The impacts of bioenergy crop production on carabids and associated biocontrol services.

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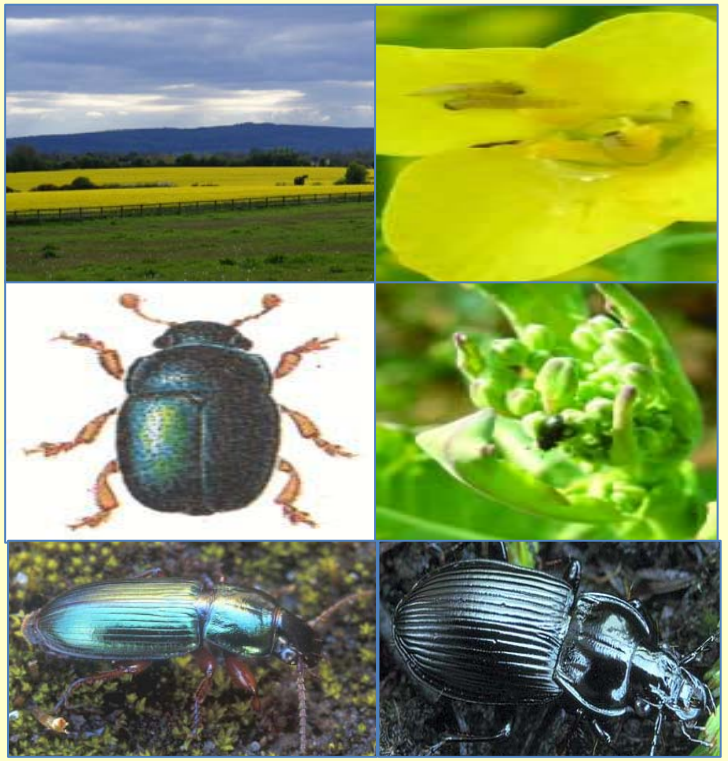
The impacts of bioenergy crop production on carabid and biocontrol services

- **Field research**

➢ Examining the impact of annual & perennial bioenergy crop production on carabid diversity.

- **Experimental research**

➢ Examining the role of carabids in the provision of biocontrol services.



Predator biomass drives natural biological control

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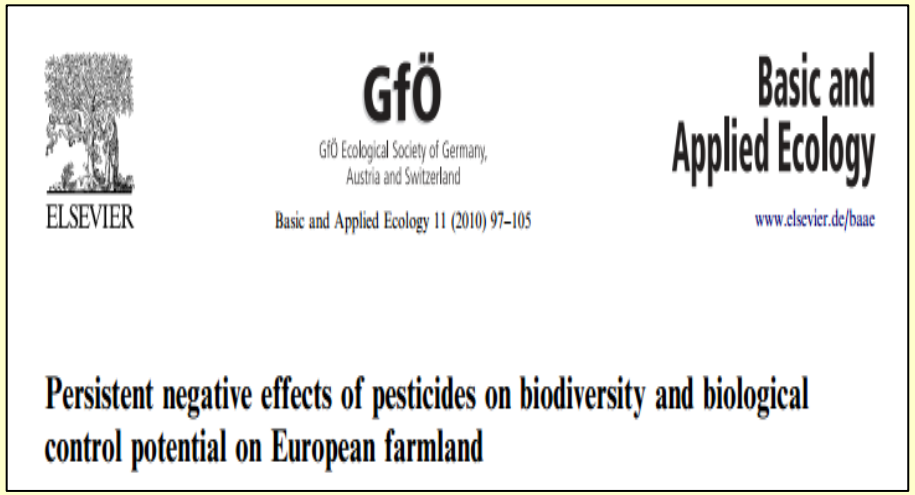
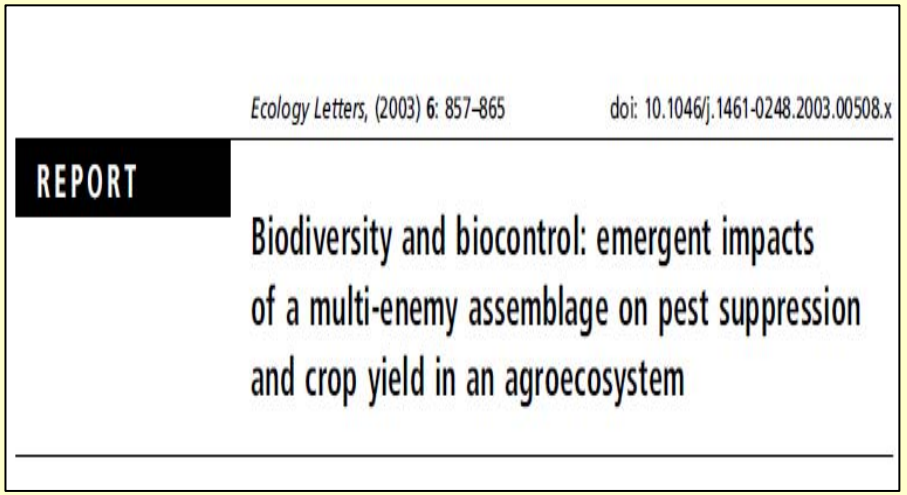
Justification for research





