

# Experiences in the detection of citrus canker and citrus greening in Florida, USA

Holly L. Chamberlain

Pest & Disease Management, LLC

Owner, Manager

# PDM, LLC

- The mission of Pest & Disease Management, LLC is to provide timely and accurate information on pest and disease incidence to citrus growers enabling them to make sound production decisions based on quantitative information versus qualitative.



# Company Profile: 2007

- Personnel & Equipment
  - Started with 8 employees
  - 4 Kubota RTVs
  - 1 platform truck
- Work days: 228
- Acres : 24K
  - (105 acres / day)







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# Company Profile: 2008



- Personnel & Equipment
  - 37 employees
  - 8 UTVs
  - 3 platforms



- Work days: 245
- Acres: 49K
  - (200 acres / day)

# Company Profile: 2009

- Personnel & Equipment
  - 42 employees
  - 4 platform trucks
  - 8 UTVs
- Acres: ~ 60K
  - (245 acres / day)





# Cost of Surveying

- Labor (60% cost of survey)
  - Minimum wage increase recently
- Equipment
- Office expense
  
- Range between (\$21.00 – 35.00 / acre)
- Published internal cost for one company (\$27.50 / acre)

# Equipment

- No equipment: WALK
- Mounted platforms
  - Tractor
  - Truck
  - Other
- Utility type vehicles (UTVs)
  - Kubota
  - Gators





## Scouting Platforms

JEEP



## Scouting Platforms

Truck mounted platforms





## Scouting Platforms

Tractor mounted – 3 point hitch



## Scouting Equipment

John Deere Gator



# Other Equipment

- Computers
- Handheld GPS computers
- Flagging Tape
- Markers
- Sample bags



# Training

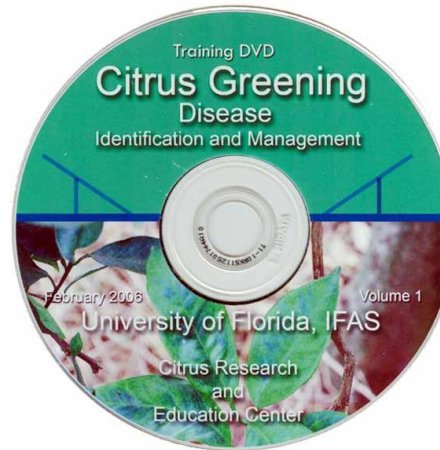
- Classroom
  - DVDs
  - Laminated Handouts
  - Field Notebook
  - ID cards
  - Posters
  - Artificial branches







# Learning Tools



**UNIVERSITY OF FLORIDA, IFAS**  
EDUCACION SOBRE LA CANCROSIS DE LOS CITRICOS

**SINTOMAS DE LA CANCROSIS:**

- Lesiones carnecillas elevadas (ambos lados de la hoja) con bordes húmedos y halo amarillo
- Defoliación, manchas y caída prematura de frutos

**¿COMO SE DISEMINA?**

- Lluvia y viento
- Equipos contaminados
- Traslado de plantas infectadas o expuestas y de partes de las mismas

**¡PREVENGA LA DISEMINACION!**

- Desinfecte al personal y equipos con productos aprobados
- No traslade plantas infectadas o sus partes
- Evite contactos innecesarios con cítricos, sobre todo si están húmedos

NO tome muestras de plantas sospechosas debido al riesgo de aumentar la diseminación de la cancrrosis. Si Ud. sospecha que sus árboles tienen la cancrrosis, llame a la línea telefónica de ayuda de su área para más información

Condados de Miami-Dade/Broward/Palm Beach/Monroe  
llame al (800) 850-3781  
Otros condados, llame al (800) 282-5253

Citrus Research and Education Center  
Lake Alfred (883) 888-1181, www.ifas.ufl.edu  
Indian River Research and Education Center,  
P.O. Box 1770, 888-3282, www.ifas.ufl.edu  
Southwest Florida Research and Education Center,  
Hemmelen (239) 480-3400, www.ifas.ufl.edu

