Native Grass Establishment: the battle with invasives occurs below ground

THE UNIVERSITY of ADELAIDE

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The Battle of Grassland Restoration

Battle Field

Old-fields at Para Woodlands

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Opponents

Invasive annual grasses

vs

Native perennial grasses

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‘Root’ to Victory

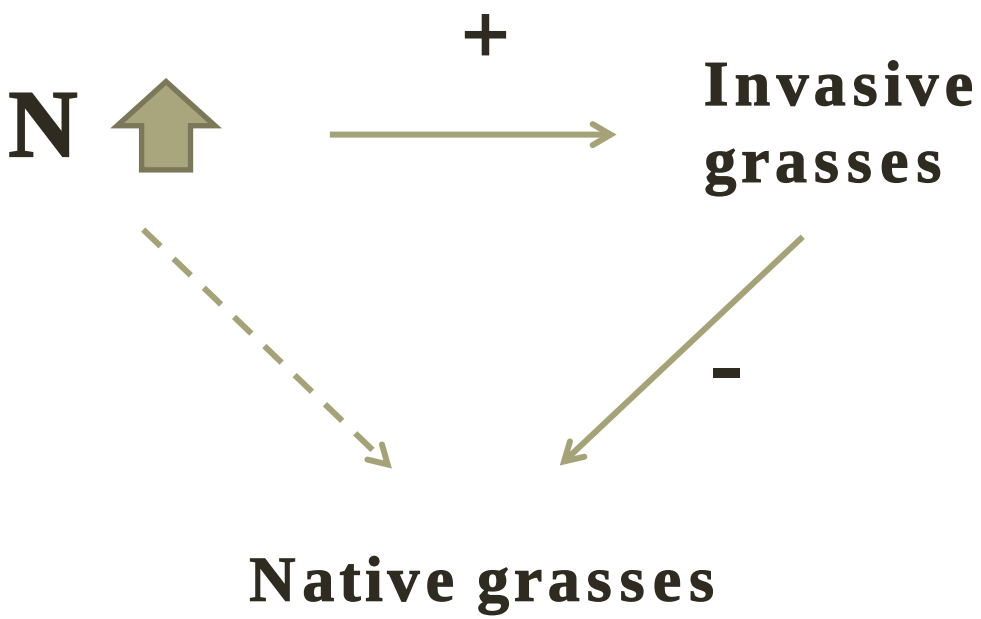
Know your enemy!

Nutrient availability, soil microbes & resource use

Nutrient availability

Invasive species can

- Take advantage of increased nutrients
- Maintain higher soil nutrient



Soil microbes

Important for plant growth

- Pathogens, aeration of soils & controlling nutrient cycles

Weed invasions may change microbial communities

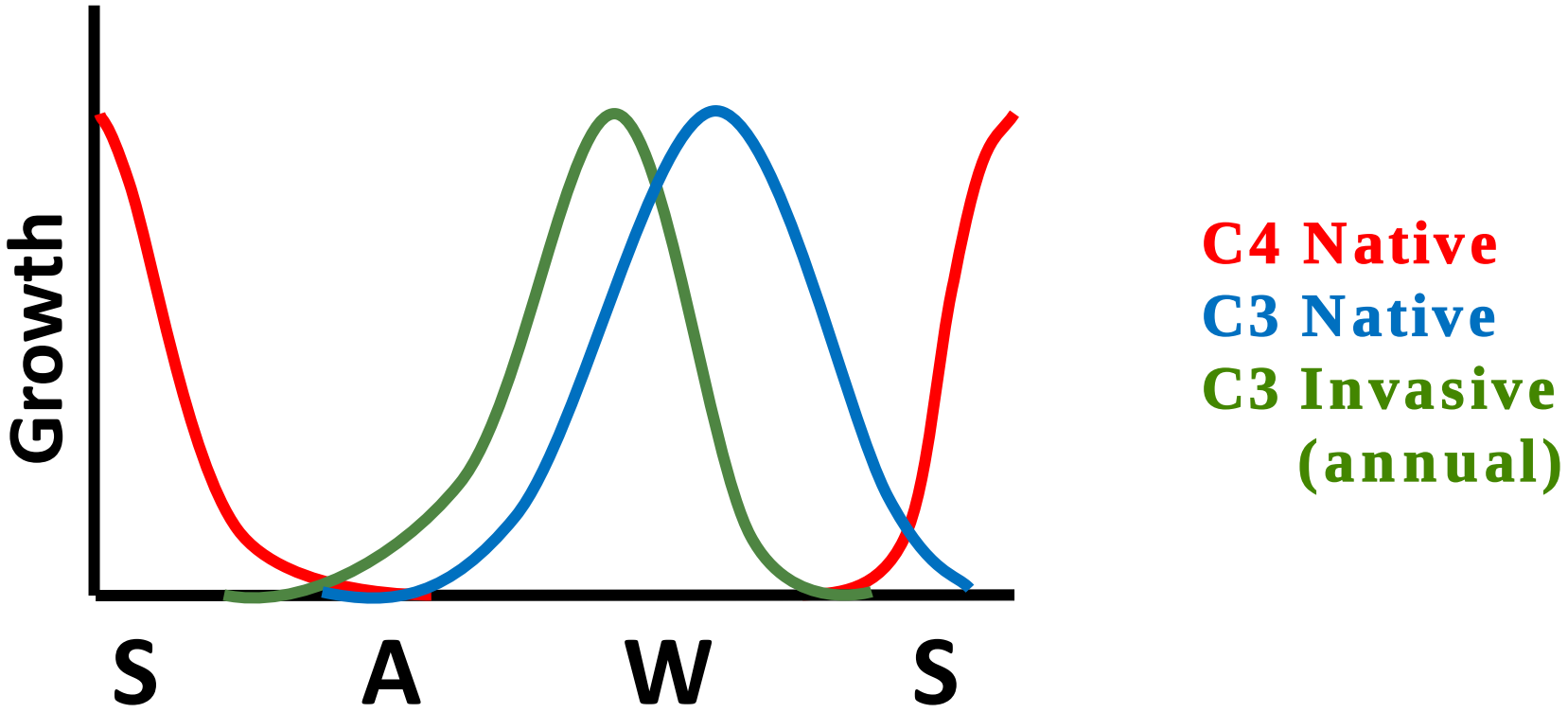
- Changes in the organic matter, root exudates, root structures

Changes may be too great to support native revegetation

- Particularly in degraded systems like old-fields

Resource use

- Successful restoration achieved by selecting native species with a diversity of functional traits
- Invasive species will be unlikely to establish if their niches are occupied



Research questions

1. Site preparation
   - Which weed management techniques can reduce nutrient availability & improve native grass growth?

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   - How do soil microbial communities influence restoration outcomes?

