Beetles in farming landscapes

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What makes a beetle (Coleoptera)?

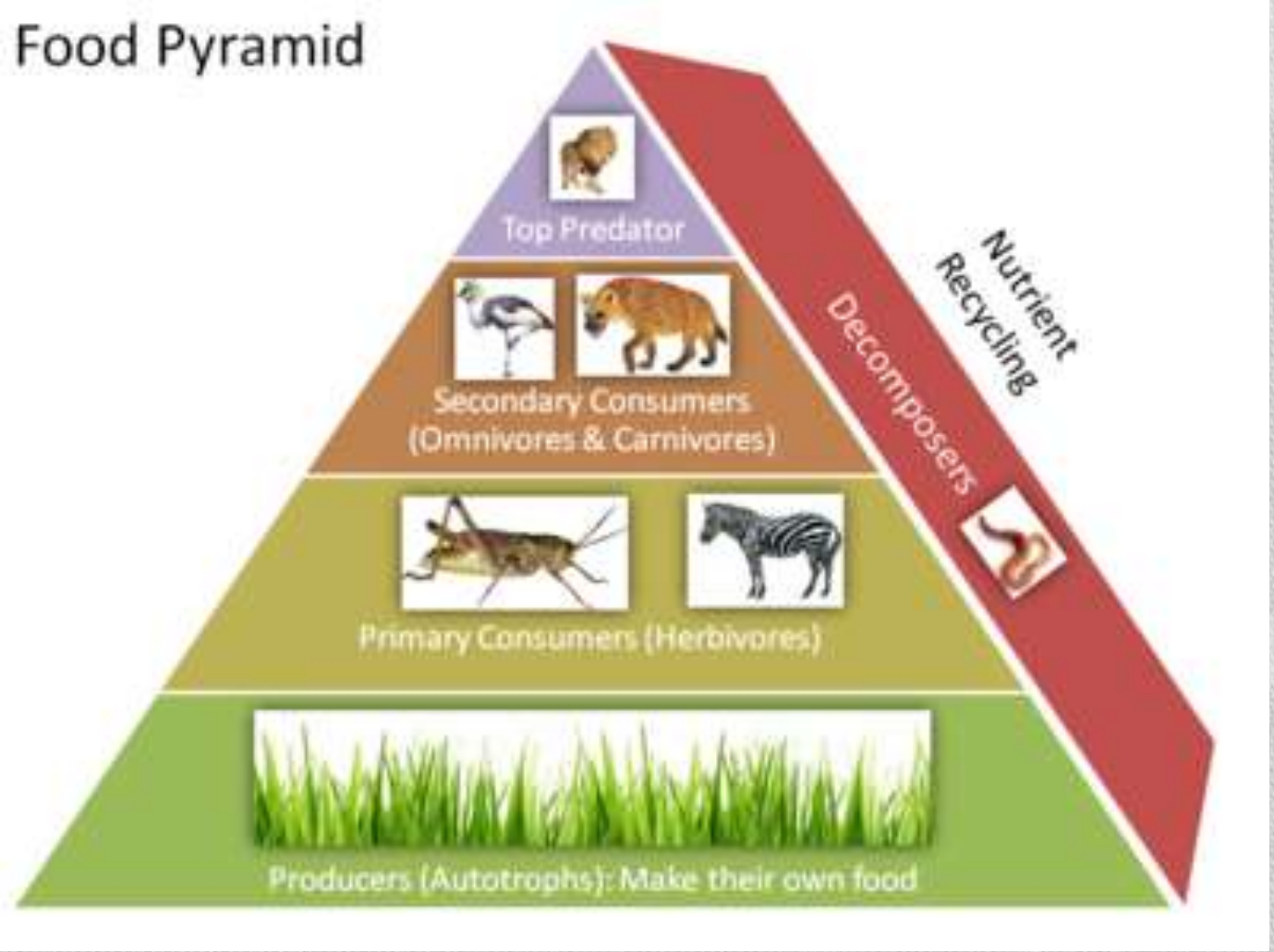
Source: Australiangeographic.com.au

"The Creator would appear as endowed with a passion for stars, on the one hand, and for beetles on the other, [...] there are nearly 300,000 species of beetles known, [...] compared with [...] 9,000 species of birds and a little over 10,000 species of mammals. Beetles are more numerous than the species of any other insect order. ..."*

(J.B.S. Haldane, What is Life – the Layman's View of Nature p248)

* 1.5 million estimated

Why beetles?



Source: maggiessciencecconnection

Beetle diversity in the region

Including some local residents!

Source: bowerbird.org.au

Source: padil.gov.au

Source:museum victoria.com.au

Source: bowerbird.org.au

Source: bowerbird.org.au

Approx. 30,000 beetle species, 113 families in Australia

Farming landscapes

Remnant patch focus in conservation…

… influence of **habitat edges**?

… **Farm paddocks** are heterogenous across space & time

How can we better manage the farmlands for both biodiversity & food production?

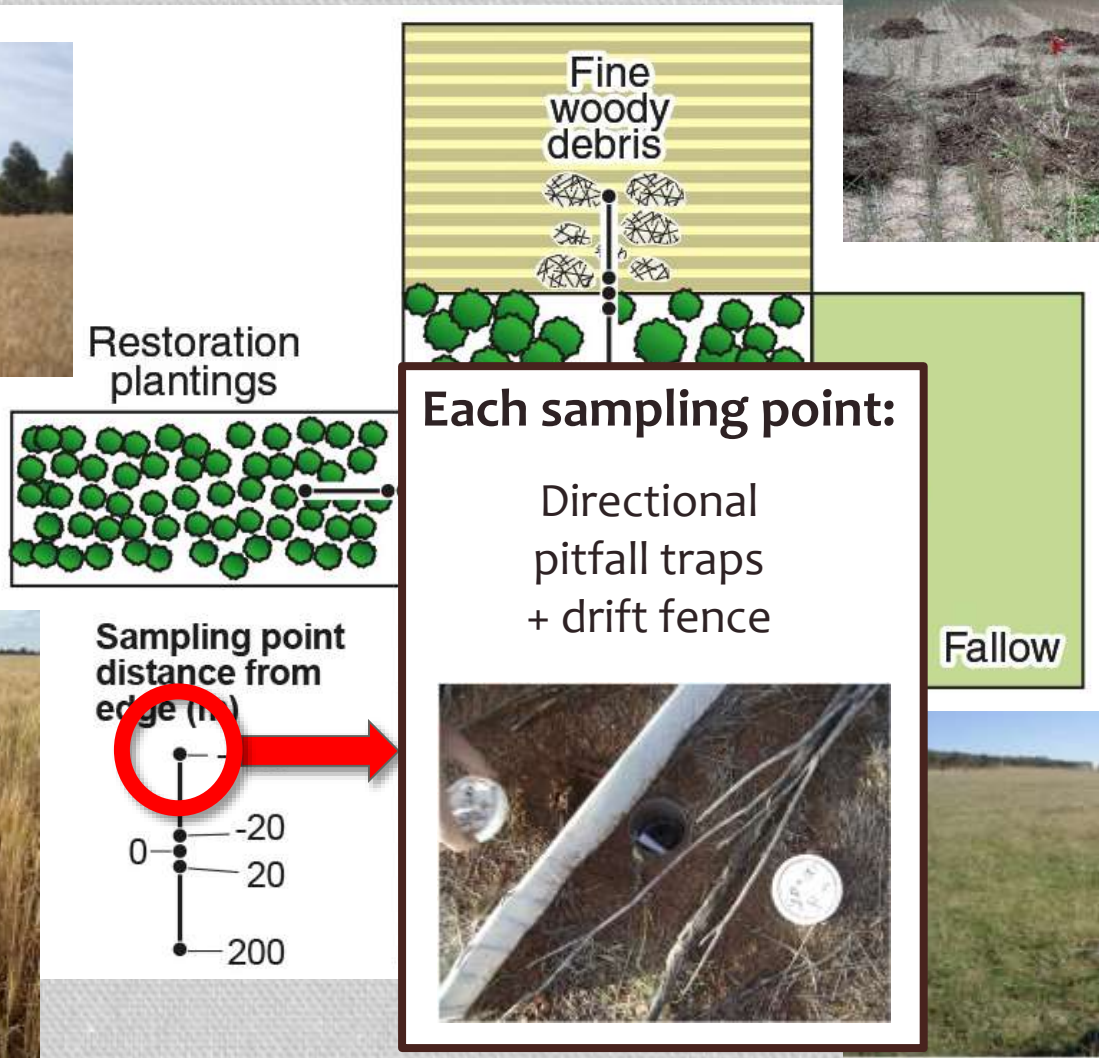
Study sites

- 11 sites in NSW Lachlan catchment (200 km span)
- Prime mixed cropping-grazing land

Methods: Study design

4. Woody debris (euc-based), 20m wide

3. Plantings <10 years, 30m wide



Each sampling point:

Directional pitfall traps + drift fence

1. Crop

2. Fallow

Methods: Two sampling periods

- 440 traps opened for 2 weeks
- Spring (Oct 2014), Summer after harvest (Jan-Feb 2015)

Temporal changes of mid growth, full growth, harvested wheat crop

Methods: Field shots

Woody mulch sourced from Eucalyptus oil plantation

Setting up, locating, collecting pitfall traps…

Woody debris application video

Video: Mal Carnegie

The hard work was **after** fieldwork!

Methods: Year-long lab work

- 11,360 individuals, 495 species, 53 families of beetles

Beetle morphospecies reference collection

Pinning & labelling specimens *correctly* is time consuming!

