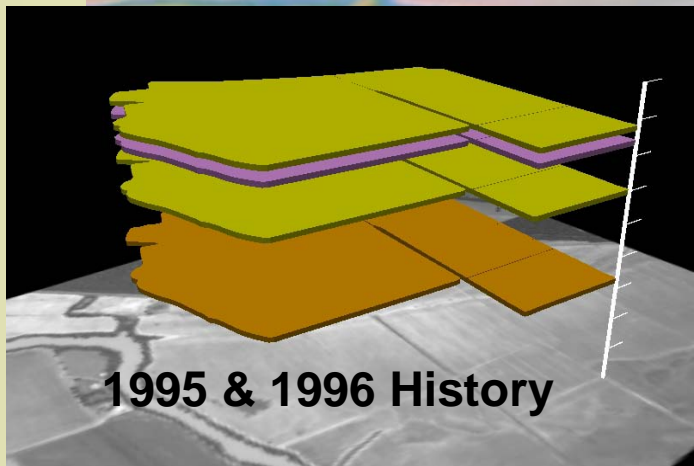
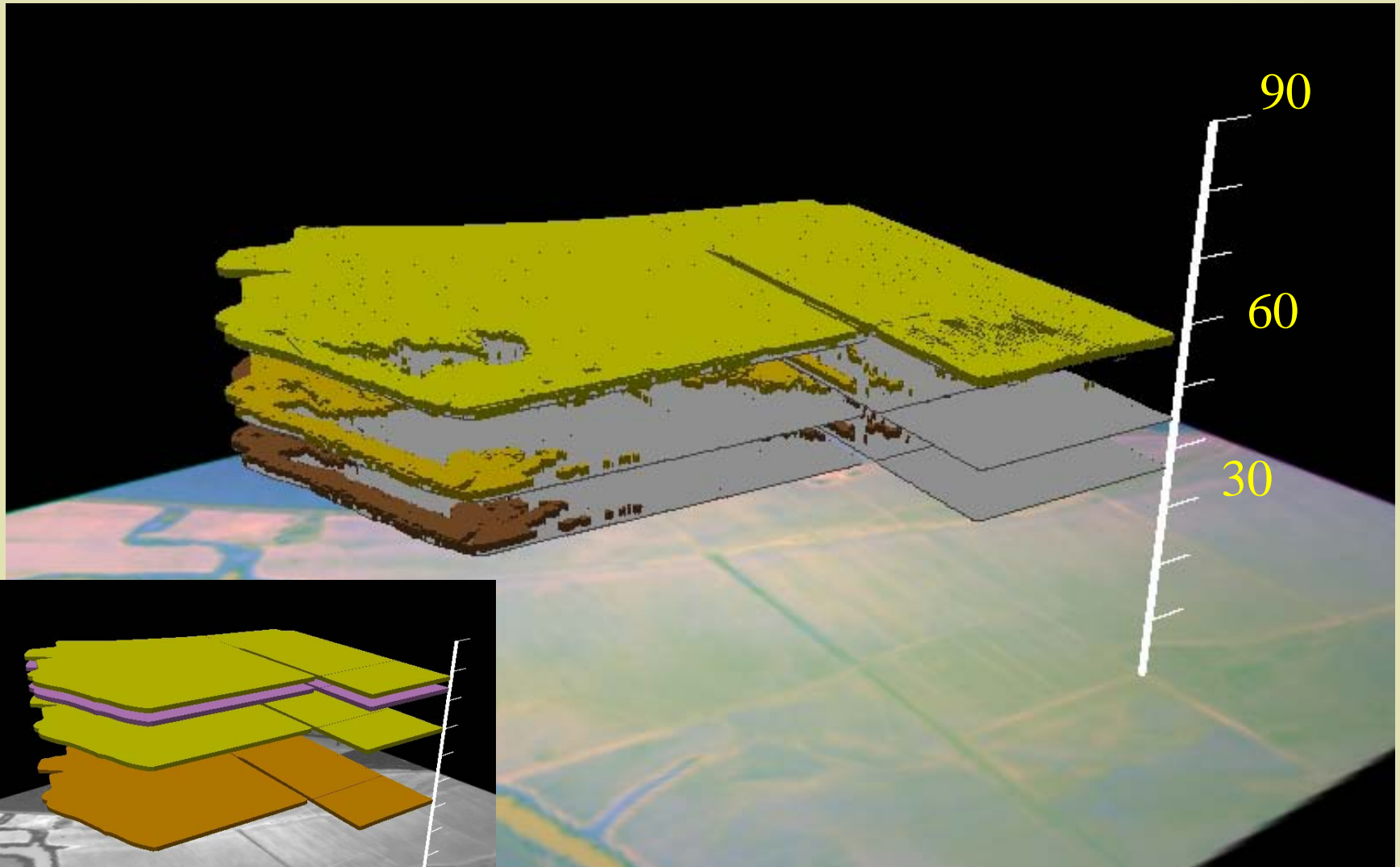


# Definition of Precision Agriculture or Site-specific Management (SSM)

- The Right Amount...
- At the Right Place...
- At the *Right Time!!!*
- And can involve usage of broadcast applications and choice of chemical types...(achieved in 2011)

# Timing and Prescribed Extent of 1999 SVI Applications



# Application of FRAGSTATS metrics to Categorical Imagery Products used for Tarnished Plant Bug Sampling and Management

**Jeffrey L. Willers, USDA-ARS, Genetics and Precision  
Agriculture Research Unit, Mississippi State**

**Georges Backoulou, Oklahoma State University,  
Noble Research Center Stillwater, OK**

**And with the assistance of:**

**V. M. Stern, R. F. Smith, R. van den Bosch, and K. S. Hagen**

***THE INTEGRATED CONTROL CONCEPT***

**Hilgardia, 29(2). 1959**

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# H I L G A R D I A

*A Journal of Agricultural Science Published by  
the California Agricultural Experiment Station*

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Vol. 29

OCTOBER, 1959

No. 2

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## **THE INTEGRATED CONTROL CONCEPT<sup>1</sup>**

**VERNON M. STERN, RAY F. SMITH, ROBERT van den BOSCH,  
and KENNETH S. HAGEN<sup>2</sup>**

ALL ORGANISMS are subjected to the physical and biotic pressures of the environments in which they live, and these factors, together with the genetic make-up of the species, determine their abundance and existence in any given area. Without natural control, a species which reproduces more than the parent stock could increase to infinite numbers. Man is subjected to environmental pressures just as other forms of life are, and he competes with other organisms for food and space.

