyllid control program must consider other pests and diseases
  - Spray applications made just prior to a flush cycle during active growing season on ***grove by grove basis*** (edge treatment first)
  - ***Perimeter treatment*** to target immigrating psyllids after whole grove treatment and between major flush cycles (assist in dealing with habitats where nothing is done)

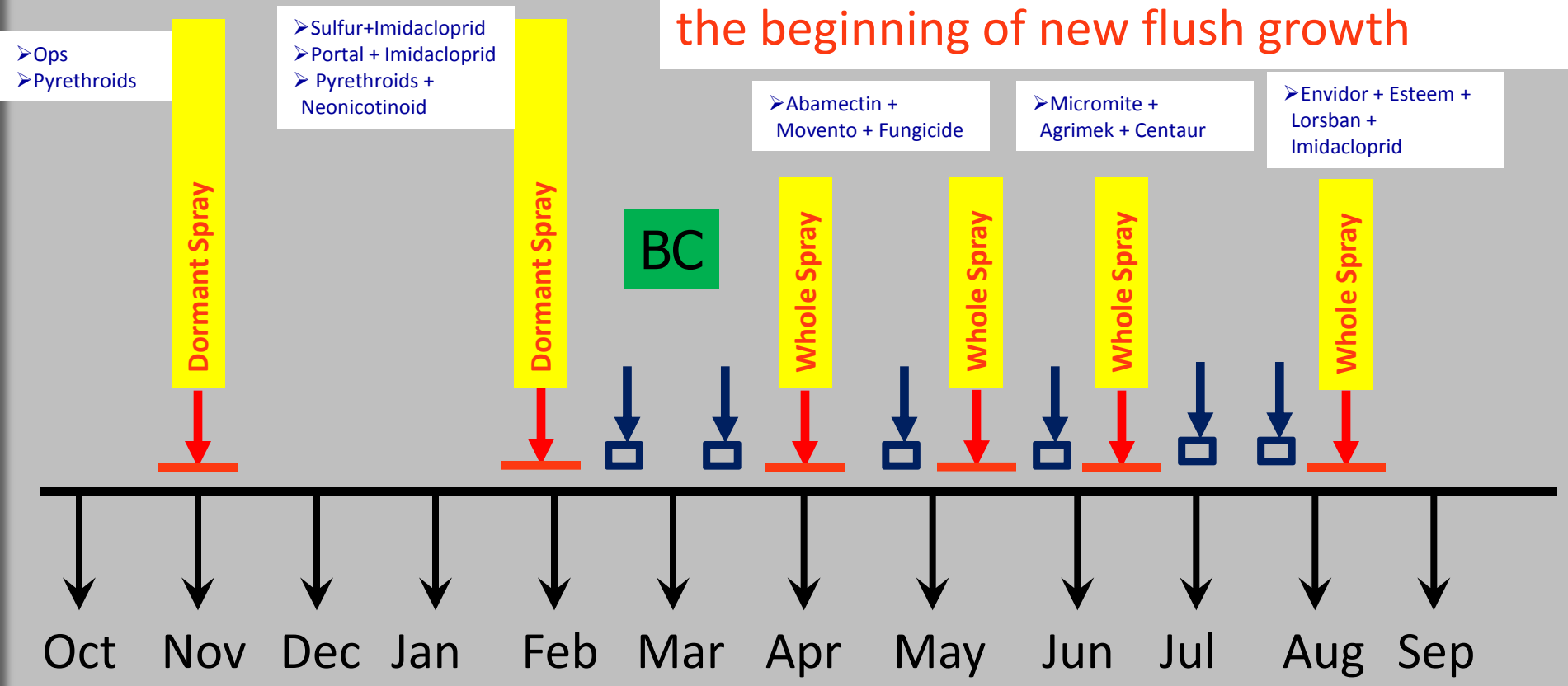
Area-wide Integrated Management System (AIMS) for ACP in Texas

- Program is made of **two coordinated and ACP-targeted dormant sprays in fall and winter** (November and January-February)
- **Multi-pest control** approach during active growing season (March-October)
- **AIMS implemented in commercial groves**, but since 2011 a biological control program with *T. radiata* in ongoing in residential areas and abandoned groves (courtesy of APHIS-PPQ)
- **Inoculative biocontrol for other pests** (scale insects, mealybugs, blackfly…)