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   - Which weed management techniques can reduce nutrient availability & improve native grass growth?
2. Microbial communities
   - How do soil microbial communities influence restoration outcomes?
3. Planting strategies
   - Can incorporating functional diversity & resource use into planting strategies make revegetated communities more resilient?

Site preparation

Overall aim - to gain a better understanding of the mechanisms involved in successful restoration

Application – reducing nutrient availability and weed competition to tip the balance in favour of natives

Site prep. - methods

Experimental design

- Weed management (3 m^2 x 6 reps)
    - Slash + remove
    - Burning
    - Scalping
    - Control
- Reducing nutrients (1 x 2 m subplots)
    - +/- Carbon
    - 0.5 kg/m^2 sugar
    - 0.4 kg/m^2 sawdust
- Planting tubestock and direct seeded *Rytidosperma caespitosum*

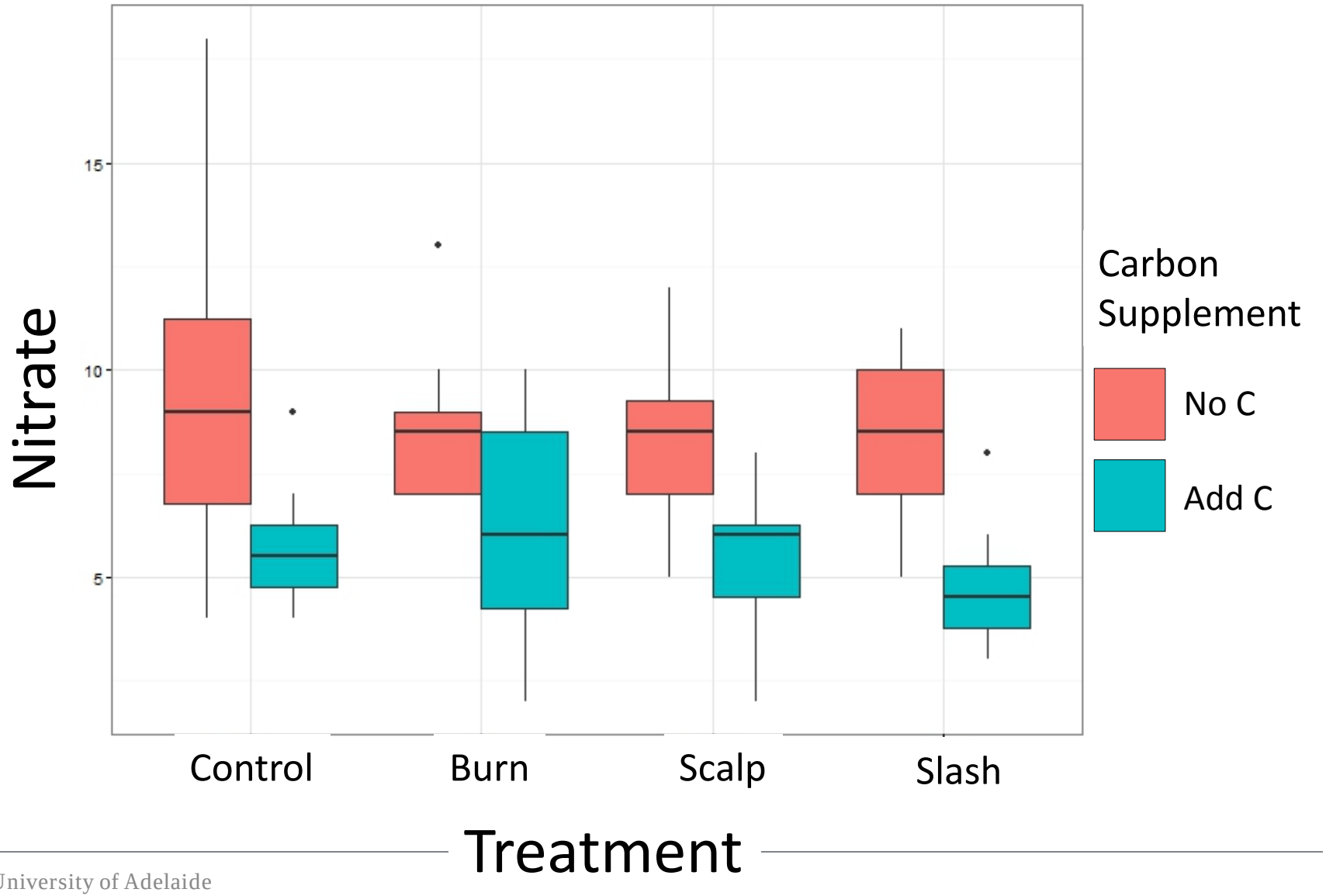
Site prep. - methods

Measurements after 5 months

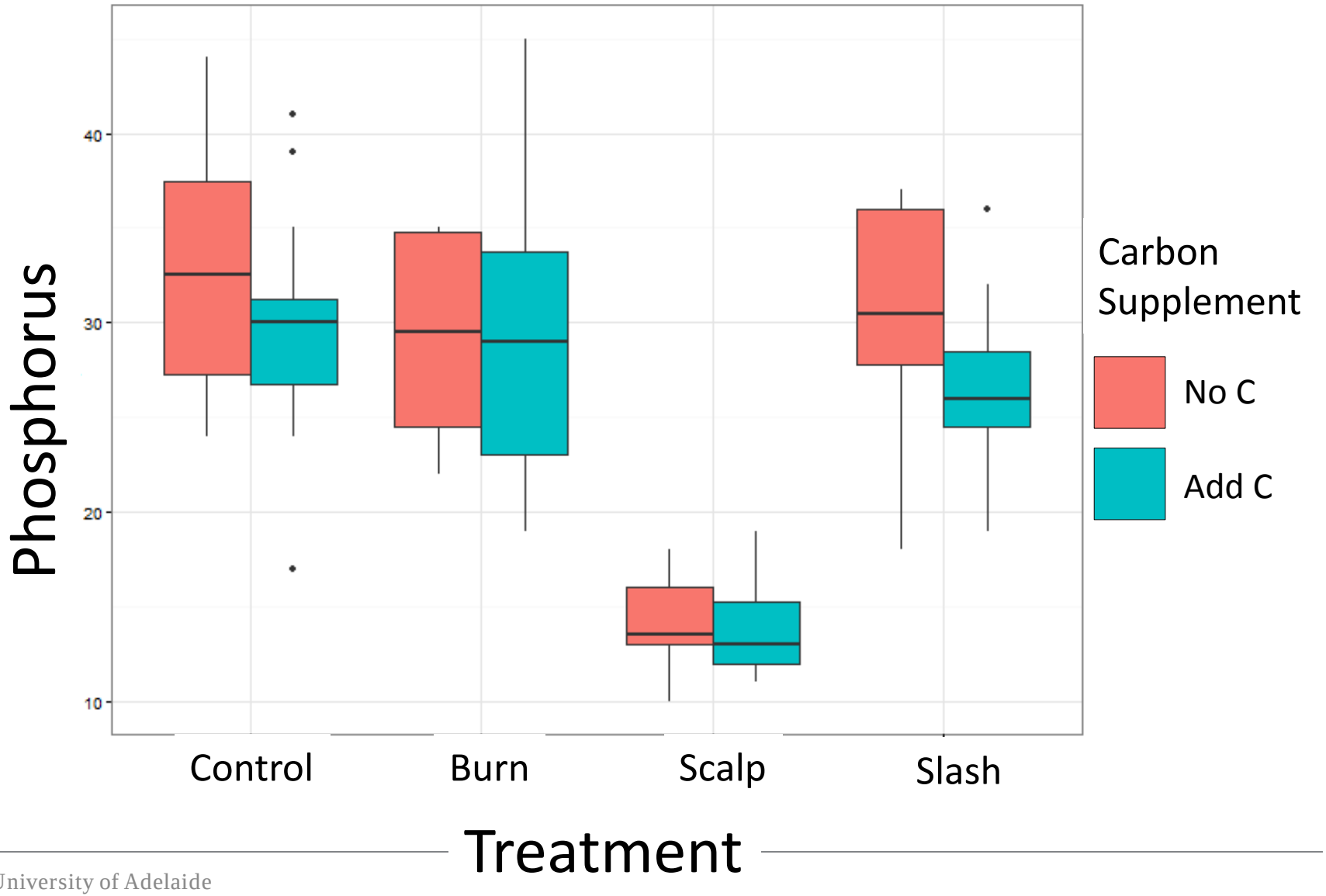
- Soil conditions
    - Changes in nutrients
    - Microbial community composition
- Success of weed management
    - Total biomass of different species
- Native grasses
    - Seedling emergence and mortality
    - Tubestock survival
    - Plant growth (biomass)

