



Quantifying biodiversity benefits of trees on farms – How much value do agroforestry plantings hold for biodiversity?

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I would like to begin by acknowledging the Traditional Owners of the land that we're meeting on today, and pay my respect to their Elders past and present.



Woody plantings and natural capital accounting

- Woody plantings are a common action in intensive agricultural landscapes to improve ecosystem services and biodiversity
- Woody plantings include agroforestry and restoration
- Quantitative data and refined methods are needed to account for biodiversity values



Global meta-analysis

Aim: to quantify outcomes of woody plantings for biodiversity in agricultural landscapes in a biodiversity accounting context.



Scale



Global meta-analysis

We hypothesised:

1. Woody plantings on cleared agricultural land of forest/woodland landscapes enhance biodiversity but generally don't reach the value of native reference sites
2. Plantings increase in biodiversity value with age, area, nativeness and richness of the planting
3. Species composition measures indicate lower biodiversity benefit than richness or abundance



Global meta-analysis

- Web of Science Core Collection used the following consistent search string:

TS=((agroforest* OR revegetat* OR "restoration planting*" OR "environmental planting*" OR "farm forest*" OR "shelter belt" OR shelterbelt* OR "alley farm*" OR woodlot* OR "wood lot*" OR "pasture tree*" OR silvopast* OR "wind break*" OR windbreak* OR "tree belt*" OR "tree planting*" OR restoration OR plantation* OR hedge*) AND (agricultur* OR farm)) AND (biodiversity OR diversity OR "species richness" OR animal* OR fauna* OR plant* OR bird* OR avian* OR invert* OR mammal* OR reptile* OR amphib* OR snail* OR frog* OR lizard* OR forb* OR shrub* OR understory OR understory))

- The search and subsequent snowballing led to 17, 639 references that we screened by abstract and title, and inclusion of 189 studies (730 data rows) in the analyses



Meta-analysis contrasts (treatments)



+

AND/OR



Moderator variables

Characteristics of the planting:

- Diversity
- Native vs exotic
- Management intensity (e.g. unmanaged or managed for timber or other production)
- Area
- Age



