



Landscape effects on pest populations and their role in IPM

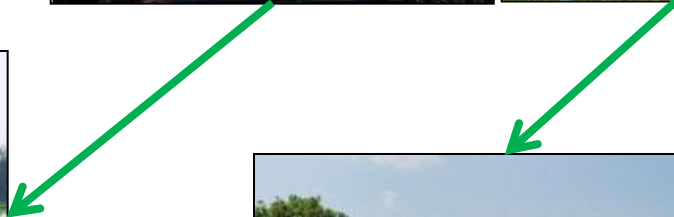
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The James Hutton Institute

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Audrey Alignier
INRA

Field scale pest control

“FIELD” – an area of open land planted with a crop and typically bounded

The primary unit of crop management.

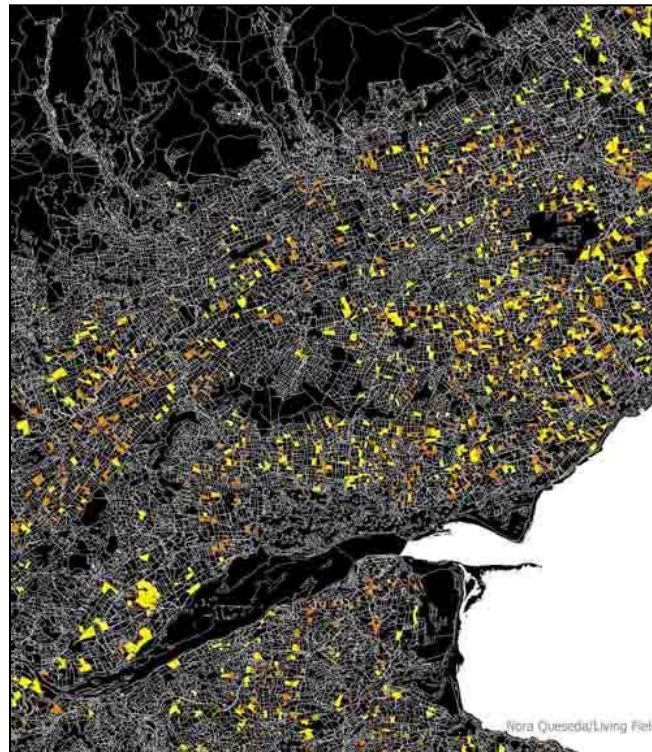


Dispersal



Engineering landscapes

- Local pest control fails as field populations don't exist in isolation
- Regulate of many pest populations can only be achieved at the landscape scale.



Engineering landscapes

A challenge and opportunity for IPM and sustainable pest control:

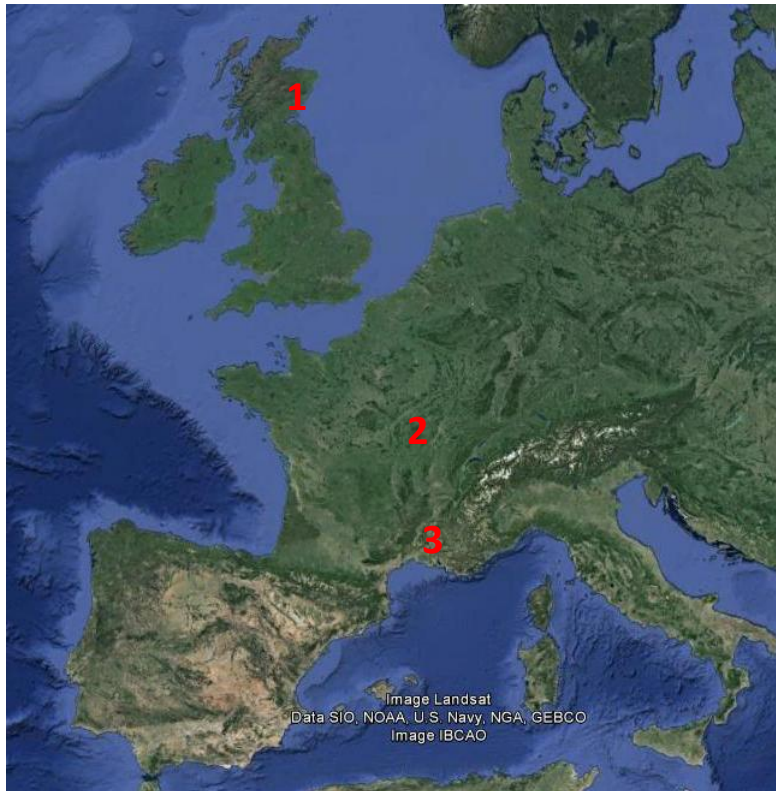
1. Identify pests with landscape sensitivity
2. Describe landscape features and characteristics.
3. Manage landscapes to suppress pests and reduce pesticide use.



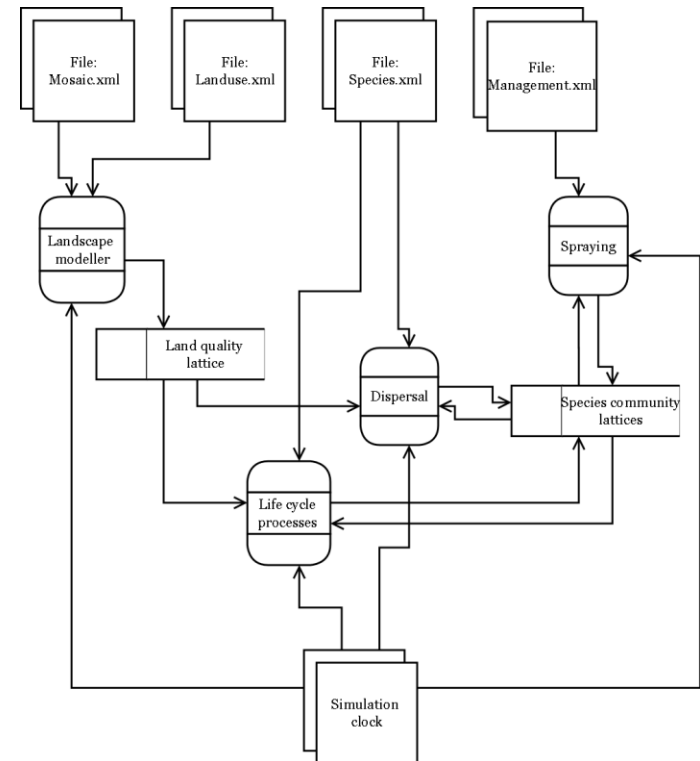
The PURE approach

Landscape scale observational studies and computer simulation modelling to explore the ways in which the different habitats in the crop production environment can be managed.