- Community functioning dependent on:

1. Identity effects
2. Diversity effects
3. Biomass effects

- Challenge to identify aspects of predator diversity most beneficial to prey suppression.

- Need to understand the mechanisms of ecosystem functioning to allow for informed management.

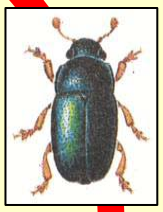
Hypotheses

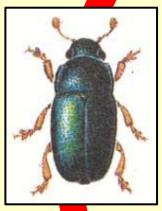
1. Predator diversity reduces pest survival rate more than predator biomass.

2. Interactions amongst predators lead to complementary use of prey resources.

3. Predator identity effects and diversity effects remain consistent as predator biomass changes.

Meligethes aeneus (pollen beetle) – carabid – winter oilseed rape complex





Carabid predator biocontrol potential exists when 2nd instar larvae drop to the ground surface.

Understanding the study system

1. What is the impact of high and low pesticide management of winter oilseed rape on:

   a) crop yield

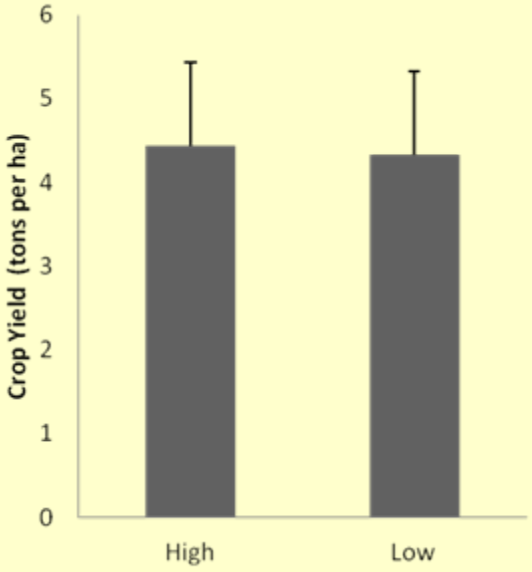
   b) carabid species richness

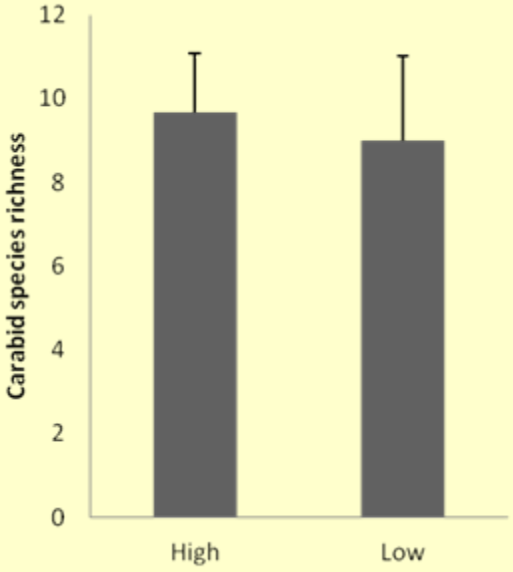
   c) carabid abundance (Field study)