Native unmanaged diverse planting

Native managed monoculture

Native managed monoculture

Exotic managed monoculture

Measures

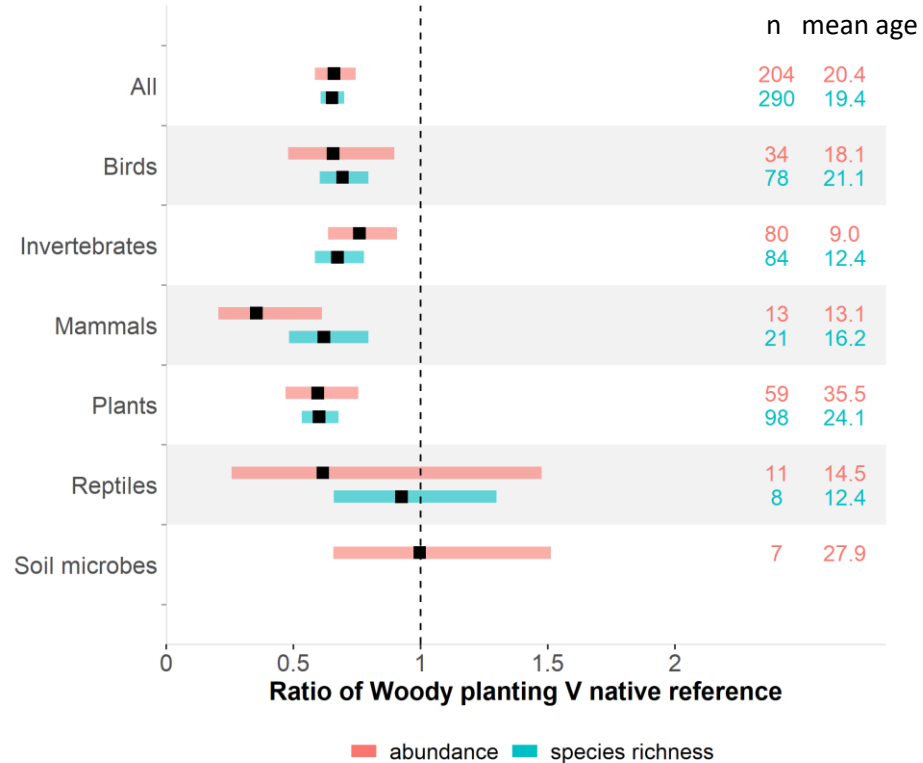
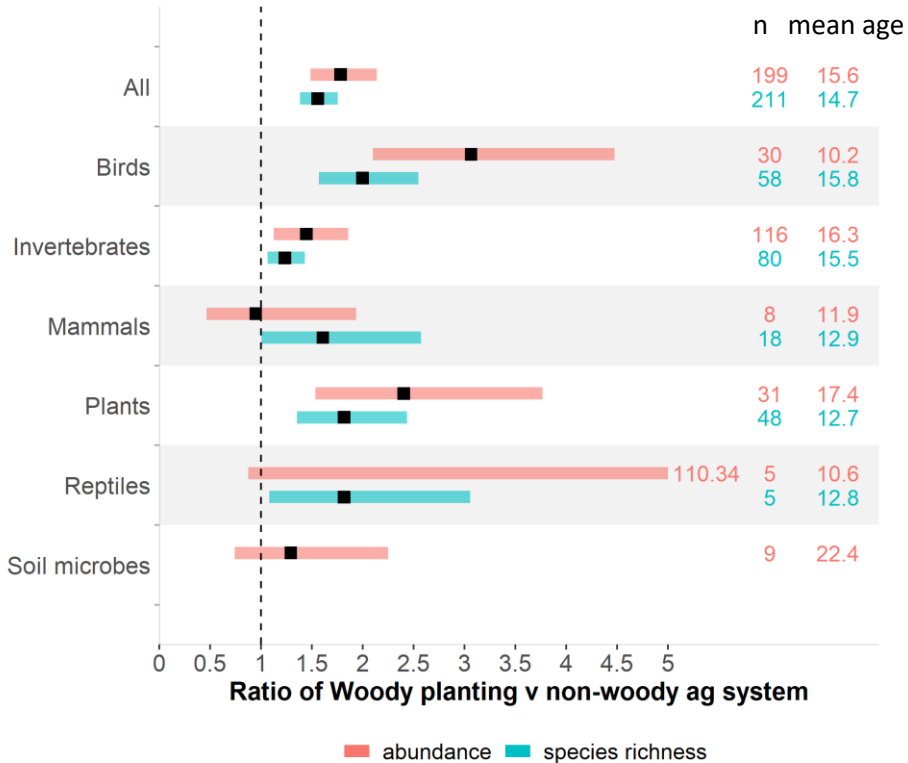
Comparison of three biodiversity measures

- Abundance
- Richness
- Composition (mean compositional similarity/distance)



Results expressed as Treatment/Control

Preliminary analysis



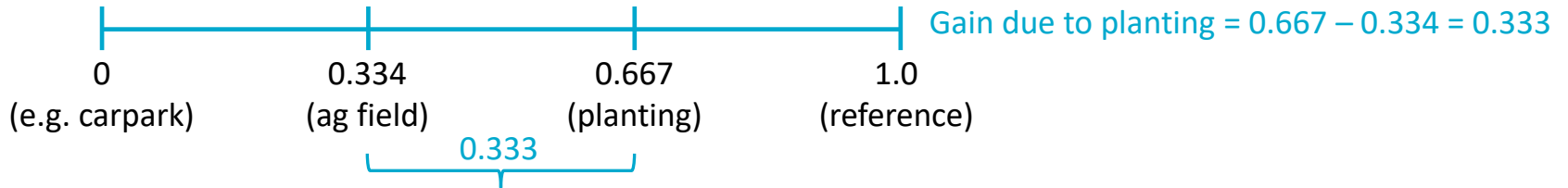
Results expressed in an accounting context