Field studies



Modelling



Weed communities

Survey

Presence of 13 weed species within 58 fields over 2004-2011

Field

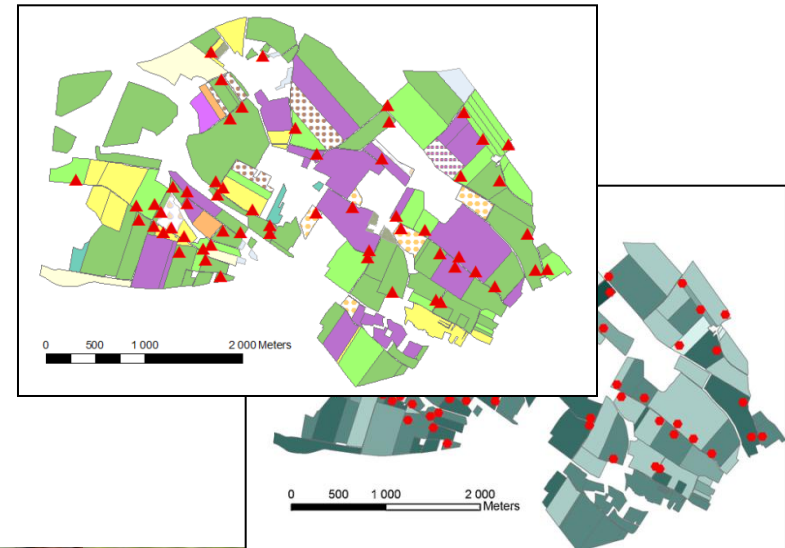
crop type and class, herbicide TFI, tillage

Border

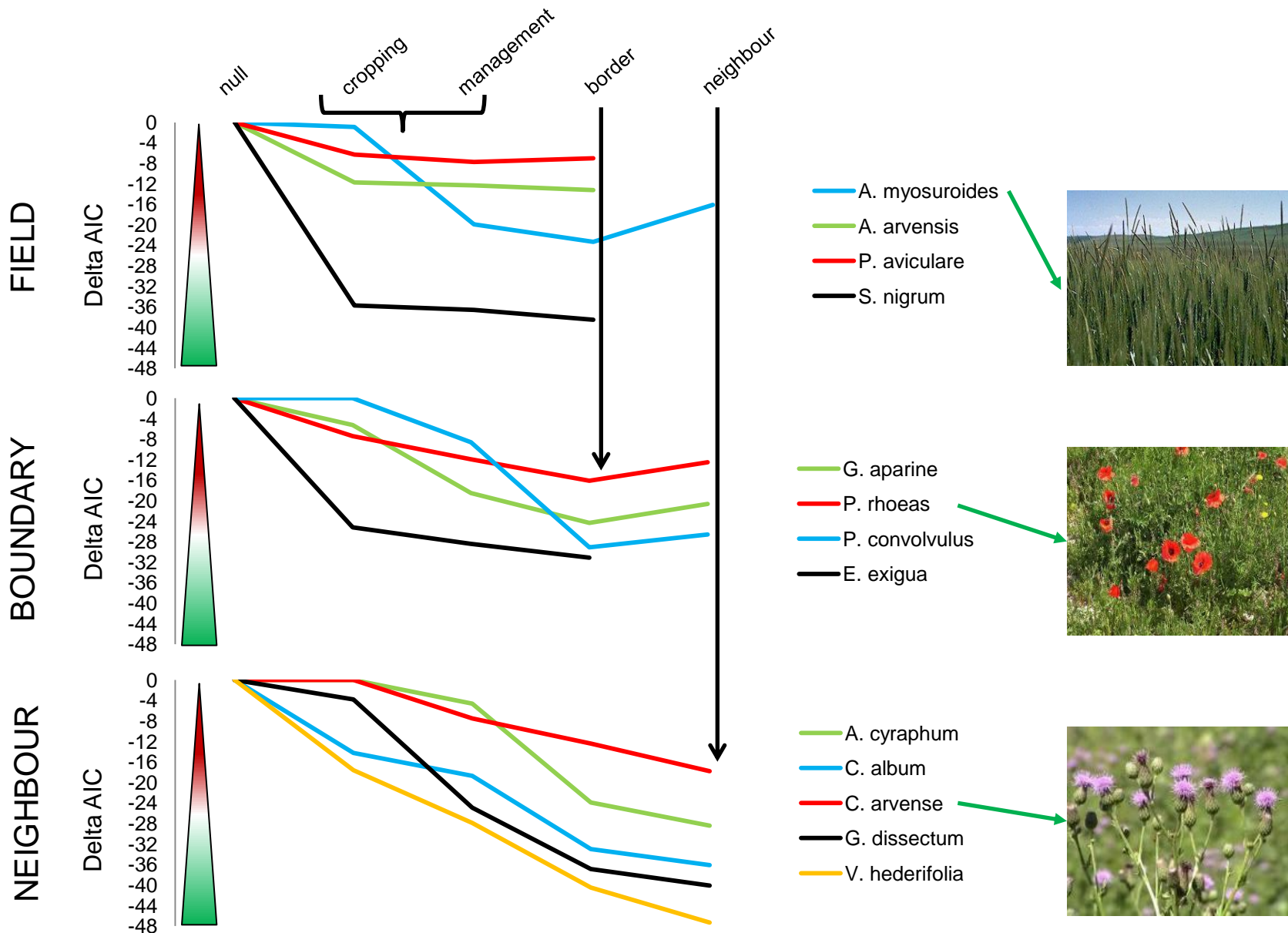
habitat type (herbaceous, herbaceous+wood, herbaceous+non-veg)

Landscape (neighbour field)

herbicide, tillage, spring cropping



Weed communities



Codling moth



Survey

Density of codling moth larvae and parasitism rate in 37-49 apple orchards over 2006-2010