Información Adicional:  
canker.ifas.ufl.edu  
www.ifas.ufl.edu/extension  
Productos Químicos Aprobados para  
Descontaminación:  
www.ifas.ufl.edu/extension/extension.ufl.edu

Practice SAFE CITRUS



JAN 25 2007

**Citrus Canker Self-Survey Training**  
University of Florida, IFAS

Florida Department of Agriculture & Consumer Services, CCEP  
FDACS, Division of Plant Industry  
USDA, APHIS, PPO  
Citrus Industry

H.L. Chamberlain, UFIFAS

UNIVERSITY OF FLORIDA IFAS

University of Florida  
Citrus Research and Education Center Training DVD

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# Training

- Field
  - Manager training / supervised learning
    - 1st week
  - Field supervisor training
    - 1-2 weeks
    - Back seat in UTVs
  - Senior scouts
    - 90 day probation
    - In general, 3-4 months for inspector to REALLY learn disease (depends on exposure)





# Competitions and Incentives

## IRCS 2008 & 2009 Champions



## Employee Recognition



# Flagging

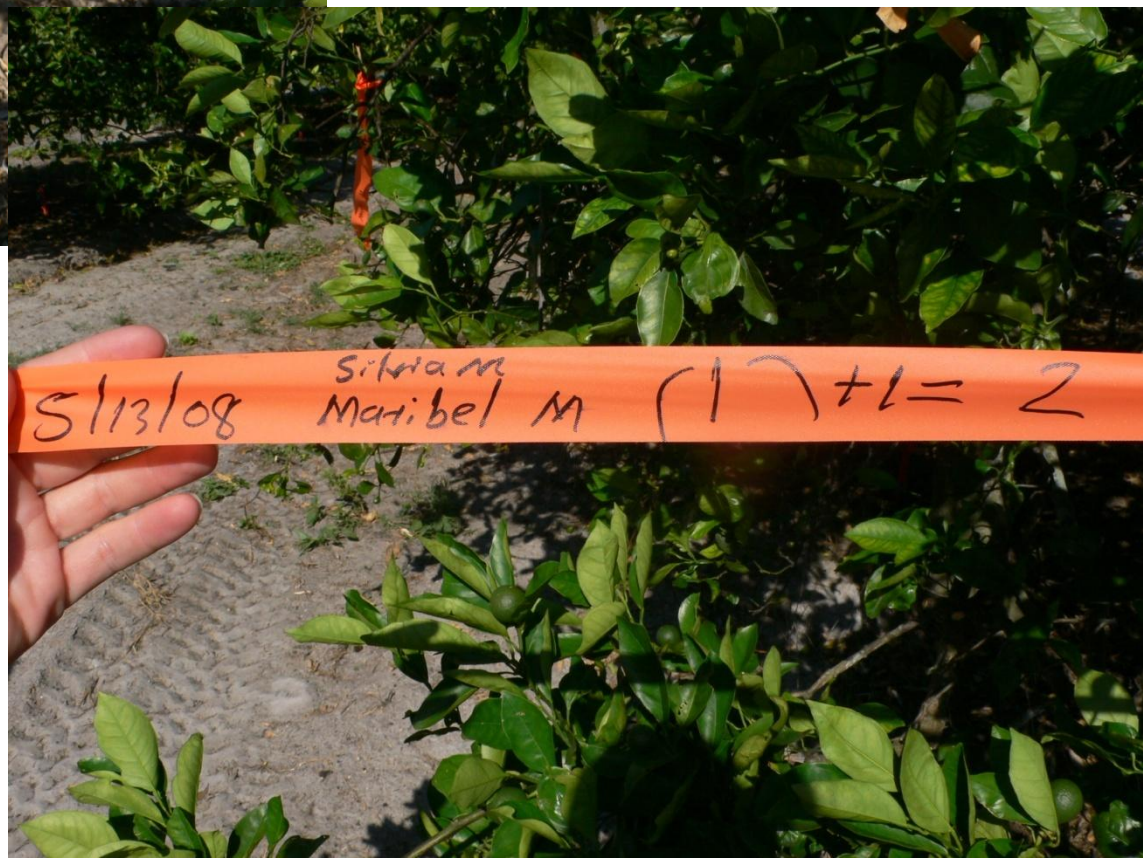


- Block completion sheet
- 2 color system
  - SUSPECT
  - VISUAL CONFIRMED
- Both row ends
  - Total number in row
  - Date
  - Inspector names
- Both sides of the trees
  - Date
  - Inspector name