- 2 new millipede species, 1 new genus! →

Photo: R. Mesibov

Part 1. Patterns of beetle diversity

(what, where, when)

Setting the scene:

- Beetle biodiversity & ecosystem services
- We don't know how beetle diversity changes over time and space

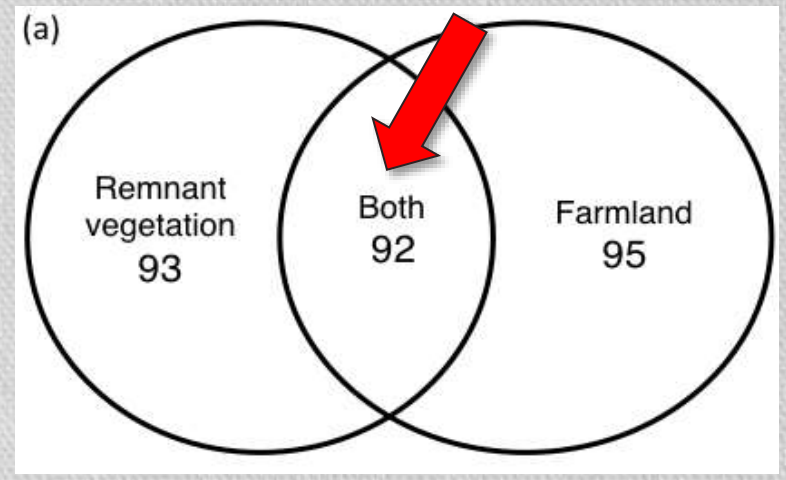
Research question:

How does **farm land use** & its change **over time** affect beetle assemblages in remnant patch & adjacent farm land use?

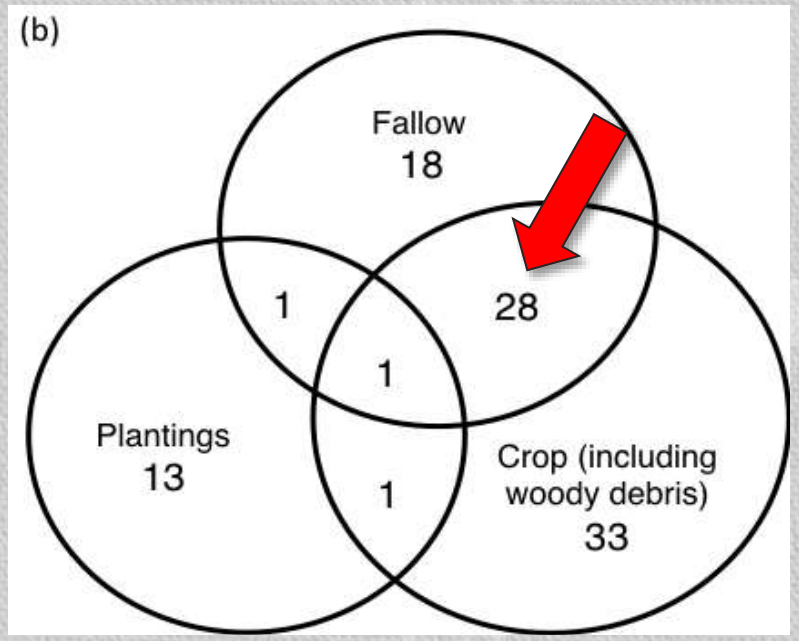
Species composition (“*what species*”)

- Significantly different species between remnant patch & farmlands, but …

A third of species found in both remnants & farmlands

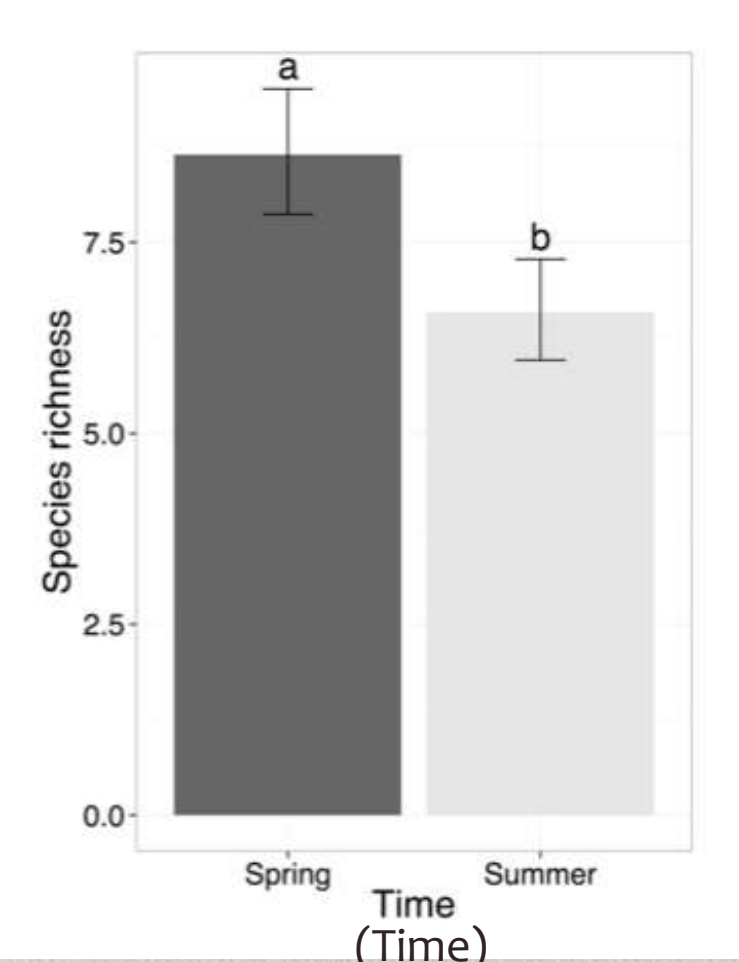


Large proportion of species occur in both crop & fallow



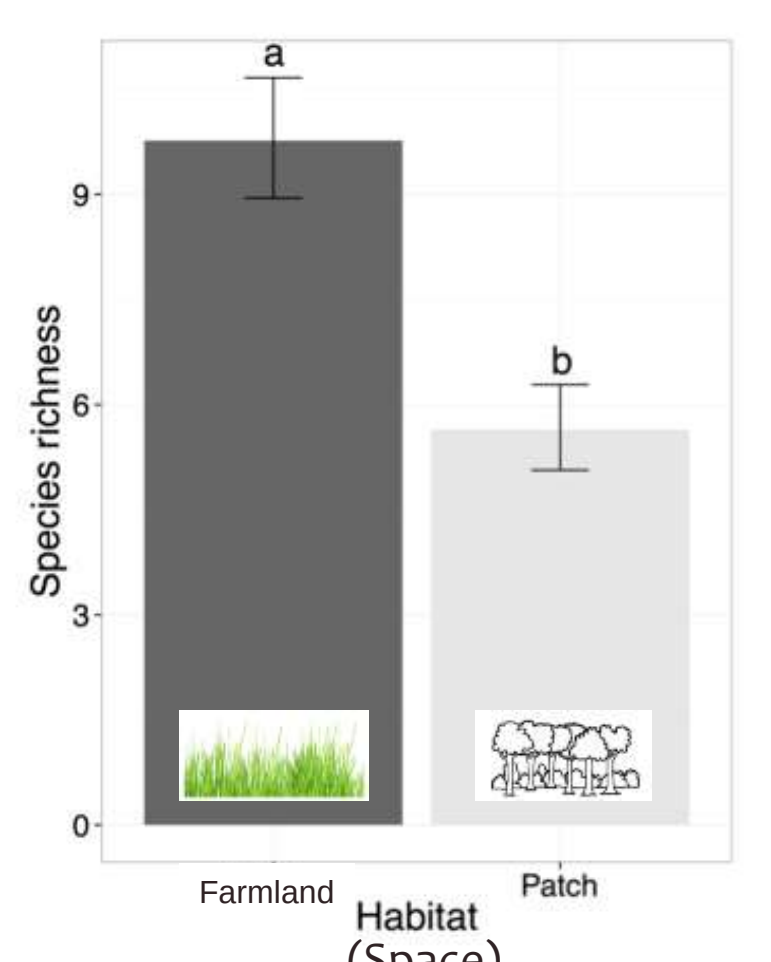
Species richness (“*how many species*”)

Decrease between spring & summer



(Time)

Higher species richness in farmland than remnant patch



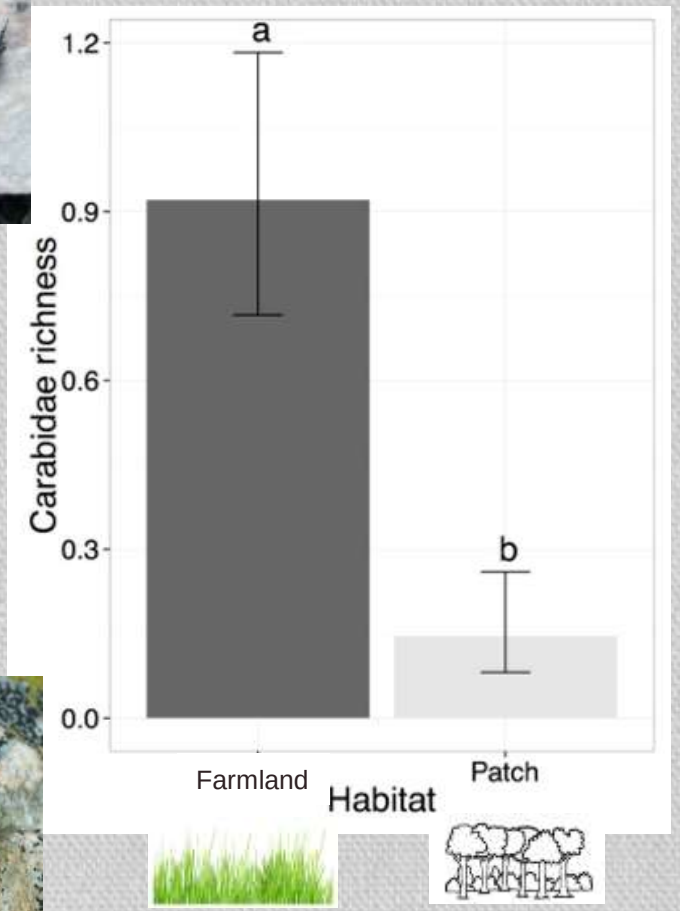
(Space)

Species richness: two predatory families

- Farmland > remnant patch

Carabidae (ground beetle)

Scraphites sp.

