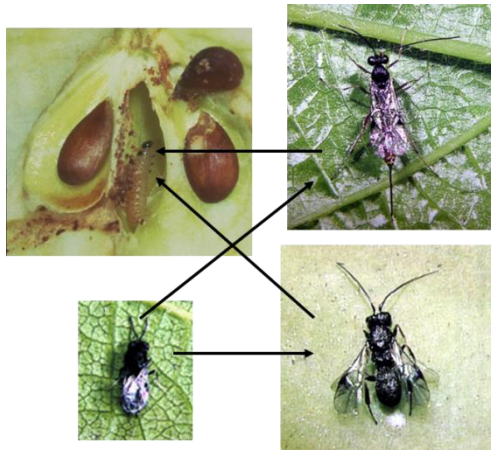
Response of pest *(Codling moth)* and pest-enemy *(parasitoids)* populations to landscape characteristics in *(apple)* orchard systems

B. Ricci, M. Maalouly*, P. Franck, J.-F. Toubon, J.-C. Bouvier, S. Maugin, J. Olivares, M. Siegwart, C. Thomas, C. Lavigne

Horticultural Plants and cropping Systems (PSH), INRA, Avignon, France

PURE WP 10.3



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*Present address: INRA UMR Agroécologie, Dijon, France

Context

Landscape affects pest and pest enemies populations

- species use habitats outside fields (food, overwintering…)
- dispersal abilities

Specificities of perennial crops

- stability
- arboreal species

} Landscape less important ?

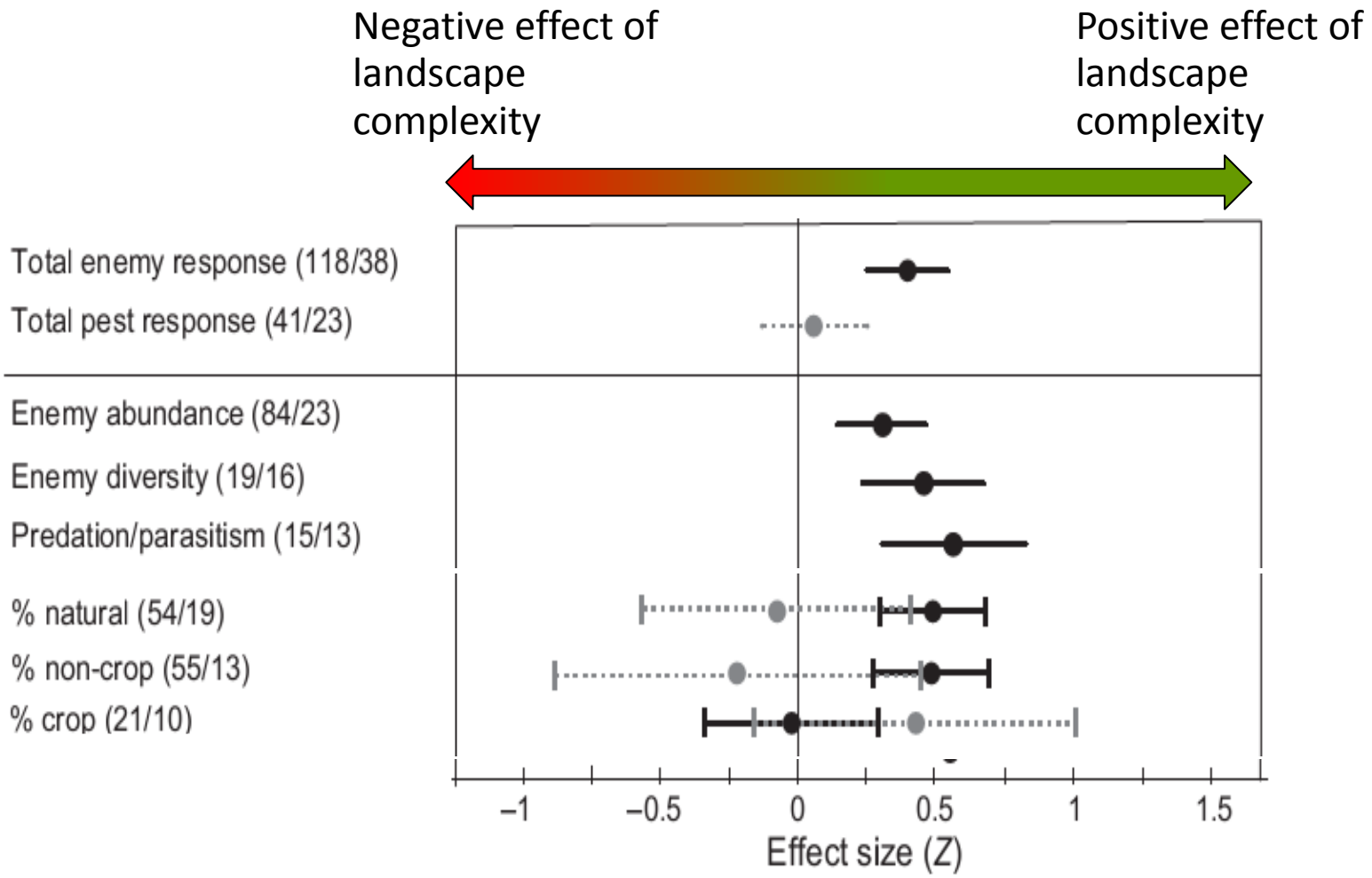
What landscape elements to consider?