Rytidosperma caespitosum

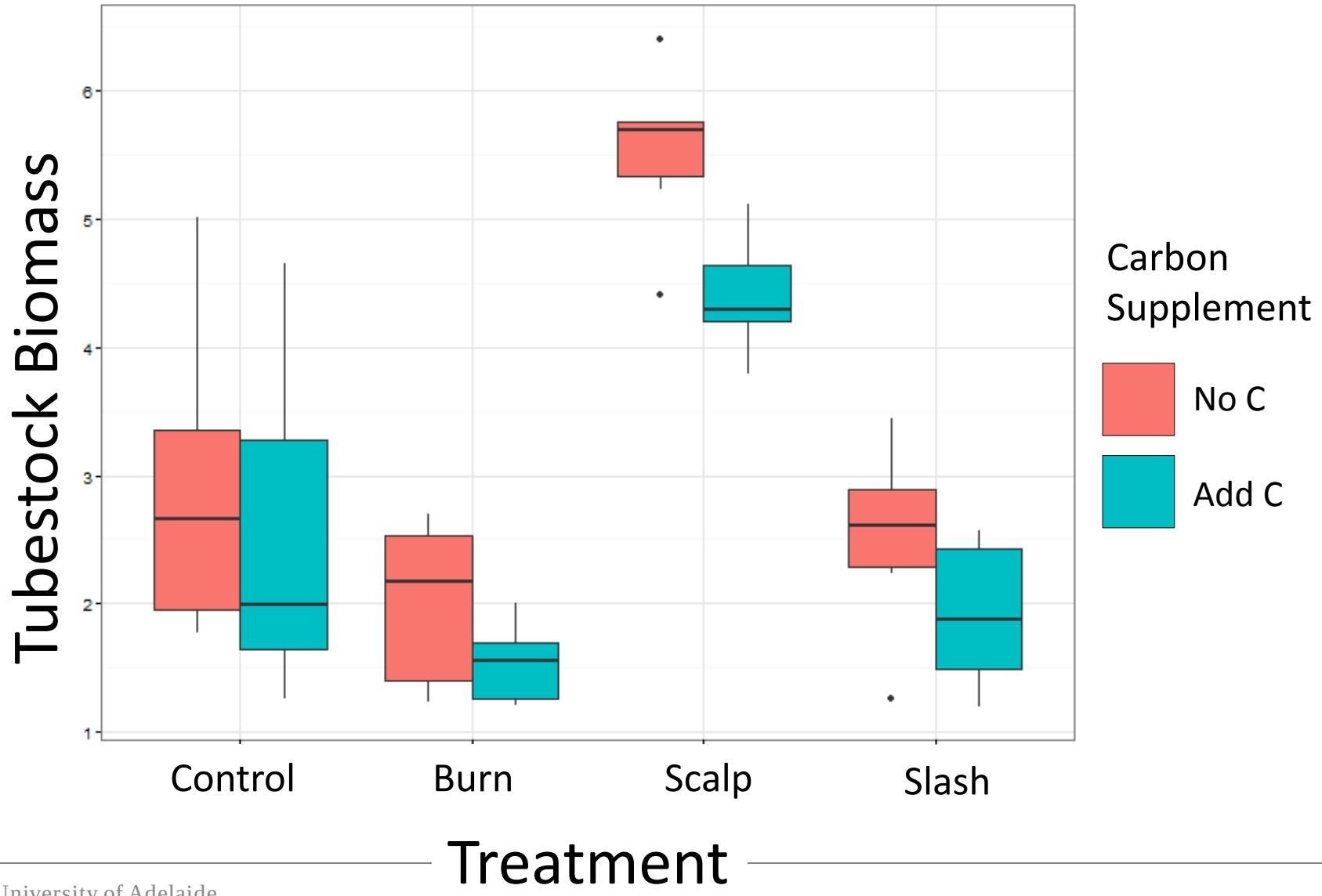
Did the soil nutrients change?



