It Takes a Village to Manage Lygus: A Retrospective

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UC Statewide IPM Program

University of California
Agriculture and Natural Resources

UC IPM

Making a Difference for California

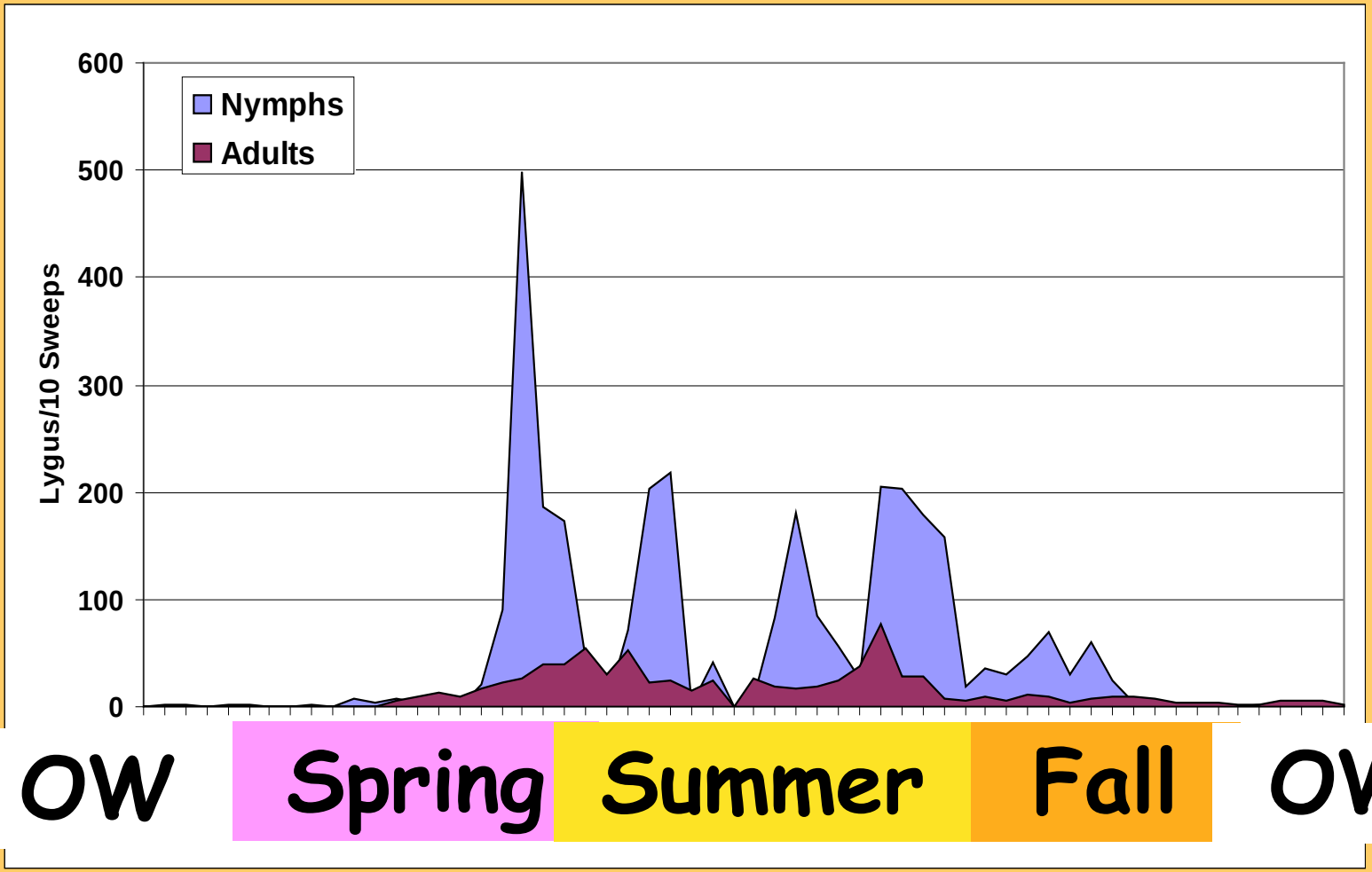
Overview

- Lygus as a pest
- On the shoulders of giants
- Forecasting annual outbreaks
- Lygus in the landscape
- Managing the farm for Lygus
- Getting the community engaged
- Future implications

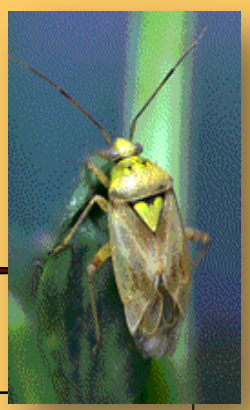
Biology

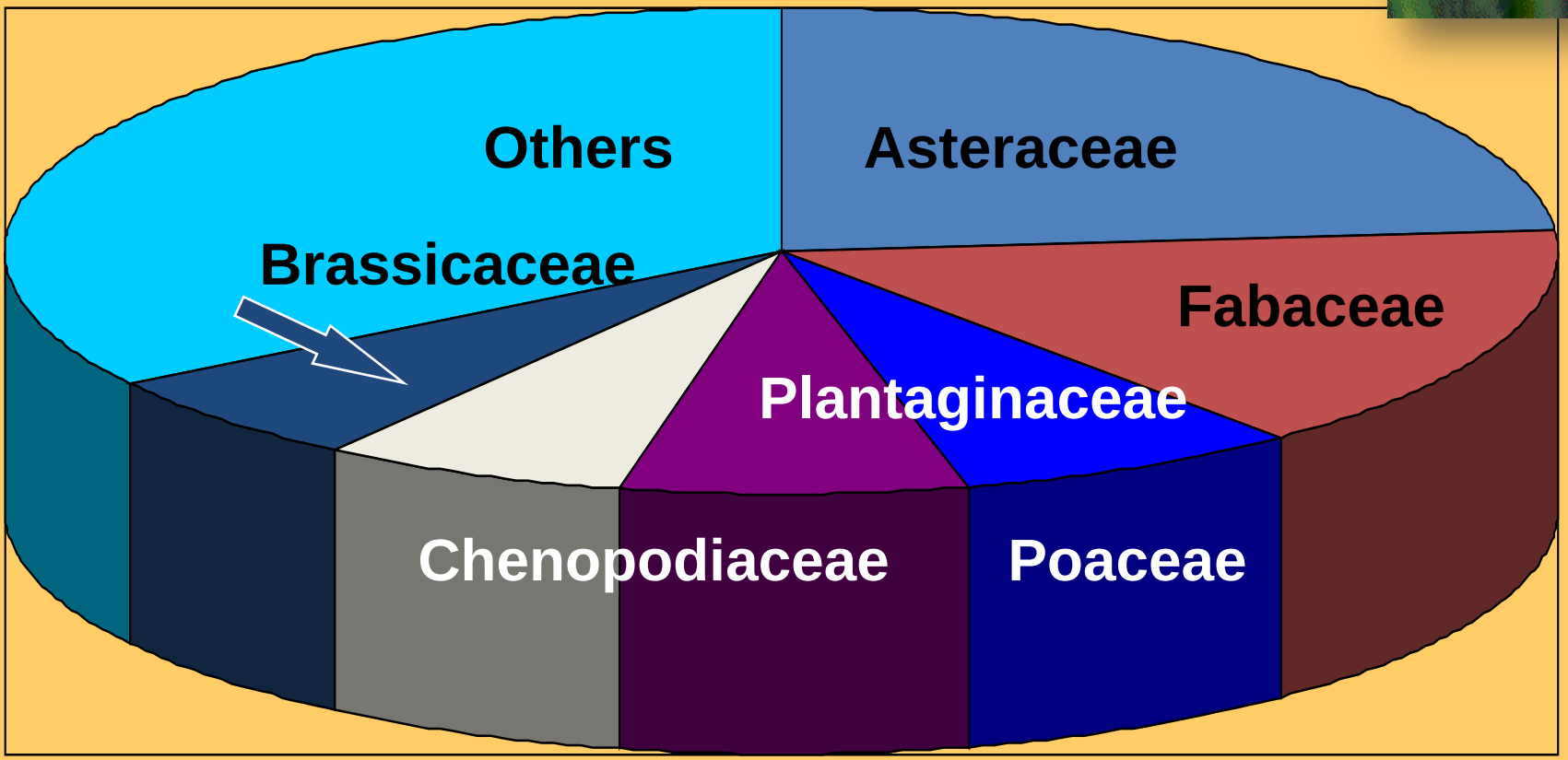
- Two species in SJV, *L. hesperus* & *L. elisus*
- Adults and immature can cause damage
- Newly winged adults need more time to development
- Native insect
- Wide host range
- Over winters as immature adults
- 5 Generations/yr
- 21 days per generation in summer

Lygus Population Densities Through a Year in Alfalfa Forage Field



L. hesperus Hosts





From: Scott, 1977

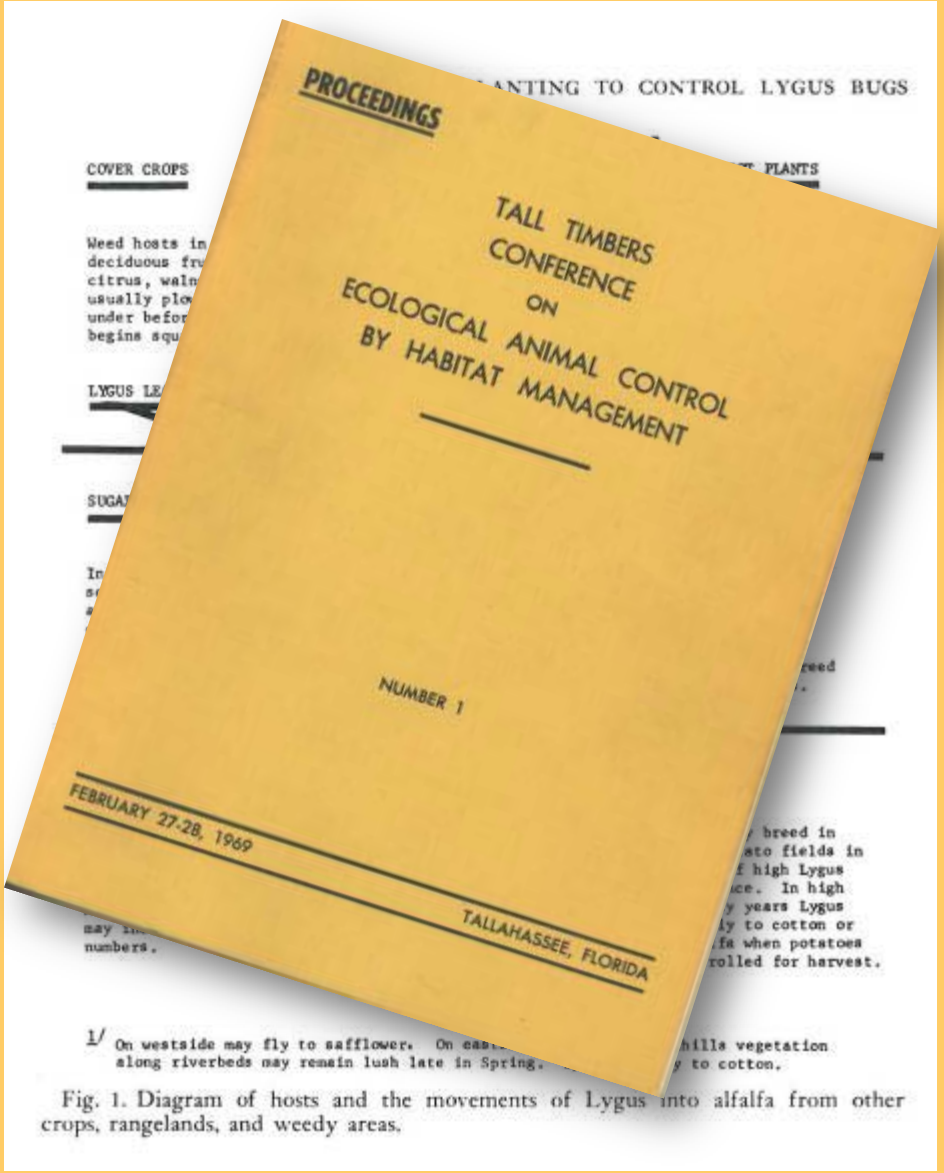
Pest Status Of Lygus

Crop	Pest Status
Alfalfa*	Non-Pest, sink/source
Safflower*	Non-pest, source
Cotton*	Pest, 2-10/50 sweeps
Pistachios	Pest, No threshold
Common beans	Pest, 1-2/sweep
Lima Beans	Pest, 1-1.5/sweep
Lettuce	Pest, No threshold
Strawberries	Pest, 1 per 10 plants
Apples & Pears	Pest, 1 dmg fruit/100
Blackeye Beans*	Pest, .5 – 1/sweep
Seed Alfalfa*	Pest, 4-10/sweep

Examples of Damage by Lygus to Cotton Key Pest, Especially During Early Fruiting

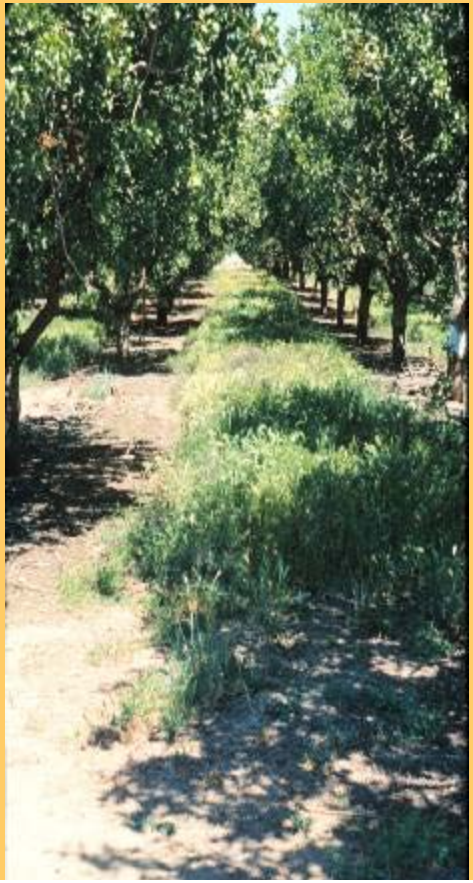
Contributions of Prof. Vern Stern, UCR

- Most cotton arthropod populations must re-build each year
- Populations must move into a field and it is the surrounding cropping environment that determines the degree of pest severity
- Some crops and weeds can act as a source or as a sink
- The landscape mosaic has both a spatial and temporal component
- The landscape can be manipulated



Landscape is a Mosaic of Crops, Weeds and Native Plants



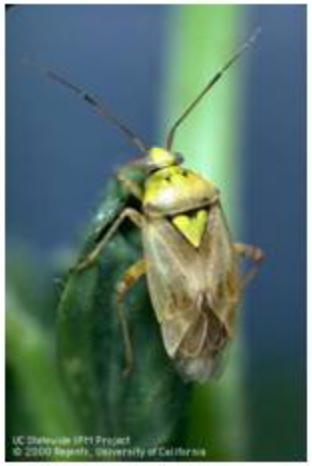



That Changes Through the Year

Spring Survey to Predict May Lygus Movement

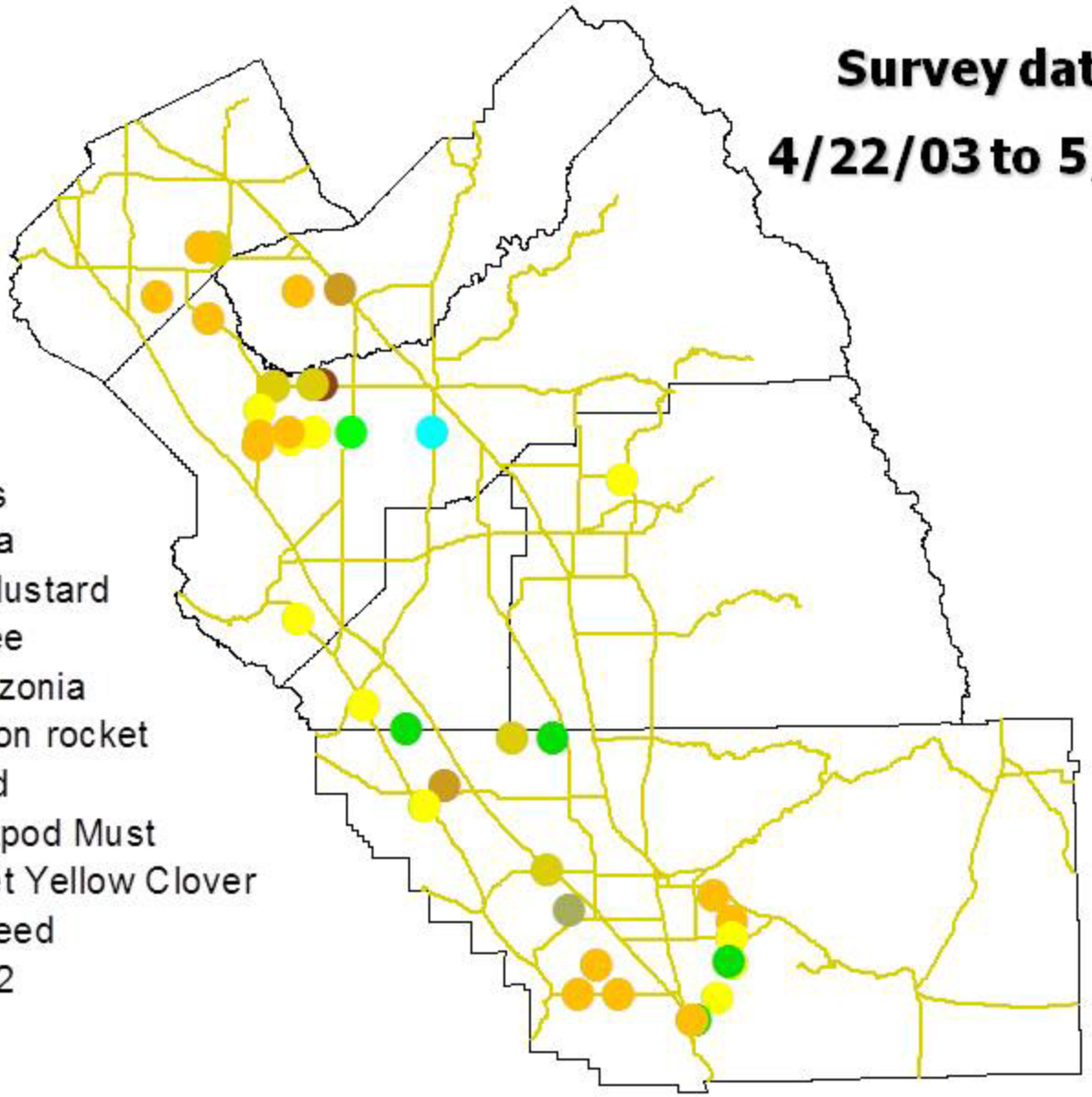
- After 1978 Great Lygus Disaster,
- Efforts were made to estimate potential population buildup and date of mass movement
- Westside foothill area surveyed for hosts and Lygus annually since 1981
- Is there enough time for Lygus to buildup and threaten SJV crops?
- Will the population move when cotton is at a sensitive stage?
- Survey & reporting has changed over time

Lygus Survey 2003

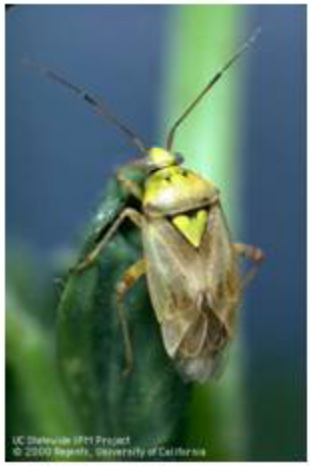


Survey dates:

4/22/03 to 5/9/03



Lygus Survey 2003



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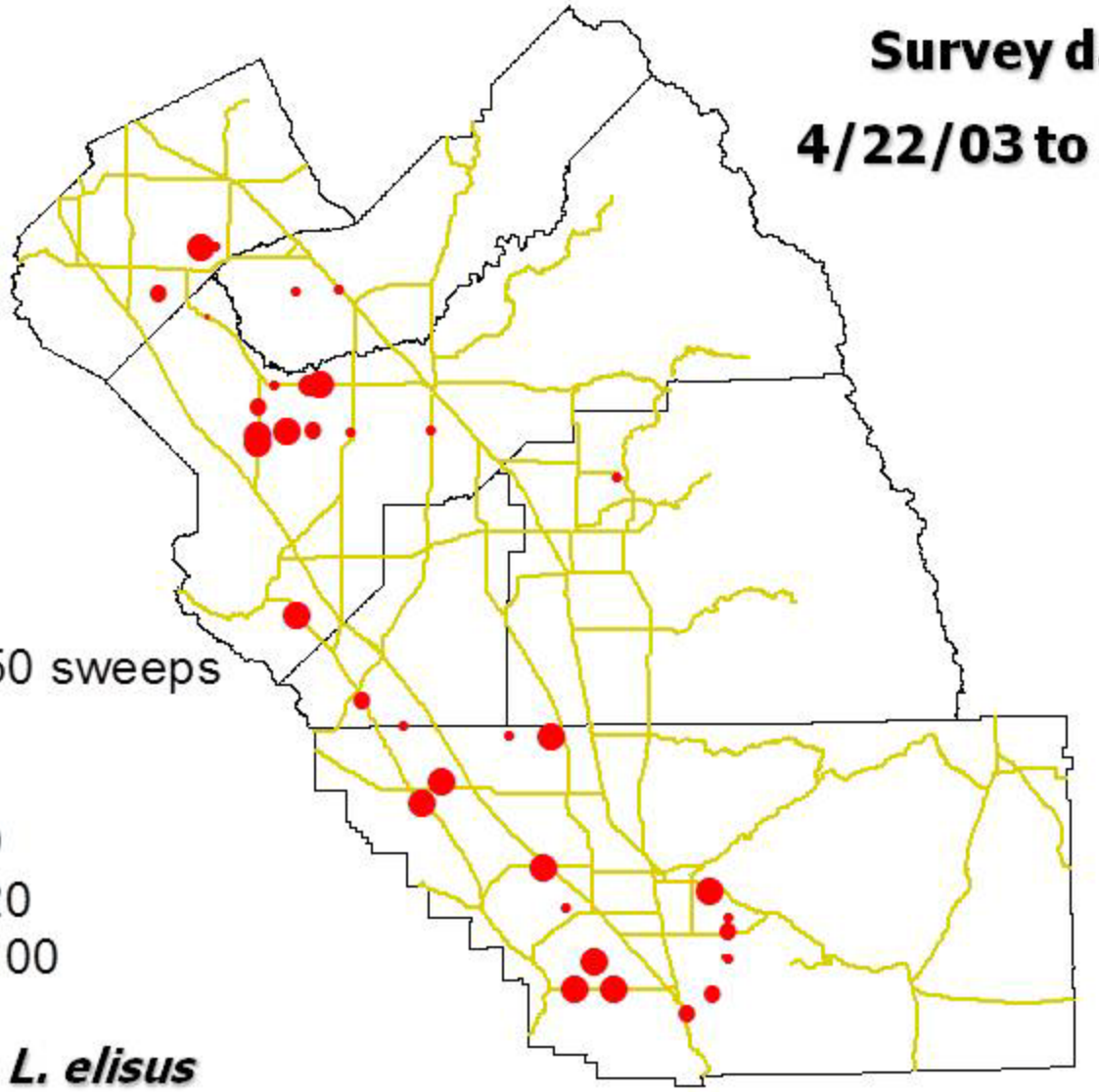
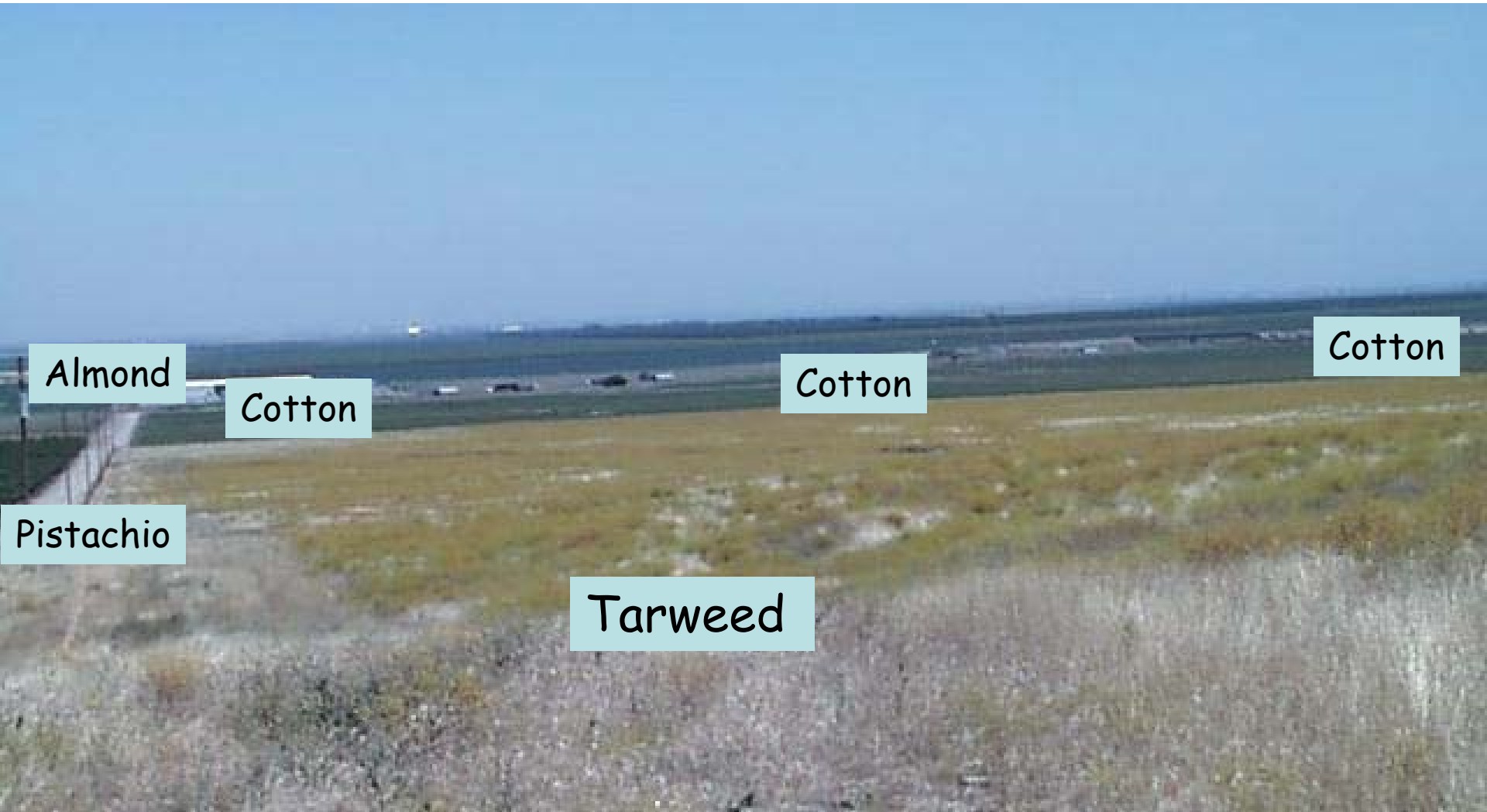