- land cover: amount of crops
  amount of host crops
  amount of semi-natural habitats
- land use : intensity of agricultural practices (e.g. crop protection)

How to consider them?

- amount -> habitat
- distance -> availability

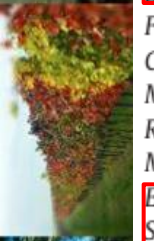
Effects of landscape complexity



Chaplin-Kramer et al. 2011

Pest abundance and amount of host crop in landscape

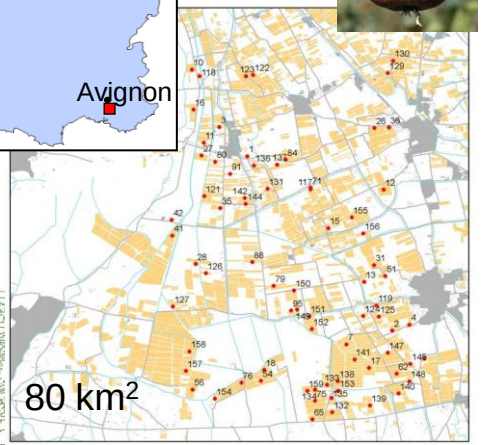


Pest species	*SIGN*	Sampled crop	Landscape variable	Buffer width
Leptinotarsa decemlineata	+	Potato	% potato of preveous year	2000 m
Thrips tabaci	+	Leek	% horticulture	5000 m
Rhophalosiphum padi	+	Cereal	cereal area/maize area	50000 m
Delphacodes kuscheli	+	Grassland	% winter pasture	2500 m
Cydia pomonella	–	Orchard	% orchard	100 m
Lobesia botrana	+	Vineyard	% vineyard	100 m
Empoasca vitis	–	Vineyard	% vineyard	100 m
Lobesia botrana	+	Vineyard	% vineyard	100 m
Empoasca vitis	–	Vineyard	% vineyard	100 m
Frankliniella occidentalis	+	Sweet pepper	% greenhouse	1000 m
Ceutorhyncus napi,C pallidactylus	–	Oilseed rape	% oilseed rape	800 m
Meligethes aeneus	–	Oilseed rape	% oilseed rape	1000 m
Rhophalosiphum padi	0	Spring barley	proportion of spring cereals to total cultivated area	400 m
Meligethes aeneus	0	Oilseed rape	% oilseed rape	500 m–6000 m
Eupoecilia ambiguella	0	Vineyard	% vineyard	100 m
Scaphoideus titanus	0	Vineyard	% vineyard	100 m
Ostrinia nubilalis	0	Maize	% maize	admin. units
Dasineura brassicae	0	Oilseed rape	% oilseed rape	100m–2000 m

