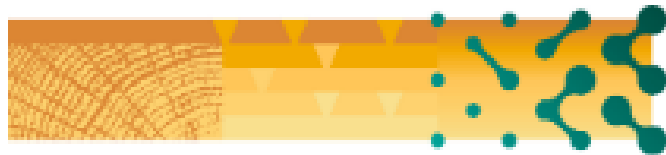


# Spatial patterns of deer and browsing mammal damage in young pine plantations

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# Context



- Browsing mammals cause damage to forestry
- Study site – Radiata pine (*Pinus radiata*)
- Browsing mammal species present:
  - Deer – Sambar deer (*Rusa unicolor*)
  - Macropods – Swamp Wallabies (*Wallabia bicolor*)

## Main types of damage:

- Bark stripping
- Antler rubbing
- Scent marking
- Browsing



# Field - locations



Overview map of field location

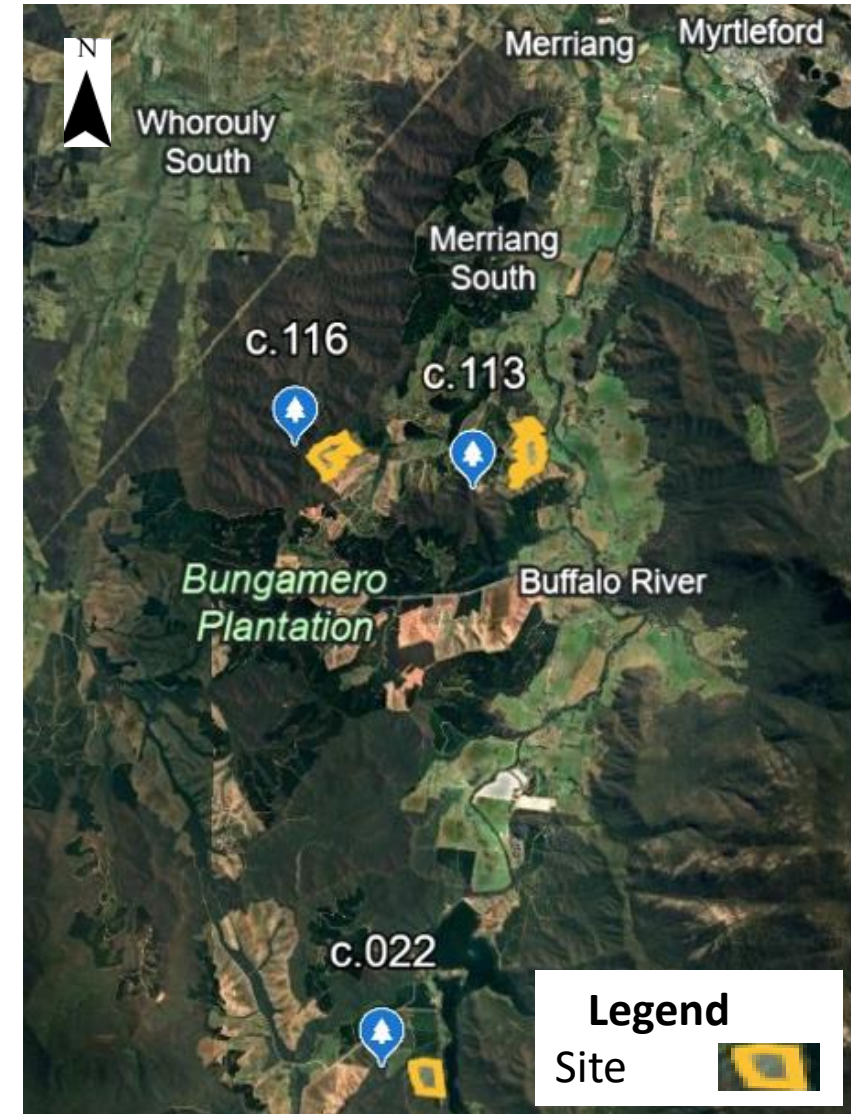


Figure 1: Merriang plantation field sites

# Research questions

- 1) Is there variation in browsing mammal damage to trees within radiata pine coupes?
- 2) What browsing mammals are causing bark stripping damage?
- 3) What factors influence spatial variation in browsing mammal damage across all coupes?



# Methodology

## Sampling design:

- 3 coupes of 4-year-old trees, with plots of 12 trees
- Total of 165 plots
- 2016 trees assessed

## Traits assessed:

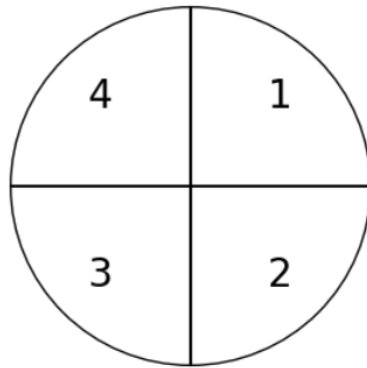
- Leader damage + multiple leaders
- Bark stripping
- Browsing damage to foliage
- Foliage health
- Number of deer & macropod scats – within plots
- Tree height and diameter at breast height (DBH)
- Environmental site characteristics

# Assessment of animal impacts in softwood forestry plantations

## Bark stripping assessment around quadrants:

Bark stripping (BS) = score below 1m and score above 1m

Stem quadrant damage represented as 90° wedges viewed from above  
Score of 4 = 76% to fully ringbarked