Orchard

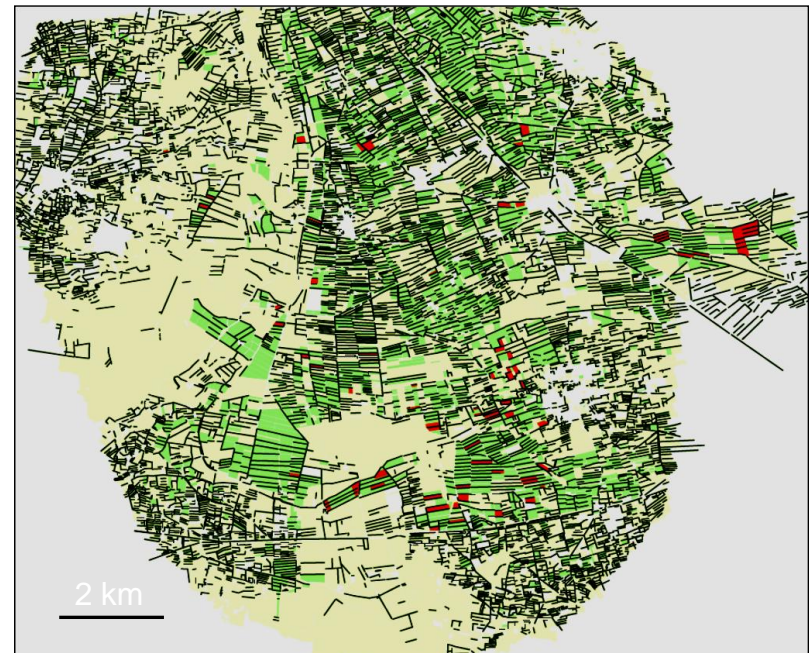
Management (organic v conv.)
Pesticides
Area and shape

Border

Hedgerow orientation and length
Windbreak hedge
Spontaneous hedge
Hedge diversity

Landscape (250m)

Hedgerow length, orientation
Management
Woodland
Water channels



Codling moth

Larval density

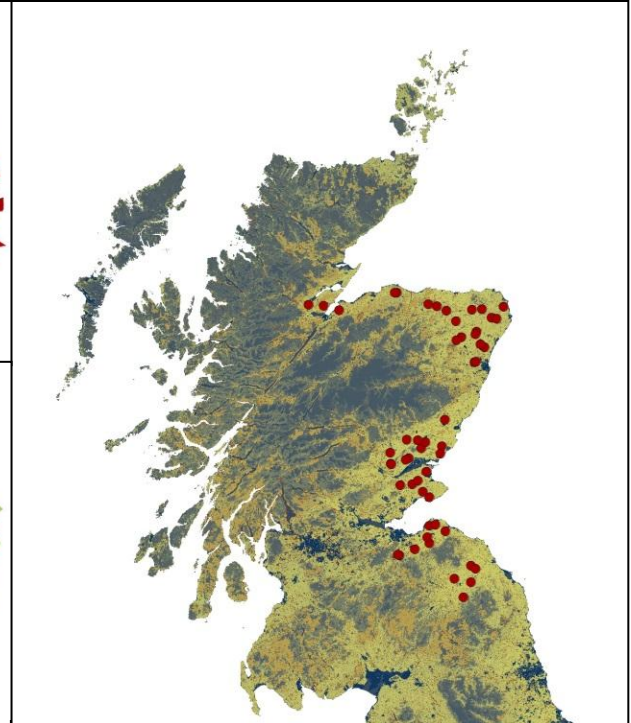
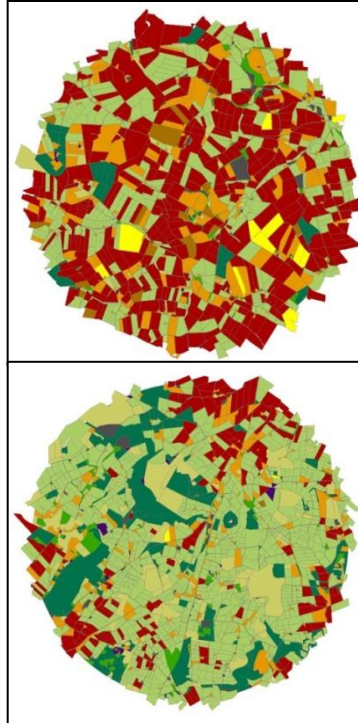


Variables	Estimate	Sum of Sq	F value	p-Value
<i>Crop management (=organic)</i>	-0.629	46.31	19.9	1.44 x 10⁻⁵
<i>Orchard area</i>	-4.1 x 10 ⁻⁵	5.69	2.45	0.119
<i>Hedgerow orientation</i>	-6.129	20.13	8.65	3.70 x 10⁻³
<i>Hedgerow length</i>	-6.62 x 10 ⁻²	0.06	0.03	0.868
<i>Area abandoned orchard</i>	4.6 x 10 ⁻³	0.03	0.01	0.906
<i>Area conventional orchard</i>	-7.8 x 10 ⁻³	1.68	0.72	0.396
<i>Area of woodland</i>	9.3 x 10 ⁻³	0.2	0.09	0.769
<i>Water channel length</i>	-3.098	20.07	8.63	3.75 x 10⁻³

Parasitism rate

Variables	Estimate	Std. error	z value	p-Value
<i>Codling moth density</i>	2.38 x 10 ⁻³	0.010	0.230	0.818
<i>Crop management (=organic)</i>	1.289	0.353	3.651	2.62 x 10⁻⁴
<i>Presence of spontaneous hedge</i>	0.472	0.337	1.403	0.161
<i>Insecticide treatments</i>	-0.045	0.028	1.581	0.114
<i>Hedgerow orientation</i>	2.833	2.677	1.058	0.289
<i>Hedgerow length</i>	0.010	0.498	0.021	0.983
<i>Area abandoned orchard</i>	-0.032	0.057	0.557	0.577
<i>Area conventional orchard</i>	-0.025	0.011	2.159	0.031
<i>Area of woodland</i>	-0.015	0.035	0.425	0.671
<i>Water channel length</i>	0.409	1.289	0.318	0.751

Generalist predators



Generalist predators

Survey (2008)

Relative abundance/activity of in 40 fields and field margins in 2008

Field (2000-2008)

Management (organic v conv.)

Crop intensity

Area and shape

Border (2008)

Type (Stone wall:grass)

Adjacent land (crop:non crop)

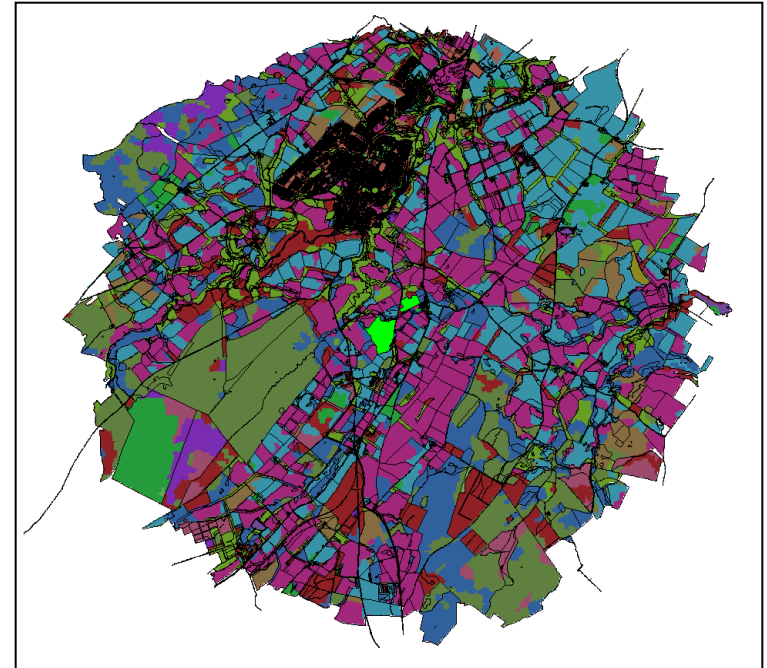
Landscape

(2000-2008; 0.5, 1, 2, 3, 4, 5 km)