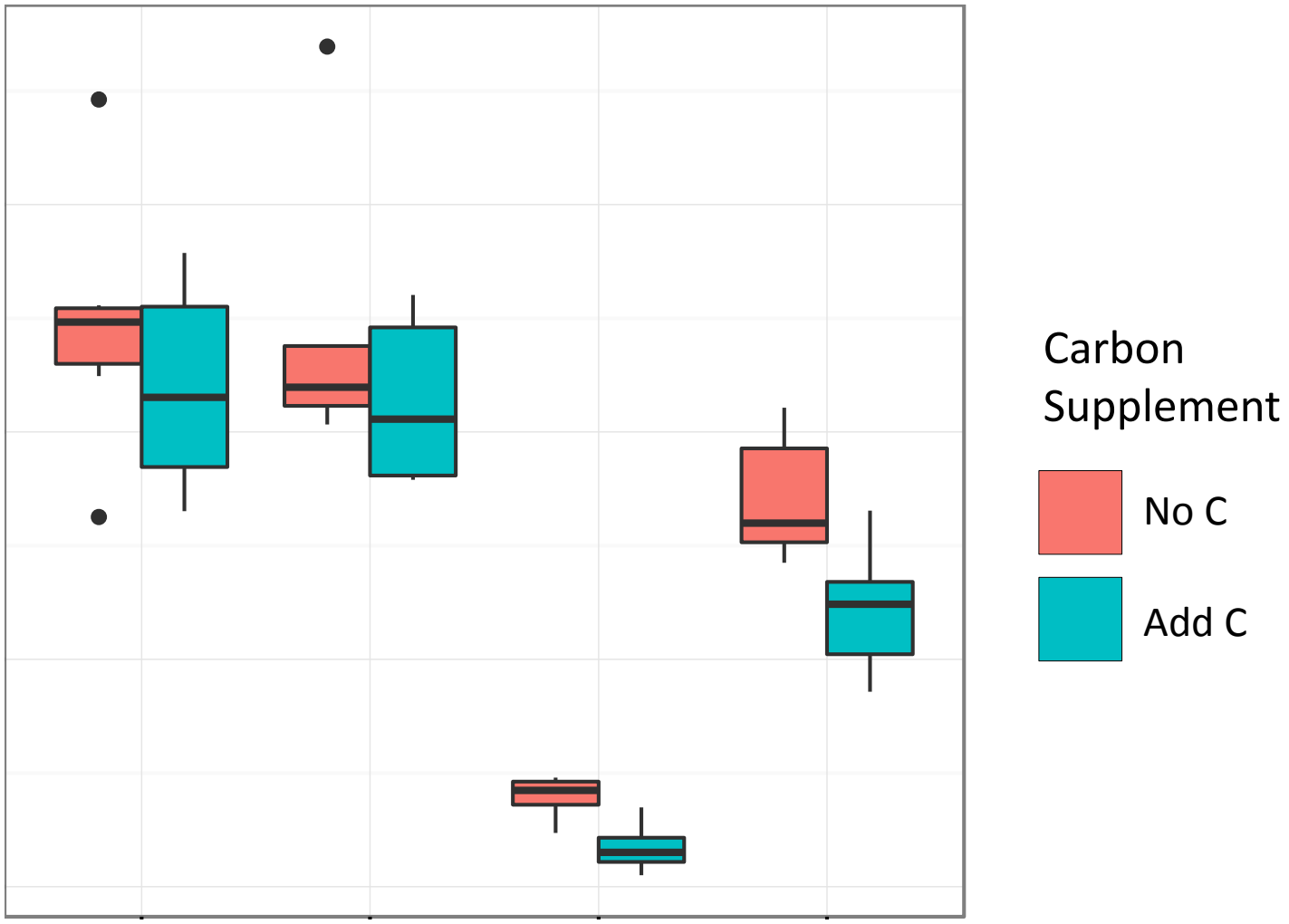
Did the soil nutrients change?



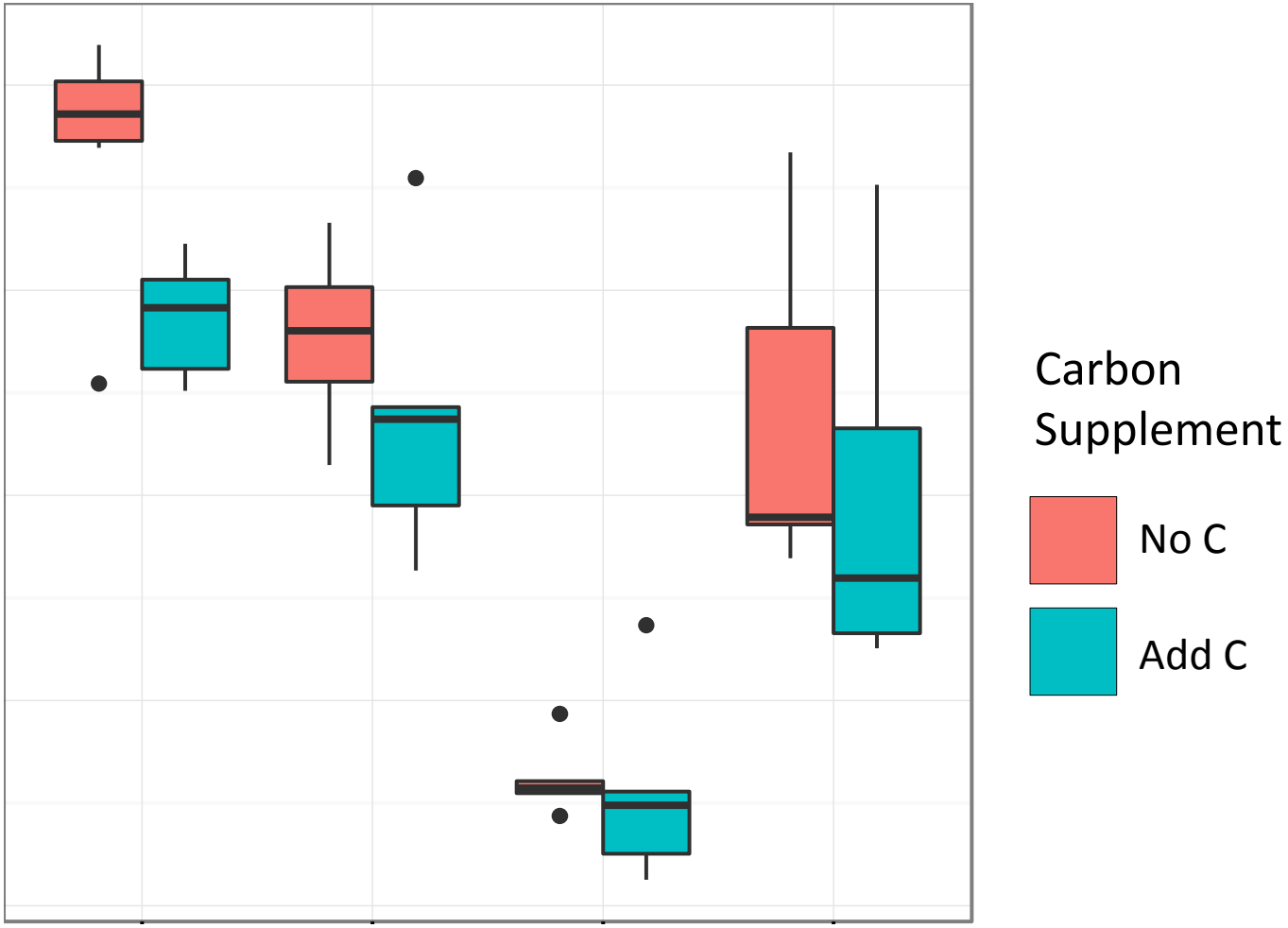
How were the natives affected?