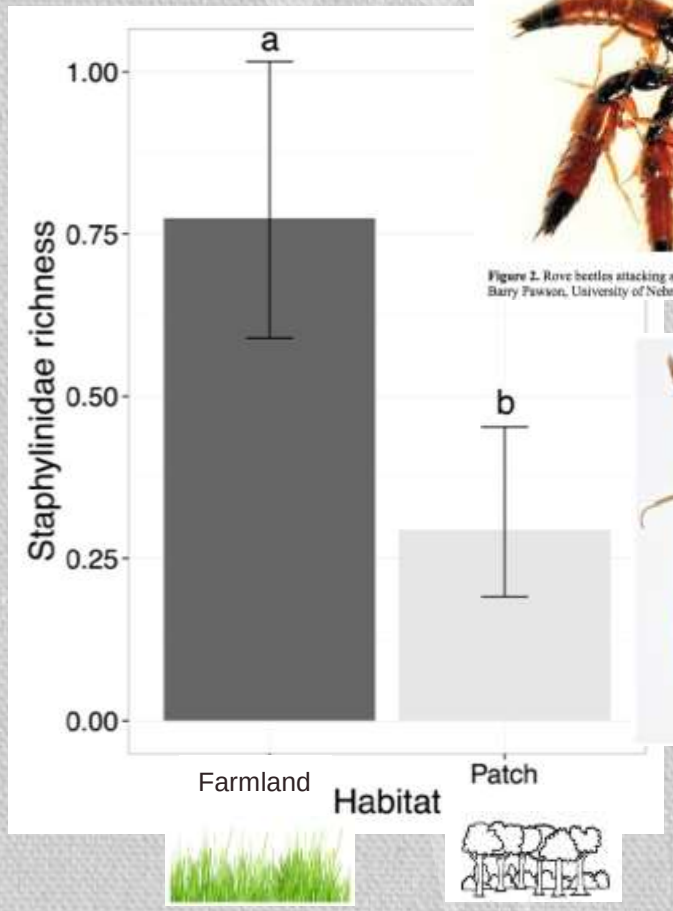


Sarticus sp.

Staphylinidae (rove beetle)

Source: entnemdept.ufl.edu

Figure 2. Rove beetles attacking a house fly maggot. Photograph by Jim Kalisch and Barry Pawson, University of Nebraska-Lincoln.

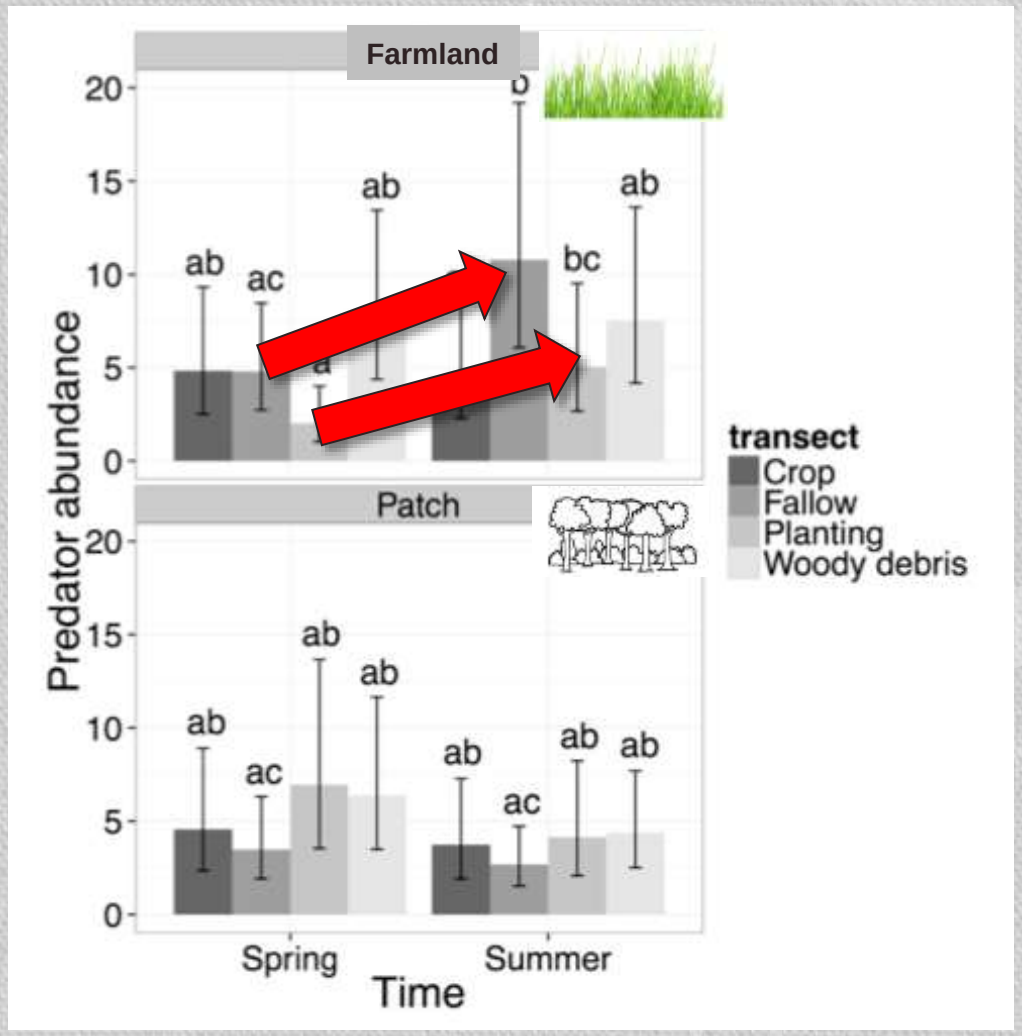


?Oxypodini sp. 3

Abundance ("how many individuals")

- **Predators** generally use fallow & planting during summer

Predator abundance

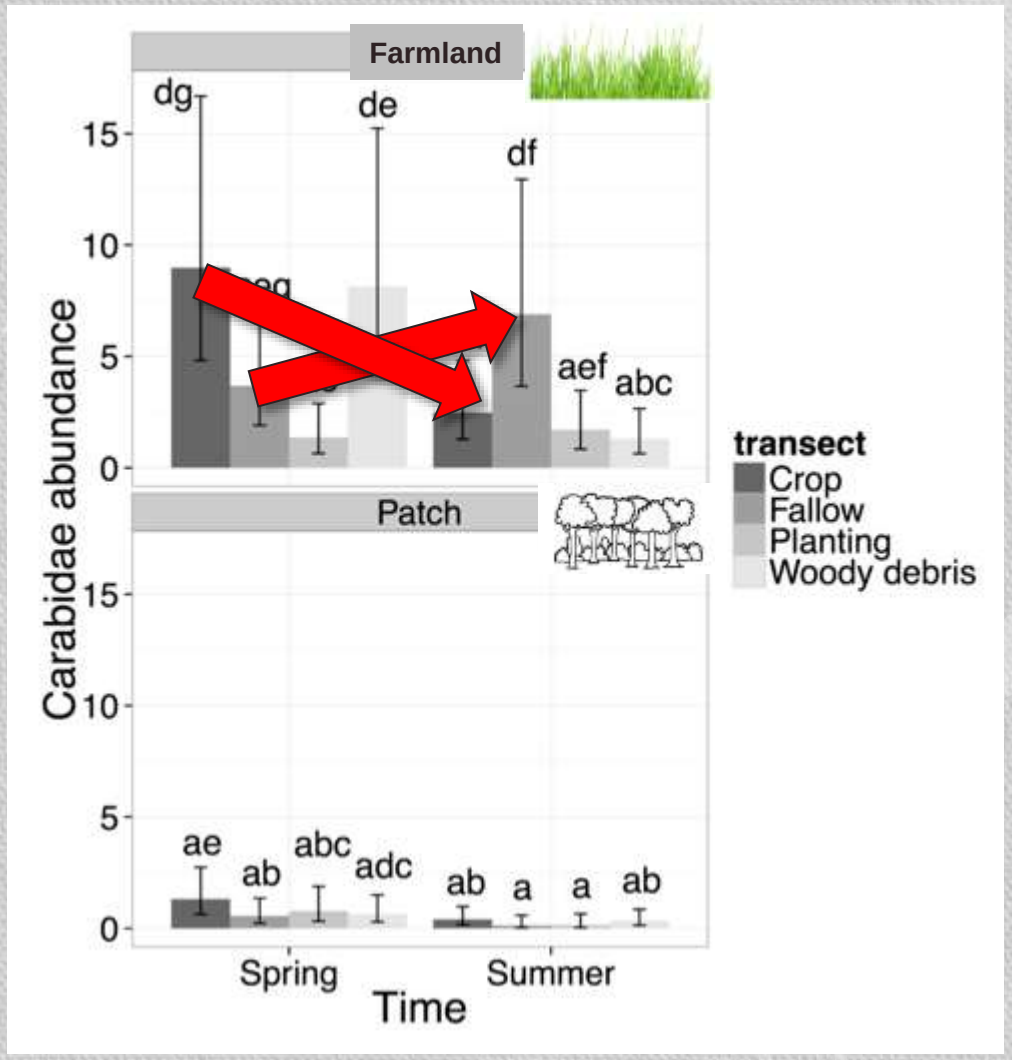


Abundance

- Crop-fallow changes for a predatory **carabid** beetle family!