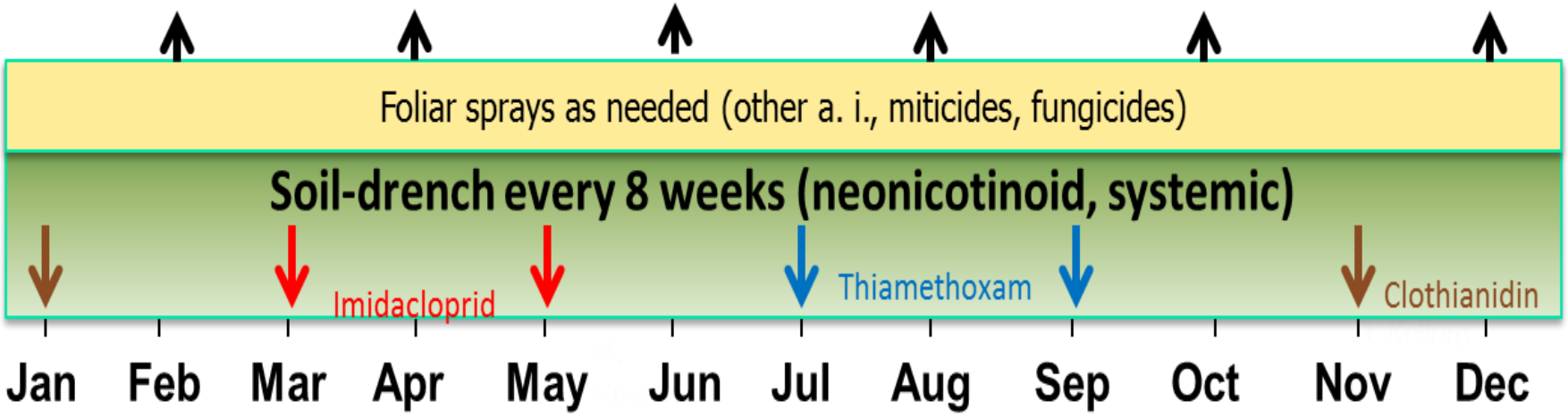
Suggested Treatment for Mature Groves

Coordinated dormant sprays

Psyllid control needs to continue during the growing season specially before or at the beginning of new flush growth



Suggested Treatment for pest control in Young plantings



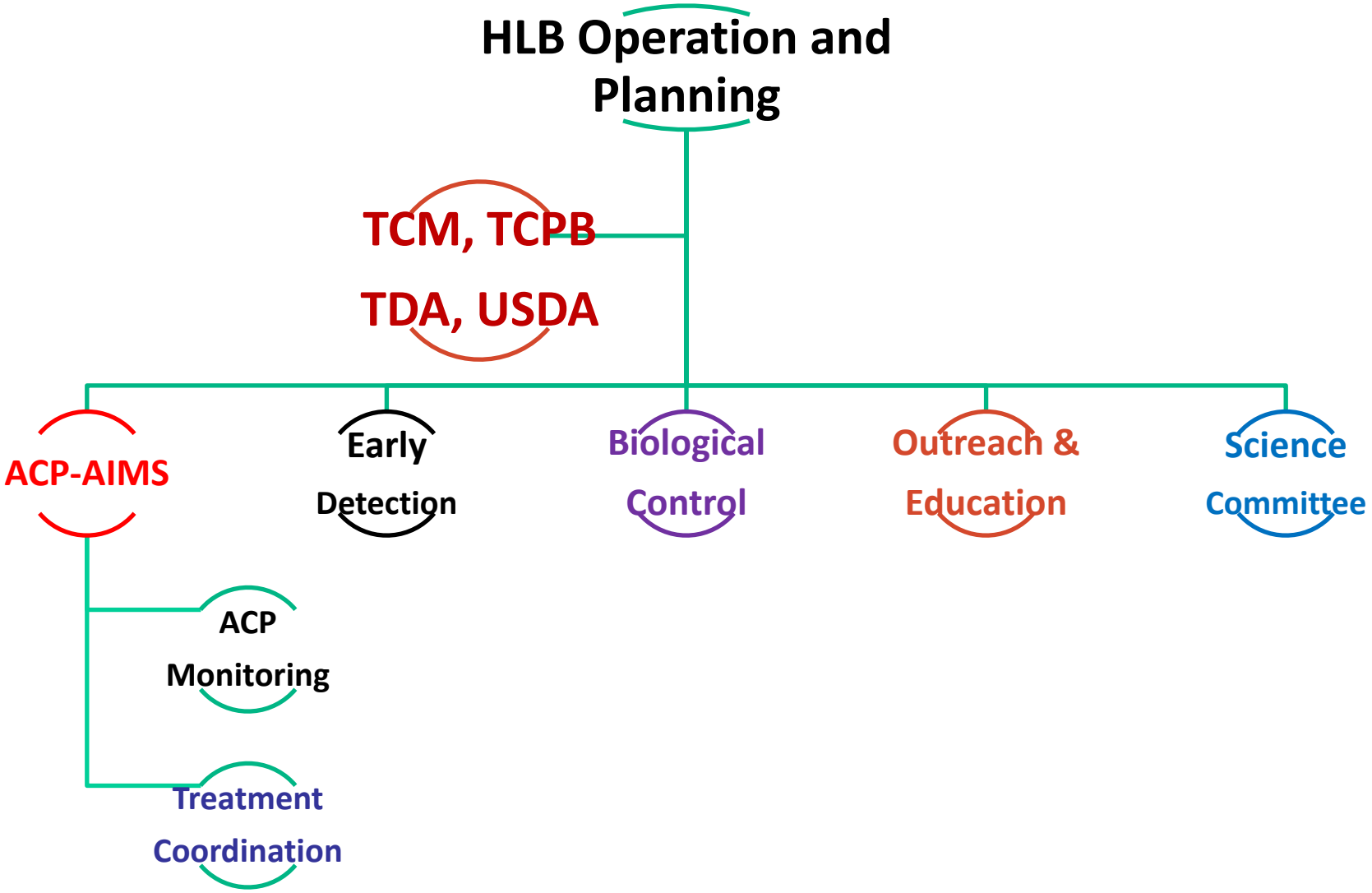
Suggested season long treatment program for AWM of ACP

