A Collaborative Approach: Using NZ native plant DOM super producers to mitigate metal toxicity

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Background

- Dissolved copper (Cu) and zinc (Zn) pose a threat to aquatic ecosystems and existing engineered systems often fail to address their environmental impact
- This collaborative research (see diagram for overview) explores how plant-derived dissolved organic matter (DOM) can reduce metal toxicity in freshwaters
- By combining mātauranga Māori (indigenous knowledge), engineering, chemistry and ecotoxicology we aim to co-develop practical, culturally grounded, nature-based solutions for metal pollution

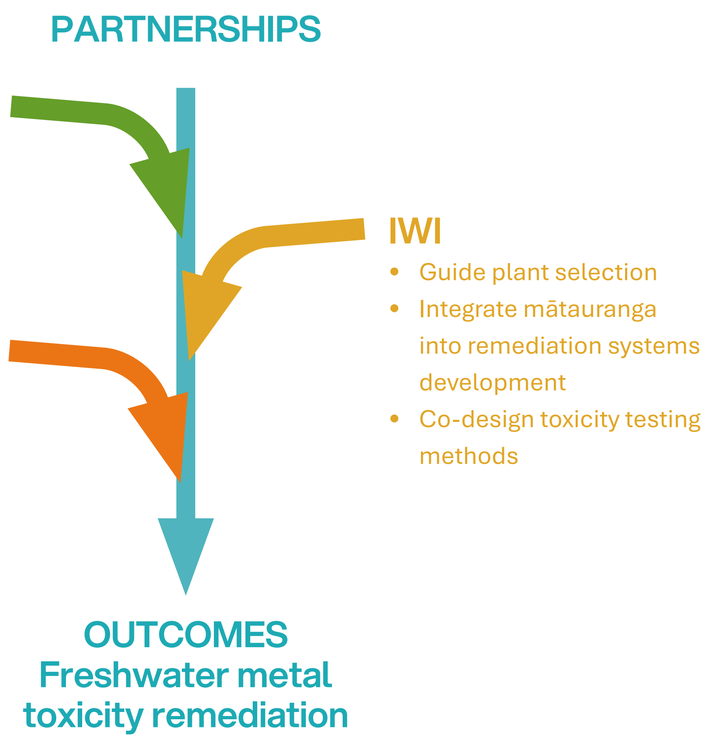

Figure 1
Test organism – *D. thomsoni* under magnification (right) and a DOM stained freshwater stream (left)

Methods

- Three native NZ plants—Mānuka (*Leptospermum scoparium*), Karamū (*Coprosma robusta*), and Pōhutukawa (*Metrosideros excelsa*)—were selected using mātauranga Māori for their association with Wai Māori
- Leachates were prepared by soaking 100 g dried leaves in 4 L of aged, aerated nanopure water at 20 °C for 7 days. The leachate was subsequently decanted, centrifuged (3000 rpm), filtered (GF/C), quantified for yield and diluted as required
- Acute 48-hour toxicity tests using juvenile *Daphnia thomsoni* (Fig. 1) assessed survival across five concentrations of Cu, Zn, and a 1:6 Cu:Zn mixture, with and without 5 or 10 mg/L plant-derived DOC

Results

DOC yield

- Mānuka 45 mg/g
- Karamū 52 mg/g
- Pōhutukawa 25 mg/g

The concentration-response relationships were influenced by both the DOC source and concentration, as well as the specific metal, highlighting complex interactions (Fig. 3).
Based on EC50 values, higher DOC levels reduced Cu and Zn toxicity to *D. thomsoni* (Fig. 2)

At 5 mg/L DOC:

- Mānuka was most effective for Zn (2.3x reduction compared to the negative DOC control), least for Cu (3.8x)
- Pōhutukawa was most effective for Cu (12x), second for Zn (1.9x)
- Karamū was second for Cu (5.1x)

At 10 mg/L DOC:

- Mānuka was most effective for both Cu (25x) and Zn (3.5x)
- Pōhutukawa followed closely (20x Cu, 2.8x Zn)
- Karamū was least effective

For Cu:Zn mixtures:

