Use of pesticides and fertilisers in New Zealand’s planted forests – implications for water quality

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New Zealand’s planted forests

- Currently 7% (1.7 million ha) planted forest cover
- Main species *Pinus radiata* (90%)
- Around 70% FSC certified
Planted forest rotation - key chemical & fertiliser use

Typical rotation length = 28 years

Pre-plant weed control – glyphosate, metsulfuron

Post-plant fertiliser - nitrogen, phosphorus, boron

Post-plant weed control – terbuthylazine, hexazinone, triclopyr & clopyralid

Pest & disease control
- copper fungicide (dothistroma needle blight)
- alpha-cypermethrin (Eucalyptus tortoise beetle)

Typical rotation length = 28 years
Issues - chemical & fertiliser use in NZ planted forests

- Use of chemicals, cost effective & critical for viability of tree crop
- Increasing national & international pressure to reduce or eliminate use
  - FSC
  - NPS-freshwater management
  - Nutrient limit setting – water and land
- Forest industry wanting to increase productivity
- Needs to be within sustainable limits – impact on ‘social licence to operate’

Objectives

- Research to date on impact of chemical use on water quality
- Outline research in progress on fertiliser use & water quality
- Research gaps
Terbuthylazine & Hexazinone

- Aim: to evaluate the environmental fate of terbuthylazine and hexazinone under operational conditions

- Two field studies
  - Kaingaroa Forest – Pumice Soils, treated 2 consecutive years, 1st year data presented
  - Omaio Forest – steepland, Recent Soils, 1 year (data not presented)

Kaingaroa Forest

- aerially sprayed 1st November 2012, Release KT; 17 L ha⁻¹; Terbuthylazine (43.5% w/v) and Hexazinone (6.5% w/v) & tracer
- 10m no-spray buffer along stream
Kaingaroa Forest monitoring

- Site 1, 12.5ha (100% sprayed)
  - tracer plates along stream channel
  - pre-spray, spray day & post-spray monitoring water (herbicides & WQ), sediment and algae (herbicides) & flow

- Site 2, 51.8 ha (45% sprayed)
  - Spray day & post-spray monitoring water (herbicides & WQ) & flow
Results - spray day

- Spray drift into stream approx. 28% of spray rate

### Spray day - herbicide concentrations in stream

- **Terbuthylazine (ppb)**
  - Sediment (Site 1): 3300
  - Algae (Site 1): 8100
  - Site 2 (water): 32

- **Hexazinone (ppb)**
  - Below DL 1 month
  - Below DL 1-4 months

1 ppb = 1 µg L⁻¹
Cumulative effects of herbicide use

- Landscape scale (capture spatial & temporal variation in herbicide treatment programmes)

- Upper Rangitaiki Basin (118,345 ha)
- 71% in planted forest
- Flow gauge median flow of 13.411 m³ s⁻¹ (c.f. long-term average 21.446 m³ s⁻¹)
- Prototype excel model routed herbicide residues from their point of entry into the river to the flow gauge on the Rangitaiki River
Cumulative effects of herbicide use - results

- Some localized space & time crowding
- Modelling of chemical residue loadings and concentrations of terbuthylazine & hexazinone indicate herbicide residues in the river mainly below analytical detection limits
- Safety factors for drinking water quality standards, aquatic organisms, and human Acceptable Daily Intake levels were very large

Modelled daily average concentrations of (A) hexazinone (Yr 2) & (B) terbuthylazine (Yr 1)
Copper in waterways

- Three sites in the central North Island
- Pumice soils
- Tree ages 4-15 years

- Aerial application mid-November
- 1.14 kg cuprous oxide (Sites 1 & 3), 1.125 kg cuprous oxide (Site 2) + 2 L mineral oil + water + 5 L solution
- Spray drift method
Site 1: 5 yr-old-trees

Below detection limit of 11 ug L⁻¹

Copper concentration (µg L⁻¹)

Days after treatment
Copper concentration (µg L\(^{-1}\))

Days after treatment

Site 2: 8-9 yr-old-trees

Site 2

sprayed area
tracer plates
water monitoring point
flight line direction
stream flow direction

Copper concentration (µg L\(^{-1}\))

Days after treatment

Site 2: 8-9 yr-old-trees
SITE 3

- **sprayed area**
- **tracer plates**
- **water monitoring point**
- **flight line direction**
- **stream flow direction**

Copper concentration (µg L⁻¹) vs. Days after treatment

- **W1**
- **W2**
- **T1**
- **T2**
- **T3**

0 480 960 1140 1920 meters
Results

- Wide range of site conditions – copper detected for a few hours on the day of application, not detected in 1st rainfall event
- NZ drinking water standards (2,000 ug L\(^{-1}\)) not exceeded
- FSC standard (LC\(_{50}\) 18.9 ug L\(^{-1}\) for 48 hours) – concentrations exceeded but below time threshold
- ANZECC guidelines - freshwater trigger value to protect 95% of species is 1.4 μg/L. This applies to waters of hardness of 30 mg/L as CaCO\(_3\), test duration (7-42 days) concentrations exceeded but below time threshold (based on regression)
- ANZECC interim sediment quality guideline trigger values (low- 65 mg kg\(^{-1}\); high-270 mg kg\(^{-1}\)) not exceeded
Fertiliser use

- Some studies but dated
- Current research – Growing Confidence in Forestry’s Future (GCFF) programme (increased productivity within sustainable limits)
- Research underway for mid-rotation water quality fertiliser trial

1. Tairua Forest
   - Control
   - Liquid foliar N & P fertiliser
   - DAP

2. Tarawera Forest
   - Control
   - Liquid foliar N & P fertiliser
   - Urea

Site 3: Yet to be confirmed
Key Results & conclusions

- Using latest technologies, GIS, GPS, boom & nozzle configurations, & following good management practices, label instructions, minimise risk to aquatic environment

- Highest risk on the day of application and rainfall events shortly thereafter

- Risk to human health low

- Risk to aquatic environment generally low, however impact where the threshold is exceeded but not the time frame is unknown
Knowledge Gaps

Chemical Use in NZ planted forests

- Glyphosate key chemical used but no NZ field data - but a literature review on its use in production forests
- Need to assess impacts on NZ aquatic organisms at concentrations and durations typically occur in planted forest streams under operational scenarios
- North Island sites – replication into other site conditions
- Further development of the cumulative effects model

Fertiliser use

- Need to assess latest fertiliser treatments (operational & experimental) in the early part of the forest rotation on water quality
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References