Type of Spray	Timing	Method	Target site	Application method	Recommended insecticides
Fall dormant spray	Early November	Areawide coordinated sprays	Whole orchards	▪ Aerial ▪ Ground full or reduced volume ▪ Low volume	Danitol Mustang Leverage Baythroid Malathion Lorsban Imidan
Winter dormant spray	Mid-Jan to mid-Feb	Areawide coordinated sprays	Whole orchards	▪ Aerial ▪ Ground full or reduced volume ▪ Low volume	Danitol Mustang Leverage Baythroid Movento Provado Actara
Active growing season	Just before major flush cycle (Jun & Sep)	Per grove based on tree phenology and monitoring	Whole orchard	▪ Ground full or reduced volume	Danitol Mustang Leverage Baythroid Movento Provado Actara Imidan
Active growing season	Anytime	Per grove basis and monitoring	▪ Perimeter sprays	▪ Ground full or reduced volume	Danitol, Mustang, Leverage, Baythroid, Movento, Provado, Actara, Imidan Sevin, Lorsban

Implementation of AIMS for ACP in Texas

- Grower education during meetings held in October, January, and March every year
  - ✓ Just before coordinated sprays
- Outreach during growing season (to answer growers' queries)
- Frequent contacts with growers (SMS to deliver critical messages)
- Psyllid monitoring in groves as service provided to growers free of charge
- Practical recommendation on choice of pesticides (annual maximum limits, PHI, compatibilities , etc…)