**1959 Stern *et al.* state:**

- 1. Arthropod resistance to insecticides.**
- 2. Secondary outbreaks of arthropods other than those against which control was originally directed ...**
- 3. The rapid resurgence of treated species necessitating repetitious insecticide applications...and etc.**

**Stern et al. state:**

**“Whatever the reasons for our increased pest problems, it is becoming more and more evident that an integrated approach, utilizing both biological and chemical control, must be developed in many of our pest problems if we are to rectify the mistakes of the past and avoid similar ones in the future.”**

**How can this be achieved???**

# Ecological Linkages to Precision Agriculture (PA)

- The **Crop, Pests and Beneficials** require food, shelter, and space to live and reproduce.
- **PA (SSM)** exploits geo-spatial and geo-temporal relationships!!!
- **PA** proposes that pests vary from area to area across fields and from edge to edge of the same field thru the season...

# Some of the good guys...

- Obtained from commercial cotton and soybeans fields in 2010 and 2011...
- What they do is still unknown for some of them...
- The point to remember is that beneficials can persist in a PA integrated control construct....

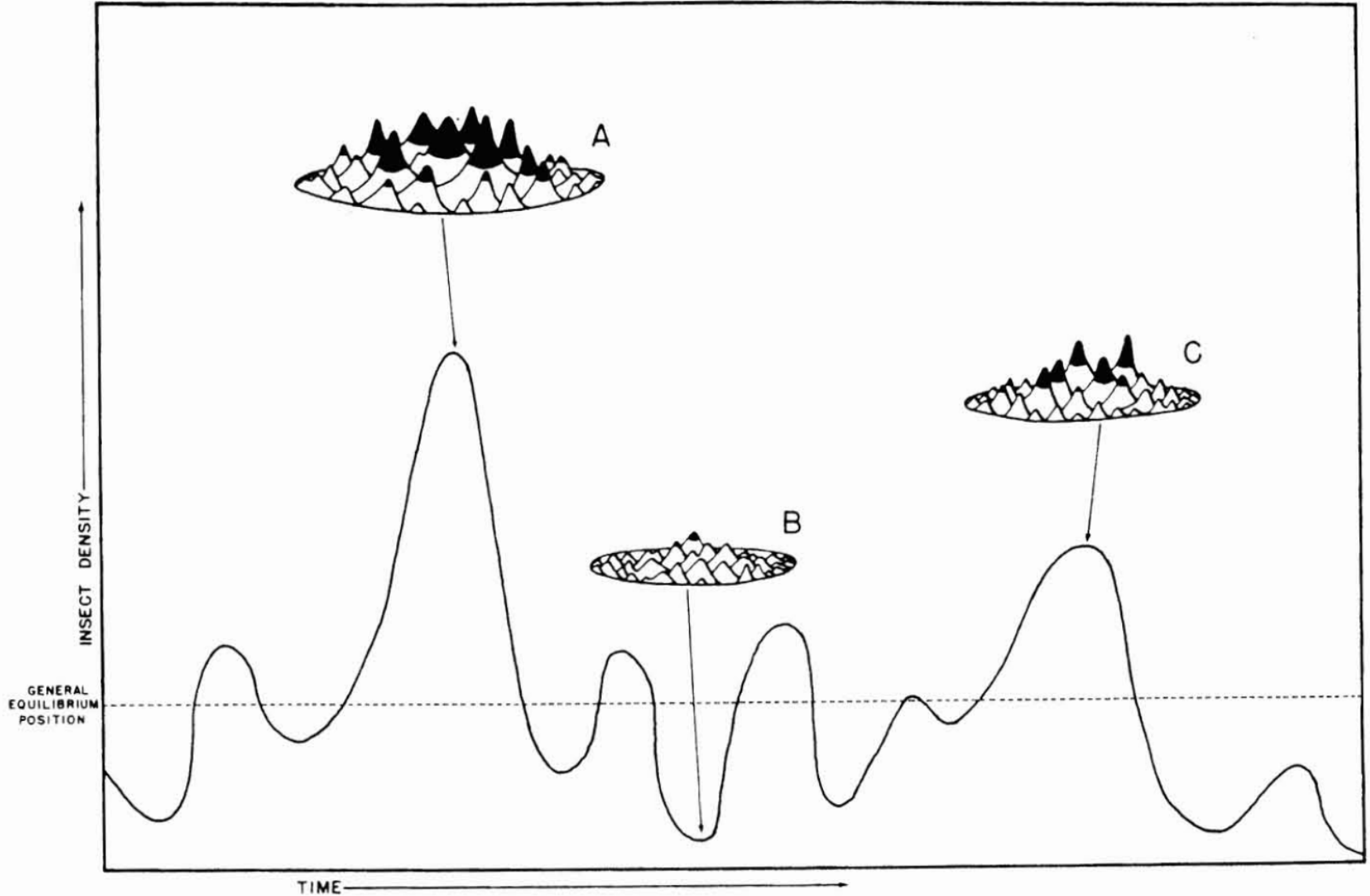




## THE INTEGRATION OF BIOLOGICAL AND CHEMICAL CONTROL

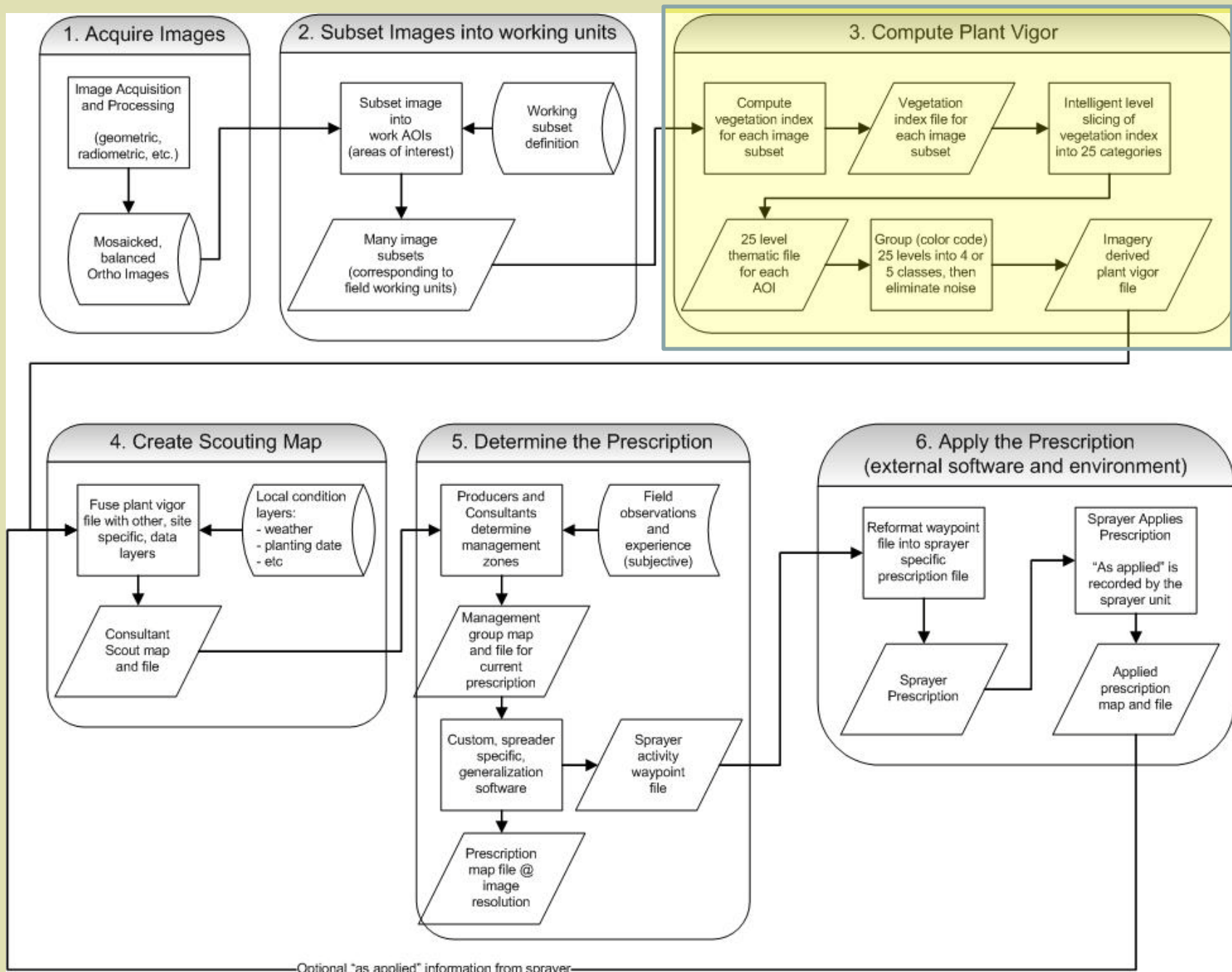
- “Biological control and chemical control are not necessarily alternative methods; in many cases they may be complementary, and, with adequate understanding, can be made to augment one another. One reason for the apparent incompatibility of biological and chemical control is our failure to recognize that the control of arthropod populations is a complex ecological problem. This leads to the error of imposing insecticides on the ecosystem, rather than fitting them into it.” (Stern et al. 1959)