Visual confirmed tree,  
inspector name, date



Row end marked with date,  
inspectors, total row count









# Data Management

- Recording information is vital to success of program
- All visually confirmed / suspect trees GPS
- Inspector name & symptomology recorded as part of the GPS record
- Block completion sheets are also filled out
- Serveon Inc. software package
- iPAQ hardware
- User friendly
- Wireless data sync

# Grower Report

- Spreadsheet
  - Block name
  - Date of survey
  - HLB tree count
  - CC tree count
  - Sample count
- Map
  - HLB
  - CC
- Lab Results
  - Starch results
  - qPCR results

Blocks	Date Surveyed	Acres	HLB Suspect	HLB Visually Confirmed	Canke r	Sample s
Davis 1	6/17/2009	47.69	0	0	0	0
Davis 2	6/17/2009		0	0	0	0
Davis 3	6/17/2009		0	0	0	0
Davis 4	6/17/2009		0	2	0	2
Davis 5	6/17/2009		0	0	0	0
Davis 6	6/17/2009		0	0	0	0
Davis 7	6/17/2009		0	7	0	7
Whitehurst A	6/17/2009	108.98	0	0	0	0
Whitehurst B	6/16/2009		0	4	1	4
Whitehurst C	6/17/2009		0	2	56	2
Skipper South - A	6/18/2009	93.6	0	1	0	
Skipper South - B	6/18/2009		0	2	0	2
Skipper A.M	6/18/2009		0	0	0	0
Skipper B.M	6/18/2009		0	5	0	5
Skipper A N	6/18/2009		0	2	1	2
Skipper B. N	6/18/2009		0	2	0	2
<b>TOTALS</b>		<b>250.27</b>	<b>0</b>	<b>27</b>	<b>58</b>	<b>26</b>

