# The biodiversity benefits of urban green spaces – golf courses, gardens and parks

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AGCSA
Australian Government
Australian Research Council
Royal Botanic Gardens Melbourne
Australian Research Centre for Urban Ecology

# What's biodiversity ever done for me?

- Convention on Biological Diversity (CBD)
- Ecosystem services:
  - *Pollination*
  - *Pest control*
  - *Food-web maintenance*

- Mental health and wellbeing
- Ecological indicators of overall system health
- Driving factor in fed / state / local gov. funding and planning for urban centres
- Good public image
- Reduced maintenance costs – business case

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# Green space in cities

- Over 80% of Australia's population live in urban centres
- Green spaces (golf courses) provide important social and environmental services
- Urban landscape planners need evidence of these benefits
- Inner-suburb green space is being converted to 'residential'
- New outer-suburbs often centred around a golf course

# Urban green space & biodiversity

- 20-30% of Melbourne city is urban green space (UGS)
- Golf courses are the largest form of UGS
- Melbourne GCs occupy 51 $km^2$
- Provide habitat for:
  - Rare plants
  - Insects
  - Mammals
  - Birds


Spring Valley Golf Course

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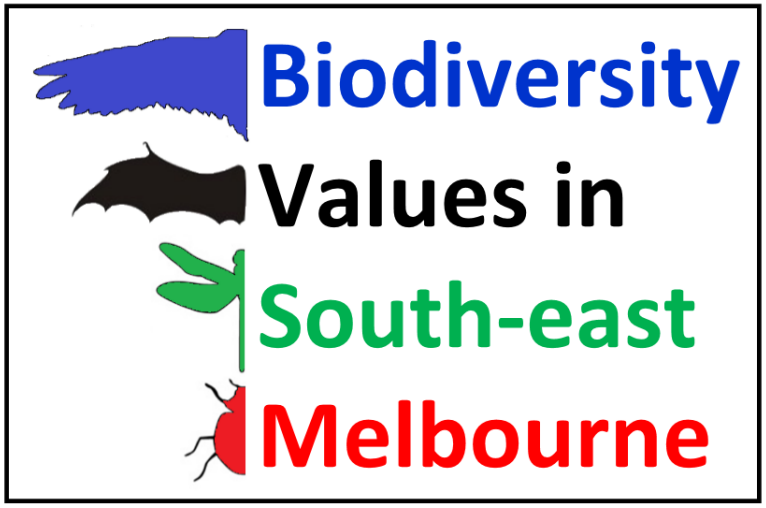
# Project Aim

To improve our understanding of biodiversity benefits and ecosystem services provided by urban golf courses

1. To measure the benefits of biodiversity to the hydrology of urban golf courses

2. To measure differences in biodiversity between urban golf courses and the adjacent residential areas and the benefits of this.



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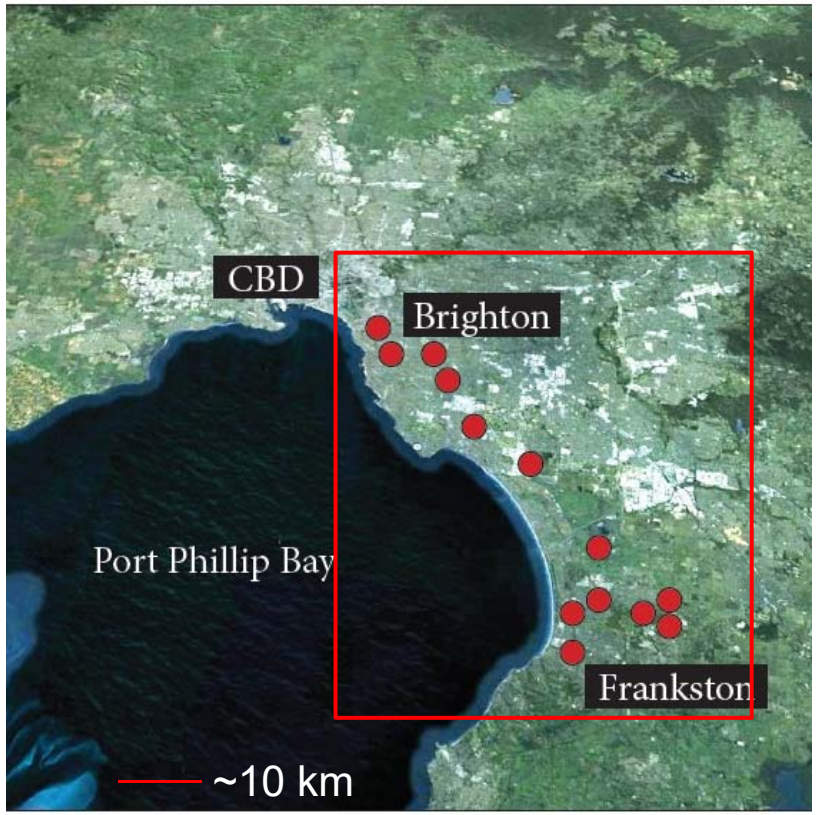
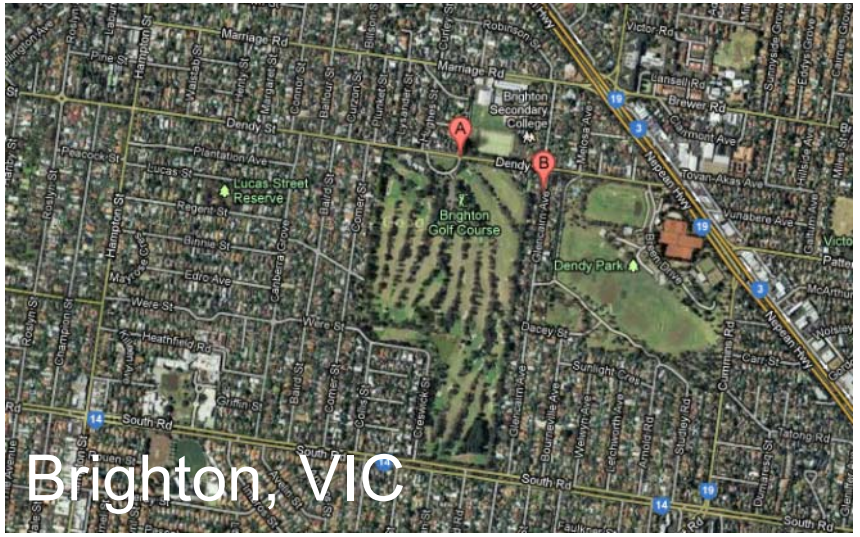
# Project design





- Age – decade of establishment (5-100 yrs)
- Vegetation management

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# Project design

## Comparison of different forms of green space

Parks and reserves

Residential gardens

Golf courses

# Project design

Included ‘parkland’ and ‘natural’ styles

Public and private

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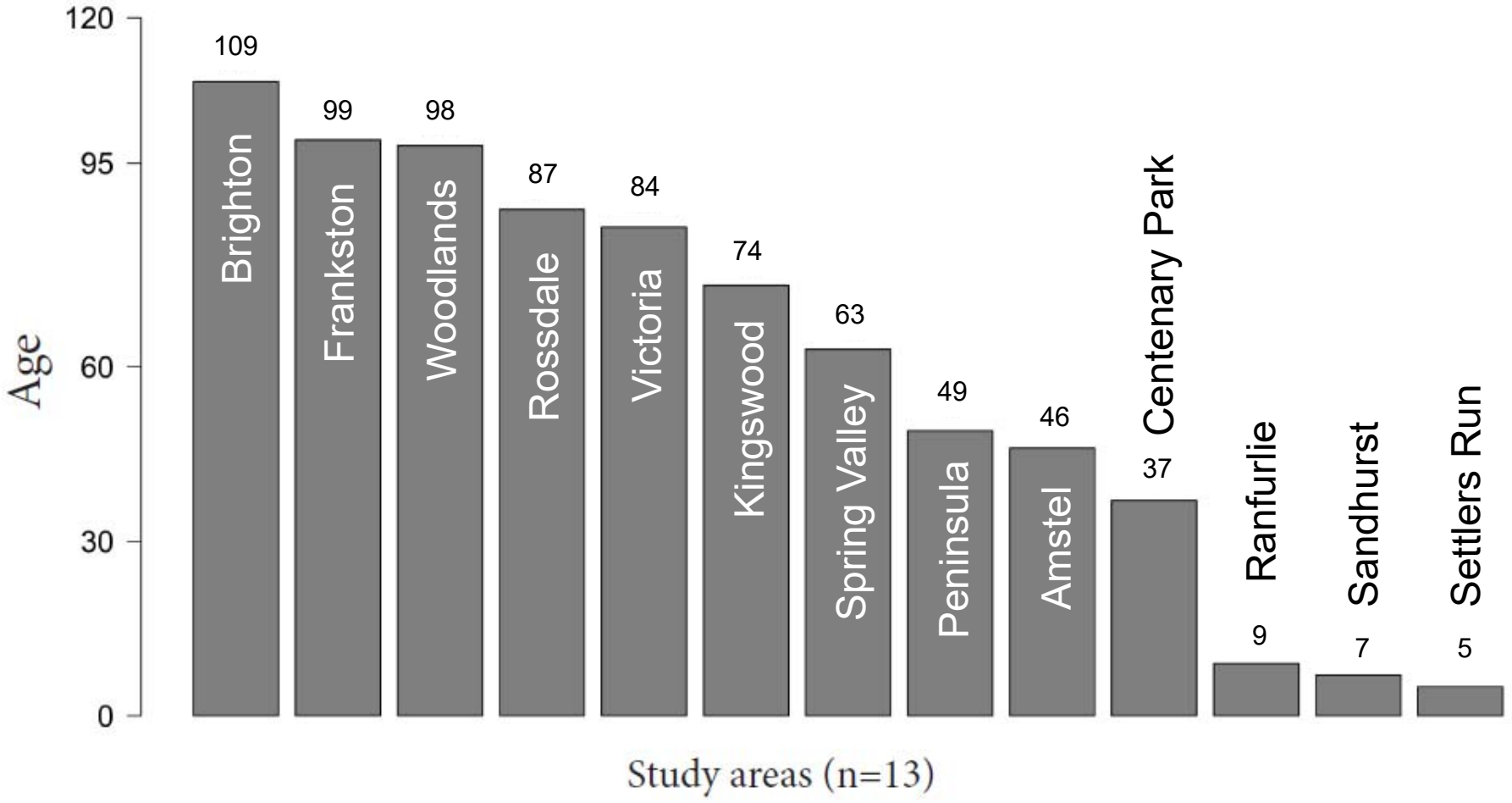
# Golf course age