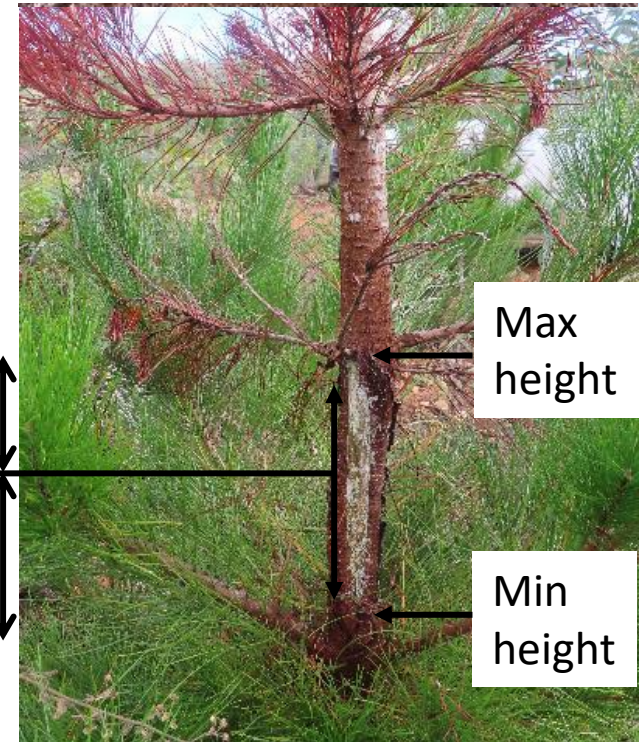
BS score around stem  
0 to 4

BS score around stem  
Score 0 to 4

1m



Tree with multiple leaders



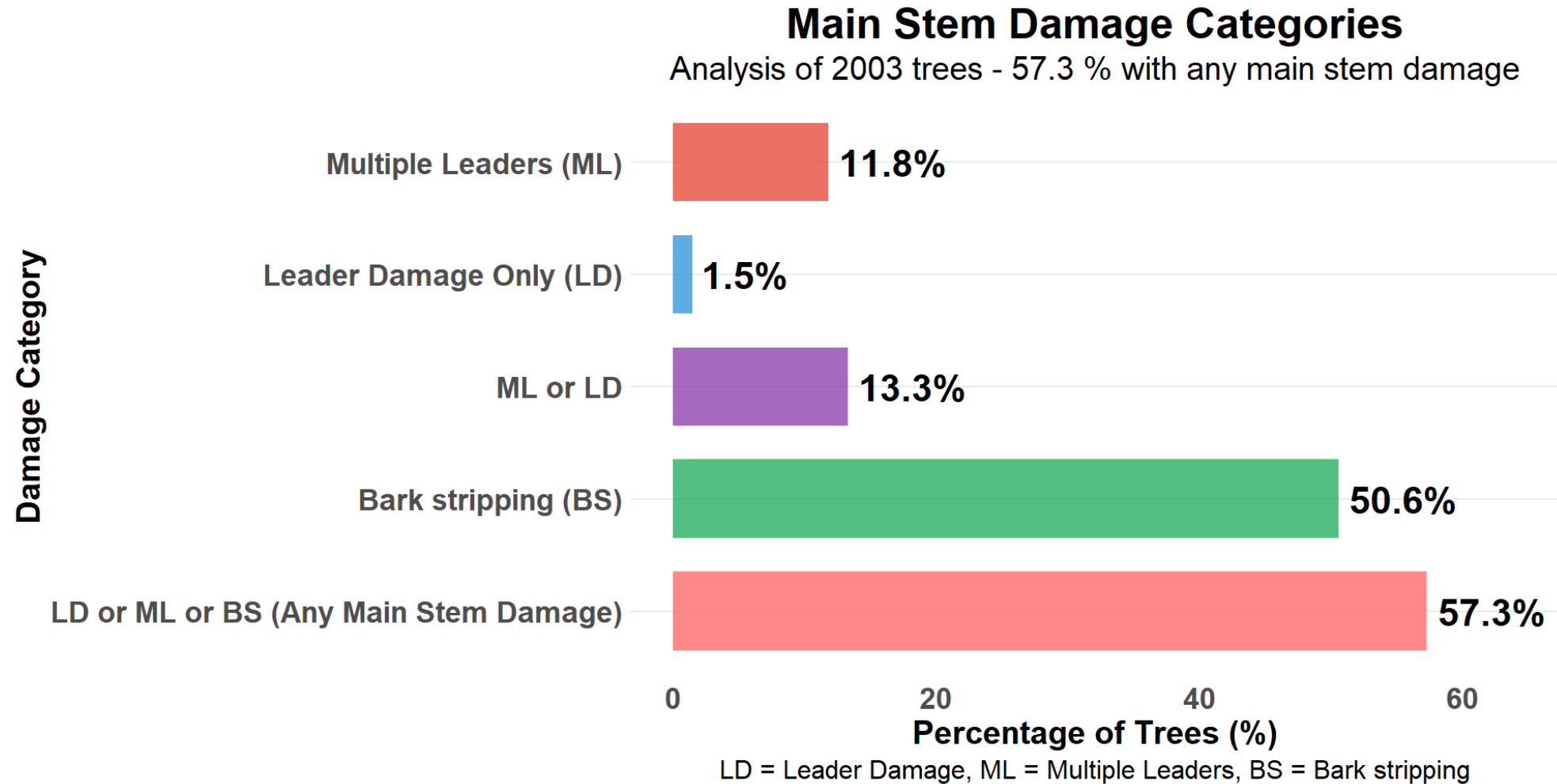
Bark stripping measurements



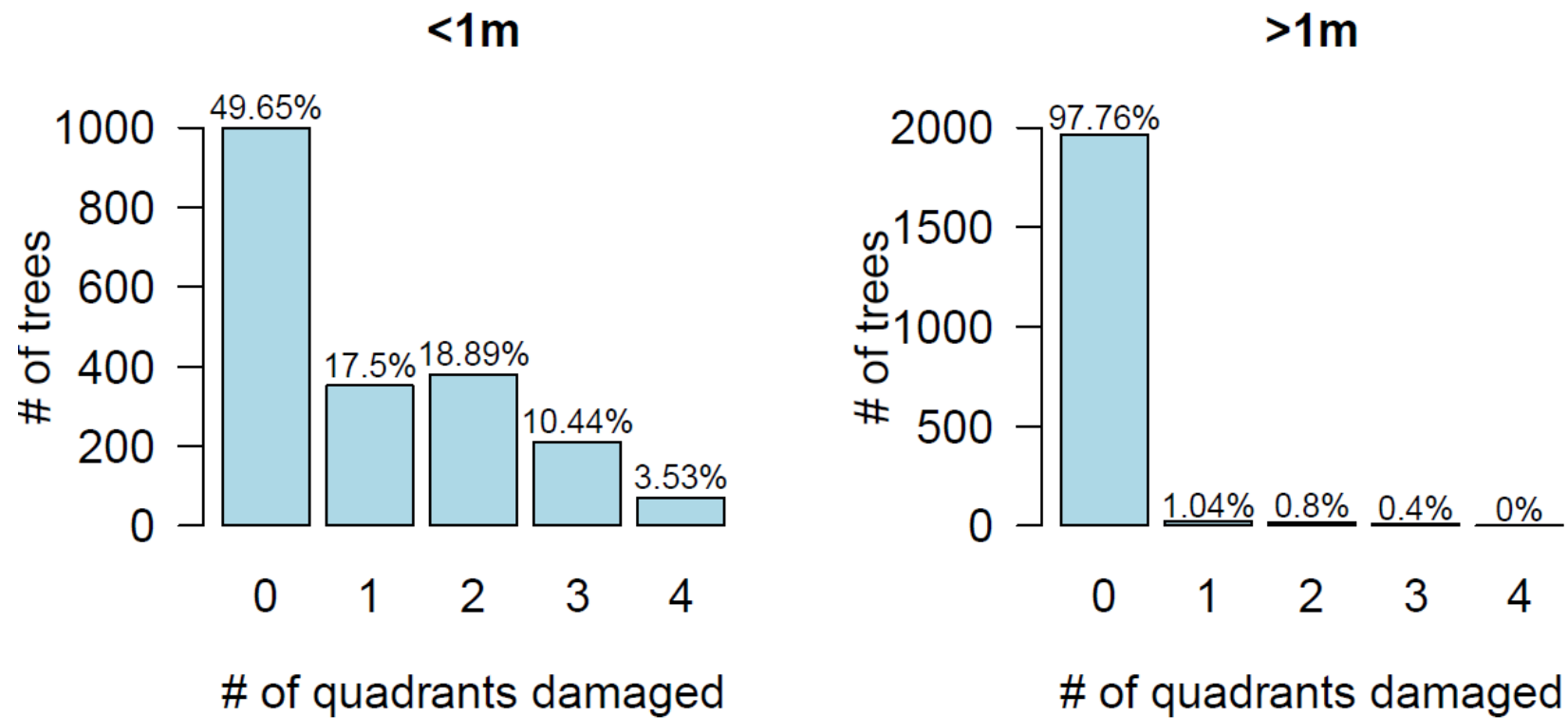
## Question 1

**Is there variation in browsing  
mammal damage to trees  
within radiata pine coupes?**

