Variation in groundwater ecosystems impacted by agricultural landuse

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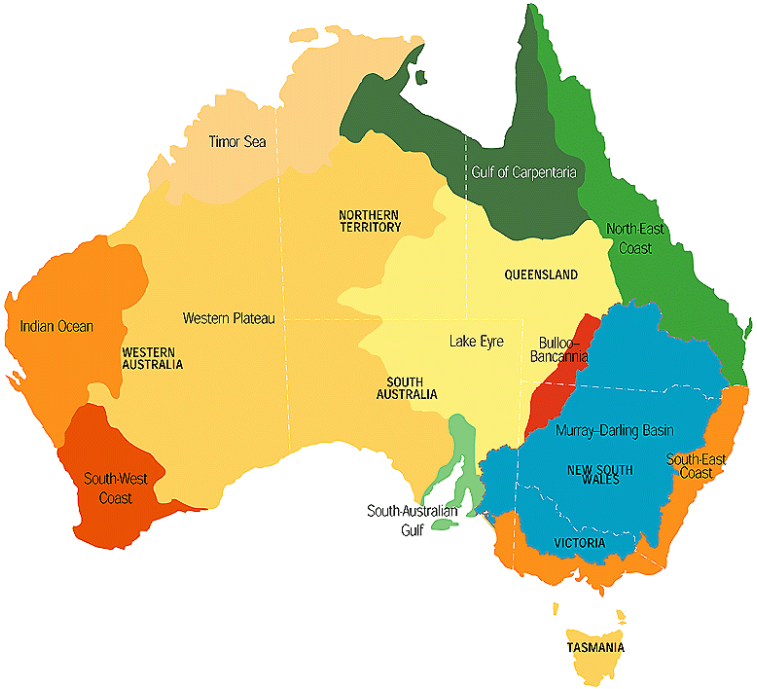
Murray-Darling River Basin, Australia

- Australia's most important agricultural region
  - Produces ~33% of food
- Rivers & floodplains support
  - 40% of all Australia's farms
  - 75% of all irrigated crops & pastures



North-west New South Wales

- Principal cotton growing region in Australia
  - Crops irrigated from rivers & alluvial groundwater
- Dryland (non-irrigated) cotton & other crops
- Some cattle grazing

Are groundwater ecosystems impacted by these activities???

Our model….

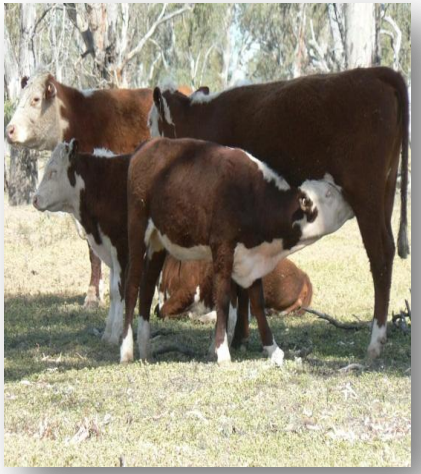
- Intensive agriculture leads to changes in groundwater conditions

  - Effects greatest for irrigated areas because of greater connectivity between surface and aquifer