# ECONOMIC THRESHOLDS AND THE GENERAL EQUILIBRIUM POSITION

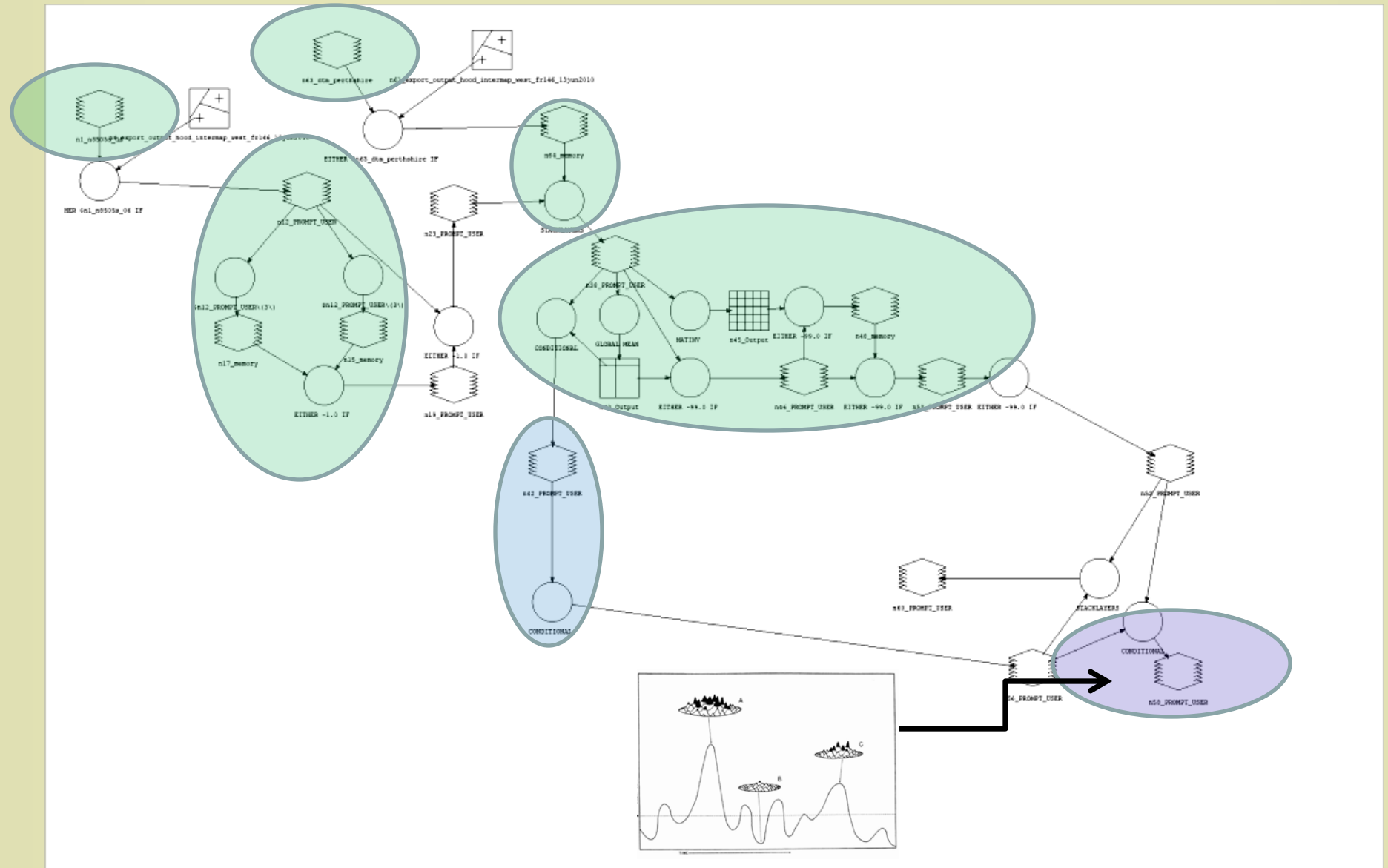


Since pests vary within a single field, edge to edge, over time...  
PA is the process that **INTEGRATES BIOLOGICAL AND CHEMICAL CONTROL**

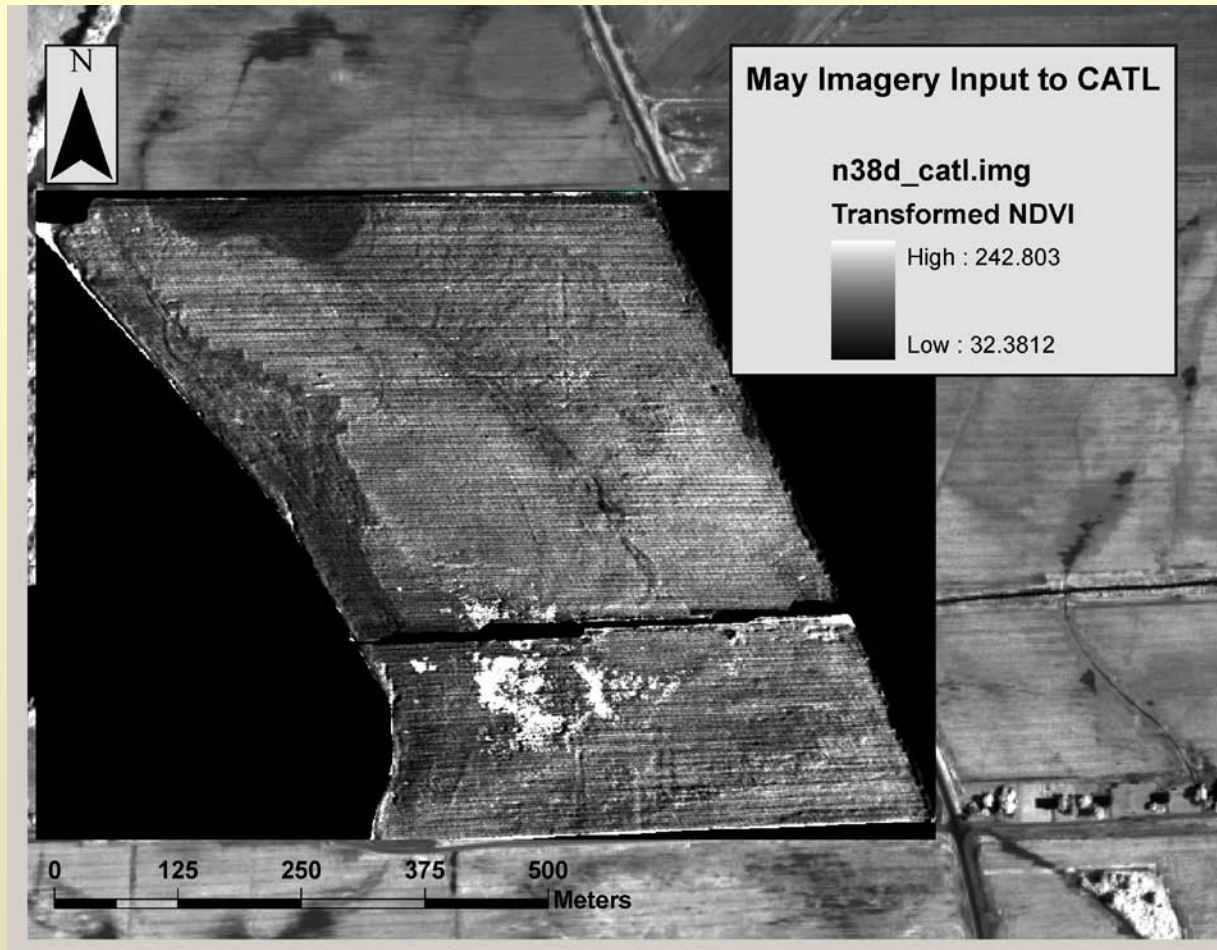
- Field example – May 2012
- Building the Categorical, Pseudo-likelihood product (CATL)
- Analyses of CATL by FRAGSTATS