Carabidae abundance (ground beetles)

Green carab beetle (*Calosoma schayeri*)



Abundance

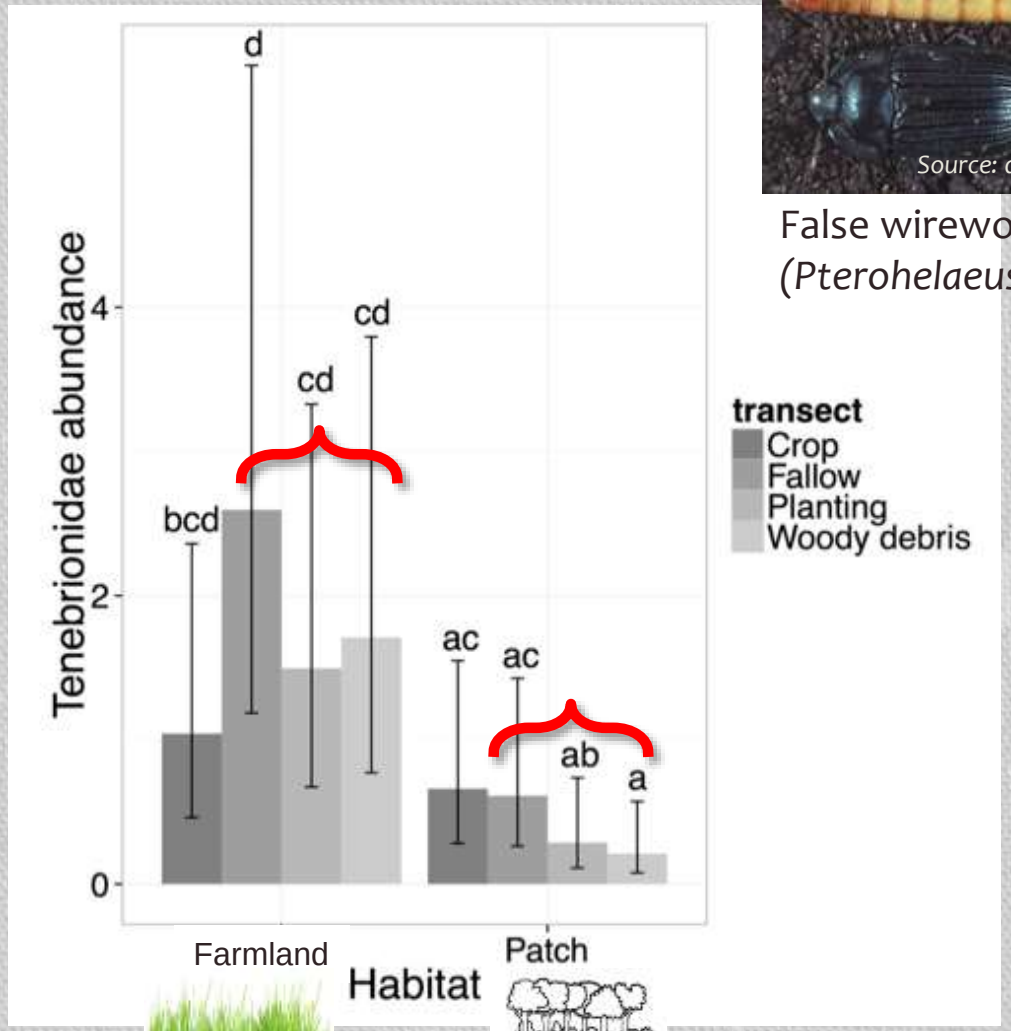
- More **tenebrionid** beetles in un-cropped or mulched farmlands (detritivores)

Tenebrionidae abundance (darkling beetles)

False wireworm (*Pterohelaeus sp.*)

Field bronze beetle (*Adelium brevicorne*)

Pie-dish beetle (*Cillibus incisus*)



Part 1. Conclusions

- Surprising result: higher diversity in farmlands
- Remnant woodland patches still important!
- Diverse landscape with mix of land-uses needed
- Fine woody debris improved detritivore abundance

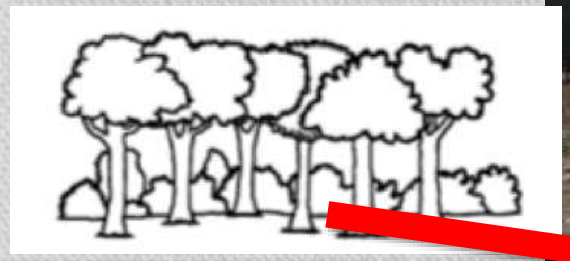
Source: agric.wa.gov.au

Part 2: Habitat edges & movement

Setting the scene

- Influence of habitat edges
- Definitions: Edge, ecotone, ecological boundary, field margin, etc.

"What's an edge?"



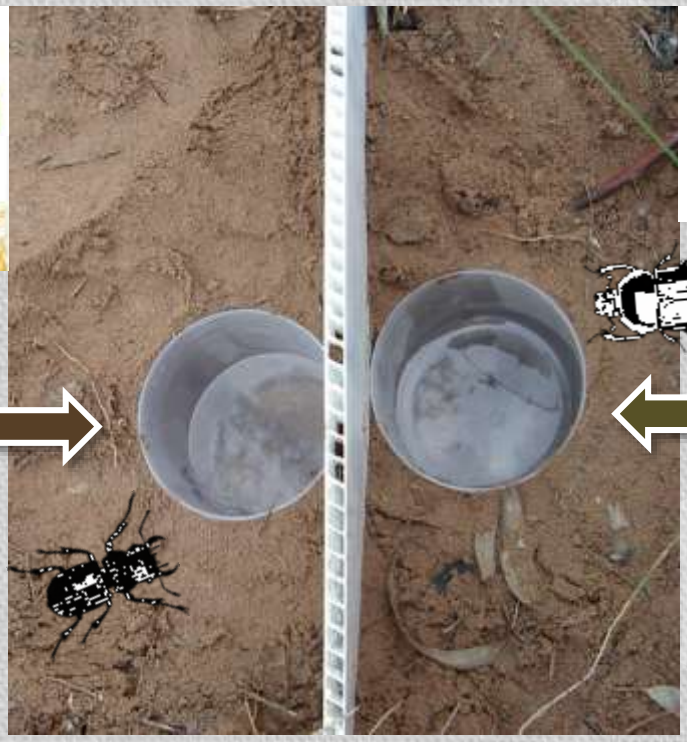
"Hard" edge
i.e. strong effects

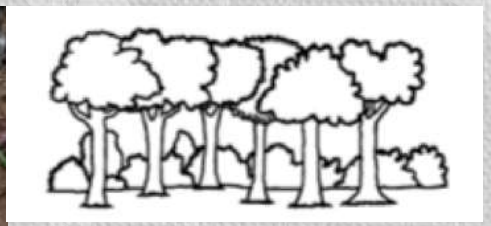
Research questions

1. Explore beetle diversity across the **edges** between woodlands & four different farmland types
2. Any changes over **time**?
3. Are beetles moving in certain **directions**?

Movement direction

- Specify direction at each trap point
- 3 possible classifications





1. To remnant woodland patch

2. To farmland

3. No directional preference

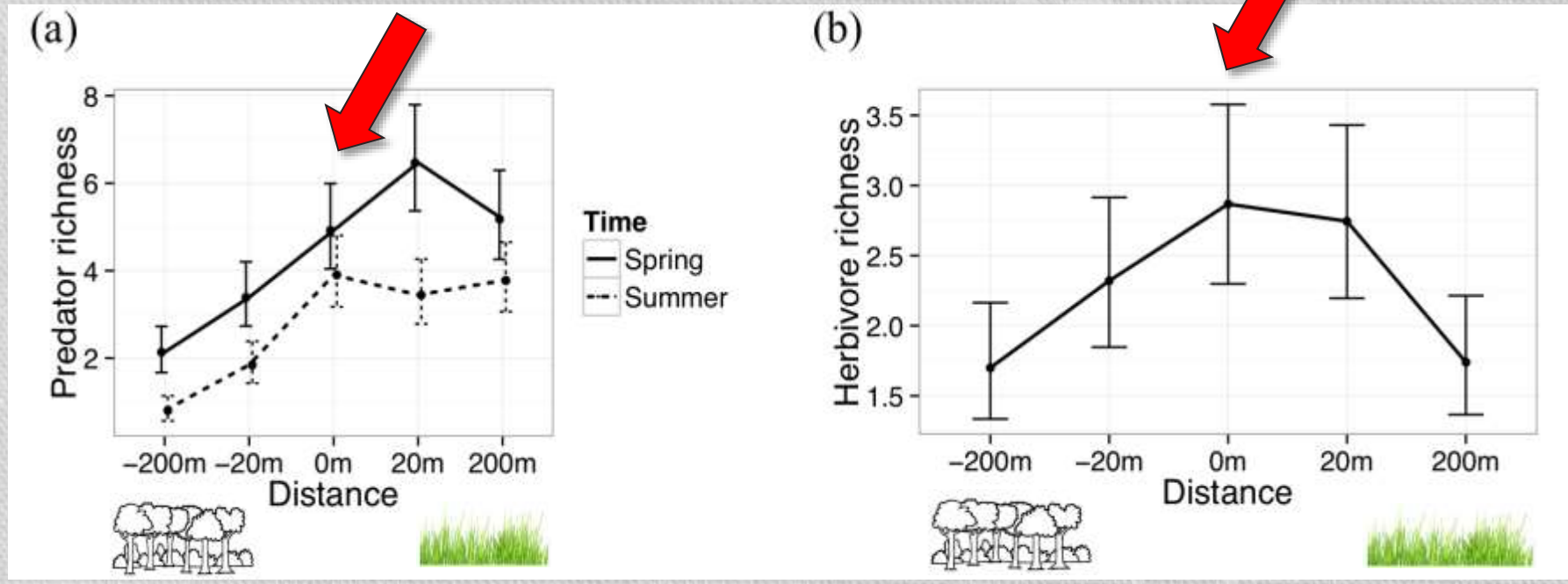
Results for trophic groups & common families

- Beetle responses to edges depend on farm type
- These responses often change over time, except for herbivores
- Directional movement found!