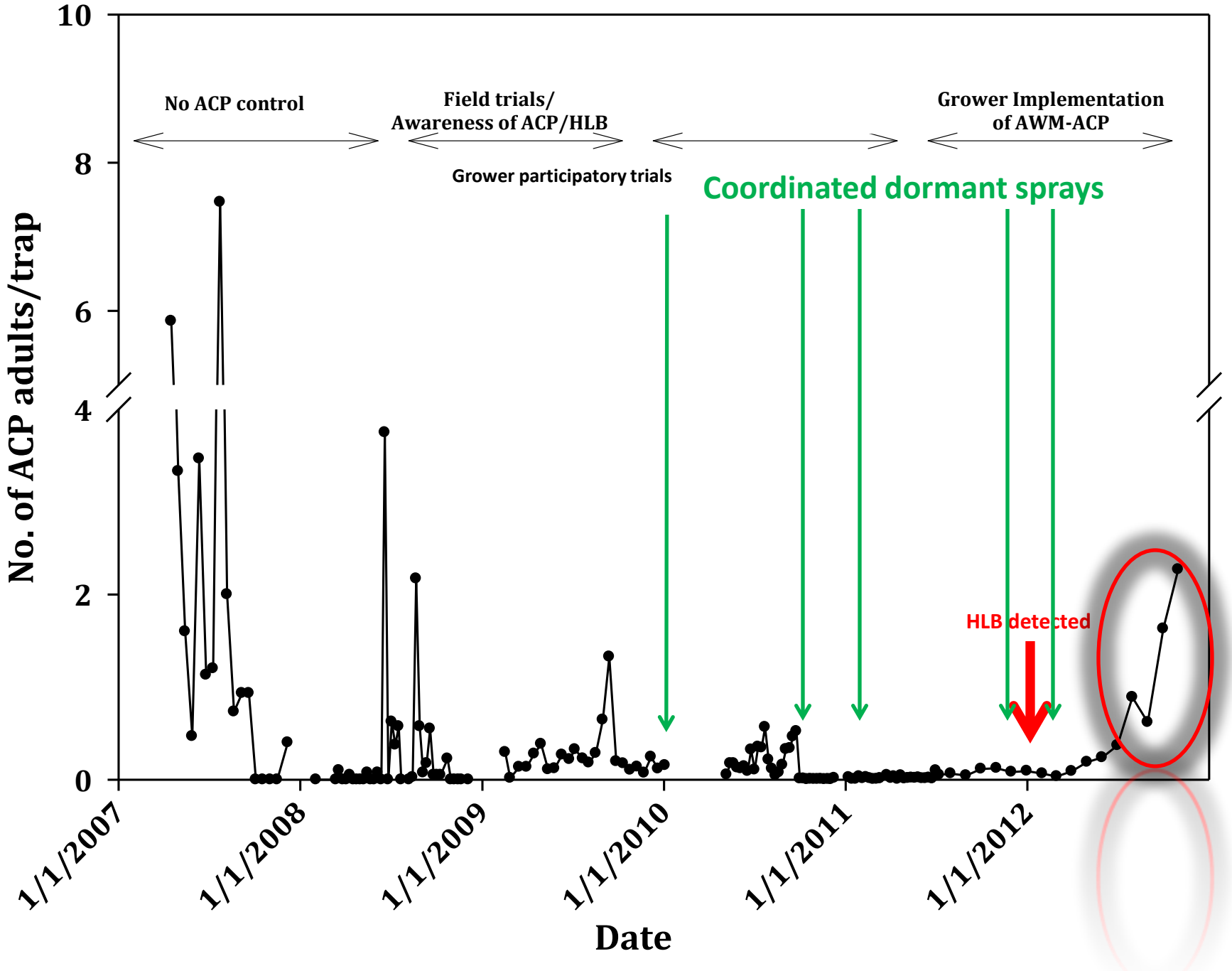
Organizational Chart for HLB mitigation



Implementation of AIMS by Growers

Spray Period	Acres sprayed	Percentage	Acreage covered at least once
Jan 2010	15,413	56.6%	**56.6%**
Nov 2010	22,859	84.0%	**85%**
Jan 2011	17,614	64.7%	
Nov 2011	16,899	**62.1%**	**81%**
Jan 2012	20,967	**80.0%**	
Nov 2012	22,700	**88.6%**	**87.1%**
Jan 2013	21,350	**83.3%**	

AIMS ACHIEVEMENTS



Implementation of AIMS by Growers

- Psyllid AWM program has been largely adopted by growers
- Launched in January 2010, has produced some benefits
- Reduction of ACP populations with time (2010-2012)
- The seemingly rise observed in 2013 is due in part to the change of sampling methods: **Only perimeter trees are now sampled**
  - **That creates a sense of urgency at grower level**

Challenges to the Implementation of ACP-AIMS in Texas

- ✓ **Coordinated efforts among growers**
  - ➢ New concept, thus not always easy to implement
- ✓ **Costs of control**
  - ➢ ACP control increases production costs
- ✓ **Lack of obvious and immediate "benefits" ($100-$200 more per acre per year)**
  - ➢ Not a direct pest (disease vector)
- ✓ **Residential citrus, abandoned groves where no management takes place are always source of psyllids**
  - ➢ Candidates for biocontrol and microbial control

Interface Between Residential Citrus and Commercial Grove

Weslaco, TX.