What about the weeds? - tubestock



What about the weeds? – seeding



Site prep. - summary

Carbon addition

- Reduced nitrate in soil
- Reduced weed biomass

Scalping was most successful at

- Reducing phosphorus
- Increasing native grass growth
- Reducing weed biomass

More data to come

- Seedling emergence and mortality data

Soil microbes

Compare performance of native & invasive grass species grown with soil microbial communities from

- an old-field
- a remnant grassland

1) **Does one invasive grass benefit from the invasion of another invasive grass?**

2) **Do remnant microbial communities benefit native grass growth and establishment?**

Soil microbes - methods

Control (sterile)

- Commercial grade soil, autoclaved twice

Treatment (sterile soil inoculated with 20%)

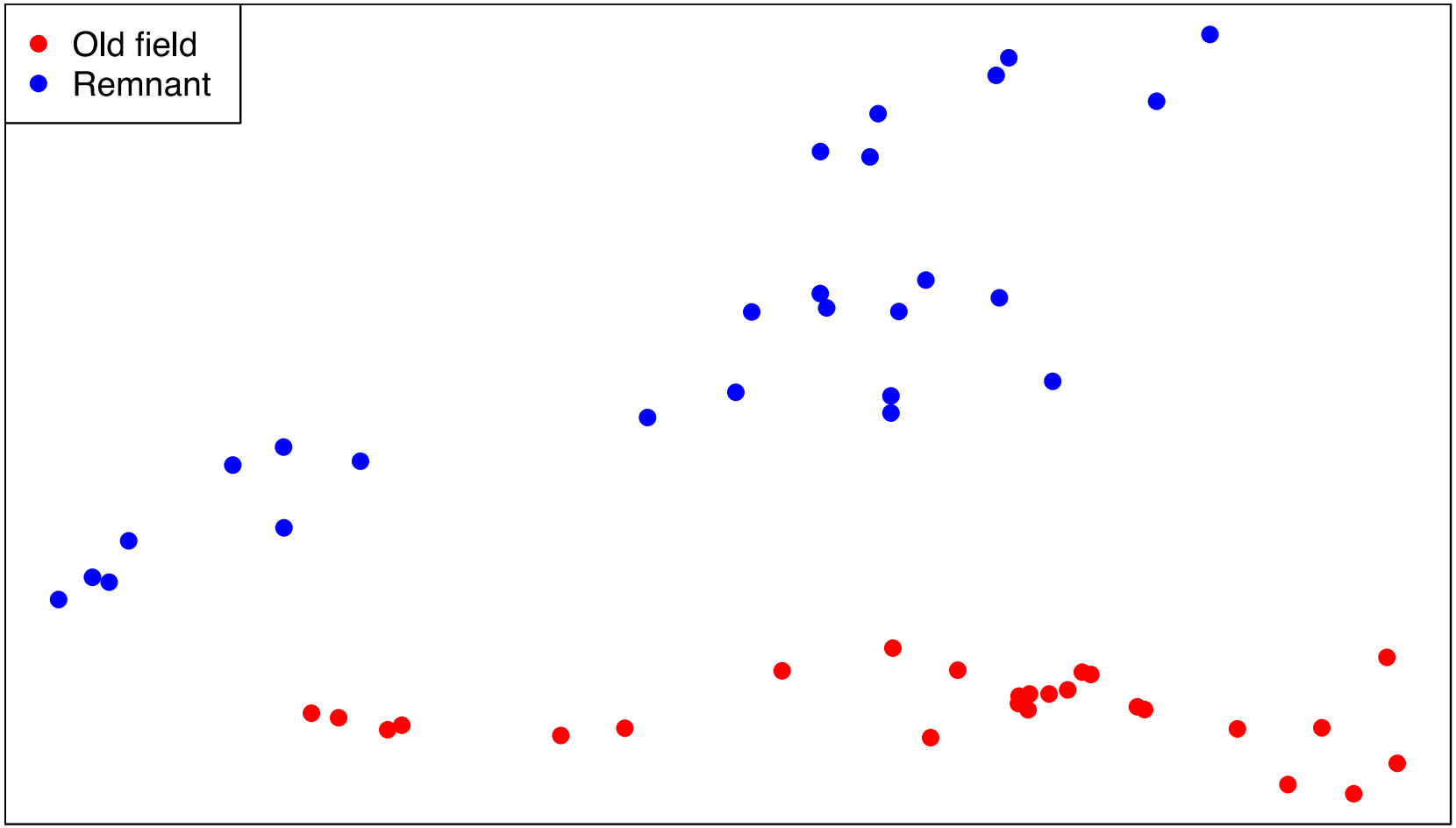
- Old-field – dominated by annual weeds
- Remnant – diverse native grassland

