

Spiders (*Arachnidae*) as biological insect control with mulch



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Surface Residue study

- Effects of surface residue on soil fungi, soil aggregate size, soil moisture and soil organic carbon
- Added insect pitfall traps to my plots
- Change in insect species with mulch and plants
 - Crickets (*Gryllinae*)
 - Carabids (*Tachyura incurva*)
 - Tiger beetles (*Cicindela punctilata*)
 - Spiders (*Arachnidae*)
 - Lycosidae* (hunting spider)
 - Opilions* (Daddy long legs)



Orb Weaver
Lyniphidae



On a pumpkin
plant in my garden

Hunting Spider
Lycosidae



<http://www.alientravelguide.com/science/biology/life/animals/arthropo/arachnid/hunting.htm>



Study Plots

- Plot size 60 cm x 60 cm x 15 cm deep
- Design Random Block, 2x3 factorial
4 replications
- Soil Sand, with 6-7% organic carbon
- Pitfall traps Vials, 3 cm di. X 10 cm deep



2004

Straw/corn stalks, surface applied x No plant/oats
Sampled daily for 1 week, Aug 1-7





2005

Corn stalk residue, mixed in/surface x no plant/oats
Sampled 1 week each month, May to August





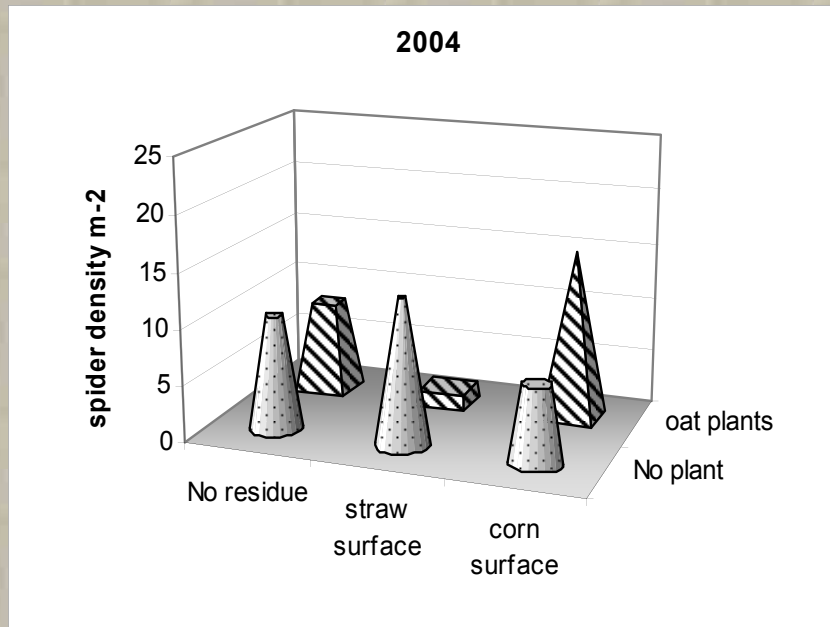
2006

PFB mixed in/surface x no plant/soybeans

Sampled weekly, May to August

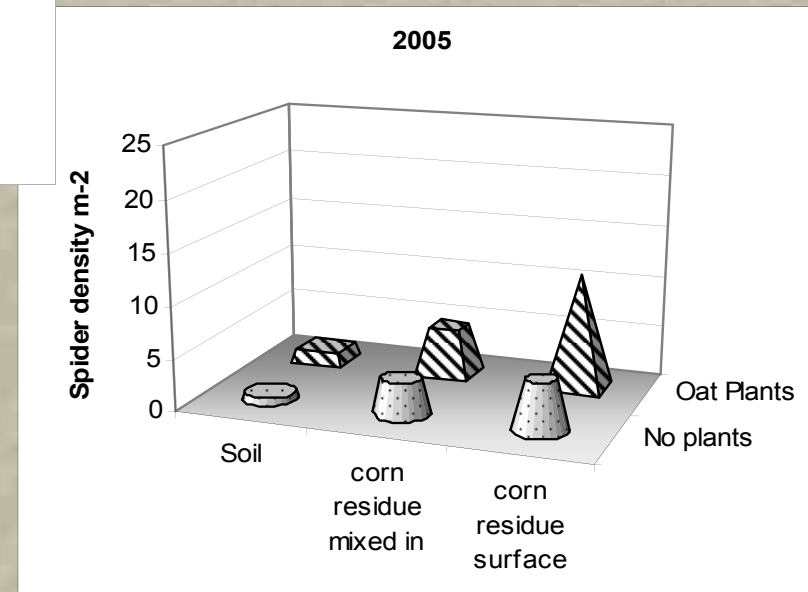


Spider density, 2004, 2005

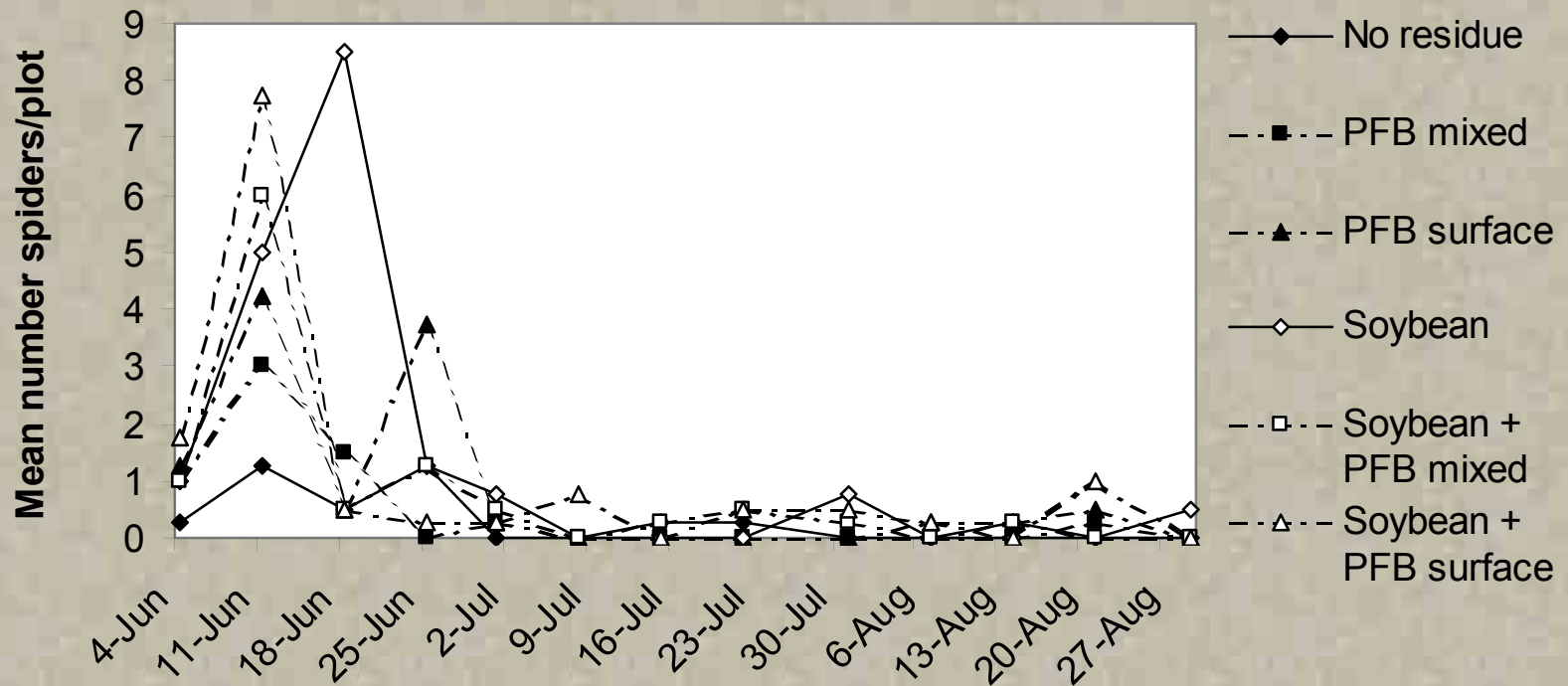


No significant treatment effect of mulch or oat plants on spider numbers in 2004 or 2005