Species richness ("how many species")

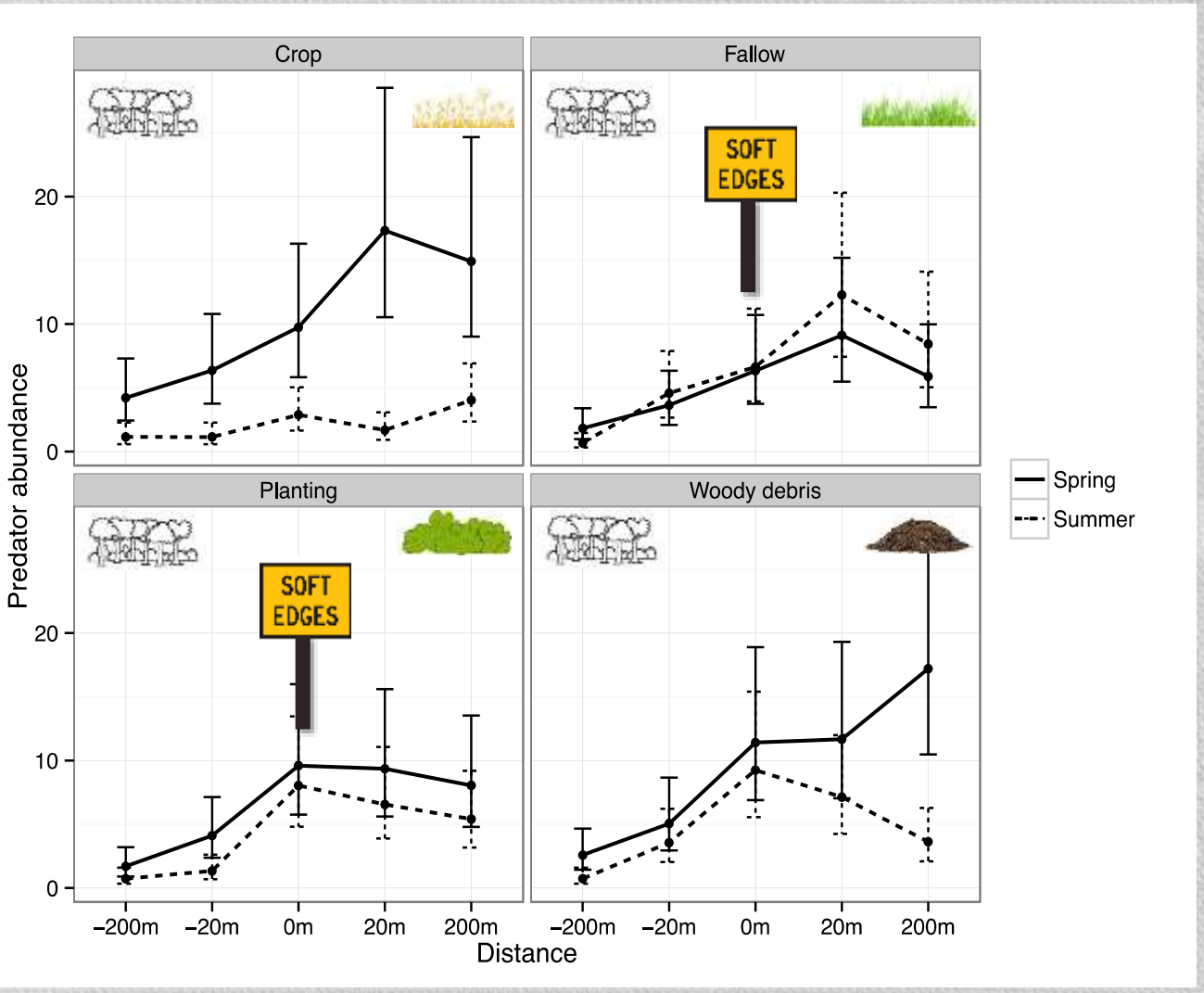
Predator richness
Remnants < farmlands
Stable at edges over time

Herbivore richness
Highest at edges



Predator abundance ("how many individuals")

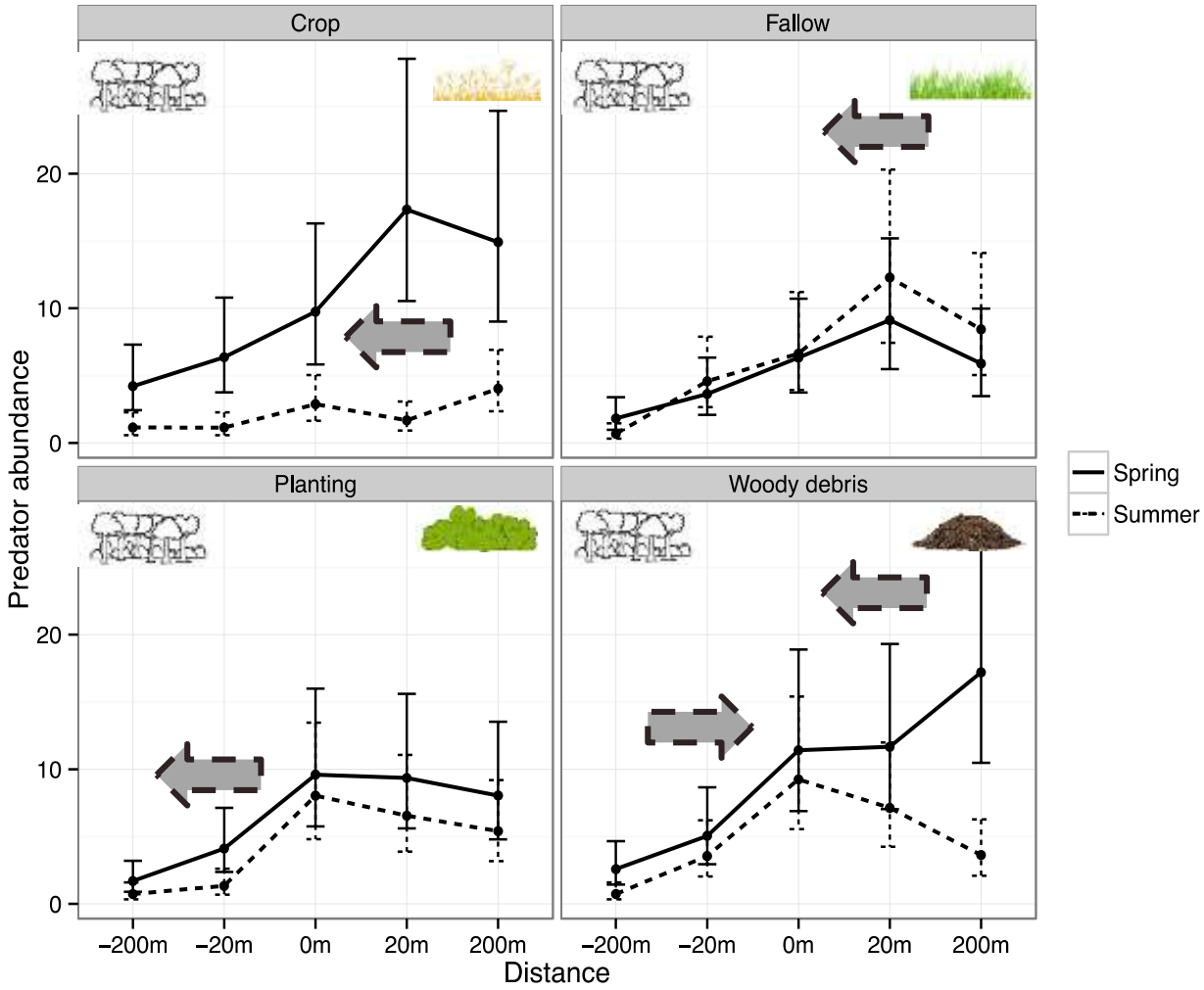
- Including Carabidae family
- Note differences for each farmland type **and** over time



Scraphites sp.

Predator movement

- Moving to edges from farms in summer **except** planting
- Woody debris and plantings used in summer



Scraphites sp.

Spring movement direction

Summer movement direction

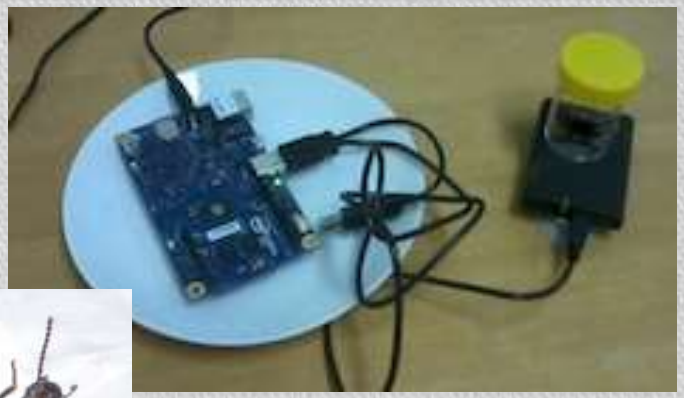
Part 2: Conclusions

- Field edges as “beetle banks”
- Edge response patterns change depending on farm type & time
- Evidence of some groups moving across habitat edges

Living on the edge or best of both worlds?

Reasons to study insects:
Loads of interesting data…

- Plant-beetle relationships
- Beetle morphology
  (body size & shape, flying ability, etc.)
- Future: Ants, spiders, beetle species-level info, etc..



(Failed) RFID tag trial…

(Failed) fluorescent powder direct tracking trial…

Ant story?