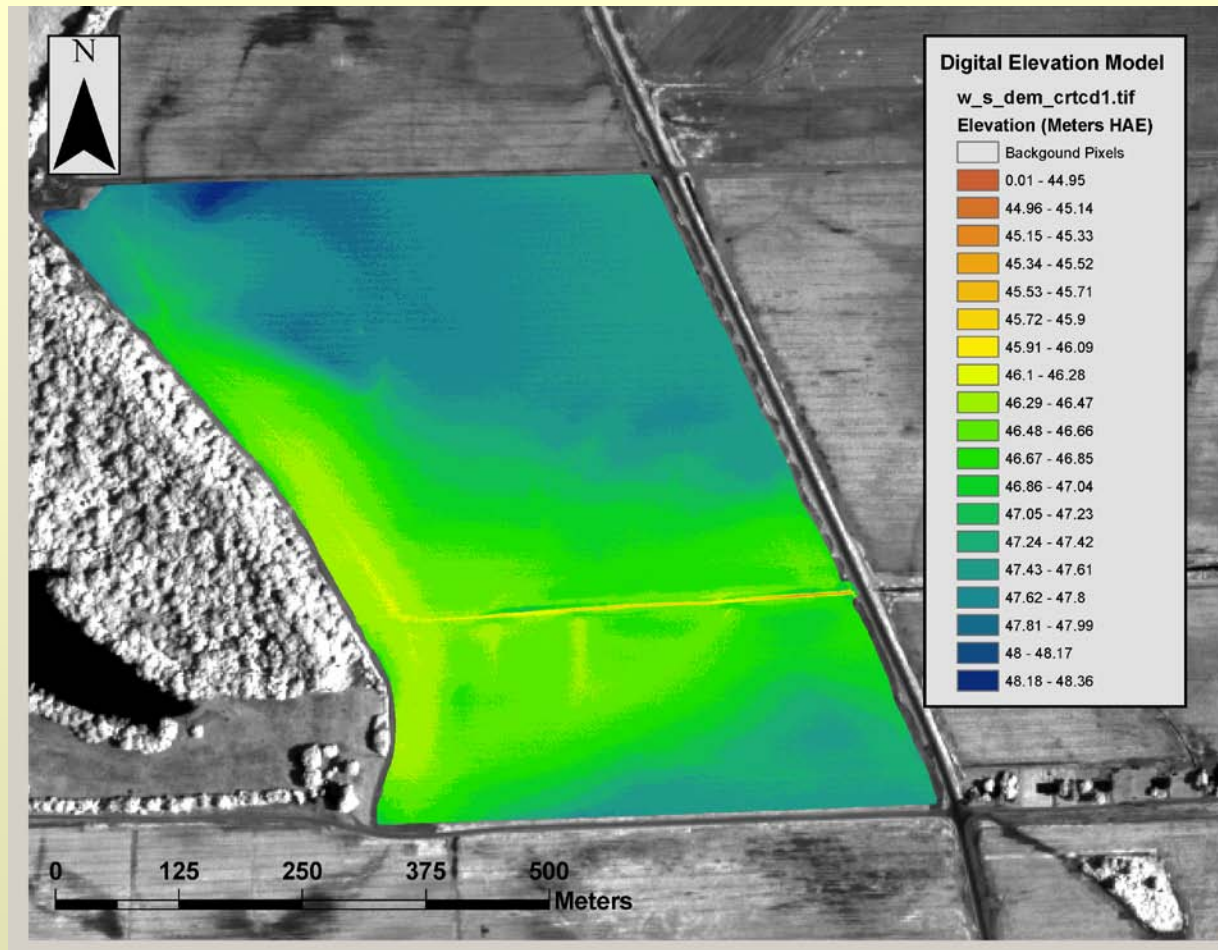
# CATL Work Flow (Willers et al. 2012)