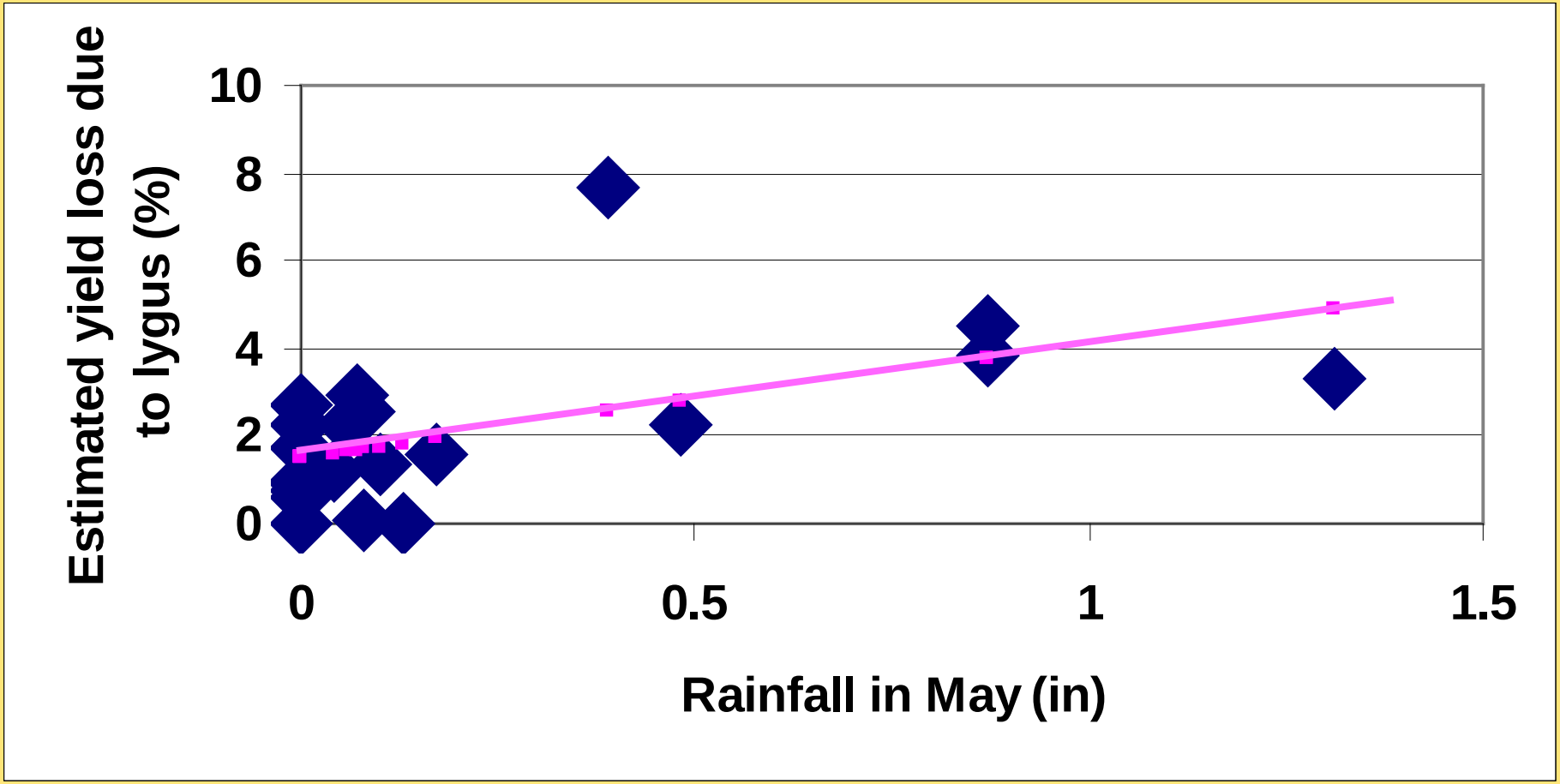
Both *L. hesperus* & *L. elisus*

West Side
Fresno County, 2005

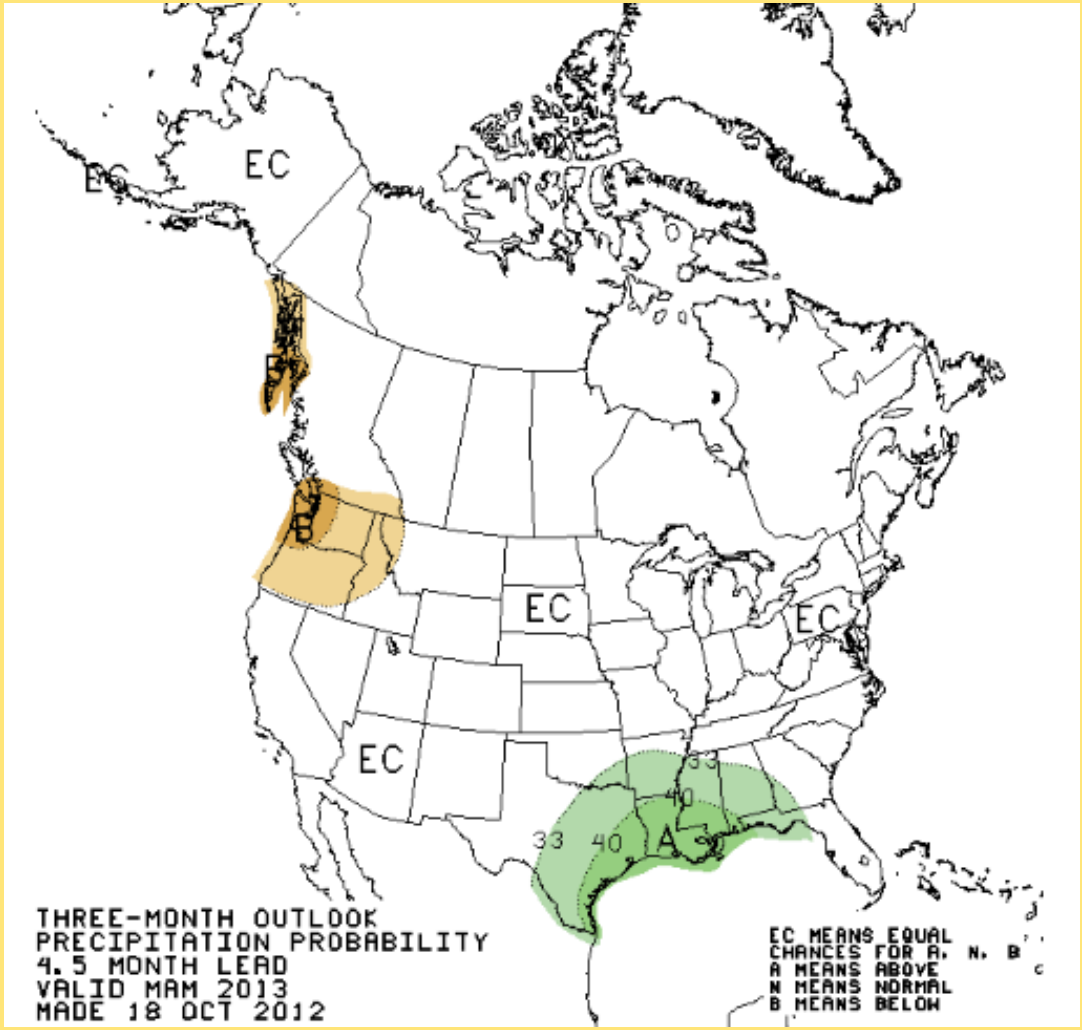


Predicting Senescing Hosts
Landsat 7 NDVI Changes

Relationship Between Rainfall and Yield Loss Caused by Lygus



NOAA 3 Month Outlook
March–April-May 2013



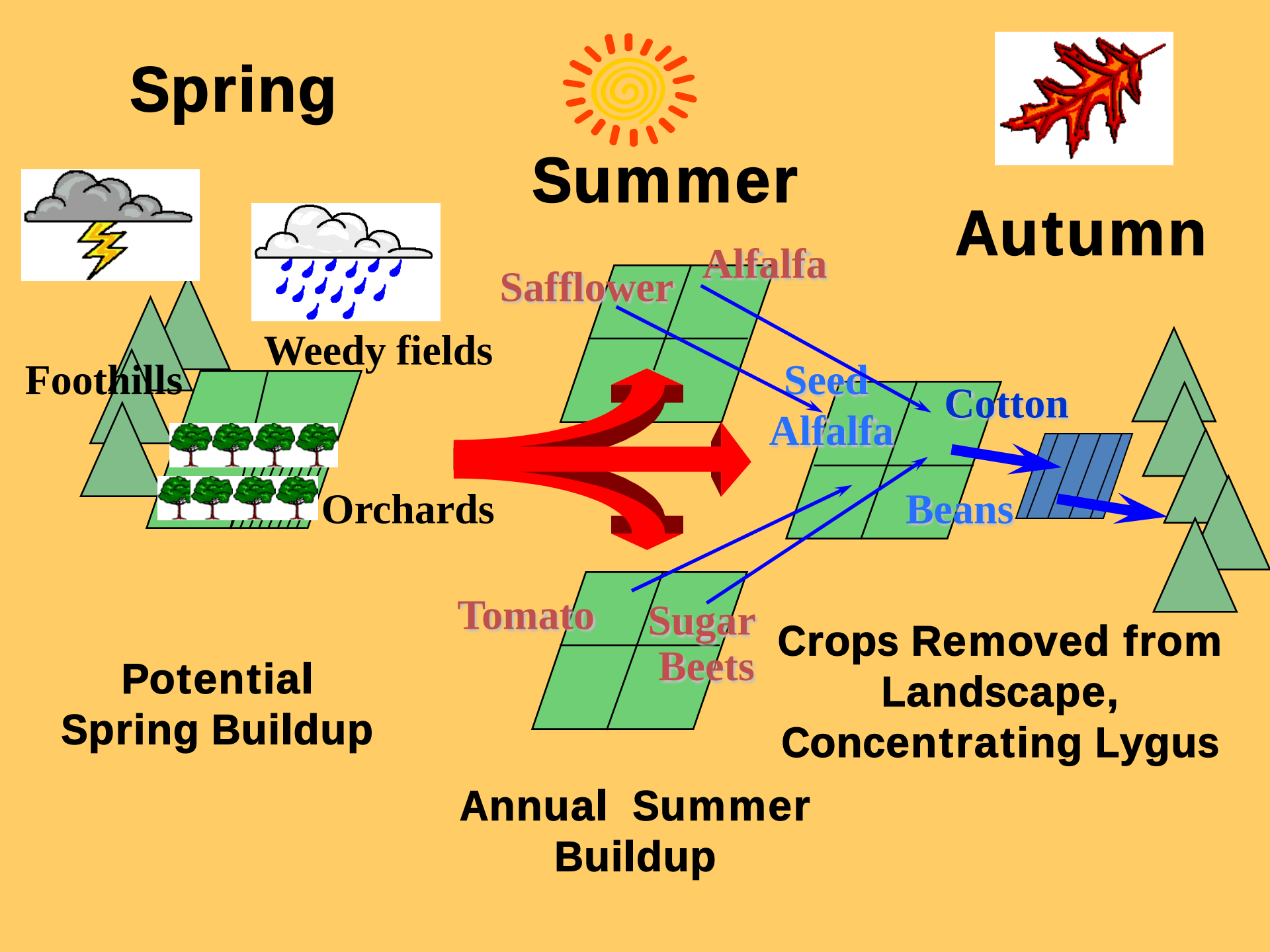
Forecasting Lygus Outbreaks

- Relationship between spring rains & seasonal Lygus population densities
- Frequency, duration and amount of rainfall:
  - Allowing certain annual plant to build and survive into June
  - Providing a host bridge between over-winter and summer generations
  - The Green Bridge in April, May and June

A Little Lygus Diddy

When hills are brown,
Hopes abound

If green in May,
Prepare to pay


Spring
Summer
Autumn
Foothills
Weedy fields
Orchards
Safflower
Alfalfa
Seed Alfalfa
Cotton
Beans
Tomato
Sugar Beets
Potential Spring Buildup
Annual Summer Buildup
Crops Removed from Landscape, Concentrating Lygus

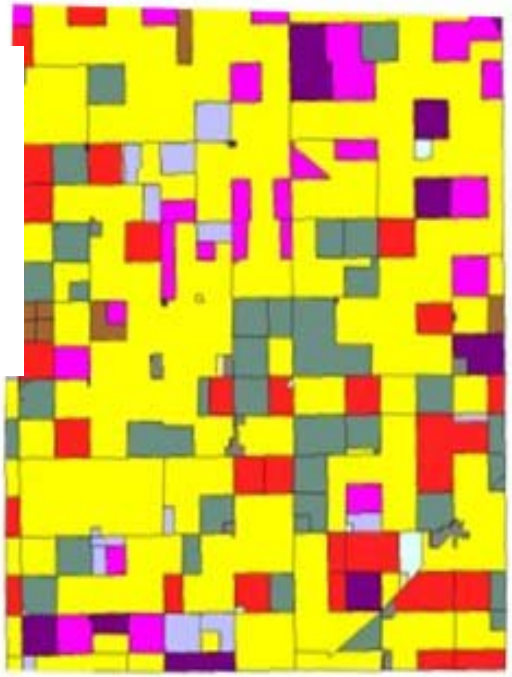
Voices from our past

"The grower, faced with rising production costs at all levels must decide if he will rely completely on insecticides to fight *Lygus* and accept the financial burden or if he will look for another method of control….."

"In attacking the *Lygus* problem, chemicals are used when absolutely necessary; but first a major change must be made in farm practices to keep *Lygus* out of cotton"

Dr. Vern Stern, 1967

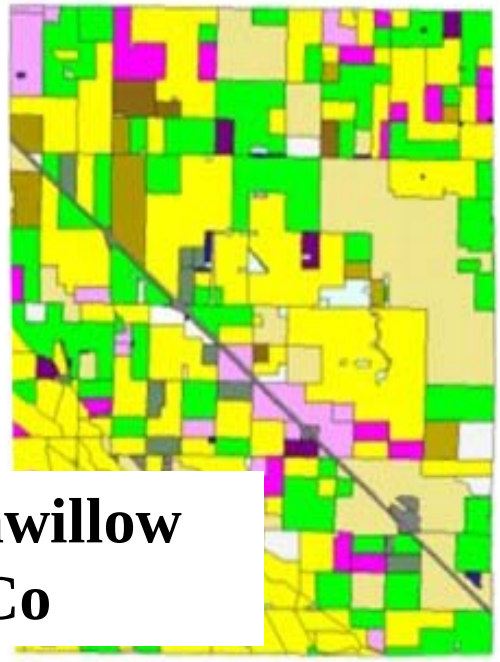
Five Points, Fresno Co



Chowchilla, Madera County

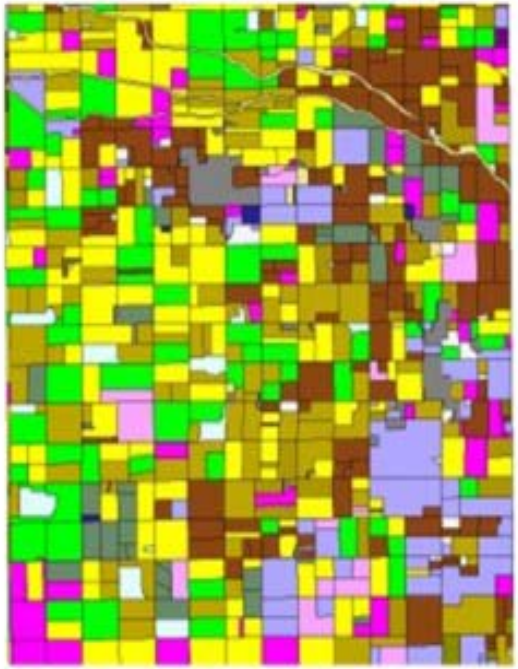
Crop Type

- Alfalfa
- Almond and Pistachio
- Corn
- Cotton
- Fallow and idle
- Grain
- Grapes
- Native Classes
- Non-irrigated agricultural land
- Other Decidious
- Other Truck
- Pasture
- Subtropical
- Tomatoes
- Urban
- Water



Buttonwillow Kern Co

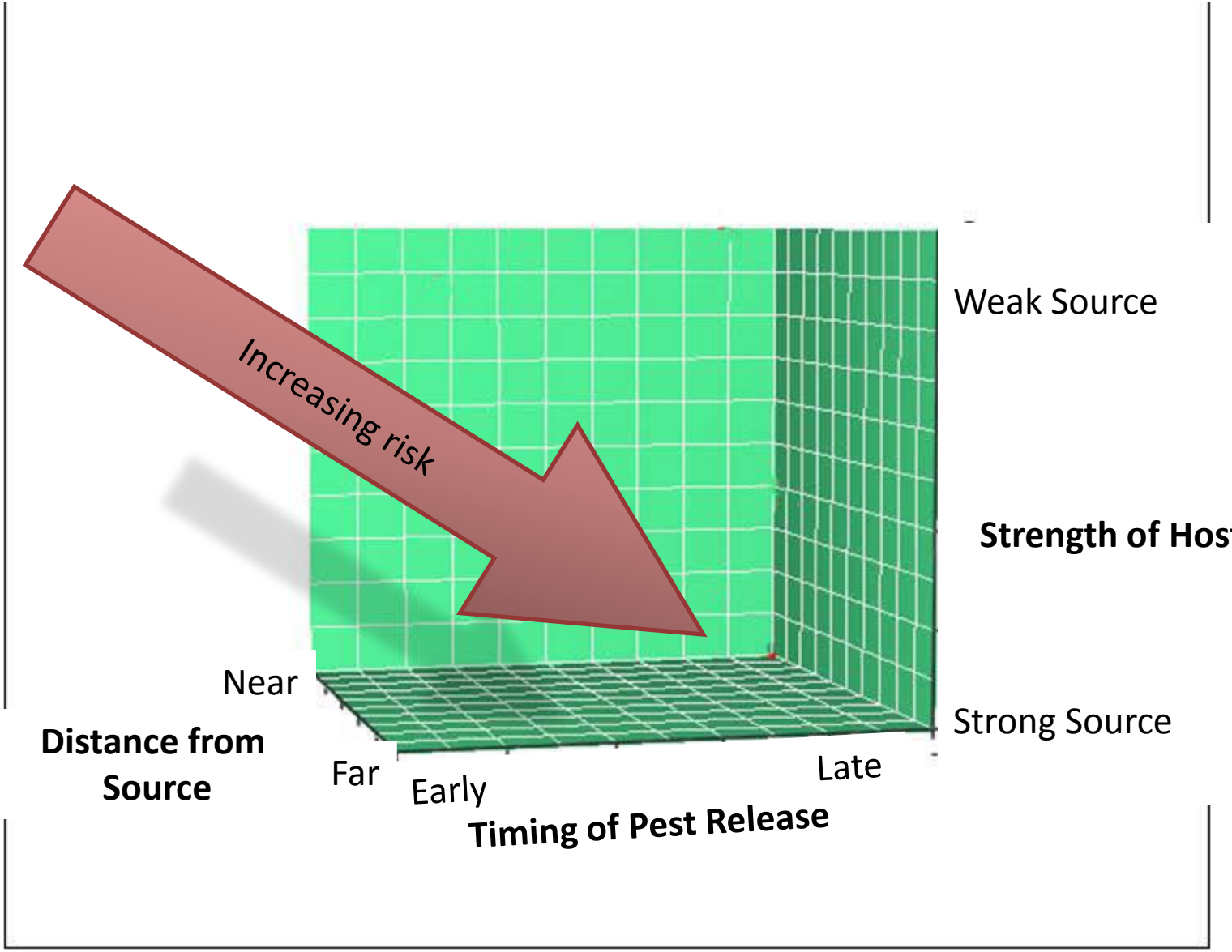
Woodville, Tulare



Risk Factors in Lygus Movement Into Cotton

- **Distance** - How far from Source?
  - There is an inherent limitation to how far an individual Lygus can fly
  - Understanding the scale of the landscape in relation to insect capabilities for movement
- **Strength** - How "strong" is the Source?
  - What is the host suitability/capacity for reproduction and completion of life cycle?
  - Are the sources synchronous in their senescence?
- **Timing** - When does the Source release the insects?
  - When is the crop most susceptible and how is it timed to Lygus movement?
- **Landscape Configuration** - What is between you and the Source?
  - Are there sufficient sinks to absorb the population surge?

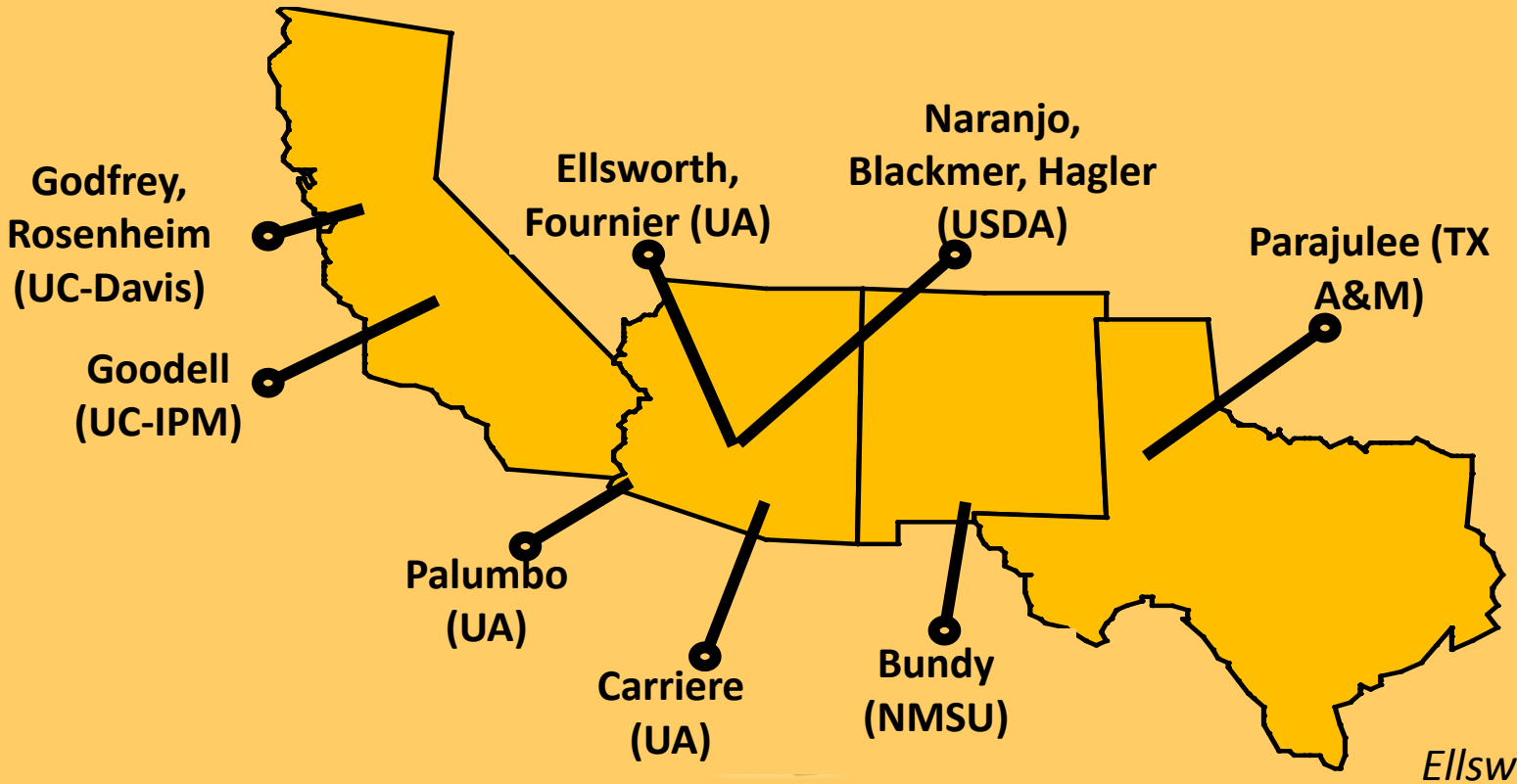
Risk Factors in Lygus Movement into Cotton



Distance & Strength Intertwined

- Distance
  - How far-reaching is a source on population density of Lygus in a cotton field
  - Focused research over past 5 years has provided good evidence
- Strength
  - How good is a host for building Lygus
  - Decades of qualitative information
  - Above studies help to quantify