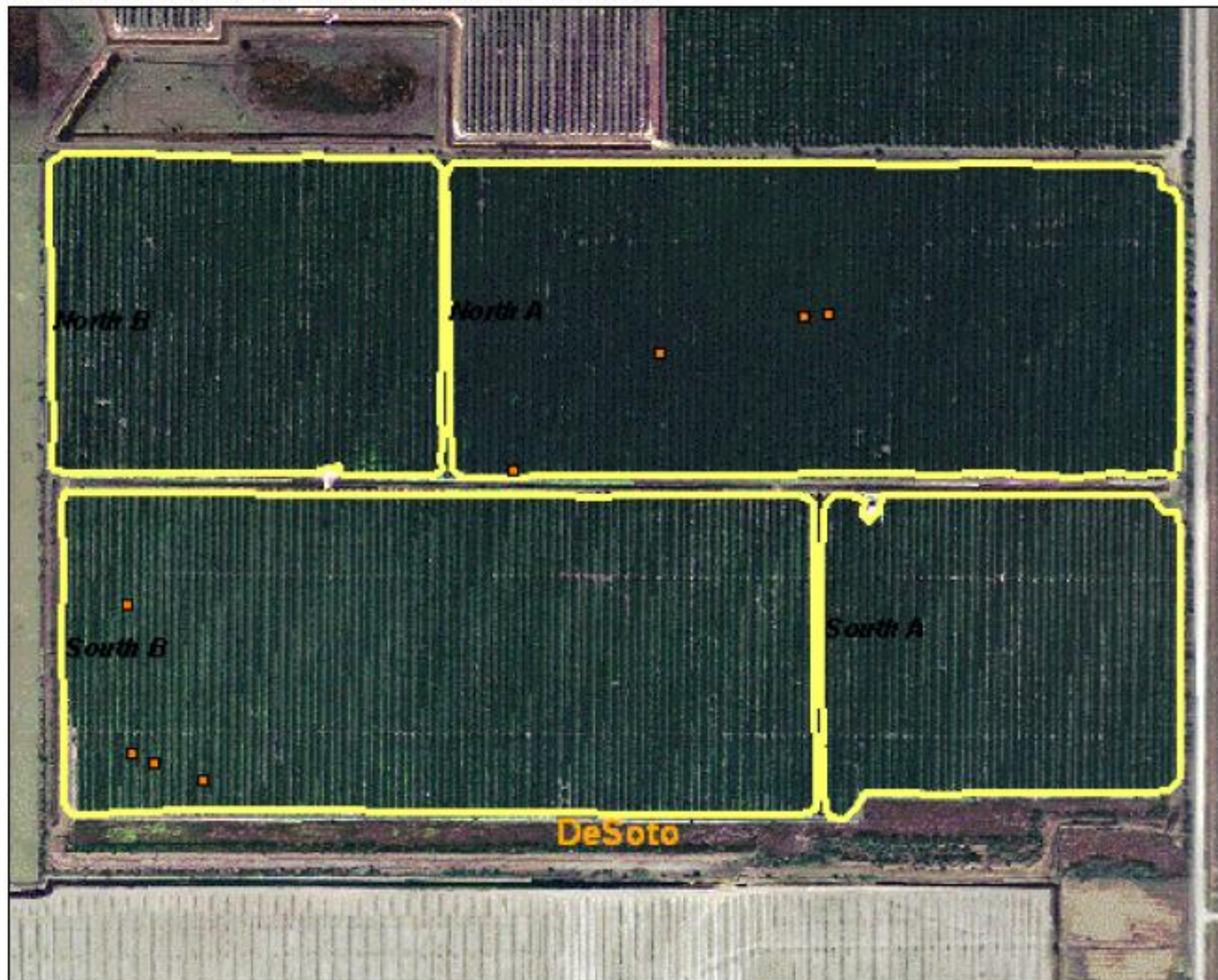


**Measurement Prevalence Map**(Please use 'Landscape' setup for print)





**Measurement Prevalence Map**(Please use 'Landscape' setup for print)



Citrus Greening  
Visually Confirmed

BARBEN GROUP  
TRICOUNTY GROVE

JANUARY 2009

HLB TREE COUNT:  
NORTH YOUNG: 4  
SOUTH YOUNG: 4  
TOTAL: 8

\*DATA POINTS ARE  
NOT TO SCALE

\*CANKER PRESENT  
IN GROVE

# HLB Testing Report

Premier Sunray  
Hwy 70  
Lake Placid  
Highlands County

Fax: 863-465-7301  
Email: hlchamberlain@embarqmail.com

☐ Assay Date Range:  
☒ 7/27/2009 to 7/27/2009

Diagnosis	HLB Positive		CT		Local Id:	Lab Id	Collected	Received	Assayed	Sample submitted by:
Block	Row	Tree								
B2N	1	6	21.34		0714091203915	97098	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	1	11	23.44		0714091203916	97097	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	2	14	20.51		0714091203917	97096	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	2	18	22.86		0714091203918	97095	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	3	2	21.68		0714091203919	97094	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	3	6	21.13		0714091203920	97093	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	4	8	20.97		0714091203921	97092	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	4	12	20.65		0714091203922	97091	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	5	4	23.11		0714091203923	97090	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	6	6	22.32		0714091203924	97089	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	7	18	20.45		0714091203925	97088	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	8	19	21.04		0714091203926	97087	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	9	1	17.58		0714091203927	97086	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	10	2	22.50		0714091203928	97085	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	10	3	23.69		0714091203929	97084	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	11	1	22.13		0714091203930	97083	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	11	2	19.94		0714091203931	97082	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	12	6	20.59		0714091203932	97081	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	14	2	23.70		0714091203933	97080	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2N	14	13	19.99		0714091203934	97079	7/14/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2S	1	6	19.69		0715091204674	97078	7/15/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2S	1	12	21.47		0715091204675	97077	7/15/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2S	2	6	20.47		0715091204676	97076	7/15/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2S	2	14	20.80		0715091204677	97075	7/15/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2S	3	14	19.97		0715091204678	97074	7/15/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2S	5	2	24.47		0715091204679	97073	7/15/2009	7/17/2009	7/27/2009	Holly Chamberlain
B2S	5	14	23.65		0715091204680	97072	7/15/2009	7/17/2009	7/27/2009	Holly Chamberlain

