



Landcare Research
Manaaki Whenua

A peek down under:

structural root architecture of some
New Zealand native plants

Chris Phillips

Mike Marden, Jagath Ekanayake & Alex Watson



Disclaimer

We are not botanists!

We are not plant ecologists!

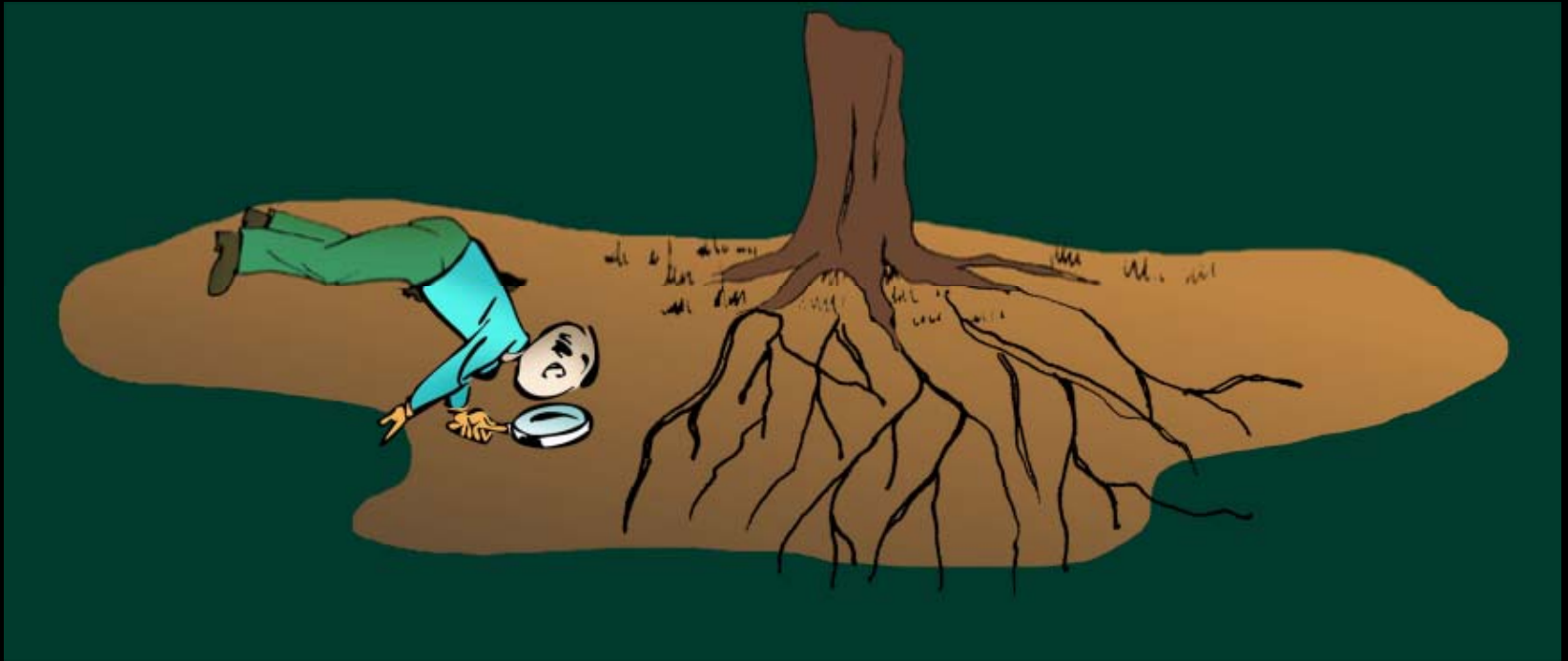
We are on the edge!

We play in the dirt!


We are statistically challenged!



Wadda ya know?



In this talk....

- 
- Context – 3 strands
 - What we've done – 2 trials
 - How we do it
 - What we've found
 - How we use the information
 - Wrap up

Context 1 – hillslope stability



- Plantation forests for erosion control
- *Pinus radiata* and other exotics
- 1980's to 1990's
- Effectiveness, densities, harvesting etc

Context 1 – hillslope stability



Context 1 – hillslope stability



Context 1 – hillslope stability



Context 2 – river bank stabilisation

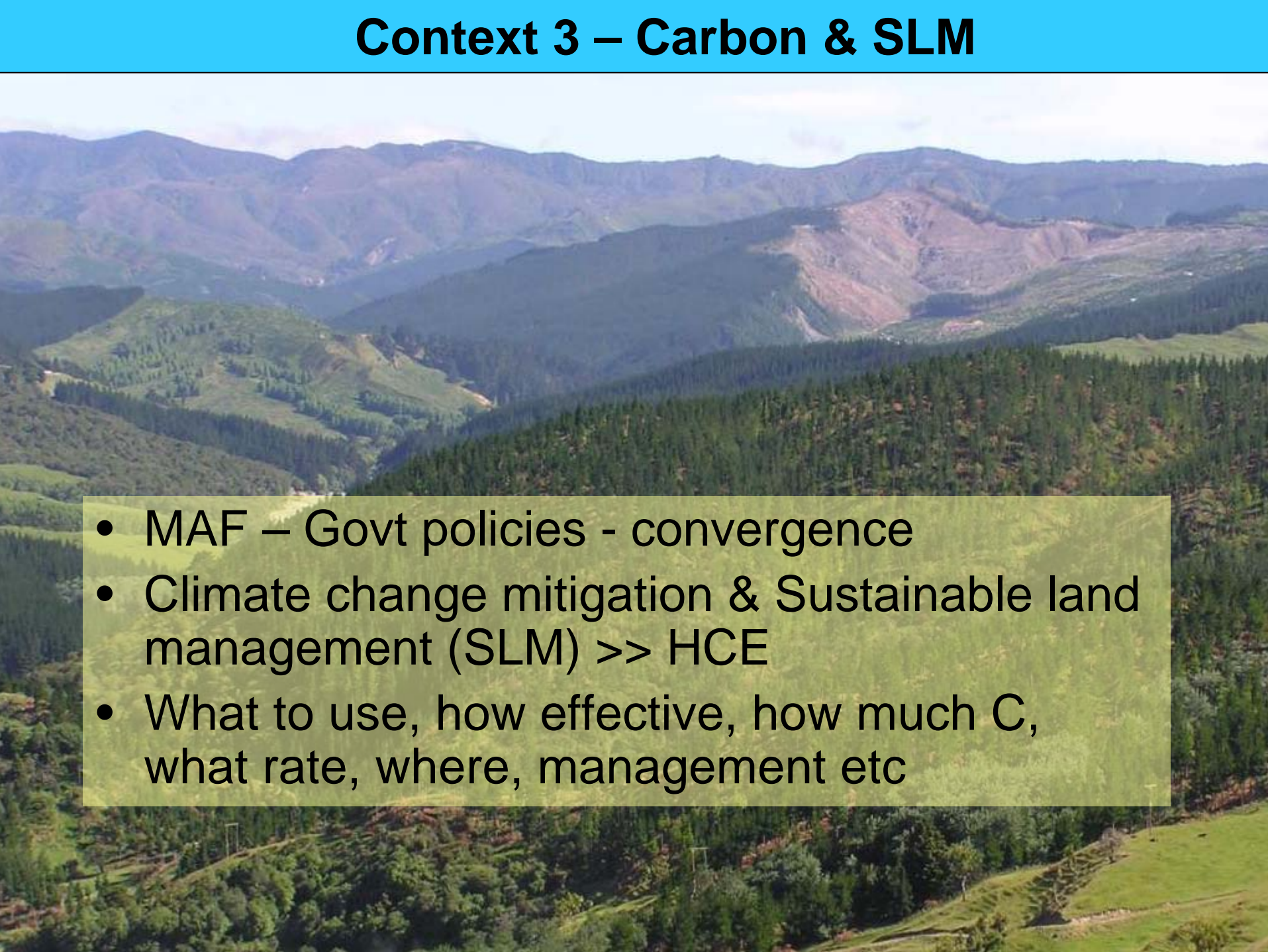


- Off the hills and into the rivers – ICM
- Riparian restoration/rehabilitation efforts
- Natives vs exotics, Ecology vs function
- Performance, build the K base

Context 2 – river bank stabilisation



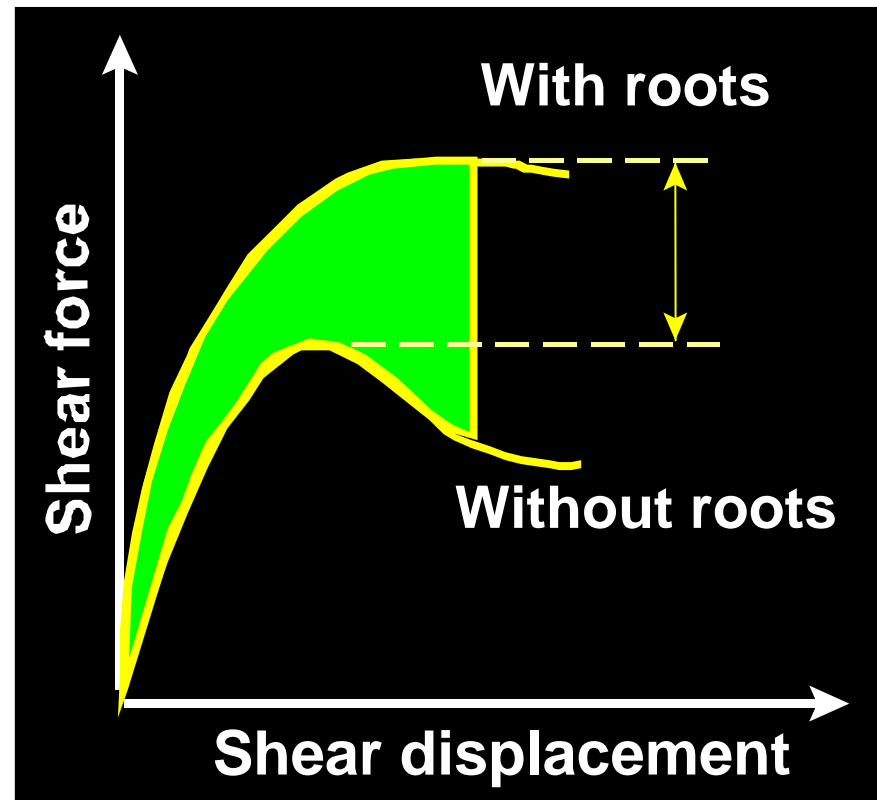
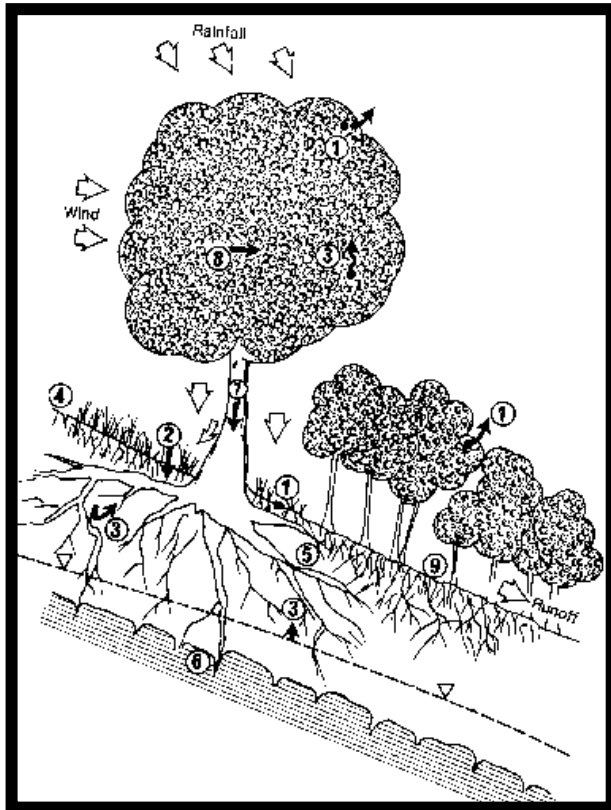
Context 3 – Carbon & SLM

- 
- MAF – Govt policies - convergence
 - Climate change mitigation & Sustainable land management (SLM) >> HCE
 - What to use, how effective, how much C, what rate, where, management etc

The Big Question?

Can our New Zealand native plants perform E & SC functions as well as introduced plants?

In geotechnical terms, how do we quantify the benefits of vegetation to soil stabilisation?



