Site occupancy of native plants in New Zealand

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in this talk......

• Setting the scene
• Our approach
  – root site occupancy
• How we do it
• Some results
• Wrap up
Context – 1

Why the focus on natives?

• Loss of riparian vegetation
• Loss of ecosystem services
• Degraded water quality & habitat

• Public desire to redress
• Community action
• Natives over exotics
• What to use, how many & where

http://icm.LandcareResearch.co.nz/
Context – 2

Effectiveness of wide-spaced trees
Context – 2

Effectiveness of wide-spaced trees

How many? How far apart? Where to plant? When effective? How to gauge effectiveness?
The Big Question?

Can our New Zealand native plants perform a river bank stabilising function as well as introduced plants?

In geotechnical terms, how do we quantify the benefits of vegetation to soil stabilisation?
Native plant database
Mean max. root spread
5 year old natives

growth – above and below, canopy occupancy, root architecture, root biomass, root occupancy, root depth, root strength, root X-sectional area/shear area
Root site occupancy

100% root site occupancy
Root site occupancy

100% root site occupancy

What about these bits?
Poplars

Cabbage tree

Totara

McIvor et al (2007)

Czernin & Phillips (2005)

Marden & Phillips (unpub.)
Root site occupancy

Root biomass
Total root length
Root surface area
Root reinforcement
Etc.

Radial distance from stem/stump
Root site occupancy

Root reinforcement index (RFI) = \frac{\text{Root surface area}}{\text{Root spread area}}
Example - 5 Year old Cabbage tree
Estimating the Reinforcement Index (RFI)

Root surface
Area (cm²)

6301
3263
514

50cm 100cm 150cm

RFI(0 – 50 cm) = \( \frac{6301}{PI(50)^2} \) = 0.8022

RFI(0 – 100 cm) = \( \frac{3263}{PI(100^2 - 50^2)} \) = 0.1385

RFI(0 – 150 cm) = \( \frac{514}{PI(150^2 - 100^2)} \) = 0.0131

RFI = 0.9538

RSA = 2\(\pi\)R*L
Effective Root Spread Radius (ESR) = \[ \frac{\int_{0}^{R} x \cdot RFI(x) \, dx}{\int_{0}^{R} 1 \, dx} \cdot R \]

Note: For an ideal tree which has (100% root surface area / spread area, RFI = 1), \( ESR = R \)

\[(ESR)(cm) = \left( \frac{\text{Moment of RFI distribution of measured root spread on Y axis}}{\text{Moment of RFI distribution for 100% root spread on Y axis}} \right) \cdot R\]
Fig-5 Estimating ESR – 5 Year Cabbage tree

ESR (cm) = \[
\frac{[40.1 \times 25 + 15.22 \times 75 + 12.45 \times 66.6 + 7.1 \times 125 + 4 \times 91.6] \times 150}{[150 \times 75]}\]
= 57 cm
Effective root spread measured & predicted using model equation

\[ y = a + \frac{b}{x^{0.5}} + \frac{c}{\exp(x)} \]
### Model parameters

#### Parameters for Effective Root Spread Radius

<table>
<thead>
<tr>
<th>Species</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-Finger</td>
<td>175.89</td>
<td>-328.5</td>
<td>416.75</td>
<td>94</td>
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<tr>
<td>Cabbage tree</td>
<td>311.82</td>
<td>-567.9</td>
<td>698.45</td>
<td>96</td>
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<td>Karamu</td>
<td>347.6</td>
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<td>857.97</td>
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<td>Kohuhi</td>
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<tr>
<td>Kowhai</td>
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<td>Lemonwood</td>
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<td>-536.3</td>
<td>683.5</td>
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<td>Mapou</td>
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<td>-105.8</td>
<td>137.3</td>
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<tr>
<td>Rewarewa</td>
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<td>-277.58</td>
<td>360.6</td>
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<td>Ribbonwood</td>
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<td>1100.4</td>
<td>98</td>
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<td>Tutu</td>
<td>452.8</td>
<td>-826.7</td>
<td>1013.59</td>
<td>99</td>
</tr>
</tbody>
</table>
Site occupancy (%) for planting density 2m x 2m

- 5-Finger
- Cabage tree
- Karamau
- Kohuhu
- Kowhai
- Lacebark
- Lemonwood
- Rewarewa
- Ribbonwood
- Tutu
Next steps?

- Aim to develop a simple tool
- Choose a mix of species
- Optimisation for site reinforcement
- Scenario testing
- Carbon modelling
- Other parameters such as canopy spread – shade etc
Takeaways

• Not all native plants perform the same
• Root surface area reflects root-soil interaction
• Root site occupancy good measure
• Effective root spread better estimator than mean max root spread
• Develop models for use in planting plans
• Use natives for different functions?
Thanks for listening

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

Peter Senge