B3S	3	9	21.12	0713091203574	97036	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	4	1	22.01	0713091203575	97035	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	5	1	22.17	0713091203576	97034	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	5	3	22.54	0713091203577	97033	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	6	1	23.57	0713091203578	97032	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	6	3	24.06	0713091203579	97031	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	7	3	23.26	0713091203580	97030	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	7	4	22.28	0713091203581	97029	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	7	6	23.26	0713091203582	97028	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	8	6	26.18	0713091203583	97027	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	8	8	28.06	0713091203584	97026	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	8	9	23.02	0713091203585	97025	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	9	6	20.75	0713091203586	97024	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	9	8	21.13	0713091203587	97023	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	10	4	23.47	0713091203588	97022	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	10	5	22.80	0713091203589	97021	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	11	4	22.19	0713091203590	97020	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain
B3S	11	5	22.22	0713091203591	97019	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain

# Diagnosis

## No HLB Found

Block	Row	Tree	CT	Local Id:	Lab Id	Collected	Received	Assayed	Sample submitted by:
B3N	14	8	32.03	0713091203571	97039	7/13/2009	7/17/2009	7/27/2009	Holly Chamberlain

Number Positive	79	Number Questionable	0	Total samples	80	Total Positive (+ and questionable)	98.8%
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# Grove Conditions

- General grove care
- Tree age
- Mixed versus solid planting
- Knowledge of surrounding groves and area
- Grower spray programs
- Time of year
- Ridge versus Flatwoods
- Hedged or not hedged

# Grove Condition

**Mowed**



**Not Mowed**





# Grove Conditions





# Grove Condition

## **Mature Trees**

- Require platforms for scouting
- Necessary to see down in the tree

## **Young Trees**

- Depending on spacing, should walk
- Should also be aware of psyllid pressure

# Grove Condition

**Uniform Stands**



**Mixed Age Stands**



# Grove Condition

- Grove Health
- Spray Programs
  - REIs
  - Inspector safety is paramount
- Both affect psyllid pressure and also ability to detect HLB



# Season 2009

- Significant cold events  
(Jan – Feb)
- Extreme drought  
periods (April)
- Bloom (Feb – March)
- Flush (May – July)



# Identification and Detection

- Symptoms difficult
- Symptoms often resemble nutrient deficiencies or other problems
- Confirmation by PCR is necessary until proven track record or special cases
- Iodine starch test – cheap alternative



# Symptoms

- Leaf chlorosis, yellow shoots
- Early symptoms usually appear on one sector or branch of the tree
- Blotchy mottle or variegated type of chlorosis
- Defoliation and premature fruit drop
- Small upright leaves, new leaves developed after defoliation will be small and slender “rabbit ears” with symptoms resembling zinc deficiency
- Fruit are small, low quality, often lopsided, may not color properly, seed abortion occurs