Our hypothesis…

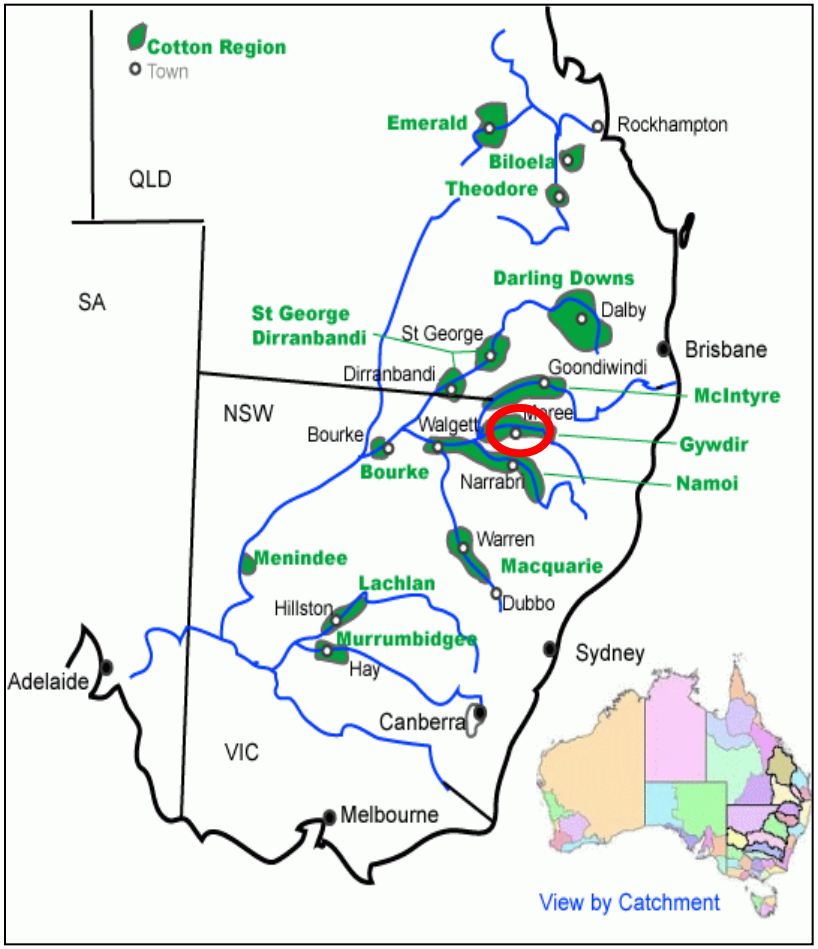
- There will be differences in the groundwater ecosystems between areas of different land use



Description of region

- Gwydir R alluvial aquifer near Moree
- Region semi-arid, seasonal (summer dominated) rainfall