What we've been doing

- Exotic species
- 2 native trials
- 1 MSc. on Cordyline

What we've been doing - natives

Riparian plant trial

Common name

Karamu
Ribbonwood
Kowhai
Lemonwood
Kohuhu
Lacebark
Mapou
Fivefinger
Cabbage tree
Rewarewa
Manuka
Tutu



Marden, Rowan, Phillips (2007; 2005)
Phillips & Marden (2006)

Podocarp trial

Common name

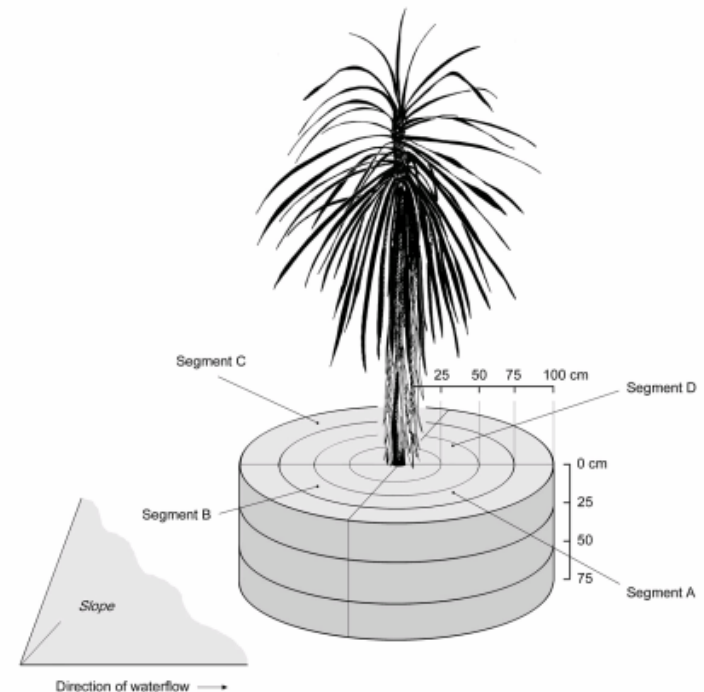
Kauri
Rimu
Kahikatea
Miro
Totara
Matai
Puriri
Titoki

Sedge grass
NZ Mountain flax
Toe toe



Still in progress

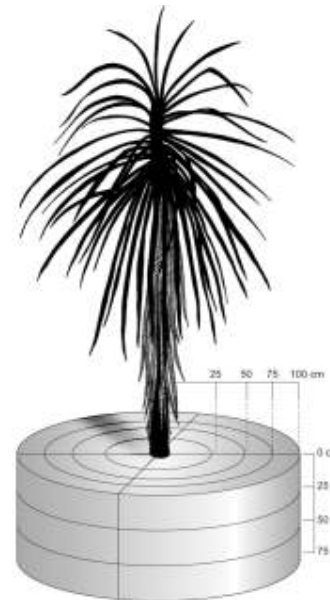
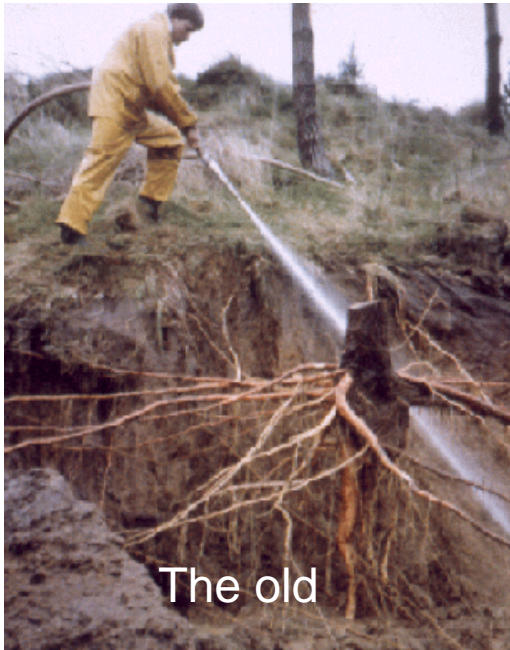
Cabbage trees



Czernin (2002)
Czernin & Phillips (2005)

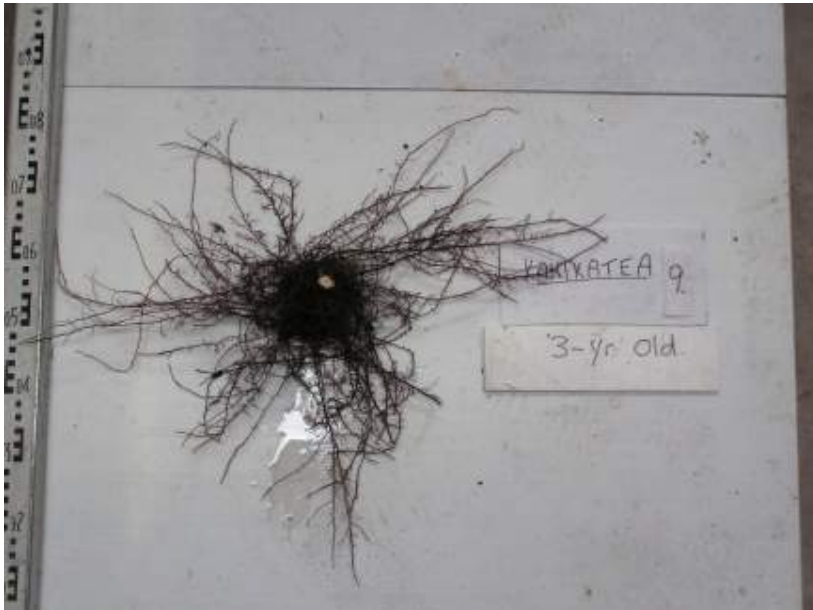


How we do it

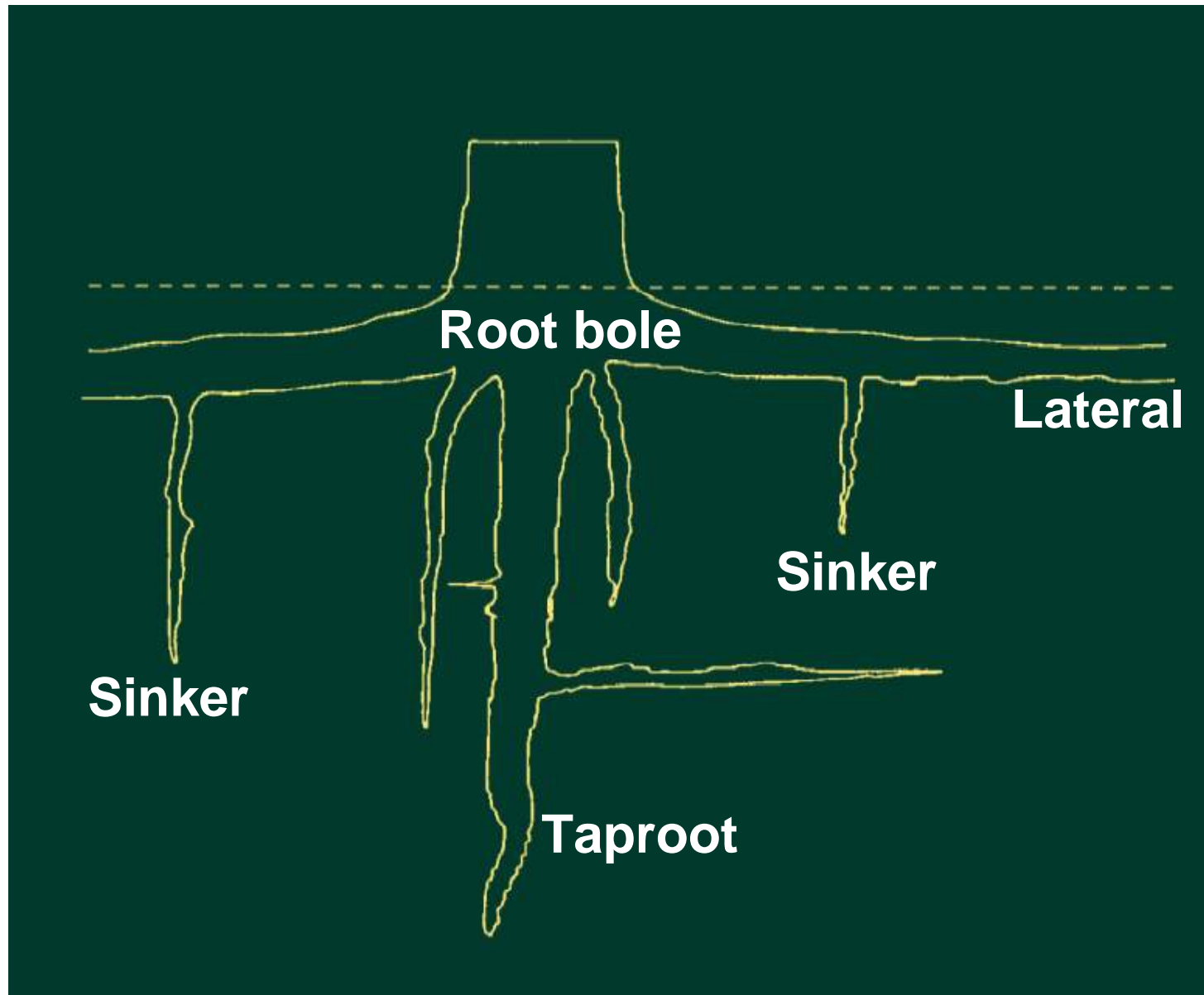


What we've found

- General growth patterns
- Biomass
- Root length
- Root depth
- Site occupancy
- Root strength



Root architecture



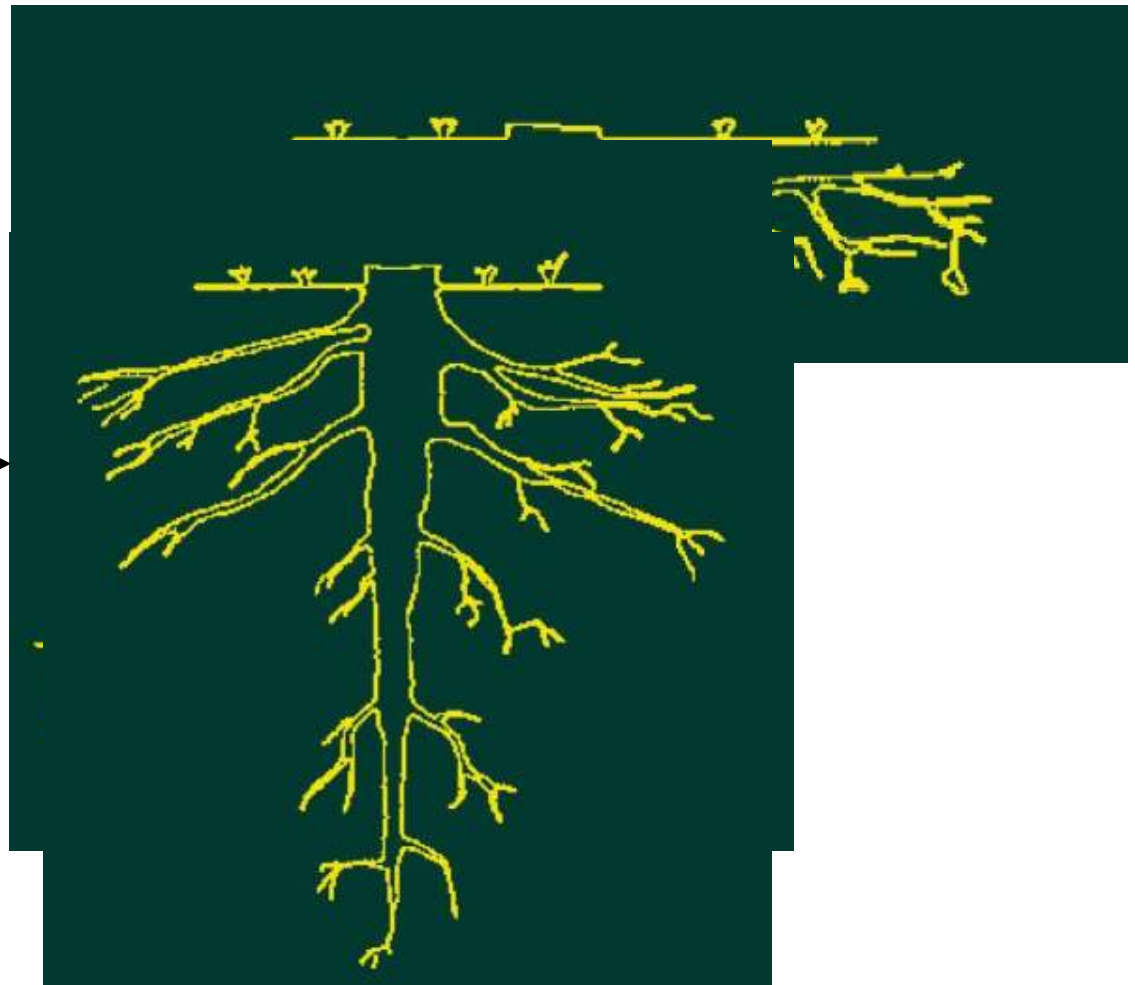
Root architecture

Tree root forms

- plateroot

- heartroot →

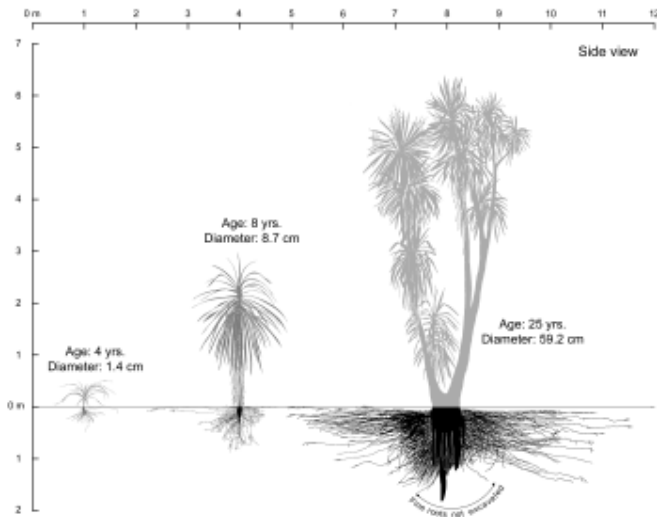
- taproot →



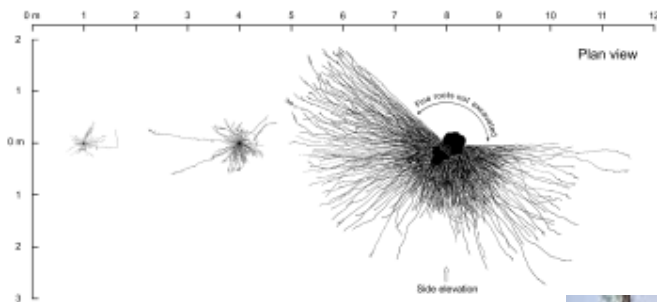
What we've found – growth

Cabbage tree
(*Cordyline australis*)

25



13



7

5



Czernin (2002)
Czernin & Phillips (2005)

What we've found – growth

Fivefinger
(*Psuedopanax arboreus*)

2 m

1 m

0



1 year old



2 year old



3 year old



4 year old

3.35 m

What we've found – growth

4 yr old

Kauri

1 m
0



Totara



What we've found – growth

Toe toe



3 year olds

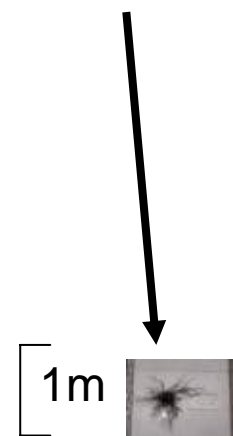
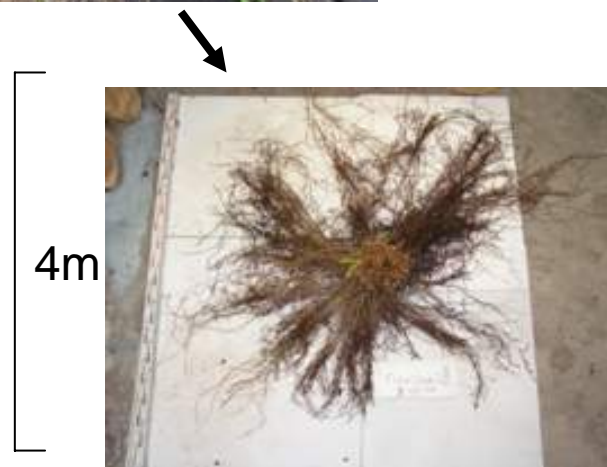
Flax