# Image Intermediate (May 2012)

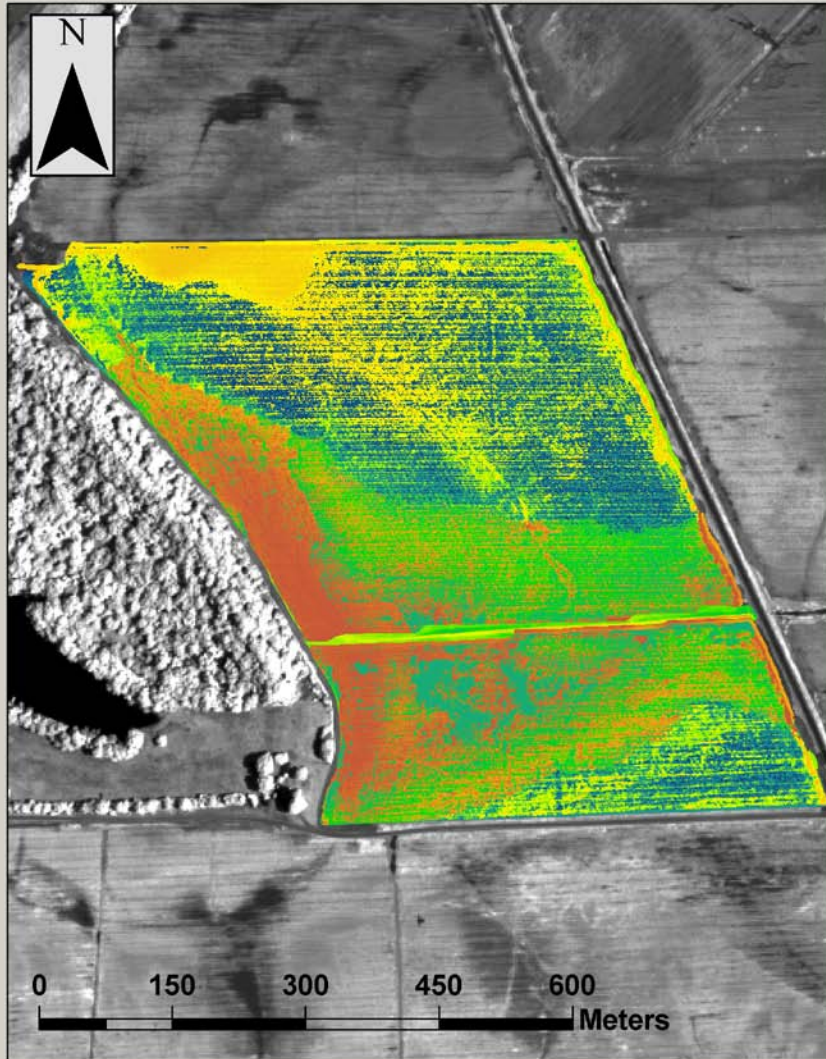


# Digital Elevation Model (LIDAR 2003)





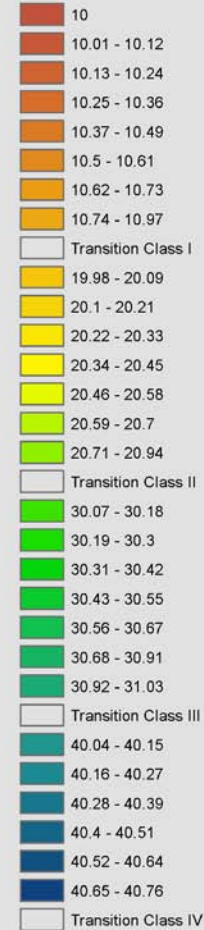
# CATL Data Product (May 2012)



## Categorical, Pseudo-Likelihood Classification

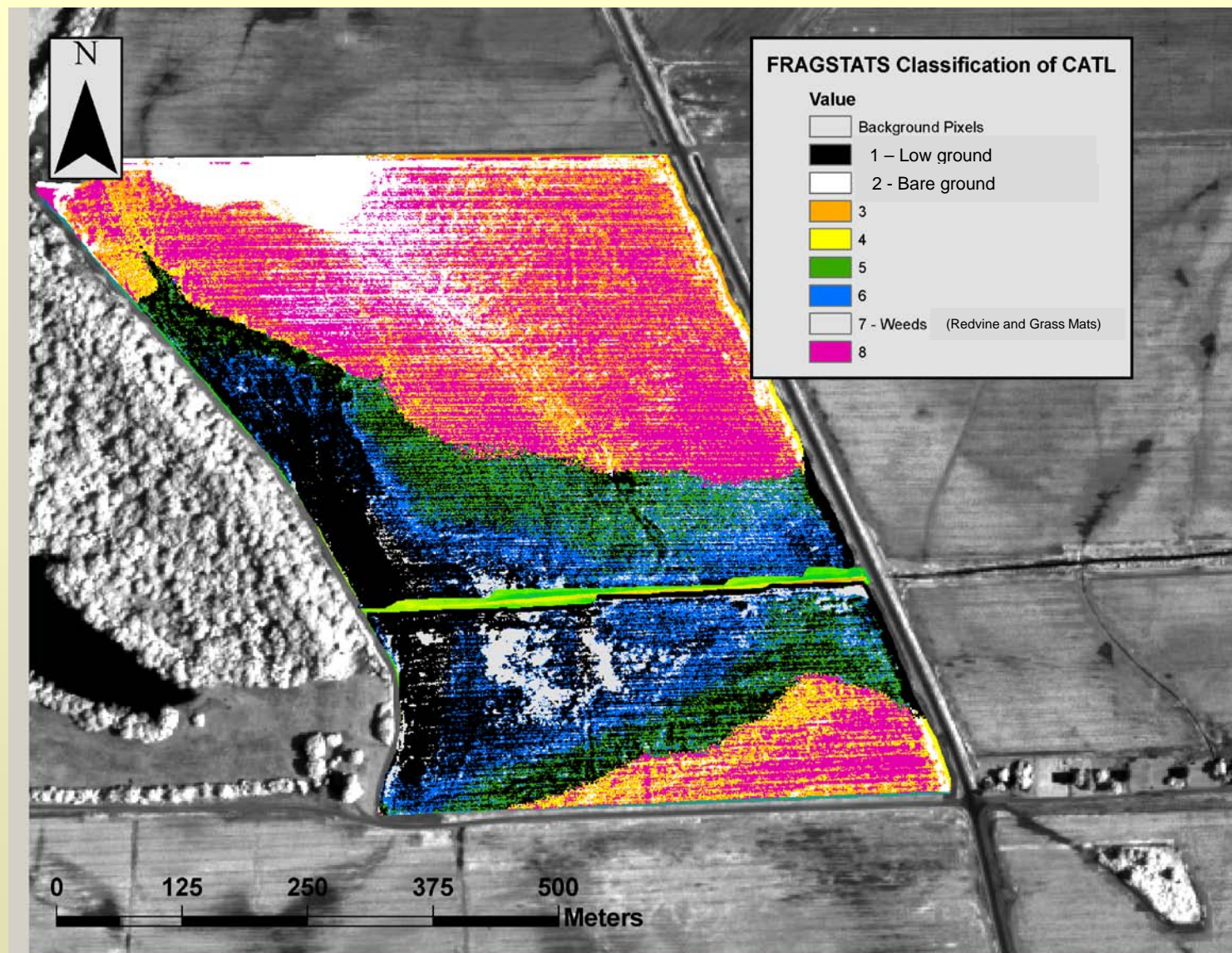
n58d\_catl.img

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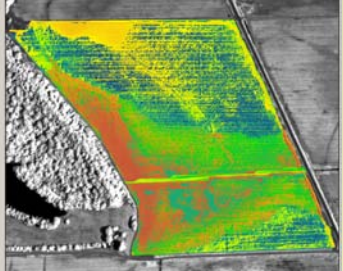
# FRAGSTATS Classes