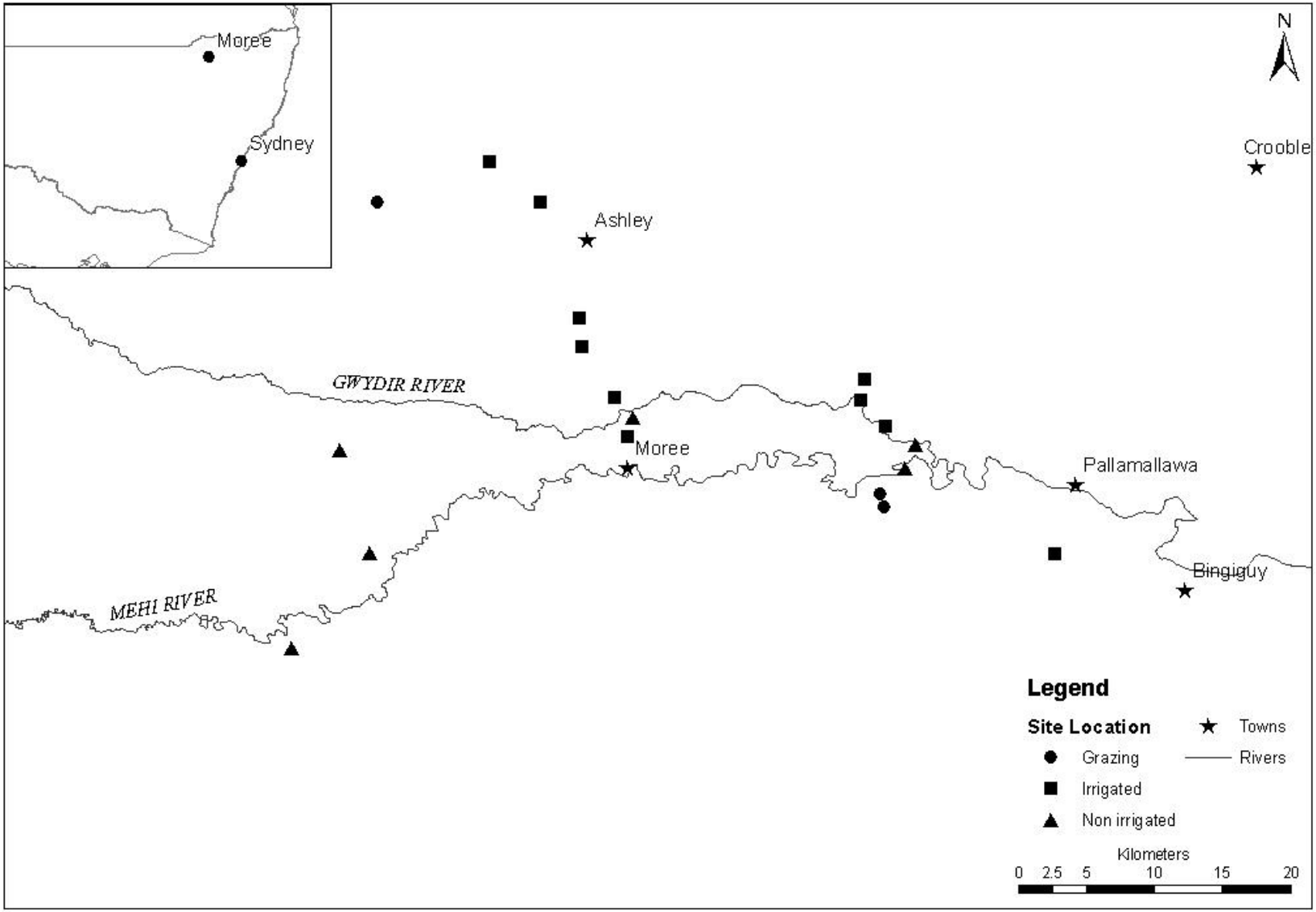


About the region

- Intensive agricultural landscape
  - Irrigated cotton crops
  - Dryland cotton
  - Beef grazing




Study location



Methods

- Study region
  - 19 sites (bores) around Moree
  - 10 – 30 m deep
  - Sites allocated to either
    - Irrigated cropping
    - Non-irrigated cropping
    - Grazing
  - Bores sampled in winter (post harvest) and summer (growing season)

Sampling Methods

- Pump 300 L for stygofauna
  - Water filtered (63 µm) preserved in 100% ethanol
  - ID to morphospecies
- After 300 L take sample for microbial analysis & water quality
  - Analysed for
    - 55 agrochemicals
    - Nutrients
    - DOC

Microbiological Methods

- Biolog Ecoplates™
  - Indicate microbial community through metabolic fingerprinting
  - Inoculated with groundwater (including fine sediments)
  - Colour development after 6 days at 590 nm

Microbiological Methods(cont)

- Cotton strip assays
  - Calico placed in bores
  - Left for 6 weeks
    - microbes degrade cellulose
  - Loss of tensile strength directly relates to microbial activity