# Turn the leaf over!



**Mottle fades through to the underside**

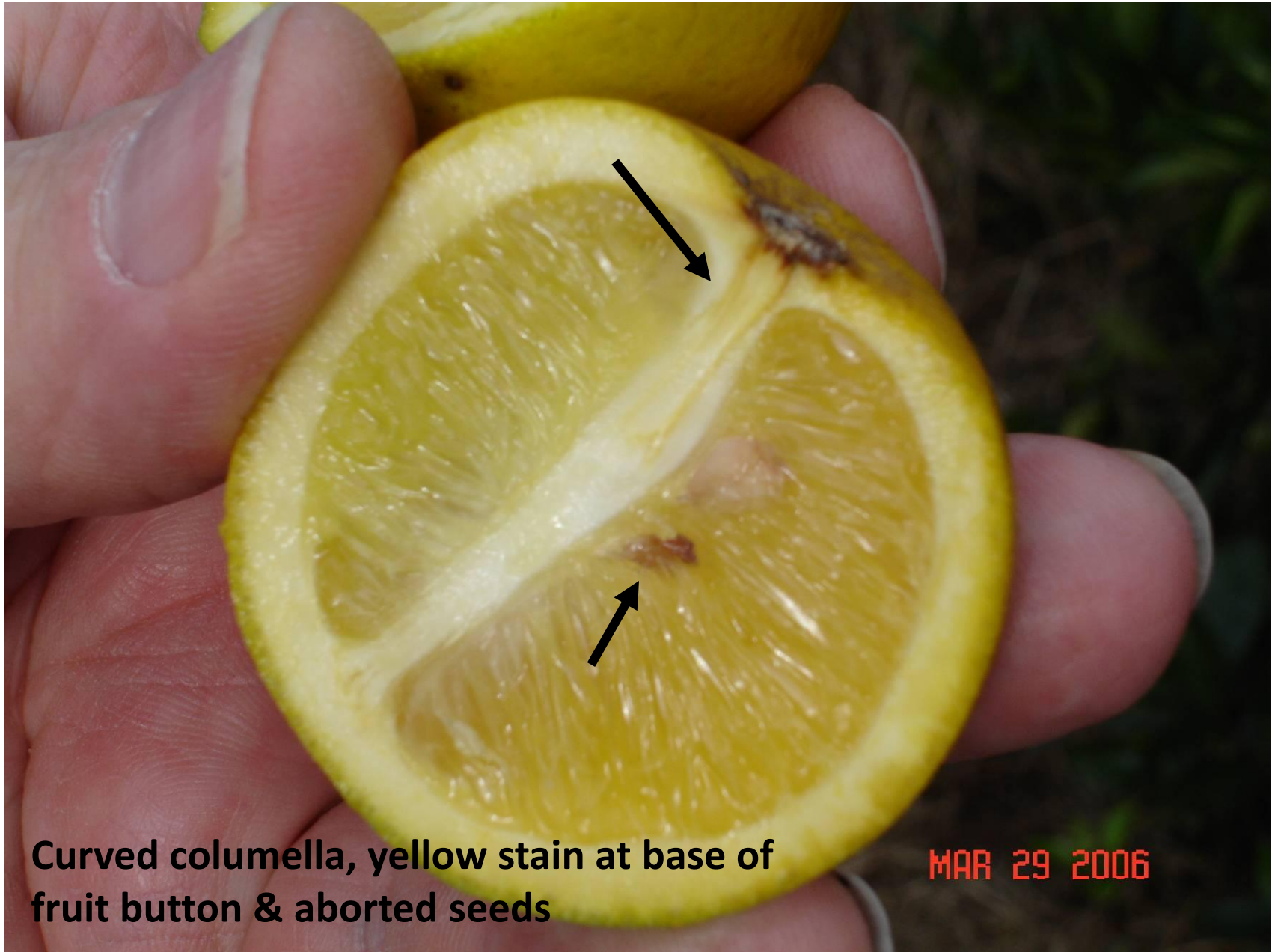


# Citrus Greening Leaf Symptoms





# Citrus Greening Fruit Symptoms



Curved columella, yellow stain at base of  
fruit button & aborted seeds

MAR 29 2006



# Citrus Problems:

## *NOT* Citrus Greening





# Citrus Problems: *NOT* Citrus Greening





# Psyllid Identification





# Insect Vector: Asian Citrus Psyllid

## Nymphs



**New leaf distortion (high psyllid populations)**

# Iodine Starch Test



# Iodine Starch Test





# Greening Trends

- Proximity to water
- Tree age (vigor)
- General grove health (grove management)
- Geographic location
- Seasonality