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# Measurement plots

# Habitat (vegetation) structure

**STRUCTURAL COMPLEXITY** – the vertical arrangement of the habitat

HIGH

LOW

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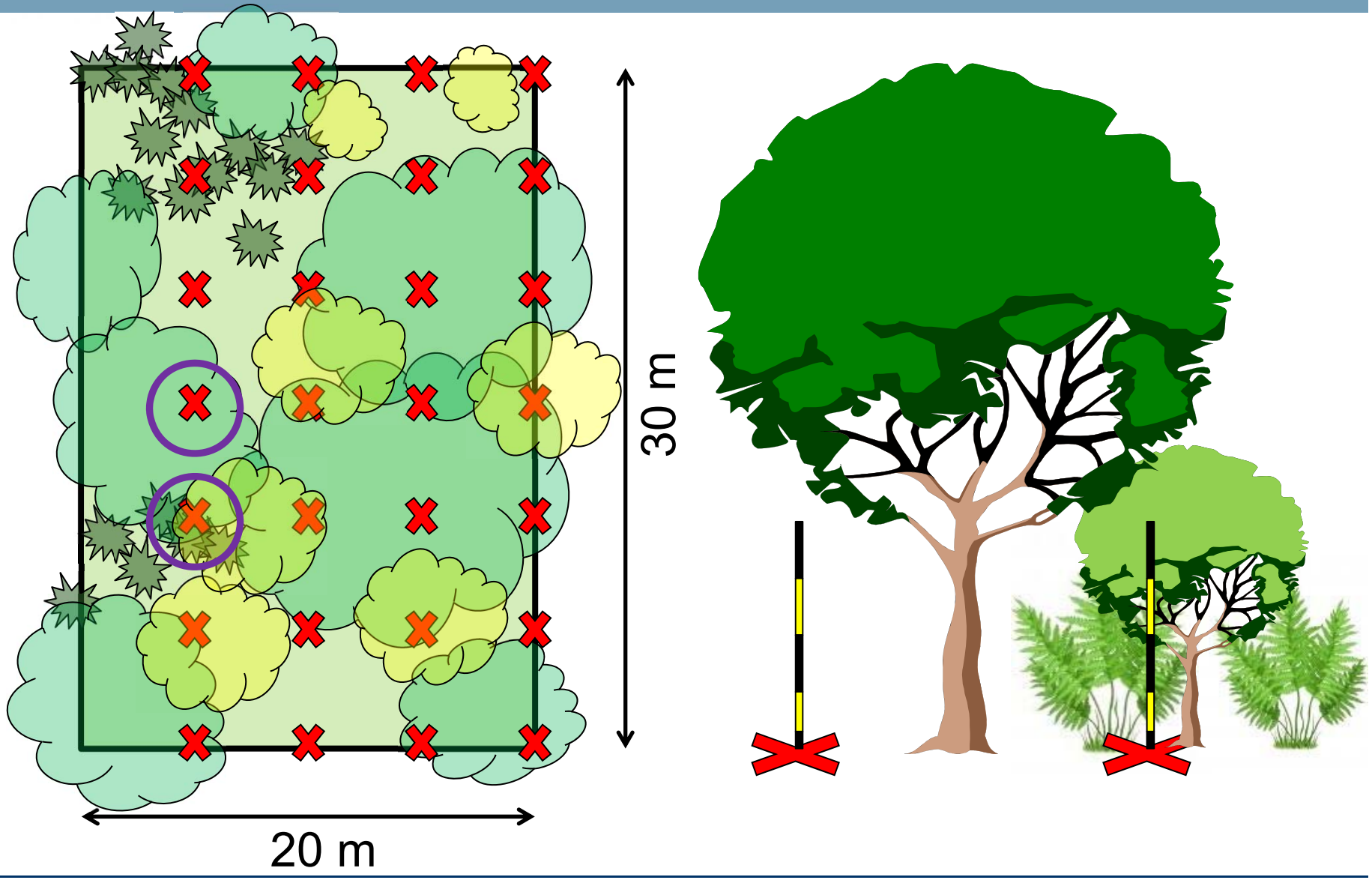
# Measuring vegetation structure



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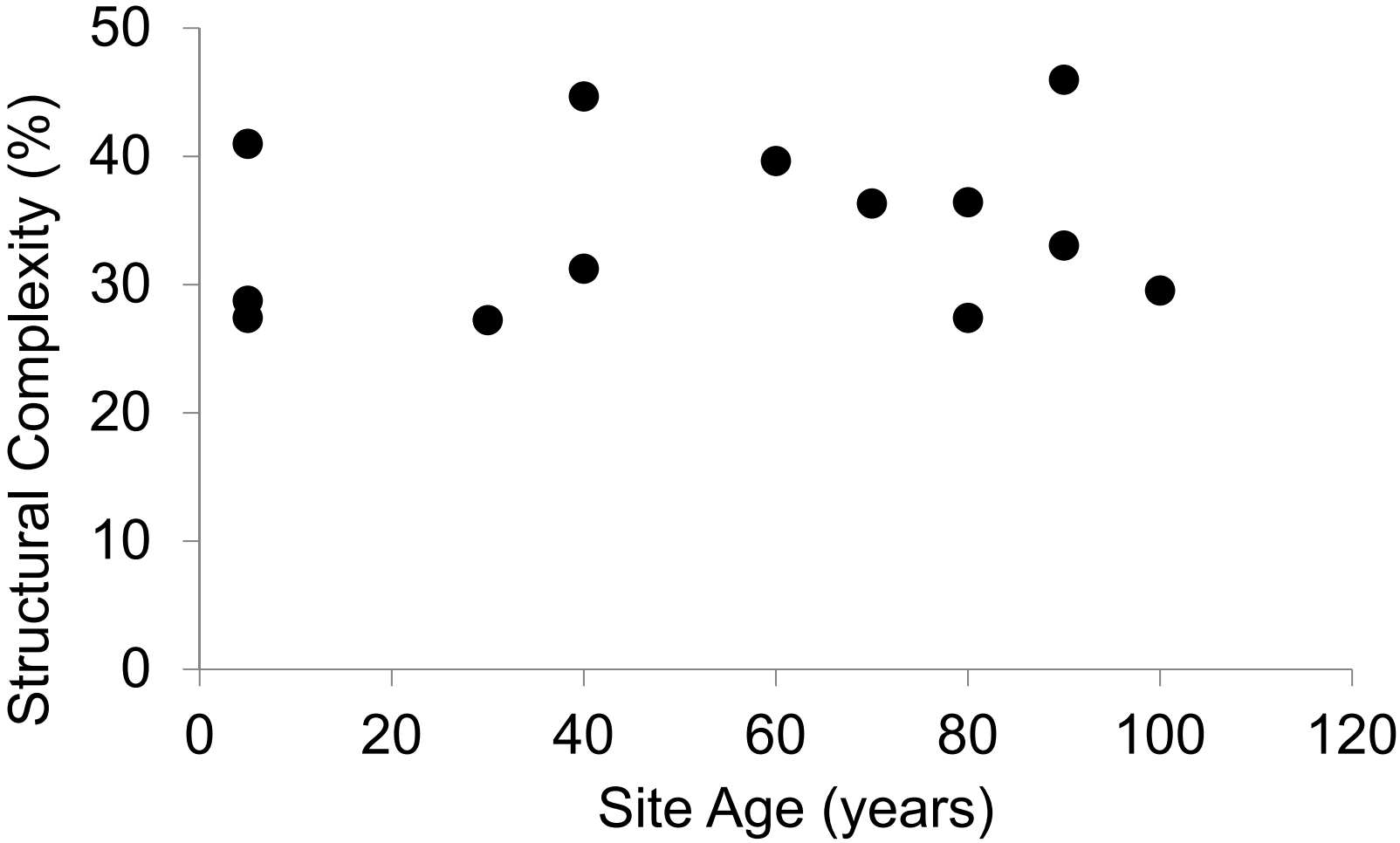
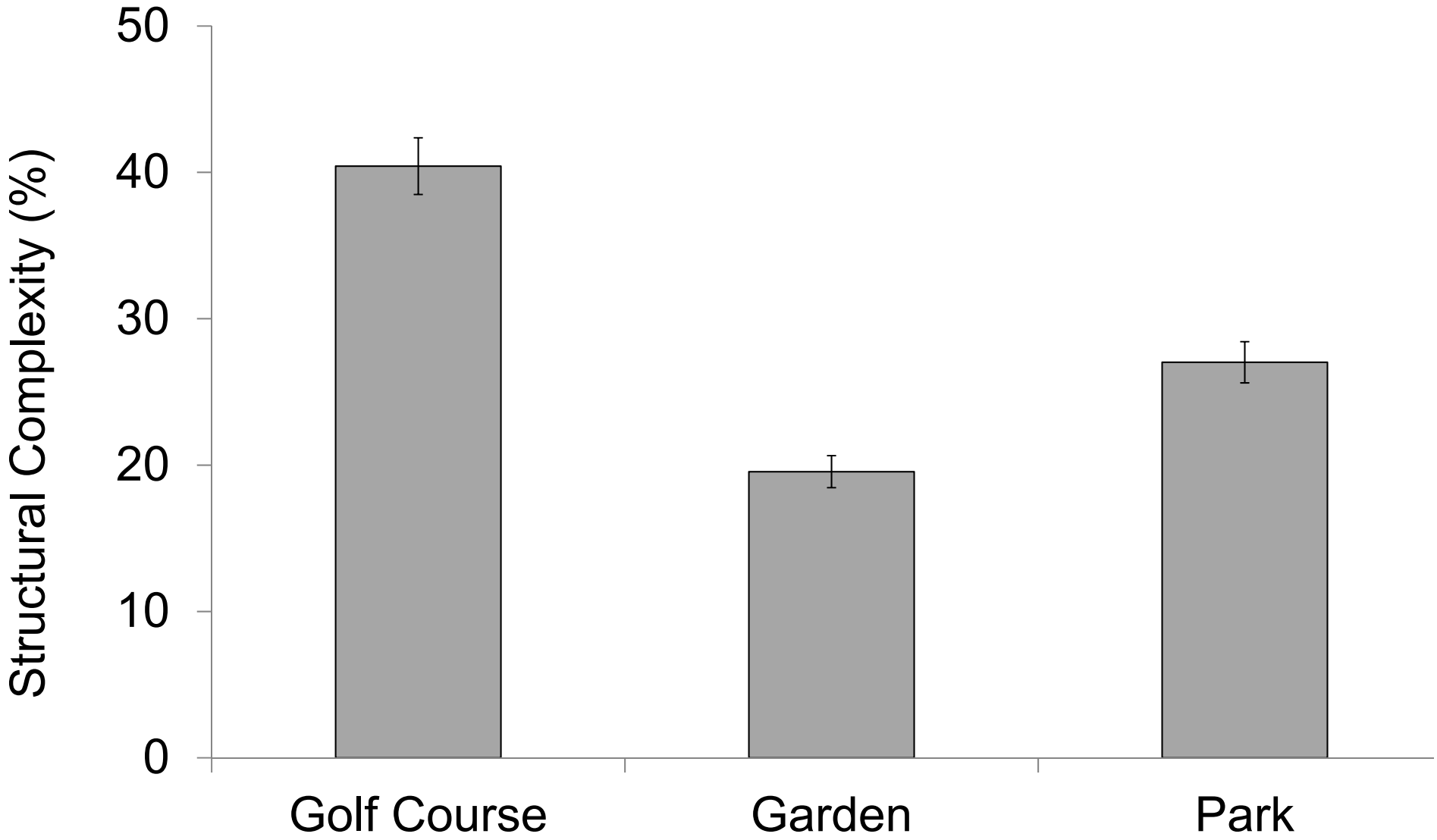
# Measuring vegetation structure

- Structural complexity variation among GC




Structural Complexity (%)
50
40
30
20
10
0
Golf Course
Garden
Park

# Link between vegetation and soil

- How does vegetation complexity influence soil properties?