- Mānuka provided the greatest protection at both DOC levels

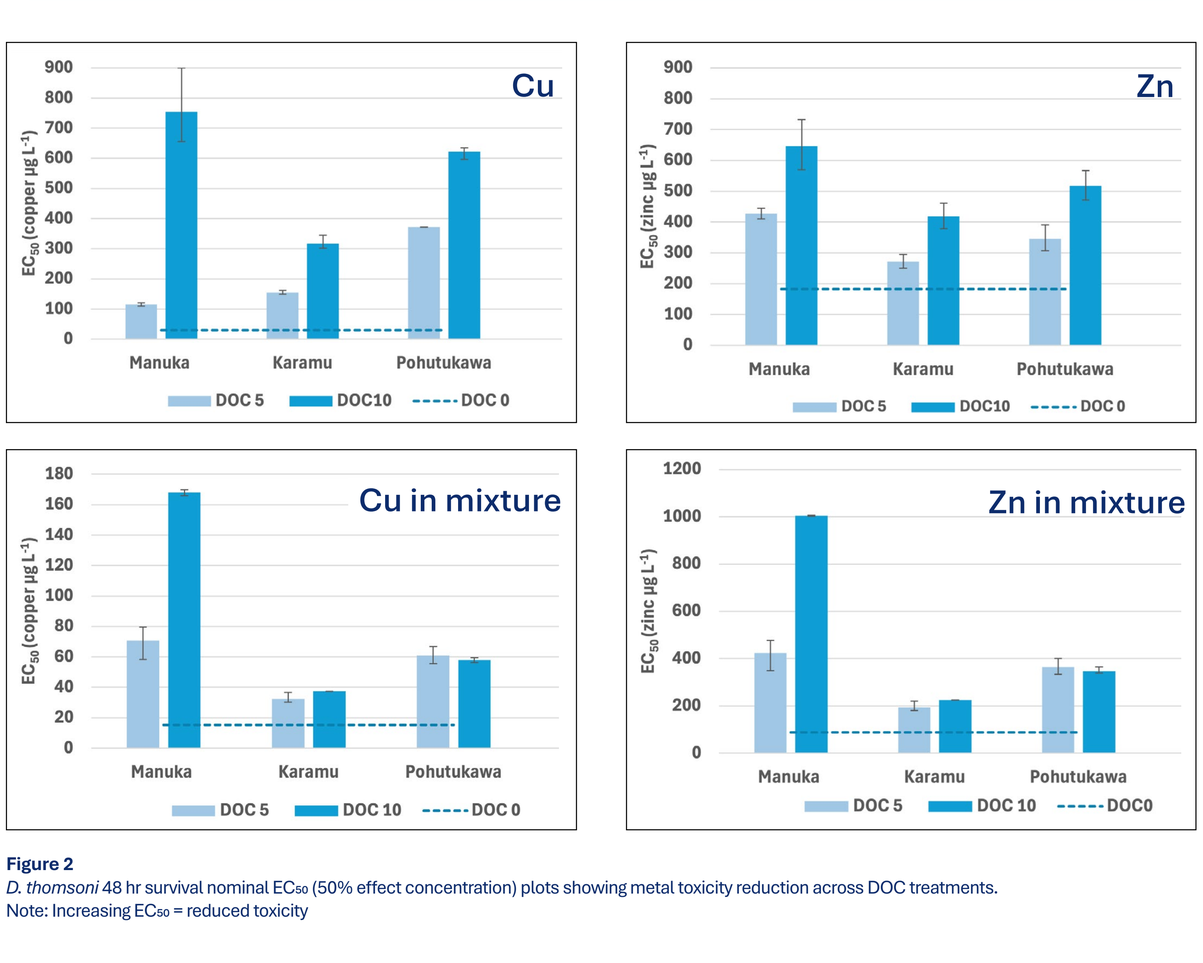

Figure 2
D. thomsoni 48 hr survival nominal EC_{50} (50% effect concentration) plots showing metal toxicity reduction across DOC treatments.
Note: Increasing EC_{50} = reduced toxicity

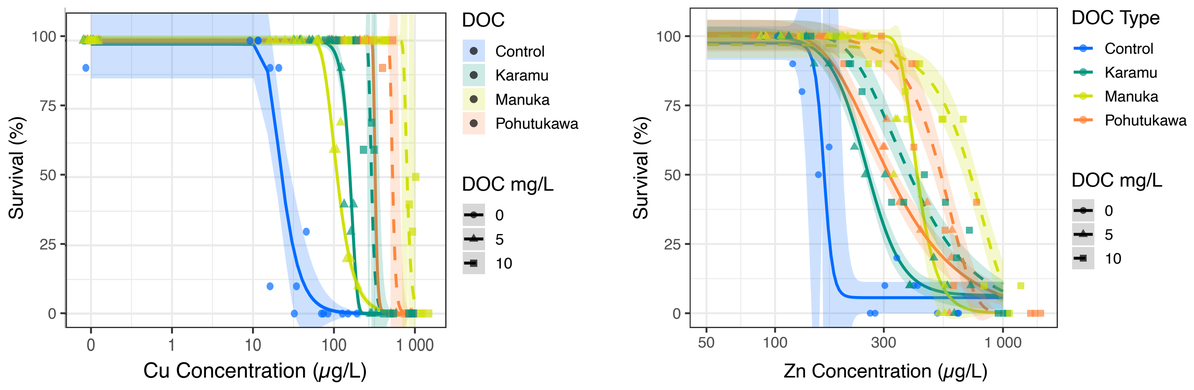

Figure 3
Nominal concentration-response relationships for *D. thomsoni* 48 survival when exposed to a combination of metal (Copper left and Zinc right) and DOC treatments

Conclusions

- DOM from Pōhutukawa and Mānuka offered the greatest protection, despite lower yields—highlighting their potential as effective, culturally relevant components in nature-based metal remediation systems.

Next steps

Ongoing toxicity and DOM characterisation are informing a DOM-metal mixture bioavailability model to better predict metal impacts and guide mitigation using identified 'super producers'. Further plant screening and model validation are planned. Standard toxicity methods are being reviewed with iwi to integrate mātauranga Māori, ensuring alignment with Māori values, a globally novel approach. Future assessments of potential nature-based solutions will shape end-user guidance of feasible, culturally aligned systems that enhance the mauri of our freshwaters.

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