Carex



Kahikatea & Puriri



What we've found – root spread

5 year old

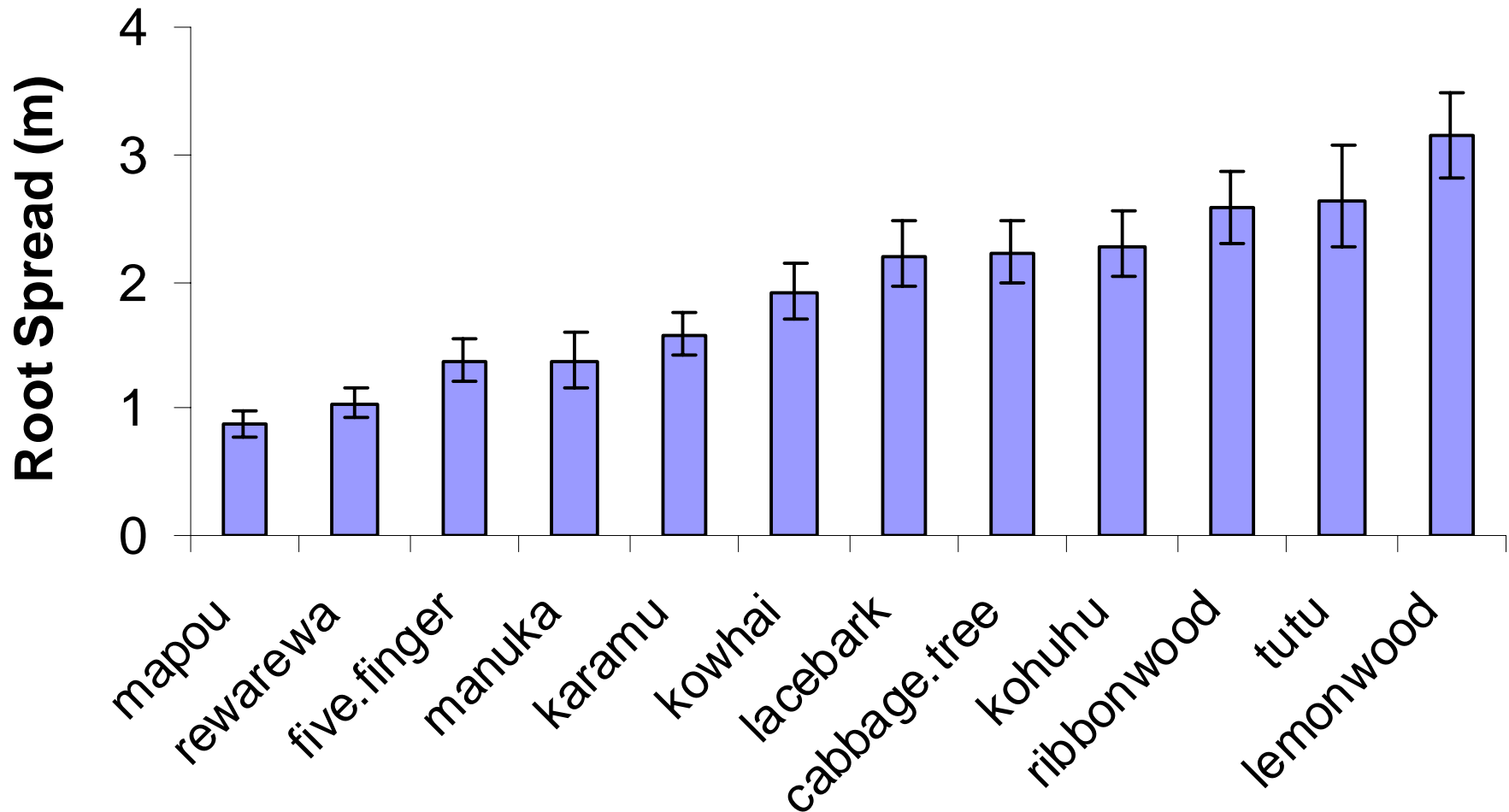
← *Pittosporum tenuifolium* (kohuhu)



↑
Coprosma robusta (karamu)