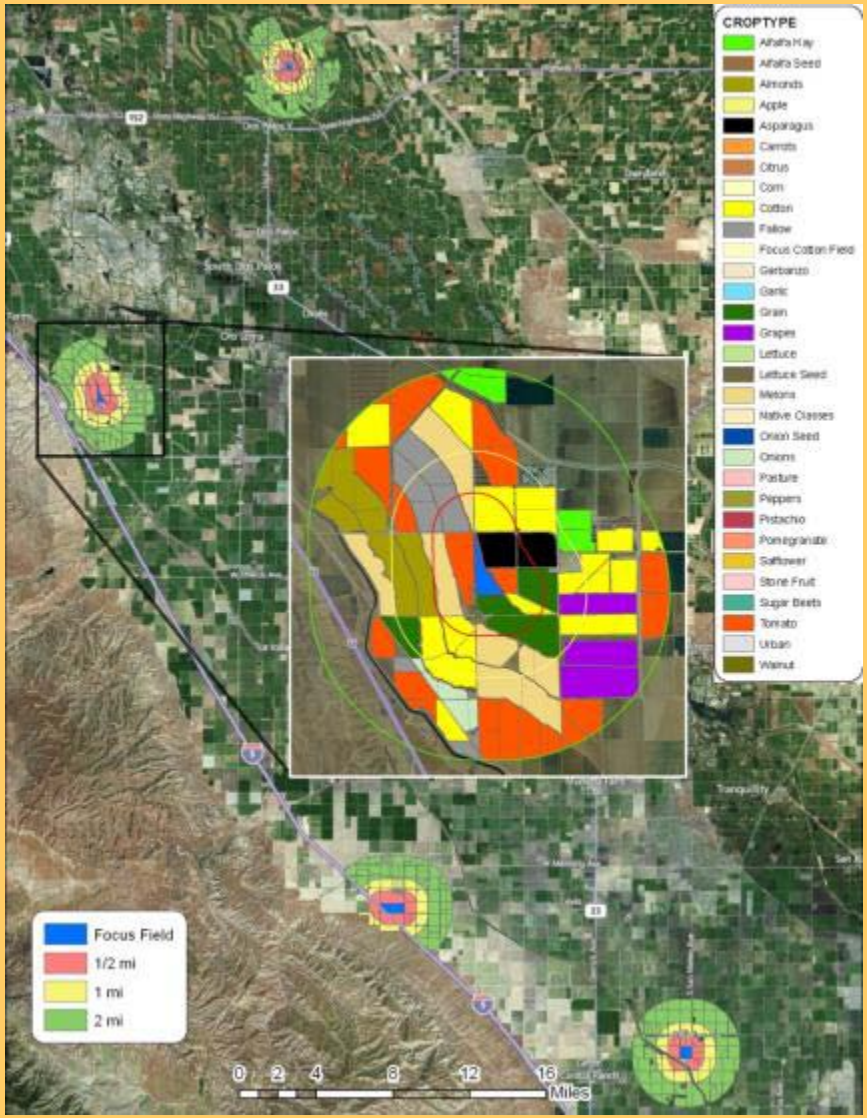
Developing and Implementing Field and Landscape Level Reduced-risk Management Strategies for Lygus in Western Cropping Systems



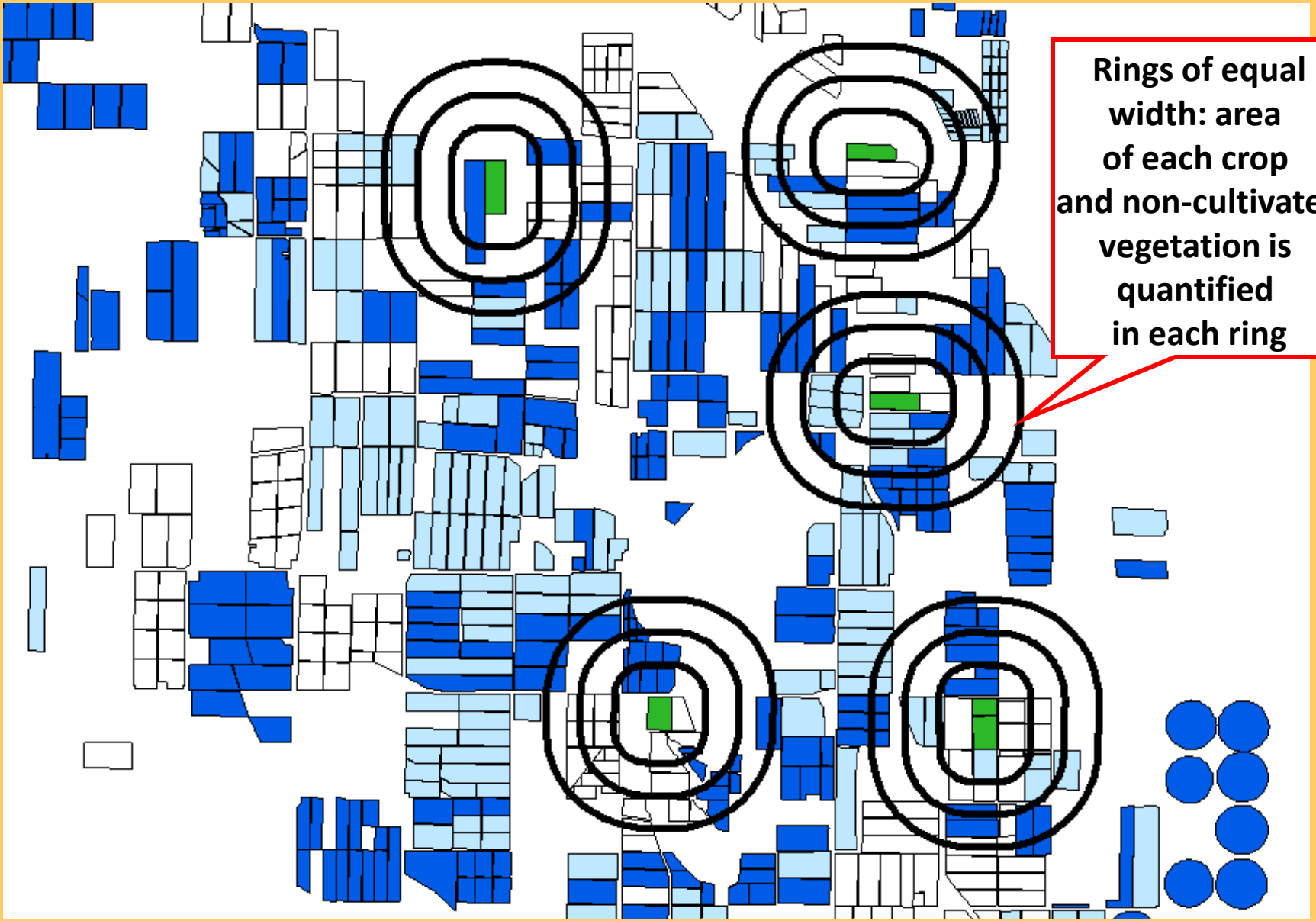
Ellsworth/UA

RAMP Project

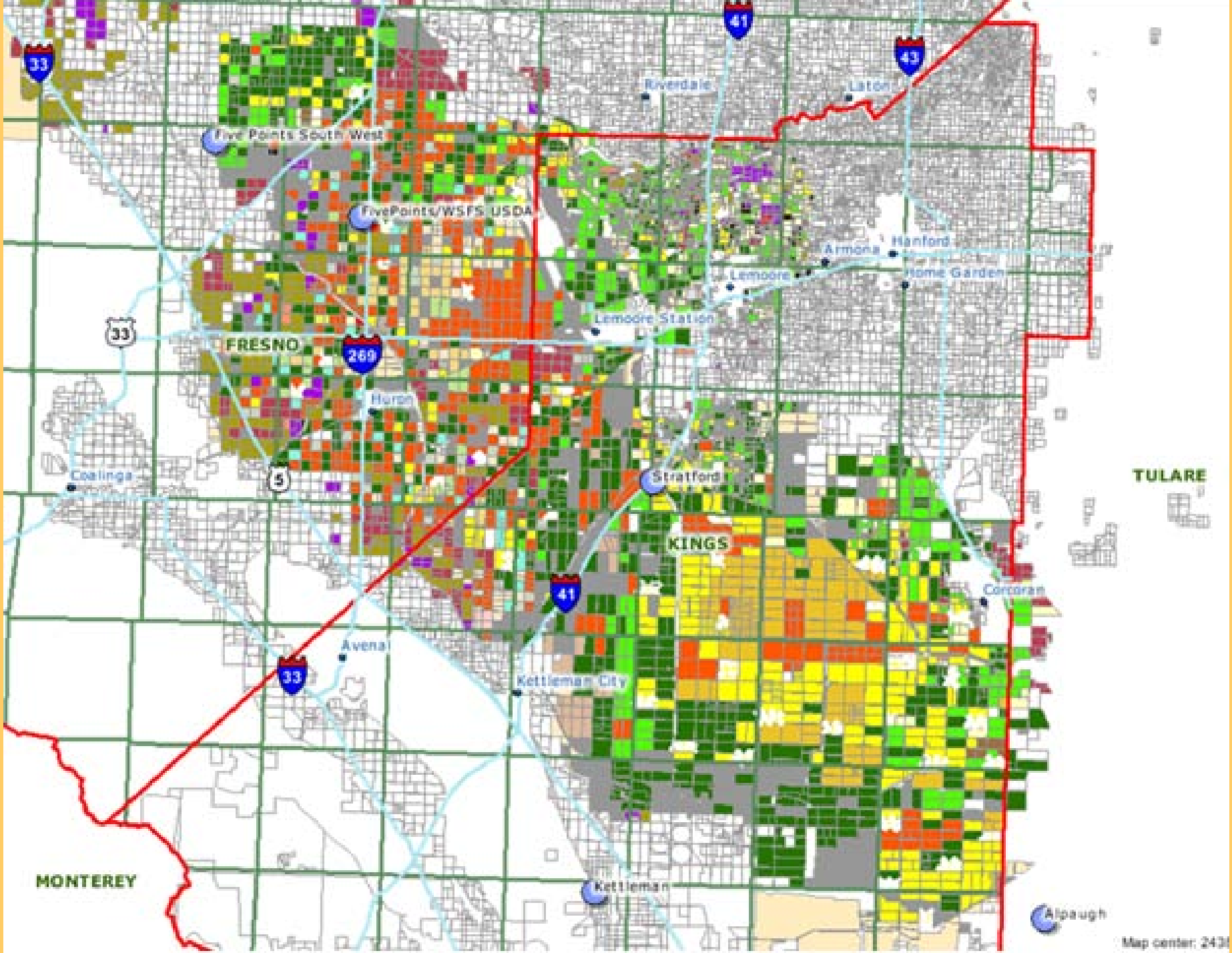
Relating Surrounding Crops to Lygus Density



- Which crops are most related to high Lygus densities
- Focus cotton field is sampled weekly for Lygus
- Crops in area around focus field is mapped
- Ring slices surrounding focus field
- ½ mile, 1 mile , 2 miles



Source: Carrière et al

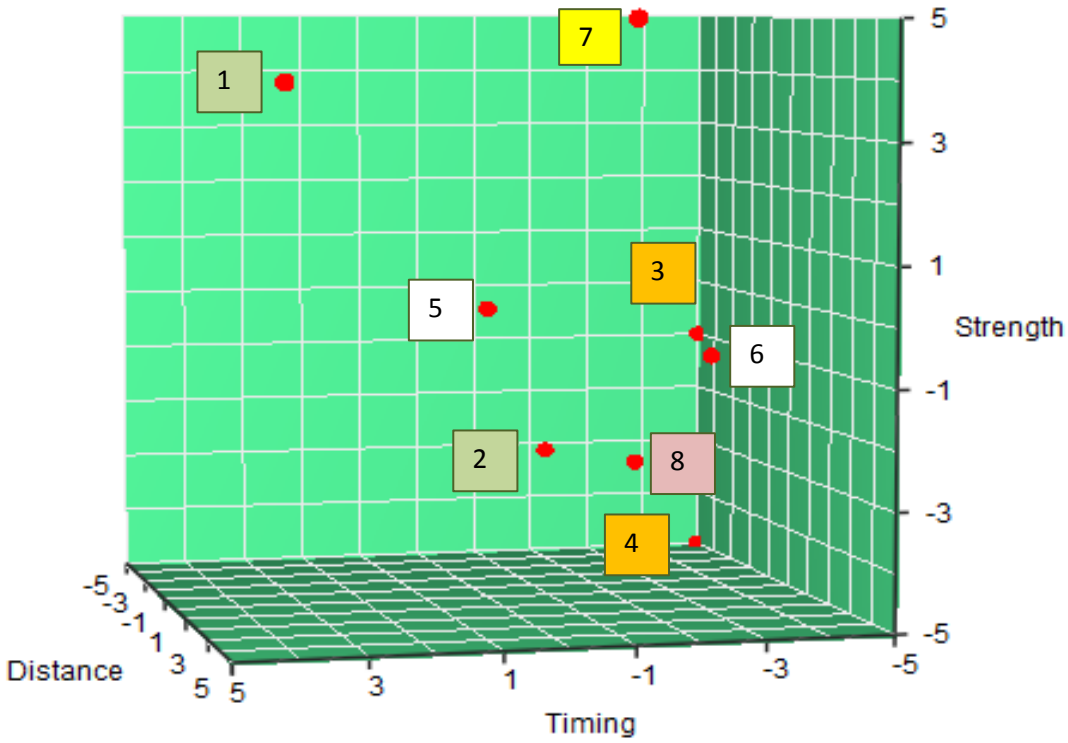

Five Points South West
FivePoints/WSFS USDA
Riverdale
Laton
Armona
Hanford
Lemoore
Home Garden
Lemoore Station
FRESNO
Hurno
Coalinga
Stratford
KINGS
TULARE
Concoran
Avenal
Kettleman City
Kettleman
MONTEREY
Alpaugh
Map center: 243

Results from Multistate RAMP SJV Data

Habitat	2007	2008	2009	Distance of Association	
				Meters	Miles
Cotton	Sink	Sink	Sink	2700	1.7
Alfalfa	Source	Sink		1500	1.0
Uncultivated	Sink			1200	0.75
Safflower	Source	Source	Sink	2700	1.7
Seed Alfalfa	Source			2700	1.7
Tomato	Sink				

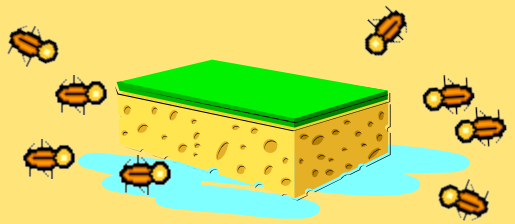
Carrière Y, Goodell PB, Ellers-Kirk C, Larocque G, Dutilleul P, et al. (2012) Effects of Local and Landscape Factors on Population Dynamics of a Cotton Pest. PLoS ONE 7(6)

1	Alfalfa Managed
2	Alfalfa unmanaged
3	Safflower managed
4	Safflower unmangaged
5	Neutral
6	Weedy but neutral
7	Cotton
8	Sugar beets



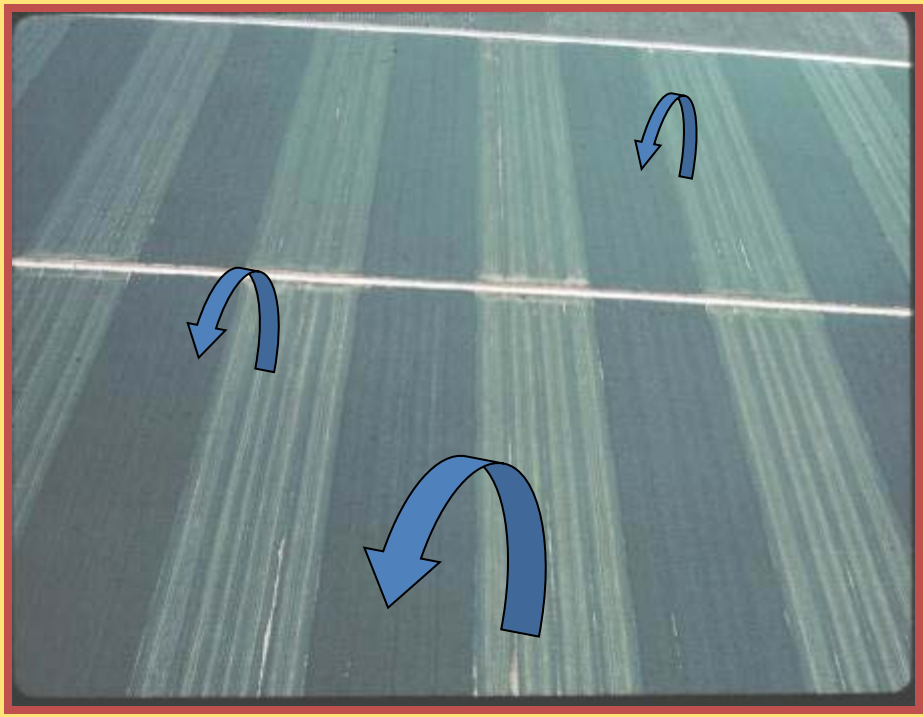
Alfalfa Forage is a Key Crop

- It is a preferred Lygus host but not susceptible to damage
- It is one of the few crops grown for vegetative rather reproductive part
- Crop is continually in vigorous pre-reproductive state, always in a vegetative state of growth
- A field can absorb lygus from surrounding area, acting as sponge



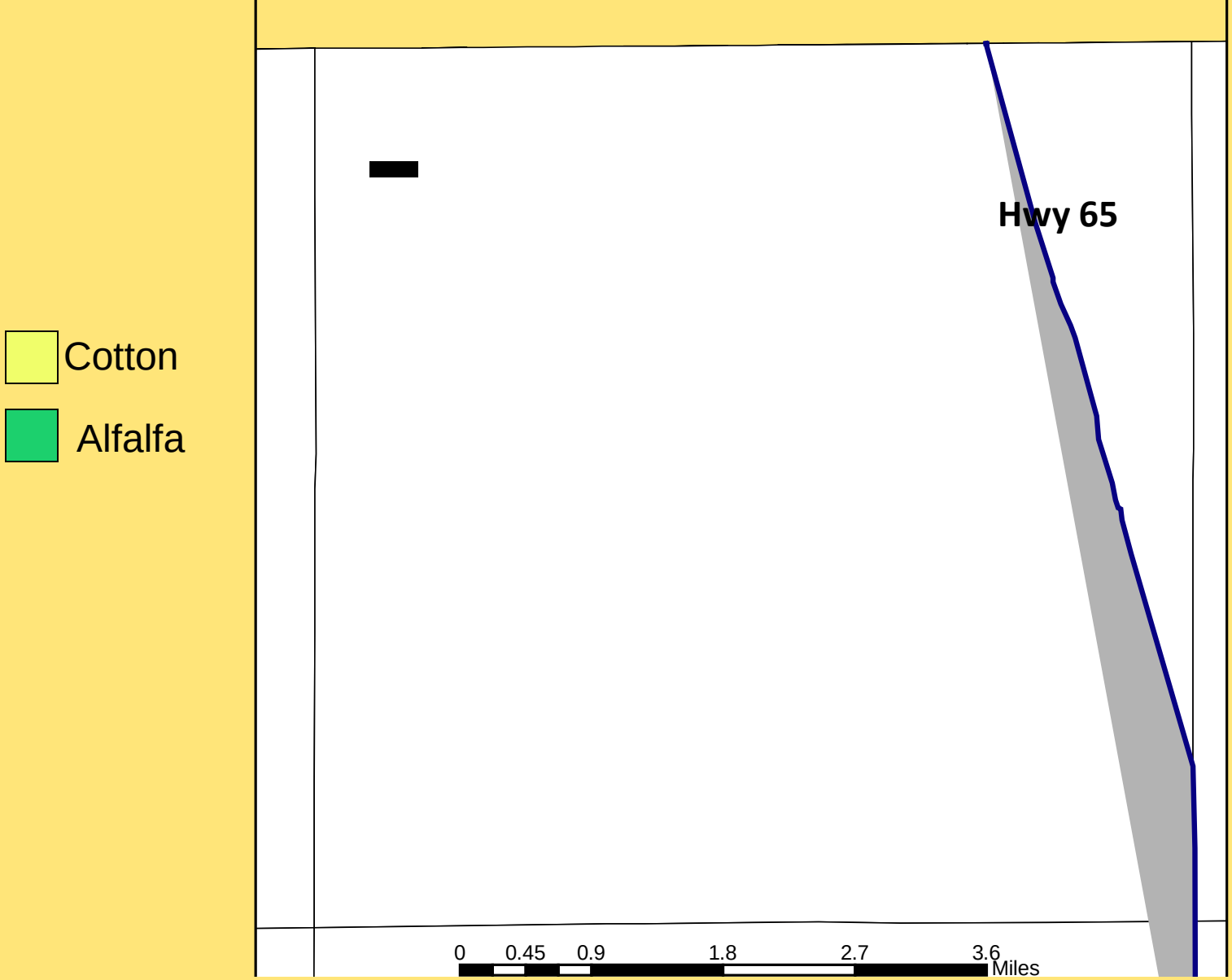
Regional Approach Circa 1960's
Strip Cutting Alfalfa Fields

- Within a field, split harvest schedule
- ½ of field is cut every 14 days
- Concept acceptable, execution cumbersome
- Interferes with custom harvest, irrigation management
- Not widely accepted

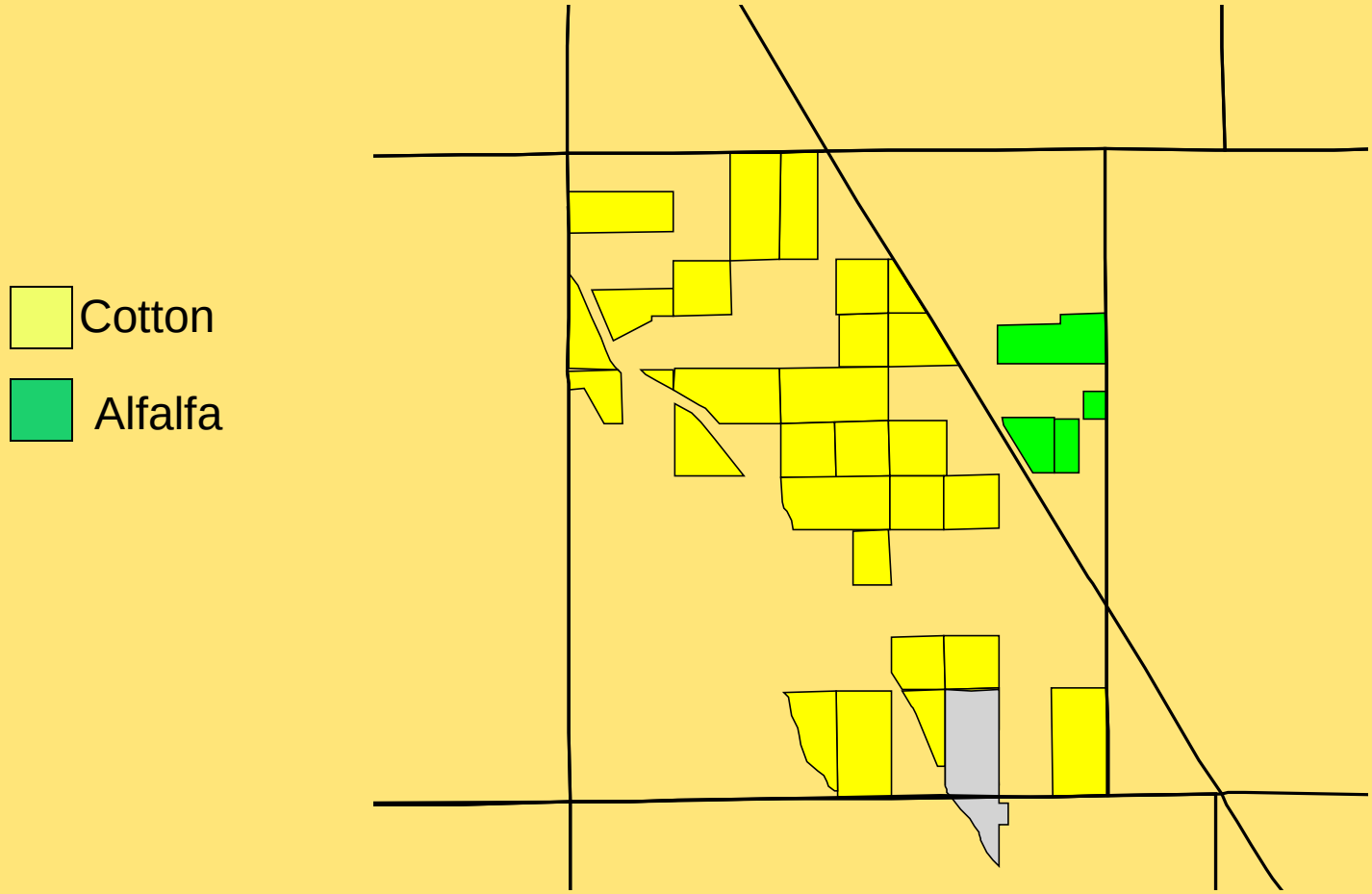


Regional Approach Circa 1960's Interplanting Alfalfa and Cotton

- Alfalfa placed with cotton
- Both crops managed for production
- Strip cut to maintain attractiveness
- Adopted and used in large fields
- Not widely accepted due to crop production incompatibilities



Excellent spatial arrangement of cotton & alfalfa



Poor spatial arrangement of cotton & alfalfa

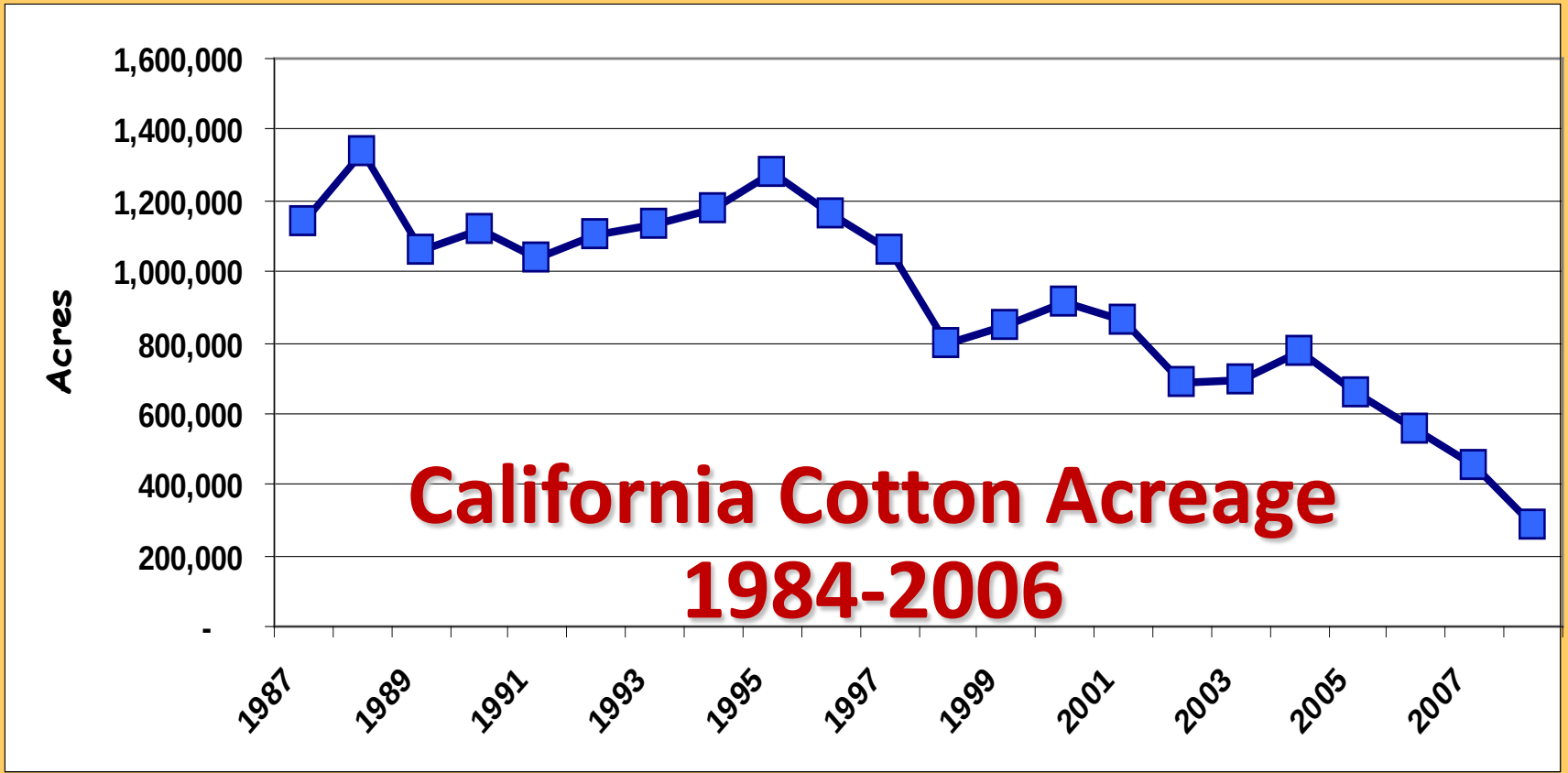
Why is Safflower Such An Important Source of Lygus?