The treatment of oat plants plus corn residue had the highest spider density both years



Spider census summer 2006



The number of spiders significantly increased
by the plant ($p < 0.001$)
by the PFB mixed into the soil ($p = 0.004$)
surface applied ($p < 0.001$)



PVA (population viability analysis)

Time Series Analysis

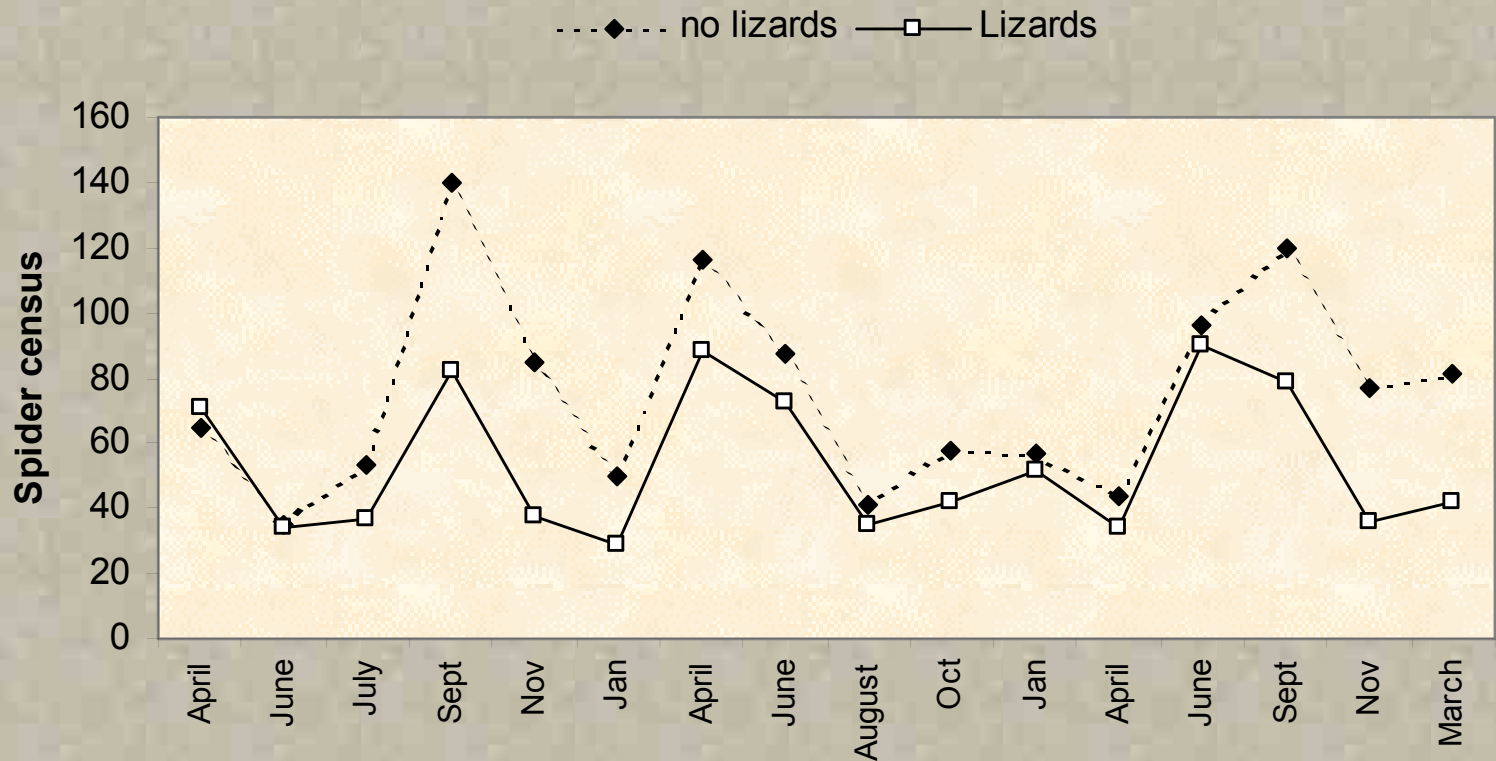
- Analyze data trends over time
- Predict time to extinction
- Test for
 - Density Dependence
 - Carrying capacity
 - Sensitivity and elasticity