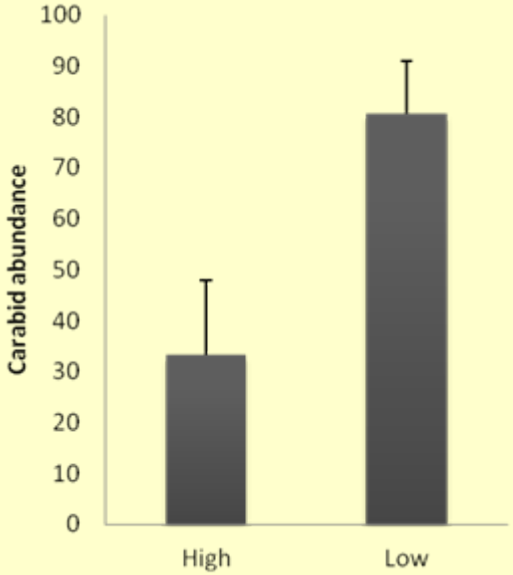
2. What carabid species are most abundant at the time of pollen beetle larval drop to the soil surface? (Field study)

3. Of the most abundant carabid species, which have the capacity to prey on the pest? (Laboratory feeding experiment)

Impact of high and low pesticide management of winter oilseed







- 58.68% reduction in carabid abundance in crops under high pesticide management.

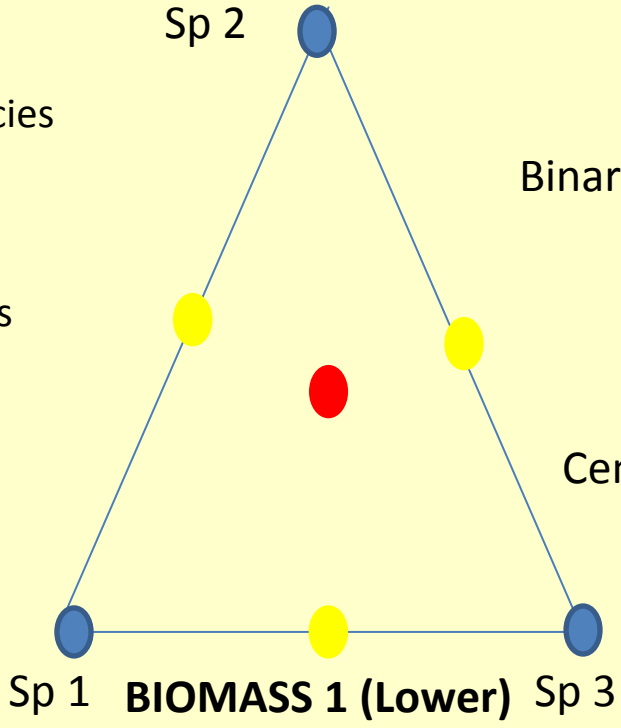
Species	Mean (±se) abundance	Mean number of larvae killed (±se) in 2 hours
Bembidion lampros Generalist Insectivore 	**221.33 ± 25.11**	**0 (*)**
Poecilus cupreus Generalist Insectivore 	**161.17 ± 27.04**	**9.14 ± 1.14**
Harpalus affinis Granivore 	**131.17 ± 34.23**	**4.14 ± 0.77**
Pterostichus melanarius Generalist Carnivore 	**34.33 ± 9.46**	**18.14 ± 1.61**