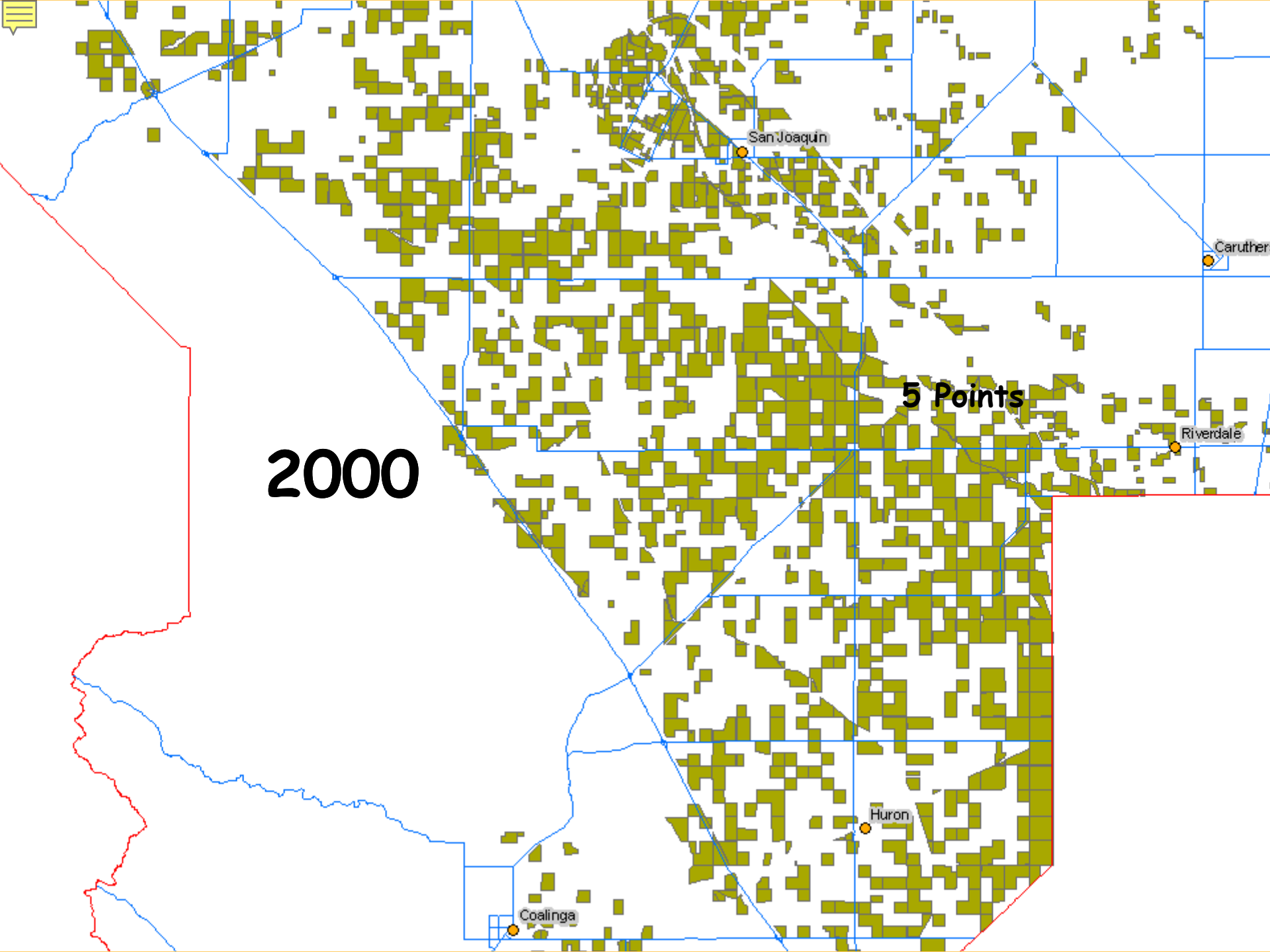
- Provides Green Bridge between for spring and summer populations
- Provides habitat for extended period (1-2 gen.)
- Lygus is NOT normally treated as pest

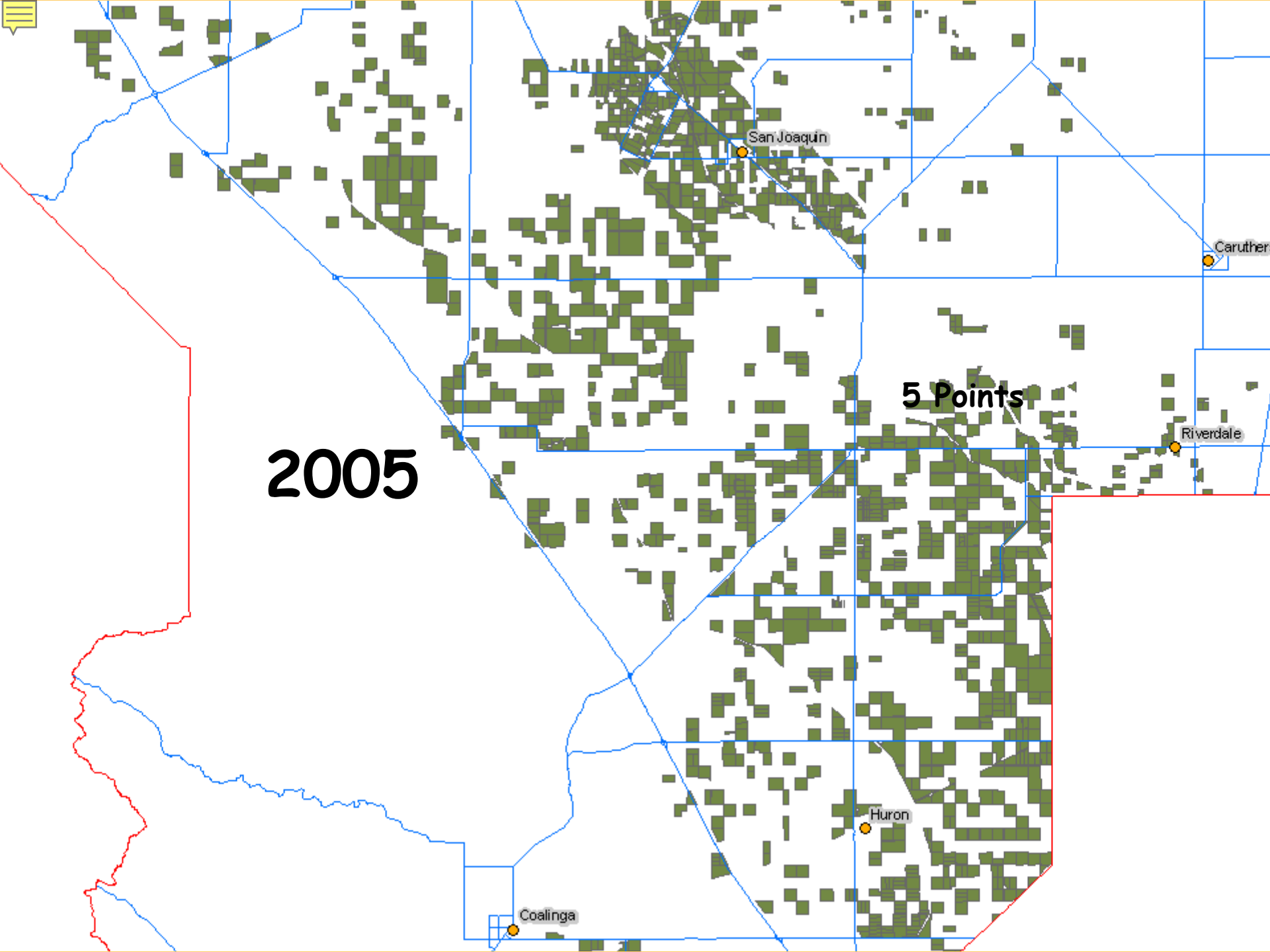
✓Is a good host for Lygus to build & to inflict damage on susceptible cotton

Fragmenting IPM

- What happens to an established and successful IPM program when the landscape in which it was developed, no longer exists?




2000
San Joaquin
5 Points
Riverdale
Huron
Coalinga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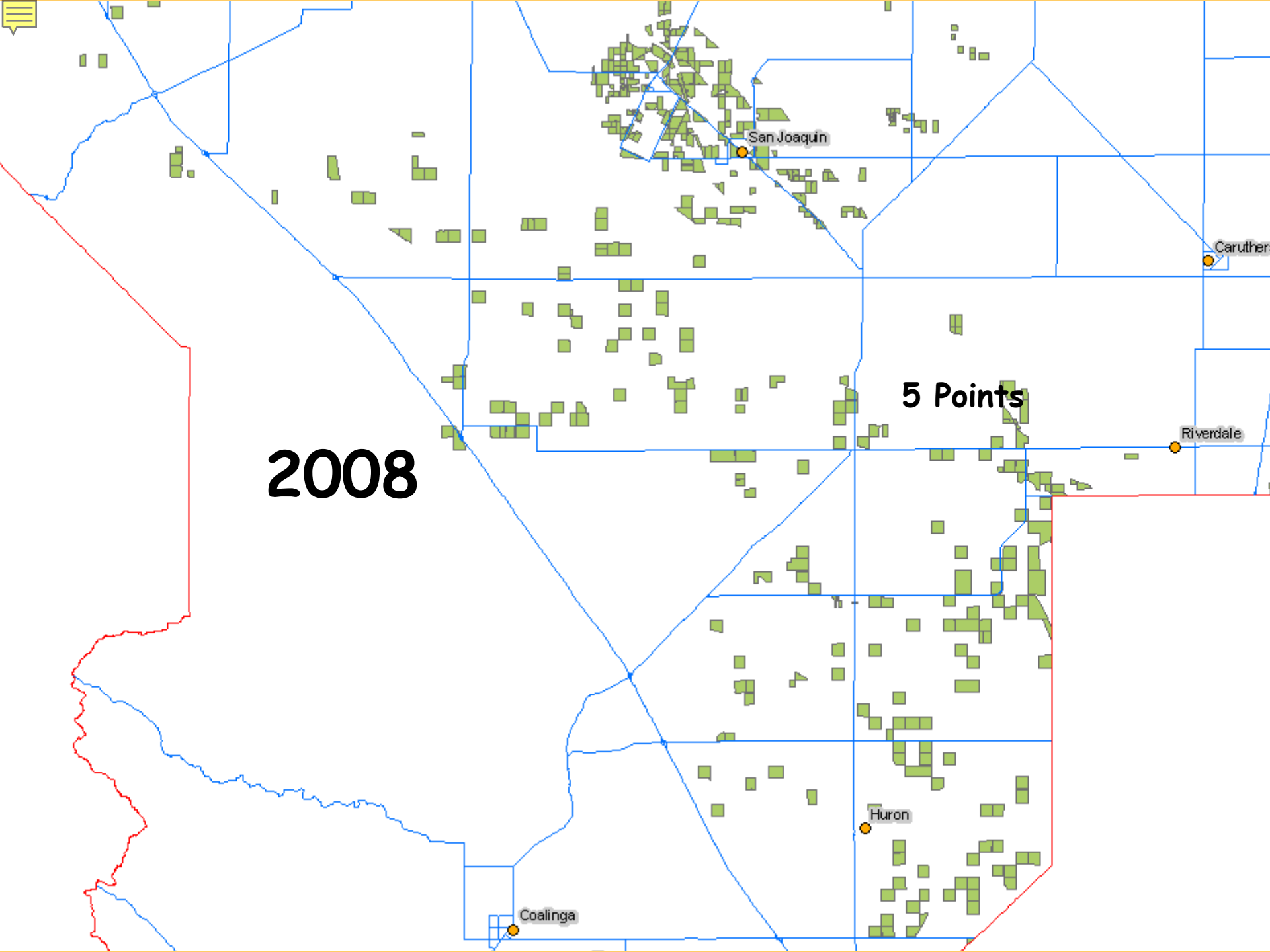
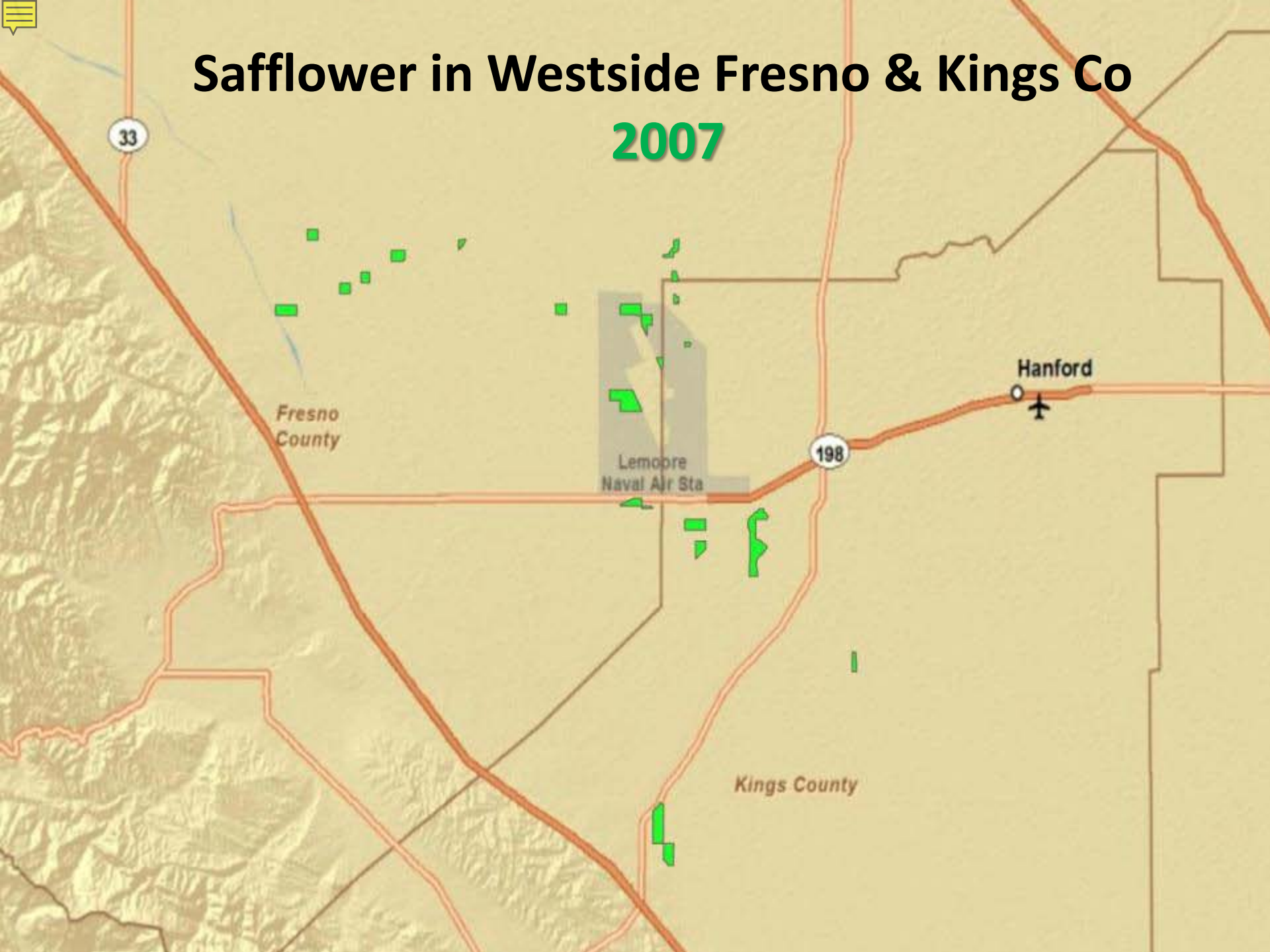

2008
5 Points
San Joaquin
Caruther
Riverdale
Huron
Coalinga

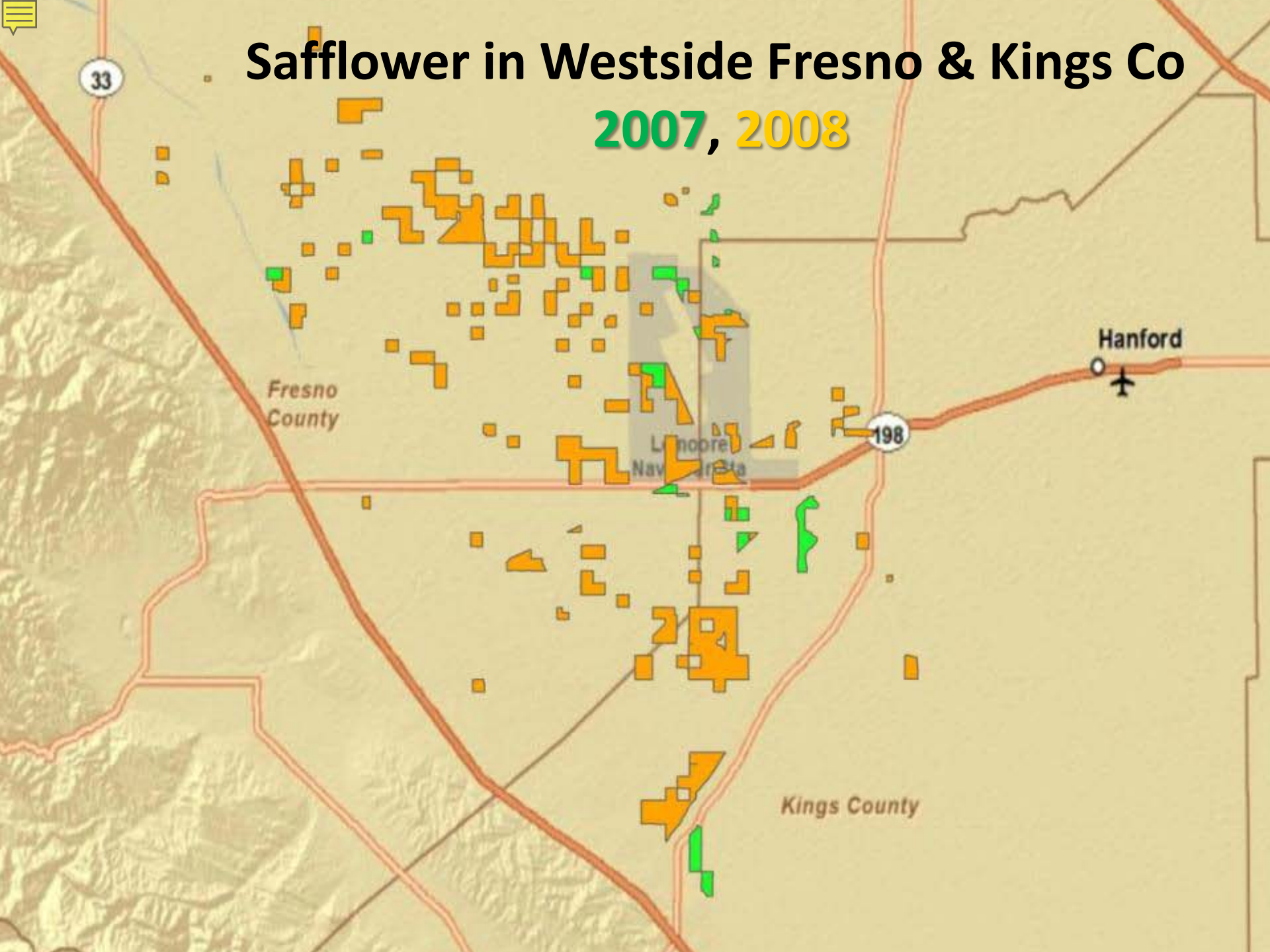
Safflower in Westside Fresno & Kings Co

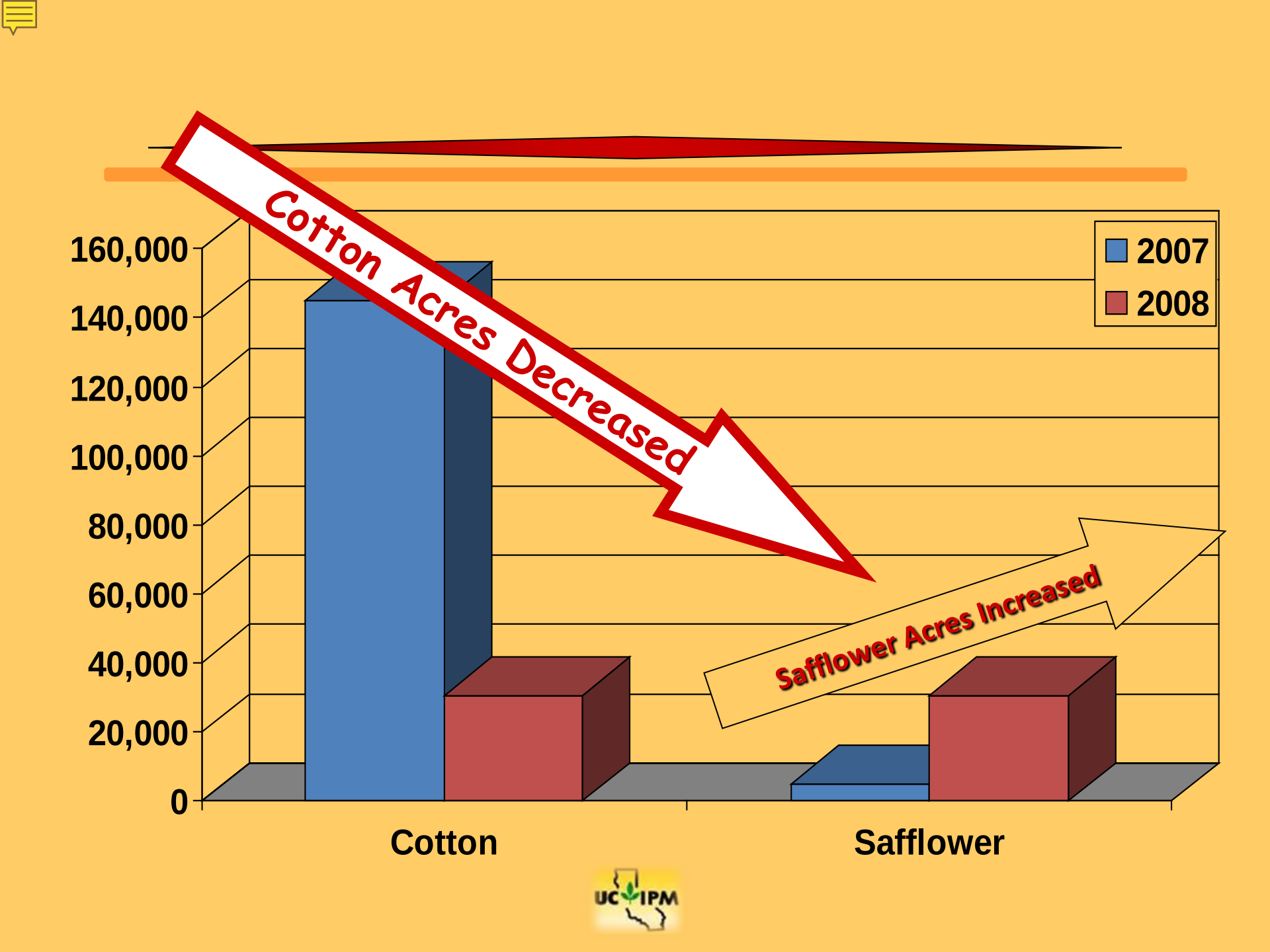
2007



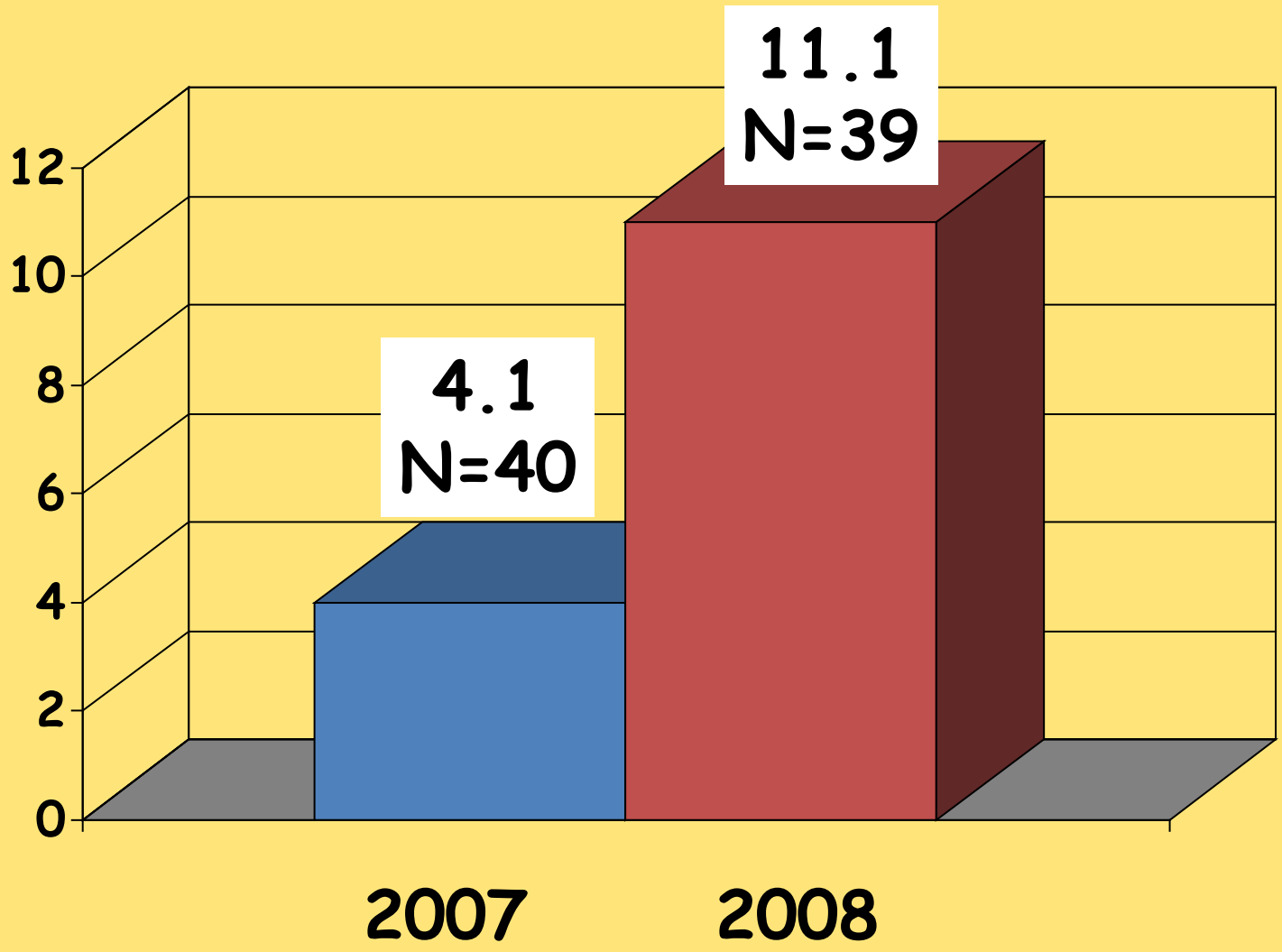
Safflower in Westside Fresno & Kings Co

2007, 2008




Cotton Acres Decreased
Safflower Acres Increased
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
2007
2008
Cotton
Safflower
UC IPM