Veres et al. 2013

Local context



Study site

A dense zone of apple production in the Lower Durance Valley
Intensive production (mean ~10 insecticide treatments/ year)
Dense windbreak network

Pest and pest enemies

Insect pest:

Codling moth , *Cydia pomonella (Tortricid)*
3 generations per year
Resistances to biological and chemical insecticides

Studied pest enemies:

Hymenoptera parasitoids

Questions

Codling moth

- Does the landscape surrounding orchards impact the abundance of codling moth in orchards?
- Is it necessary to consider crop protection at orchard and landscape levels ?
- Are the effects of local and landscape characteristics of similar magnitude?

Parasitism

- Does the level of codling moth parasitism depend on on landscape characteristics ?

Sampling of pests and pest enemies

Approximately 40 orchards each year from 2006 to 2010

Perilampus tristis

Counts of

codling moths larvae
adults emerging as codling moth
adults emerging as parasitoids

Ascogaster quadridentata

Pristomerus vulnerator

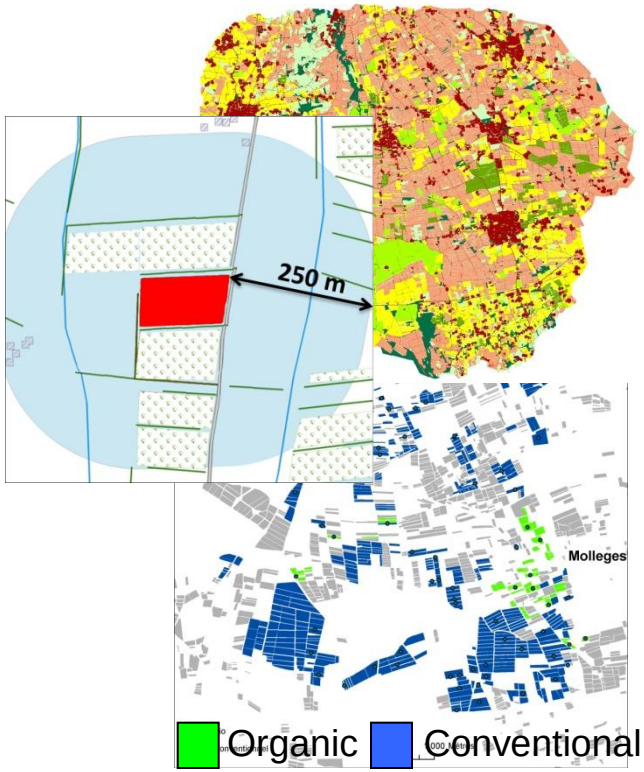
Description of apple orchard environments

At the orchard level

- **Crop production :** organic *vs.* conventional
- **Crop protection:** number treatments ; exclusion nets;
- **Hedgerow:** physical structure and floristic composition

At the landscape level

- **50-250m-Buffer** around apple orchards
- **Land cover:** proportion of perennial/ annual crops and semi-natural habitats (wood)
- **Land use:** proportion of conventional, organic and abandoned orchards
- **Hedgerow network:** length and orientation



Statistical analyses

Dependent variable (to explain)

Codling moth abundance

Considered factors

Two options= with or without considering crop protection

Scale of effect

Orchard	Model1
Orchard + hedge	Model2
Orchard + hedge + landscape	Model3
Orchard + hedge + landscape+ orchard * landscape	Model4

Model comparisons with AIC

Collected codling moths and parasitoids

Year	# orchards with codling moth	# orchards with parasitoids	# diapausing CM larvae	# adult individuals (# parasitoids)
2006	46	10	4853	2815 (112)
2007	45	7	3133	2753 (89)
2008	40	20	3239	2687 (80)
2009	33	13	4786	3990 (181)
2010	38	12	7595	5124 (85)