# What is the amount of leader damage & bark stripping damage – for < 1m & > 1m

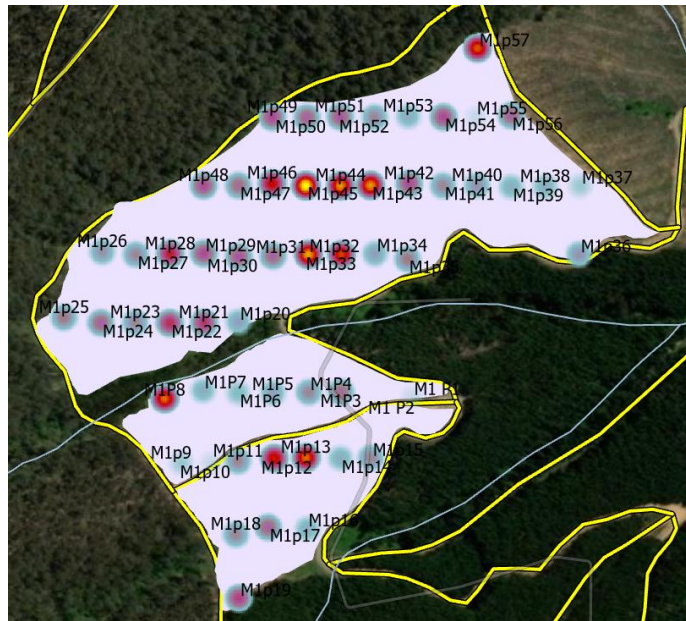


## What is the amount of bark stripping damage for all trees?



Quadrant damage scores for bark stripping around the main stem

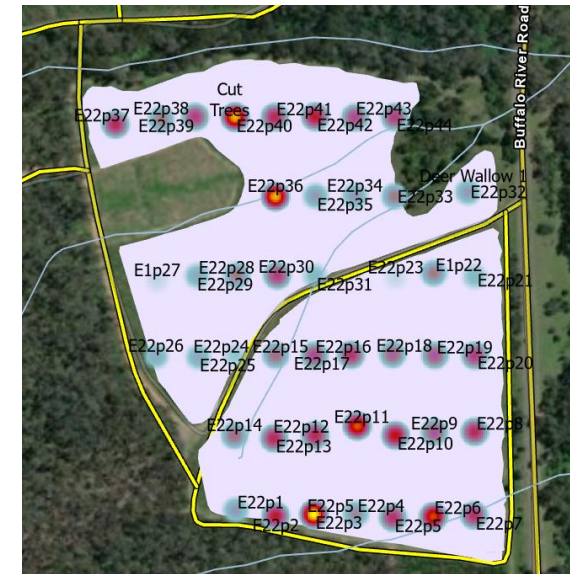
## Heat maps of mean bark stripping damage (combined <1m & >1m) for plots within coupes