Biological group	Measure	Biodiversity value [§]	n	Biodiversity value ^{§§}	n	Mean age	Biodiversity value
		Agricultural field		Planting			
Birds	abundance	0.21*** (0.14-0.32)	24	0.66** (0.48-0.9)	34	18.1	1.00
	species richness	0.28*** (0.22-0.36)	47	0.69*** (0.60-0.79)	78	21.1	1.00
Invertebrates	abundance	0.77 ^{ns} (0.41-1.43)	32	0.76*** (0.64-0.91)	80	9.0	1.00
	species richness	0.67** (0.45-0.86)	51	0.67*** (0.58-0.78)	84	12.4	1.00
Mammals	abundance	0.52** (0.41-0.66)#	5	0.35*** (0.21-0.61)	13	13.1	1.00
	species richness	0.40*** (0.26-0.61)	17	0.62*** (0.48-0.79)	21	16.2	1.00
Plants	abundance	0.15*** (0.08-0.32)	18	0.59*** (0.47-0.75)	59	35.5	1.00
	species richness	0.28*** (0.17-0.46)	29	0.60*** (0.53-0.68)	98	24.1	1.00
Reptiles	abundance	0.09*** (0.05-0.14)	5	0.62 ^{ns} (0.26-1.48)	11	14.5	1.00
	species richness	0.49*** (0.30-0.78)	5	0.92 ^{ns} (0.66-1.3)	8	12.4	1.00
Soil microbes	abundance	1.27 ^{ns} (0.28-5.72)	6	0.99 ^{ns} (0.66-0.51)	7	27.9	1.00
	species richness	na		na			1.00
All	abundance	0.36*** (0.26-0.5)	90	0.66*** (0.58-0.74)	204	20.4	1.00
	species richness	0.39*** (0.33-0.47)	150	0.65*** (0.61-0.70)	290	19.4	1.00

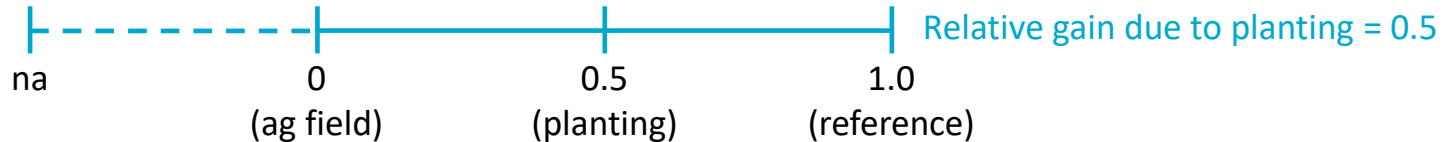
§ equivalent to Ag vs Reference ratio, §§ equivalent to Planting vs Reference ratio, #weighted heavily on a single study

Estimated benefits of planting: calculation

Method 1: **Benefit of Planting** = absolute difference between ag and planting with reference set at 1

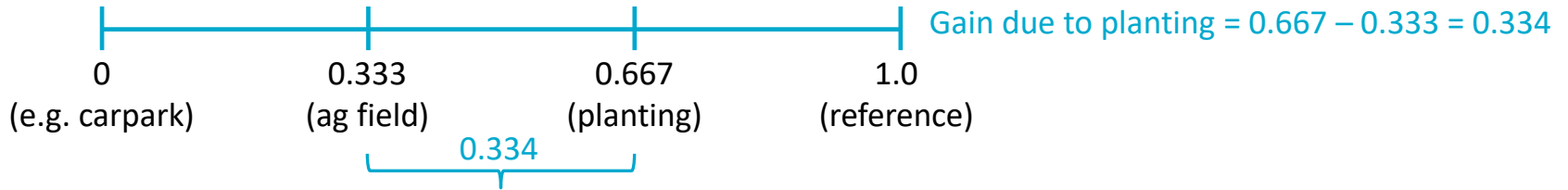


Method 2: **Proportional Benefit of Planting** = proportional gain with ag set at zero and reference at 1