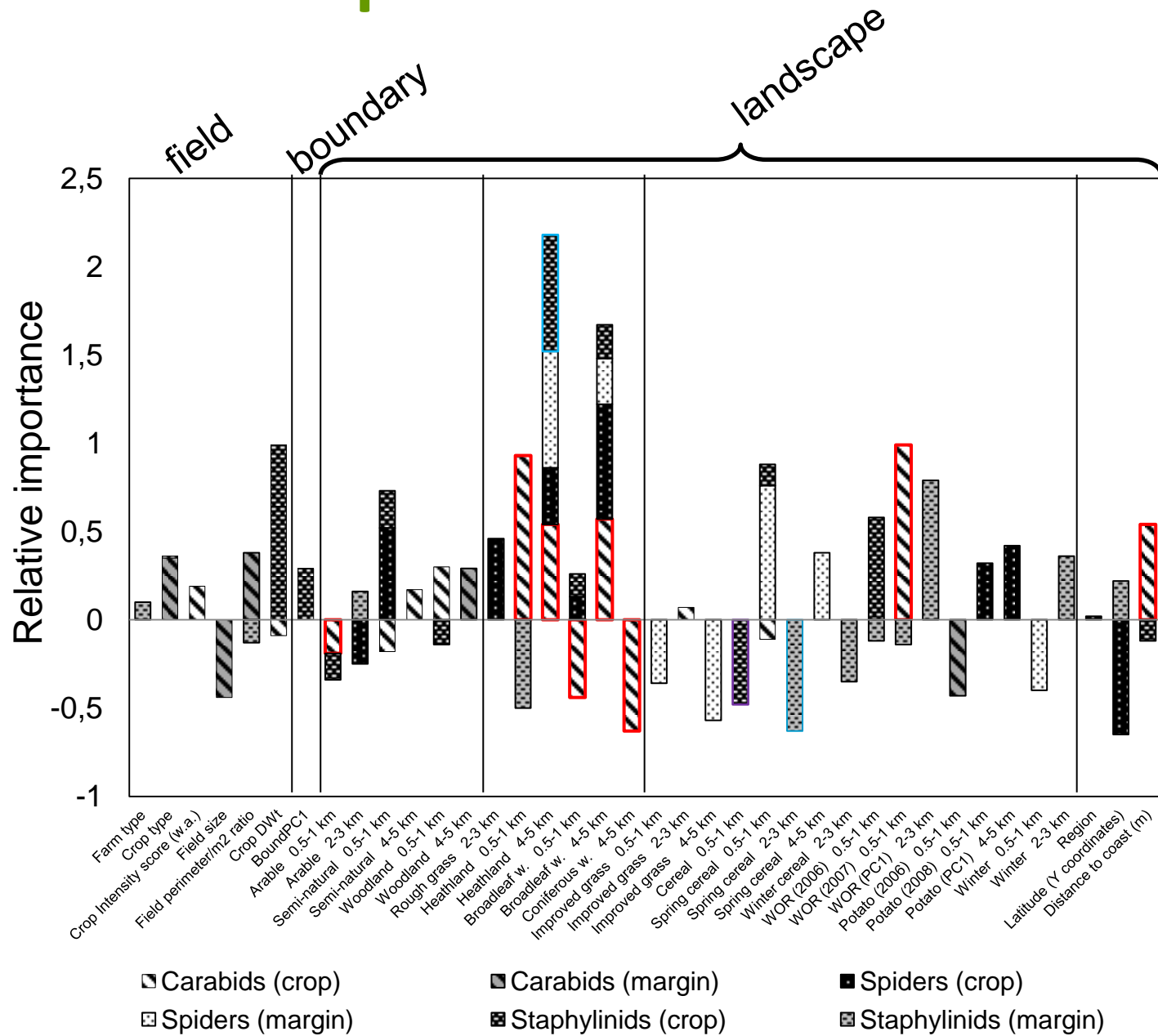
Arable (crop types)

Semi-natural (heath, rough grass)

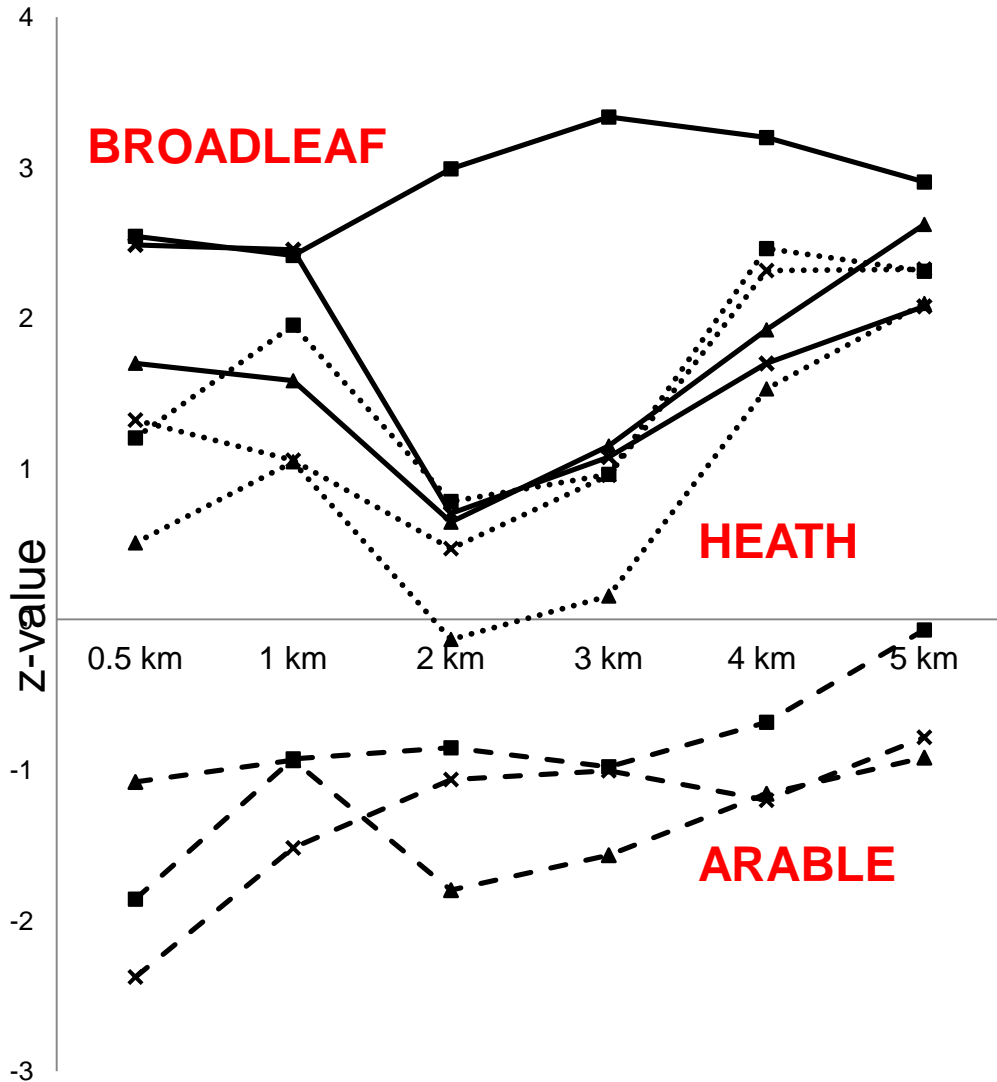
Wood (broadleaf, coniferous)