Lolium rigidum

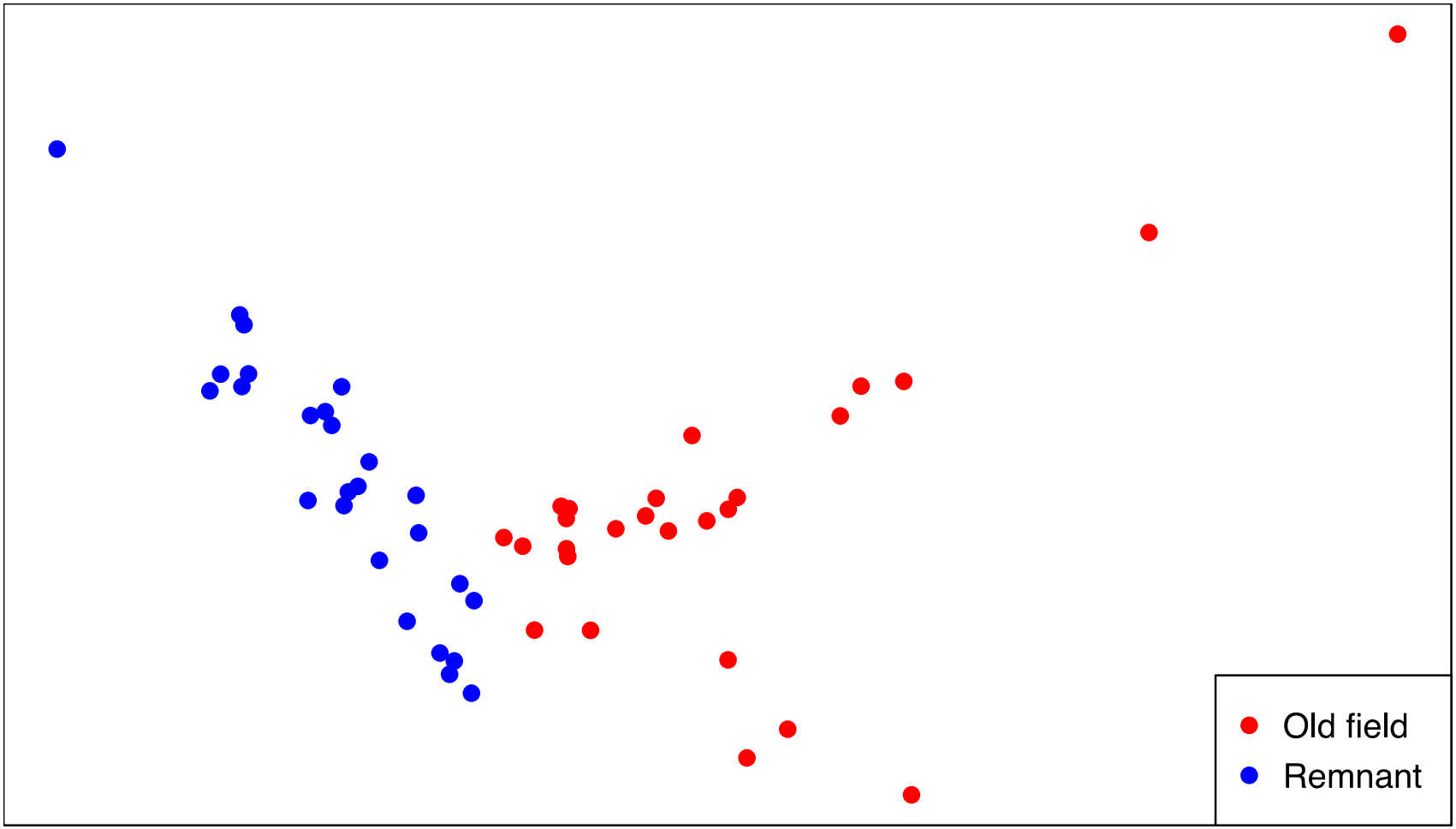
Rytidosperma auriculatum

Austrostipa nodosa

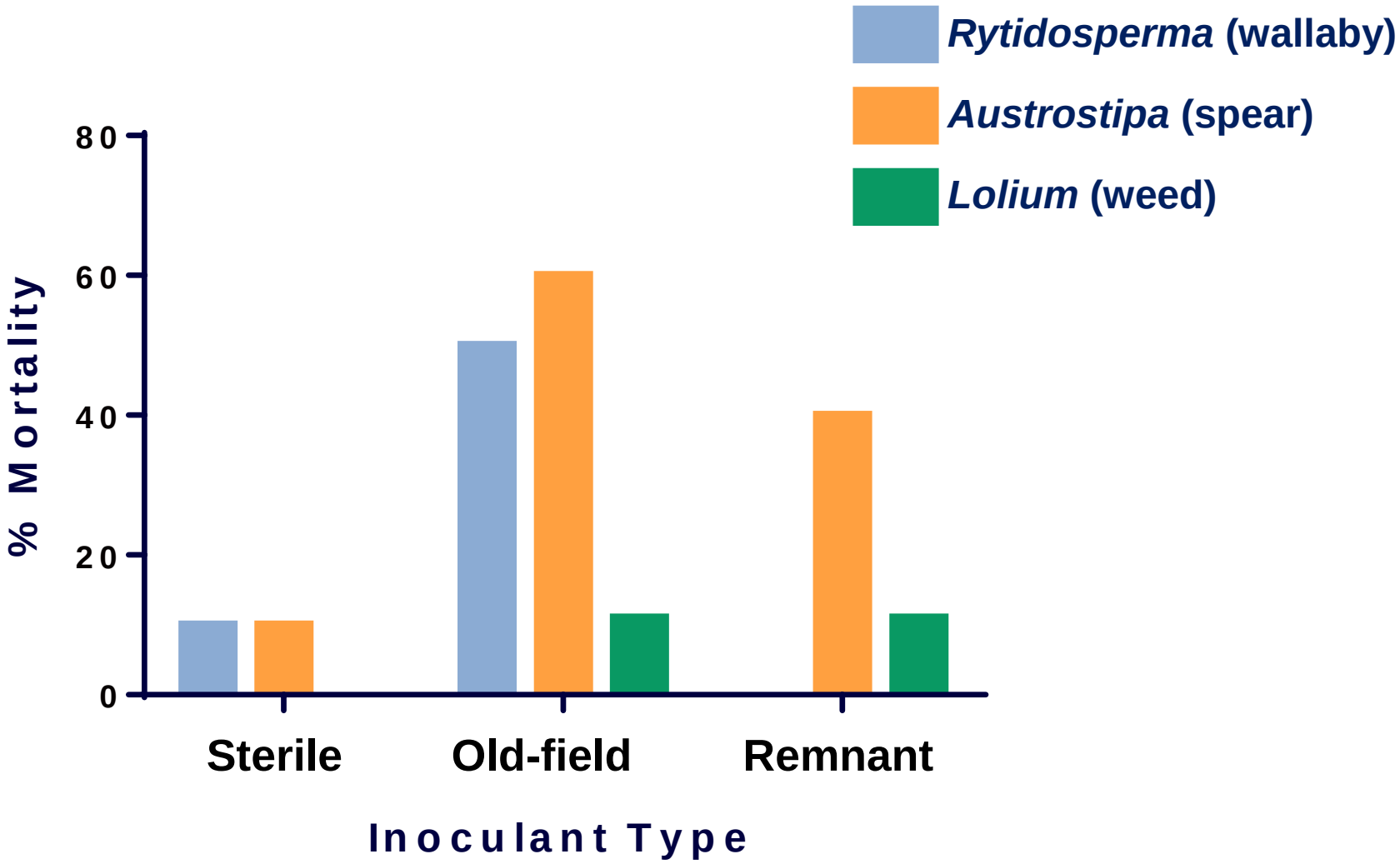
Were the bacterial species different?



Were the fungal species different?