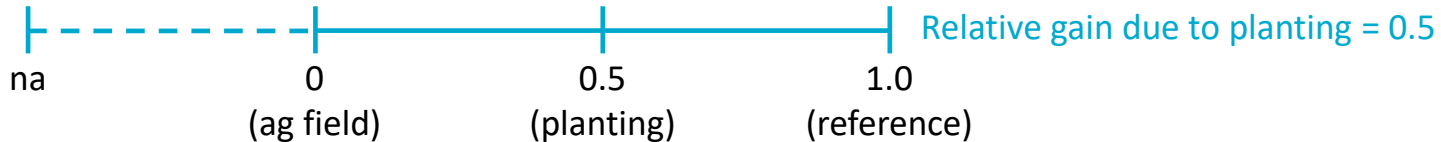


Estimated benefits of planting: calculation

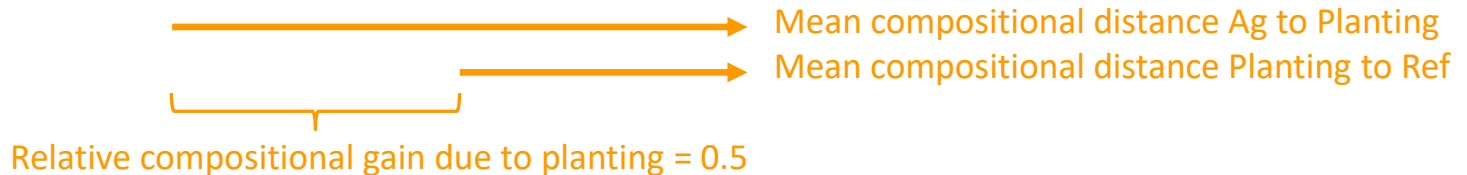
Method 1: **Benefit of Planting** = absolute difference between ag and planting with reference set at 1



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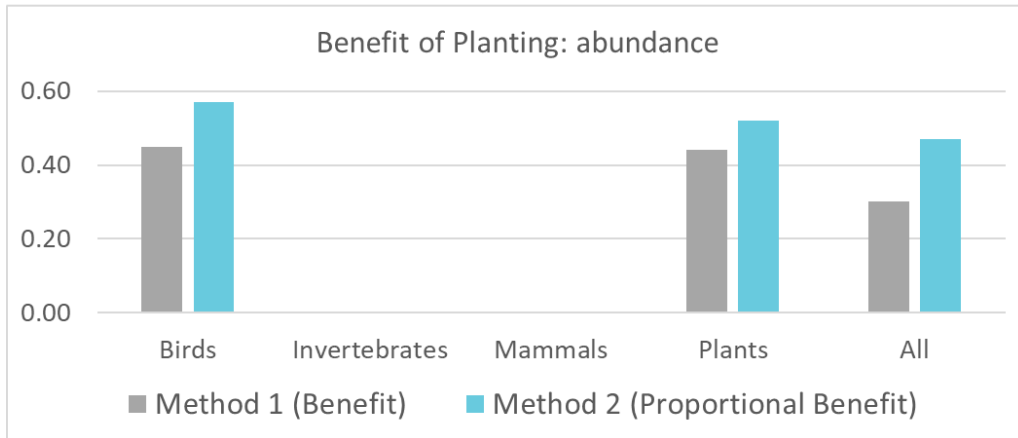
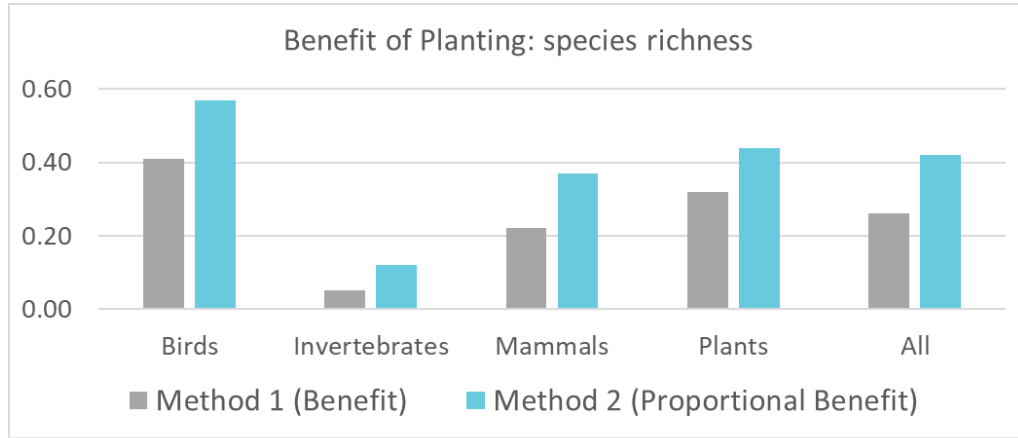