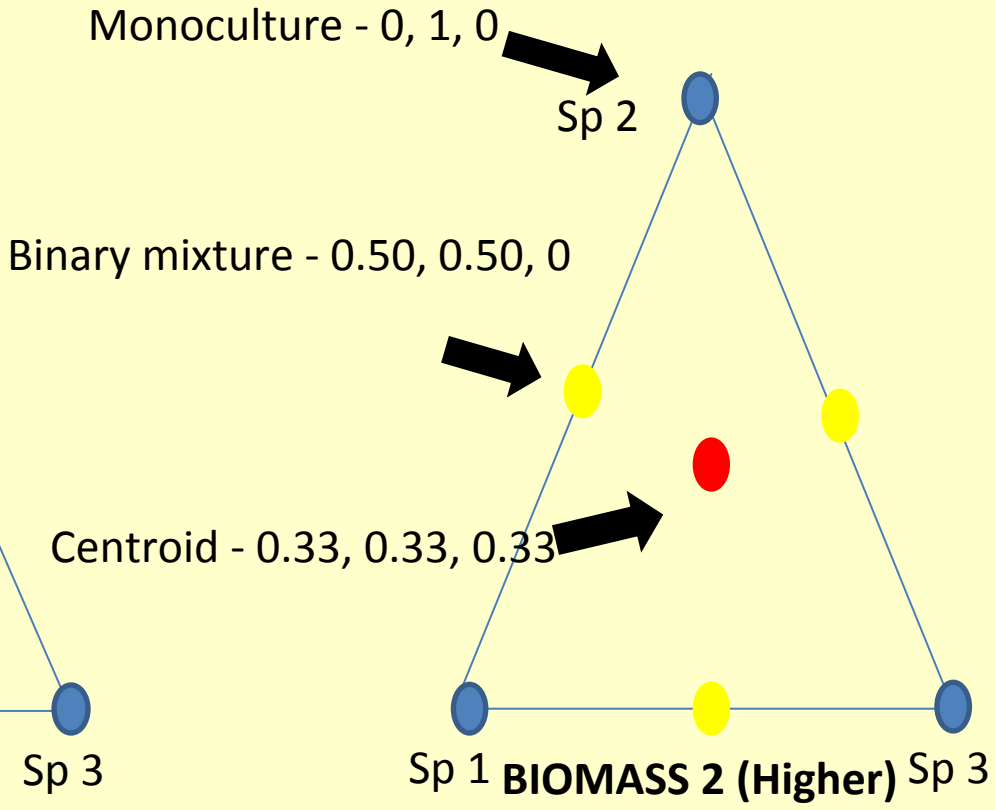
Simplex

Monoculture
100% of one species

Binary mixture
equal proportions
of two species

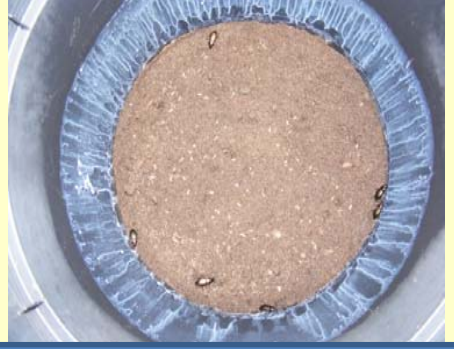
Centroid
even proportions
of three species