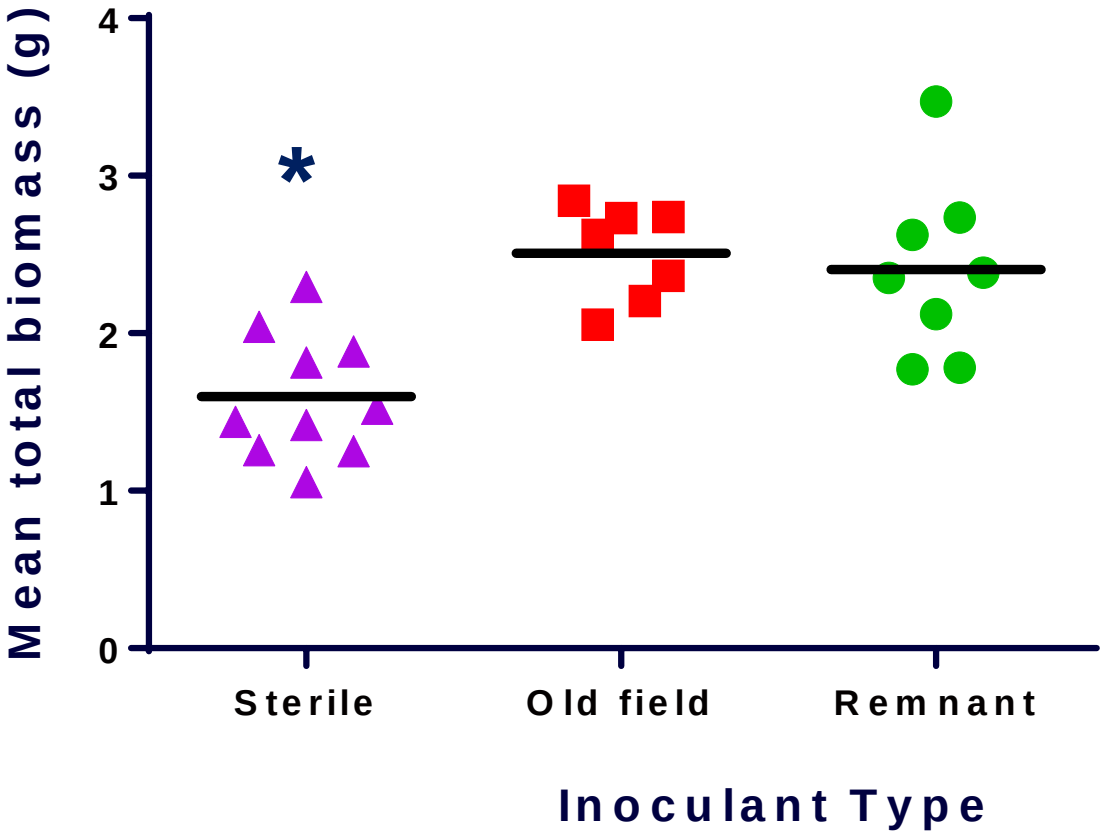


Soil microbes – plant mortality

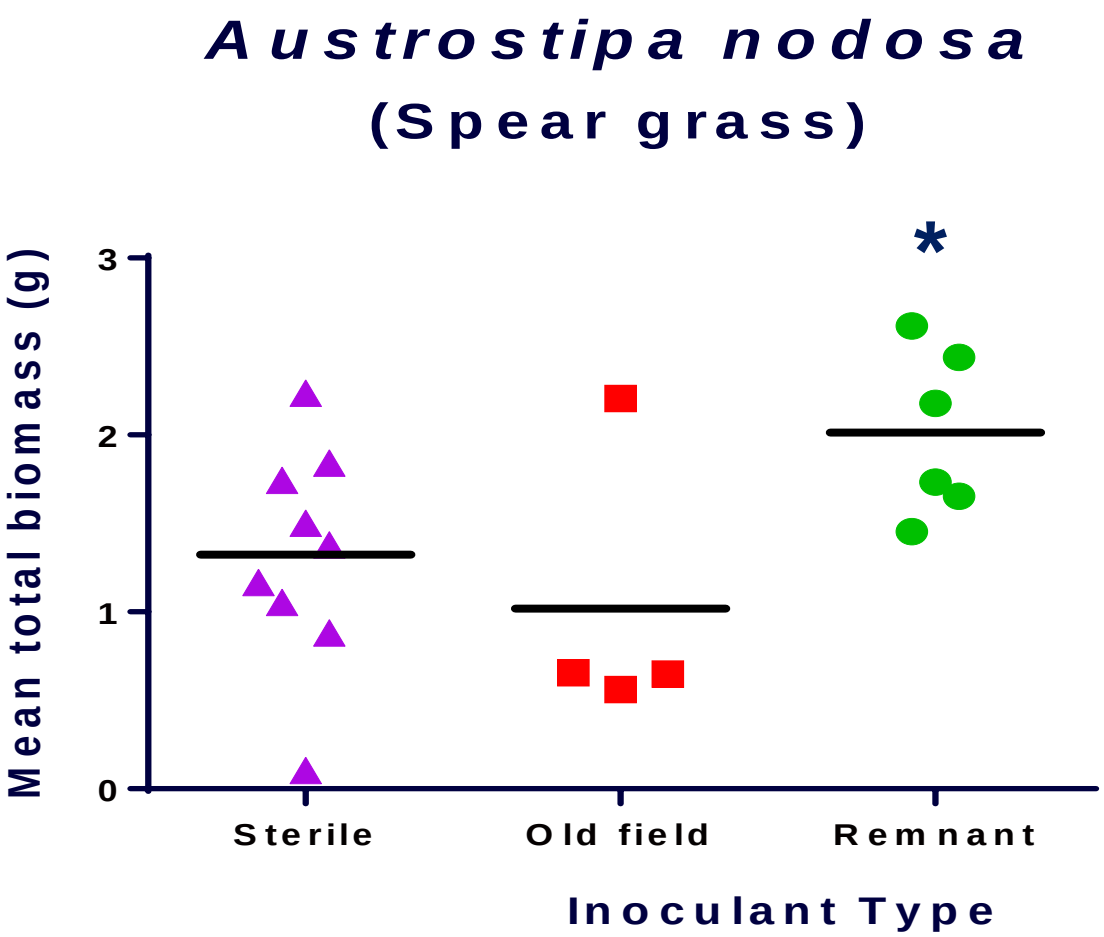


Soil microbes – plant growth

Lolium rigidum (weed)