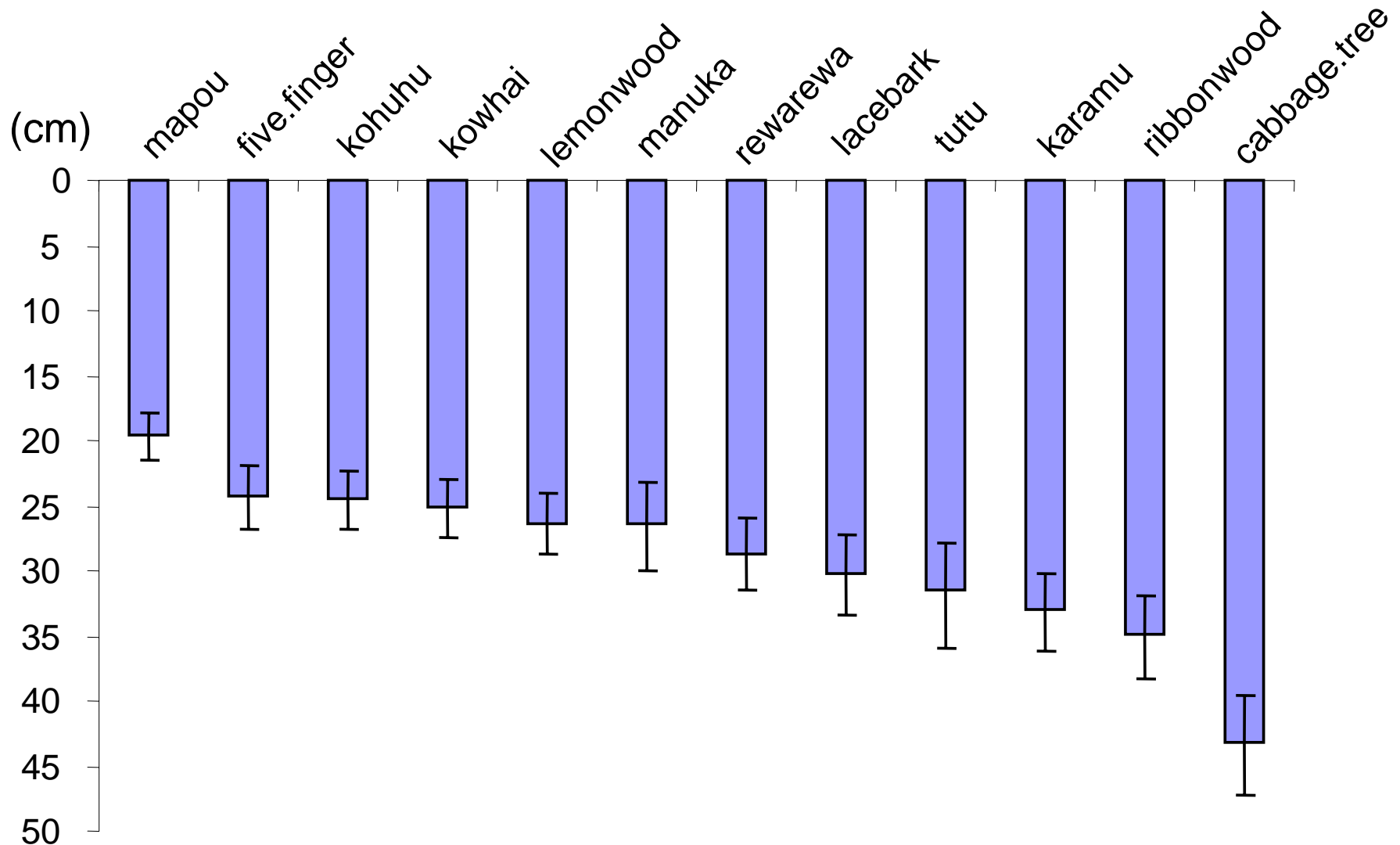
What we've found – root spread

Mean max. root spread – 5 year old



What we've found – root depth

Mean max. root depth – 5 year old



What we've found – root depth



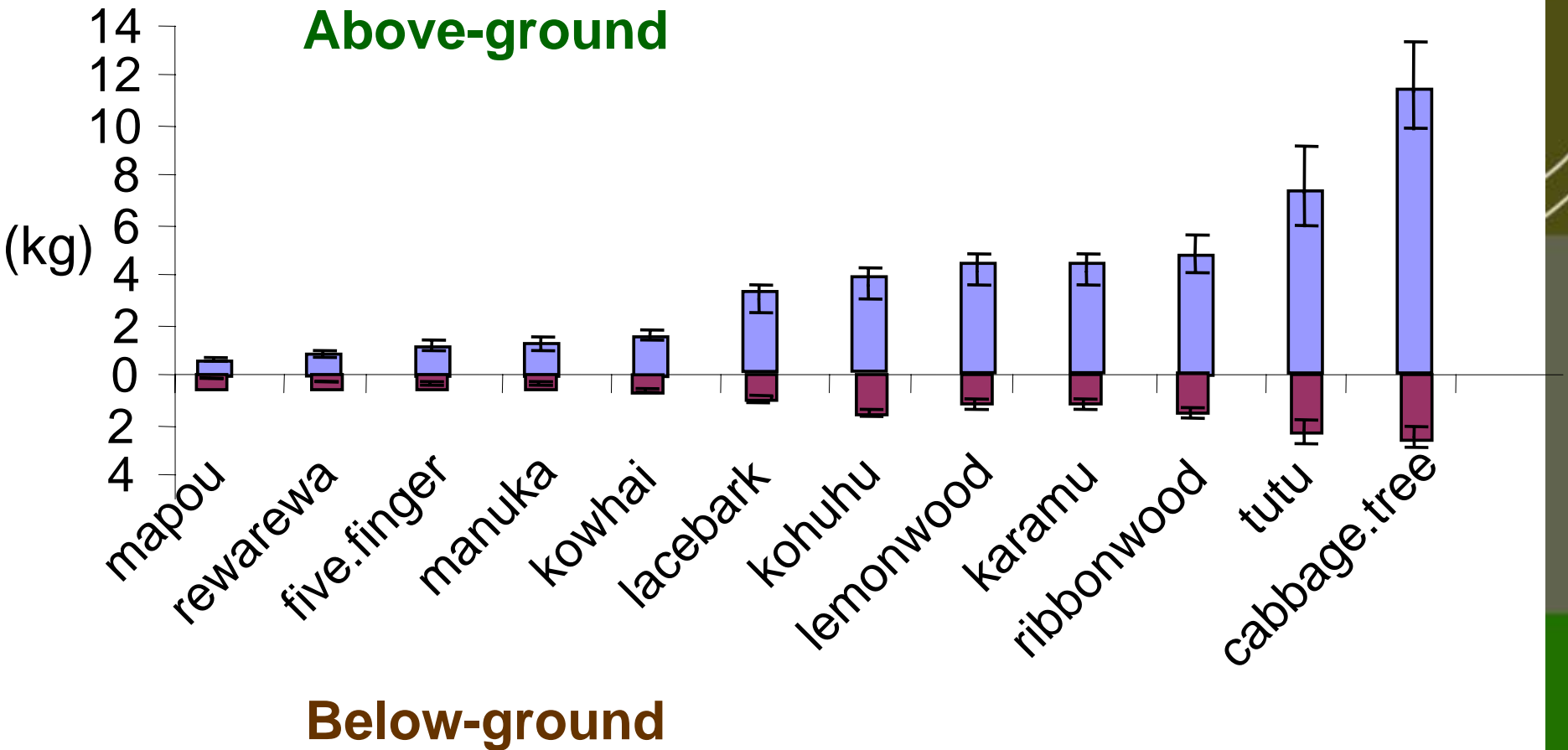
Ribbonwood

Cabbage tree →



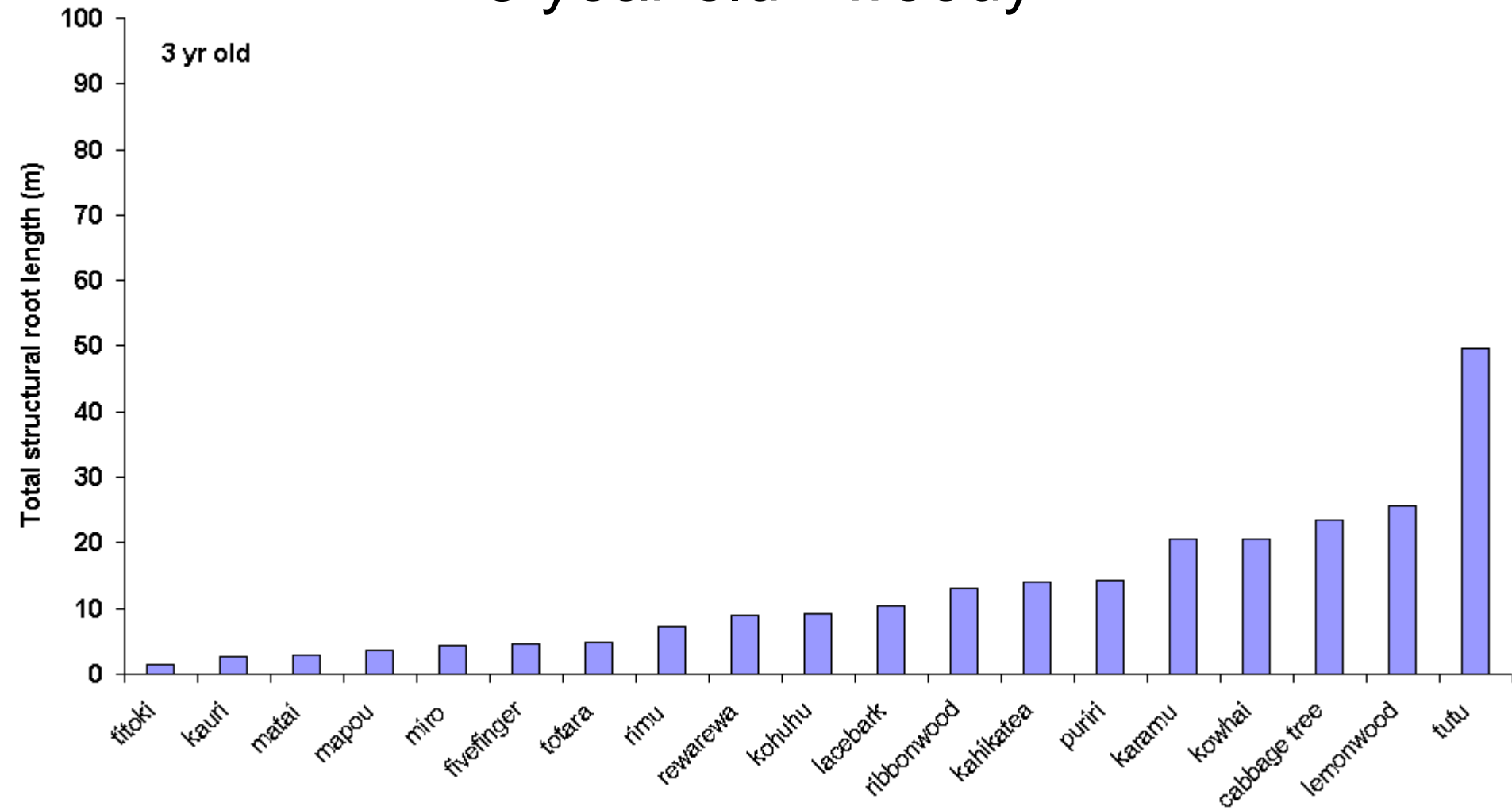
What we've found – biomass

5 year old



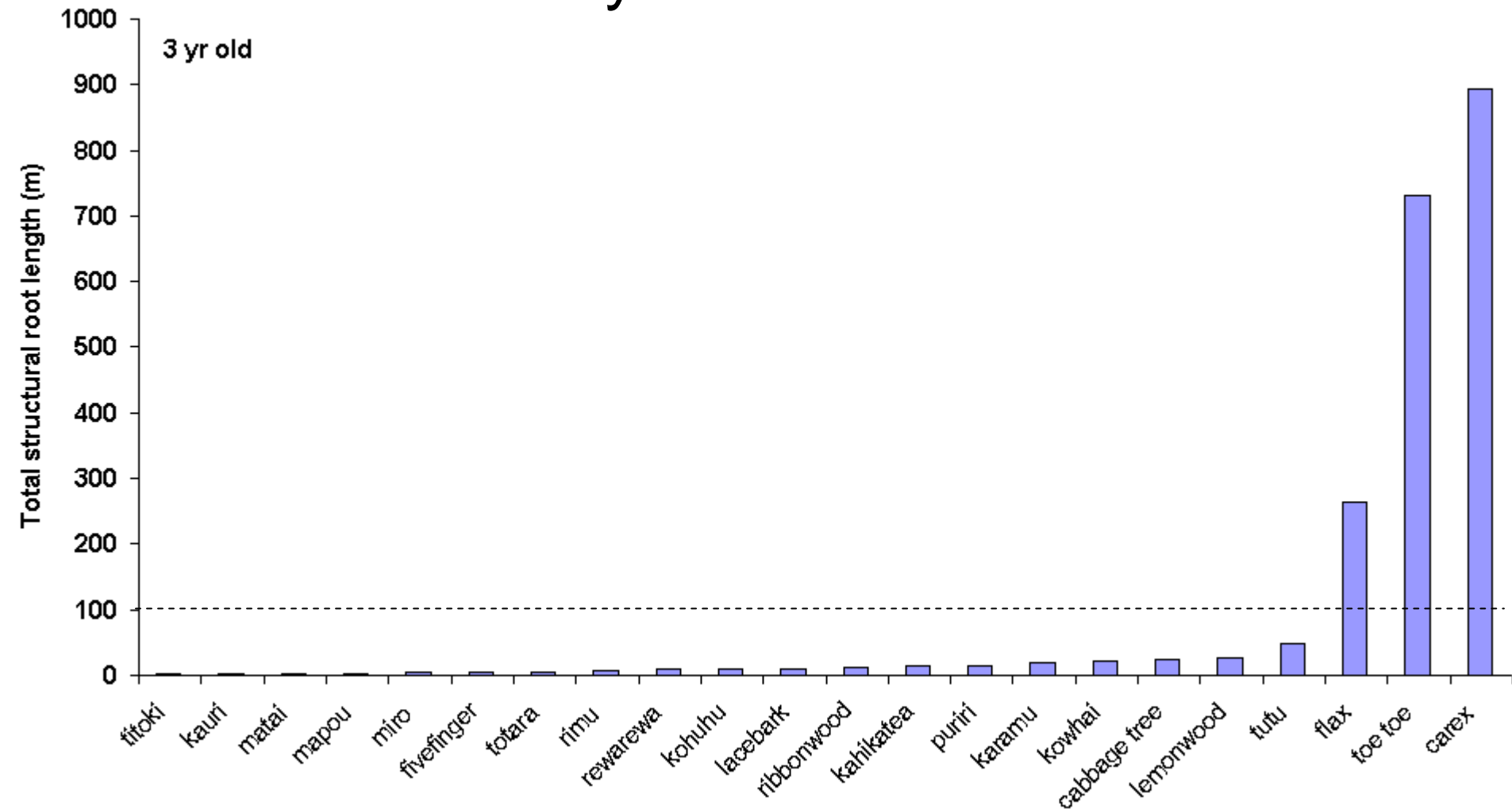
What we've found – root length

3 year old - woody



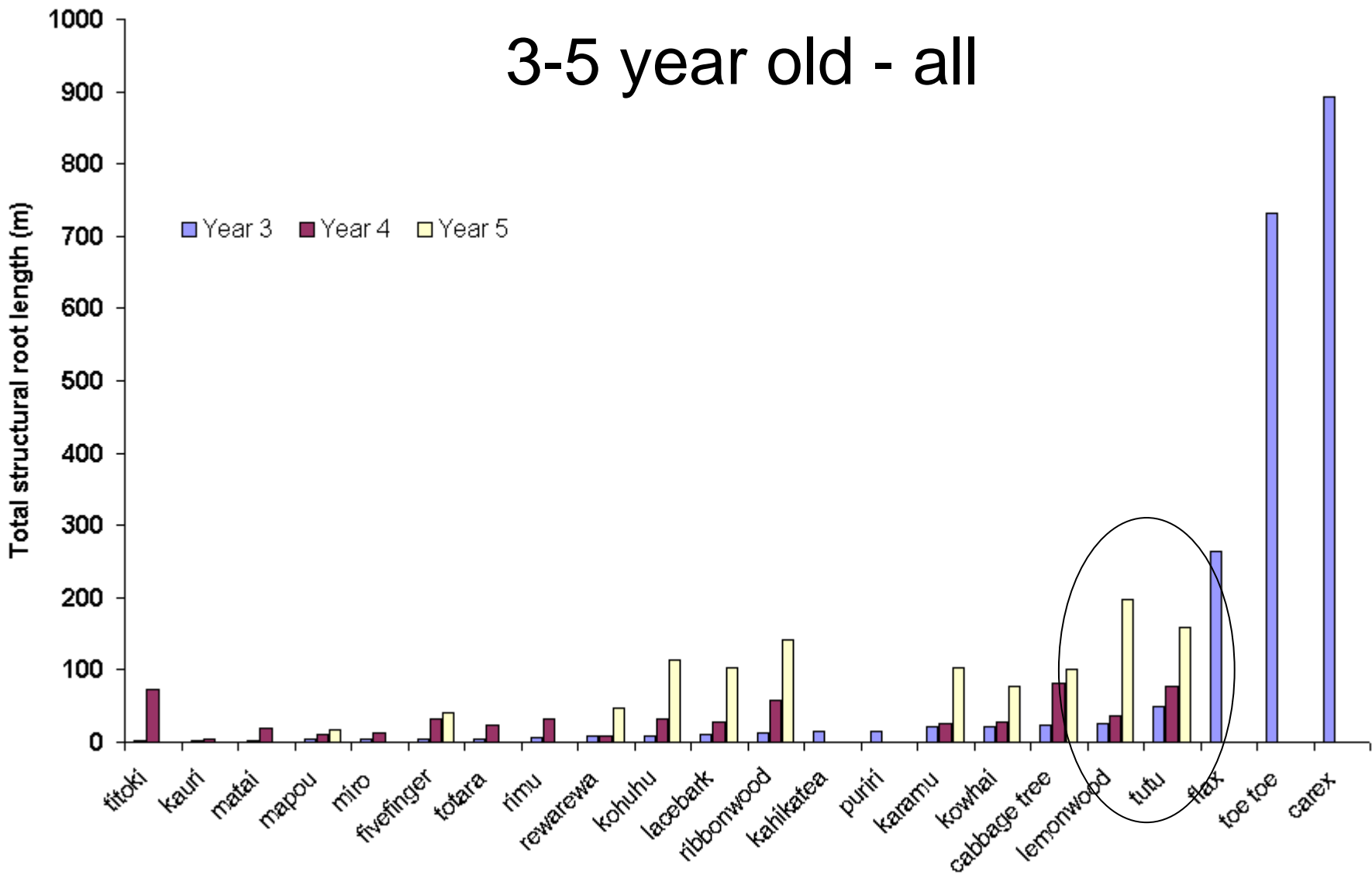
What we've found – root length

3 year old - all



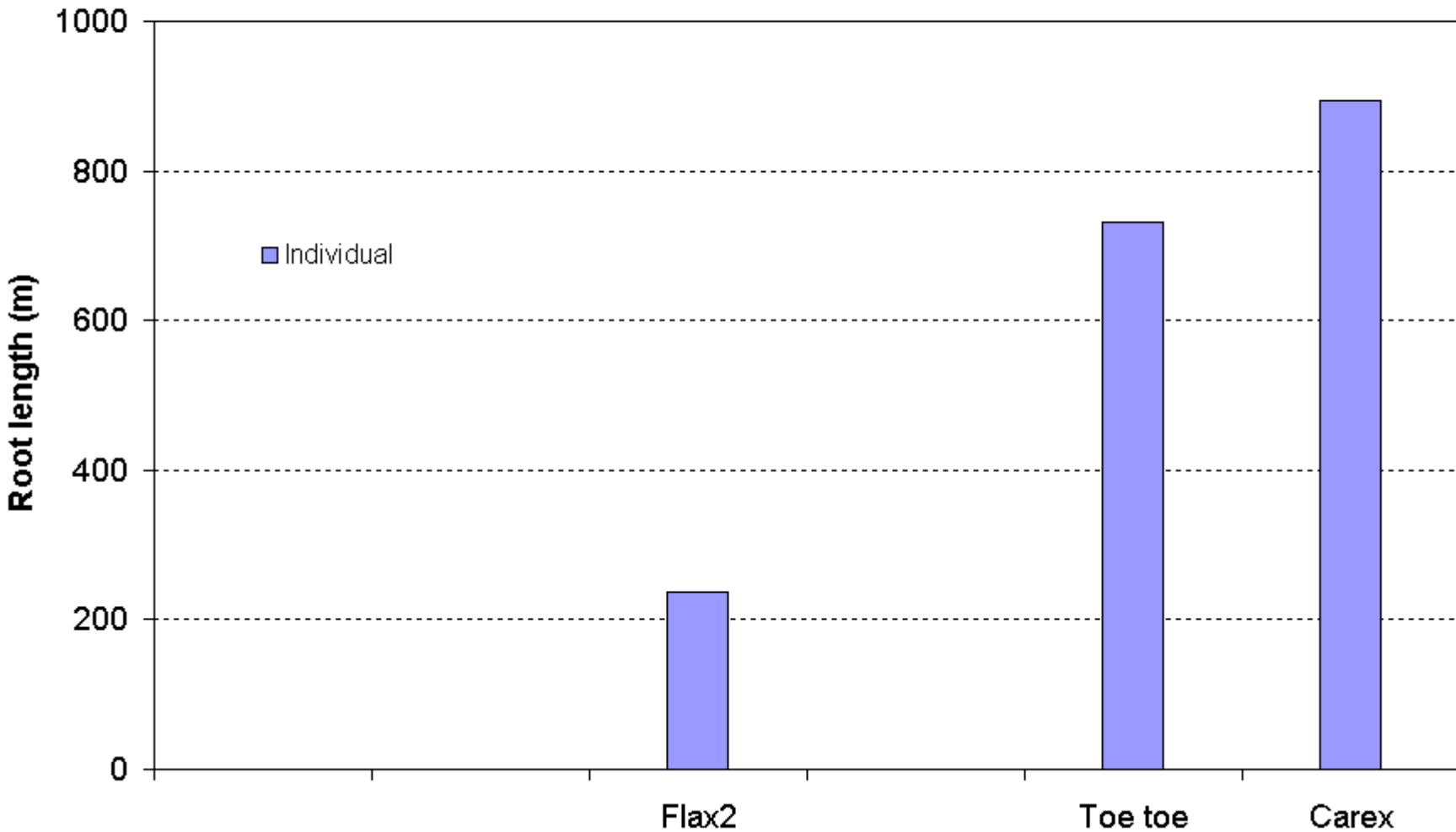