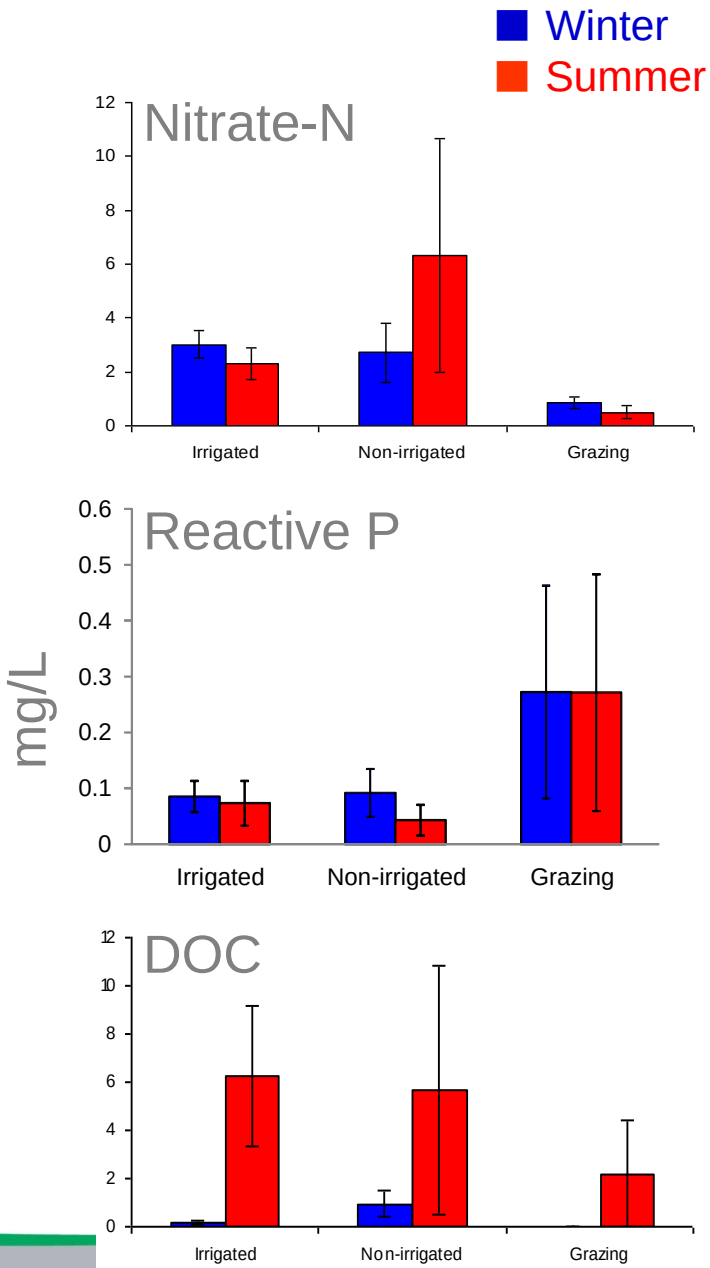
Data analysis

- Univariate data
  - 2-way ANOVA

- Multivariate data
  - 2-way PERMANOVA
  - nMDS
  - RELATE

Water quality results

- Agrochemicals rare
  - diethyl atrazine at 2 irrigated sites
- Nitrate lower at grazing sites
- Reactive P higher at grazing sites
- DOC higher in summer across all sites
- No difference in water quality profile (multivariate analysis)

