Stabilising characteristics of NZ riparian plants

Chris Phillips & Mike Marden
Outline

• Set the scene
• The question
• What we did
• What we found
• What it means
• Summary

http://icm.LandcareResearch.co.nz/
An aside …… context?
Would you ….

• Take on a new breed of sheep or cow on your farm because someone said it would be good?
• Would you want to see numbers on growth performance? Mortality? Costs/benefits?
• Would you match the animal to the farm or accept that it is ok for any farm?

• What about native plants and their introduction back into NZ’s managed landscapes?
Riparian functions

- Filtering of contaminants – bugs, sed., nutr.
- Bank stabilization
- Nutrient uptake by plants
- Denitrification
- Shading for temperature
- Shading for instream plant control
- Input of wood & leaf litter
- Enhancing fish habitat
- Controlling downstream flooding
- Recreation
- Aesthetics
The Issue
The cure-all?
The Big Question?
Can our New Zealand native plants perform a river bank stabilising function as well as introduced willows?

In geotechnical terms, how do we quantify the benefits of vegetation to soil stabilisation?
What do we want from our plants?

- Root depth - anchor plant
- Root spread – overlap with adjacent plants
- Strong surface root mat – hydraulic protection
- High root biomass – more the better
- Root occupancy – biggest volume
- Root strength – stronger roots more resistant to external forces
What do we want from our plants?

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2 strands of recent work

Riparian plant trial

<table>
<thead>
<tr>
<th>Common name</th>
<th>Botanical name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karamu</td>
<td>Coprosma robusta</td>
</tr>
<tr>
<td>Ribbonwood</td>
<td>Plagianthus regius</td>
</tr>
<tr>
<td>Kowhai</td>
<td>Sophora tetraperta</td>
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<td>Lemonwood</td>
<td>Pittosporum eugenoides</td>
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<td>Hoheria populnea</td>
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<td>Mapou</td>
<td>Myrsine australis</td>
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<tr>
<td>Fivefinger</td>
<td>Pseudopanax arboreus</td>
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<tr>
<td>Cabbage tree</td>
<td>Cordyline australis</td>
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<tr>
<td>Rewarewa</td>
<td>Knightia excelsa</td>
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<tr>
<td>Manuka</td>
<td>Leptospermum scoparium</td>
</tr>
<tr>
<td>Tutu</td>
<td>Coriaria arborea</td>
</tr>
</tbody>
</table>

Cabbage trees

Marden, Rowan, Phillips  Czernin (2002)
Methods – plant trial

- 10 plants / species/ age class – 1 to 5 years
- 1 and 2 yr old plants from pots
- 3-5 yr old plants extracted from trial plot
- measured dbh, root collar, tree height, canopy width
- above-ground components - stem, branches & foliage
- root system extracted intact - air lance
- below-ground - root bole (stump) & roots
- roots – diam. size classes measured for length
- all components oven dried and weighed
- tensile strength of roots tested
Root spread

*Pittosporum tenuifolium* (kohuhu)

*Coprosma robusta* (karamu)
Root spread – 5 year old

(cm)

mapou, rewarewa, five-finger, manuka, karamu, kowhai, lacebark, cabbage.tree, kohuhu, ribbonwood, tutu, lemonwood
Results - root depth
Root depth – 5 year old

Mapou: 50 cm
Fiveinger: 45 cm
Kohuhu: 40 cm
Kowhai: 35 cm
Lemonwood: 30 cm
Manuka: 25 cm
Rewarewa: 20 cm
Lacebark: 15 cm
Tutu: 10 cm
Karamu: 5 cm
Ribbonwood: 0 cm
Cabbage tree: 5 cm
Root depth – cabbage tree

\[ y = 4.8813x \]

\[ r^2 = 0.9617 \]

Mean root collar diameter (cm) vs Rooting depth (cm)

Czernin (2002)
Biomass – 5 year old

Above-ground

Below-ground

(mapou rewarewa five.finger manuka kowhai lacebark kohuhu lemonwood karamu ribbonwood tutu cabbage.tree)

(kg)
Root tensile strength

(1 - 4 mm diameter)

Willows 30 - 75 MPa

Watson & Marden (submitted)

Mean max. tensile strength (MPa)

Riparian plant trial

Exotics

Willows 30 - 75 MPa

Rata
Lacebark
Hard beech
Kowhai
Manuka-1
Manuka-2
Red beech
Kanuka
Kohuhu
Kamahi
Fivesfinger
Rewarewa
Cabbage tree
Mountain beech
Douglas fir
Ribbonwood
Radiata pine
Lemonwood
Tutu
Karamu

Making a difference for a truly clean, green New Zealand

Manaaki Whenua Landcare Research
Implications for bank stabilization - small streams

• no limitations, provided that bank height is not more than ~2 m and channel bed is stable
• success depends on density - formation of dense canopy & full root occupancy of the soil
• shallow soil stabilisation after 3-5 years
• improvement in deeper slope stabilisation expected within 7-10 years of establishment
• species can withstand breakage and over-topple
Implications for bank stabilization - large streams

• lack of roots in deeper soil layers limits usefulness in streams where bank undercutting occurs
• ineffective if bank height exceeds effective rooting depth ~ 2 m.
• banks would need to be graded and unstable channel beds artificially regraded prior to planting
Decisions?

Ecologically designed vs functional performance?

- Depth – cabbage tree, ribbonwood
- Spread – lemonwood, ribbonwood
- Above gd biomass – cabbage tree, tutu
- Below gd biomass – cabbage tree, tutu
- Tree height – lacebark, ribbonwood, cab. tree
- Canopy spread – tutu, karamu
- Root strength – lacebark, kanuka, kohuhu
Summary

• NZ natives take longer to grow than exotics – but not slow
• Some natives can regenerate, eg cabbage trees - good
• On own, natives not as good as willows for stabilising soils
• Effective after about 5 years
• Change the ecological mix to suit site
• Mixed plantings of natives and exotics?
• More work needed
  – non-woody spp
  – Mixed exotic/native
  – modelling
The end

http://icm.LandcareResearch.co.nz/
## Species list and numbers extracted for partitioning

<table>
<thead>
<tr>
<th>Common name</th>
<th>Botanical name</th>
<th>Number of plants extracted /species/year</th>
<th></th>
<th></th>
<th></th>
<th>Species Total</th>
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<tbody>
<tr>
<td>Karamu</td>
<td>Coprosma robusta</td>
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<tr>
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<td><strong>Annual totals</strong></td>
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</table>
Biomass

*Pseudopanax arboreus* (fivefinger)