Land use pressures on water quality in dairy farming catchments in New Zealand

Ross Monaghan
David Houlbrooke
Denise Bewsell

AgResearch

Bob Wilcock
John Quinn

NIWA
NZ Dairy Industry

18 billion litres milk year\(^{-1}\)
- 90% exported
- 19% of NZ exports

Expansion driven by:
- greater area
- \(\uparrow\) cows/ha
- \(\uparrow\) production
NZ regulatory frameworks for WQ

Few currently....

Clean Streams Accord:

  Voluntary Industry-driven initiative commitment to:
  1. fence stock out of streams
  2. nutrient budgeting
  3. protect wetlands
  4. local compliance re effluent management
  5. eliminate stock crossings
Catchment locations
(all predominantly dairy)

2001 – 2011

Toenepi 1,580 ha
Waiokura 2,090 ha
Inchbonnie 600 ha (commenced 2004)
Waikakahi 5,230 ha
Bog Burn 2,480 ha

(All predominantly dairy)
The catchment management planning process

- Monitoring, status
- Identify key land-water linkages
- Establish catchment values/targets
- Farm planning

Review the plan’s success

OVERSEER
BMP Toolbox:
Identify key land-water linkages
Establish catchment values/targets
Farm planning

Monitoring, status

Stream water quality status

Turbidity
FRP (0.01 g m⁻³)
Nitrate-N (0.44 g m⁻³)
E. coli (126 cfu 100 ml⁻¹)
Black disc

% of water quality guideline

Bog Burn
Inchbonnie
Waikakahahi
Waiokura
Toenepi

(0.01 g m⁻³)
(0.44 g m⁻³)
(126 cfu 100 ml⁻¹)
Toenepi and Waiokura catchments

Olsen P = 65 mg L\(^{-1}\)
Inchbonnie, Waikakahi and Bog Burn catchments

- Monitoring, status
- Identify key land-water linkages
- Establish catchment values/targets
- Farm planning
Stakeholder workshop

- Monitoring, status
- Identify key land-water linkages
- Establish catchment values/targets
- Farm planning
Why are these streams important?

<table>
<thead>
<tr>
<th></th>
<th>Recreation</th>
<th>Fishing</th>
<th>Domestic water</th>
<th>Artificial drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bog Burn</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Waikakahi</td>
<td>✔</td>
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<td>Waiokura</td>
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Decision tools

1. Overseer® Nutrient Budgets
Decision tools

1. Overseer® Nutrient Budgets

2. BMP Toolbox

- **Effectiveness (%)**
  - Nitrification inhibitors: 25 - 35
  - Stream fencing: 3 - 13
  - Optimal effluent mgmt: 2 - 6
  - Wintering shelter: 25 - 35
  - Restricted aut grazing: 30 - 50
  - Low N feed: 10 - 15
  - Nil N fertiliser: 20 - 30
  - Dry stock farming: 55 - 65

- **Cost ($/cow/year)**
  - Nitrification inhibitors: 10 – 30
  - Stream fencing: 6
  - Optimal effluent mgmt: 6
  - Wintering shelter: 13 – 73
  - Restricted aut grazing: 65
  - Low N feed: 40
  - Nil N fertiliser: 73
  - Dry stock farming: 160 – 700

- **Cost per kg N conserved ($/kg)**
  - Nitrification inhibitors: 1 - 2
  - Stream fencing: 0.6
  - Optimal effluent mgmt: 0.6
  - Wintering shelter: 1 - 3
  - Restricted aut grazing: 65
  - Low N feed: 40
  - Nil N fertiliser: 73
  - Dry stock farming: 160 – 700

- **Net Benefit/Cost**
  - Net benefit
  - Net cost
1. Whole-farm plans
   – Toenepi

2. Riparian plans
   – Waiokura

3. “Accord + 1”
   – Waikakahi: + 1 = border dyke wash
   – Bog Burn: + 1 = effluent management
Whole farm P fertiliser inputs

Economically optimal input

P input
kg P/ha year

Toenepi  Waiokura  Waikakahi  Bog Burn

2001  2003  2006  2009
Toenepi catchment
Water quality trends: 2001-2010

<table>
<thead>
<tr>
<th>Focus</th>
<th>TN</th>
<th>TP</th>
<th>Water clarity</th>
<th>E.coli</th>
<th>%DO</th>
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<tbody>
<tr>
<td>Recreation</td>
<td></td>
<td></td>
<td>↑</td>
<td>=</td>
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**Improvements:**
- Land application of effluent
- P balance
- Some riparian protection

**Pressures:**
- Increasing stocking rate
Waiokura catchment
Water quality trends: 2001-2010

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<tr>
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<td>↓ ↑ ↓</td>
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Recreation and Fishing focus areas with trends for TN (↓), TP (↑), water clarity (↓), E.coli (↓), and %DO (=).
Waiokura riparian protection:

![Graph showing water, sediment, and phosphorus levels over time between 2001-02 and 2006-07.]
Waikakahi catchment
Water quality trends: 2001-2010

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<td>↑</td>
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[Images of a stream and a field]
## Bog Burn catchment
### Water quality trends: 2001-2010

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<td>=</td>
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<tr>
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<td>↑</td>
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BMP adoption

1. Environmental considerations set scene
   - but are often not the key driver of adoption
   - logistics & economics are

2. Range of options preferred

3. Two ingredients of success:
   a. clear signals
   b. strong extension networks
Conclusions

1. Planning process is key
   – biggest “bang for buck”

2. BMPs can make a difference
   – some at little or nil cost
   – good progress with farm nutrient management planning

3. Toolbox of options preferred

4. Slow adoption of BMPs that incur significant net cost
Value of the catchments study

1. “long” term laboratories
   a. WQ status and trends
   b. Community discussions
      - values, mitigation costs

2. Social science perspectives

   But do not prove/disprove the merits of individual BMPs
   - but smaller scale studies nested within them can
Acknowledgements

DairyNZ & Pastoral21 funders

Sustainable Farming Fund

New Zealand Fertiliser Manufacturers’ Research Association

FRST
## Toolbox of BMPs

e.g. Bog Burn dairy farms

<table>
<thead>
<tr>
<th>Reduction in N loss</th>
<th>Cost-effectiveness</th>
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<tbody>
<tr>
<td>%</td>
<td>$/kg reduced N leaching</td>
</tr>
<tr>
<td>Nitrification inhibitors</td>
<td>10</td>
</tr>
<tr>
<td>Wintering barns</td>
<td>28</td>
</tr>
<tr>
<td>Maximising the value of effluent nutrients</td>
<td>6</td>
</tr>
<tr>
<td>Restricted autumn grazing*</td>
<td>56</td>
</tr>
<tr>
<td>Wetlands</td>
<td>30</td>
</tr>
<tr>
<td>Nil N fertiliser</td>
<td>25</td>
</tr>
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<td>Low N feed</td>
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Trends in modelled N loss and production efficiency
Trends in modelled P loss and production efficiency

NS

(P < 0.05)
Best Management Practices Do Work

Sediment load at Glenavy

+5 y
Annual milk prod. L ($10^9$)