Methods

- Data set from Spiller & Schoener, 1990, Bahamas
 - Census data 18 data points over 3 yrs
 - Metepeira species populations
- Data set from Spiller & Schoener, 1988, Bahamas
 - Census data for 16 months
 - Metepeira species populations and life stage data


Spider Census (Spiller & Schoener 1990)





Curve fitting results

- AIC(Aikaki Information Criteria):
Ricker curve
 - Density Dependence (Hunter, 2001)
 - 1st order, negative feedback process of intraspecific competition



Demographic rates

Spiller and Schoener, 1988

- Poptools Basic Matrix analysis
 - Calculate population abundances

Data Input


- Census data of each life stage
- Reproductive rate
- Female survival rate
- Egg survival rate (Schaefer, 1978) Linyphiidae
- Juvenile survival rate (Chen & Wise, 1999) Lycosidae
(Wise, 1993) Web spiders



Stage Specific matrix

No lizards	Stage Specific matrix			Population
Class	Egg	Juv	Adult	Vector
Egg	0	0	0.379	374
Juv	0.5	0	0	37
Adult	0	0.3	0.518	20

Lizards	Stage Specific matrix			Population
Class	Egg	Juv	Adult	Vector
Egg	0	0	0.219	133
Juv	0.5	0	0	16
Adult	0	0.3	0.178	10



Stable stage distribution

(Excel Poptools)

	No lizards	Lizards
Egg	29%	29%
Juvenile	22%	27%
Adult	49%	45%
Total population	254	160



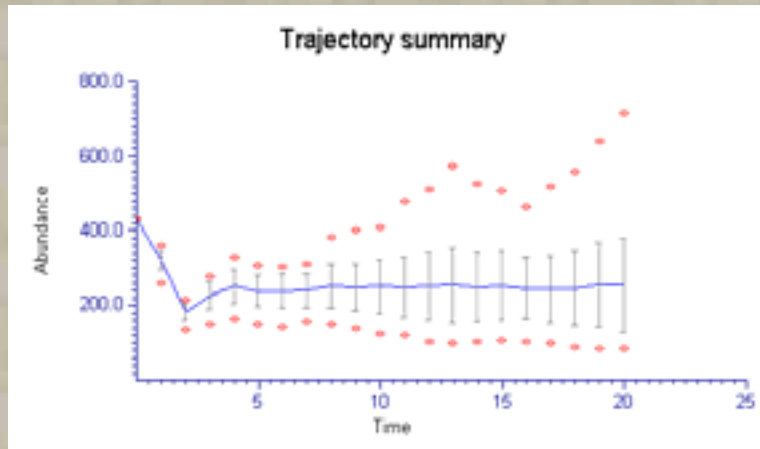
Sensitivity analysis

(Morris & Doak, 2002)

- Sensitivity: Change in vital rate (population growth rate and carrying capacity) with changes in individual survival rates of each age class
- Adult survival rate was most significant factor in population numbers, moreso without lizard predation
- increasing habitat complexity
 - has the same effect as reducing predation
 - assess population dynamics with habitat structural changes.

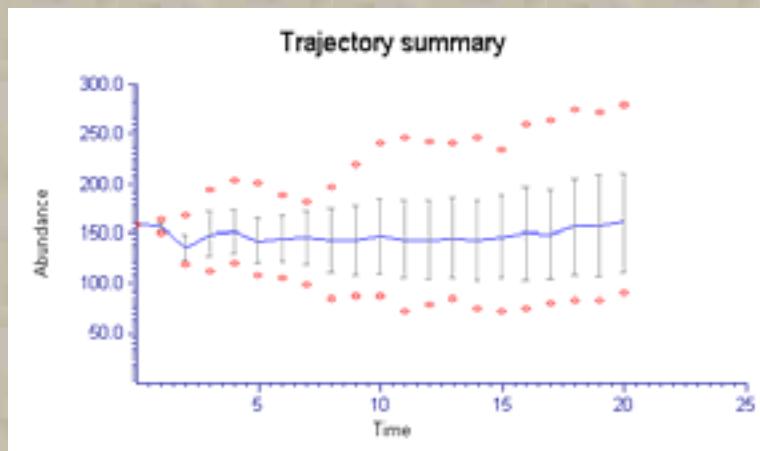
ECOLAB Stable age distribution

No lizards



Carrying capacity	80
Growth rate	1
Adult survival	0.52
Juv survival	0.30
Stable population	254