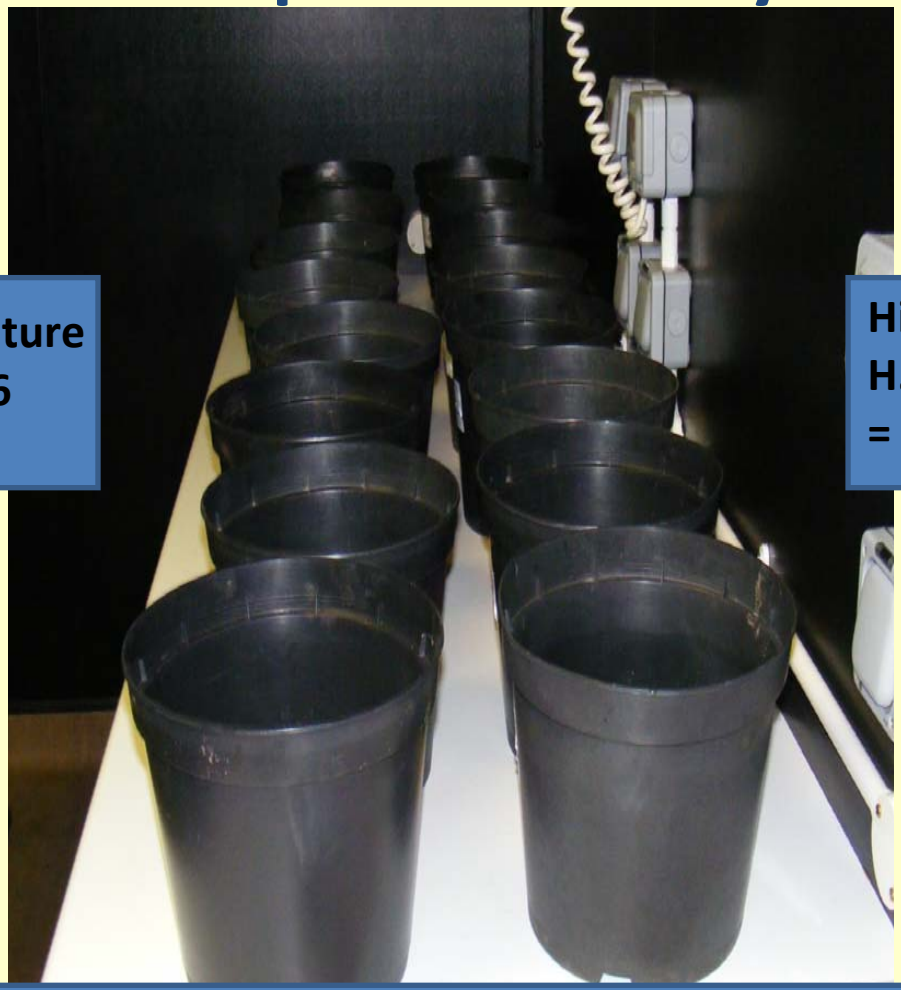


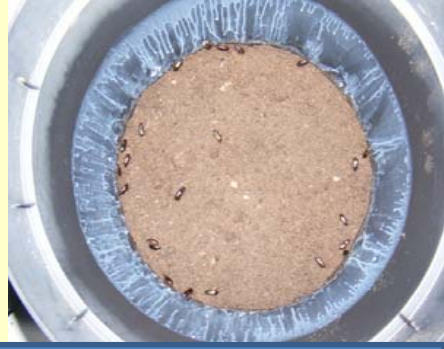
- **14 diversity treatments, at 2 carabid biomass levels.**
- **2 temporal time blocks incorporated.**
- **Within each time block - 2 controls containing no carabids to account for natural mortality of larvae.**

The experimental layout



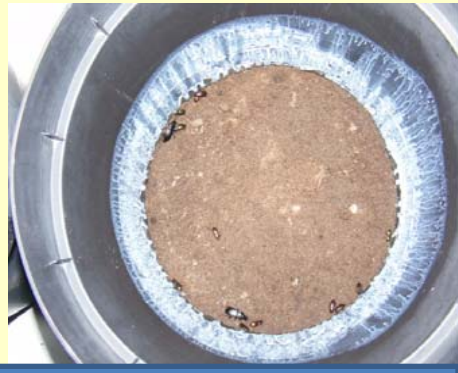
Low biomass - Monoculture
P. cupreus = 0.098g X 6
= 0.588g