Acknowledgements

- **Supervisory panel**
- **Central Tablelands Local Land Services**
  - Milton Lewis, Angus Arnott, Dom Nowlan +
- **Landholders**
  - Day, Foy, Conlan, Hall, Lucas, Nowlan, Aylott, Grimm, Robinson, Crawford, Daley families
- **Lake Cowal Conservation Centre** (Mal Carnegie) – RRR conference & woody debris
  - **Mt Mulga Pastoral Company -** Eucalyptus mulch
  - **GD & DR Anderson Transport -** Mulch delivery
  - **Fox Cullen Earthmoving -** Mulch spreading
  - **Rod's Earthmoving & Excavation** - Mulch spreading
- **Beetle ID –** John Evans, Kim Pullen, Michael Nash, Lingzi Zhou, Rolf Oberprieler, Margaret Thayer, Vladimir Gusarov, Roberto Pace
- **Plant ID –** Mikla Lewis (Young Landcare), Margaret Ning, Rainer Rehwinkel, Nicki Taws (GA), David Albrecht (ANBG), Mal Carnegie
- **Volunteers**
  - Lab: Daniel Martinez-Escobar, Shauna Priest, Imogen Moore
  - Field: Nick Shore, Alicia Ng, Margaret Ning, Dimitris Tsifakis, Jake Lennon, Hannah Selmes, Ding Li Yong, David Johnson, Hanh Huynh, Temma Carruthers-Taylor, Phil Pritchard, Greg Burgess, Michael Lai
- **Fenner/ANU/CSIRO support**
  - Lab & field services, SCU & statisticians (esp. Wade Blanchard), ANIC, Nicole, John, peers, support staff & ento and plant community & MANY OTHERS

THANK YOU

Questions?

Three conservation issues

Beetle (Coleoptera) diversity

The "hostile" farmland

Restoration plantings

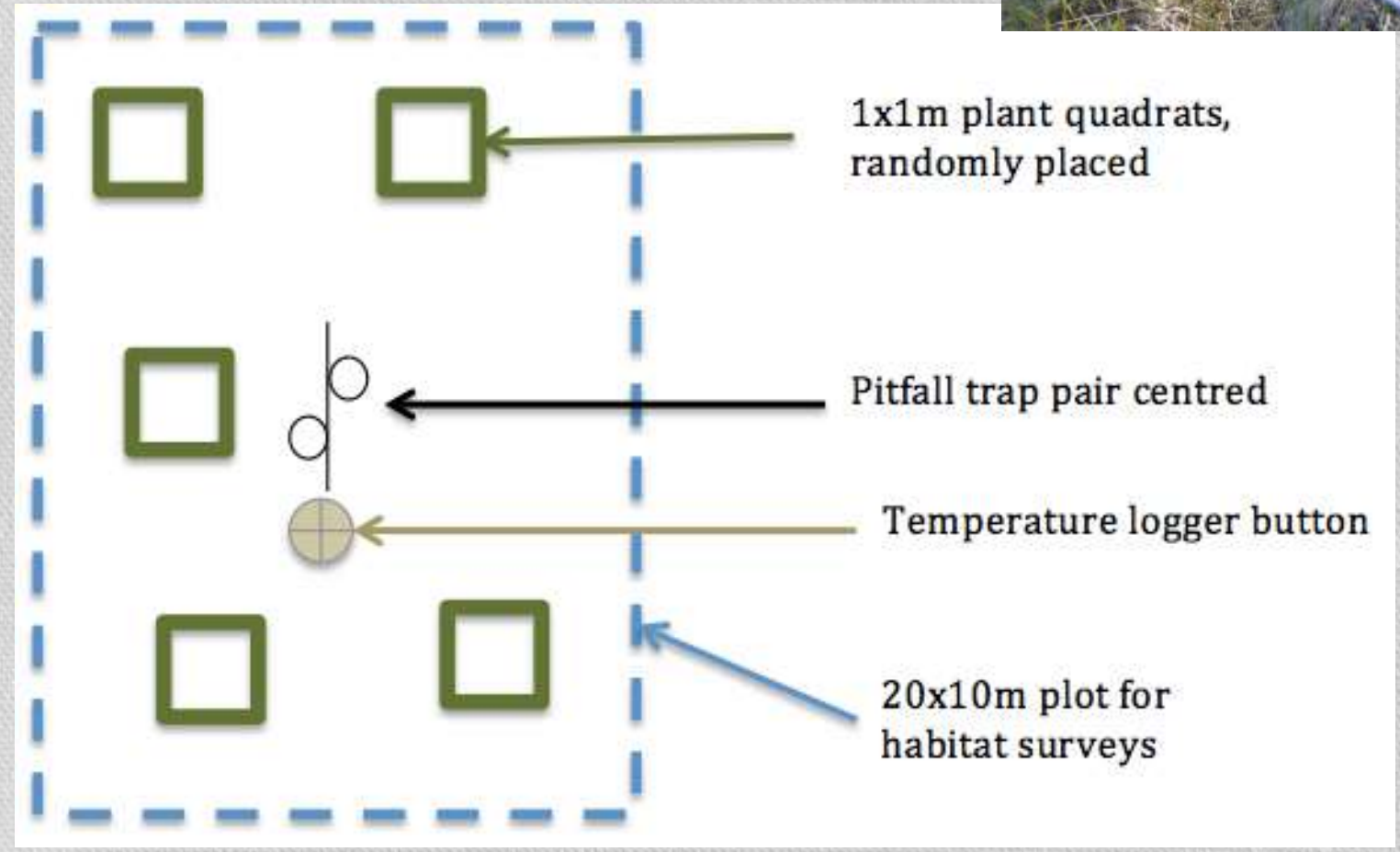
- Insect knowledge gaps
- Biodiversity value of "hostile" farmlands?
- "Are our restoration plantings effective?"

– Central Tablelands LLS`

Chew us later!

Methods: Vegetation

- Habitat characteristics (20 × 10m plots)
- Plant species (five 1 x 1m quadrats)

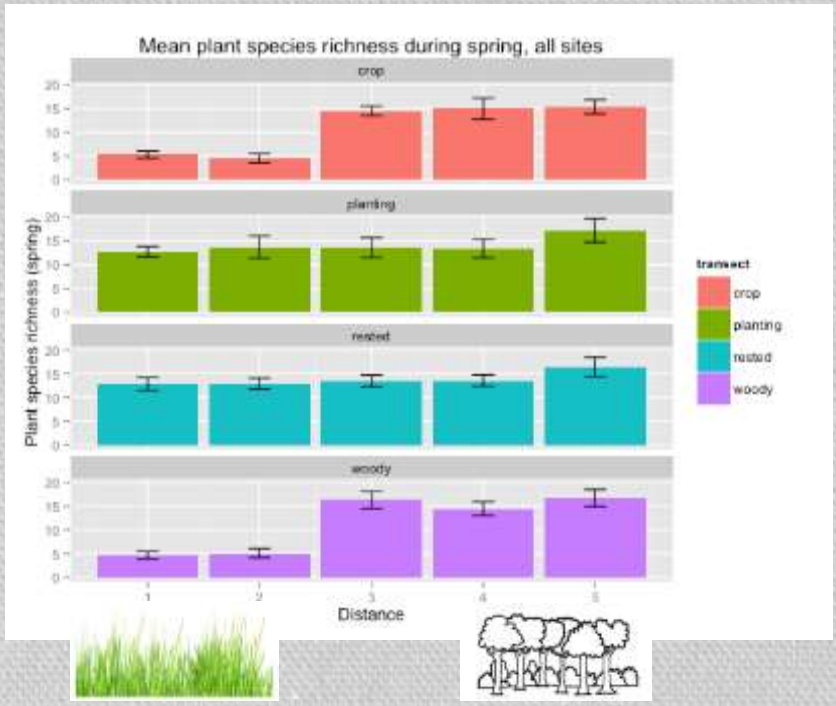


Part 3: Plant-beetle associations

Research questions: Which plant attributes best explain beetle assemblages?

Preliminary findings

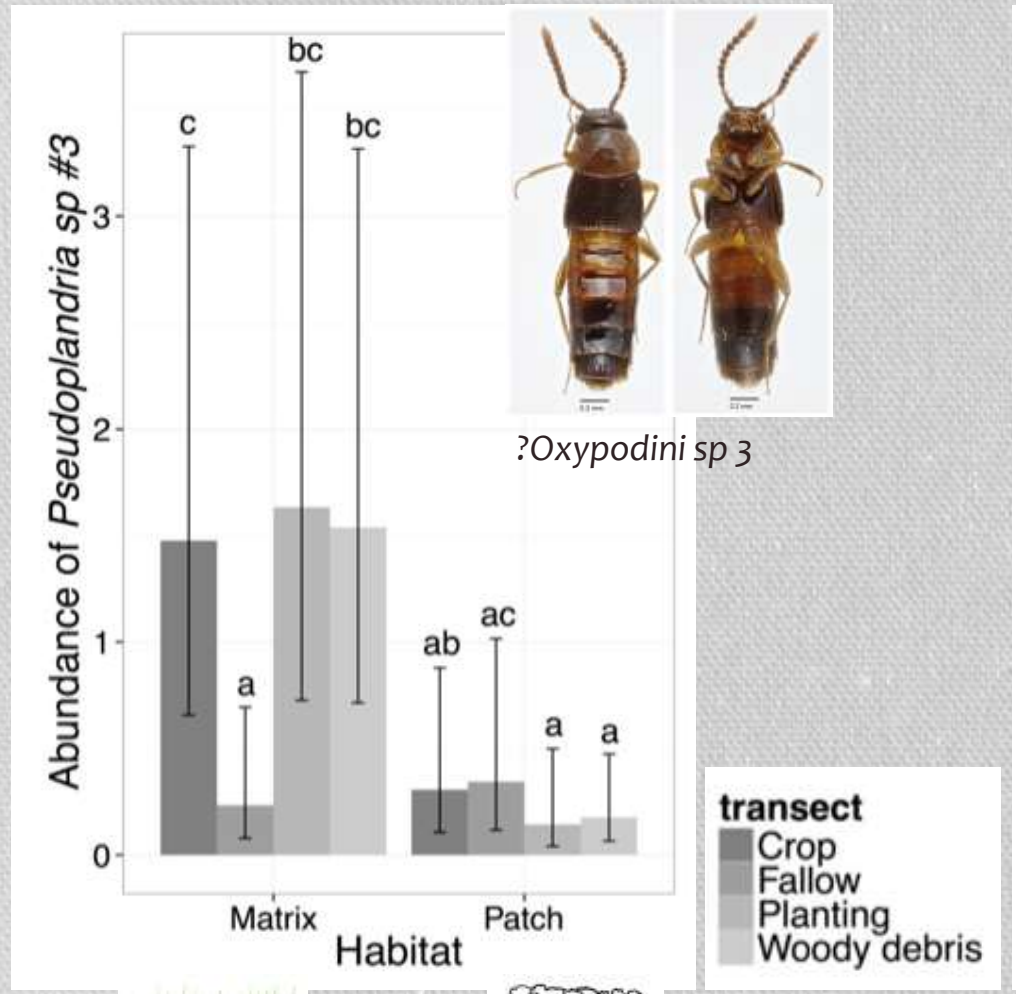
- Plant composition significantly correlated with beetle composition
- Plant species richness & vegetation structure significantly affected beetle species richness, abundance and composition