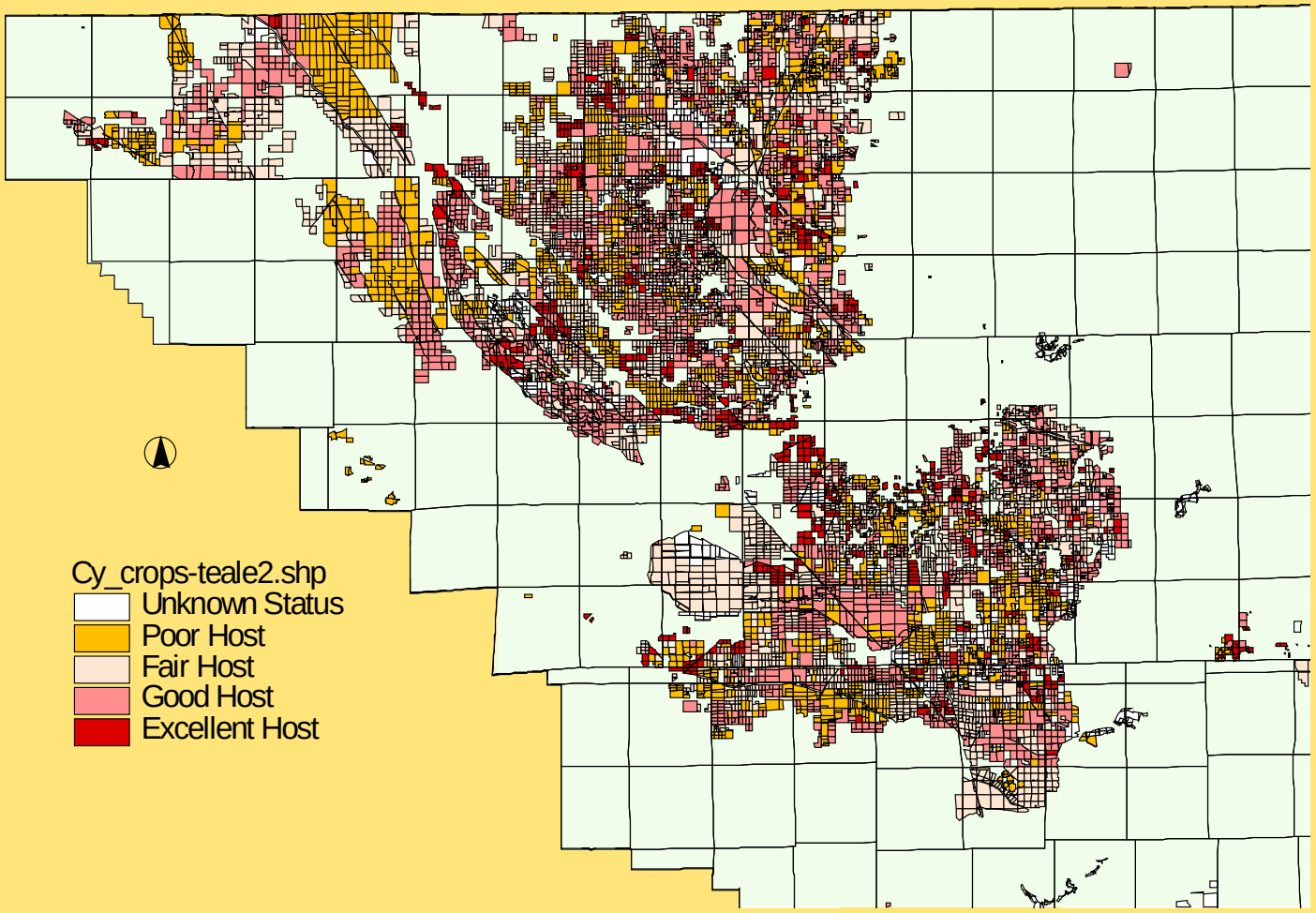
Average Number Insecticide Applications



Can We Assign Risk for a Specific Cotton Field?

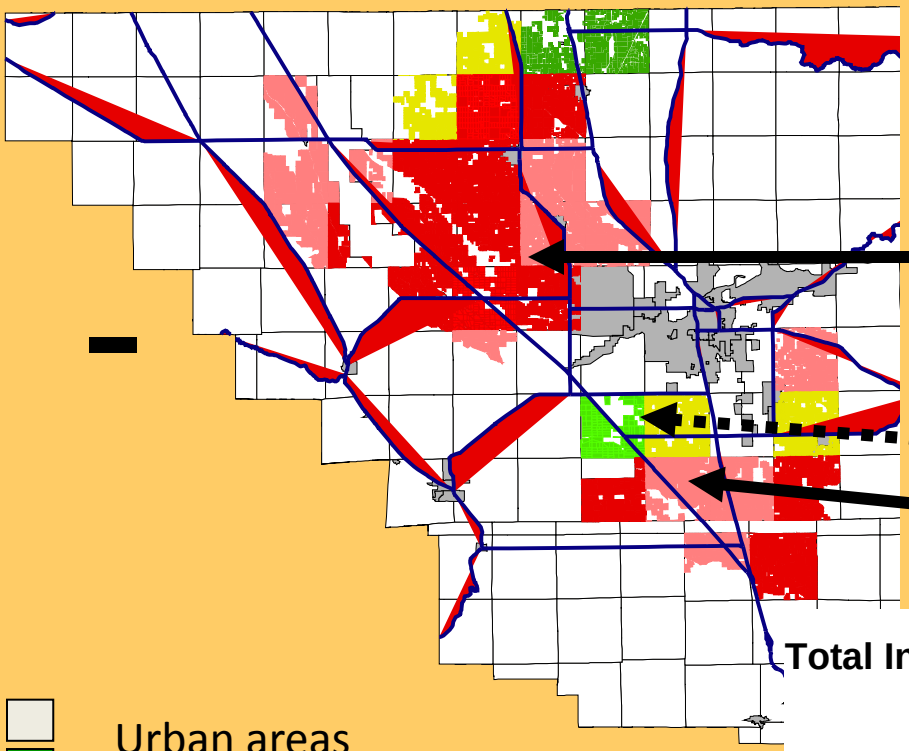
- What role does the diversity of the landscape surrounding a cotton field play in the risk of Lygus infestations?
- Are some landscape more prone to Lygus infestations than others?
- How complex does the diversity need to be?
- What can be done to mitigate the risk?

Host Status of Kern Crops



Spatial Arrangement of Cotton & Alfalfa

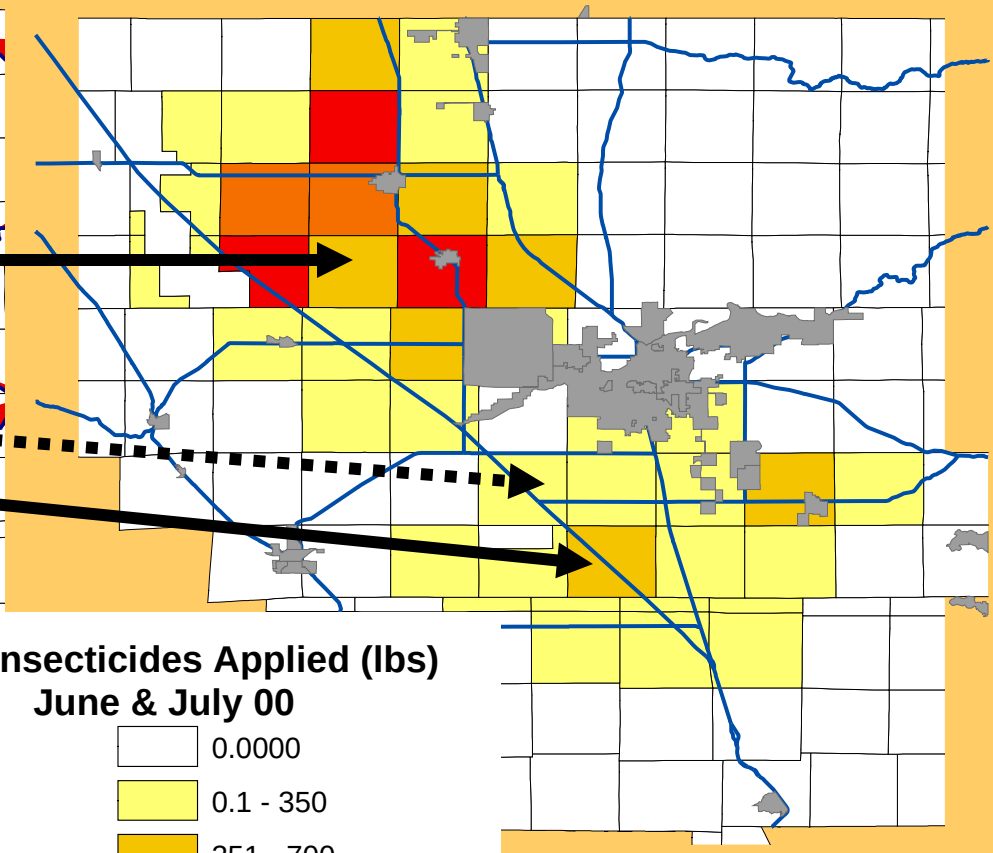
Lygus Insecticide Use in Cotton During June & July

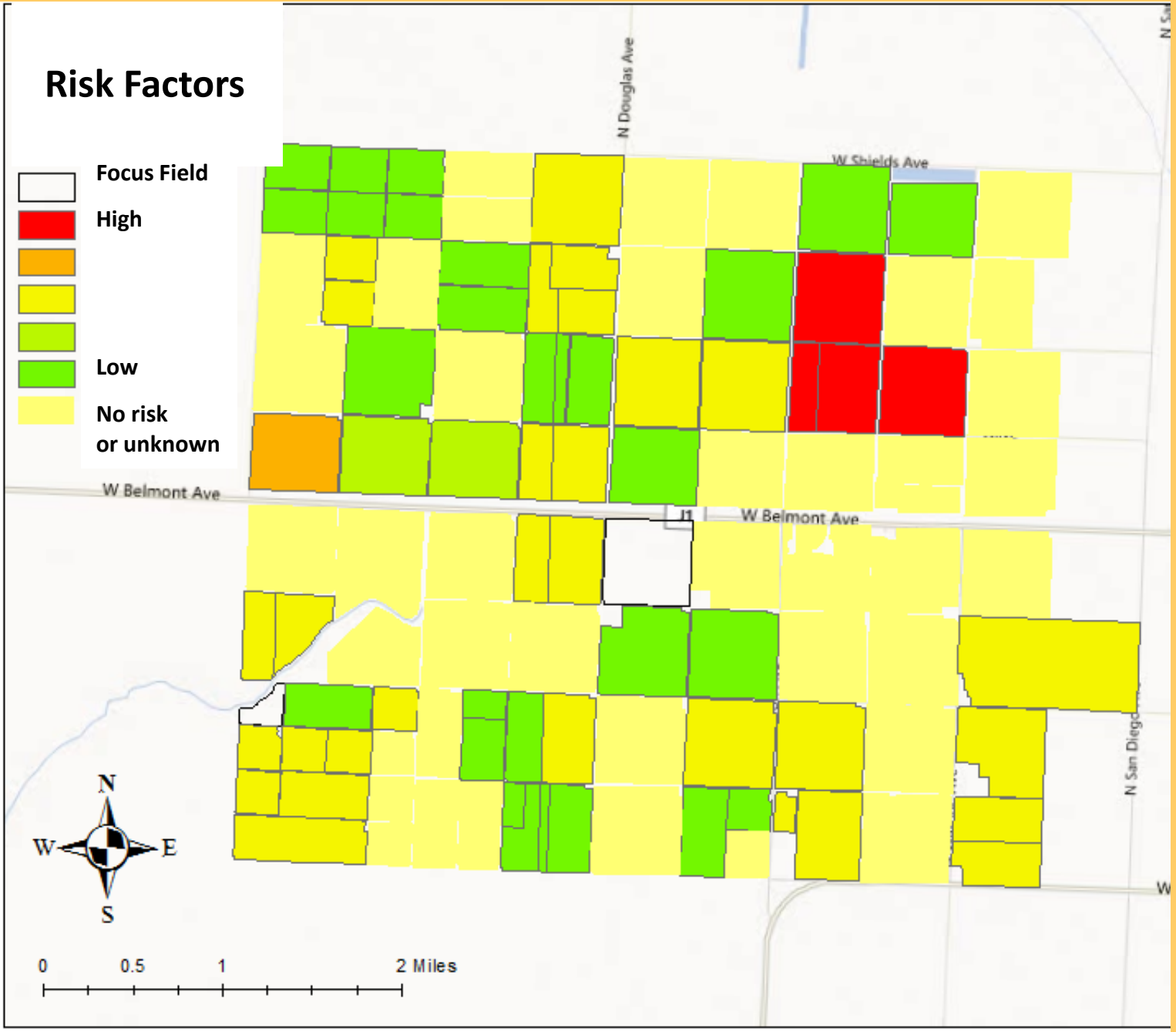


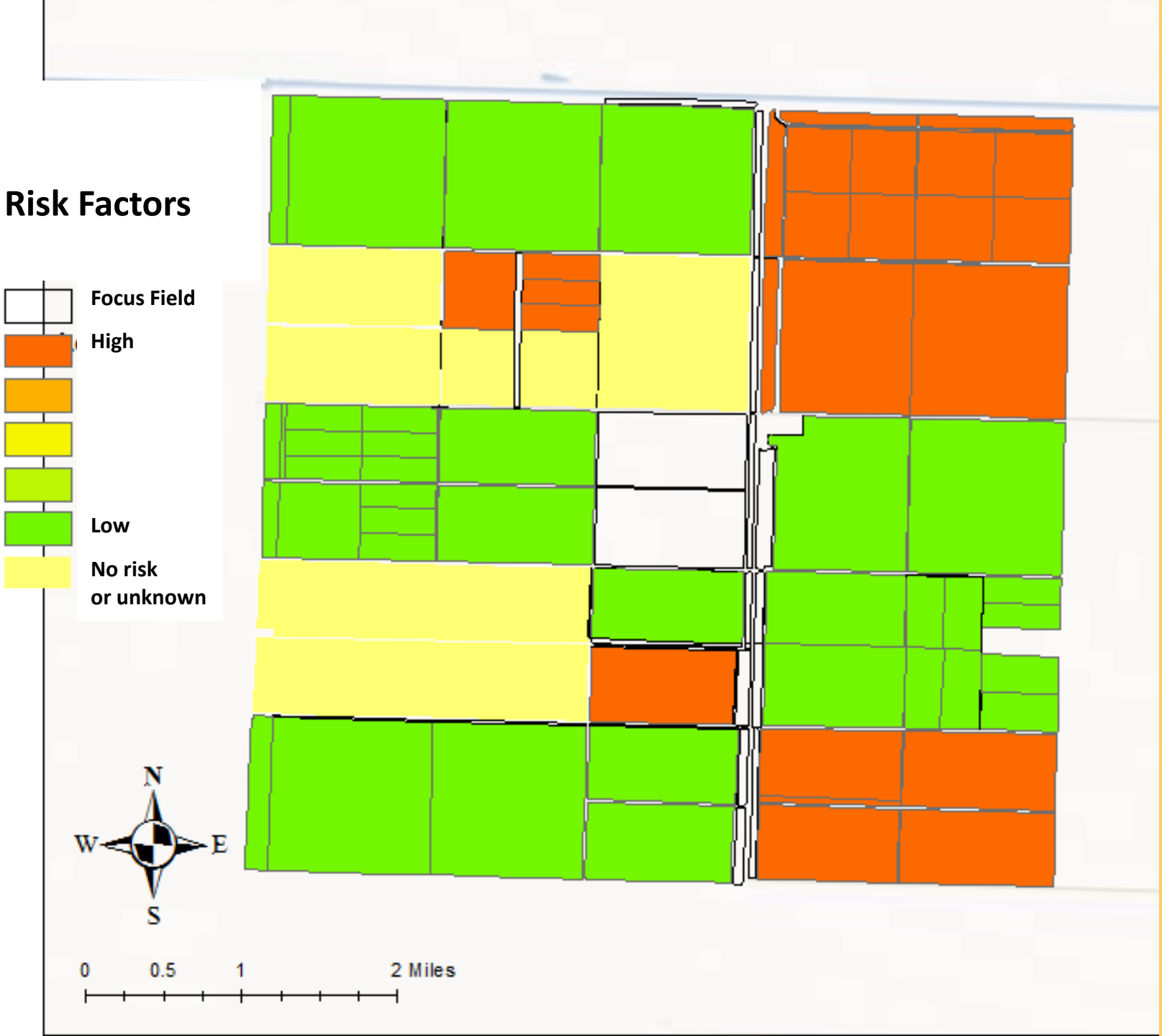
Urban areas

Alfalfa is abundant & close

Alfalfa is scarce & distant




Risk Factors
Focus Field
High
Low
No risk
or unknown
N Douglas Ave
W Shields Ave
W Belmont Ave
W Belmont Ave
N San Diego
N
W
E
S
0
0.5
1
2 Miles


Risk Factors
Focus Field
High
Low
No risk
or unknown
N
W
E
S
0
0.5
1
2 Miles

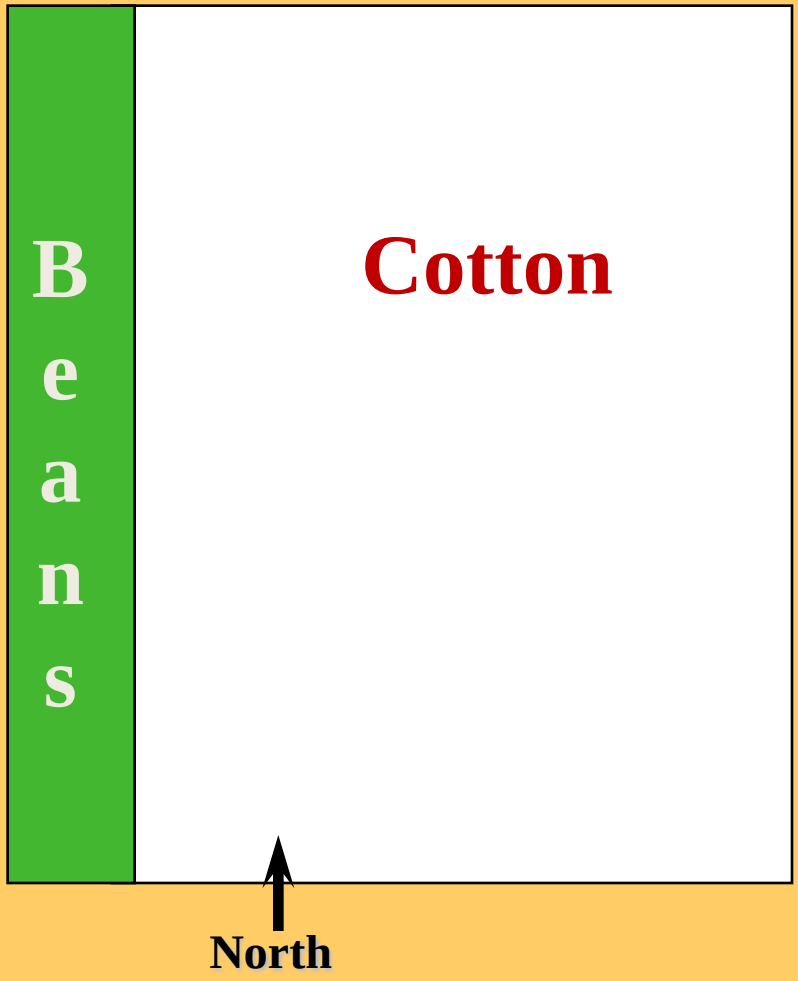
The Landscape Can be Managed

- Increasing diversity of preferred Lygus sinks
- Configuring your farm to minimize risk
- Cooperating as a community to reduce risk

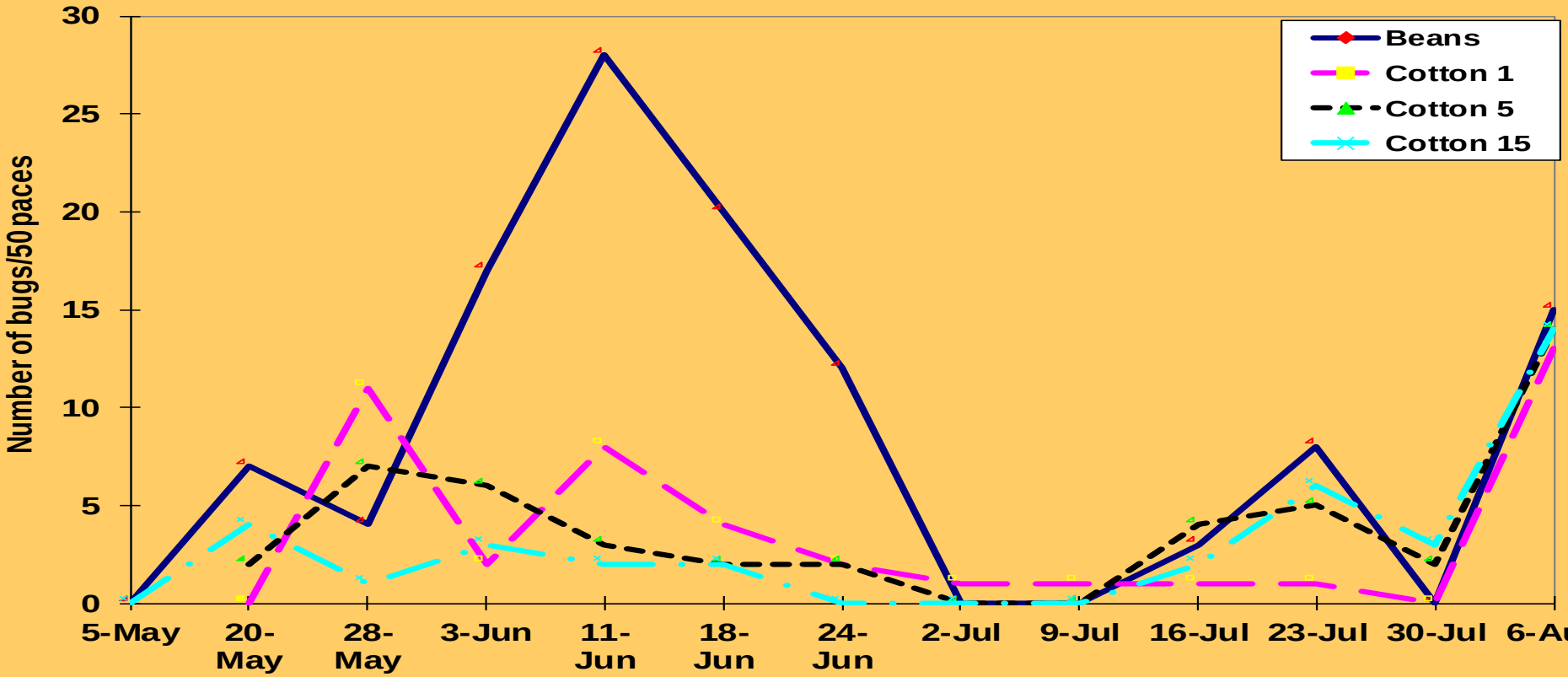
- Challenges:
  - Cooperation
  - Appreciation for the problem
  - Working toward the greater good