High biomass - Monoculture
H. affinis = 0.051g X 24
= 1.224g

Response: proportion of larvae surviving



Low biomass - Binary
1 P. melanarius + 3 P. cupreus =
0.195g + 0.294g = 0.489g

High biomass - Binary
2 P. melanarius + 12 H. affinis
=
0.39g + 0.612g = 1.002g

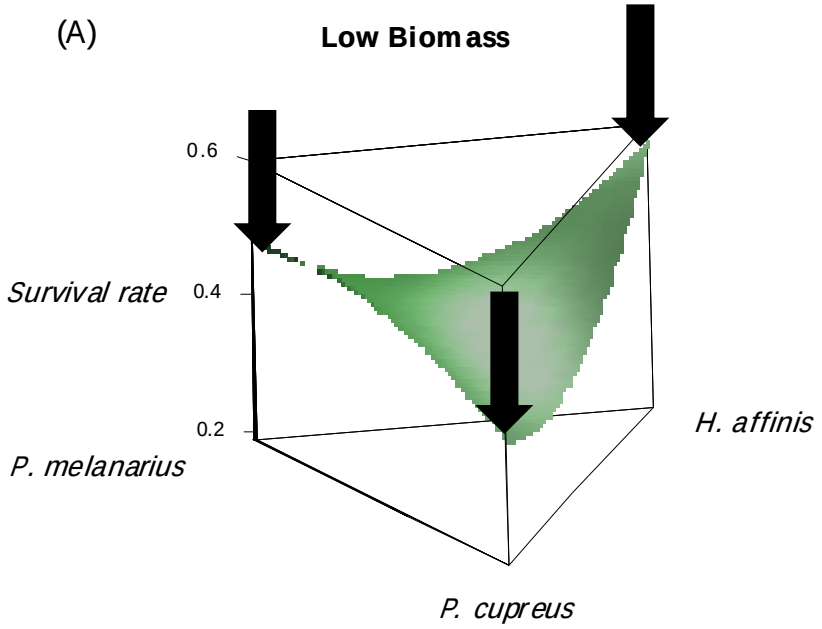
Simplex predator-pest results

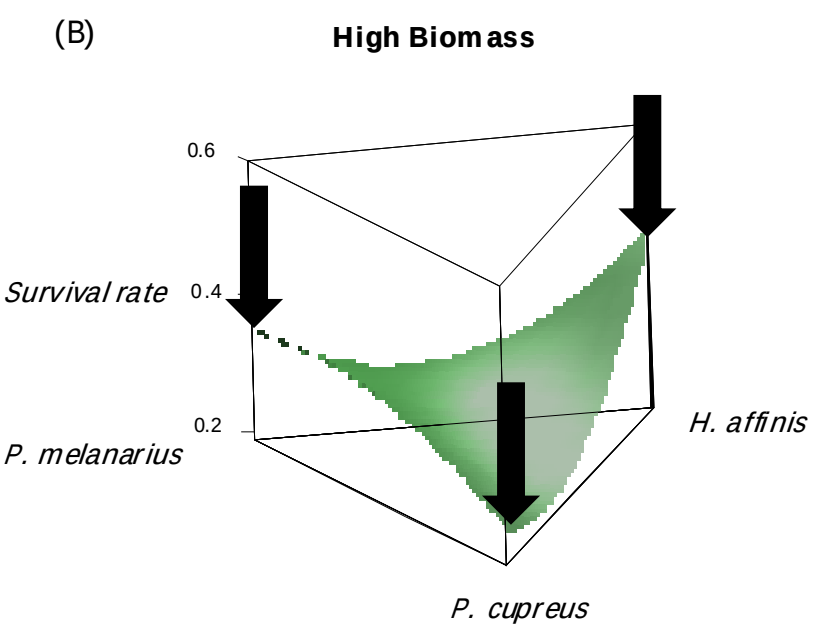
- Increased predator diversity and biomass had a positive effect on biocontrol expressed as a reduction of pest survival.

- Biomass effect shown to play a greater role than the diversity effect in the delivery of service.

Simplex predator-pest results

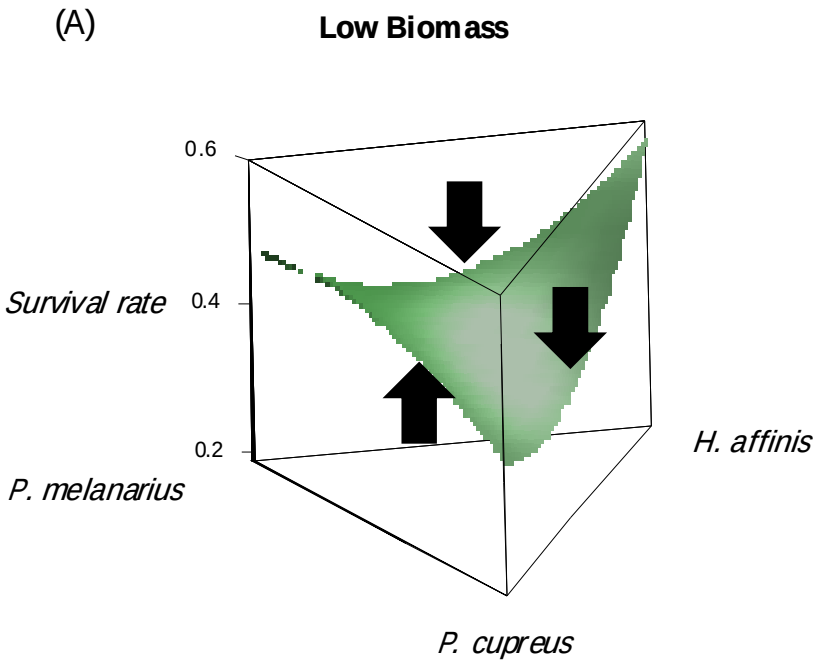
- All carabid monocultures caused a decline in pest survival rates.
- Delivery of biocontrol services was greatest with respect to monocultures of *P. cupreus*.