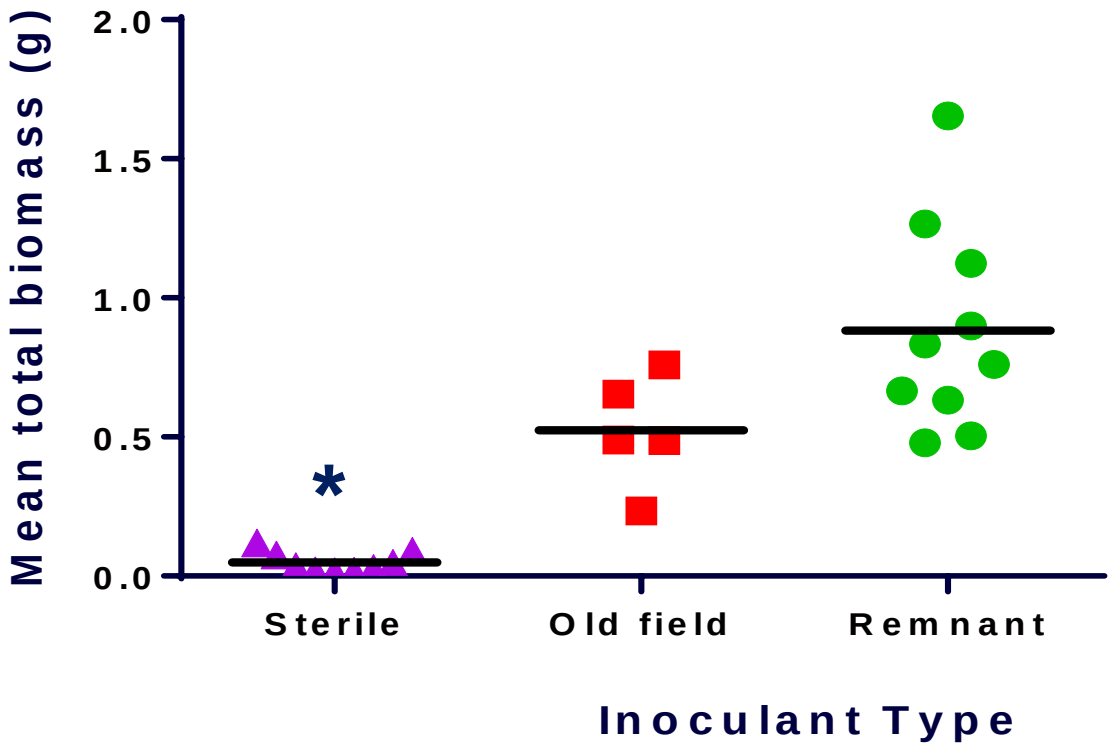


Soil microbes – plant growth



Soil microbes – plant growth

Rytidosperma auriculatum
(Wallaby grass)



Soil microbes - summary

Weed response

- Lowest mortality overall
- Not fussy with which microbes are present

Native response

- High mortality with old-field microbes
- Increased growth with remnant microbes

Applications

- Incorporating microbial inoculation into restoration programs may be beneficial for native grasses

Planting strategies

Is the resilience of revegetated communities increased by:

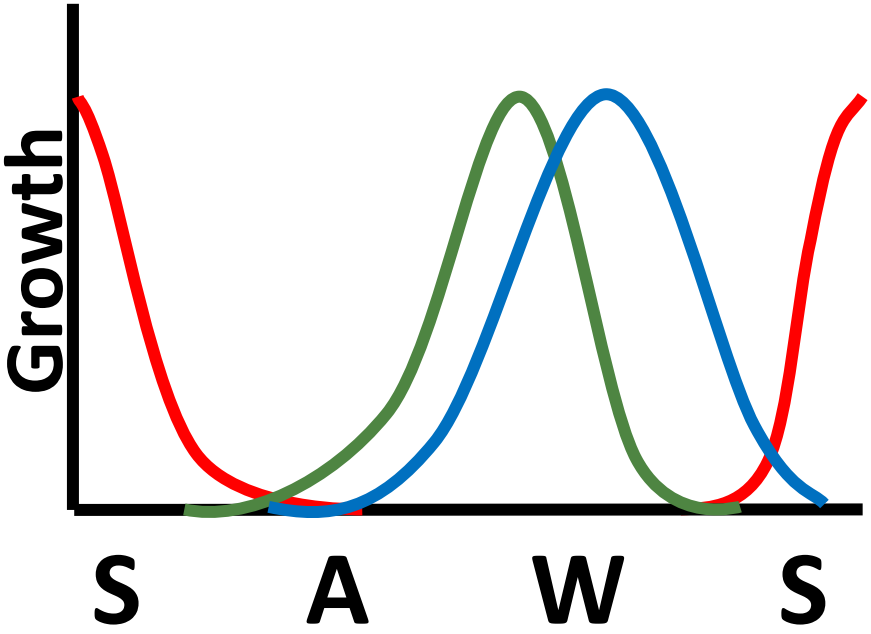
1) Functional group diversity?
2) Planting density?

How do the natives respond to these planting strategies?

- Weeded plots to look at competition between natives

Resource use:

- Measure soil moisture for 12 months
- Nutrients at time of planting and in 12 months



C4 Native
C3 Native
C3 Invasive (annual)

A. flavescens, R. caespitosum, Enneapogan nigricans, Themeda triandra

Results to come!

Expected results

Trade-off between resilience to weed invasion and competition between natives

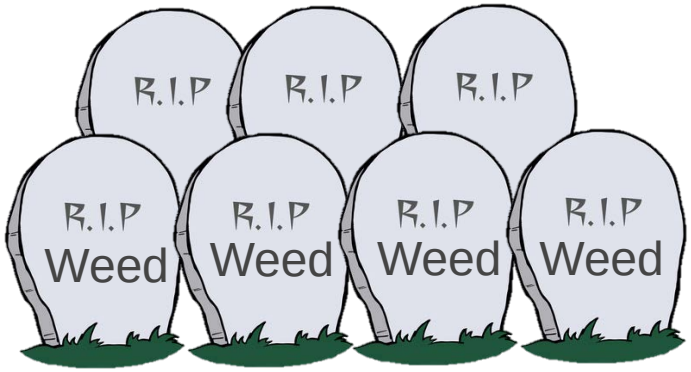
- Fewer weeds but less growth of natives at high density

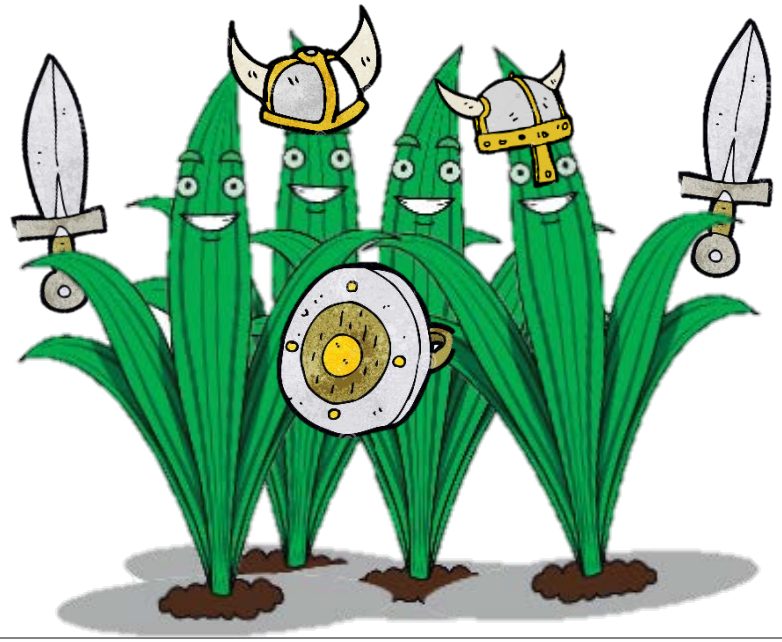
Overall fewer weeds where both C3 & C4 occur

- However, C3 have had an extra season

Summary

- Incorporating below-ground restoration into above-ground efforts may have huge implications for restoration outcomes
  - Creating conditions suitable for native grass establishment
  - Soil legacies
  - Soil microbial communities
  - Resource use





Thank you

F.N.S.

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Supervisors: ***José M. Facelli, Leanne Rosser & Timothy Cavagnaro***

... and many volunteers!

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