Maalouly et al. 2013

Factors affecting codling moth abundance
Option 1: only land cover

orchard → Apple (N=202)
orchard → Others (N=0)

hedge → Presence of host tree in hedge (N=62)
hedge → No host tree in hedge (N=140)

landscape → area with pomefruit orchard within 250m

Landscape * orchard

Year + Orchard
Year + Orchard + hedge
Year + Orchard + hedge + landscape
Year + Orchard + hedge + landscape+ interaction ⟸ Best model, ns

Factors affecting codling moth abundance
Option 2: consideration of crop protection

Orchard → Organic (N=68)
Conventional (N=134)

Hedge → Presence of host tree in hedge (N=62)
No host tree in hedge (N=140)

Landscape → Area with org/ conv orchard within 250m

Landscape * orchard

Year + Orchard
Year + Orchard + hedge
Year + Orchard + hedge + landscape
ear + Orchard + hedge + landscape+ interaction

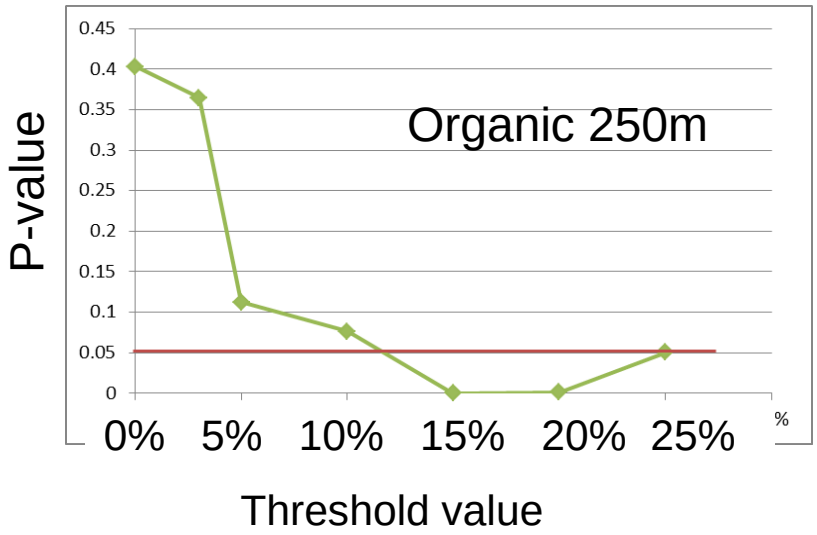
⇐ Best models

Year + Orchard*** + hedge + landscape*** + interaction *(organic)
->landscape effect only significant for organic orchards

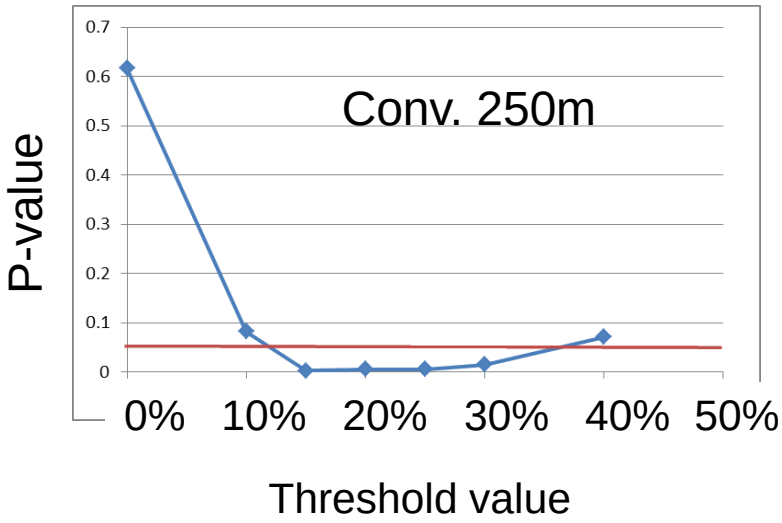
Year + Orchard*** + hedge + landscape** (conventional)

Amount of conv./org. within 250m orchard that matters

Landscape → Less than x% org/y% conv orchard within 250m (N=155/N=93)
→ More than x% org/y %conv orchard within 250m (N=41/N=103)