COMPOSITION



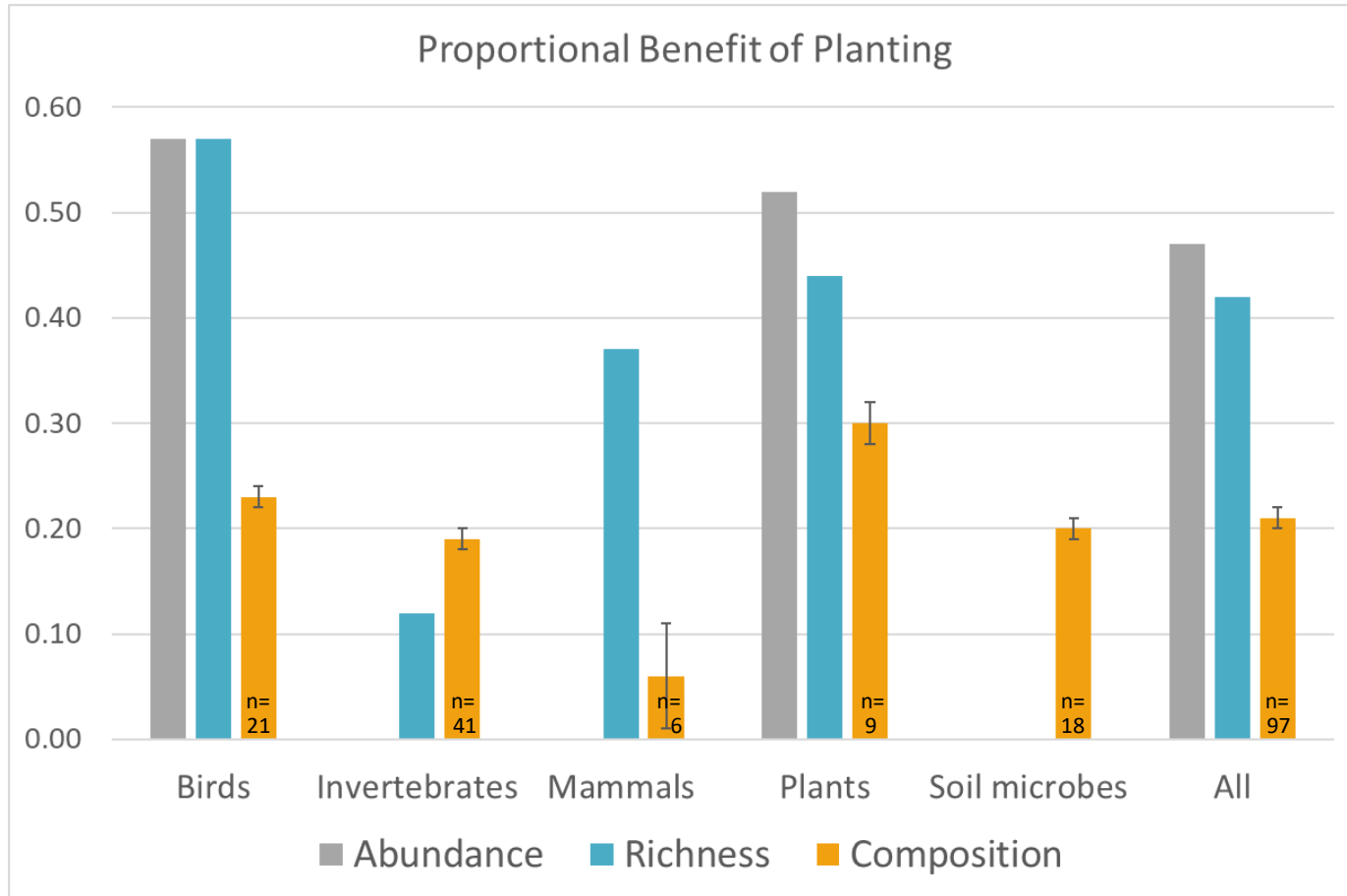
Estimated benefit of planting: richness/abundance