## **Greening Trends**

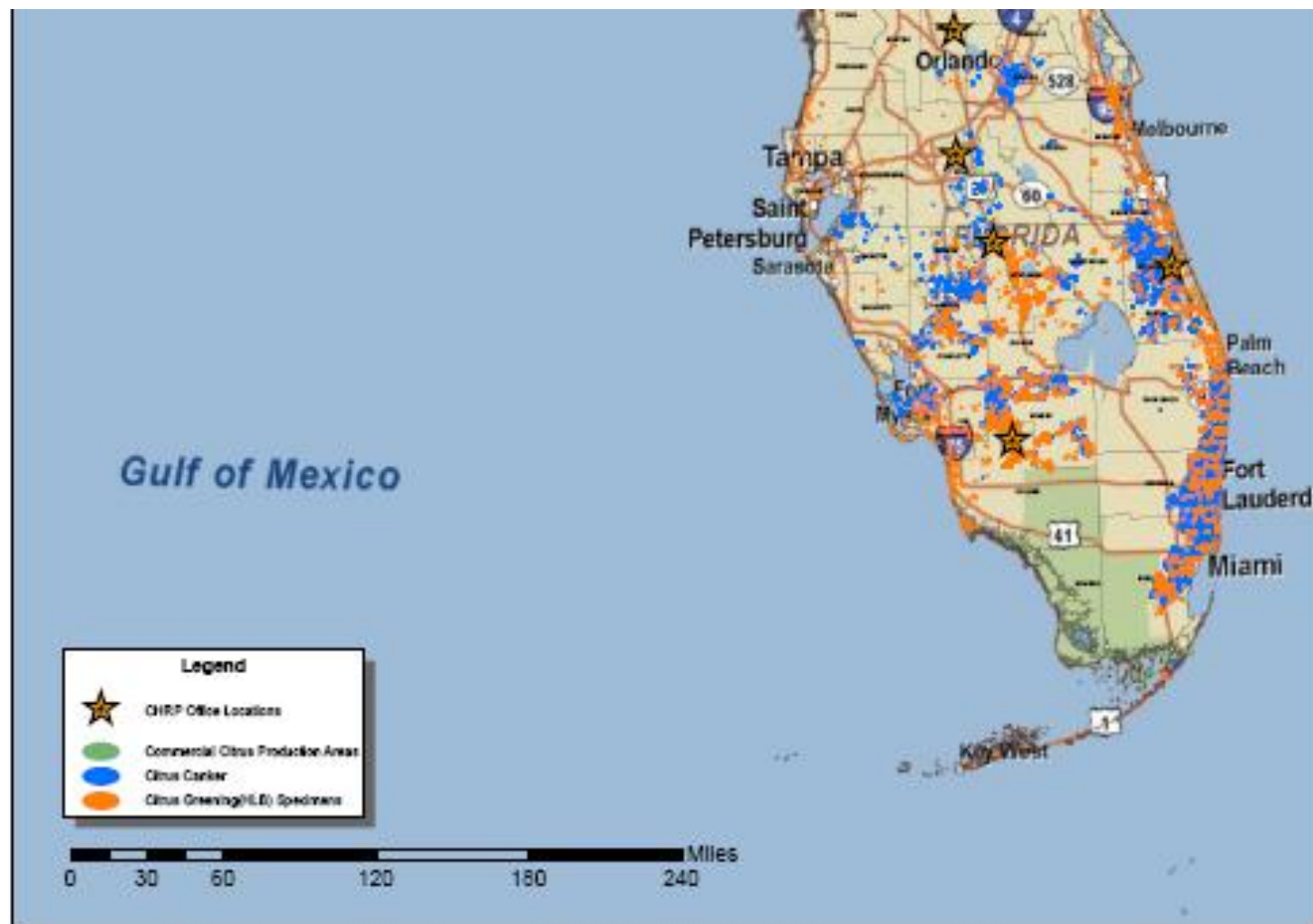
Proximity to water



## Greening Trends

Tree age (Vigor)





## Greening Trends

Geographic location



## **Greening Trends**

Seasonality



# Tree Removal

- Method
- Timing
- Spray or not?