What we've found – root length

3-5 year old - all



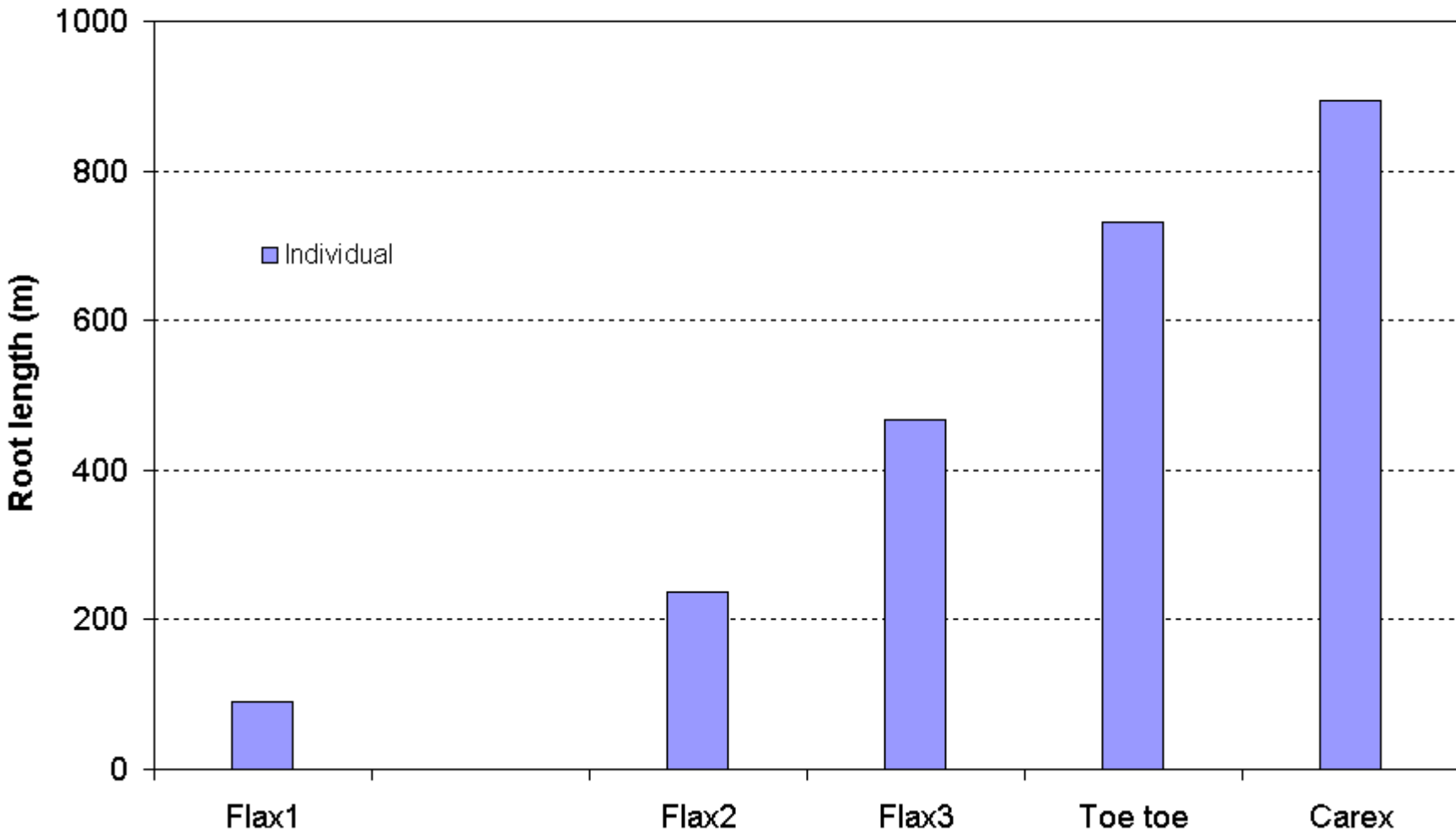
What we've found – variation

Total root length 3 year old plants (m)



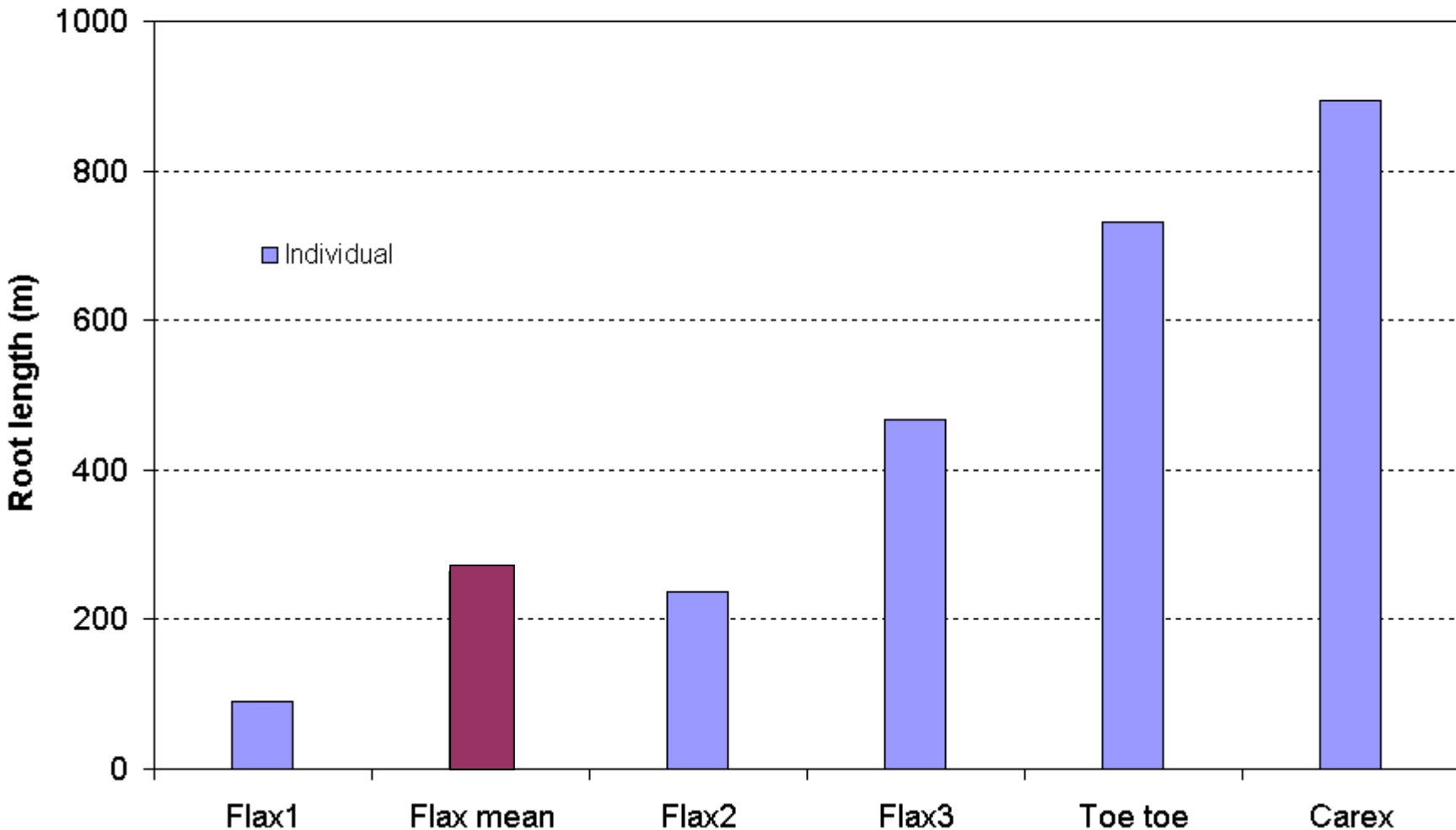
What we've found – variation

Total root length 3 year old plants (m)



What we've found – variation

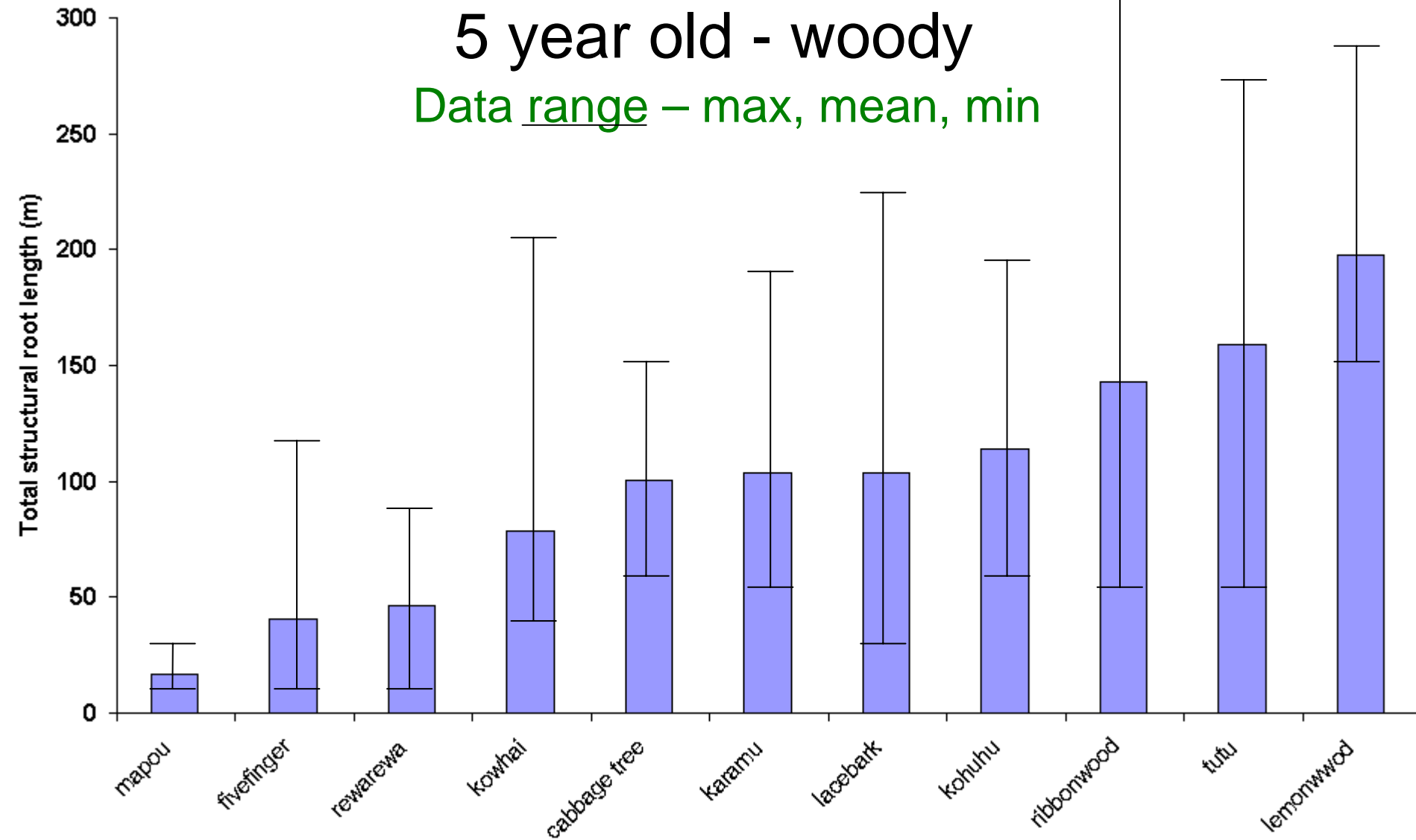
Total root length 3 year old plants (m)



What we've found – variation

5 year old - woody

Data range – max, mean, min



What we've found – root tensile strength

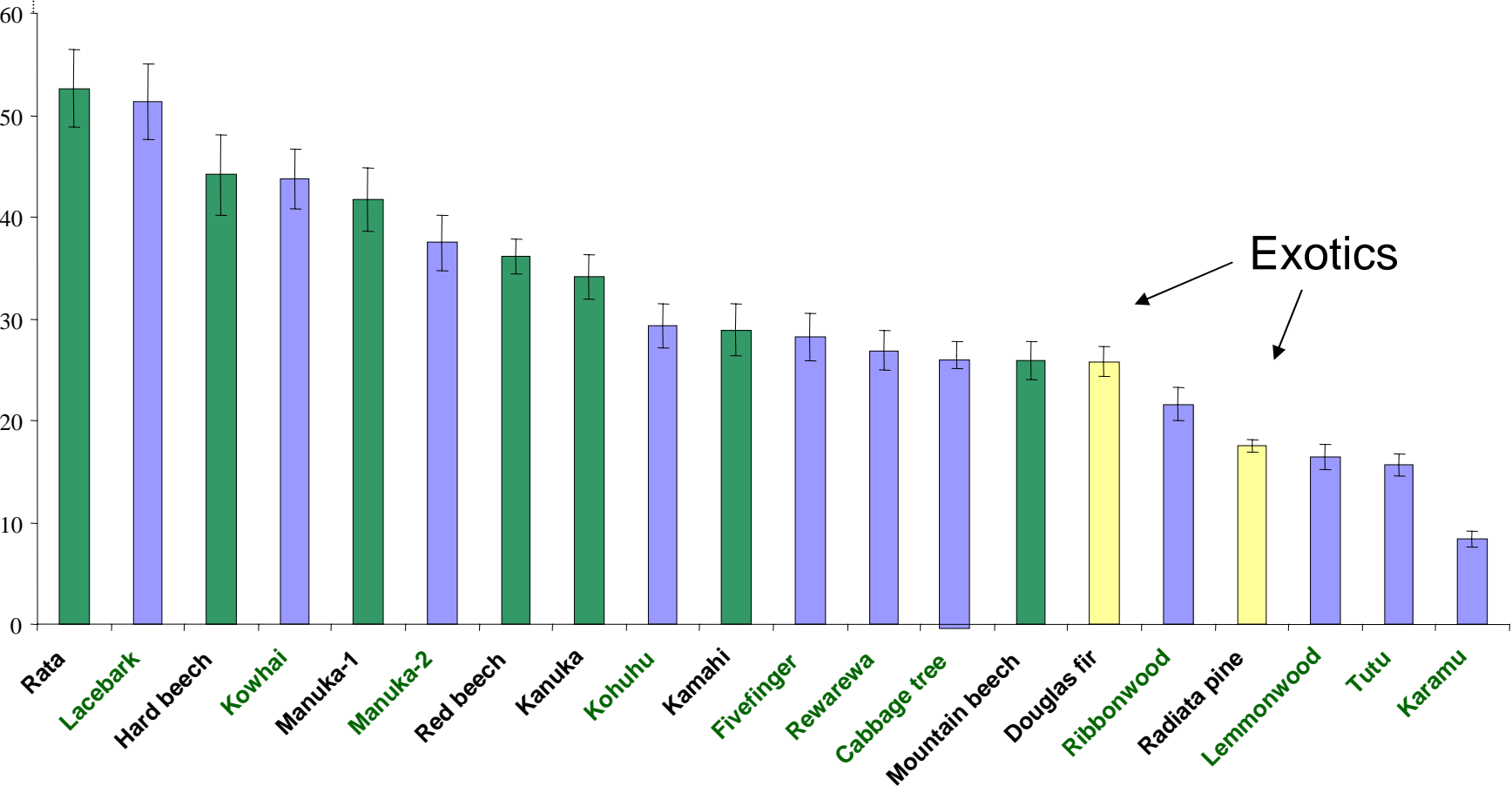
(1-4 mm diameter)