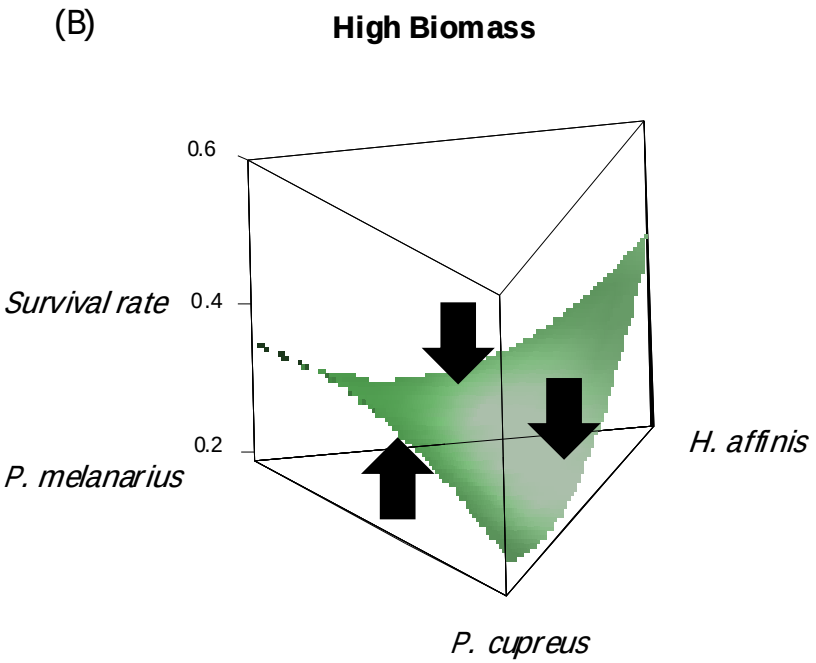




Simplex predator-pest results

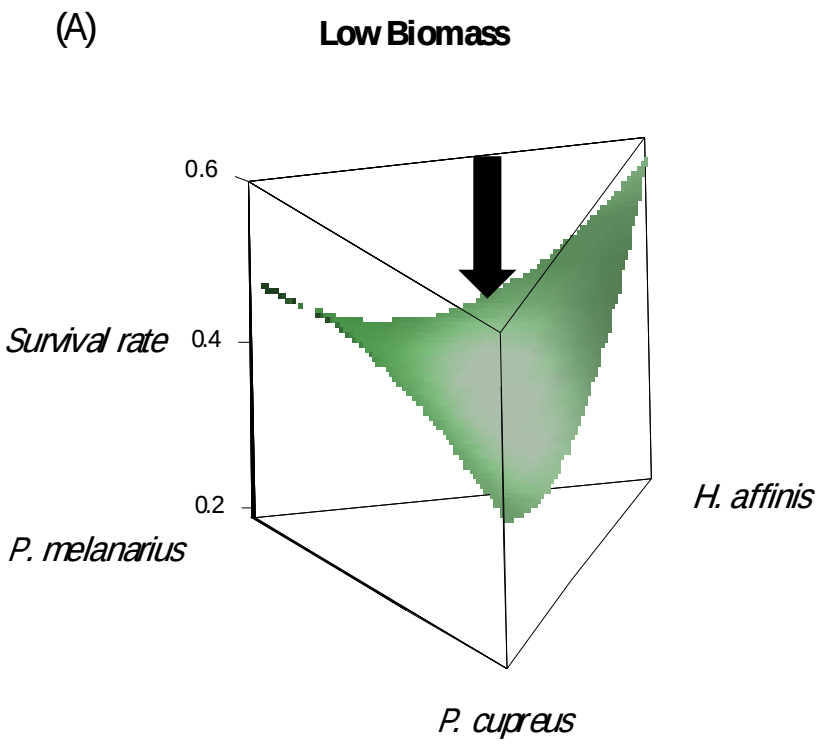
- Pest survival declined when *P. melanarius* and *H. affinis* and *P. cupreus* and *H. affinis* were combined in mixture - predatory facilitation.
- Pest survival rate increased when *P. melanarius* and *P. cupreus* were combined in mixture - behavioural interference.