Dicranolaius spp on flatweed

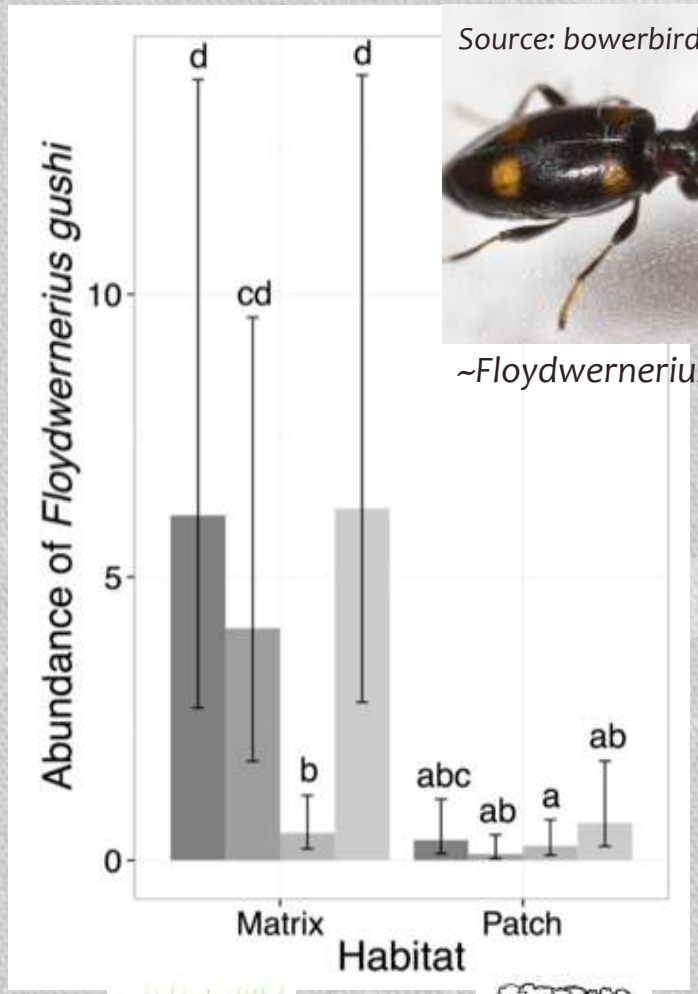
Abundance of 2 species

TBC rove beetle (Staphylinidae)



?Oxypodini sp 3

Ant-like beetle (Anthicidae)



Source: bowerbird.org.au

~Floydwernerius gushi

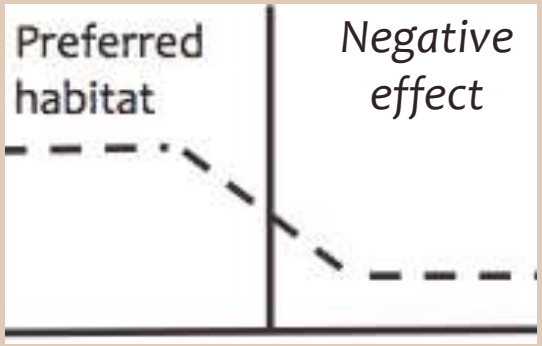
Edge effects are variable & difficult to describe!

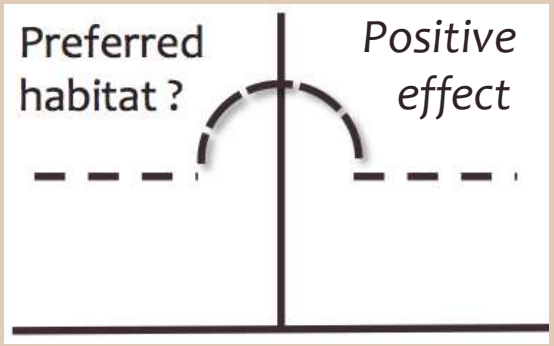
Ries & Sisk 2004

Du

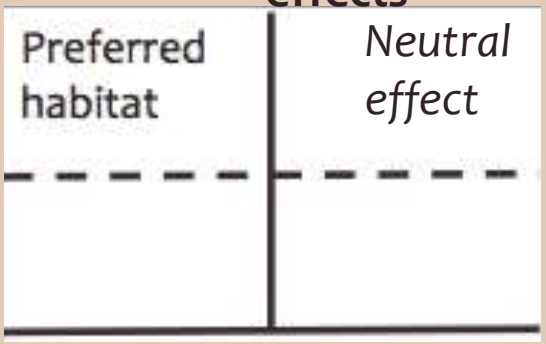
1) "hard edge"
2) neg.influence
3) pos.influence
4) mutual influence
5) "ecotone"
6) "no edge" or "very soft edge"

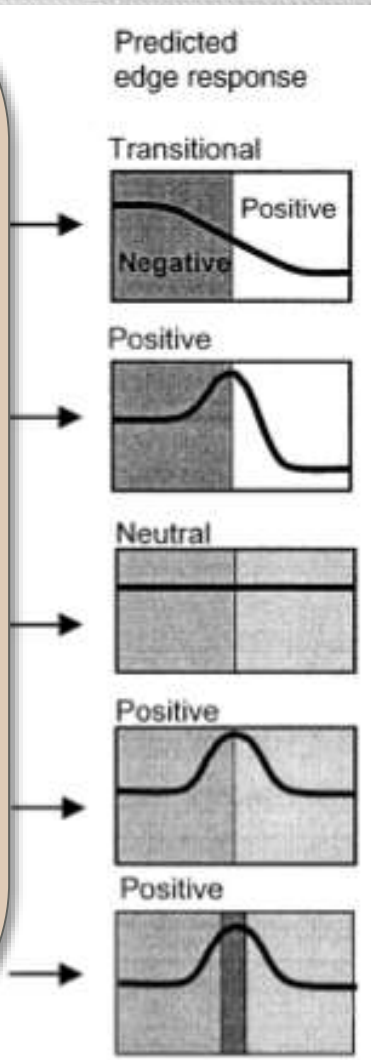
Edge = distance effects!





Strong to weak edge effects

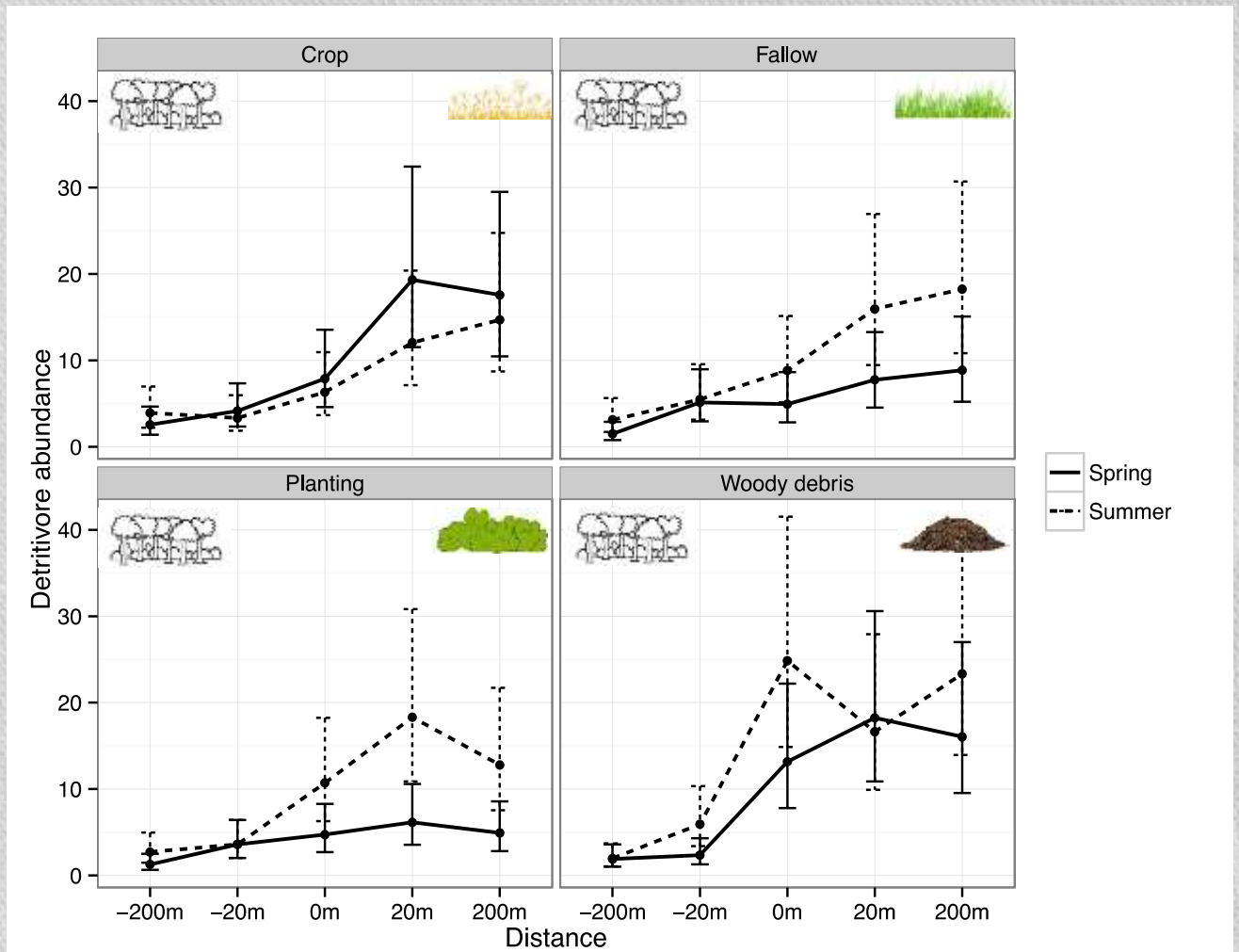




Detritivore abundance

- Edge effects weaken: crop > fallow > planting (spring)
- Time effects dependent on farm type