Willows 30 - 125 MPa

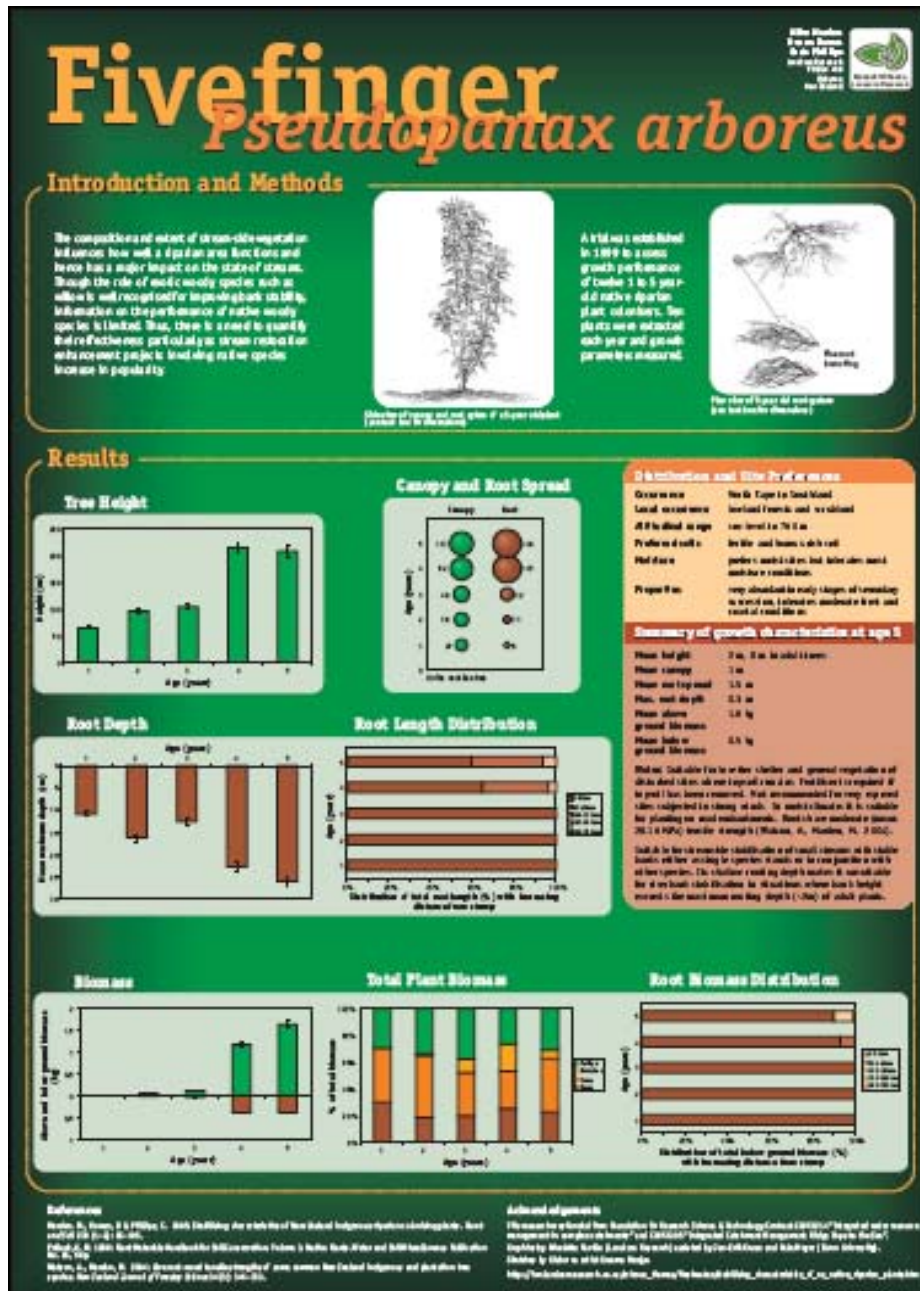
■ Riparian plant trial
■ Old FRI data

Mean max. tensile strength (MPa)



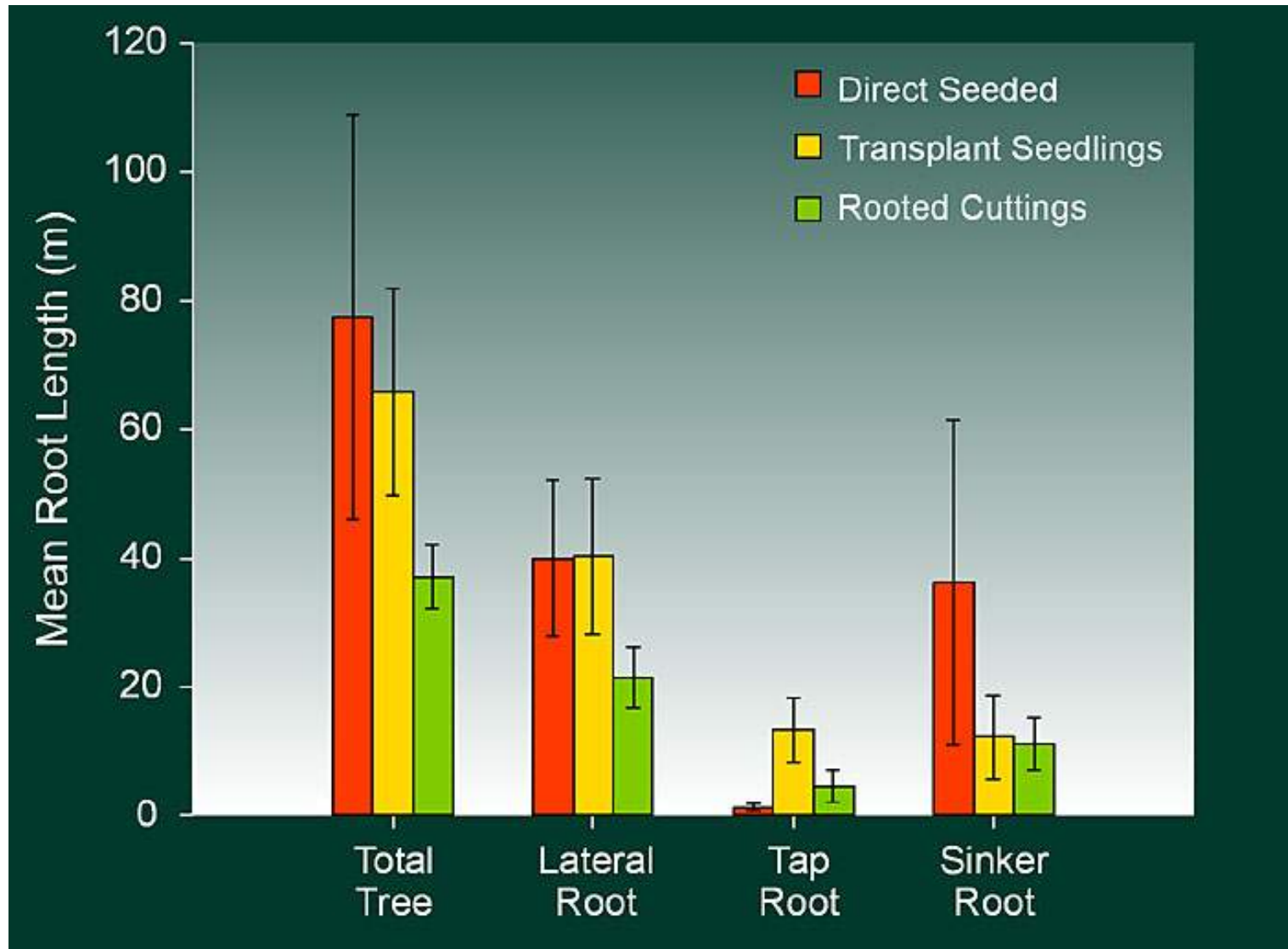
Exotics

How we use it – Knowledge delivery



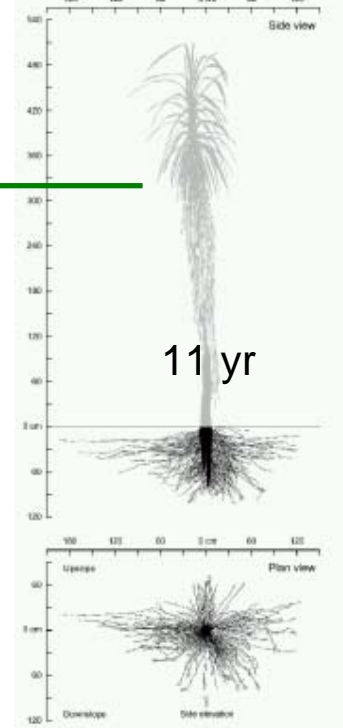
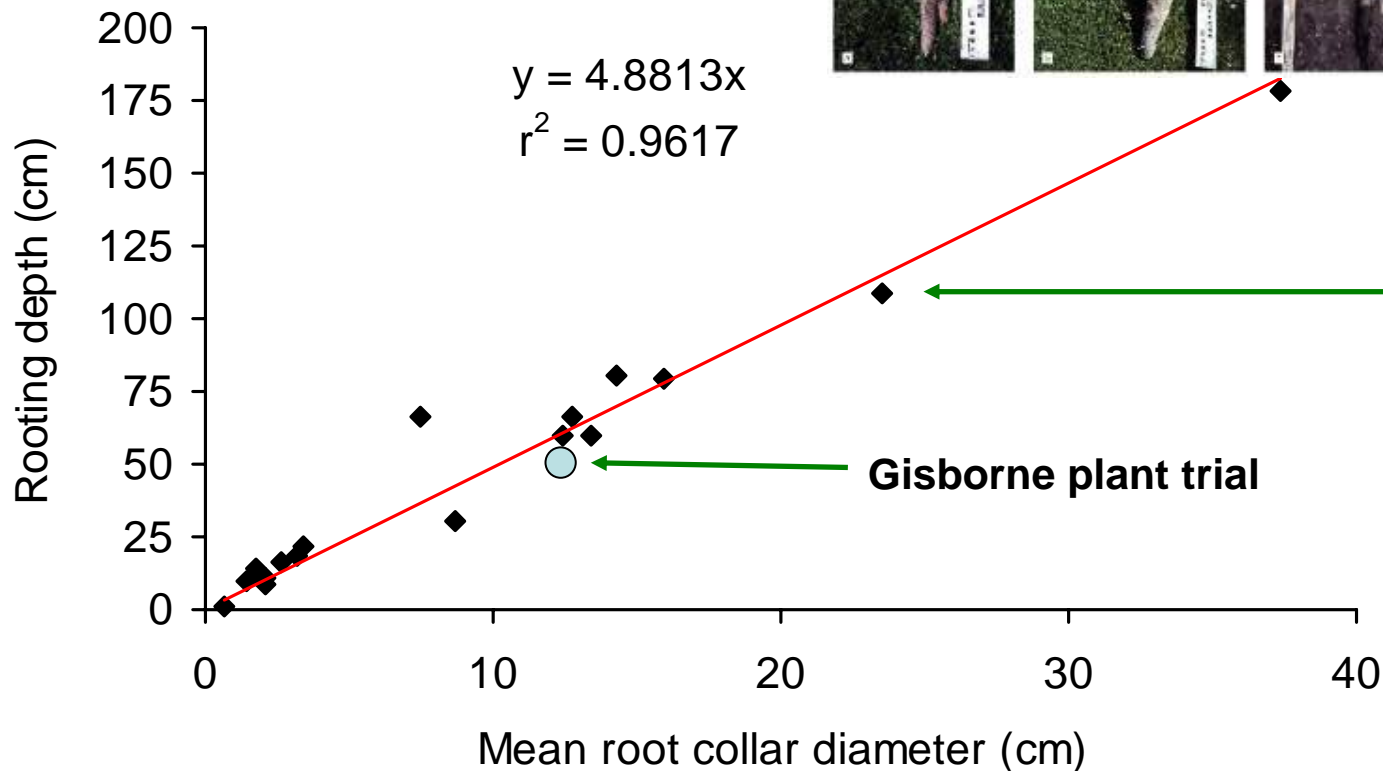
How we use it – management