*Alessandro Ossola (PhD student)*

Higher vegetation complexity = Higher soil invertebrate biodiversity = Better soil ecosystem services ?

# Habitat (vegetation) structure

| Site | Area (ha) | Site age (yrs) | Elevation (m) |
|---|---|---|---|
| Woodlands Golf Course | 59 | 100 | 15 |
| Kingswood Golf Course | 53 | 76 | 30 |
| Springvalley Golf Course | 59 | 65 | 40 |
| Peninsula Golf Course | 81 | 51 | 30 |
| Centenary Park Golf Course | 54 | 43 | 35 |

10 simple GC plots

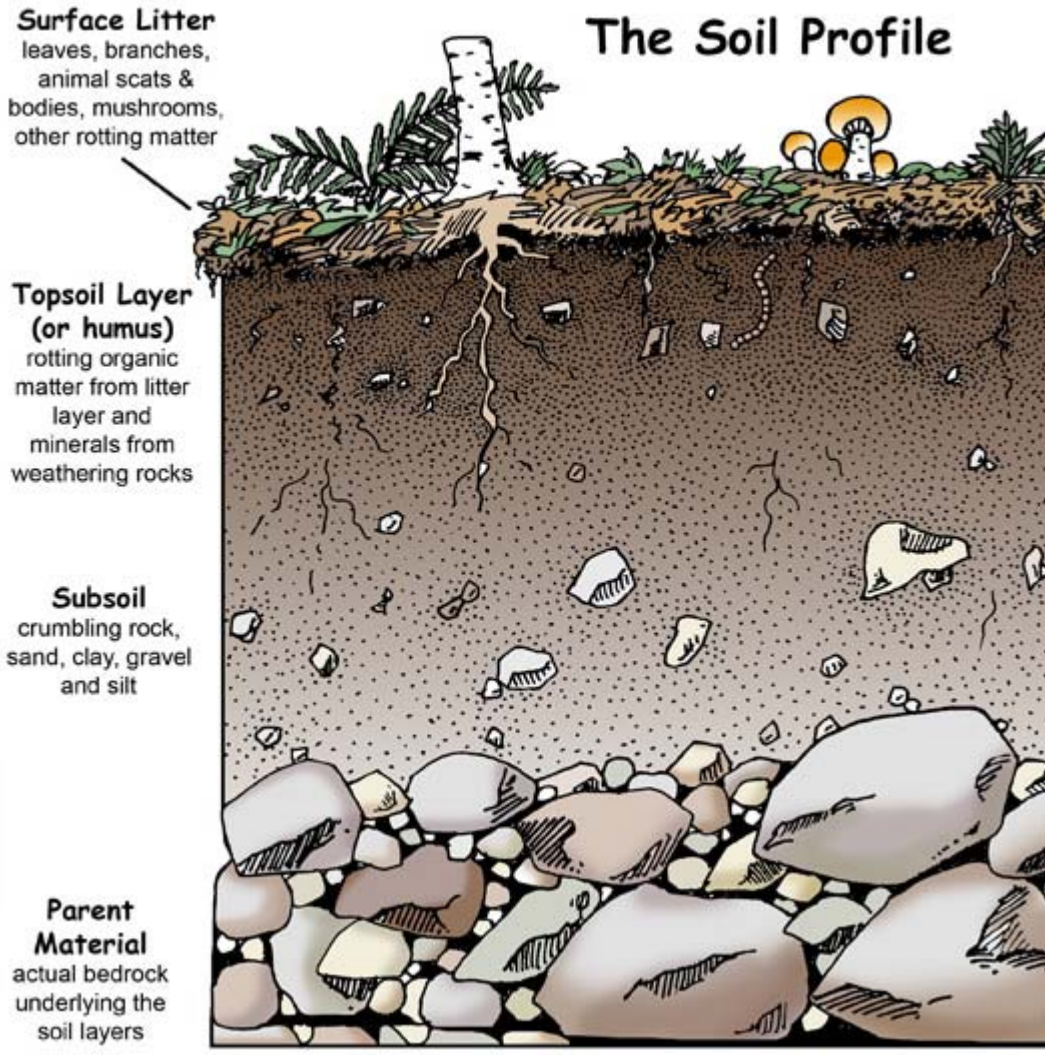
10 complex GC plots

10 complex Remnant plots

# Soil structure for water movement

Good soil structure, strong aggregates and macropores from:

- Litter accumulation
- Woody root growth
- Biological activity
- Less compaction



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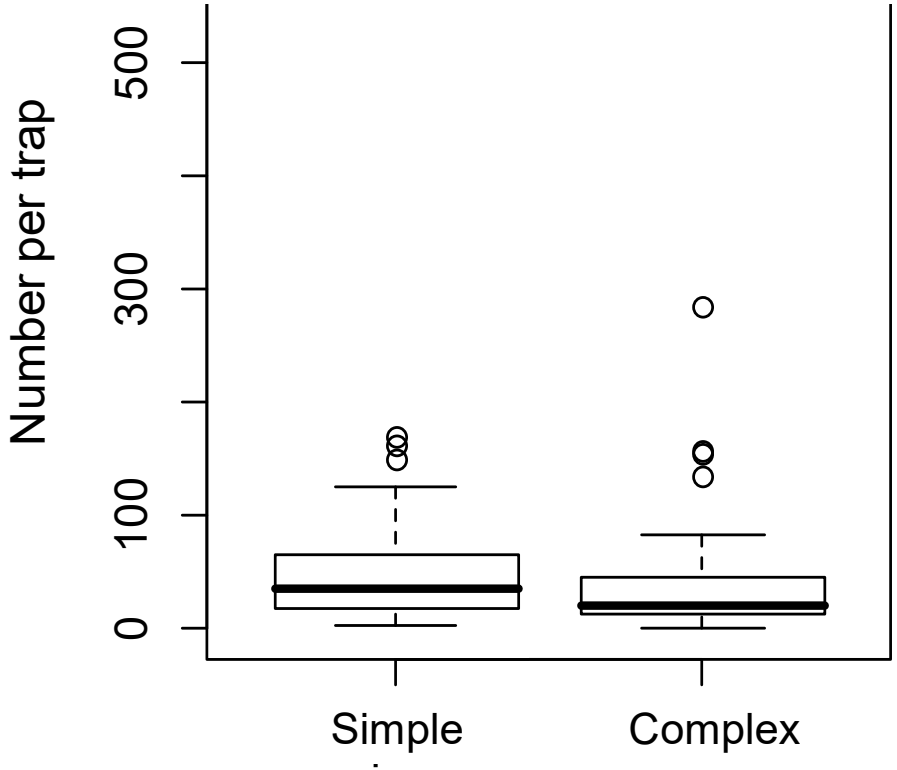
# Soil invertebrates