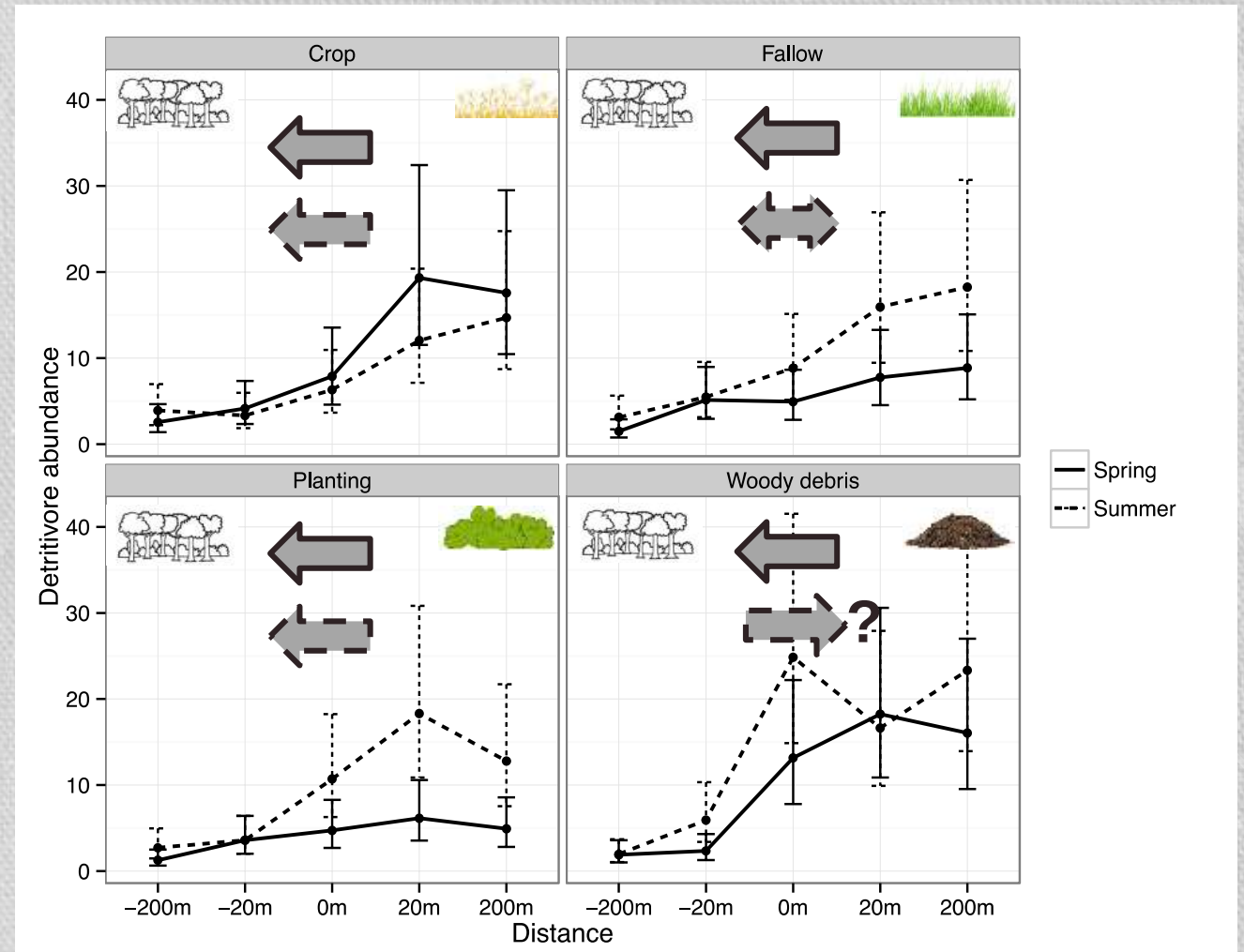
Source: bowerbird.org.au



Detritivore movement

- Spring spillover from all farm types
- Mixed farm-specific movements in summer

Source: bowerbird.org.au



Spring movement direction

Summer movement direction

Communications

1. Landholder update newsletters
2. AES conference poster
3. YLAD biodiversity field day
4. Sutton soils field day
5. Young high school field day
6. ESA & UNE RRR conferences; others?

INSECTS, PLANTS, PITFALLS AND FESTIVE WISHES!

1

Like Nicole, I have been intensely trapping insects and surveying plants between October and November before harvest. This is so that I can see if certain plants (including native plantings) affect insect movement. There are lots of data to collect, but I have been fortunate to have enough helpful volunteers, who come from different backgrounds. They include first year students, exchange students to very experienced plant experts.

Earlier in spring, we had plant ID walks with Mikla Lewis from Young District Landcare with a few staff from other LLS offices, and with Mal Carnegie from the Lake Cowal Conservation Centre. It was very helpful as it sped up my learning of the plant species in the area. Despite the dry weather we were very lucky to be able to find some flowering leek orchids and greenhood orchids in our western sites! My pitfall traps are small 250ml containers sunk in the surface with some non-toxic trapping liquid, divided by a small white drift fence which tracks which direction insects come from. The drift fence seems to have worked really well!

On first glance, the wheat crop appears to have more predatory beetles (e.g. carabids) and spiders foraging from the wheat direction although I will need to analyse more traps in the lab to understand the trends. It will be interesting to see whether this trend changes when we resume post-harvest surveys in January next year.

As the weather got warmer however, I came across an obstacle. I found that (thirsty?) kangaroos are attracted to my trapping liquid and in some places, have taken a liking to pulling out my traps and their valuable contents! So, I am finding out a way to deter them and am trialing wire mesh and possibly other methods for my summer fieldwork (many thanks to landholders who have provided me fencing mesh!).

Close-up of invertebrate pitfall traps with drift fence

Trap contents plundered by roos!

Margaret and Kat meticulously surveying plants occurring in a 1x1m square (photo by Mal Carnegie)

Have a wonderful Christmas & a safe New Year!

A massive thank you all for supporting the project!

THE NEXT THREE MONTHS…

- Trapping is closed for the December break and will resume in the first week of January 2015 through to early March 2015, to investigate and compare the responses of fauna to the post cropping activities.
- The application of woody mulch has been delayed due to severe weather, which has made it difficult for the truck to access and deliver the mulch safely. Delivery is now looking to be from next week, and potentially onto the following week, with the remainder being completed at the beginning of surveys in the first/second week of January. As discussed previously, we'll get in touch beforehand to arrange preferred access.

SPECIAL THANKS TO OUR RESEARCH PARTNERS:

NSW Local Land Services Central Tablelands

Lake Cowal Foundation

From plantings to the paddock:

Are ground-dwelling beetles and beneficial arthropods moving through fragmented agricultural landscapes?

Katherina Ng, Dan A. Driscoll, David B. Lindenmayer, Sarina Macfadyen, Milton Lewis, Angus Arndt

The Research

Millions of dollars are spent annually on habitat restoration and corridor establishment, yet their effectiveness hinges on assumptions about the movement ecology of suitable species into restored habitats. It is unclear how plantings affect the movement of beetle and beneficial arthropod species through attributes such as habitat structure, microclimate, and plant assemblage[1].

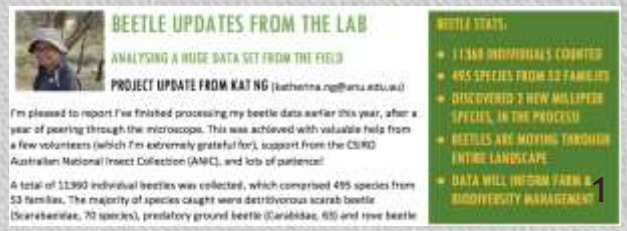
I will explore how simple modifications to the matrix, such as fallowing paddocks or temporarily adding

Study Design

Hypothesis: the extent of movement from a remnant woodland patch into the surrounding matrix will depend on the degree of contrast between the two habitats in terms of vegetation and management intensity.

- Sites in mixed-cropping areas of NSW Lachlan River Catchment
- Transects extend from remnant into four matrix treatments: recent biodiverse tree plantings, cropping, fallow/pasture, woody debris manipulation
- Pitfall trap arrays, sampled 3 times a year
- Experimental releases and observations of individual movement paths using micro RFID tags.

2



BEETLE UPDATES FROM THE LAB

ANALYSING A HUGE DATA SET FROM THE FIELD

PROJECT UPDATE FROM KAT NG (katherina.ng@anu.edu.au)

I'm pleased to report I've finished processing my beetle data earlier this year, after a year of peering through the microscope. This was achieved with valuable help from a few volunteers (which I'm extremely grateful for), support from the CSIRO Australian National Insect Collection (ANIC), and lots of patience!

A total of 11990 individual beetles was collected, which comprised 495 species from 53 families. The majority of species caught were detritivorous scarab beetle (Scarabaeidae, 70 species), predatory ground beetle (Carabidae, 65) and rove beetle

BEETLE STATS:

- 11,990 INDIVIDUALS COUNTED
- 495 SPECIES FROM 53 FAMILIES
- DISCOVERED 2 NEW MILLIPEDE SPECIES, IN THE PROCESS!
- BEETLES ARE MOVING THROUGH ENTIRE LANDSCAPE
- DATA WILL INFORM FARM & BIODIVERSITY MANAGEMENT

1

3

4

5