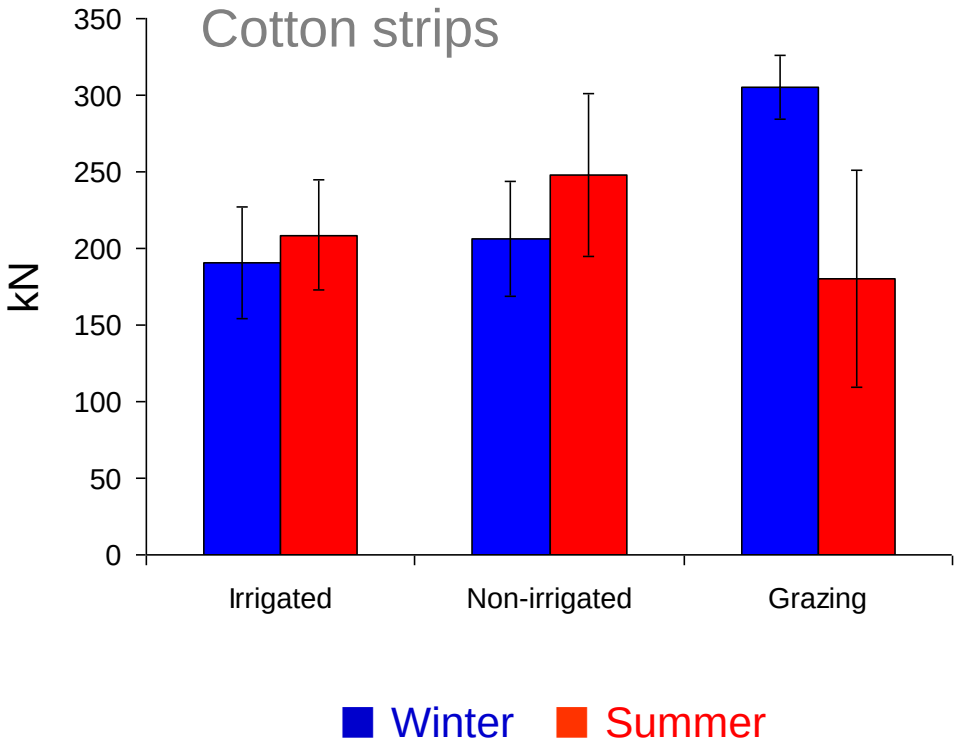


Summary

- Water Quality
  - Grazing sites less N and more P

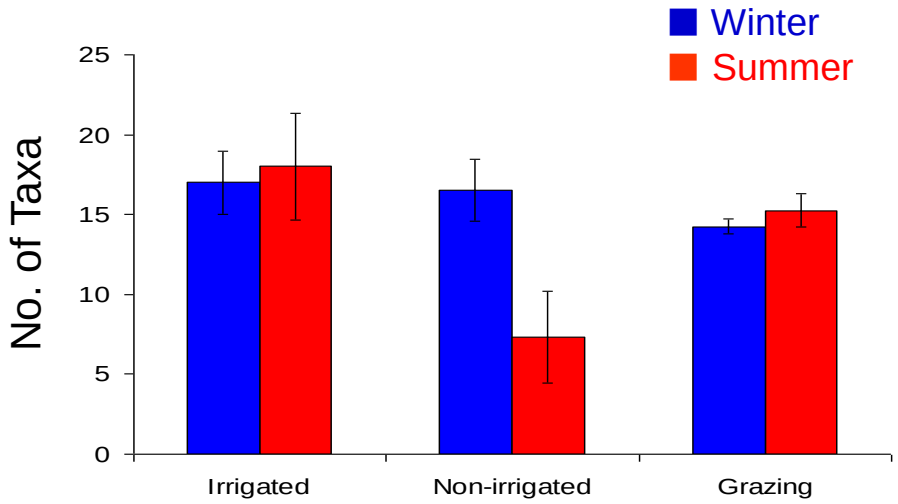
Microbial assemblages (Cotton strips)

- No difference in cotton strength
  - Microbial activity similar between land uses

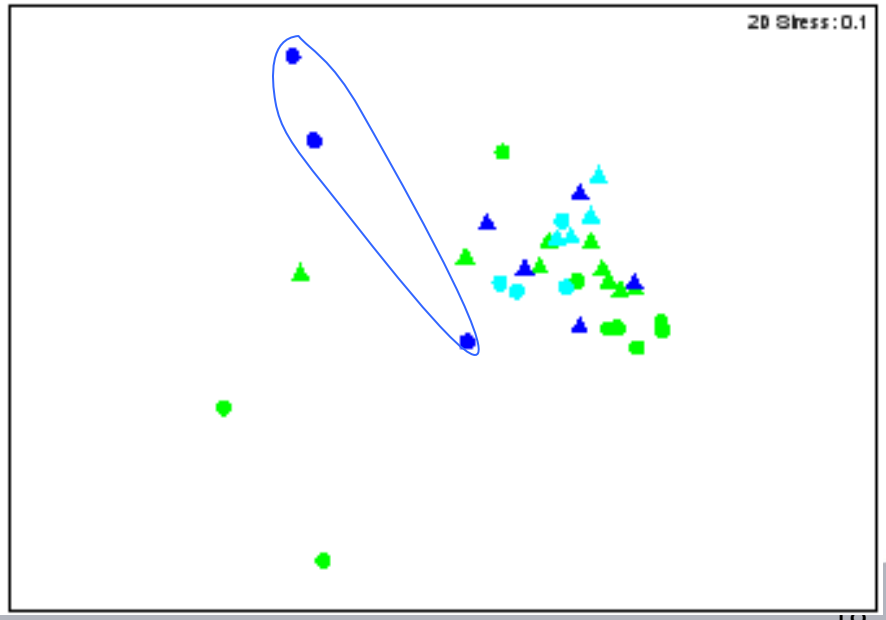


Microbial assemblages (Biolog Plates)

- Functional richness of assemblages similar between land uses
  - No sig differences



- Assemblage differences
  - Significant interaction
  - Summer non-irrigated differed to other land uses



Summary

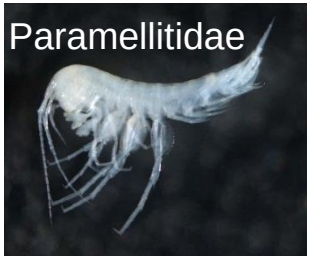
- Water Quality
  - Grazing sites less N and more P

- Microbial assemblages
  - No difference in cotton breakdown
  - Functional richness similar
  - Non-irrigated assemblages differ in summer

Stygofauna results

- 21 morphotaxa recorded
  - Acarina - 12 taxa
  - Copepoda-harpacticoids
    cyclopoids
  - Syncarida- Anaspidacea Family A
    Bathynella
    Notobathynella
    Chilibathynella
  - Amphipoda-*Paramelitidae sp*
  - Ostracoda
  - Oligochaeta