Planting types – radiata pine 3 yr old

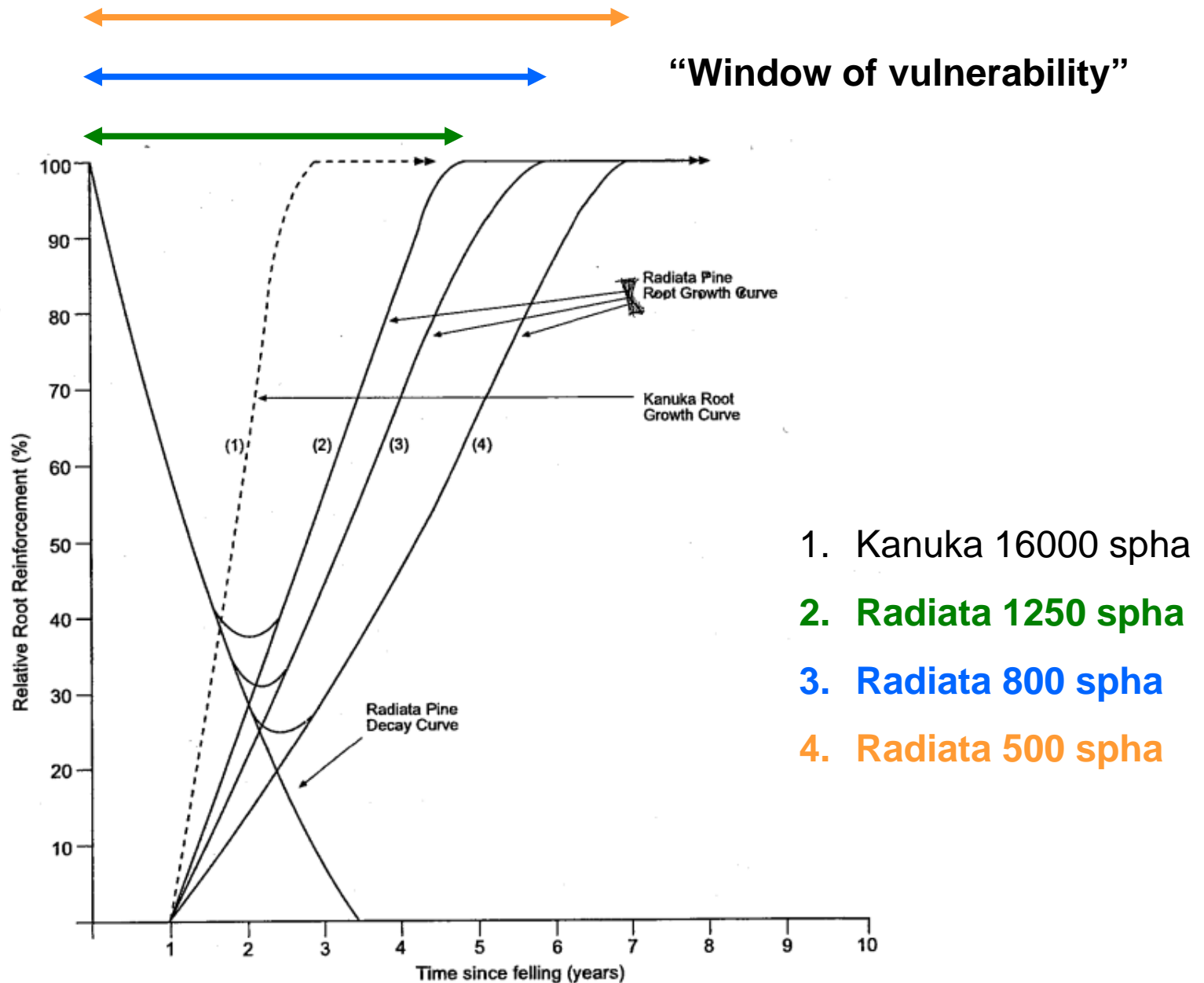


How we use it – Allometry

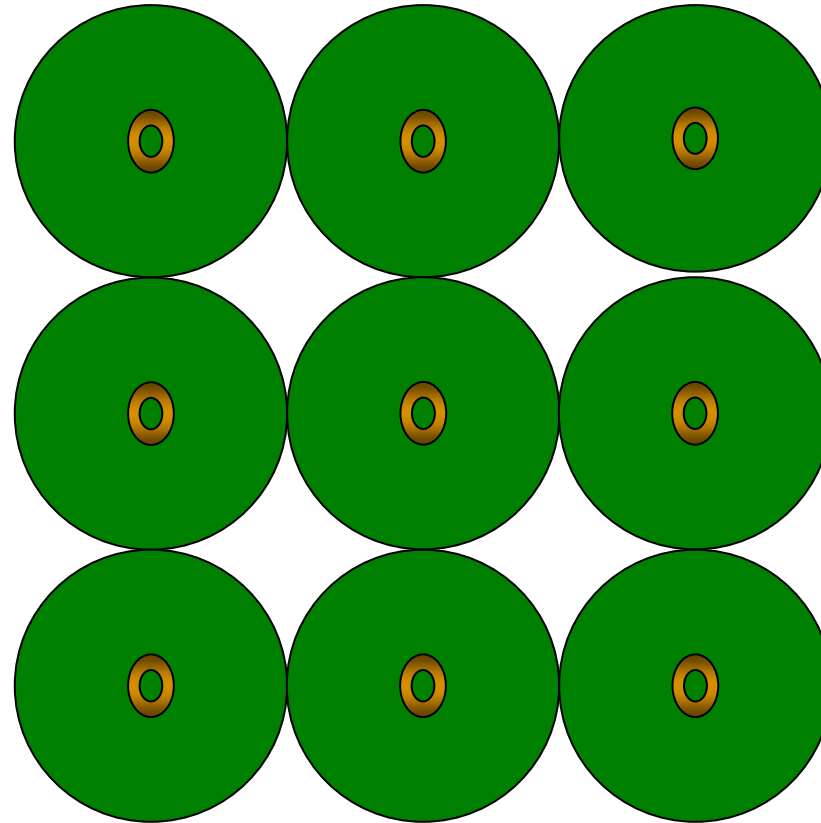
Cabbage tree root depth



How we use it – relative root reinforcement

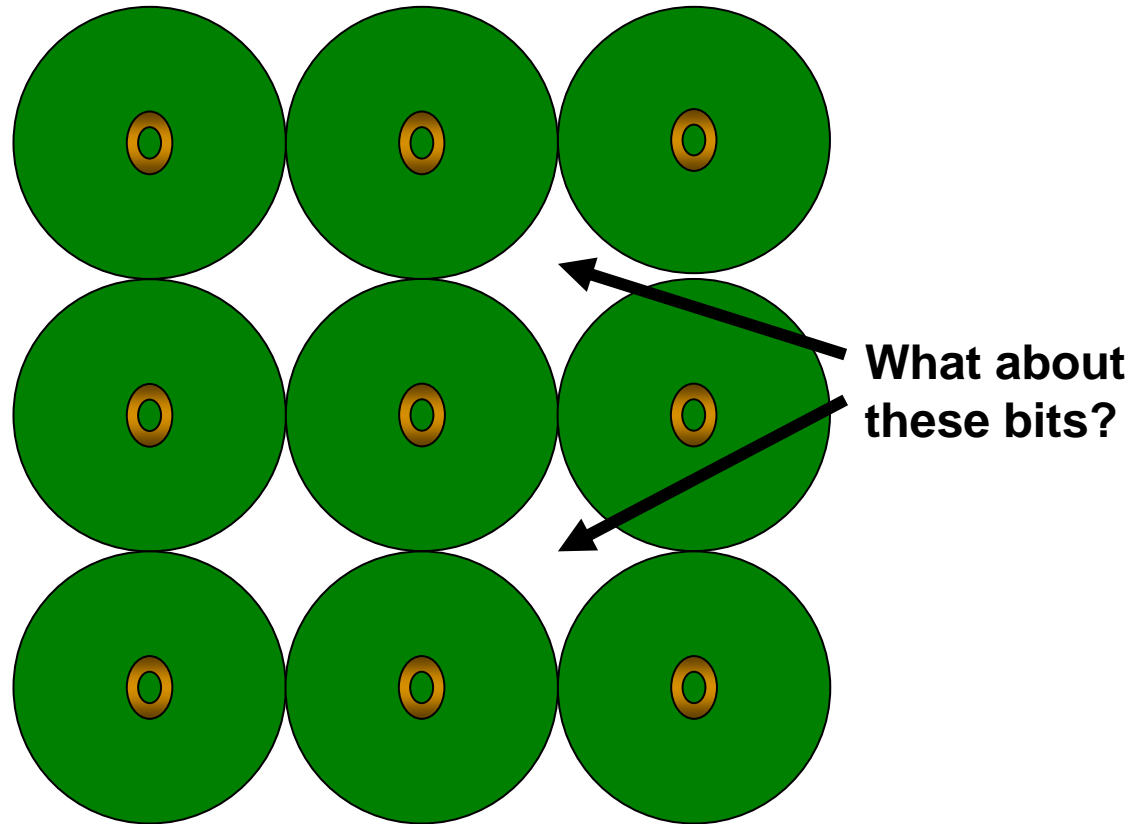


Root site occupancy



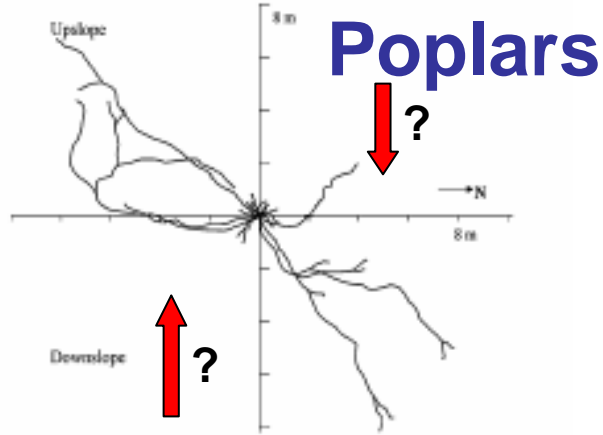
100% root site occupancy

Root site occupancy

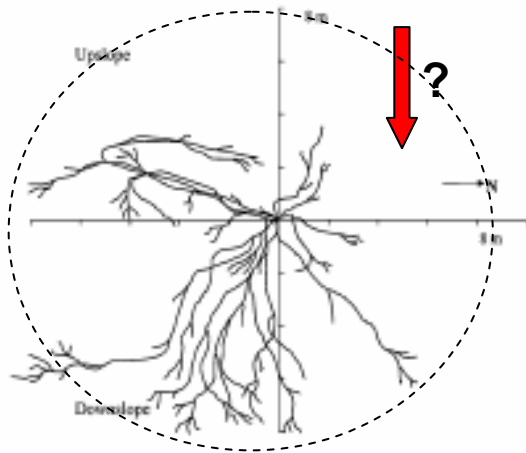


100% root site occupancy

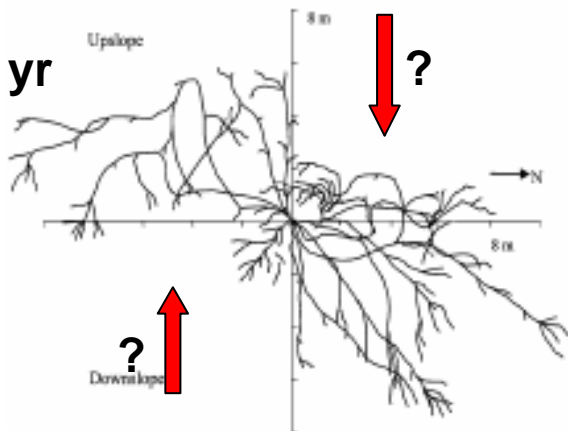
5 yr



7 yr

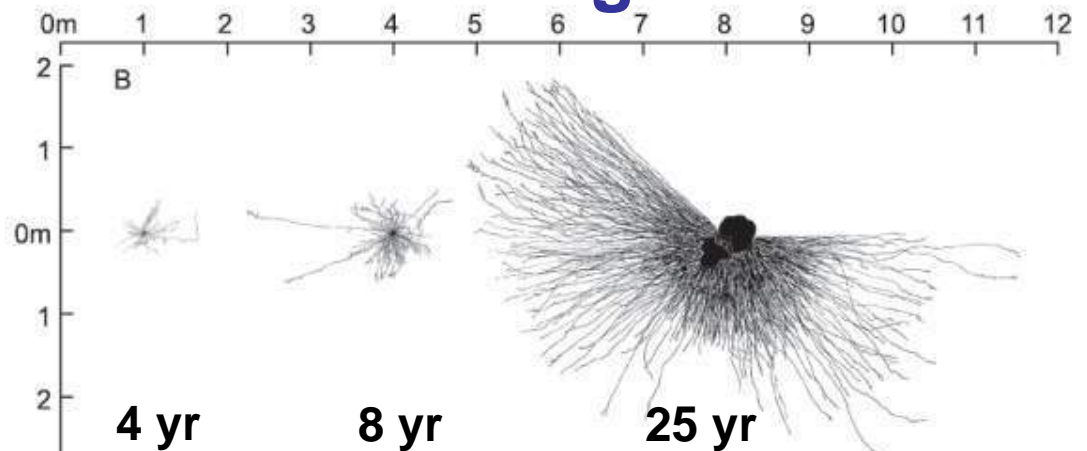


9.5 yr



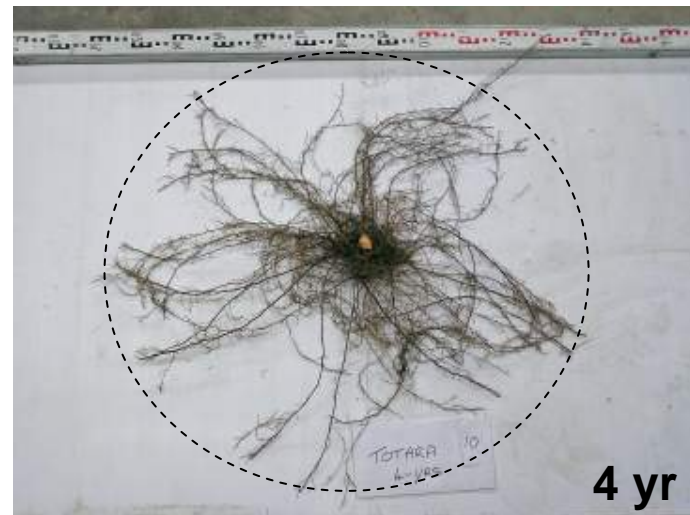
McIvor et al (2007)

Cabbage tree



Czernin & Phillips (2005)

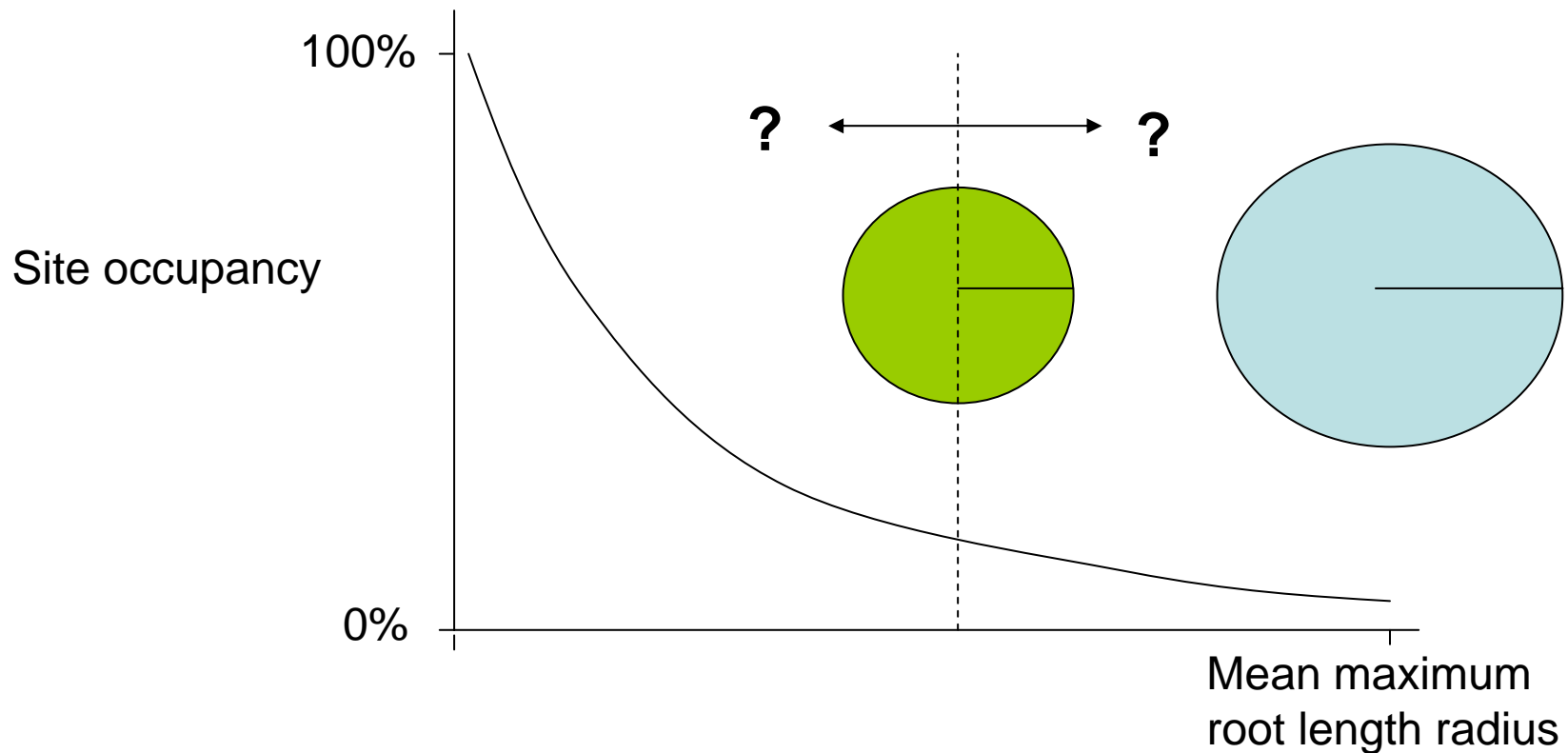
Totara



Marden & Phillips (unpub.)