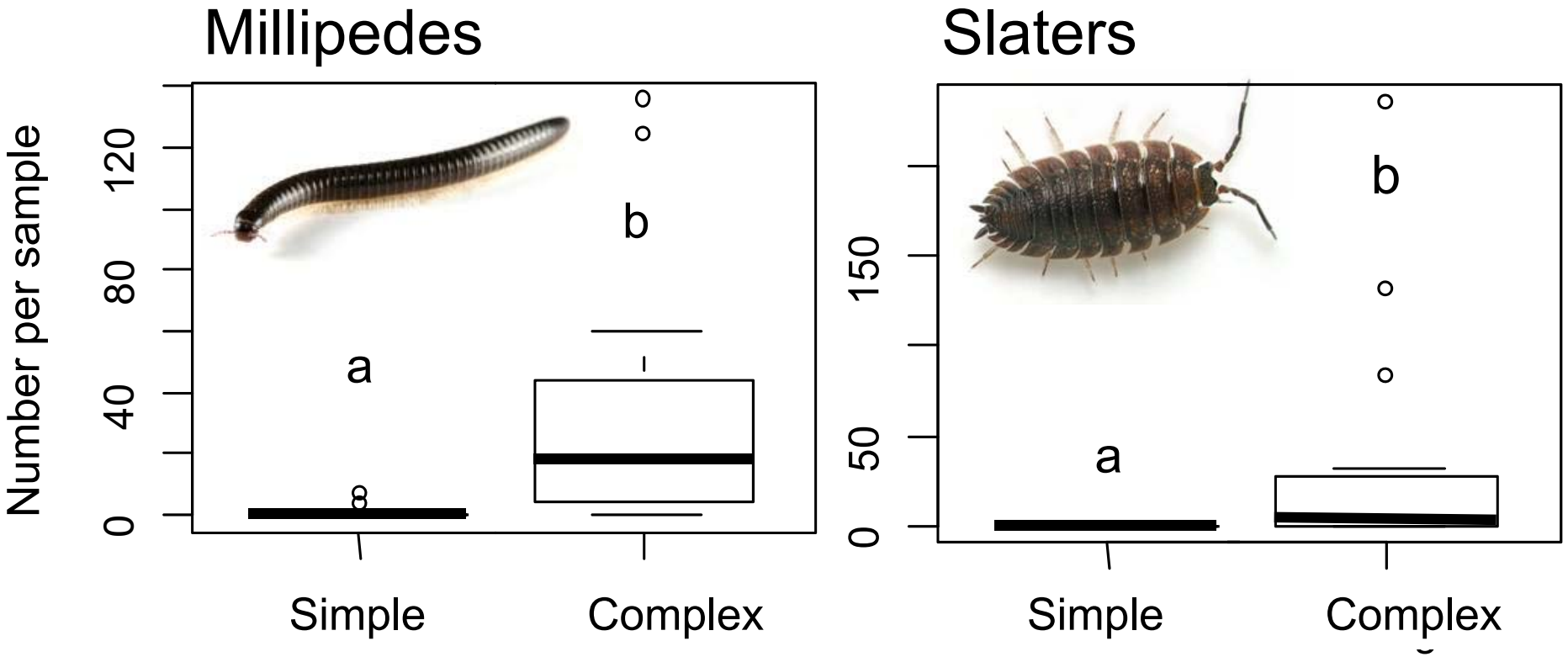



## Ants

- Ants are important soil engineers

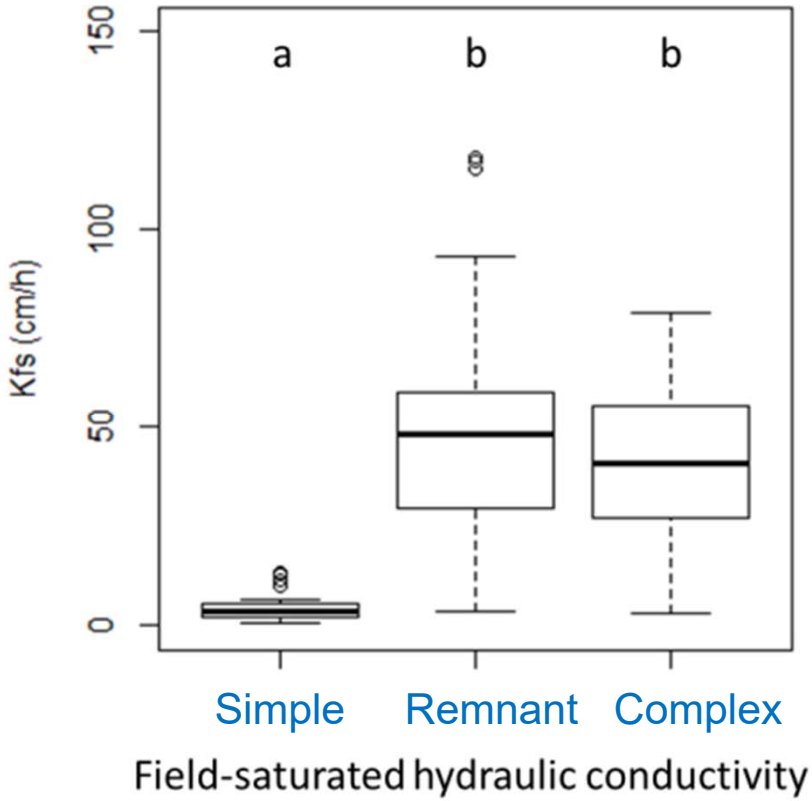
- Even if their abundance is similar under Simple and Complex vegetation, species composition is different, with bigger species capable of creating macropores more abundant in Complex areas.

# Soil invertebrates

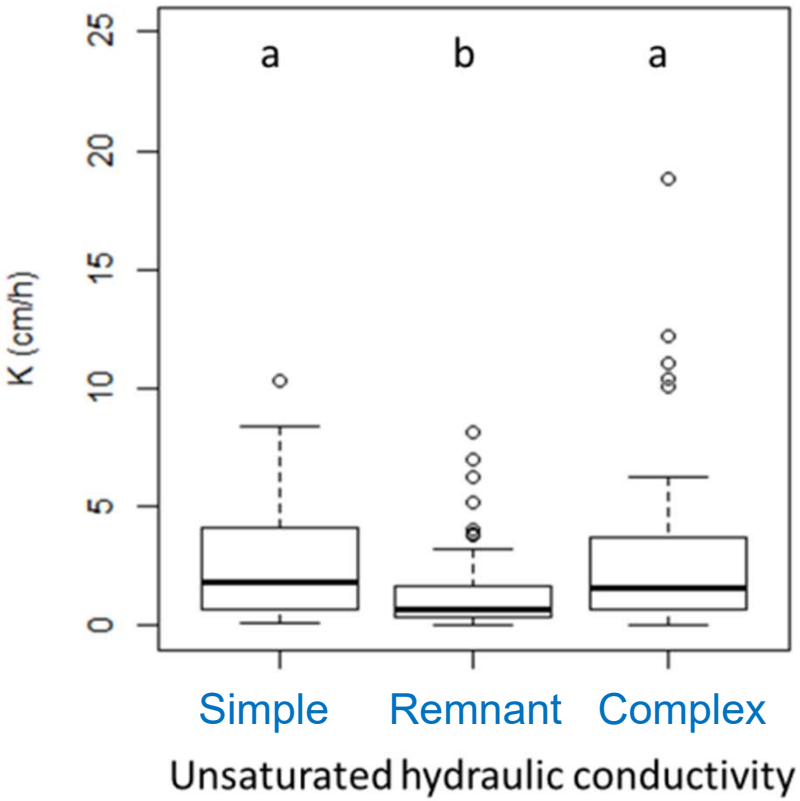



- Higher decomposer abundance under complex vegetation structures

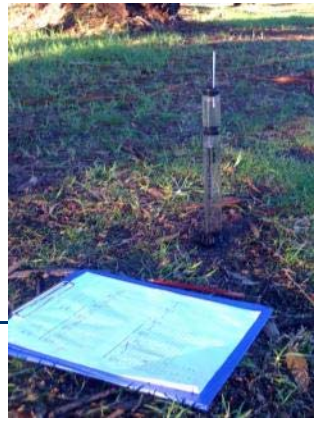
# Soil water infiltration



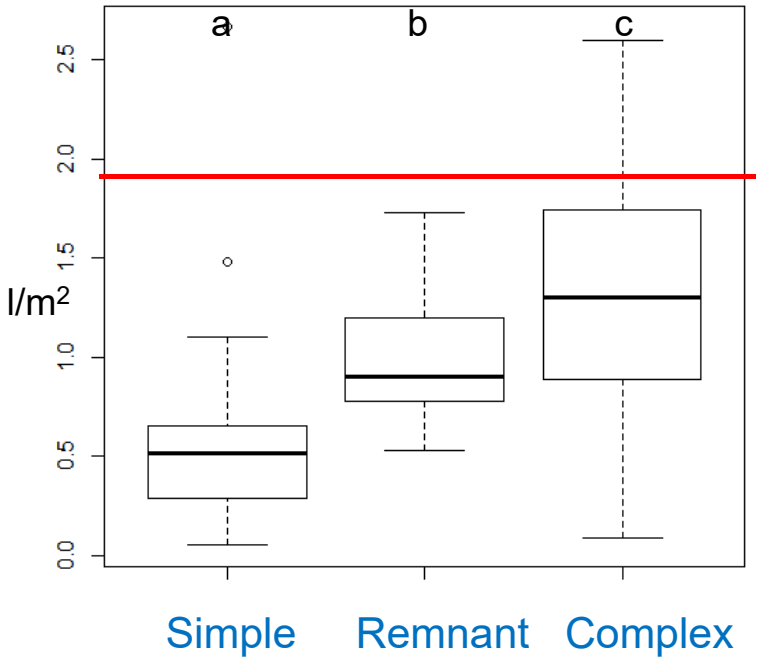

Field-saturated hydraulic conductivity




Unsaturated hydraulic conductivity



# Litter water holding capacity




# Managing runoff

This means that Simple out-of-play areas might generate runoff, particularly during storms, instead of draining runoff from fairways.

Complex vegetation areas can absorb any kind of precipitation intensities and even runoff generated by fairways

Above-ground tree biomass was 107.7 ± 15.7 Mg C $ha^{-1}$ in wooded UGC areas. There was a weak relationship between tree C stock and UGC age. The upper 0.3 m of soil in wooded UGC stored 113.9 ± 9.1 Mg C $ha^{-1}$.

Soil C stocks in adjacent grass rough (86.9 +7.2 Mg C $ha^{-1}$) and turfed fairway (77.5 +10.5 Mg C $ha^{-1}$) were significantly smaller ($p \leq 0.005$). If the two UGCs established on forested land were ignored, the difference in soil C:N ratio between UGC wooded green space and fairway, or rough, increased significantly with increasing UGC age (Δ+3.0 in 100 years).

# Measuring biodiversity

**Aim 2)** To measure differences in biodiversity between urban golf courses and the adjacent residential areas and the benefits of this.

- Beetles
- Bugs
- Bees
- Birds
- Insect-eating bats

# Animals & Ecosystem Services

## Bees

Pollinators

## Bugs

Insect pest control (predators)

## Beetles

Scavengers, predators, and herbivores


## Birds

Seed dispersal, insect pest control

## Bats

Insect pest control

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# Insect surveys

- Targeting bees, bugs and beetles



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# Beetles

Student Jess Mackie looked at beetles on golf courses

# Beetles (Coleptera)

- Collected over 40,000 beetles in light traps
- 197 morpho-species
- Most abundant families were Carabidae, Scarabaeidae and Hydrophilidae


Carabidae

Scarabaeidae

Hydrophilidae

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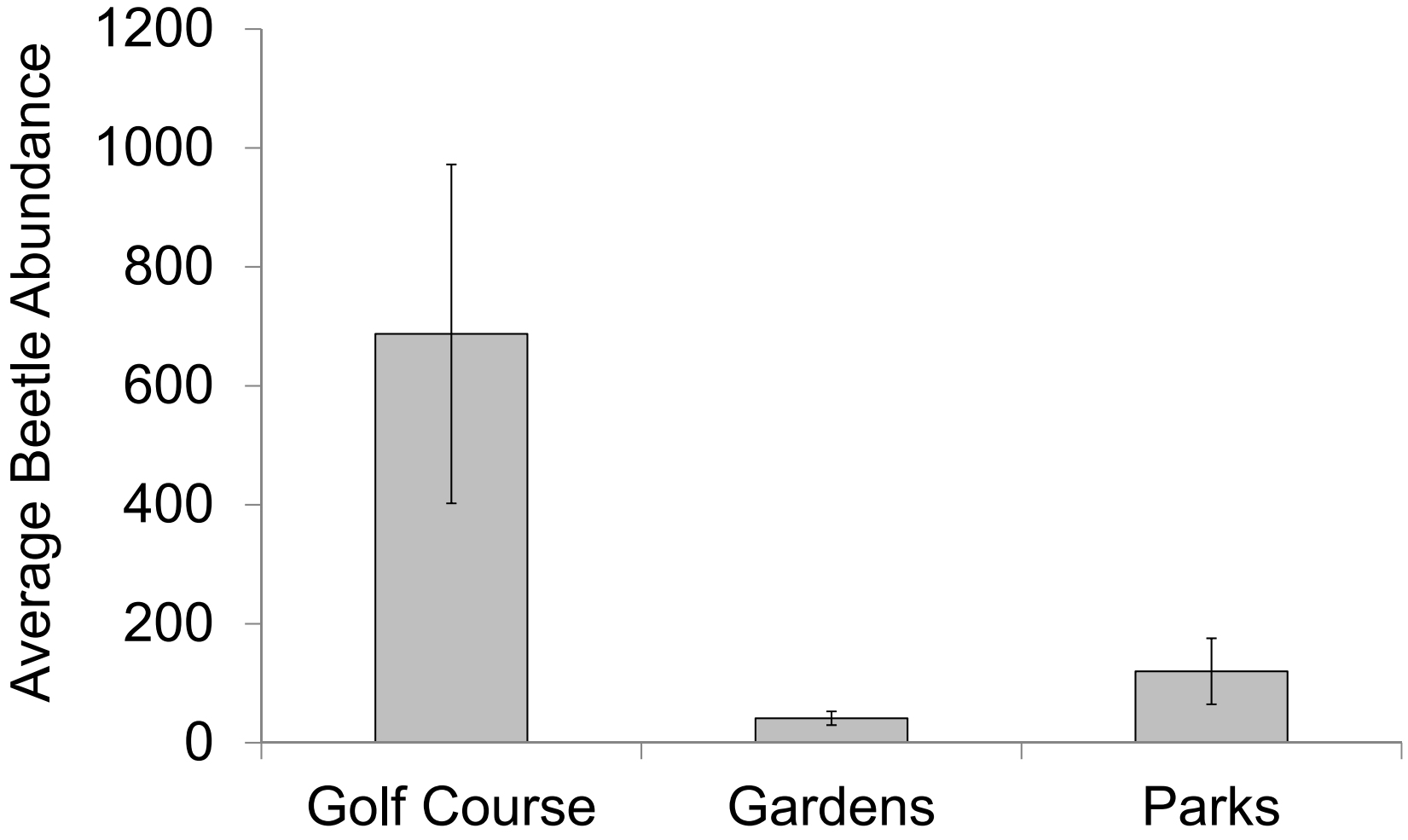
# Beetles