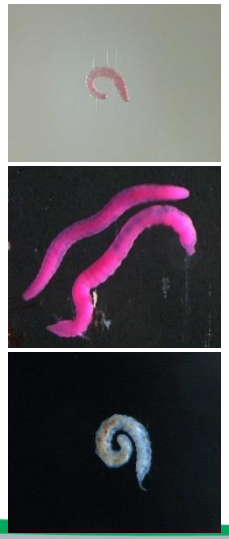
Amphipods



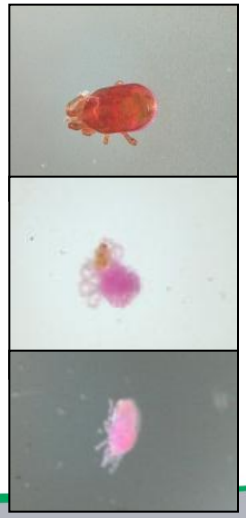
Copepods

Syncarids

Oligochaetes

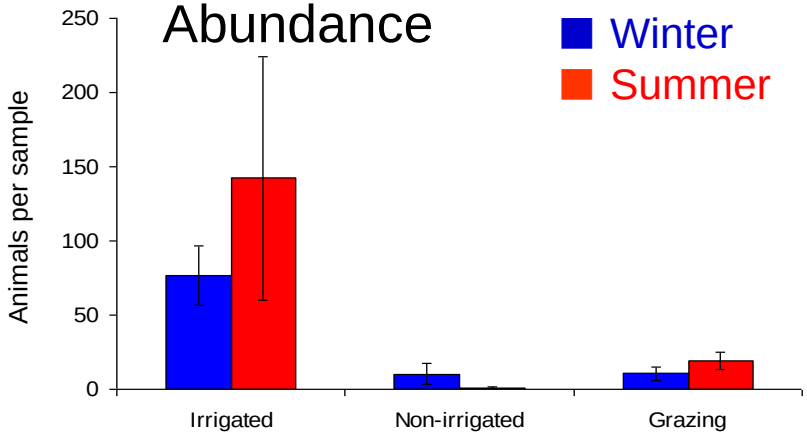


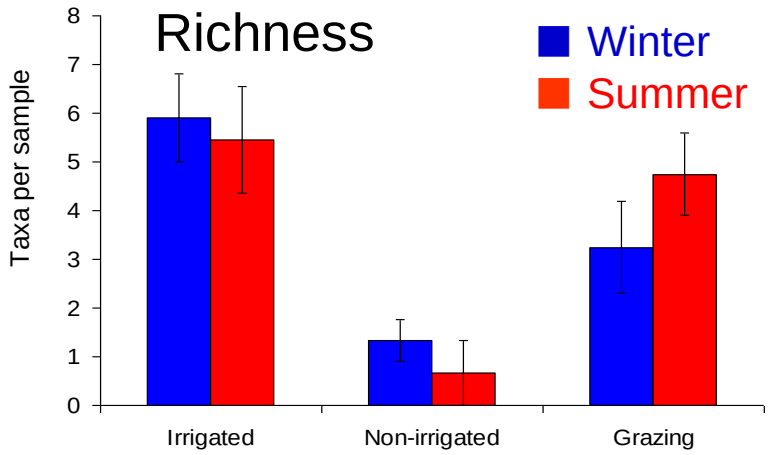