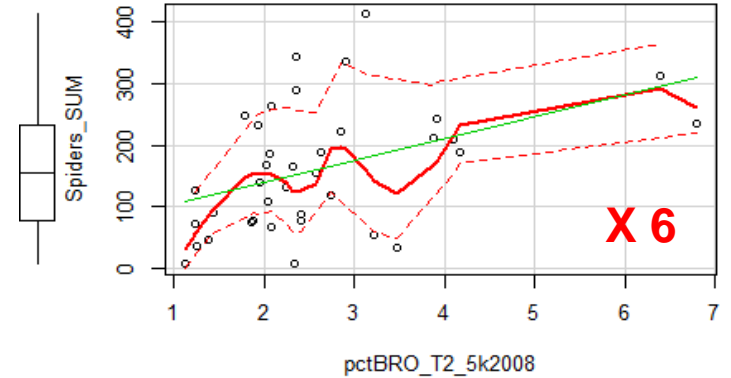
Generalist predators



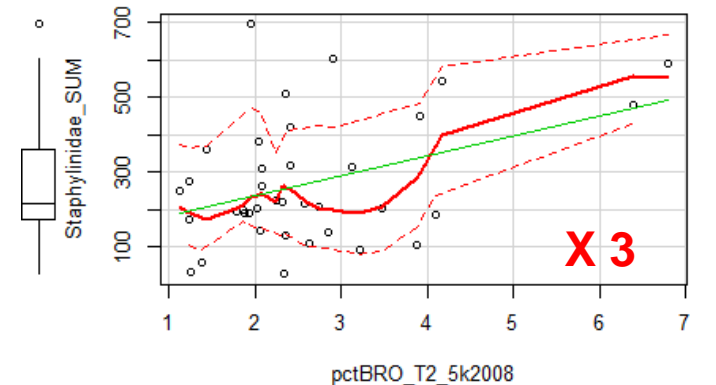
Generalist predators



Spiders(Crop)/Broadleaf-woodland- at 5km

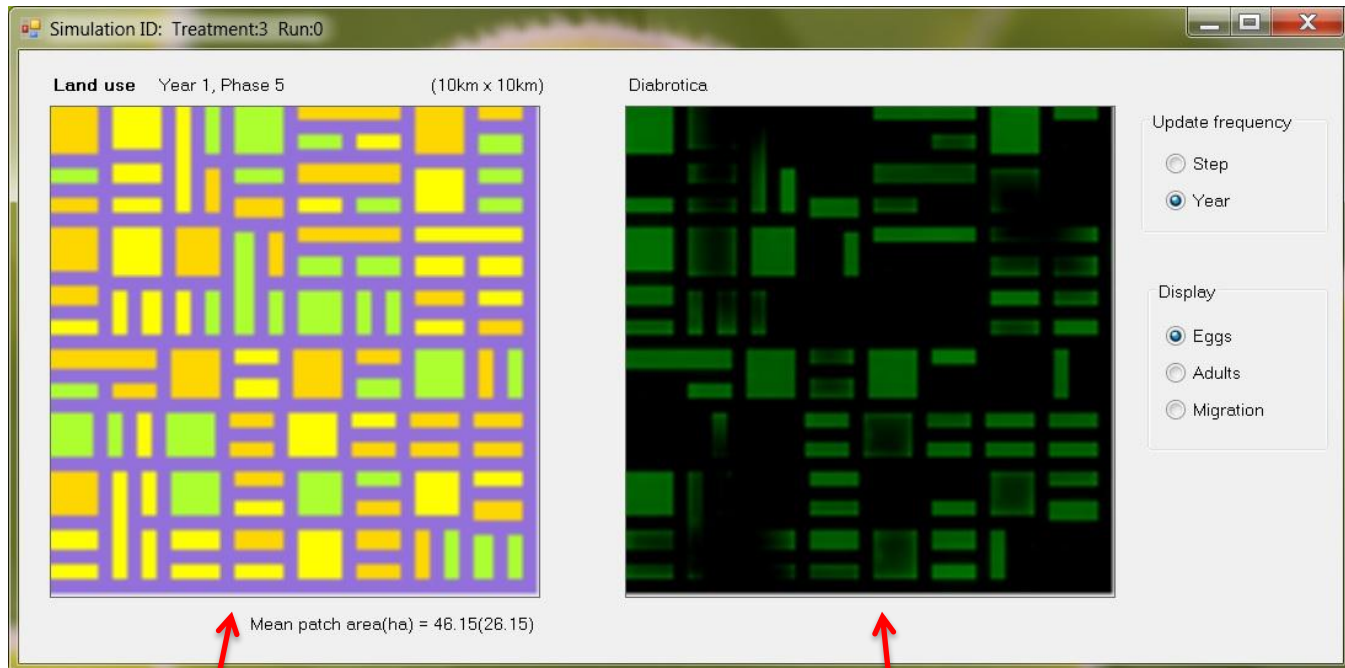


Staphylinidae(Crop)/Broadleaf-woodland- at 5km



AgBioscape – landscape modelling

AgBioscape couples discrete time population models with a spatially explicit simulation of the farmed landscape.