Buffer Strips Help to Manage Lygus

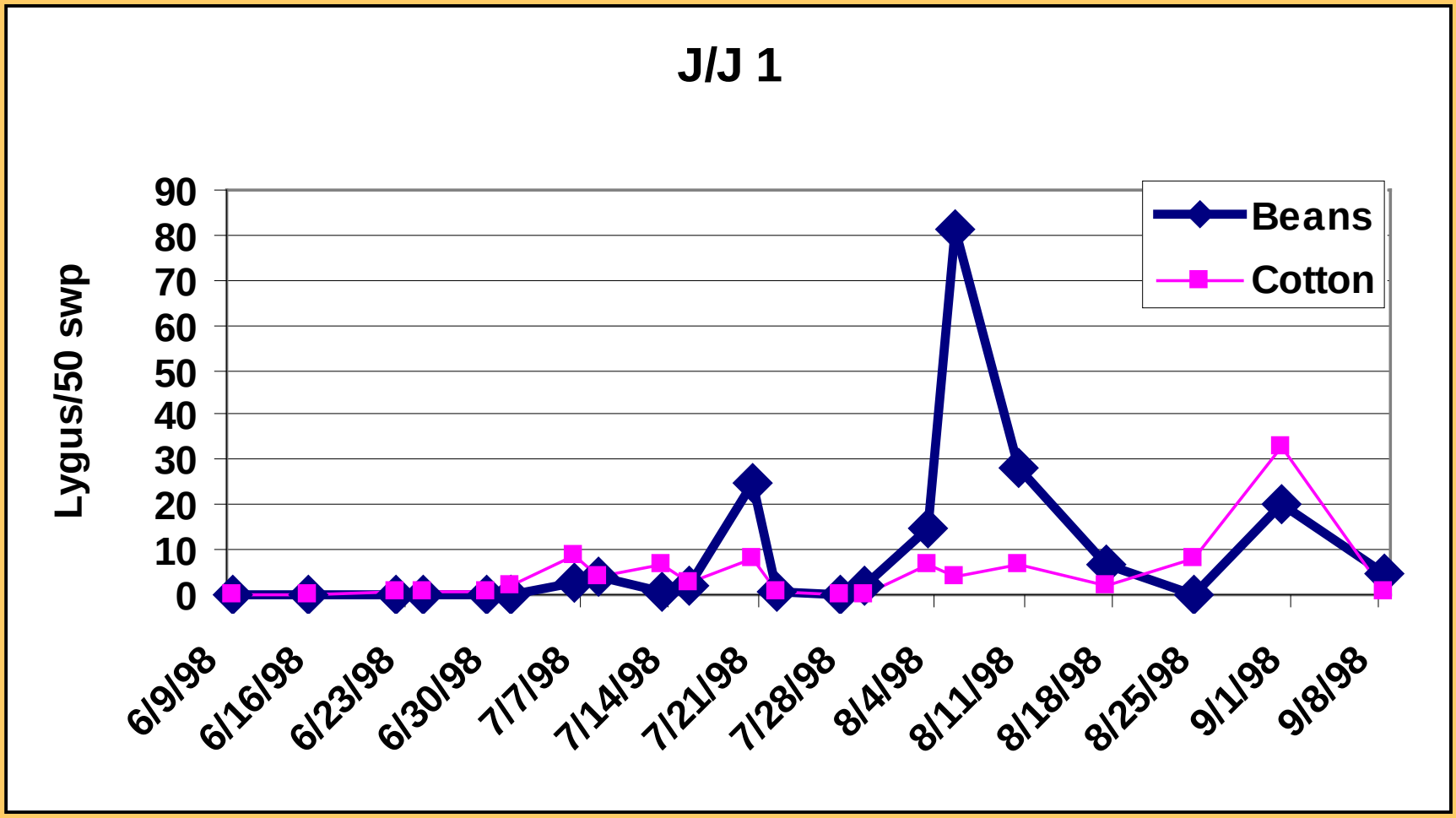
- Cowpea/Lima Bean
- More attractive than cotton
- 30 foot strip on upwind side
- *Snow fence*
- Slows migration
  - provides lead time
- Concentrates population
  - creates killing zone
  - reduces area to be treated
- Management similar to cotton



Lygus Populations in Cotton & Cowpea Buffer 1997

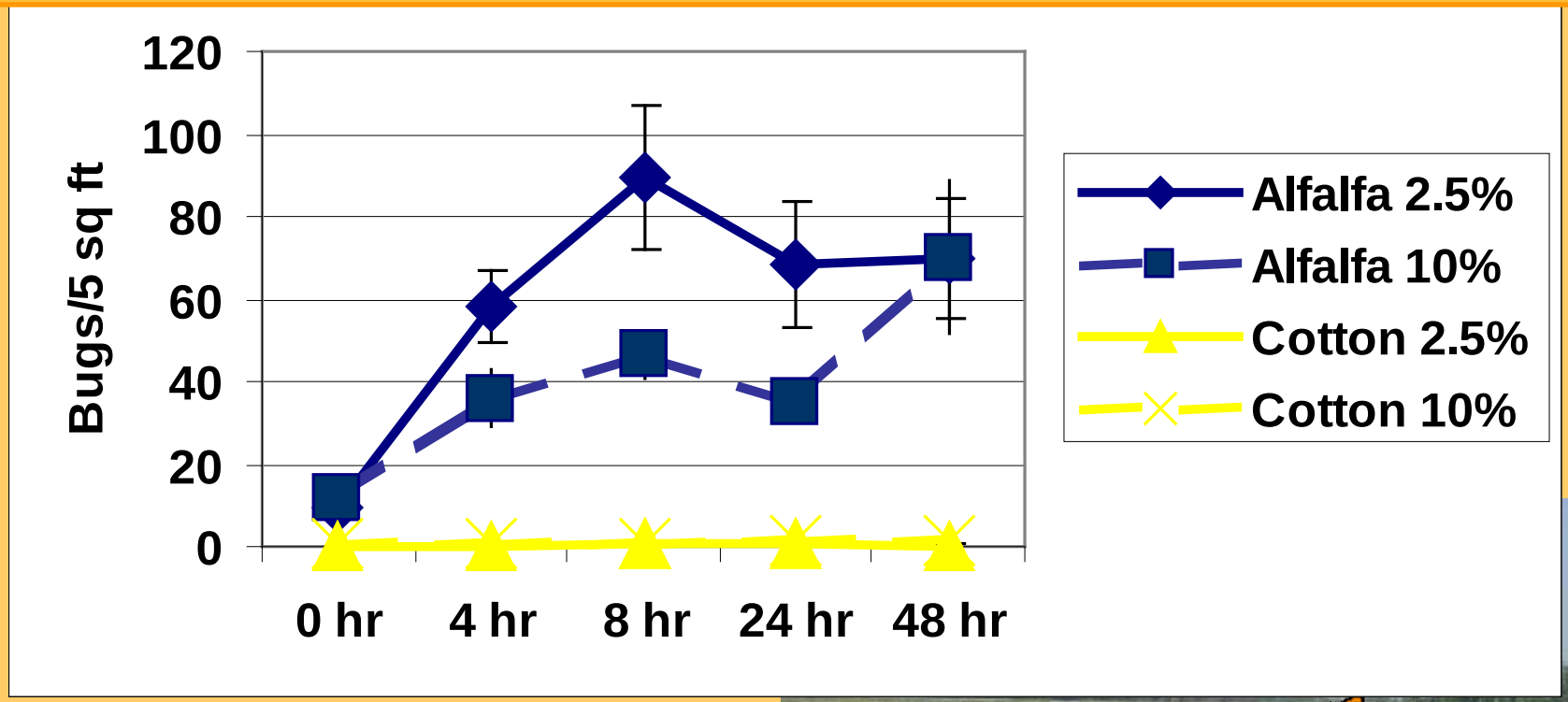


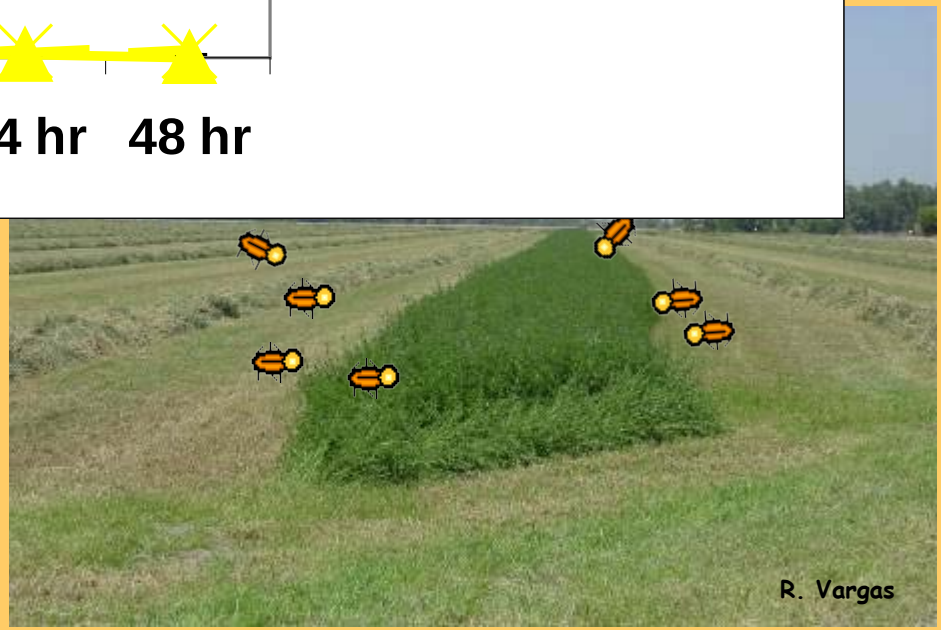
Do Buffer Strips Work?



Leaving Habitat for Lygus in Alfalfa

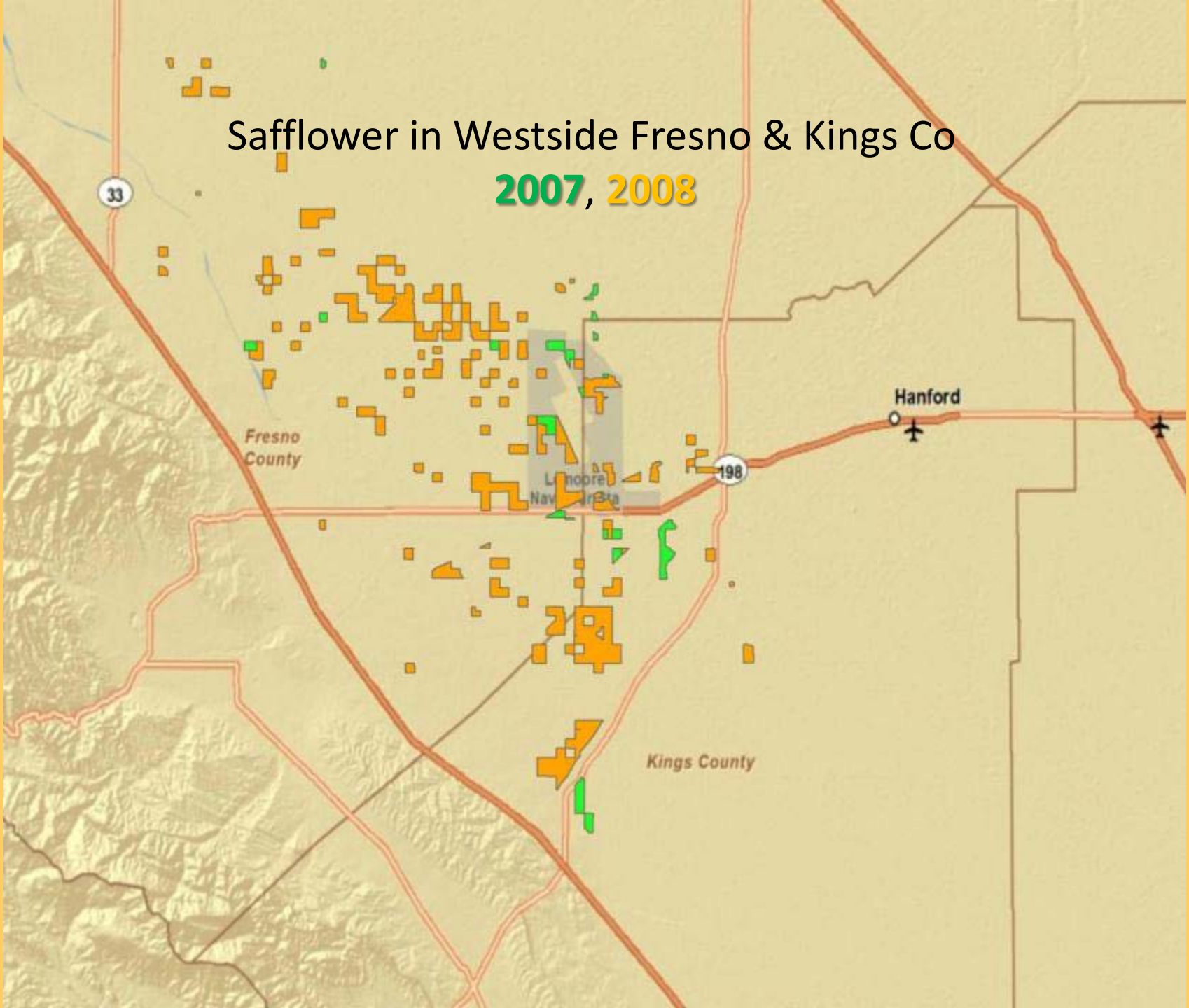
Adult Lygus Population Densities In Alfalfa and Cotton





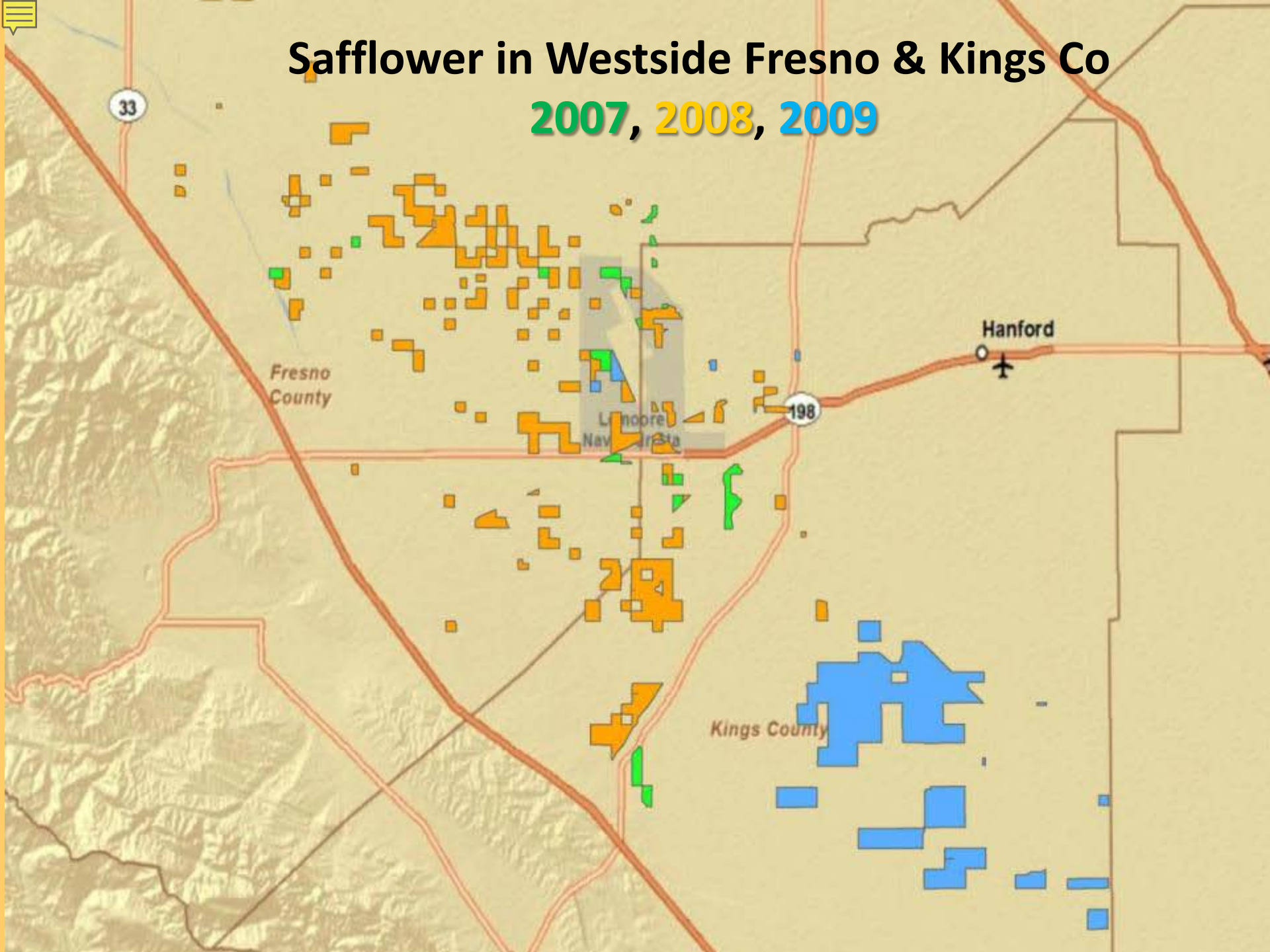
Safflower in Westside Fresno & Kings Co

2007, **2008**

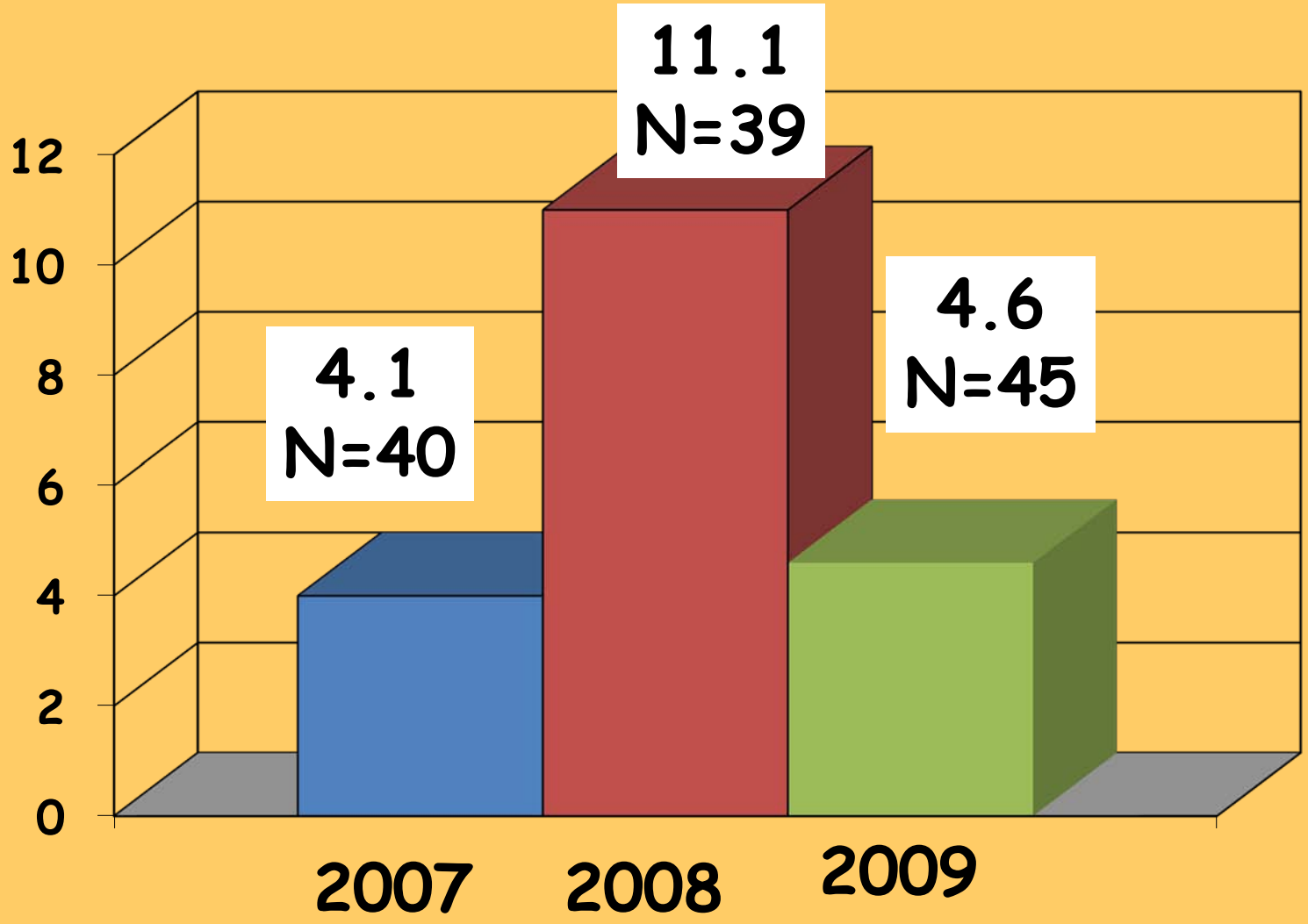


Safflower in Westside Fresno & Kings Co

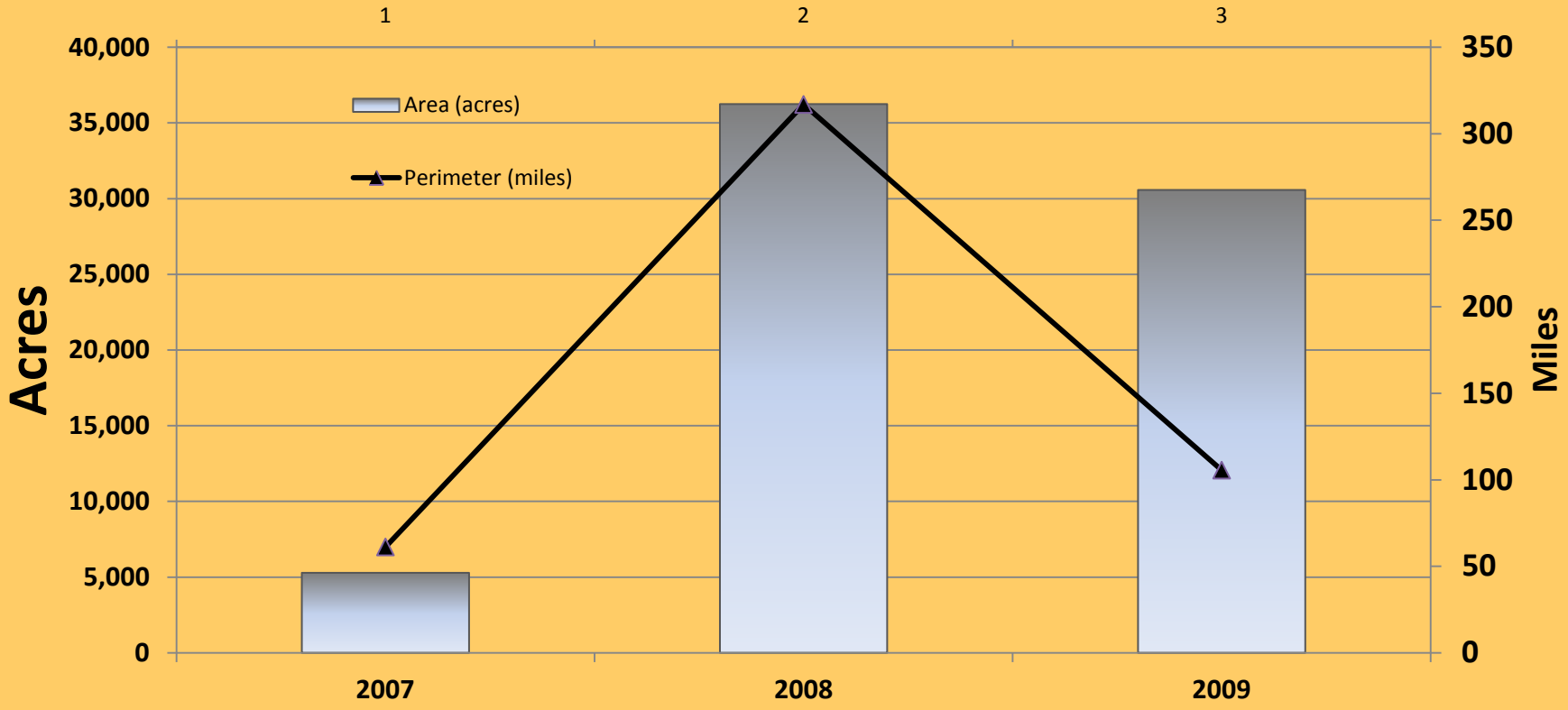
2007, 2008, 2009



Average Number Insecticide Applications On Cotton within RAMP Study Area

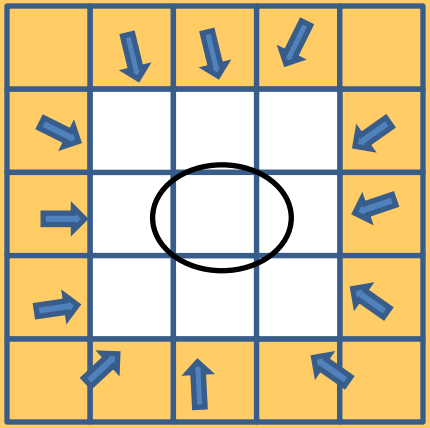


Safflower in West Fresno Co, 2007-09
Area vs. Perimeter

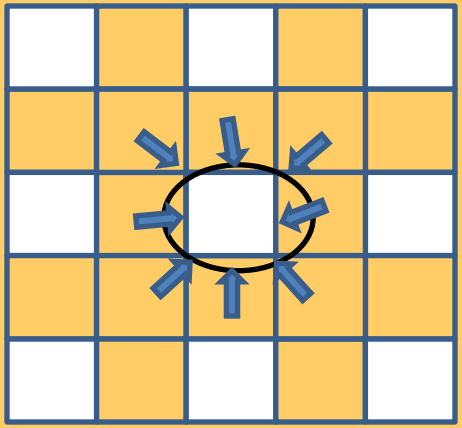


Management of Fragmented Landscapes
Planning Landscapes for IPM

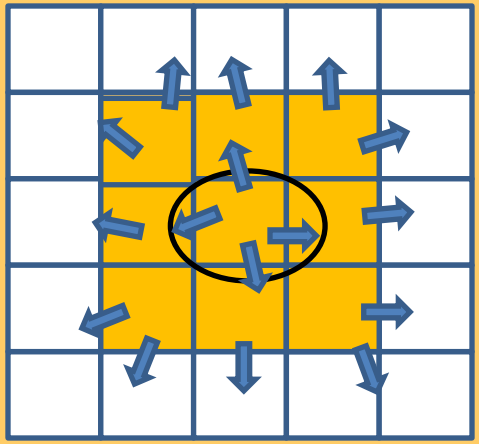
- Where key sources are intermixed with cotton sinks, problems arise
- Important to minimize boundary and interface