15%-20%



15%-30%

Magnitude of local and landscape effects

Adjusted means via model predictions

Local

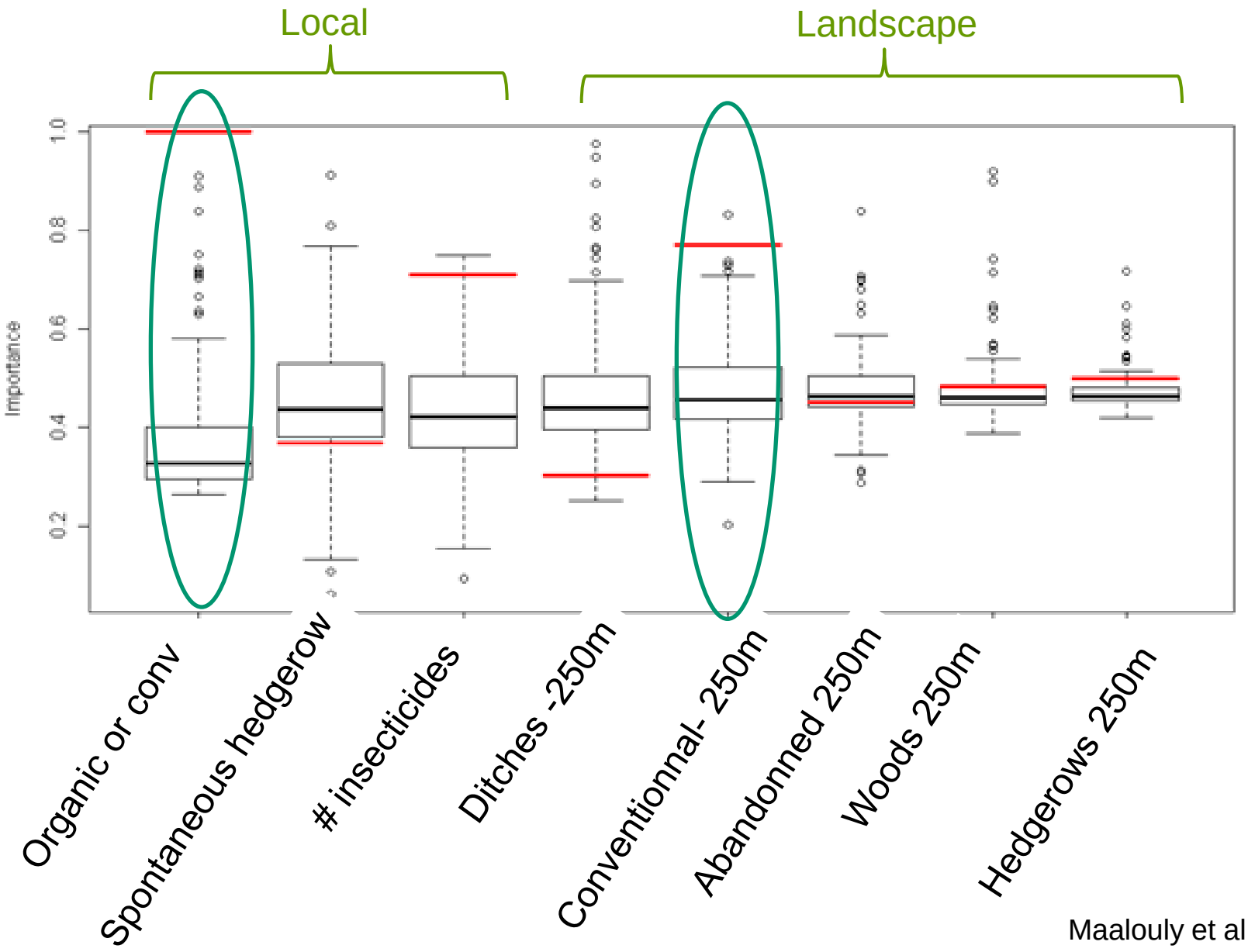
Crop protection	Abundance
organic	3.41
conventional	0.78