# Tree Removal

**LOADER**



**TREE CHOPPER**





# Tree Removal



# Tree Removal

- Timing
  - Harvest intervals
  - Equipment availability
  - Disease incidence
- Spray or not
  - Depends on timing





# Tree Removal





# Pitfalls of Survey Work

- Equipment maintenance
- Weather
- Wildlife
- Disease Incidence
- Abandoned groves



# Wildlife





# Wildlife



# Abandoned Groves

## Abandoned Grove Defined:

No commercial fruit harvest during last two seasons

No production care during the past two years, including weed control and mowing

Grove use transferred to other uses (pine or livestock)





# No Cure for HLB

- “Because no curative methods of HLB are available, control is preventive and largely based on inoculum elimination by removal of infected trees and chemical treatments against vectors. Strict quarantine measures must be implemented to impair further international spread of HLB agents and their vectors.” J.M. Bové

Maintain Low Incidence  
of HLB

**BASIC CONTROL STRATEGY**



# Greening Management

- Disease-free nursery stock
- Detection
- Removal of symptomatic trees
- Suppress psyllid populations

# How many times to survey per year?

- Goal: 4X / year
- Possibly more in 'hot spots'



# Universal Survey Advice...

- Learn what normal looks like for that particular citrus species or variety.
- Look for any abnormalities (i.e, excessive defoliation, yellowing) in the appearance.
- Practice good observation skills. Find ways that work for you to stay alert while you survey. Survey in teams for accountability.





# Universal Survey Advice...

- Whenever and wherever you encounter suspect symptom, mark the location. Contact your supervisor.
- DO NOT COLLECT SAMPLE!!
- Don't worry too much about overwhelming the diagnostic lab. Eventually you will learn the common syndromes and the need for sampling for common diseases may decrease.

45 samples

**Highlands**

Huanglongbing (HLB) Sample Submission Form

Submit: \_\_\_\_\_

► Date Sample Collected: 3/1/09 ► Date Sent: 3/12/09

► Submitter name: Holly L. Chamberlain Affiliation: Pest & Disease Mgmt., LLC

► Address: PO Box 1669, Avon Park, FL 33826  
300 East Cornell St., Avon Park, FL 33825

► City: Avon Park ► State: Florida ► Zipcode: 33826

Email address: HLChamberlain@embarqmail.com

Phone Number: (863) 990-7268 Fax Number: (863) 453-0564

► Results To Be Returned By: Mail ☐ Email ☒ Fax ☐

Grove/Nursery/Sample Information

► Grove/Nursery Name: Blk 2 / Hargrove / Perry Groves

► Address/Location Where Specimen Was Collected: SR 27

# Citrus Canker

- Learn canker, learn it fast
- Similar foliar and fruit diseases
- Variety
  - Not in depth, general differences
  - Oranges, Grapefruit, Tangerines
  - Early versus late oranges

# CANKER

- Inspection- to know where it is
- Decontamination- including internal, to prevent further spread
- Copper Sprays- as prophylactic or protective treatment





# CANKER MANAGEMENT

- Pruning to Remove Inoculum
  - Selective Pruning (removal of infected branches) –successful in mature Valencia trees
  - Severe Pruning (Buck Horning) – limited success, probably not economical
- Considering defoliation in limited areas
- Movement of equipment- internal decontamination zones!

# Citrus Canker Symptoms



# Case Study A: .21%

- 530 acre grove
- Midsweet and Hamlins
- Location: area of low incidence
- Number of Surveys: 6
- Tree Removal: Fast
- 1<sup>st</sup> Survey: 2 (May 2007)
- 2<sup>nd</sup> Survey: 12 (Sept 2007)
- 3<sup>rd</sup> Survey: 26 (Jul 08)
- 4<sup>th</sup> Survey: 48 (Nov 08)
- 5<sup>th</sup> Survey: 25 (Jan 09)
- 6<sup>th</sup> Survey: 18 (Apr 09)





# Case Study B: 11.75%

- 3600 acre grove
- Hamlin & Valencia
- Canker also present
- Location: south
- Tree Removal: did not remove trees at all, timely or effectively
- 1<sup>st</sup> Survey 2007: 1K
- 2<sup>nd</sup> Survey 2008: 11K
- 3<sup>rd</sup> Survey 2009: 37K



# Florida Citrus

- Complexion of the industry is changing
  - Disease incidence dictates grove management
- PDM, LLC client group are citrus growers who have been long time citrus growers and will be well into the future
- Cannot go part way with greening program...if you are going to battle greening, you have to implement all parts of the program
  - Scouting 3-4X / year
  - Pysllid suppression
  - Tree removal