Preliminary analysis

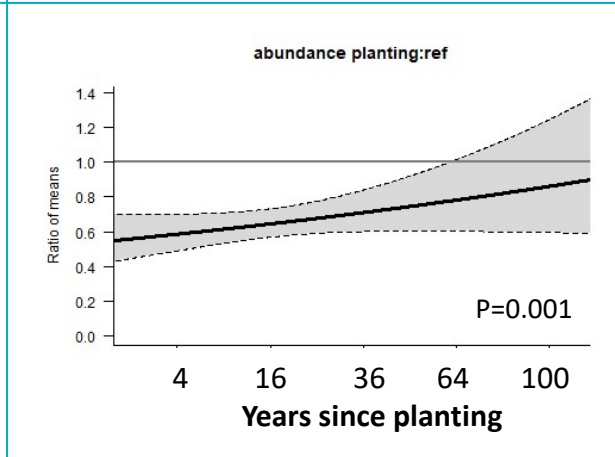
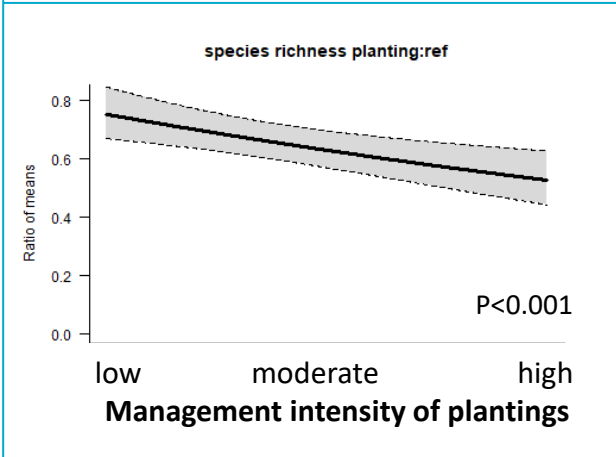
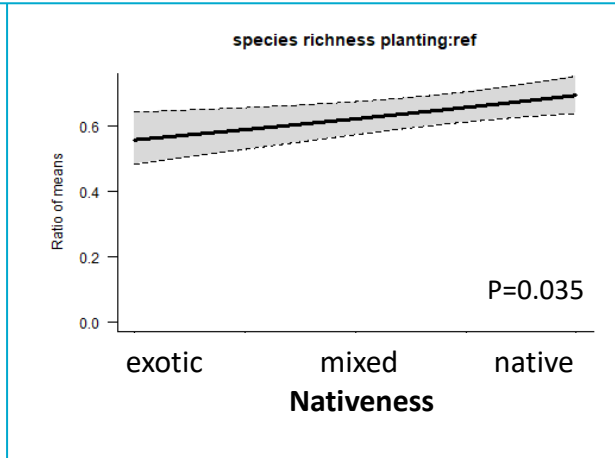
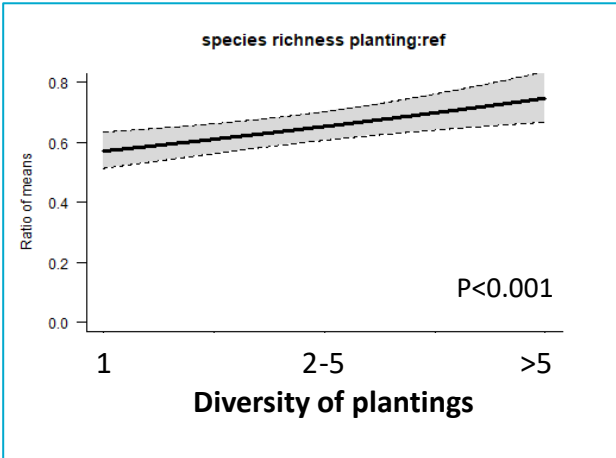