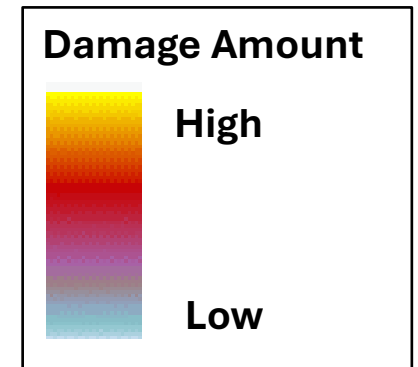
Merriang c.116



Merriang c. 113



Emu c.022



### Variation in total bark stripping explainable by plot location:

- 24.3% of variation explainable for < 1m
- only 3% of variation explainable for > 1m

## Question 2

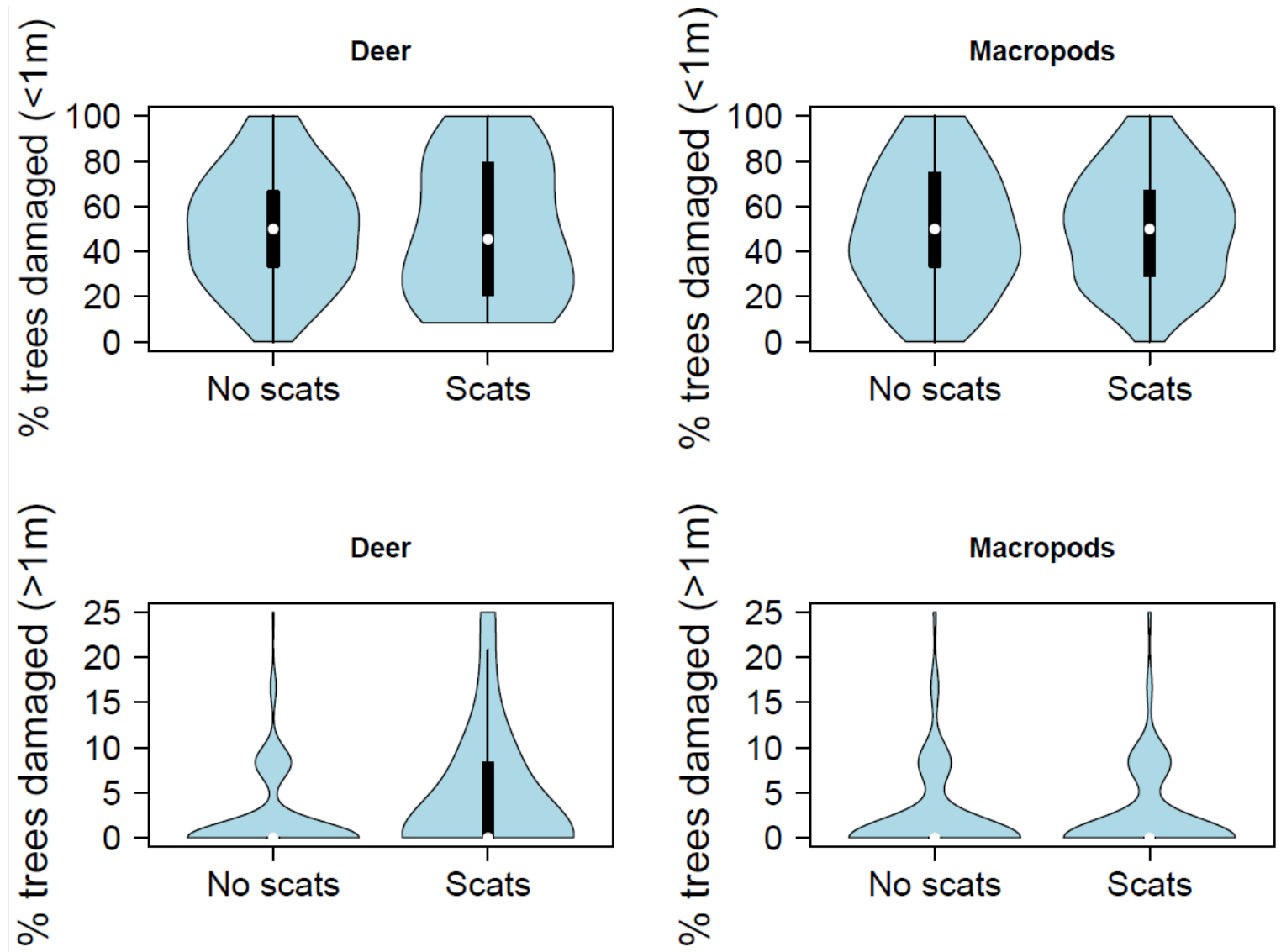
What browsing mammals  
are causing  
bark stripping damage?



## Is there a relationship between bark stripping and animal abundance?

Estimated percentage of trees' bark stripped by deer and macropods and probability of damage.