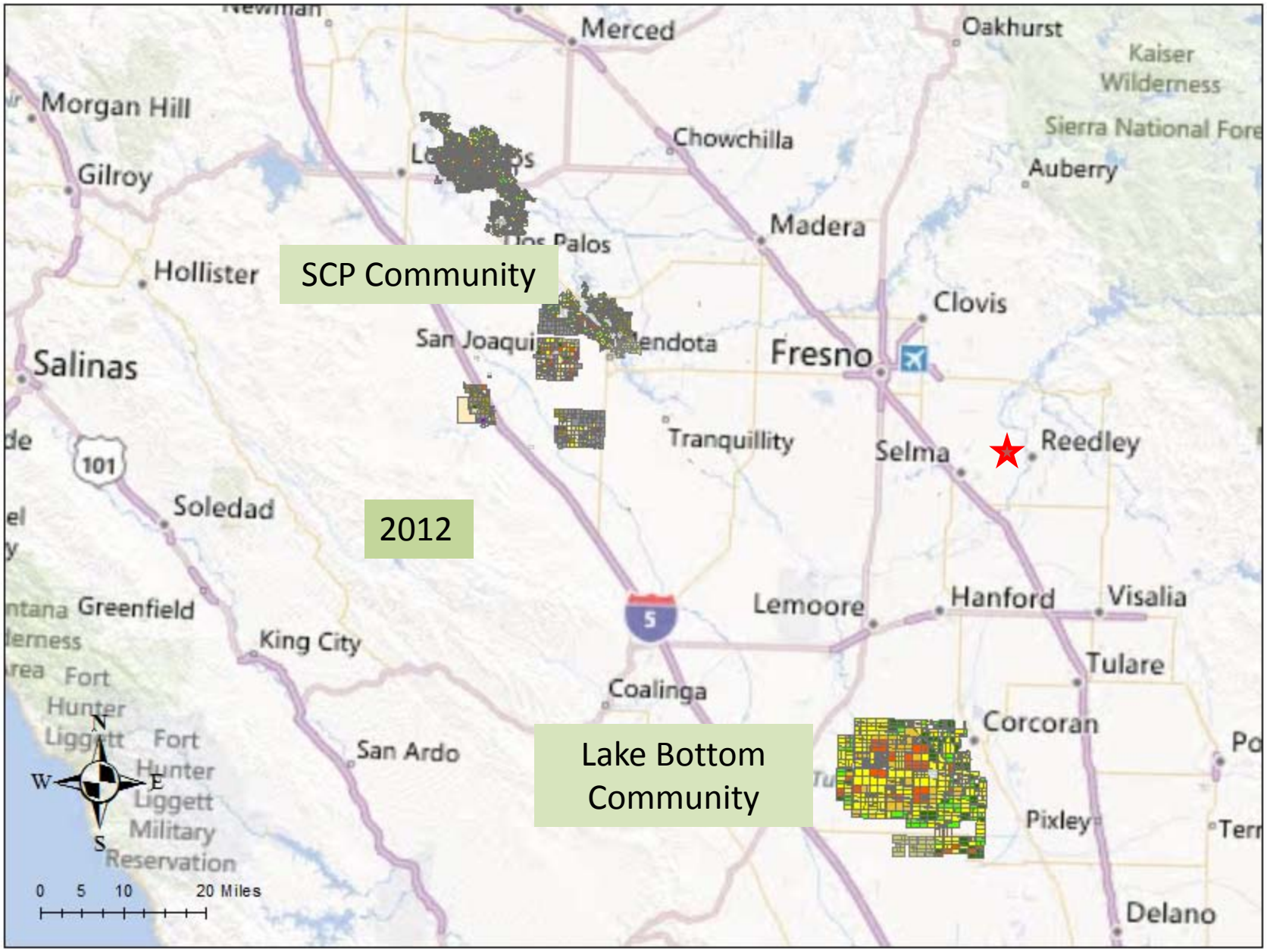
9 units of area
12 boundary units

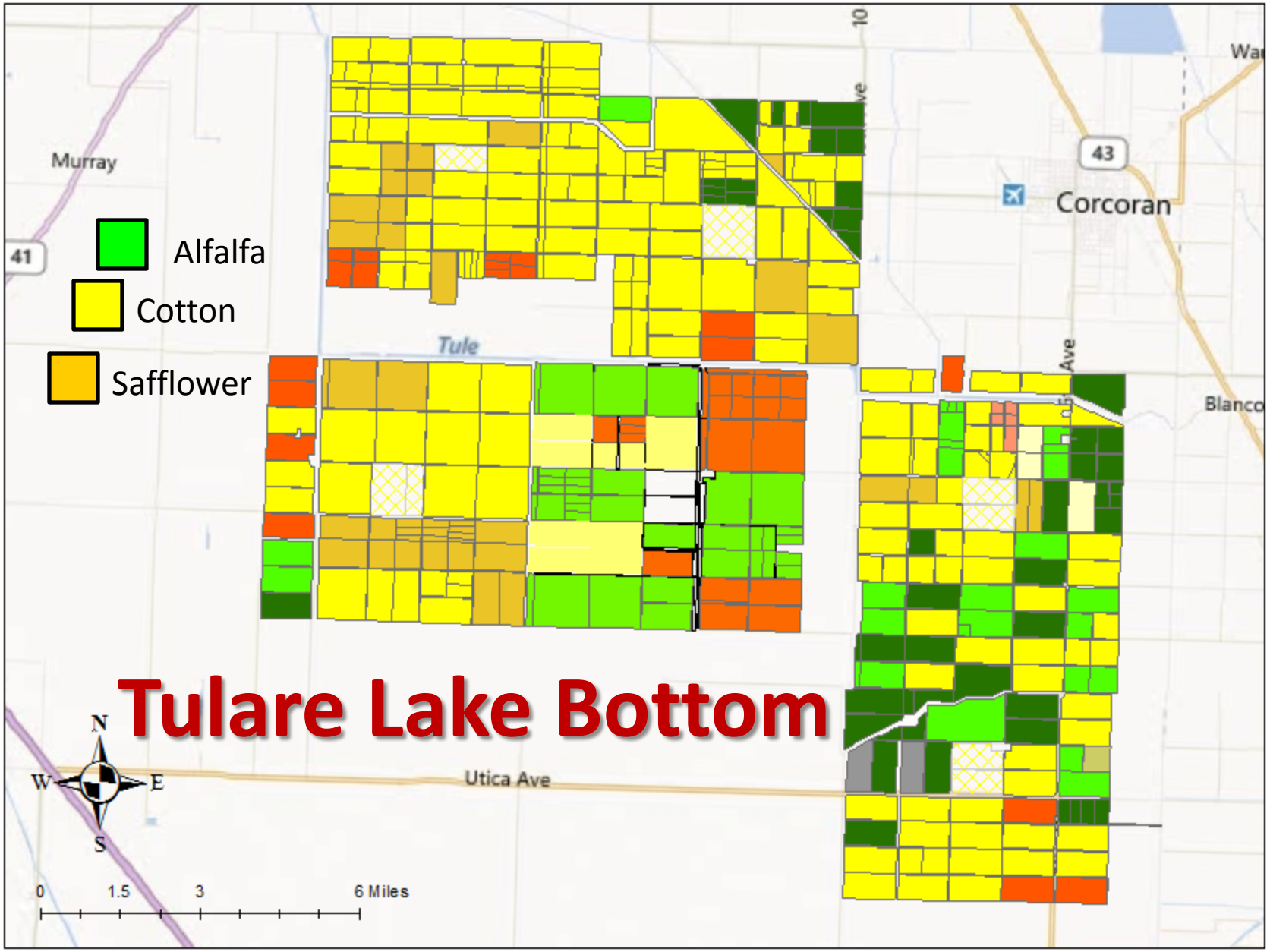


9 units of area
36 boundary units

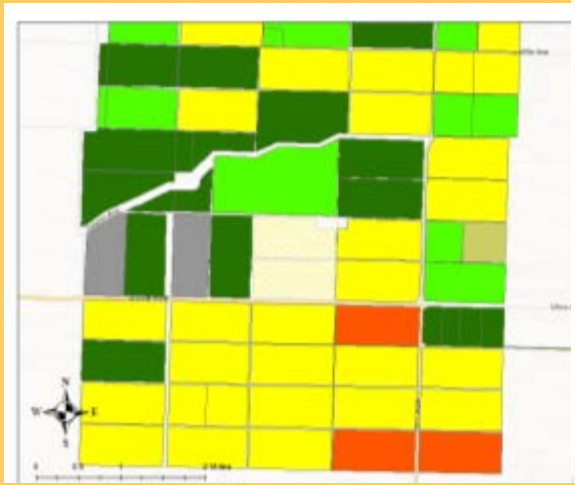


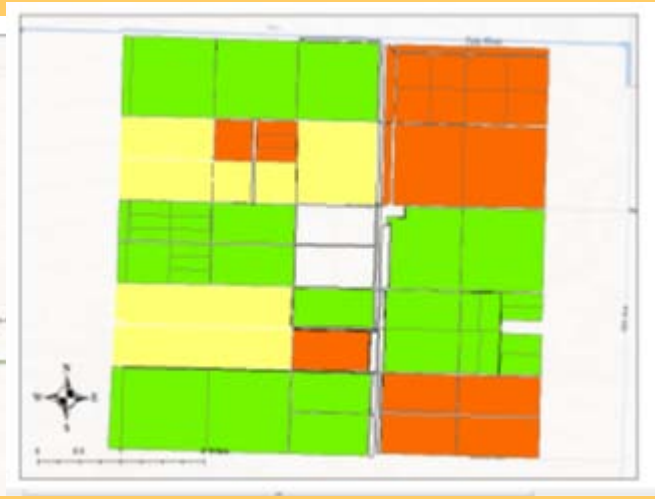
Concentrating sources
Minimize borders,
Maximize interior

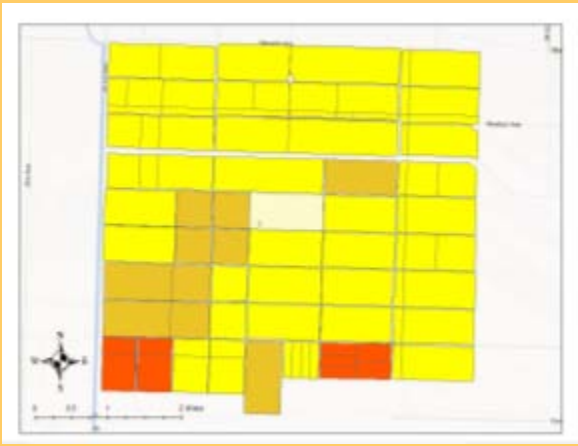

Merced
Oakhurst
Kaiser Wilderness
Morgan Hill
Sierra National Fore
Chowchilla
Gilroy
Auberry
Madera
Los Palos
SCP Community
Hollister
Clovis
San Joaquin
Fresno
Salinas
Tranquillity
Selma
Reedley
101
Soledad
2012
Greenfield
Lemoore
Hanford
Visalia
King City
Tulare
Coalinga
Corcoran
Fort Hunter Liggett
San Ardo
Lake Bottom Community
Fort Hunter Liggett Military Reservation
Pixley
Delano
N
W
E
S
0 5 10 20 Miles


Murray
41
Alfalfa
Cotton
Safflower
Tule
10
43
Corcoran
Blanco
Utica Ave
Tulare Lake Bottom
N
W
E
S
0
1.5
3
6 Miles

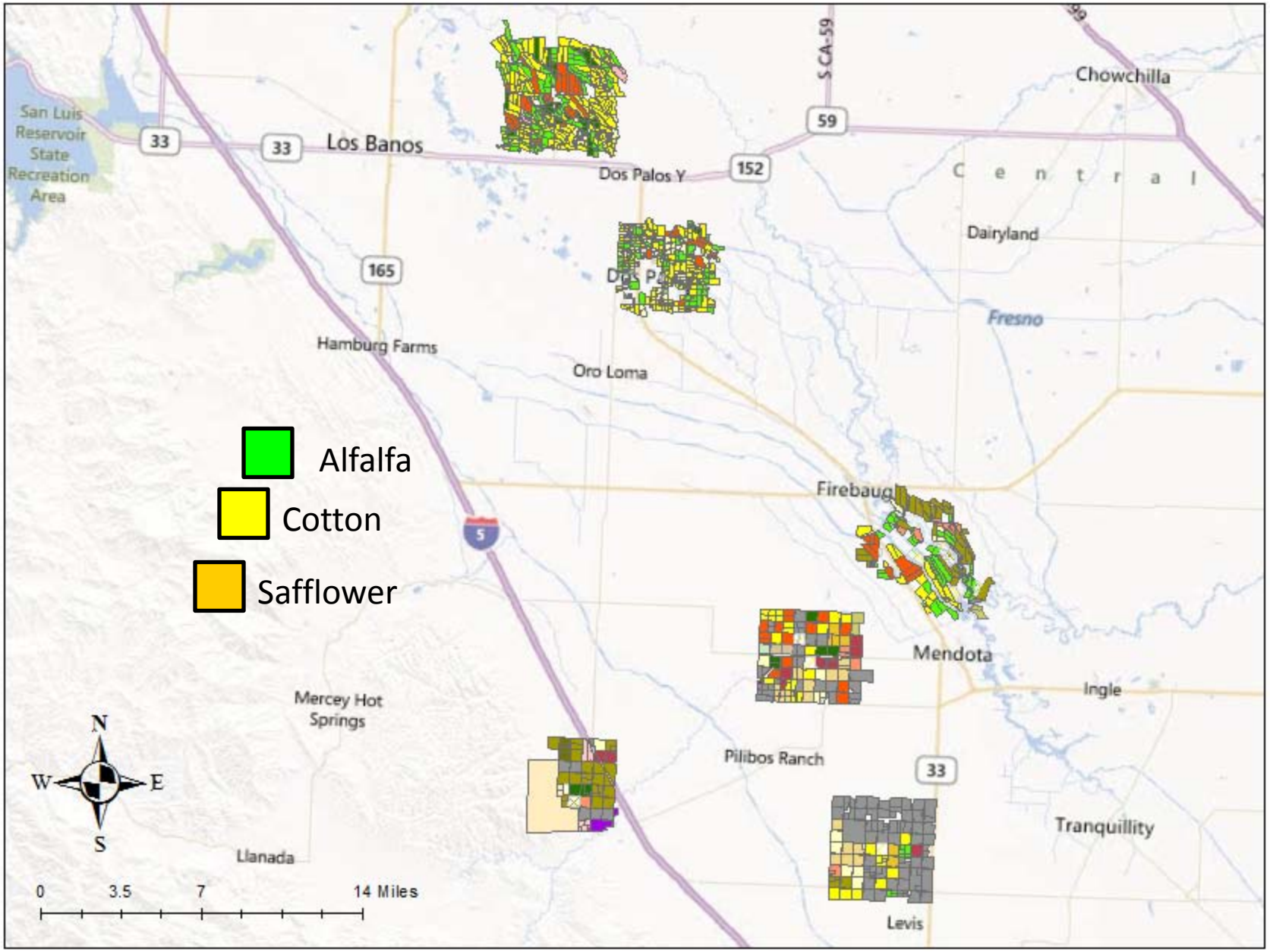
Tulare Lake Bottom



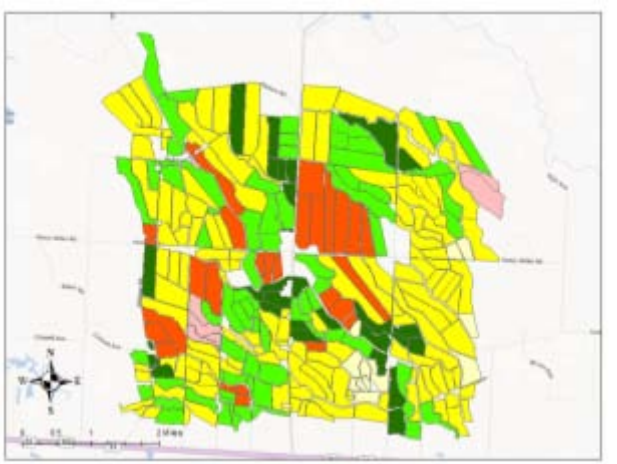


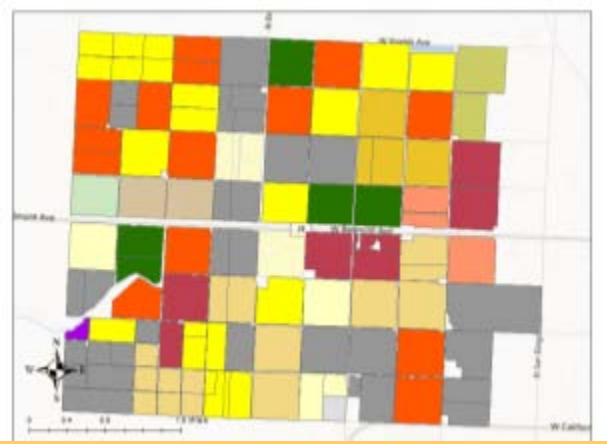


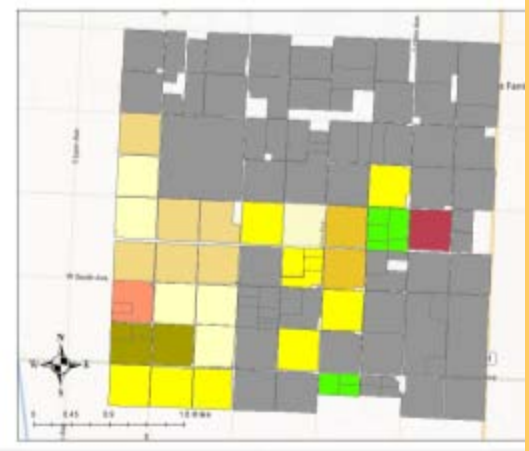
Sustainable Cotton Project

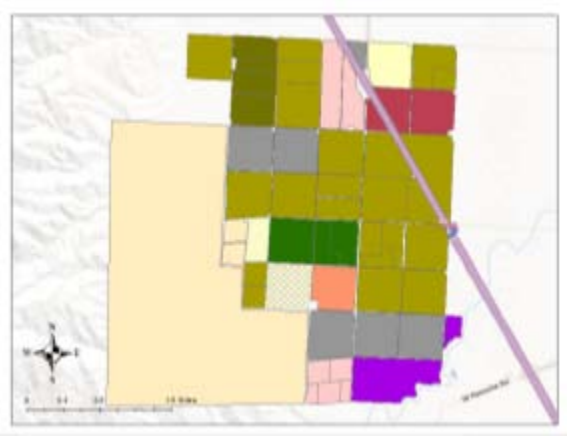


Sustainable Cotton Project
Focal Cotton Fields

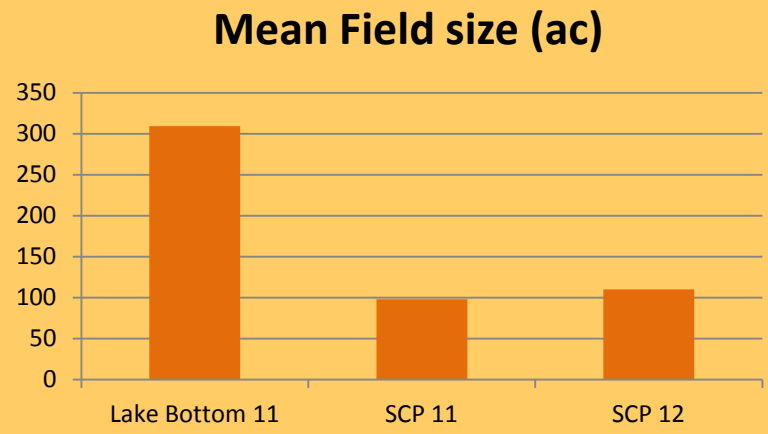


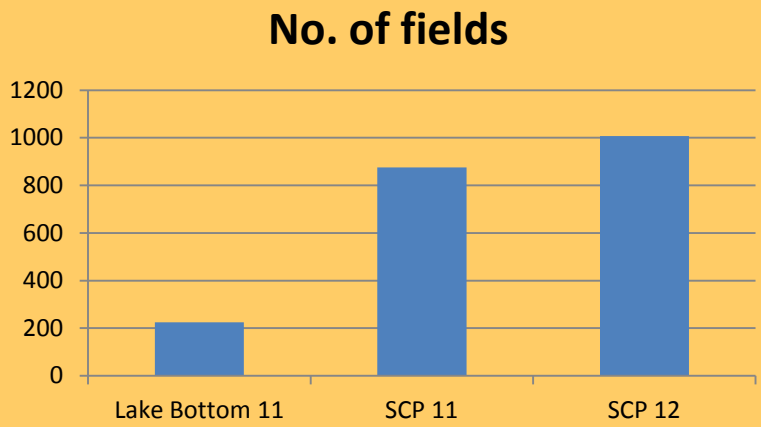


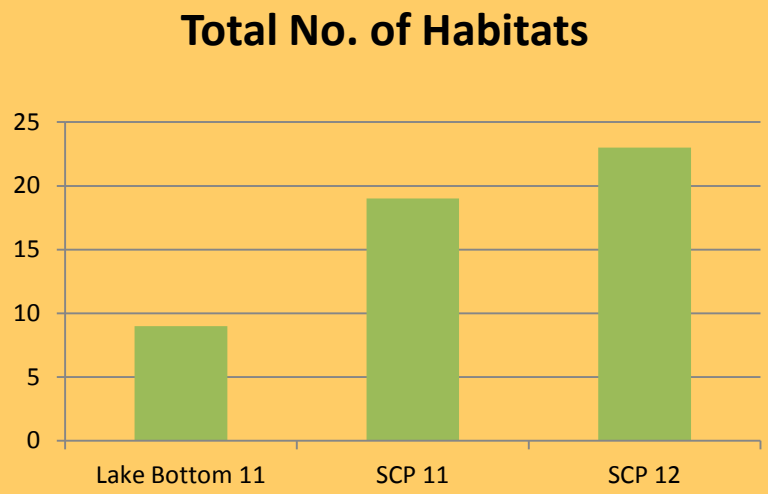


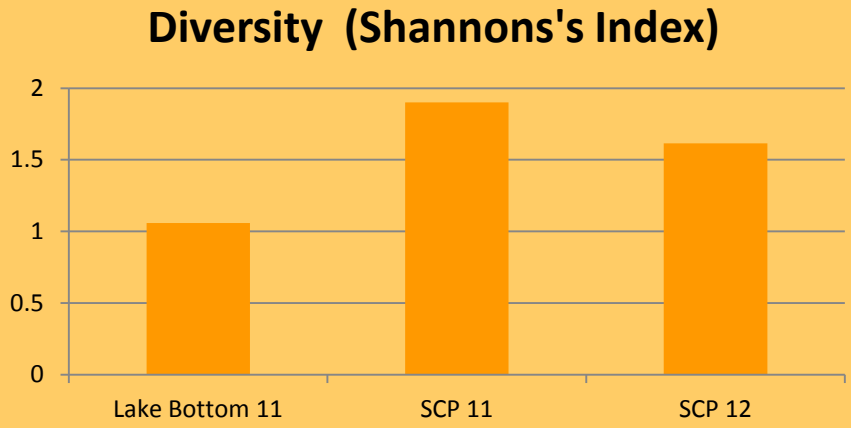


Comparison of 2 SJV Agricultural Landscapes

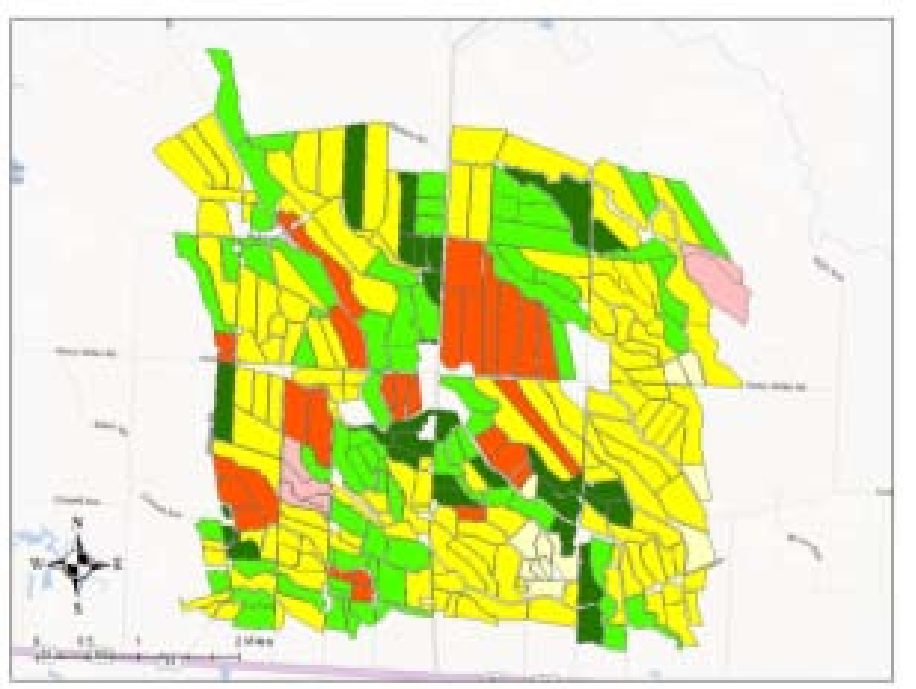


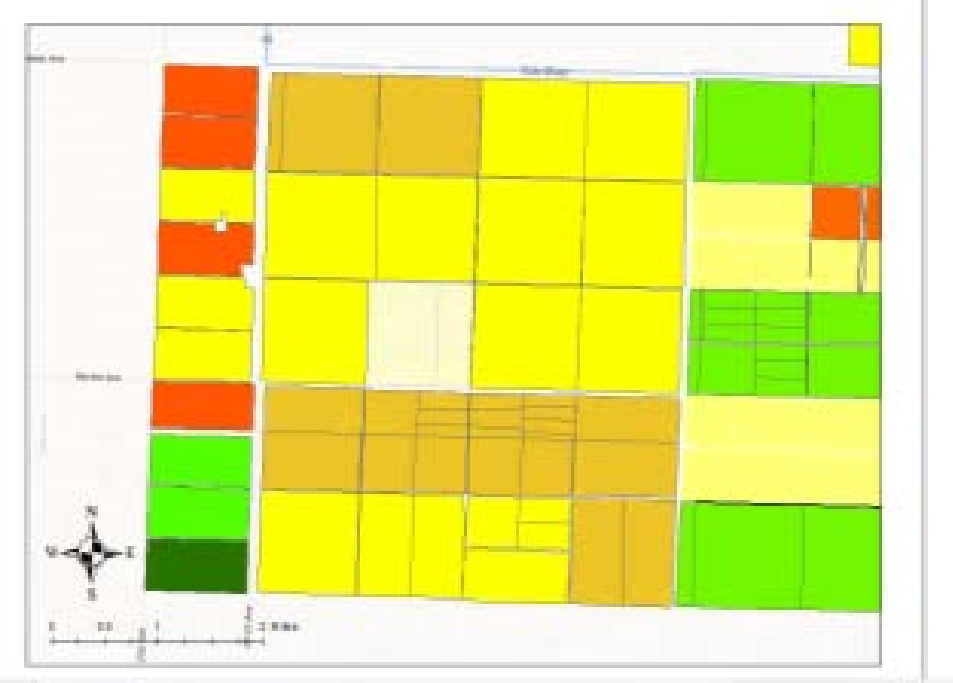






Comparison of Two SJV Agricultural Landscapes





Future Implications

- Approaches have application to other pests
- Creating cooperative community based pest management “districts”
  - Teaching the value of IPM at landscape scale
- Addressing multiple issues
  - Landscape planning can provide documentation for environmental and regulatory issues
  - NRCS links