CATL May 2012

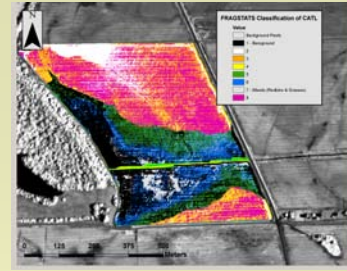
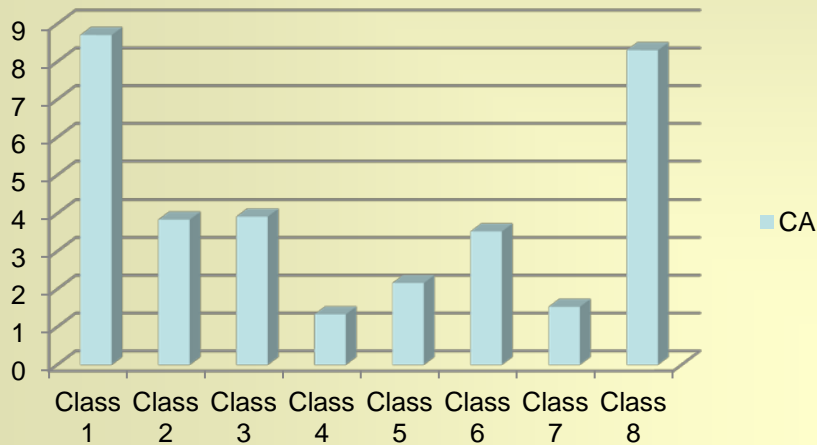


(Backoulou 2012)