Landscape

Conventional-250 m	Abundance
>25%	1.25
<25%	2.17

→ Similar order of magnitude of local and landscape effects

But…factors affecting codling moth parasitism



Maalouly et al. 2013

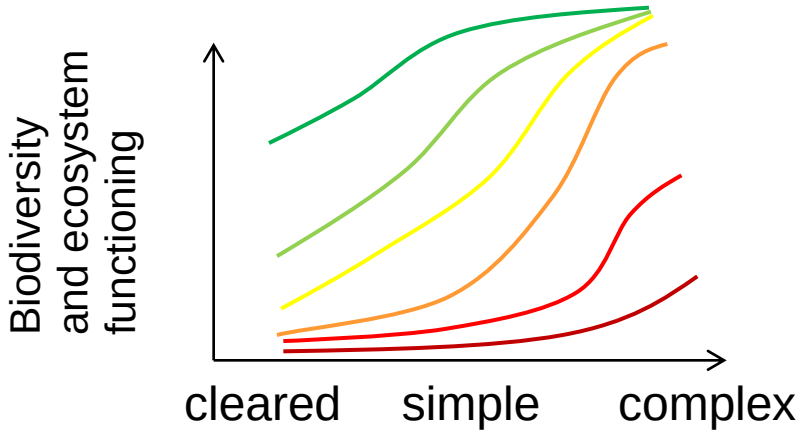
Conclusions

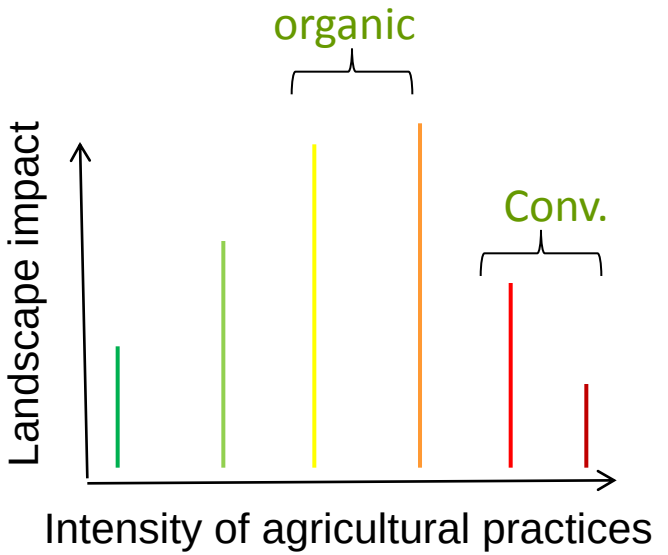
Main results

- Codling moth abundance and parasitism are affected both by local and landscape effects
- Agricultural practices are most important at both local and landscape scale
- Landscape effects have similar order of magnitude as local effects

Discussion

- Landscape effect also on a perennial crop
- Need for generalisation to other landscape
- Interaction with agricultural practices ?





Adapted from Tscharntke 2005

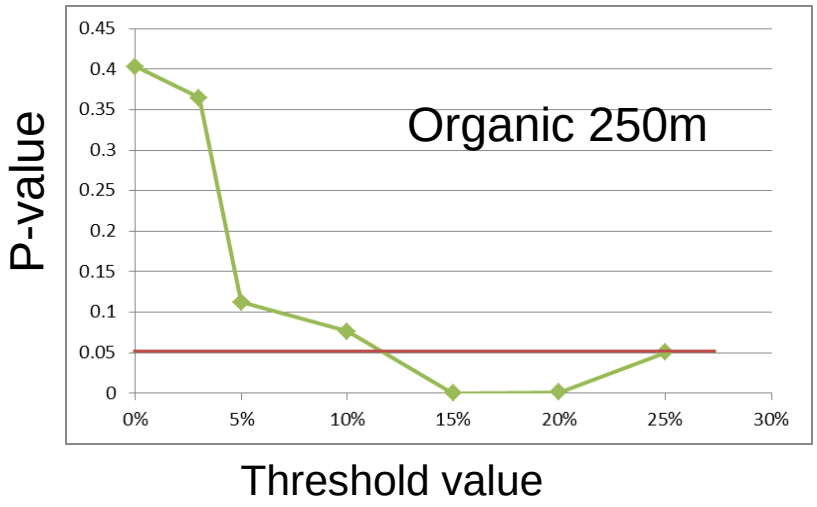
Thank you for your attention!