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# Beetles

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# True Bugs

## PhD student Luis Mata looked at bugs on golf courses

BIODIVERSITY

In late 2011, researchers from the University of Melbourne started work on a groundbreaking three-year project which will investigate the biodiversity value of golf courses. In this first of a series of updates, ATM looks at the goals of the project, while visiting PhD student Luis Mata looks at the initial insect surveys which have been conducted at the 13 Melbourne-based golf clubs involved in the project.

### Hidden helpers

In 2011 the Australian Golf Course Superintendents' Association (AGCSA), in conjunction with the University of Melbourne, announced that it was establishing a joint research project with the objective of improving the understanding of biodiversity conservation and carbon sequestration provided by urban green spaces, in particular golf courses.

Thirteen golf courses throughout south-east Melbourne agreed to take part in the study, ranging from newly established courses through to golf courses that have been on their existing site for more than 100 years. The courses are located from Brighton down to Frankston and include:

| | |
|---|---|
| Brighton GC | Spring Valley GC |

- **Bird biodiversity:** Researchers will visit each golf course 4-6 times a year to record birds observed based on sightings and song;
- **Vegetation:** Researchers will visit each golf course to map and record plant species and vegetation communities present;
- **Soil sampling:** The research team will collect soil samples from throughout the golf course

uniqueness of its plants, mammals and birds. Where else can you be amazed by the beauty of gum-trees, paperbarks and banksias? Where else can you see wallabies, enjoy the laughing calls of kookaburras, or the sulphur-crest of the cockatoo? However, despite sharing a fascination for Australia's unique animals, my true fascination and research interests are for the diversity of Australian insects!

In late 2011, I was lucky to join the University of Melbourne research team, as a visiting insect ecology PhD student, and be a part of this major scientific study into the biodiversity and carbon benefits provided by golf courses and other urban green spaces within our cities.

For me, one of the most interesting aspects of this project is the investigation of the link between golf course structure and management and insect biodiversity. This means that we will have an opportunity to learn more about how the management decisions related to golf course vegetation structure and vegetation elements may influence the biodiversity values within golf courses. This knowledge can then be used to guide management decisions that promote higher biodiversity values within golf courses.

But what do we mean by the value of biodiversity? And how does this relate to insects? Furthermore, how does insect biodiversity relate to 'ecosystem services' provided to the wider environment and community by golf courses?

The first thing to realise about insects is that some of them are herbivores and some are carnivores. Herbivorous insects can become 'pests' of valued trees, shrubs, crops, herbs and turf under favourable conditions. These insect pests are the ones we try to fight off with expensive and often ecologically unfriendly pesticides.

But many insect groups, such as assassin bugs, damsel bugs, ladybugs, mantidflies and praying mantis, are carnivorous, feeding principally upon other insects. This is fortunate as they are

Main photo: Assassin bugs, whic are part of the heteropteran bug family, are predatory species characterised by their stout bea During the first collection seaso of the golf course biodiversity project, 80 different species of heteropteran bugs were found on the 13 courses involved in th project

Damsel bugs are economically important predatory species that act as natural pest control agen

# True Bugs

## True bugs (Hemiptera)

- Collected 9500 bugs in sweep nets & light traps
- 119 species
- Most abundant species were herbivores, predatory bugs appear to be sensitive to site conditions



*Mutusca* sp


*Nabis* sp

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# True Bugs

# True Bugs

Good, predatory, pest eating bugs in:

Wooded rough

vs

Secondary rough

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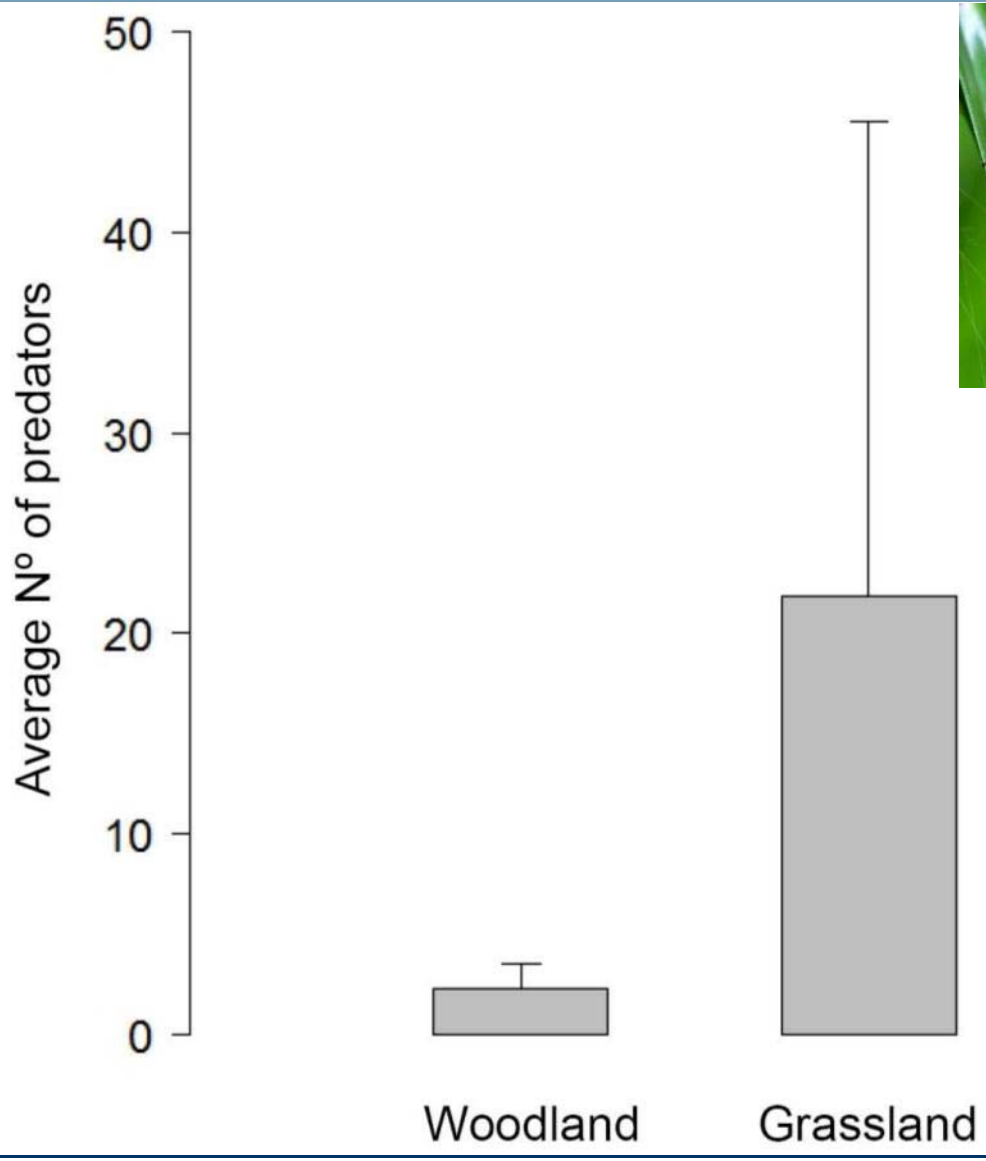
# True Bugs



# Native bees

- ~2000 species, >150 species in Melbourne
- Essential for plant pollination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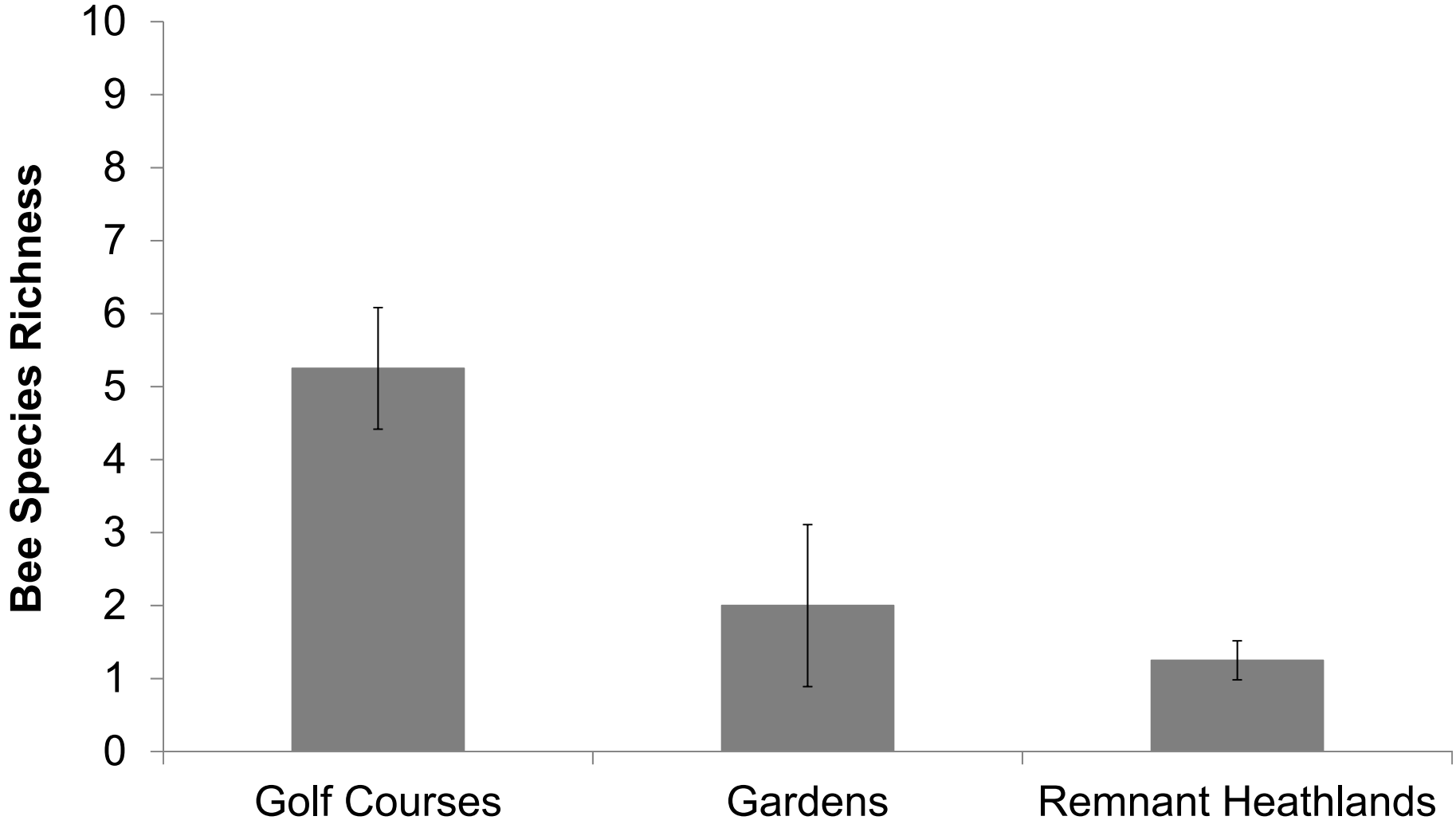
# Native bees