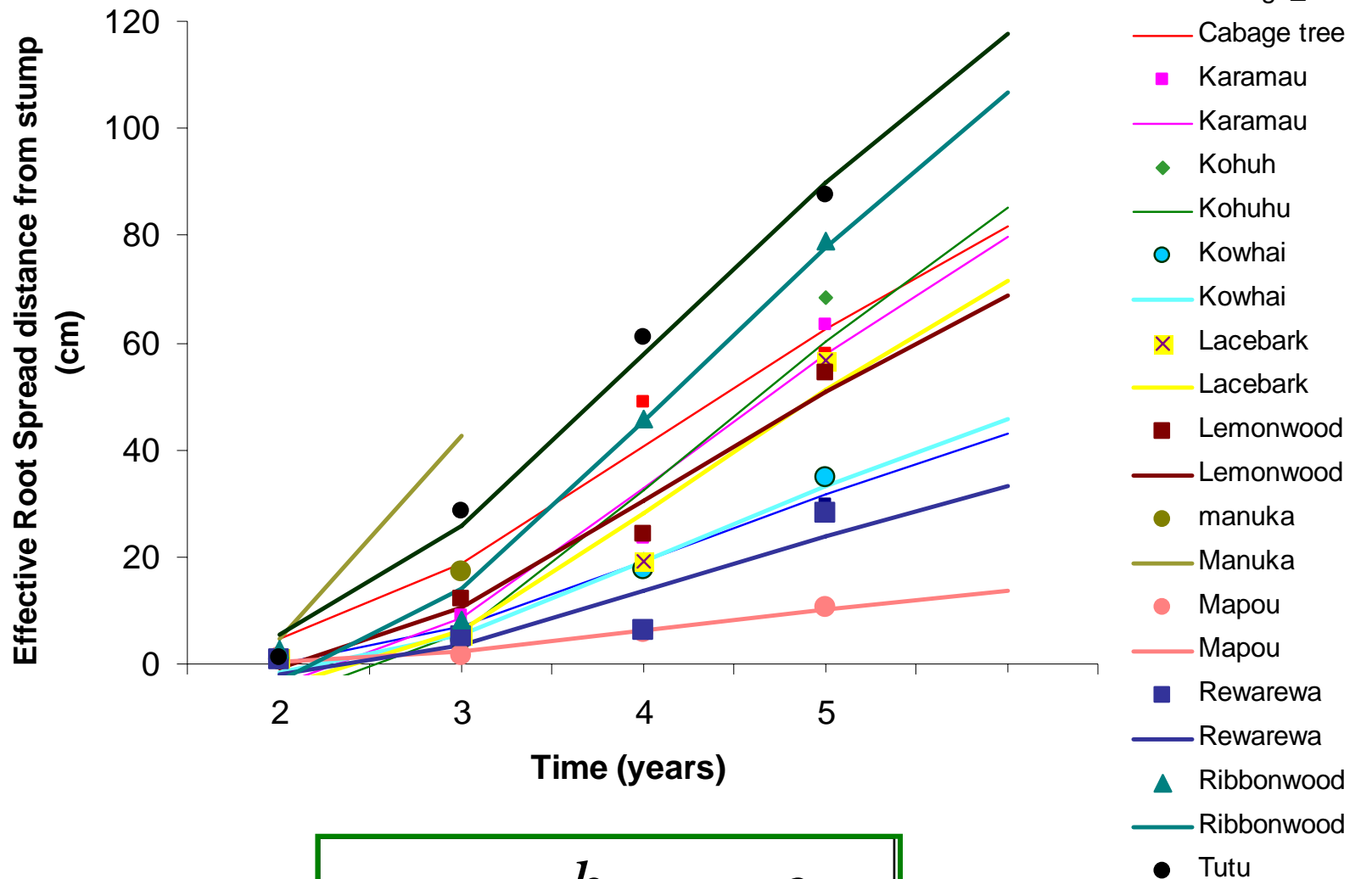
How we use it – root site occupancy model

“Effective” root spread radius



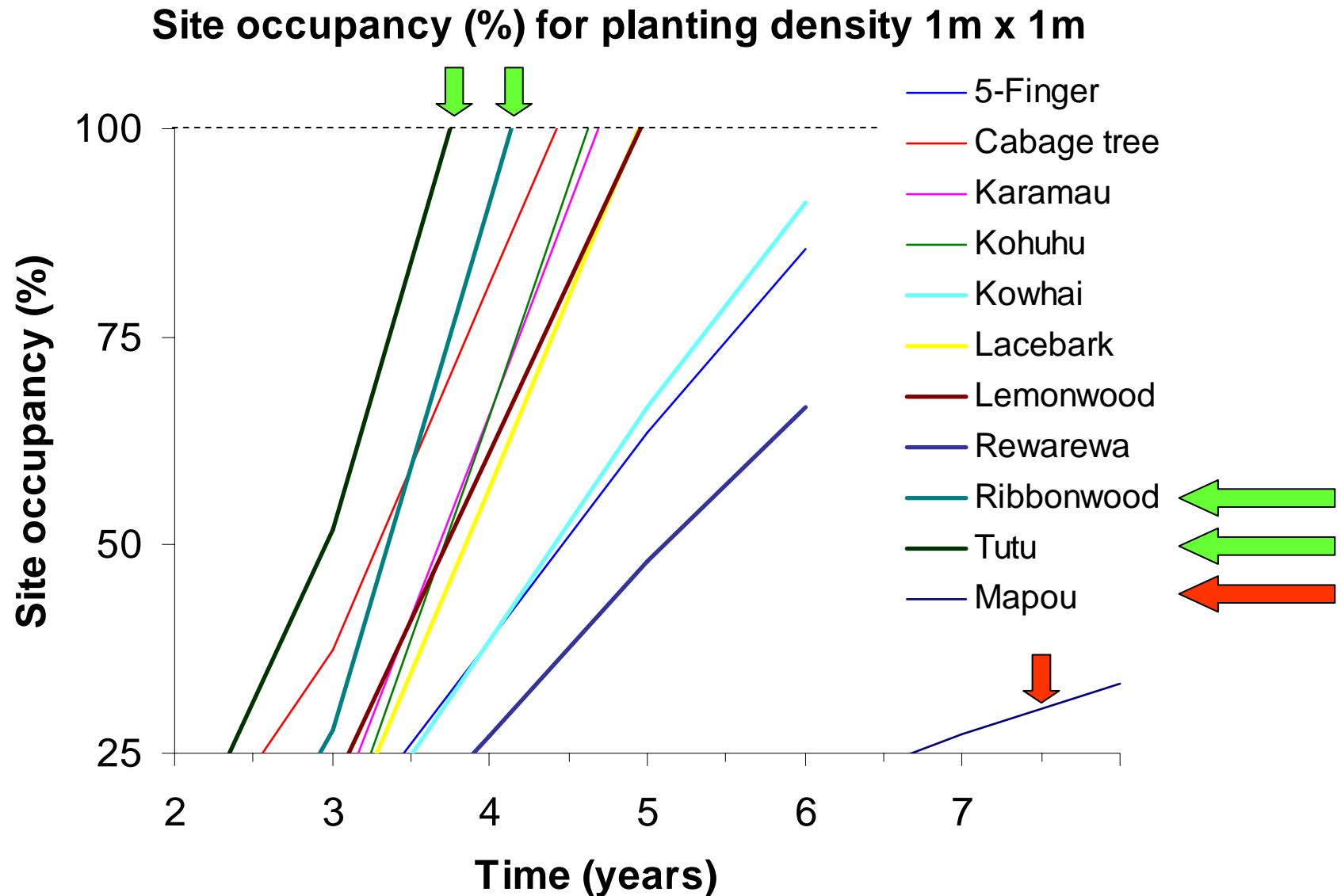
$$\text{Root reinforcement index (RFI)} = \frac{\text{Root surface area}}{\text{Root spread area}}$$

Effective root spread measured & predicted using model equation

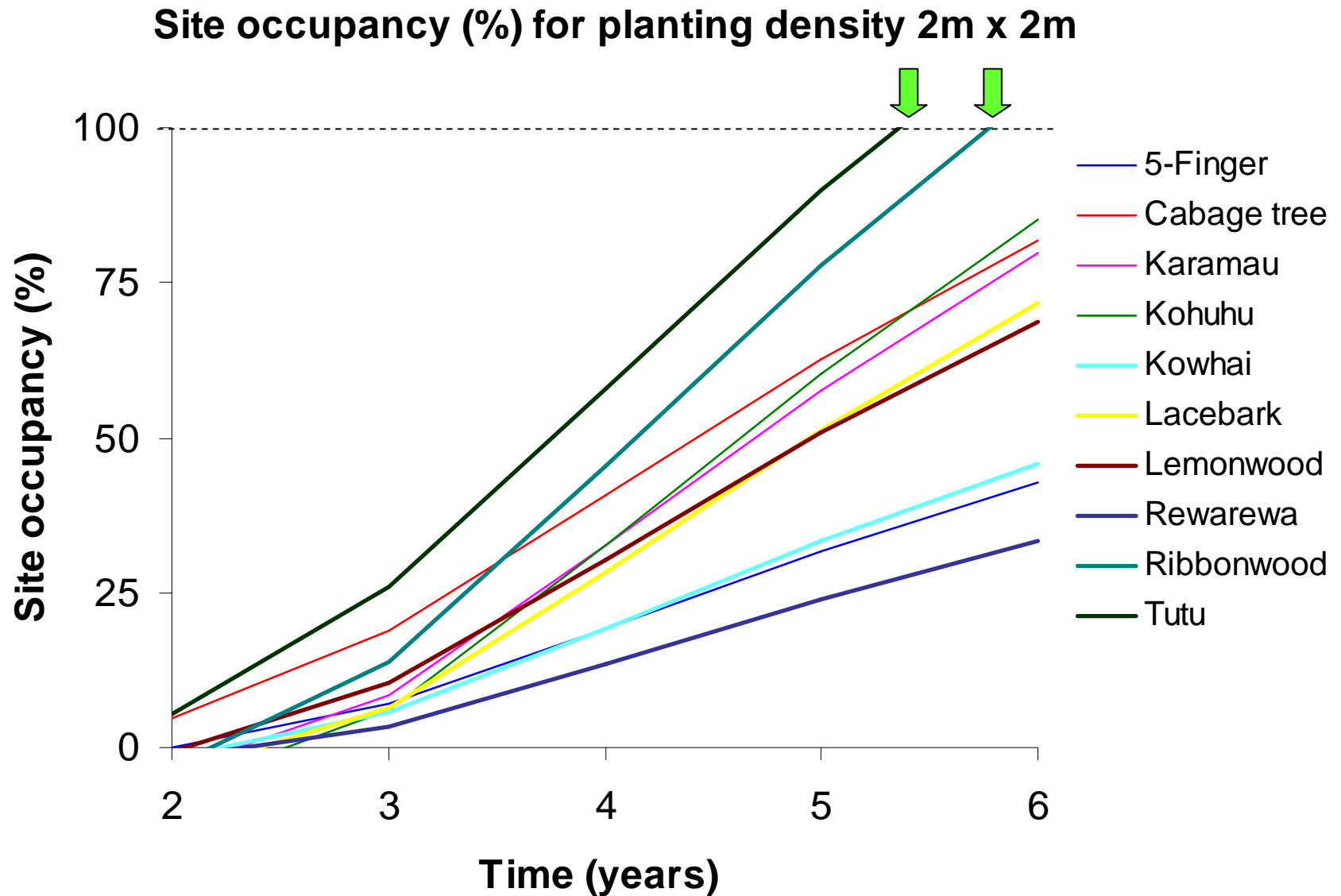


$$y = a + \frac{b}{x^{0.5}} + \frac{c}{\exp(x)}$$

How we use it – root site occupancy & density



How we use it – root site occupancy & density



How we use it – Visualisation

Avondale Stream, existing channel, May 2004



Avondale Stream, *Carex* added



Avondale Stream, *Juncus* added



Avondale Stream, native trees added



Existing channel has little in-stream cover



Riparian grasses provide cover & spawning habitat



Cabbage trees suitable above the wetland grasses



Tree ferns also suitable above wetland grasses




Chockie fish time...

- What native had the greatest tensile root strength?
- What do we call the gadget we use to expose the root systems of plants?
- What's so special about the root systems of cabbage trees?



Wrap up

- 
- We know more than we did before
 - Hard won data
 - Natives can grow quickly
 - Maybe need to look more at function
 - Opportunities for further research
 - Optimisation for site reinforcement
 - Carbon modelling
 - Modelling in general...

“The unhealthiness in our world today is in direct proportion to our inability to see it as a whole.”

Peter Senge