Interface Between Residential Citrus and Commercial Grove

Interface Between Residential Citrus and Commercial Groves

Source or Sink?
Role of residential citrus in ACP population dynamics

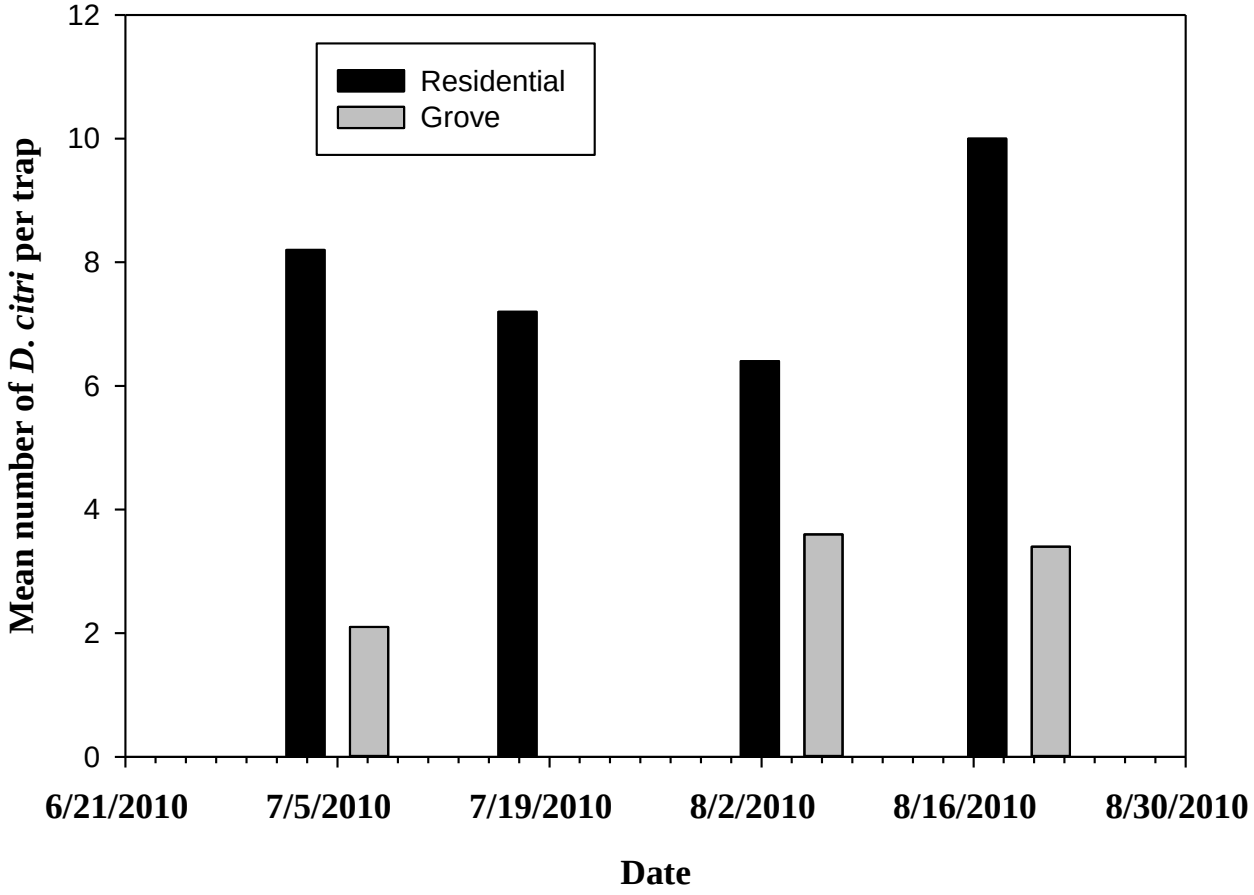
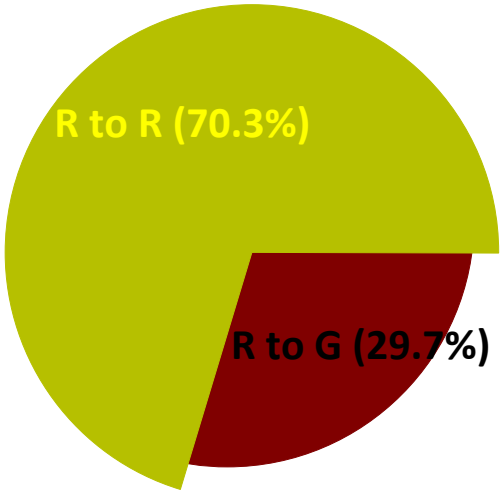