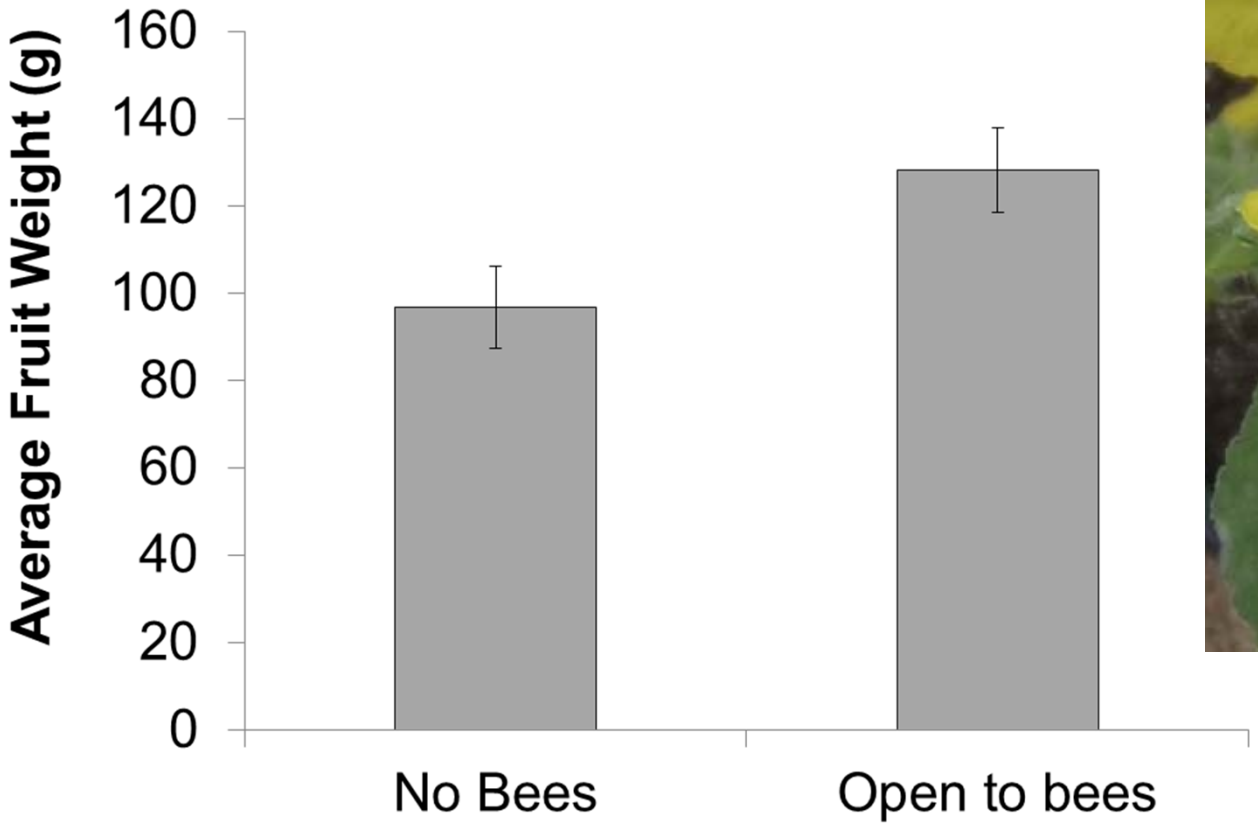


# Native bees

- Number of bees in golf courses depends on:
  - Abundance of flowers
  - Types of flowers
  - Number of native plants. Native plants are much better for native bees

# Native bees

- Pollination is more successful in golf courses with greater bee abundance and diversity




# Bird & bat surveys

- **Birds:** Early morning surveys in Spring/Summer

- **Bats:** Ultrasonic recording for multiple nights

Anabat Bat Detector

# Birds

- Recorded 106 species
- Up to 60 species in one golf course
- Min # seen in golf courses was always greater than the maximum recorded elsewhere

www.birdsinbackyards.net

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# Birds

## Interesting birds we saw….


White-eared Honeyeater


Australian spotted crake


Horsefield’s Bronze-Cuckoo


Painted Button-quail


White-naped Honeyeater


Yellow-rumped Thornbill


Rufous Whistler


Latham’s Snipe

www.birdsinbackyards.net and www.birdlife.org.au

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# Birds

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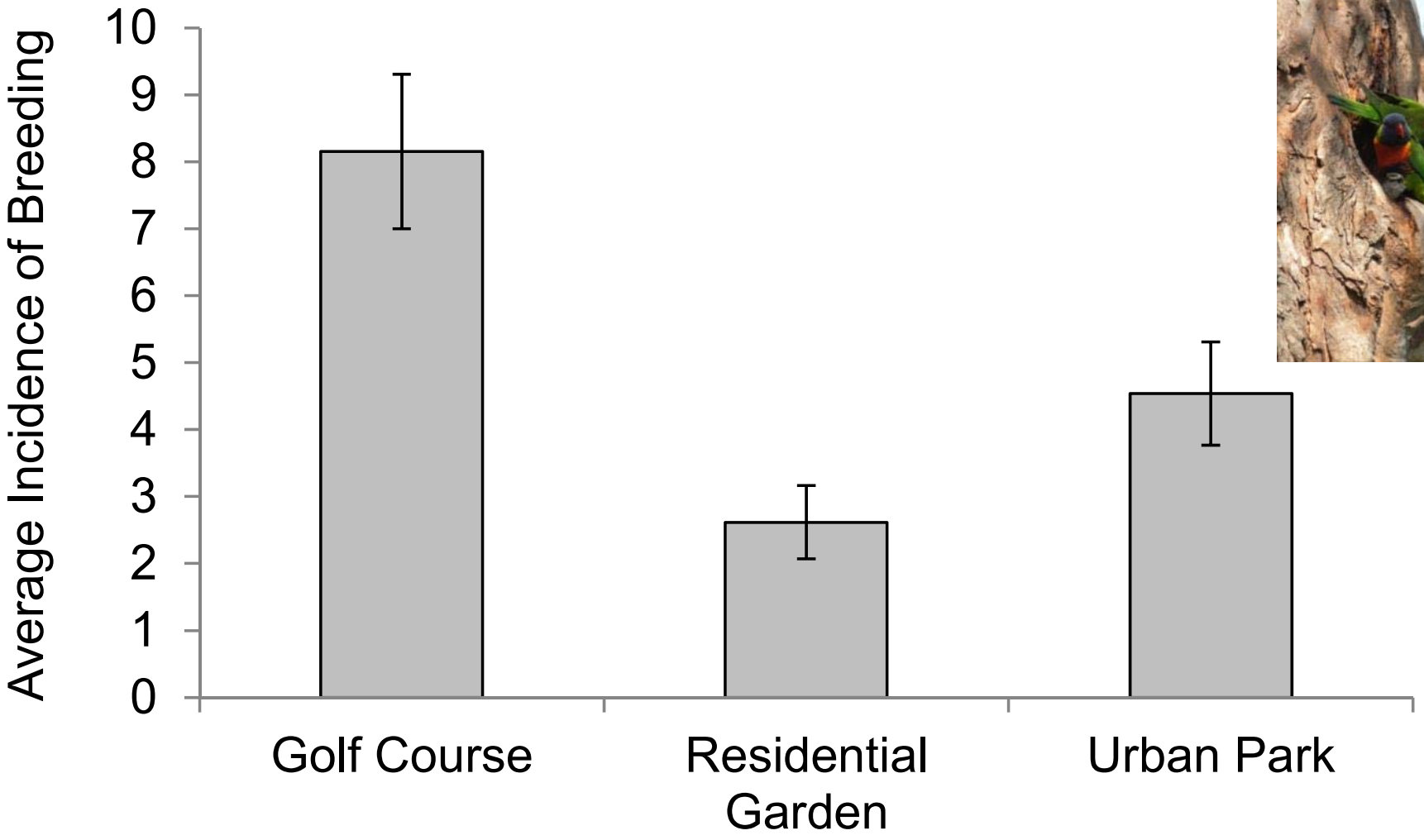
# Birds



# Insect-eating Bats

- We recorded 24,000 bat calls from 14 species
- Bats recorded in every course, every park and every yard – some courses had 10 bat species
- Top order predator
  - Vegetation management > insect density/diversity > bat diversity and foraging activity