Mites



Stygofauna results

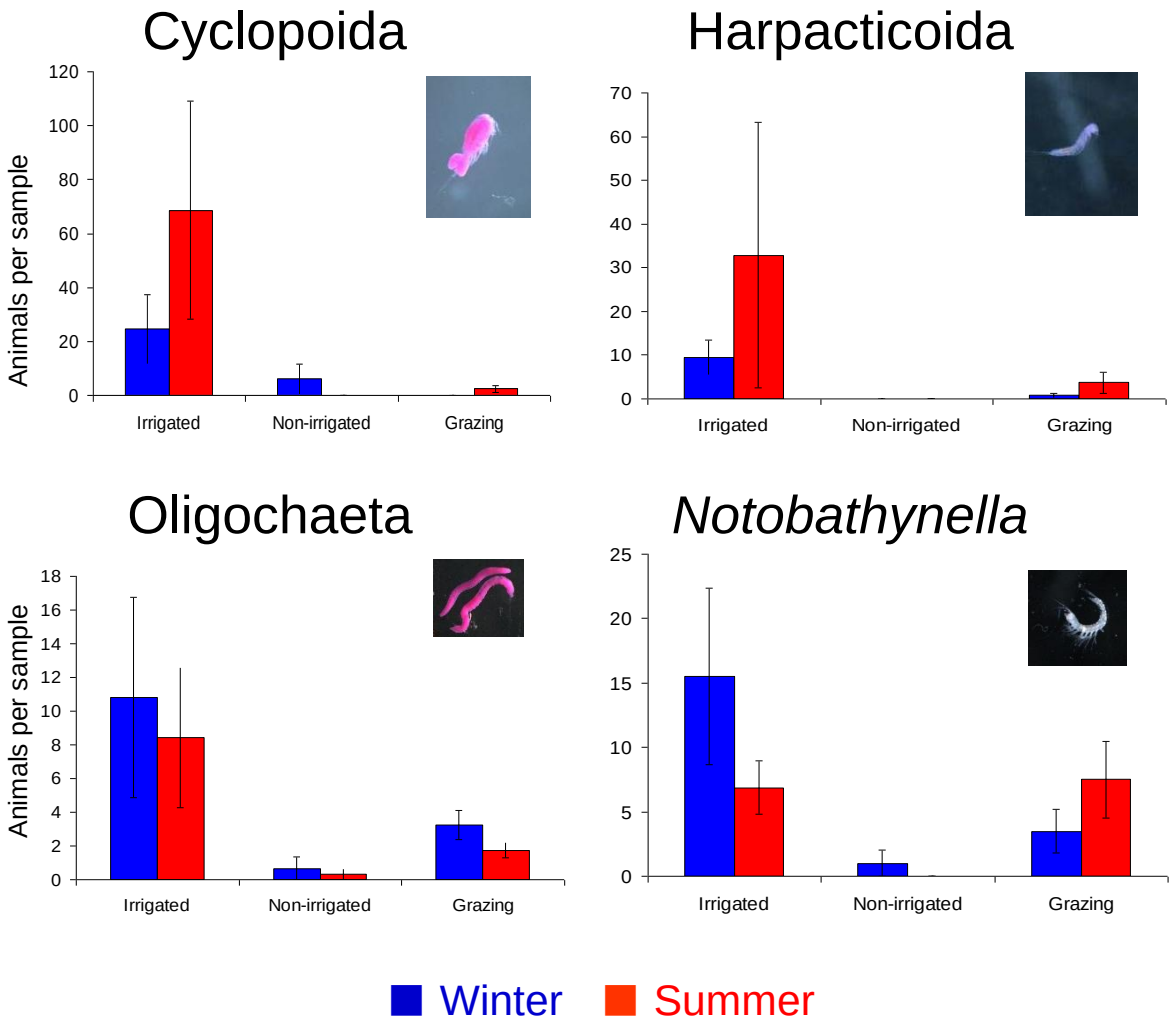
- No difference between seasons
- Significant difference with land use
  - Abundance p=0.001
  - Richness p<0.001