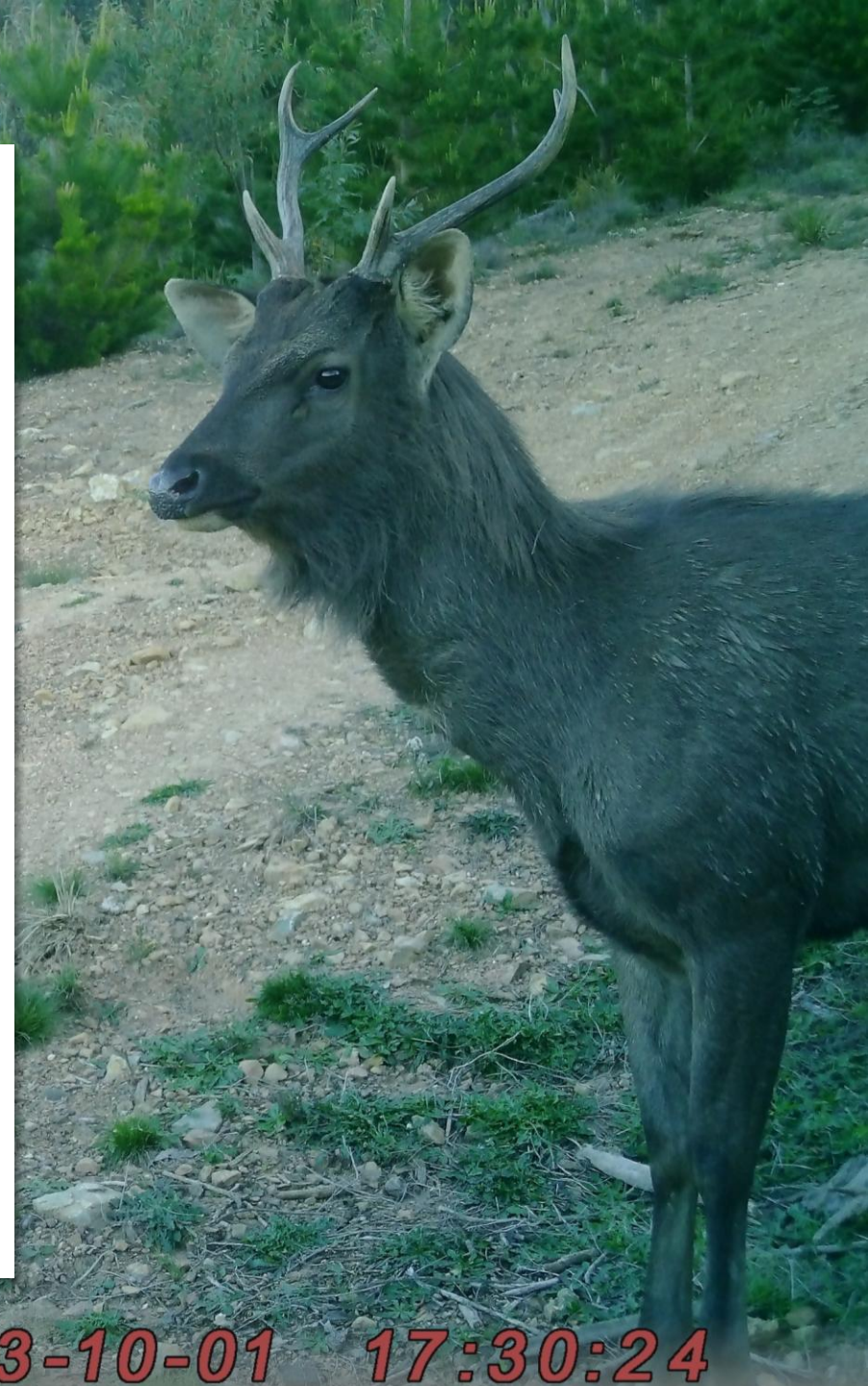
Note: animal abundance is measured in terms of scat counts.



## Question 3

**What factors influence spatial variation in browsing mammal damage across all coupes?**

- Does tree height influence damage?
- Do environmental features, distance to: cover, water or roads influence damage?
- Do topographical factors, elevation, slope and aspect influence damage?



## Relationship between bark stripping and environmental and tree factor covariates

### Bayesian model of bark stripping damage:

Zero inflated binomial regression model:

- with plot level random effects
- for below 1m we modelled if the plot level spatial random effects are spatially correlated
- for above 1m we are not modelling the spatial correlation because the damage is too sparse.

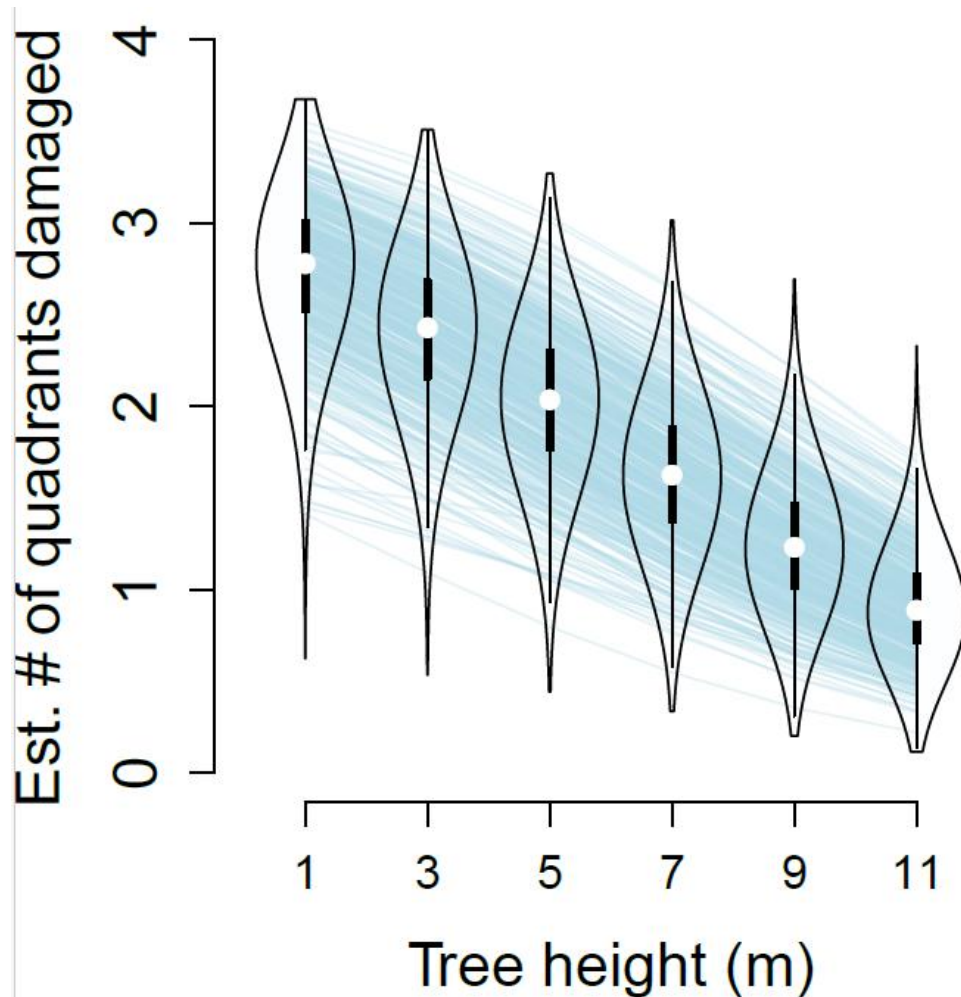
### Predictors:

- Tree height, distance to water (fine and medium scale), distance to roads, distance to mature vegetation, elevation, slope and aspect

### Factors that show an effect

- Distance to water (fine and medium scale)
- Distance to roads
- Tree height

# Stem damage less than 1m - estimated number of quadrants damaged for different tree heights - 1m compared to 11m



## Tree height

Increase at 1 m over 11 m (100% prob.)