100m

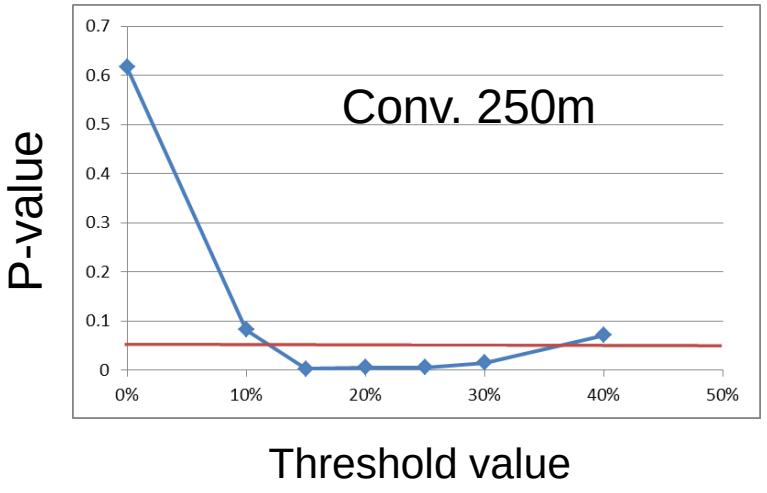
The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/ 2007-2013) under the grant agreement n°265865- PURE

Impact of threshold values on landscape effects

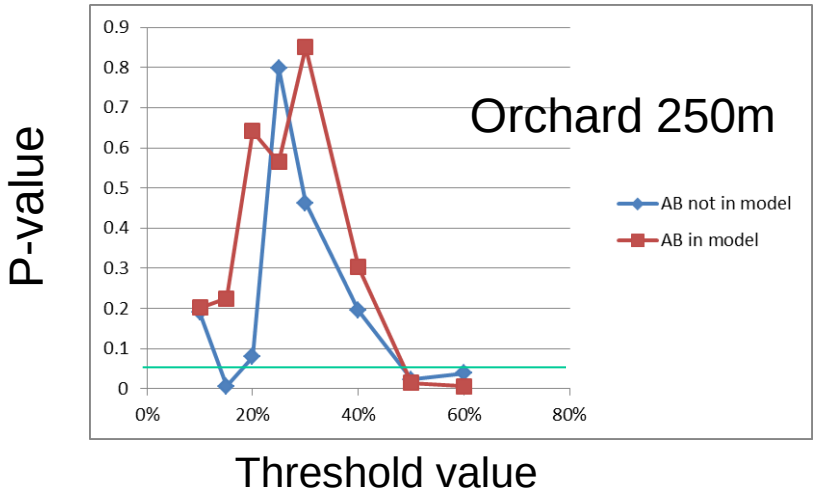
lm(log(densite.larve.diap+1)~
AB+Annee+hote.en.bdure+Bio0a250)



Lm(log(densite.larve.diap + 1) ~ AB + Annee + hote.en.bdure
+ Conv0a250s)



Lm(log(densite.larve.diap + 1) ~ (AB)+ Annee + hote.en.bdure
+vergera250



Magnitude of local and landscape effects

Adjusted means via model predictions

Local

Crop protection	Abundance
organic	3.25
conventional	0.82

	organic	conv
Org>15%	10.7	
Org<15%	3.93	

Landscape

conventional	Abundance	organic	Abundance
>25%	1.25	>15%	3.95
<25%	2.17	<15%	1.05

→ Same order of magnitude of local and landscape effects