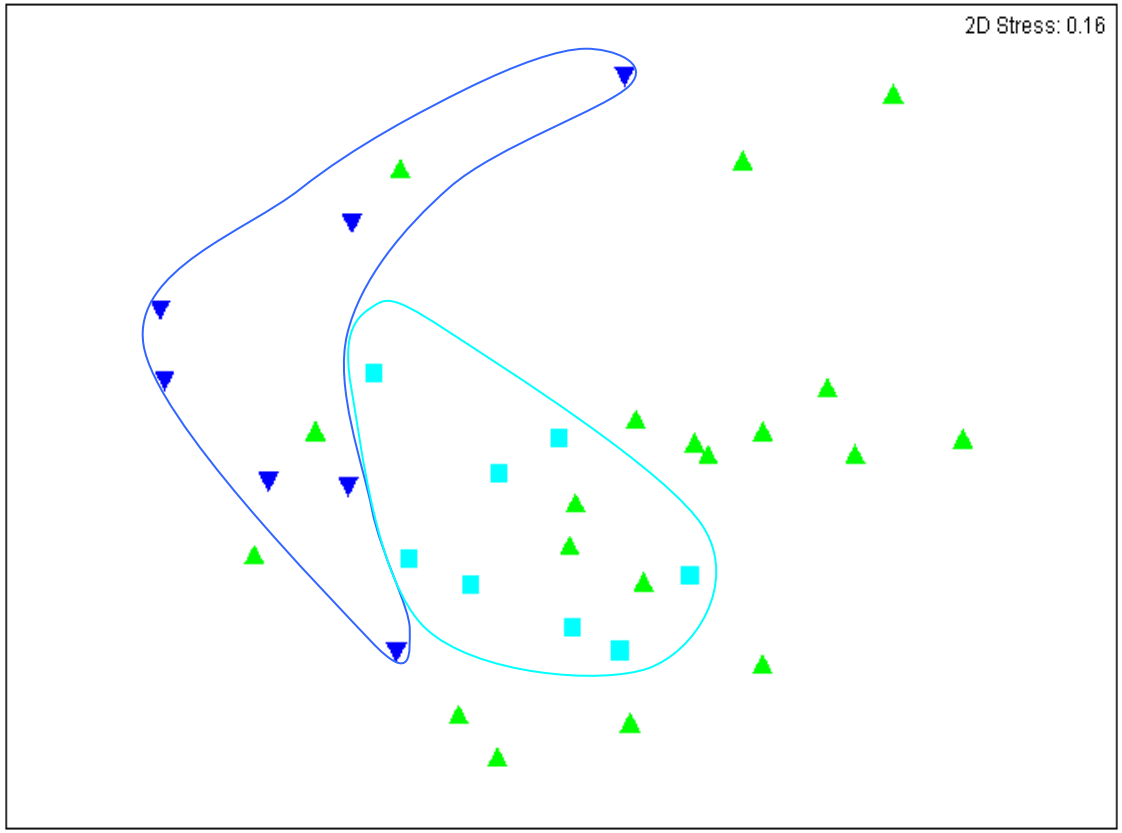
Dominant taxa

- Copepoda most abundant
- More oligochaeta at irrigated sites
- No difference between season



Stygofauna results

- Assemblages differ between all land uses
  - all groups different (P<0.05)



Irrigated
Non-Irrigated
Grazing

Stygofauna & microbes

- Little correlation between stygofauna and microbial assemblages
  - r = 0.10
  - Sites with similar stygofauna had little similarity in microbial assemblages

Summary

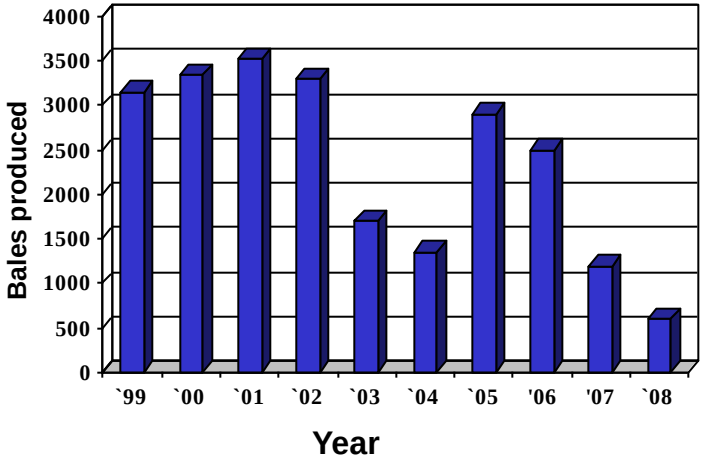
- Water Quality
  - Grazing sites less N and more P
- Microbial metabolism
  - No difference in cotton breakdown
  - Functional richness similar
  - Non-irrigated assemblages differ in summer
- Stygofauna
  - Differences in assemblages among all land uses
  - Irrigated highest abundance and richness
    - Changes consistent with disturbance
  - No correlation with microbes

Discussion

- We have shown differences between land uses across all components
  - Patterns across components don't follow model predictions
- Need to reconsider our model
  - The paradigm is for 'bottom up' control
  - Is top down control possible?
  - Would this account for our results?

Discussion

- Environmental gradient weak because of limited crop planting
  - Drought reduced recent crops by ~80%
  - Few crops = few chemicals



Discussion

- Ecosystem components respond at different temporal scales
  - Water quality – rapid (here at least)
  - Microbes – days to weeks
  - Stygofauna – months to years?

- Need to consider these different temporal scales in sampling & monitoring

Conclusions

- Groundwater ecosystems vary with land use
  - Differences evident in water quality, microbial assemblages and stygofauna
  - Gradient weak because of limited irrigation?
- Temporal scale of sampling important to show effects across all ecosystem components

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