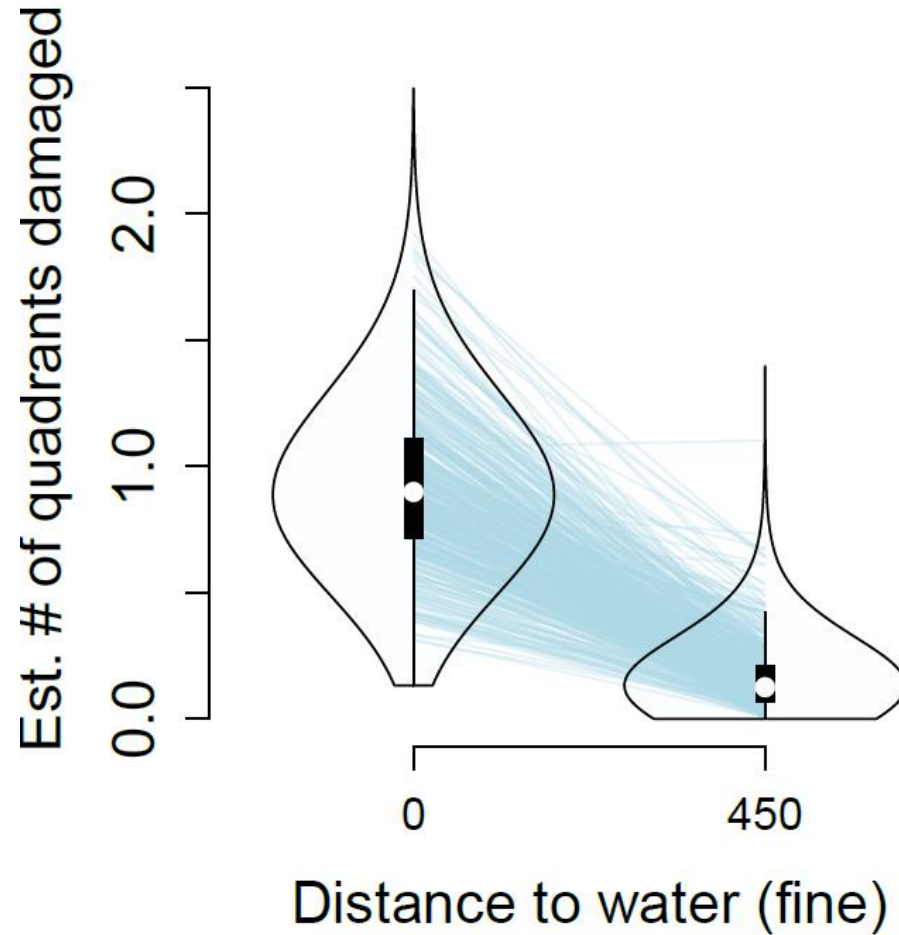
Posterior median:

1.853

95% HPDI:

1.39: 2.204

Stem damage less than 1m – estimated number of quadrants damaged  
for '0'm compared to 450 m to water at a fine scale



**Distance to water (fine)**

Increase in 0 over 450 (99.9% prob.)

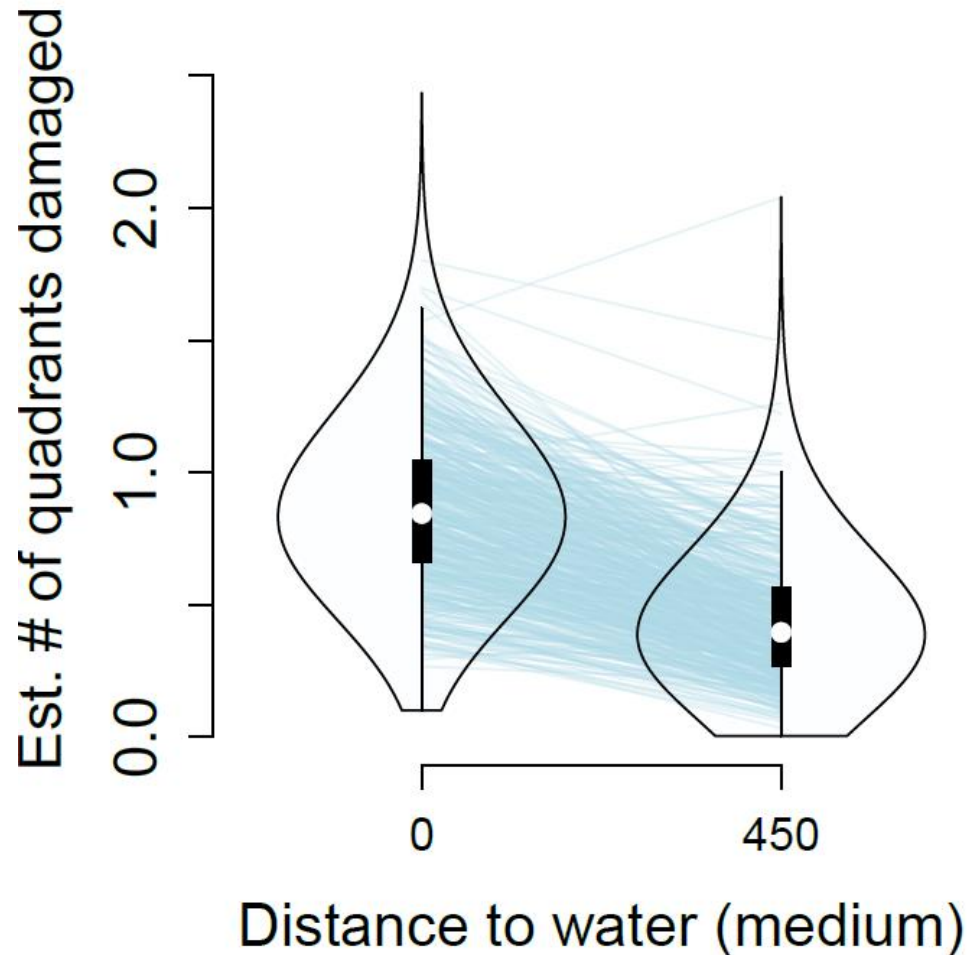
Posterior median:

0.746

95% HPDI:

0.244: 1.3

# Stem damage less than 1m - estimated number of quadrants damaged for '0'm distance to water compared to 450m at a medium scale



## Distance to water (medium):

Increase in 0 over 450 (95.7% prob.)

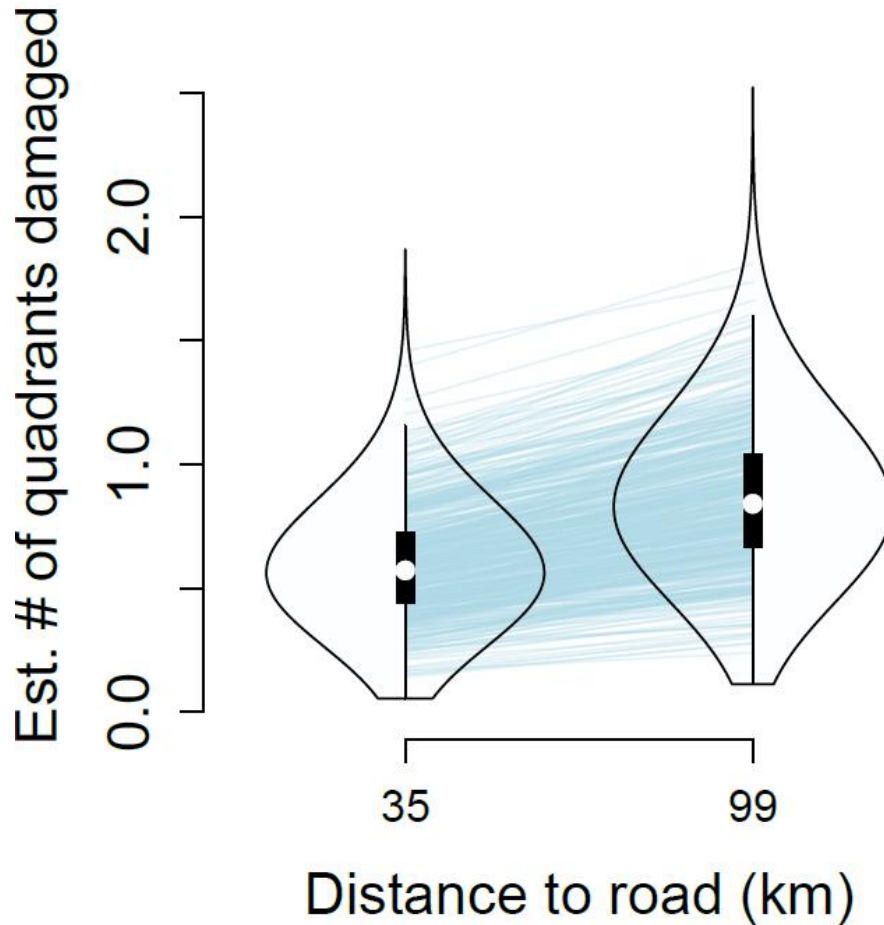
Posterior median:"

0.424

95% HPDI:

-0.074 : 0.962

Stem damage less than 1m – estimated number of quadrants damaged  
for distance to road for 99m compared to 35m



**Distance to road**

Increase in 99 over 35 (100% prob.)