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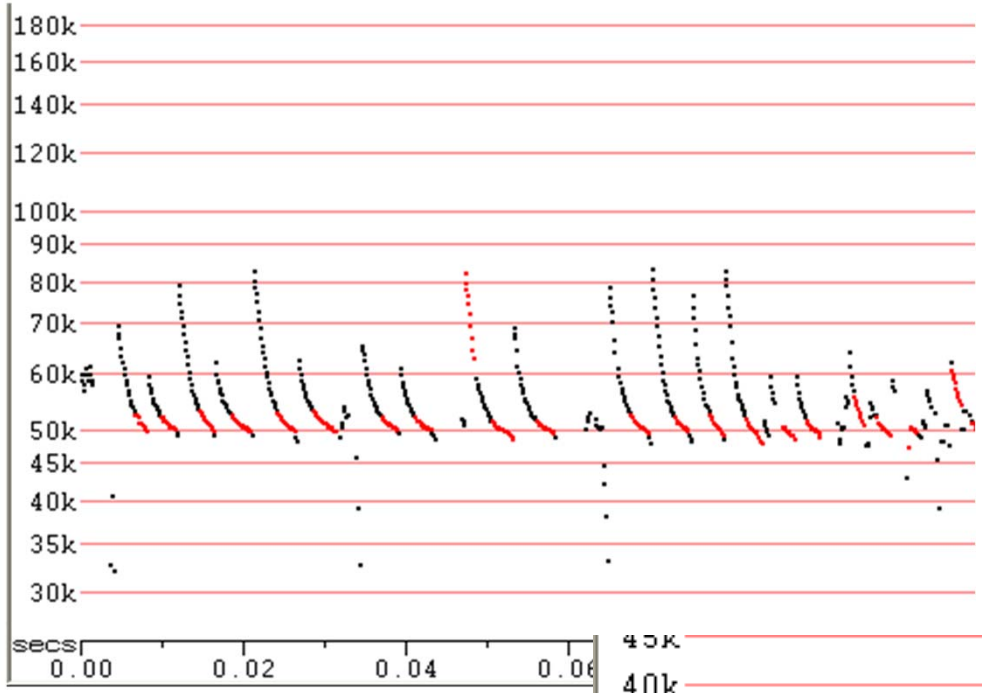
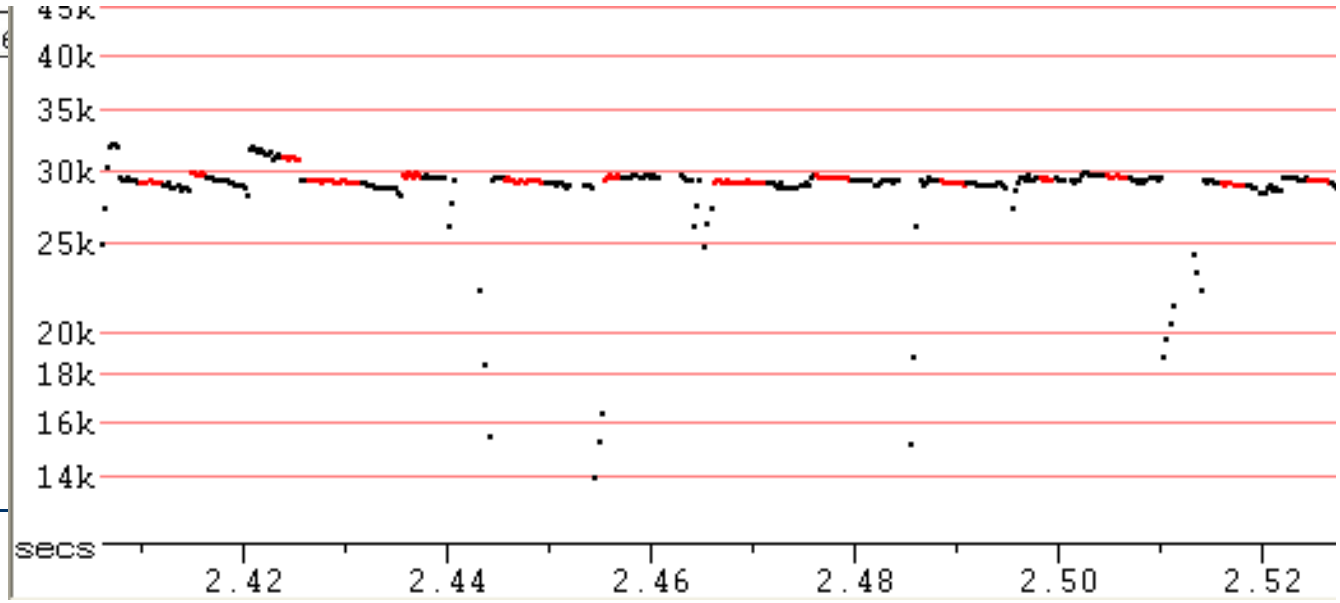
# Insect-eating Bats







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# Insect-eating Bats

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# Insect-eating Bats

# The most biodiverse sites had….

- Larger, more senescent trees
- Native plants
- Greater vegetation complexity
- These sites were often golf courses

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BIODIVERSITY

**In an increasingly urbanised environment, the University of Melbourne/Griffith University three-year study has demonstrated that golf courses play a significant role in improving biodiversity in urban areas. Pictured is Spring Valley Golf Club, one of 13 courses that were involved in the study**

# Green havens

PHOTO: BRETT ROBINSON

After three years of collecting data at 13 golf courses in Melbourne's south east, University of Melbourne and Griffith University researchers have wrapped up their project which has examined the biodiversity benefits of urban golf courses. This significant project, co-funded by the AGCSA and Australian Research Council, has provided some excellent data which

Large urban green spaces, such as golf courses, support a large proportion of the vegetation within cities and subsequently can make a big difference to the retention of urban biodiversity.

These large green spaces are important to people for a range of social and ecological reasons including recreation, social networking, biodiversity conservation, carbon sequestration and improved urban hydrology. Specifically, golf courses can provide habitat for birds, mammals, insects, reptiles and amphibians to inhabit and forage within.

In Melbourne, golf courses currently contain nine per cent of the urban green space in the greater Melbourne area. However, continued infill

Jointly funded by the Australian Research Council (ARC), the Australian Research Centre for Urban Ecology (ARC) and the AGCSA, the three-year project, which has now been completed, had three specific aims:

- To quantify the carbon stored and sequestered in the vegetation biomass and soils of urban golf courses according to management and age;
- To quantify the biodiversity benefit of urban golf courses in comparison to the adjacent residential urban areas; and
- To develop, or apply, spatially-explicit models to predict the carbon and biodiversity benefit of urban golf courses, parks and gardens, and to validate their predictive capacity.

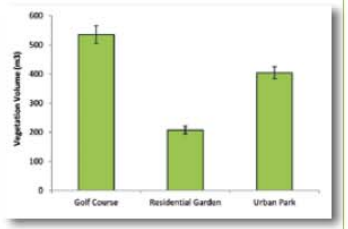
The complexity of vegetation in the 'out-of-play' areas of the golf courses varied considerably. We included golf courses that contain large patches of complex remnant vegetation, courses that had planted complex and dense vegetation in between fairways, as well as courses that are more open and park like.

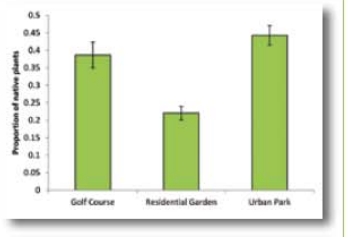
There was also a range of golf course ages, or time since establishment, the youngest being less than 10 years old and the oldest more than 100 years old. After a golf course is landscaped, it takes several decades for the vegetation to establish and surface litter to accumulate, providing a more natural ecosystem for faunal biodiversity to find refuge. As such, there may be greater biodiversity

## GOLF COURSE VEGETATION

The study found that Melbourne's sandbelt golf courses provide a huge biodiversity benefit in comparison to nearby urban parks and urban residential areas. We found that on average golf courses contain a greater volume or amount of vegetation within each sample plot (Figure 1). When compared to the same area of a surrounding residential suburb, golf courses contain more than double the amount of vegetation.

We also found that golf courses and urban parks contain a greater proportion of Australian native plants than residential areas (Figure 2) and more trees per hectare (Figure 3). Golf courses and urban parks also contain a greater density of native trees and trees with a greater diameter (larger than 40cm at breast height) in comparison to residential areas (Figure 4).



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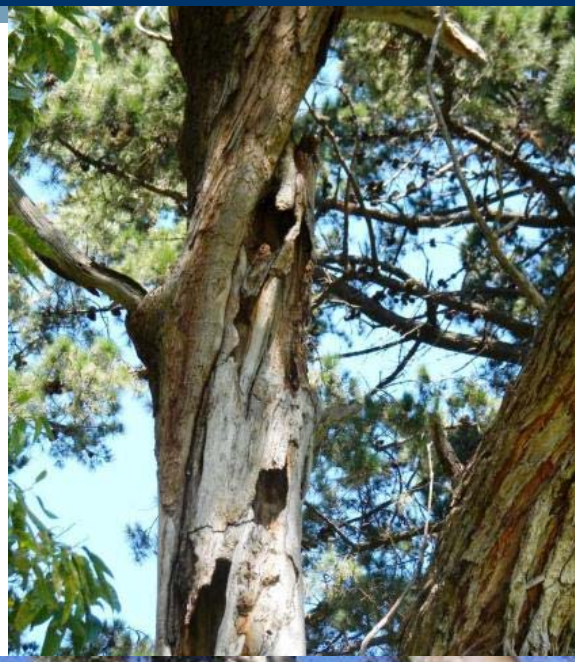
# Large trees in golf courses

# Retain large trees

Trees are:

- Critical habitat for bats, birds, reptiles, invertebrates.....
- Provide connectivity at the landscape scale
- Socially, culturally and aesthetically important
- Long lived assets that are expensive to replace



# Retain tree hollows and dead wood

- Provide shelter and den sites for ~ 300 spp. of Australian vertebrates
- Lack of large trees in urban areas
  - relatively few hollows
- Range of hollow sizes required to suit different body sizes

# Provide native plants

Providing native flowering patches & important food plants:

- Many animals need specific types of plants to feed on:
  - Nectar, pollen, preferred feed trees or flowers
  - Important for birds, bats, butterflies, bees

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# Importance of understorey vegetation