Figure : Trap catches of *D. citri* in residential and commercial citrus located within the same vicinity (in grove mean of 7 traps, and in residential means of 5 traps; traps deployed for 2 weeks)

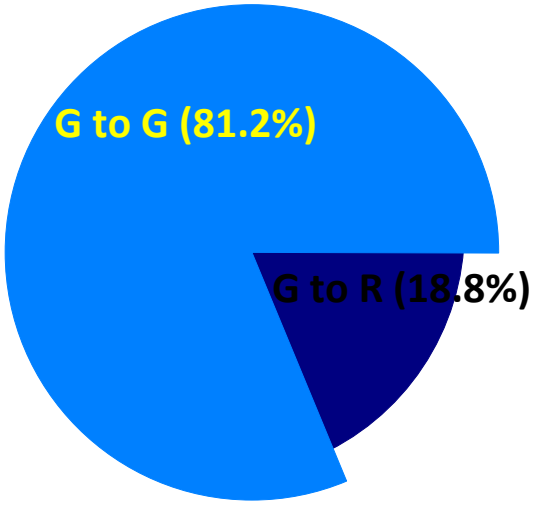
Source or Sink?

Residential citrus mostly source of ACP for groves

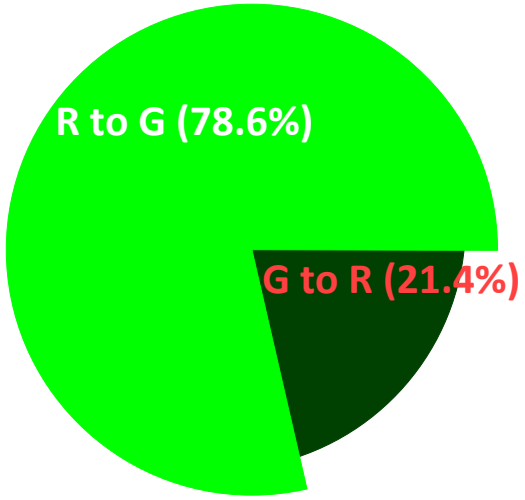
- ✓ Adult psyllids are highly mobile
  - ➢ Frequent movement of ACP between different habitats
  - ➢ Mark-release-recapture studies (Fluorescent dust):



Released in Dooryards



Released in Groves



Relative Exchange

Challenges to the Implementation of ACP-AIMS in Texas

- **Problems associated with AWM program**
  - Resurgence of 'secondary pests', mites and sucking pests (mealybugs, scale insects) can be due to AWM
  - Problem is real, but mostly due to the type of insecticides used. Minimize broad spectrum insecticides during active growing season
    - **Pyrethroids** (Danitol, Baythoid, Mustang) kill many natural enemies leading to sucking pest outbreaks
    - **OP** (Chlorpyrifos, Dimethoate) and **carbamates** may increase spider mite problems (TCM, CRdM, TSM, SSM)

Challenges to the Implementation of ACP-AIMS in Texas

- **Problems associated with AWM program**
  - *Broad spectrum pesticides are often cheaper, then growers tend to constantly use them.*
  - *But the cheapest pesticide does not always provide the cheapest pest control in citrus*
  - Prudent choice of pesticides (use softer chemicals as much as you can during active growing season)

Challenges to the Implementation of ACP-AIMS in Texas

- **Drought**
  - Trees are water stressed, once irrigated they produce profuse flush shoots leading to ACP infestations
  - Drought has led to lack of synchrony of flush cycles
  - Mild winter, no true dormancy observed, hence psyllid reproduction started earlier than expected