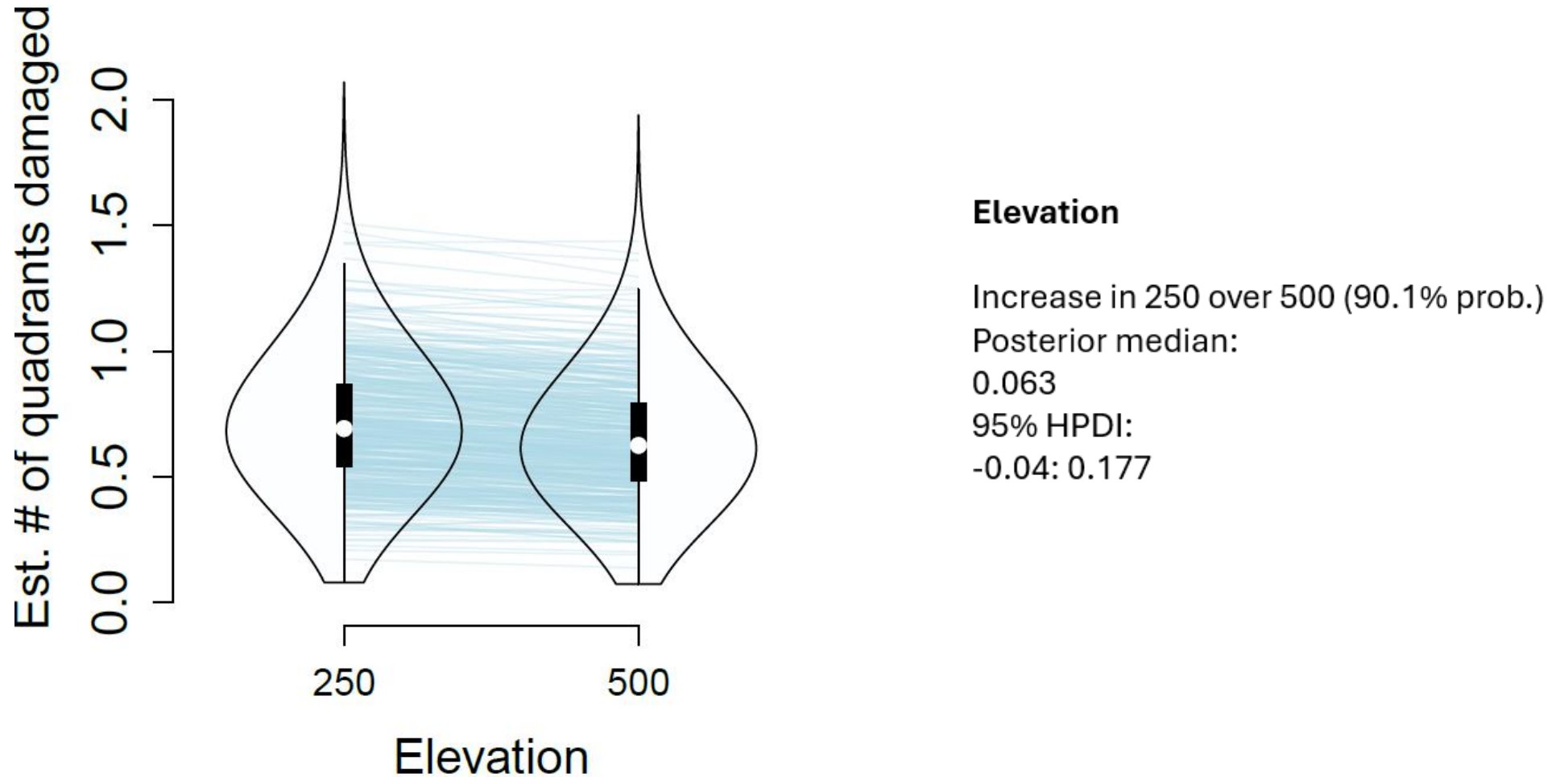
Posterior median:

0.26

95% HPDI:

0.088: 0.465

Stem damage less than 1m – estimated number of quadrants damaged  
for elevation of 250m compared to 500m



# Stem damage greater than 1m – estimated number of quadrants damaged for '0'm compared to 450 m to water at fine and medium scales

## Distance to water (fine):

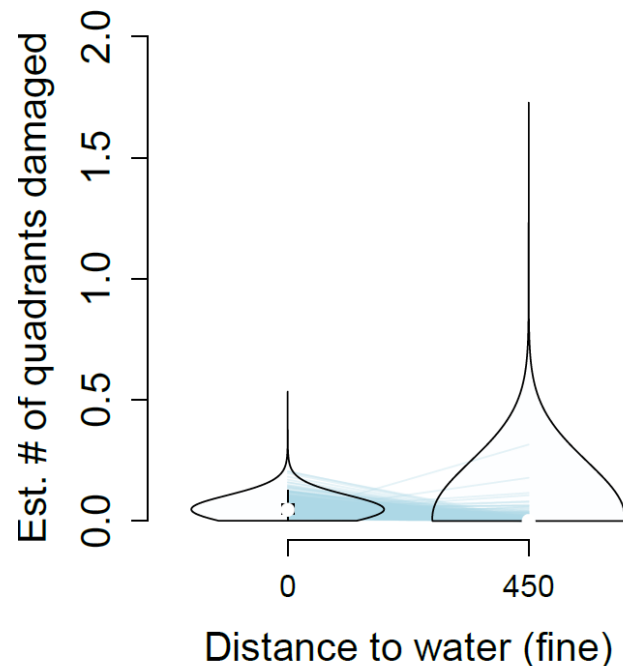
Increase in 0 over 450 (96.7% prob.)

Posterior median:

0.043

95% HPDI:

-0.007: 0.132



## Distance to water (medium):

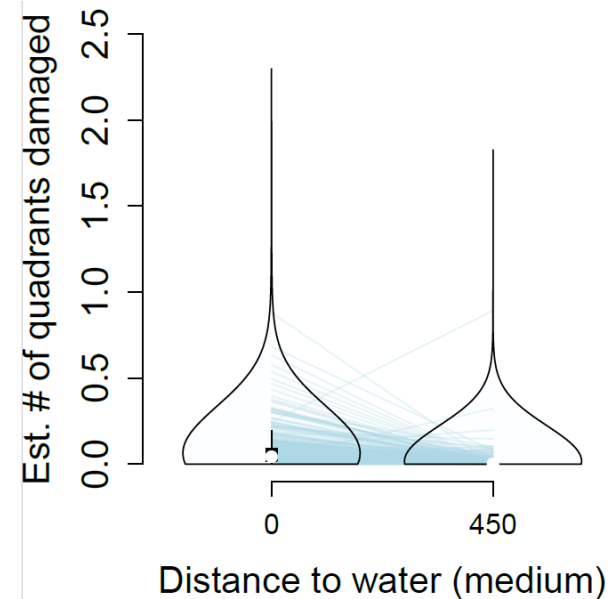
Increase in 0 over 450 (95.4% prob.)

Posterior median:"

0.035

95% HPDI:

-0.033: 0.259





# CONCLUSION

- Most of the damage is done below 1m
- Further fieldwork required to ascertain animal species responsible for what proportion of damage
- Clear spatial hot spots of damaged trees
- Shorter trees were more susceptible
- Trees closer to water and further from roads had more bark stripping damage
- Other spatial factors very small or no effects



# Acknowledgements

- Supervisors – Professor Julianne O'Reilly-Wapstra & Associate Professor Geoff While
- Dr Rosina Savisaar, Mondego Science
- Hugh Fitzgerald, UTAS
- Professor Clare McArthur, USYD
- HVP: Dr. Tarryn Turnbull, Paul Wood, John Rigoni, Amy Kirk, Stephen Elms & Toby Alker-Jones



Thank you any  
questions?