Simulated cropping landscape

Simulated pest population dynamics

AgBioscape – Diabrotica

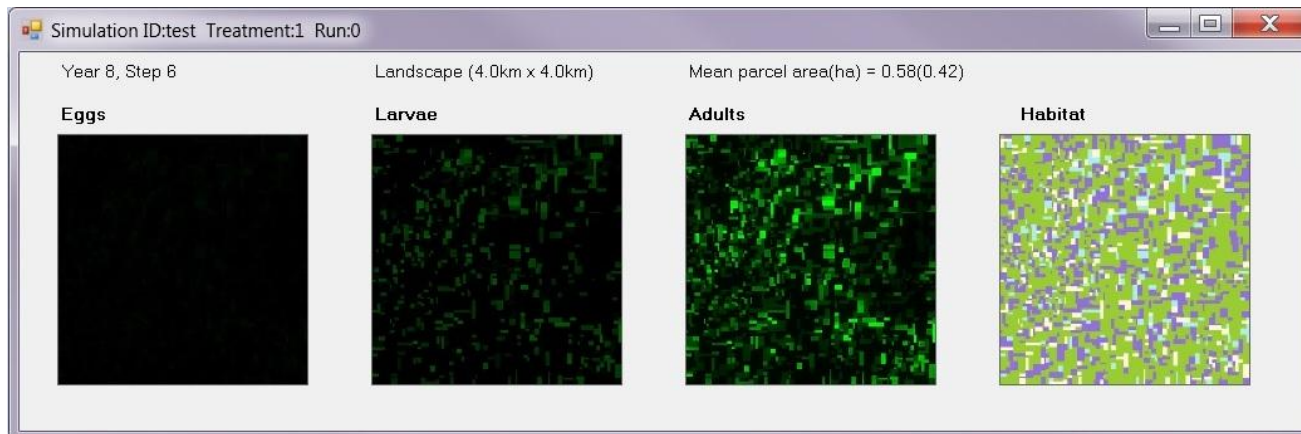
Western corn root worm has become a major pest since invading Europe in the 1990's

Withdrawn from list of regulated harmful organisms with quarantine status.

EC recommendations support rotation as effective and in line with IPM principles.



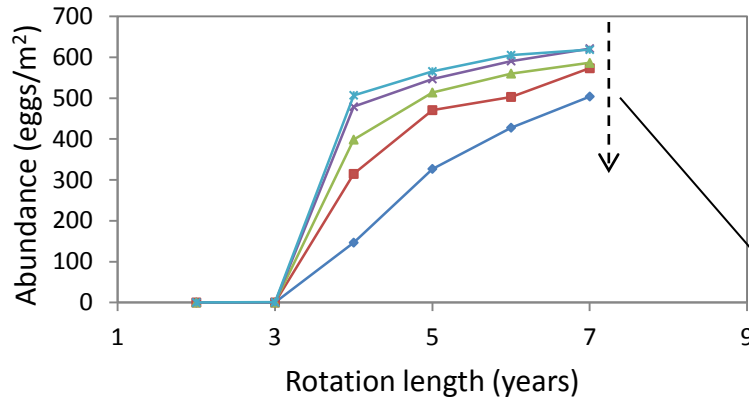
AgBioscape: model based on spatially explicit simulation of cropping patterns used examine the performance of rotation control strategies.



AgBioscape – Diabrotica

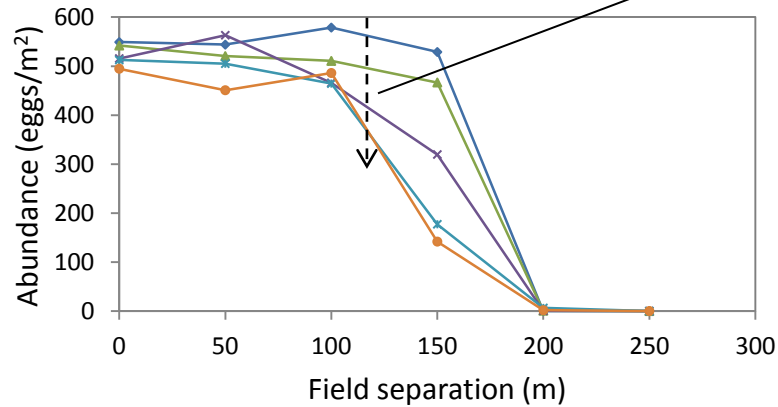


Rotation – 3 year



Field size

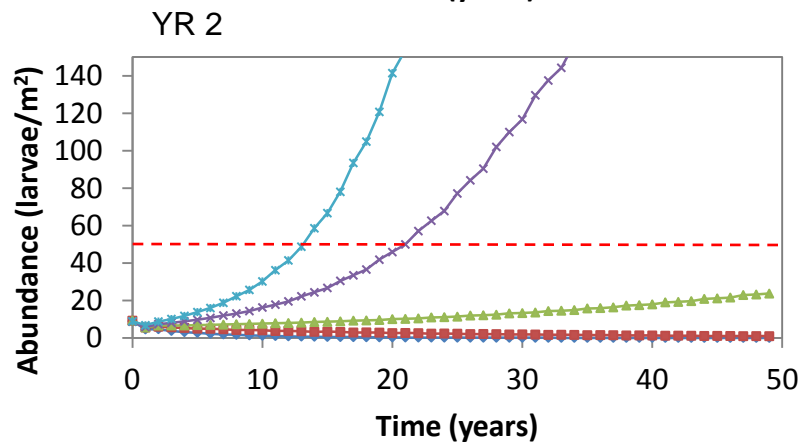
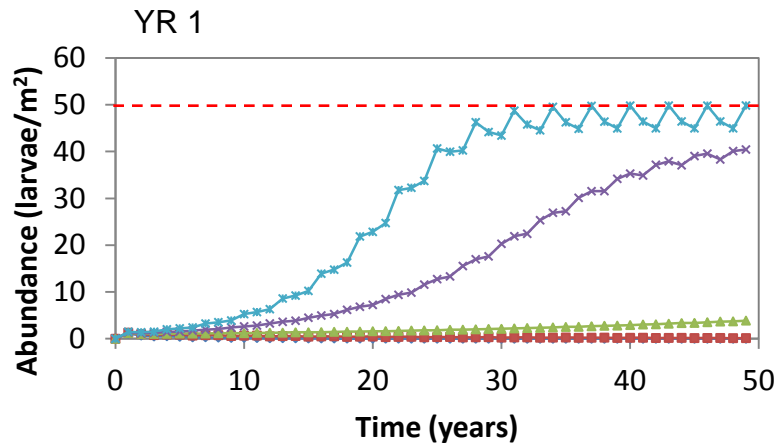
Buffer zones