# Habitat (vegetation) structure

**STRUCTURAL COMPLEXITY** – the vertical arrangement of the habitat

HIGH

LOW

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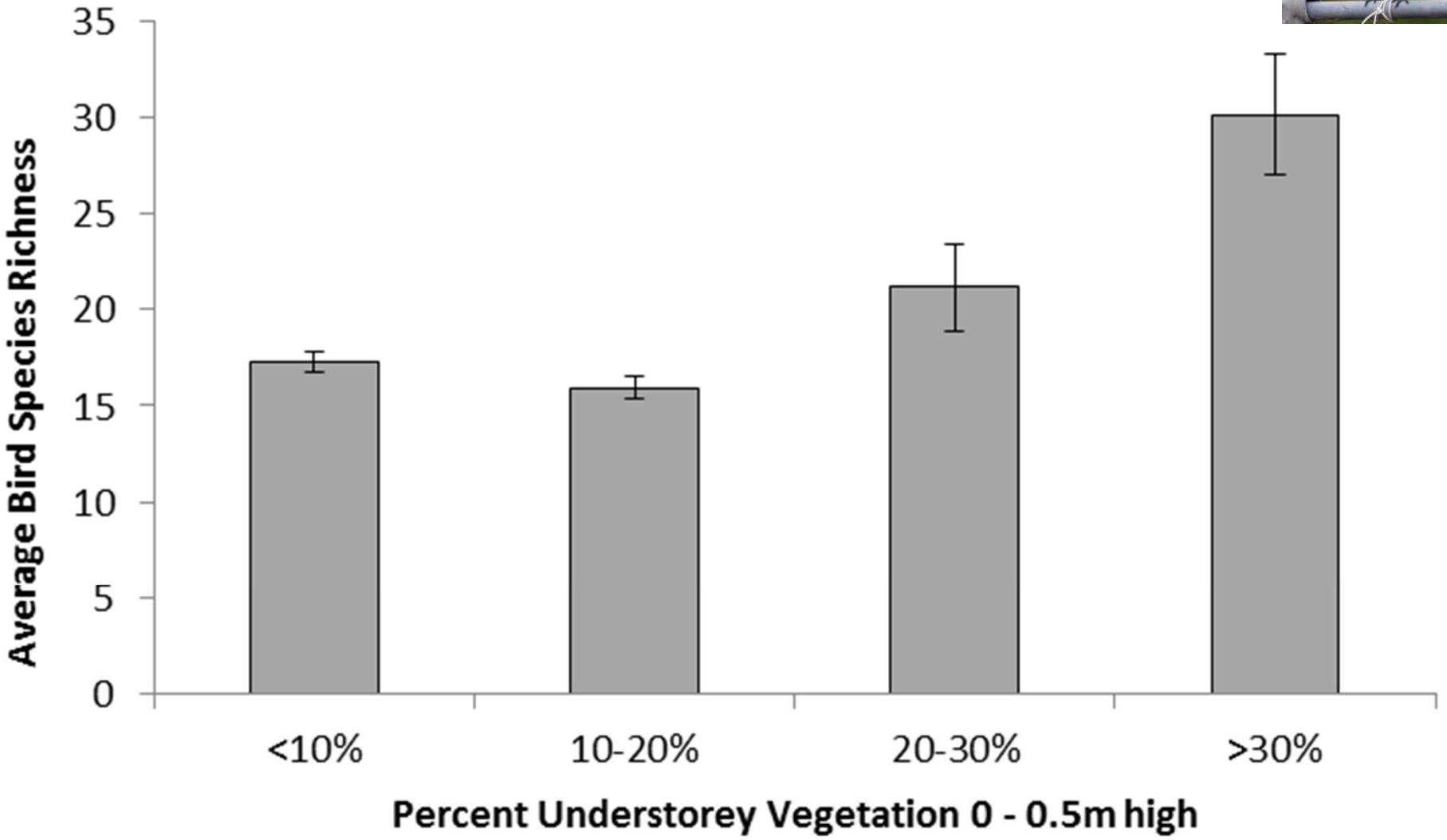
# Birds and vegetation structure



# Greater vegetation structure = more biodiversity

HIGH

LOW

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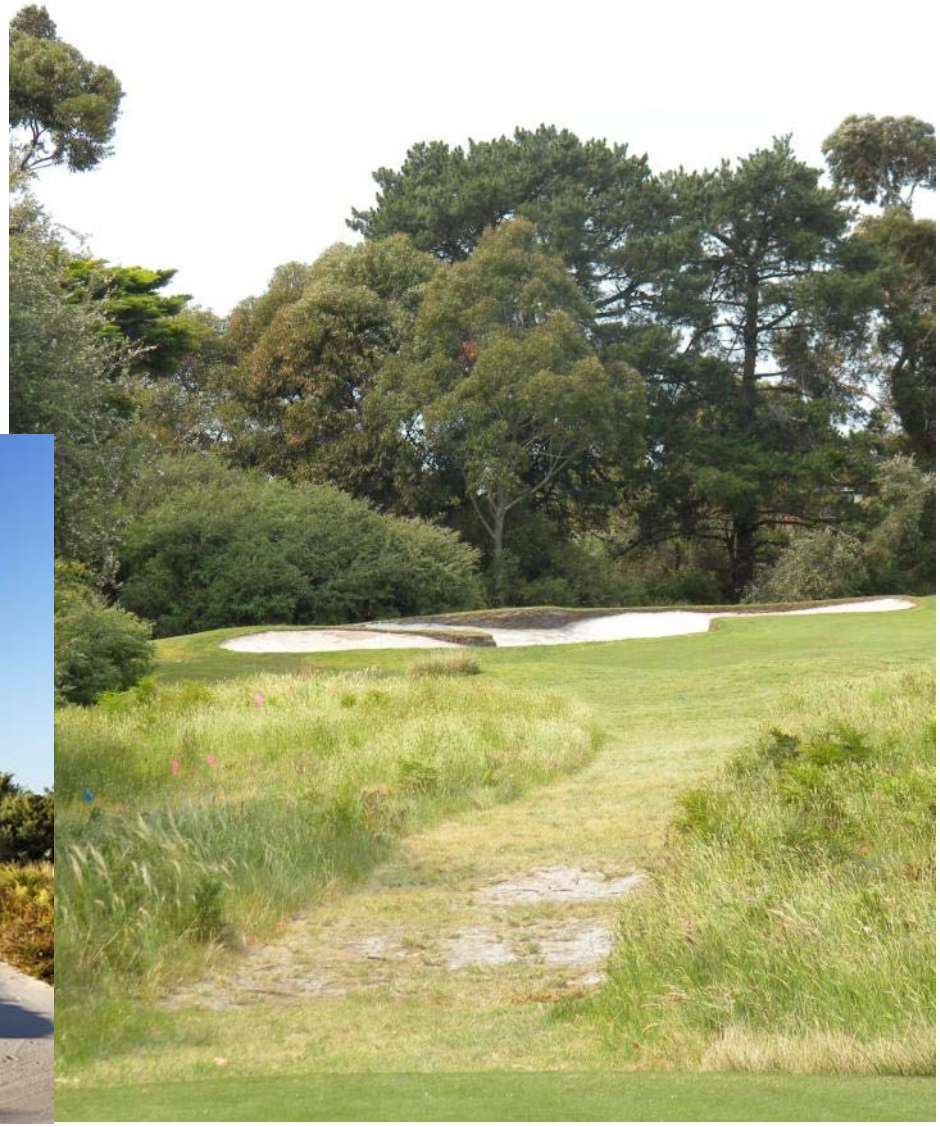
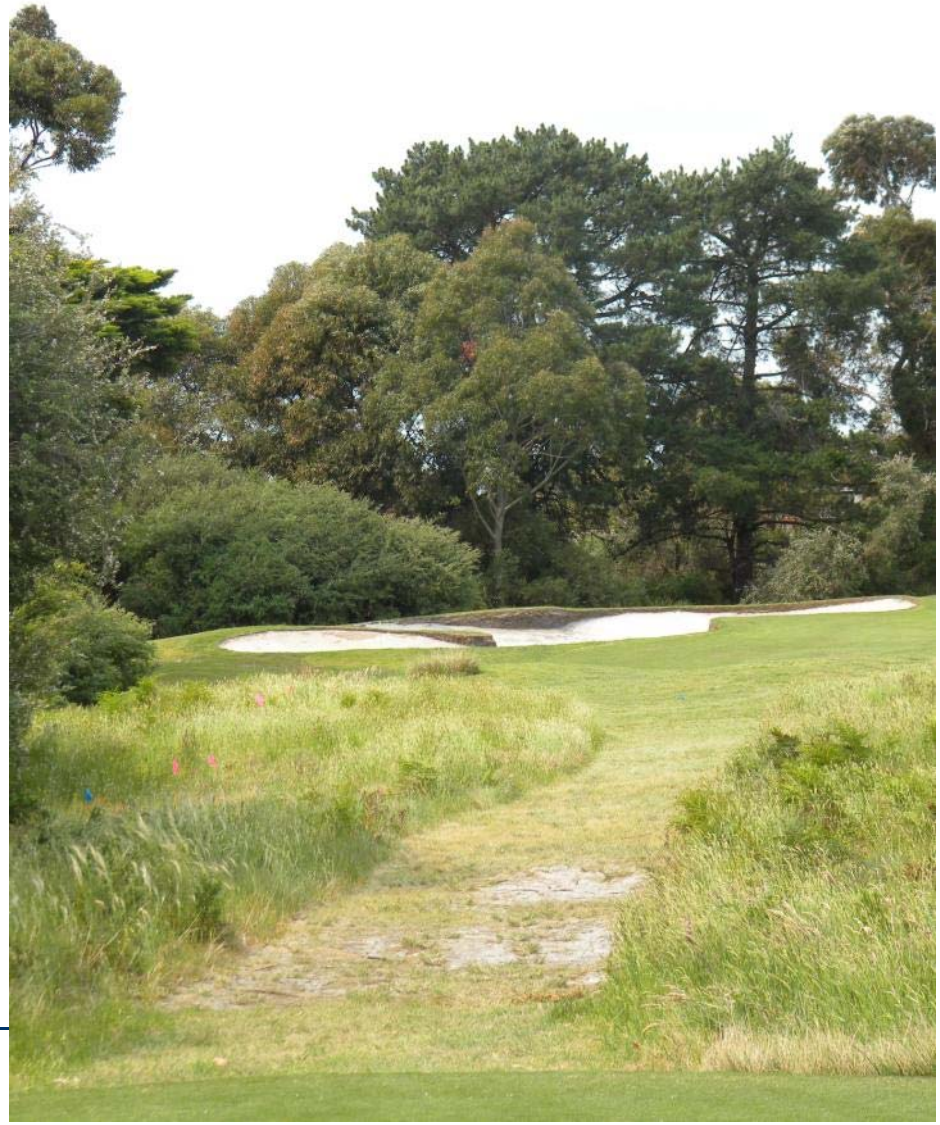
# Where can you add habitat?

- Tee carries
- Side of bunkers
- Property boundaries



# Where can you add habitat?

- In out of play, unmanaged spaces
  - No mow zones
  - Prevent human access
- Native flowering plants could be incorporated in planting designs
- Dead wood and leaf litter could be retained



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# Patches of low disturbance

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# Summary

- Golf courses and small parks provide greatest biodiversity
- How vegetation is managed influences what animals occur
- Increasing understorey structure - increases animal biodiversity
- Habitat restoration can occur ***without compromising*** recreational values

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# Acknowledgements


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• **Students:** Lee Wilson, Alessandro Ossola, Jess Mackie, Jarvis Mihsill, Virginia Harris, Luis Mata, Jess Baumann

AGCSA

Royal Botanic Gardens Melbourne

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# Thanks!






Questions?

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