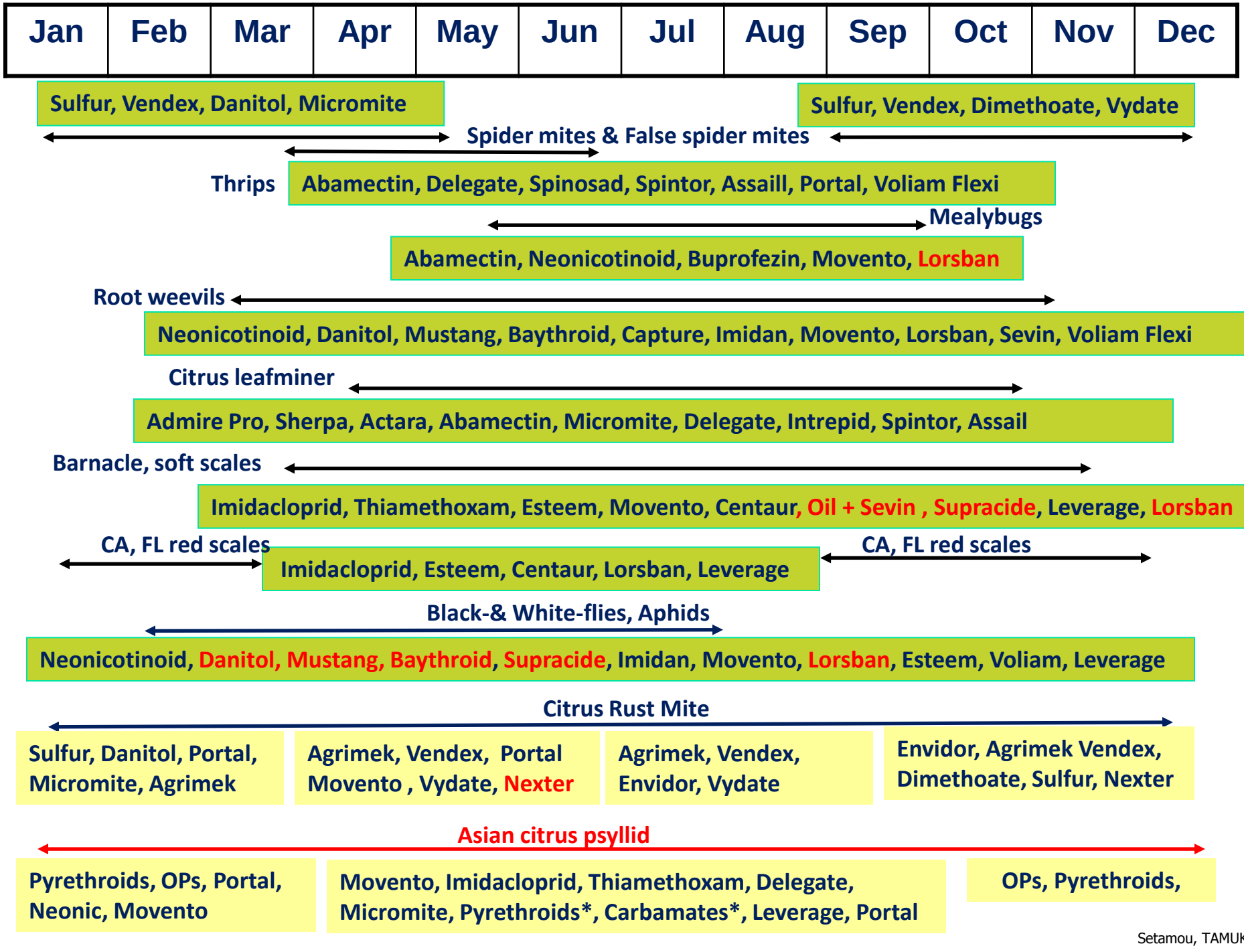
Future outlook of ACP-AIMS in Texas

- Growers must make it their own program: **Of the grower, by the grower and for the grower.**
- Collaboration between different stakeholders (growers, state and federal agencies)
- Voluntary program, but growers' participation is necessary for success
- Effort MUST be sustained; not a one time deal!
- ACP and HLB management requires working together

Development of a multipest control approach

Think more in terms of a system approach while implementing AIMS of psyllid by conducting a multi-pest control (specifically during the active growing season)

- What pest(s) can you flare up with the chemical selected for psyllid control?
- Minimize **secondary pest outbreaks** by wisely selecting your pesticide



Setamou, TAMUKCC

Development of a multipest control approach

Ensure good coverage of trees with spray mixes

- Poor spray coverage is generally a problem in citrus pest control

New sprayer head as add-on to airblast sprayer

THANK YOU!

QUESTIONS??