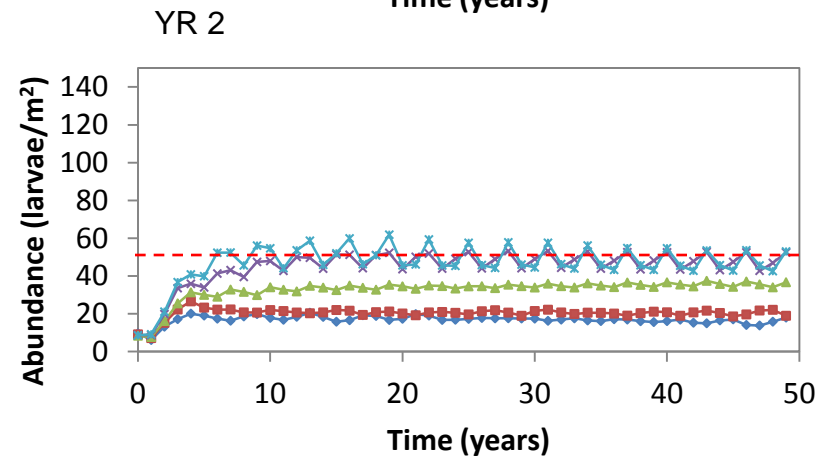
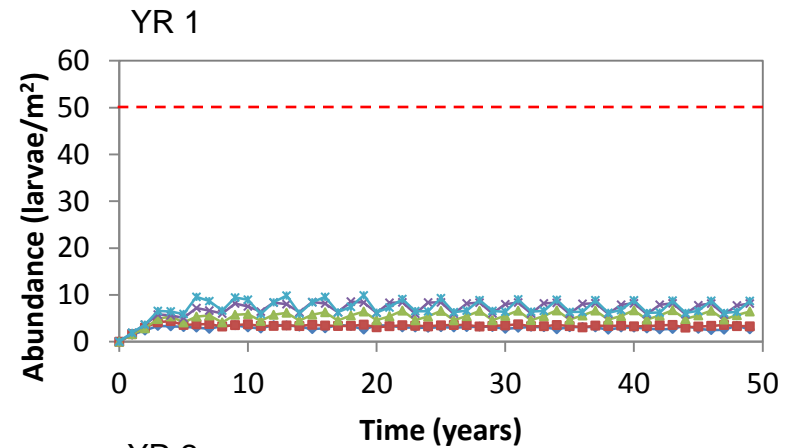
AgBioscape – Diabrotica



Fixed 3yr rotation



Threshold rotation

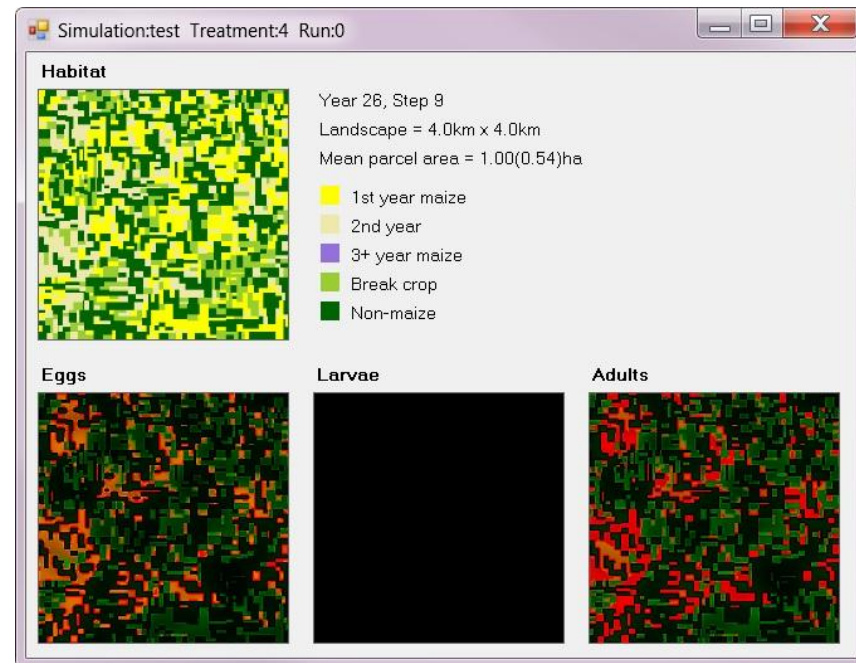
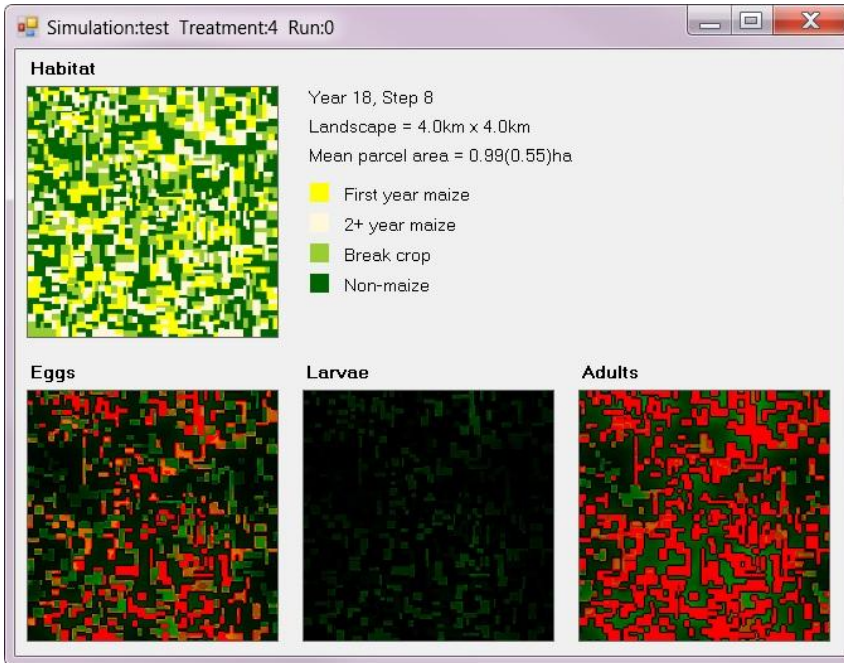


AgBioscape – Diabrotica



Fixed 3yr rotation, 60% maize

Threshold rotation, 60% maize



AgBioscape – Biocontrol



Nicholson & Bailey (1935) Host-parasitoid dynamics

Search for stability

Determinants of biocontrol

- life-history
- periodic mortality
- transient dynamics
- resource separation
- dispersal
- fragmentation