# CATL May 2012 – FRAGSTATS Charts



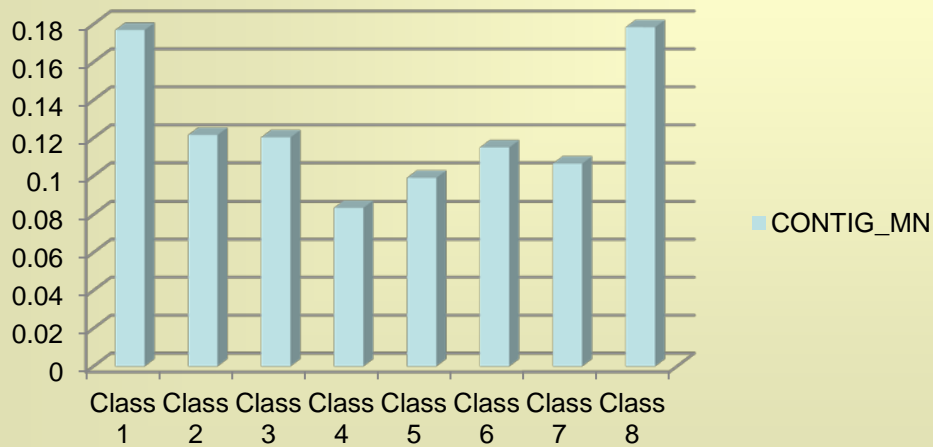
CA



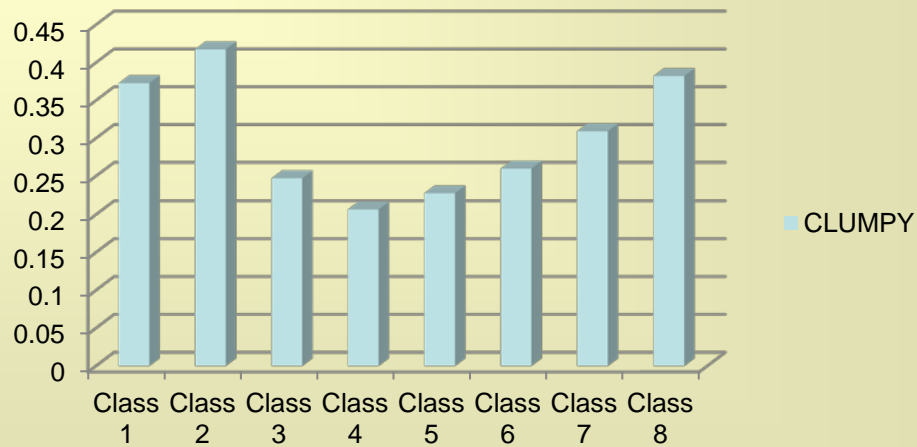
PLAND

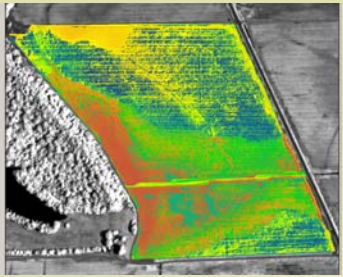


CONTIG\_MN

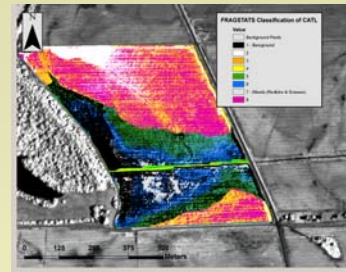


CLUMPY



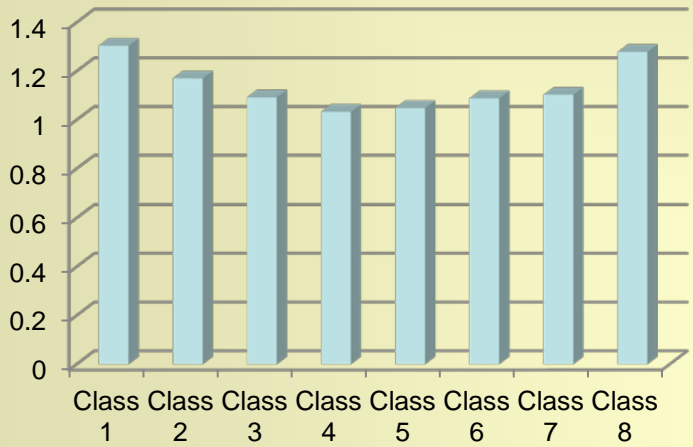


# CATL May 2012 – FRAGSTATS Charts



**SHAPE\_MN**

**PROX\_MN**



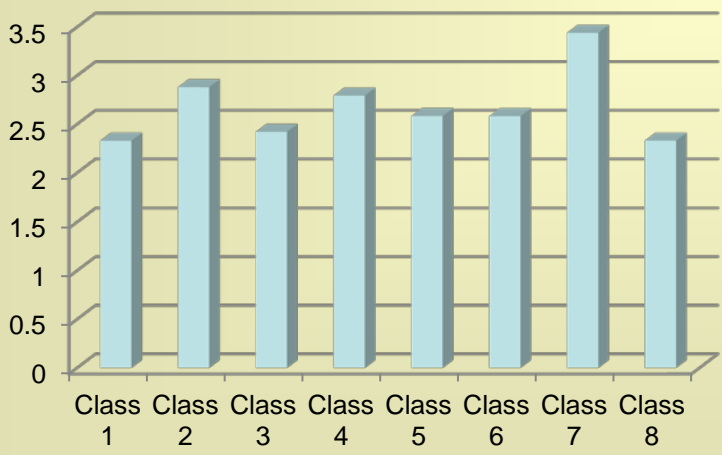
SHAPE\_MN



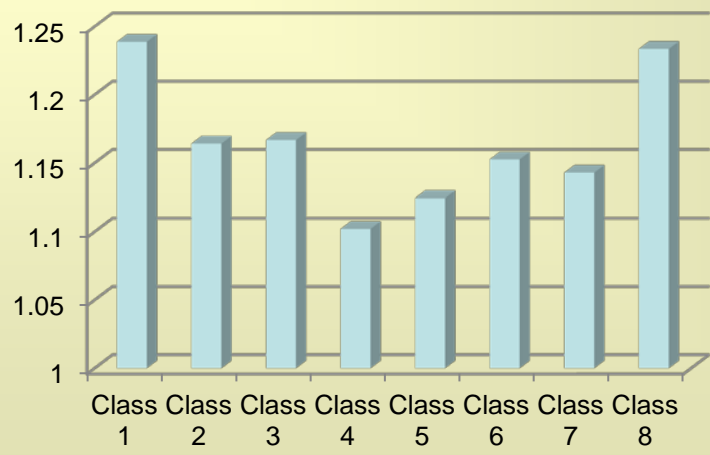
PROX\_MN

**ENN\_MN**

**FRAC\_MN**



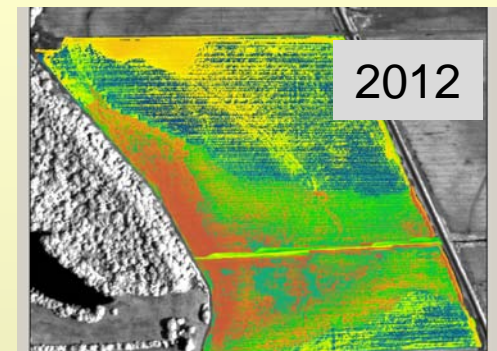
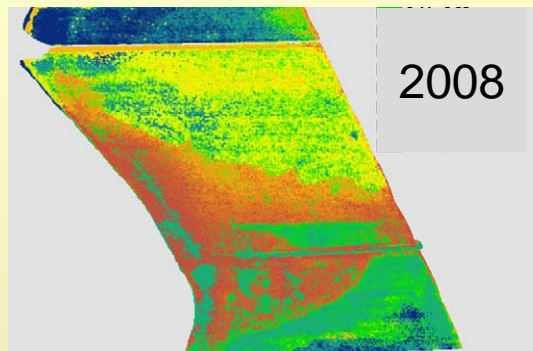
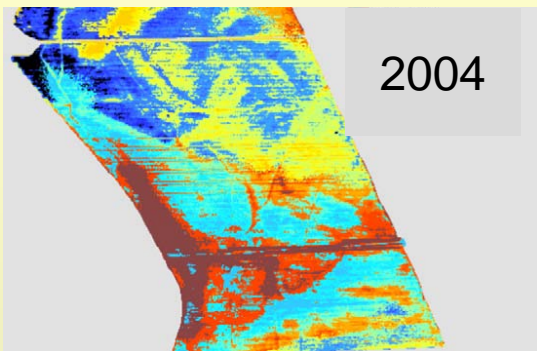
ENN\_MN



FRAC\_MN

# Future Work

- Use FRAGSTATS to compare changes over production seasons:



- Evaluate applications of FRAGSTATS metrics as covariates in spatial experimental designs and count model regression methods.

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- **Willers**, J. L., Wu, J., O'Hara, C., Jenkins, J. N. 2012. A categorical, improper probability method for combining NDVI and LiDAR elevation information for potential cotton precision agricultural applications. *Comput. Electron. Agric.* 82: 15-22.
- **Acknowledgements:** Thanks to Mr. Kenneth Hood, Producer, Perthshire Farms, Gunnison, MS for his cooperation in this research.
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