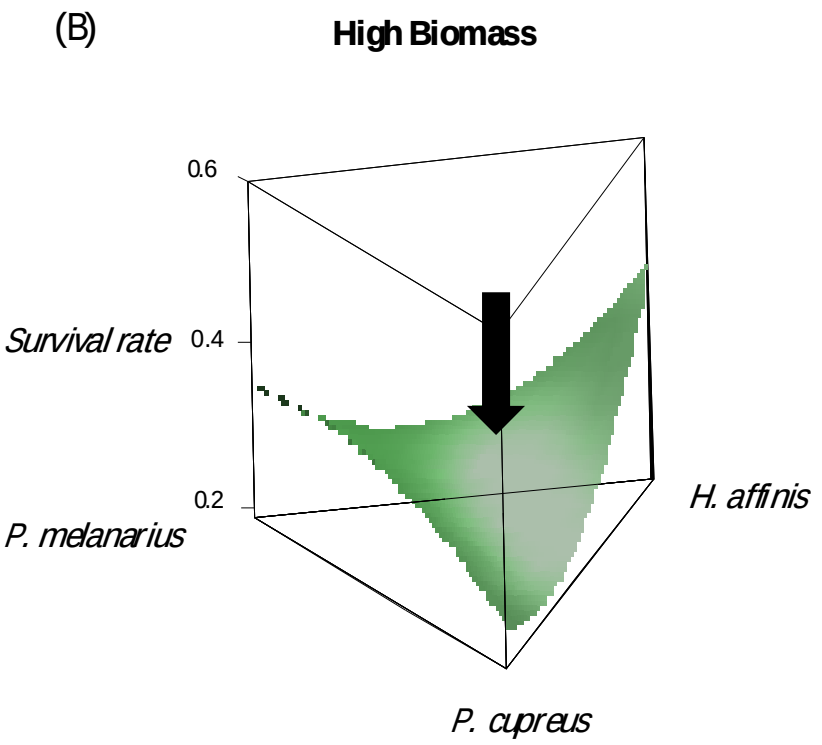




Simplex predator-pest results

- Pest survival rate was further reduced at higher biomass.
- Identity and diversity effects are shown to remain constant, irrespective of the level of predator biomass.





Conclusion

- Carabid community biomass drives the reduction in pest survival.

- A lower level of pesticide management will:

1. Enhance carabid predator biomass.
2. Improve the delivery of carabid biocontrol services.
3. Not cause producer to suffer low crop yields.

Thanks

Prof Mark Emmerson & Dr Pádraig Whelan

Dr Sam Cook, Dr Darren Murray & Dr Laura Kirwan
Nigel Watts & Steve Freeman

All the farmers/landowners

Dr Roy Anderson (carabid pictures)

Thank you for listening.

Questions?

Predator-pest interaction experimental design

- Simplex design (Cornell 2002, Ramseier et al., 2005, Sheehan et al., 2006, Kirwan et al., 2007, 2009)

- Allows the use monocultures and community mixtures of carabids at fixed levels of overall carabid biomass (low & high)