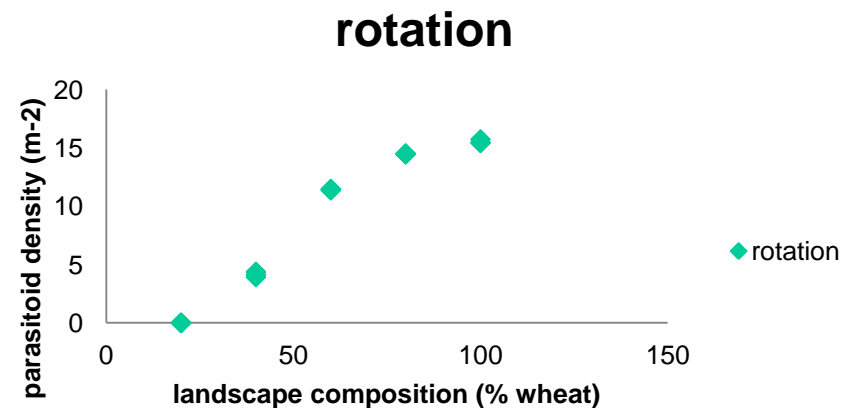
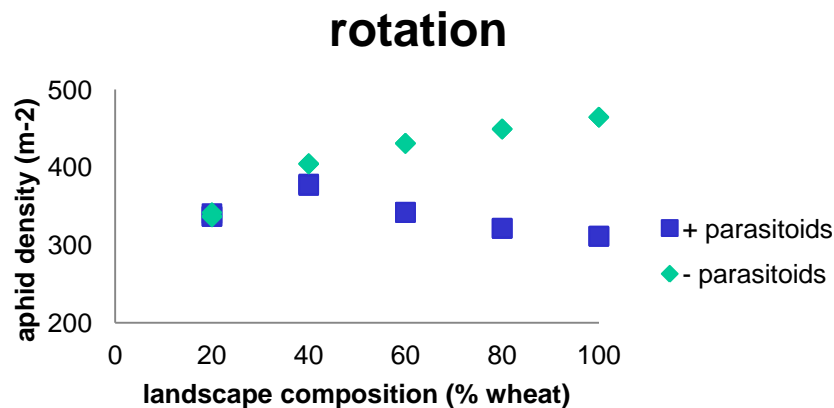
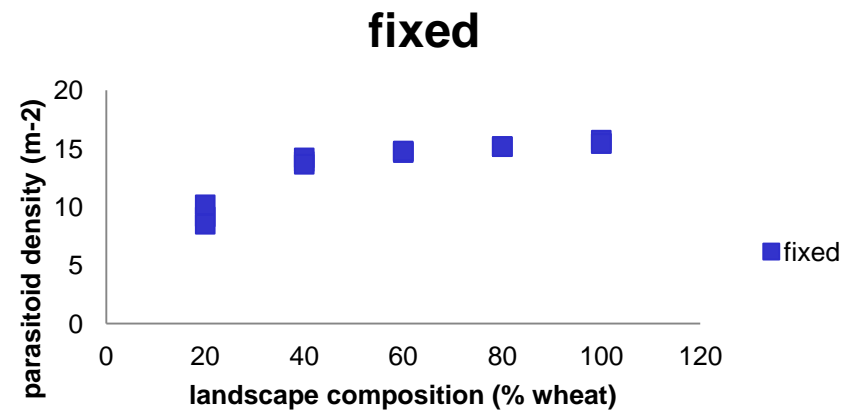
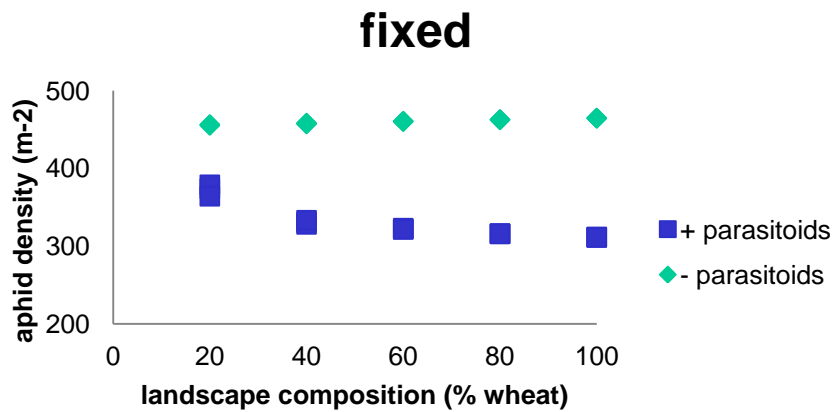
? Crop rotation ?



AgBioscape – Biocontrol



Crop rotation x parasitoid biocontrol



AgBioscape – Biocontrol



**Aphid Instar+P instars&mummy
Densities 80% Fixed
Yr 102 step 30**

Color Key
0 6e+05 1400000
Value



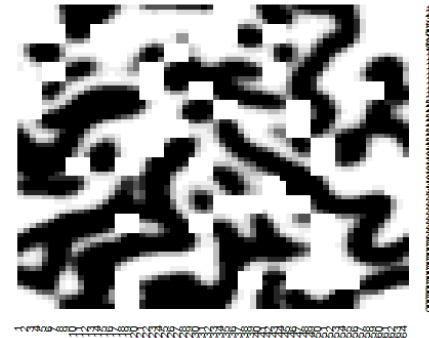
**Parasitoid adult Densities 80%
Fixed Yr 102 step 30**

Color Key
0 10000 25000
Value



**Parasitism rates 80% Fixed
Yr 102 step 80**

Color Key
0 0.4 0.8
Value



Landscape IPM: A challenge and opportunity

1. Identify pests with landscape sensitivity
 1. Landscape sensitivity is wide spread
 2. Substantial influence is possible
 3. Substantial variation also likely

2. Describe landscape features and characteristics.
 1. Crop – crop type and management
 2. Non-crop – Semi-natural: heath, deciduous wood vs coniferous wood
 3. Multi-scalar

3. Manage landscapes to suppress pests and reduce pesticide use.
 - Weeds – management of border and adjacent fields
 - Codling moth – insecticide vs biocontrol trade-off
 - Generalist predators – woodland planting schemes support biocontrol
 - Diabrotica – IPM rotation strategy | field size, % maize, compliance/monitoring



Future landscape IPM



1. Can landscape management achieve targeted pest control?
2. If not, is it valuable?
3. What other policy drivers are there that can be integrated with IPM goals?



Thank you for your attention!



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AgBioscape – Diabrotica