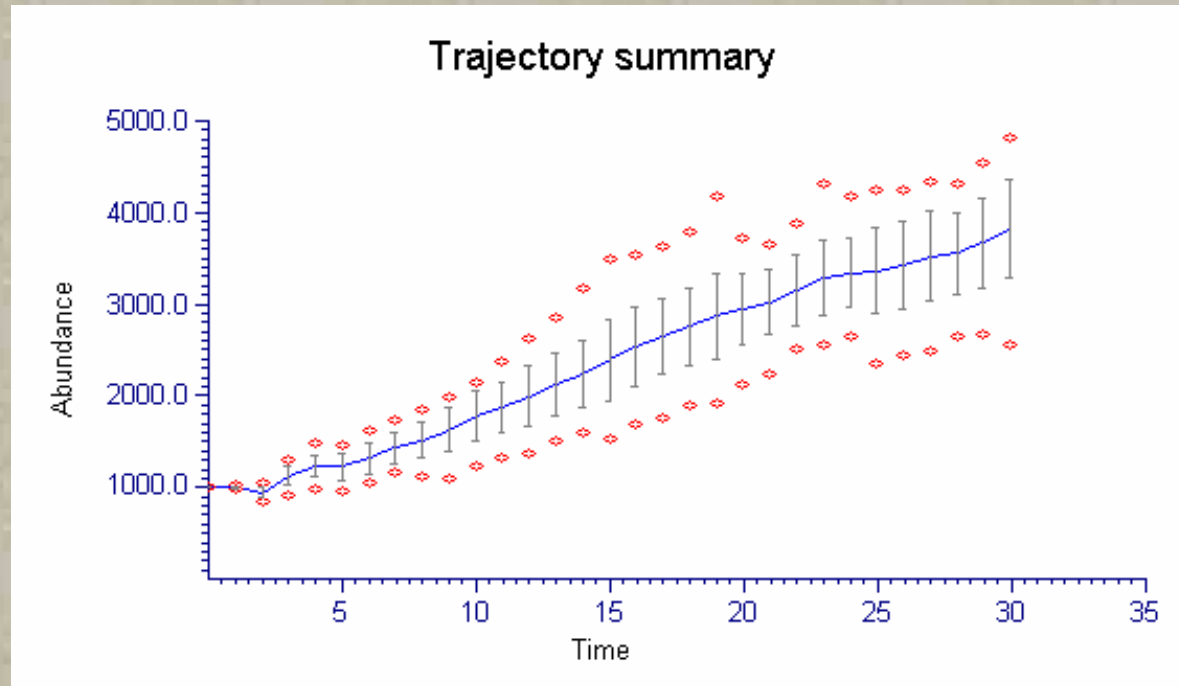
Lizards



Carrying capacity	80
growth rate	1
Adult survival	0.18
Juv survival	0.30
Stable population	160

Spider densities: Linear Increase

Growth rate	1.1	Adult survival rate	0.18
Carrying capacity	5000	Juv survival rate	0.30





Potential for spider biological control

- Increase spider density by adding vegetation or increased habitat structural diversity (web sites)

(Richert & Bishop, 1990)

- Web spiders can increase populations at rapid rates, density of 2-600/m²

(Nyffeler & Sunderland, 2003)

- Web spiders can disperse widely within 1 season by ballooning (up to 2 km)

(Nyffeler & Sunderland, 2003)



Summary

- Habitat complexity is important to maintain balance of insect species.
- Predators, such as spiders are more sensitive to chemicals and habitat change than their prey (herbivores).
- Returning insect balances via hedge rows, green cover, mulching, natural areas, maintains numbers
- Optimum balance of species by modeling
- Small effects can be successful, due to complex interactions of species.



References

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- Wolf Spider picture
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Questions