Effect of measure

Preliminary analysis



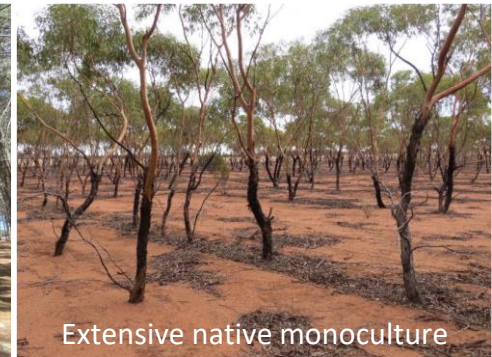
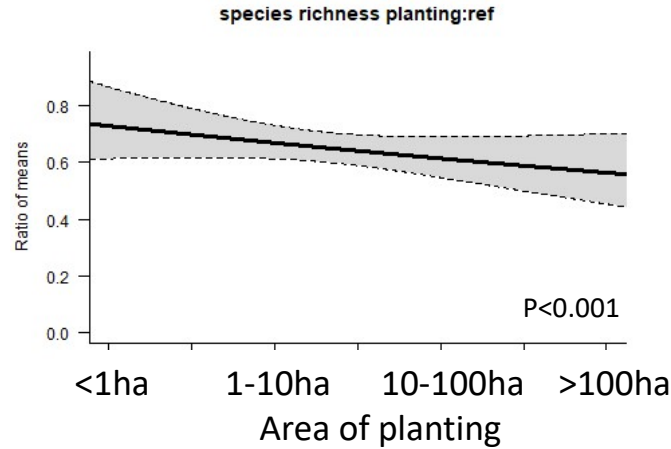
Moderator variables



Key moderator variables

Preliminary analysis

Mean biodiversity value of planting in relation to area (similar trend for width)



Conclusions

Against hypotheses:

1. Woody plantings on cleared agricultural land of forest/woodland landscapes enhance biodiversity but generally don't reach the value of native reference sites

- YES



Conclusions

Against hypotheses:

2. Plantings increase in biodiversity value with age, area, nativeness and richness of the planting

- **YES except for area**



Conclusions

Against hypotheses:

3. Species composition measures indicate lower benefit of planting than richness or abundance

- YES





Thank you

We acknowledge support for this project from the Australian Department of Agriculture, Fisheries and Forestry