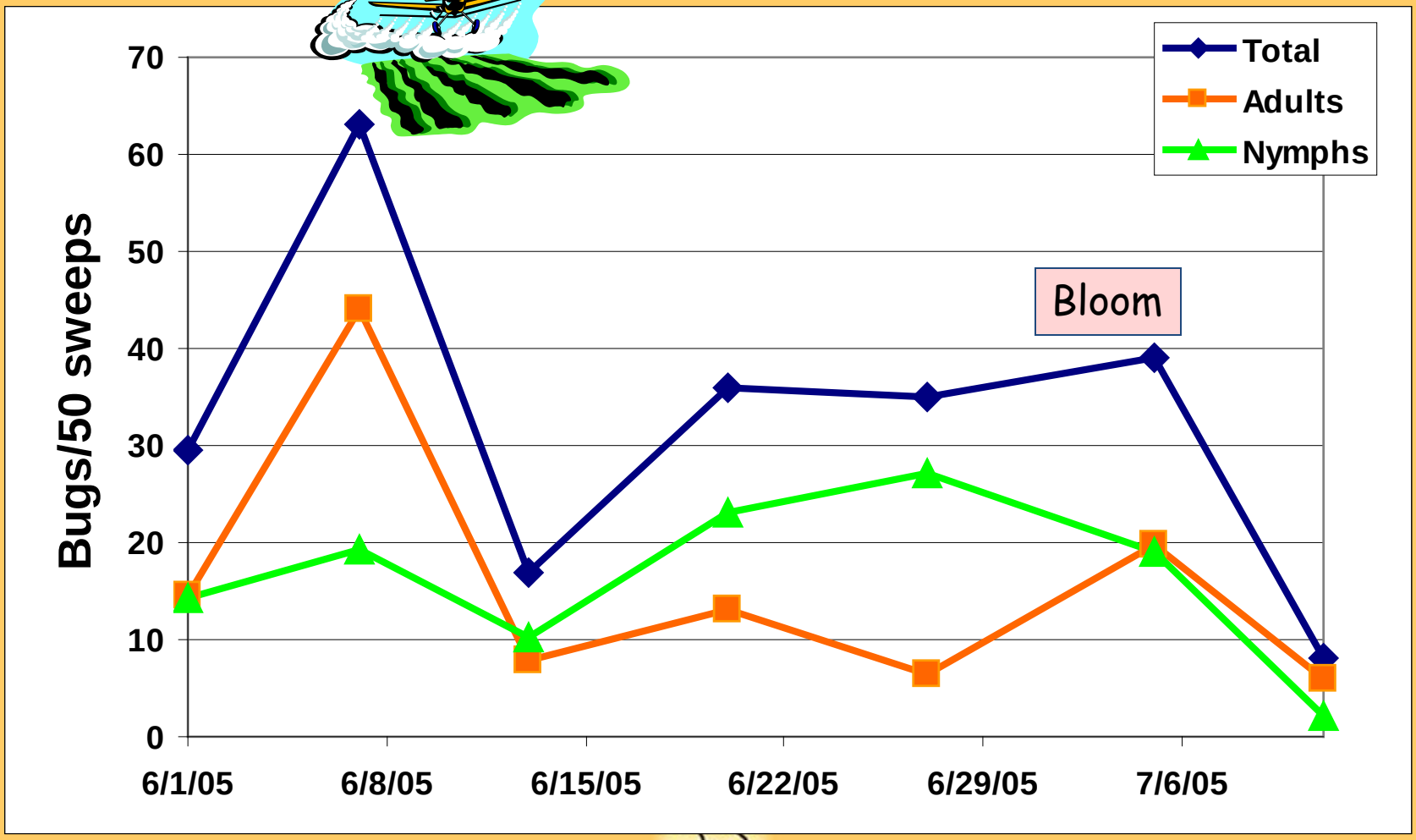
Primary Challenge: Avoid *Tragedy of the Commons*

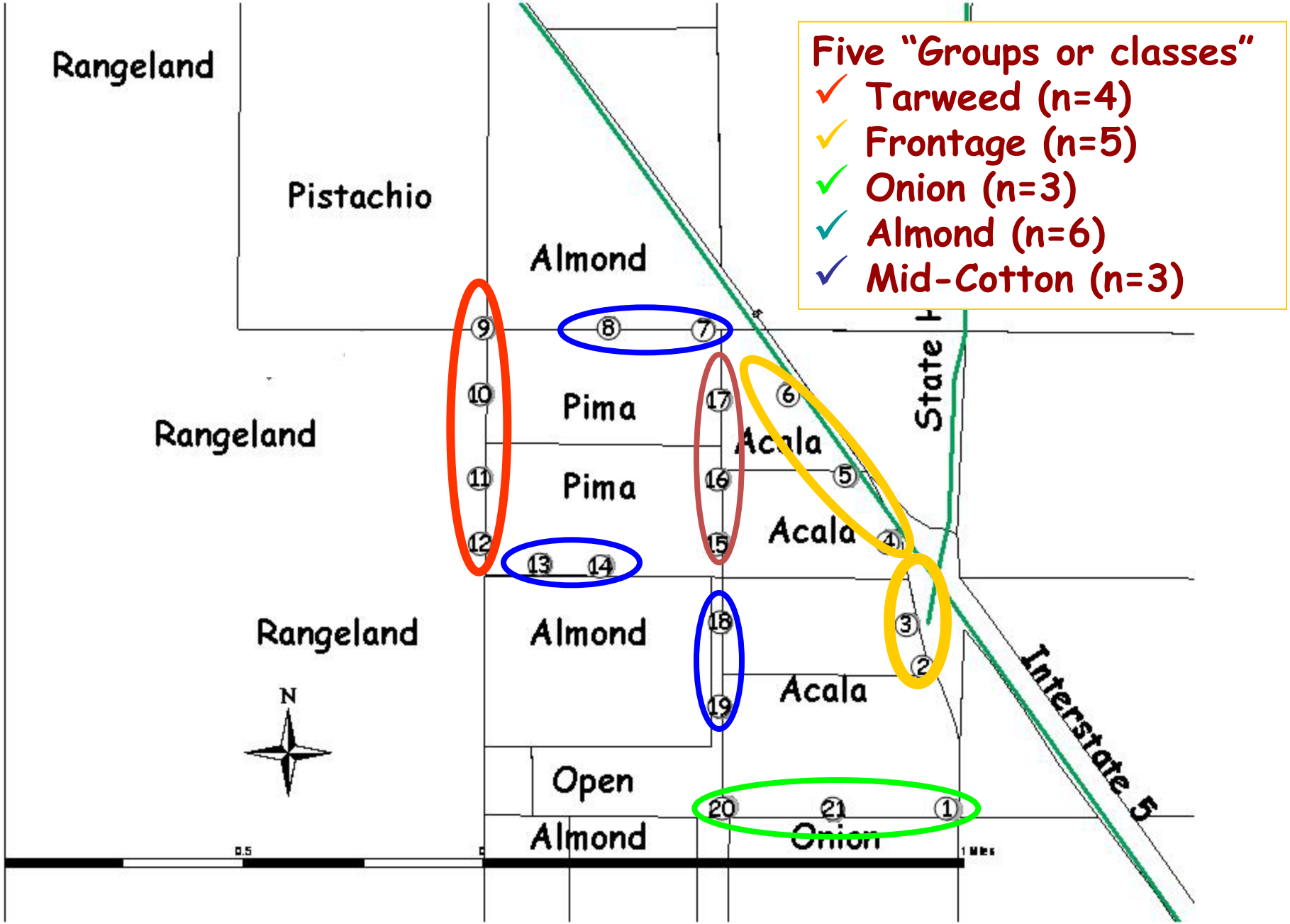
- Social challenge, not scientific
- Getting people to work together when their own best interest may not be rewarded (or harmed)
- Where large scale farms manage the landscape, many of these ideas have been implemented
  - Motivated landowners
- Where many landowners operate within the critical landscape scale, more challenging

Working with the Landscape
It's Not Easy, But Has its Rewards

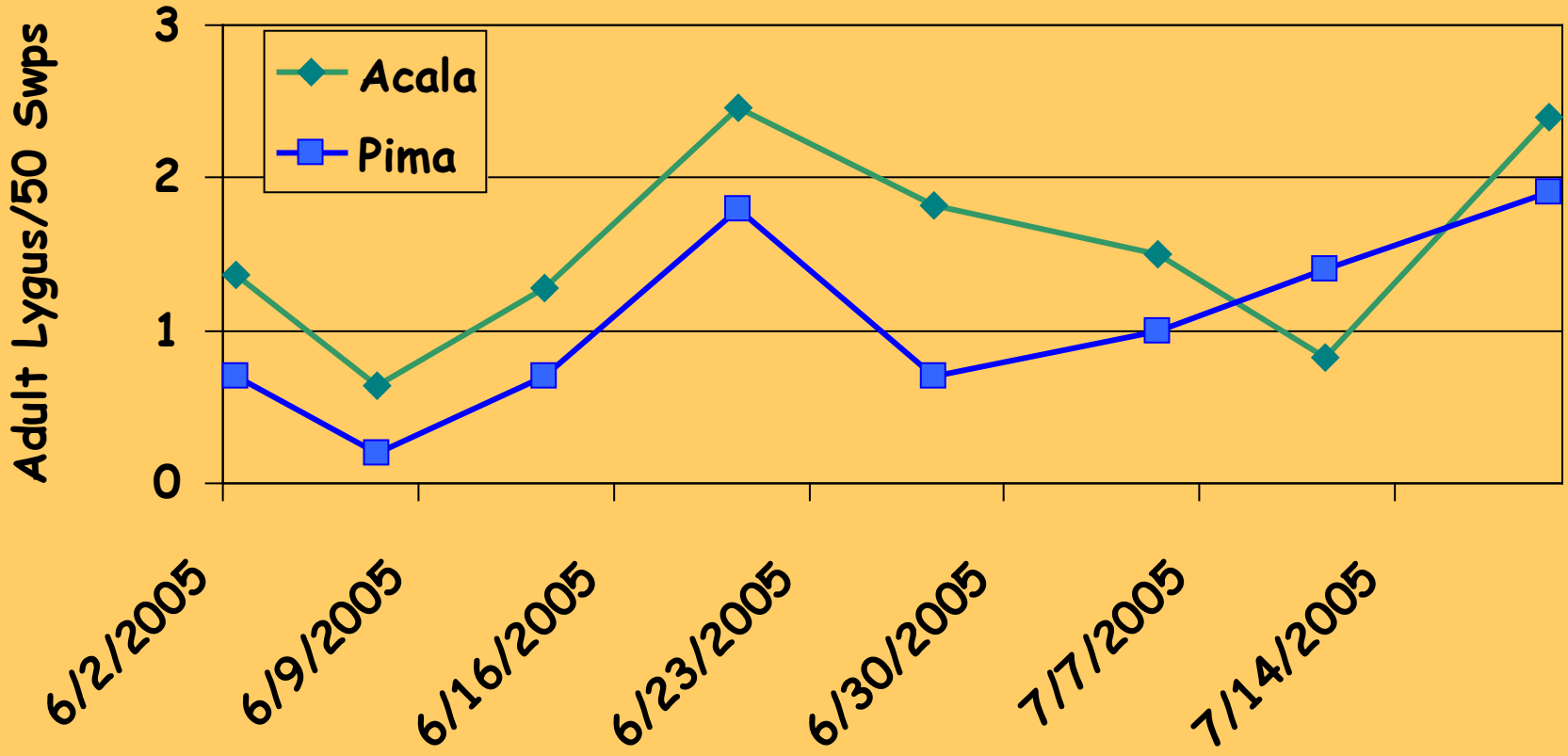
Thank You for Your Attention

Lygus Density in Tarweed 2005 – Three Rocks, CA

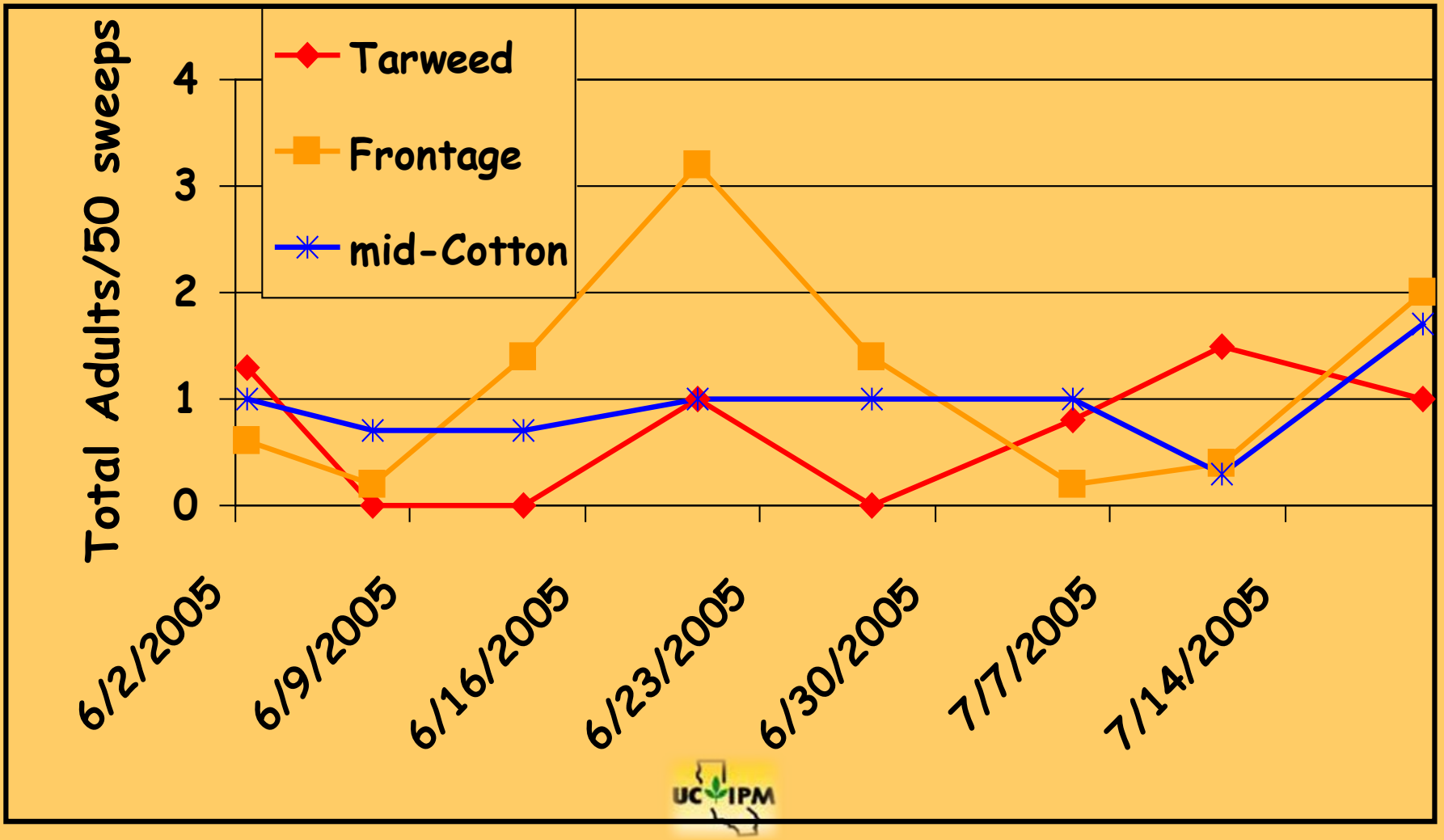



Five "Groups or classes"
✓ Tarweed (n=4)
✓ Frontage (n=5)
✓ Onion (n=3)
✓ Almond (n=6)
✓ Mid-Cotton (n=3)
Rangeland
Pistachio
Almond
Rangeland
Pima
Pima
Acala
Acala
Rangeland
Almond
Acala
Open
Almond
Onion
State
Interstate 5
N
9
8
7
10
17
6
11
16
5
12
15
4
13
14
18
3
2
19
20
21
1
0.5
1 Miles

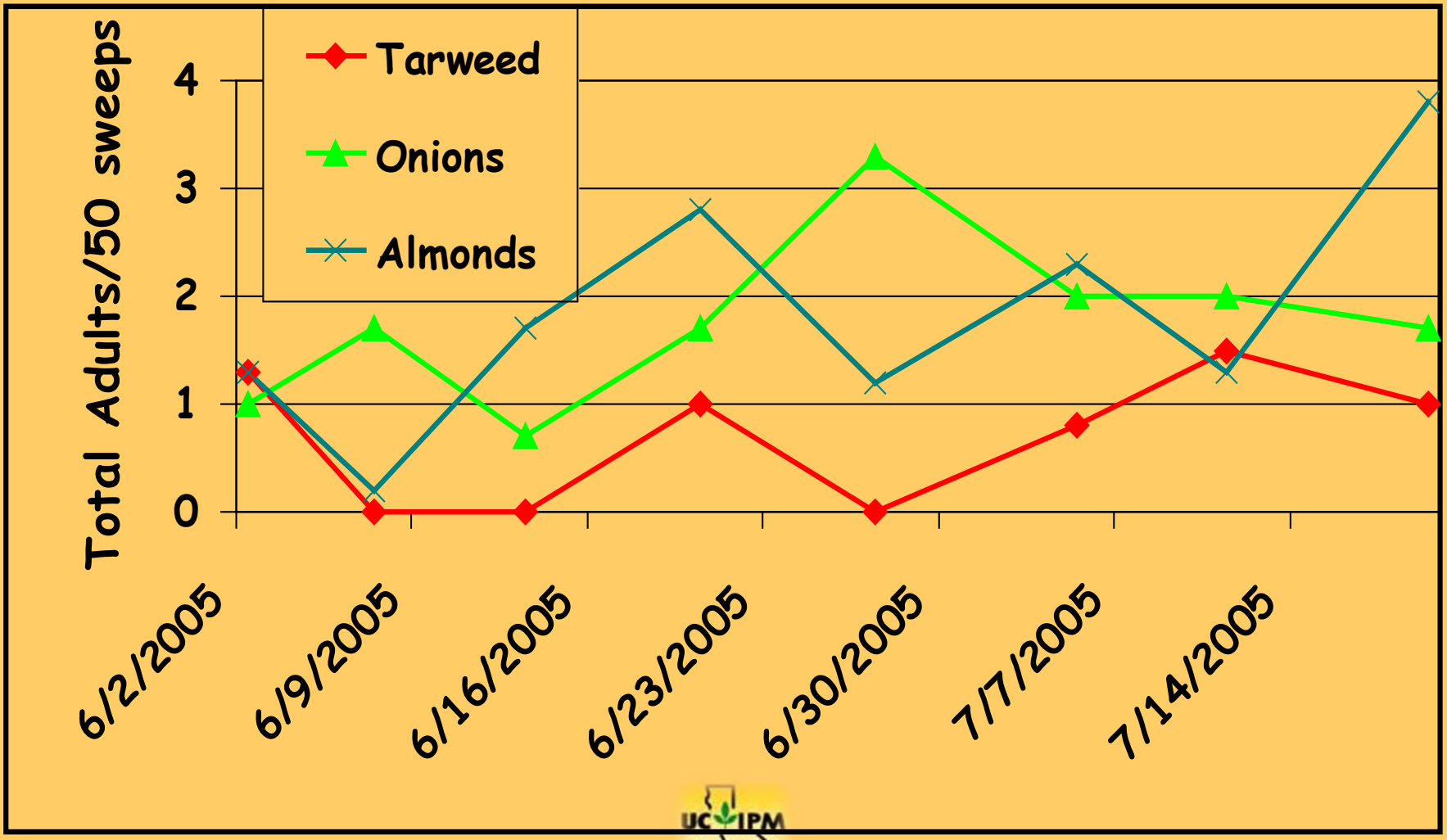
Lygus Density in Cotton



Lygus Densities in Cotton by "Class"



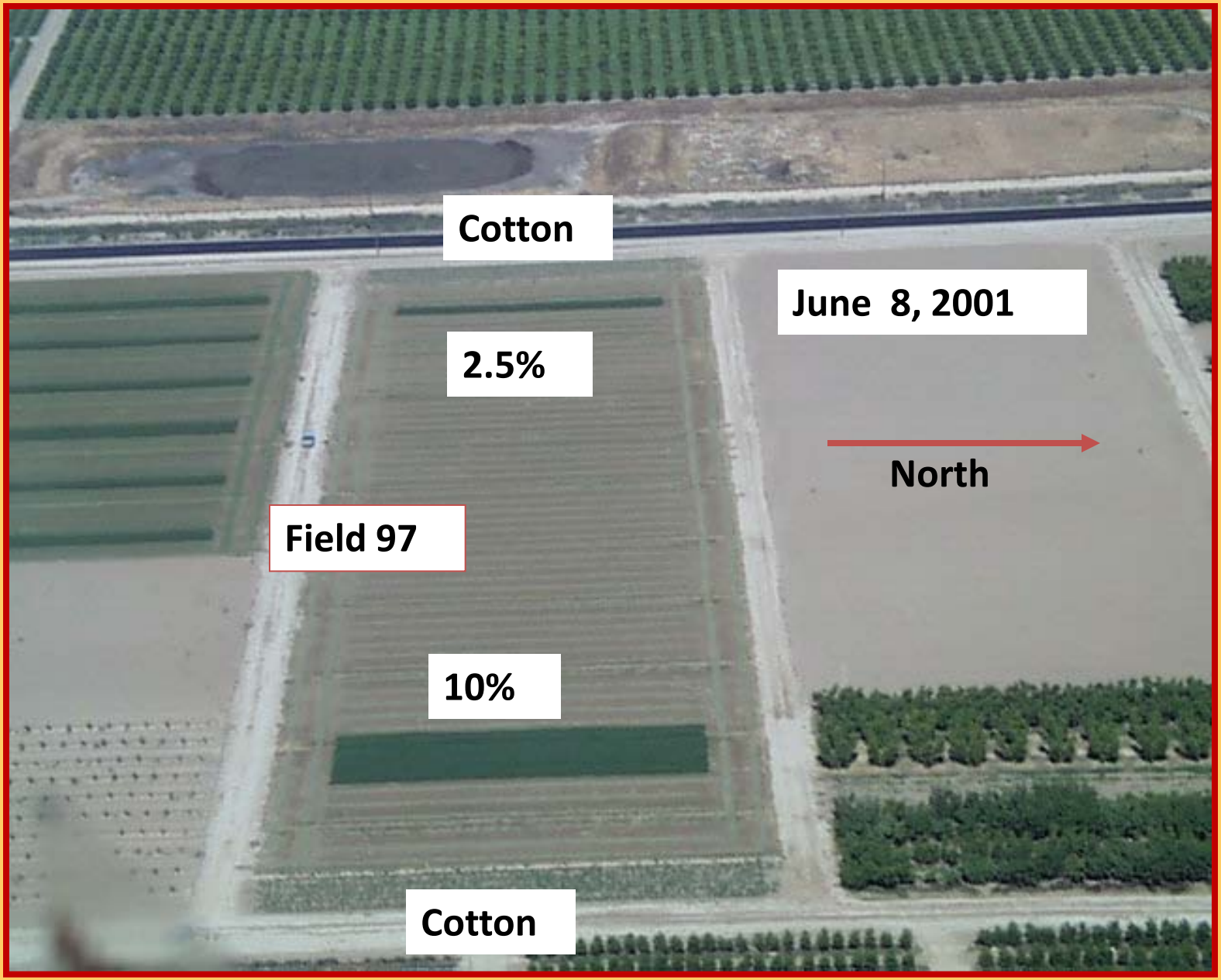
Lygus Densities in Cotton by "Class"



Crops Associated with Lygus Densities in Focal Cotton Fields

Increased Densities			Decreased Densities		
Crop	Distance		Crop	Distance	
	Meters	Miles		Meters	Miles
Safflower	3000	1.9	Almond	3000	1.9
Oat	2000	1.2	Pistachio	1000	0.62
Grape	3000	1.9	Alfalfa	2000	1.2
Onion	3000	1.9	Potato	1000	.62
Uncultivated	1000	0.62	Cotton	3000	1.9

Source: F. Sivakoff, PhD Thesis, Figure 1,
Influence of the Surrounding Landscape on Crop Colonization by an Insect Pest
(With JA Rosenheim, P. Dutilleul, and Y. Carrière)


Cotton
June 8, 2001
2.5%
North
Field 97
10%
Cotton