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

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agresearch Farming, Food and Health. First
Te Ahuwhenua, Te Kai me te Whai Ora. Tuatahi

DairyNZ

Fonterra

NIWA
Taihoro Nukurangi

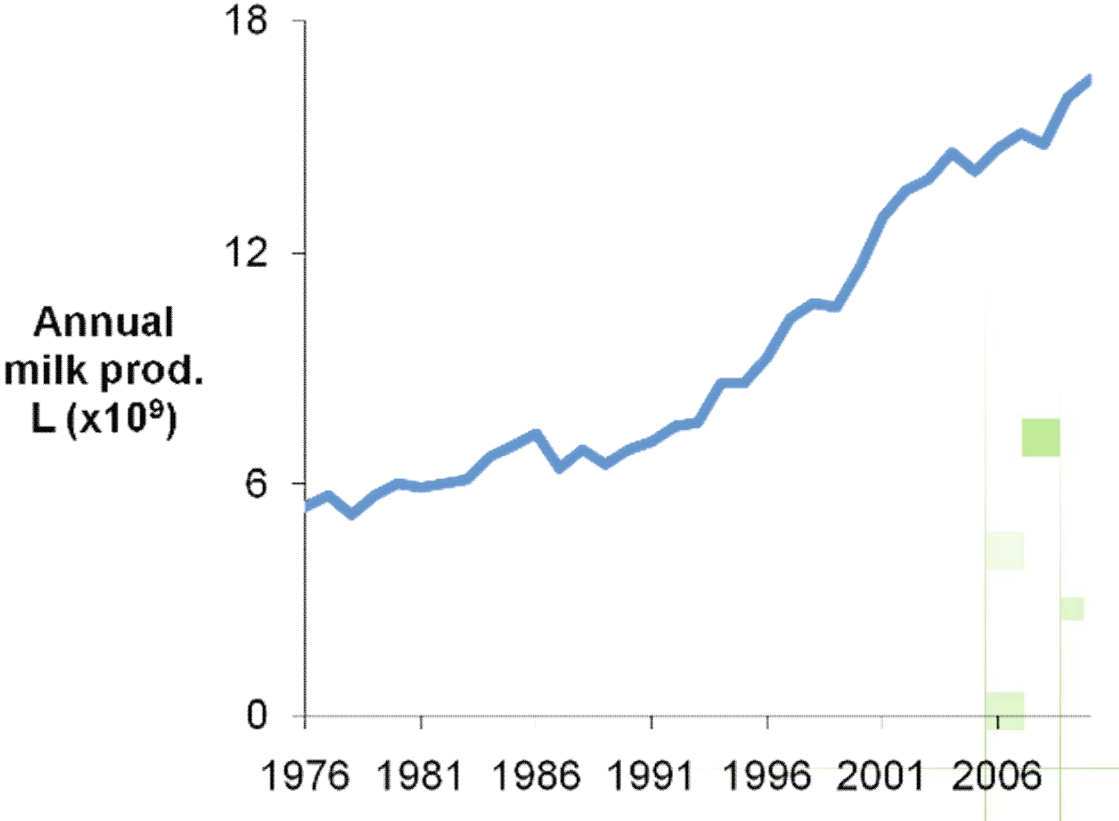
NZ Dairy Industry

18 billion litres milk year^{-1}

- 90% exported
- 19% of NZ exports

Expansion driven by:

- greater area
- ⇧cows/ha
- ⇧production



NZ regulatory frameworks for WQ

Few currently....

Clean Streams Accord:

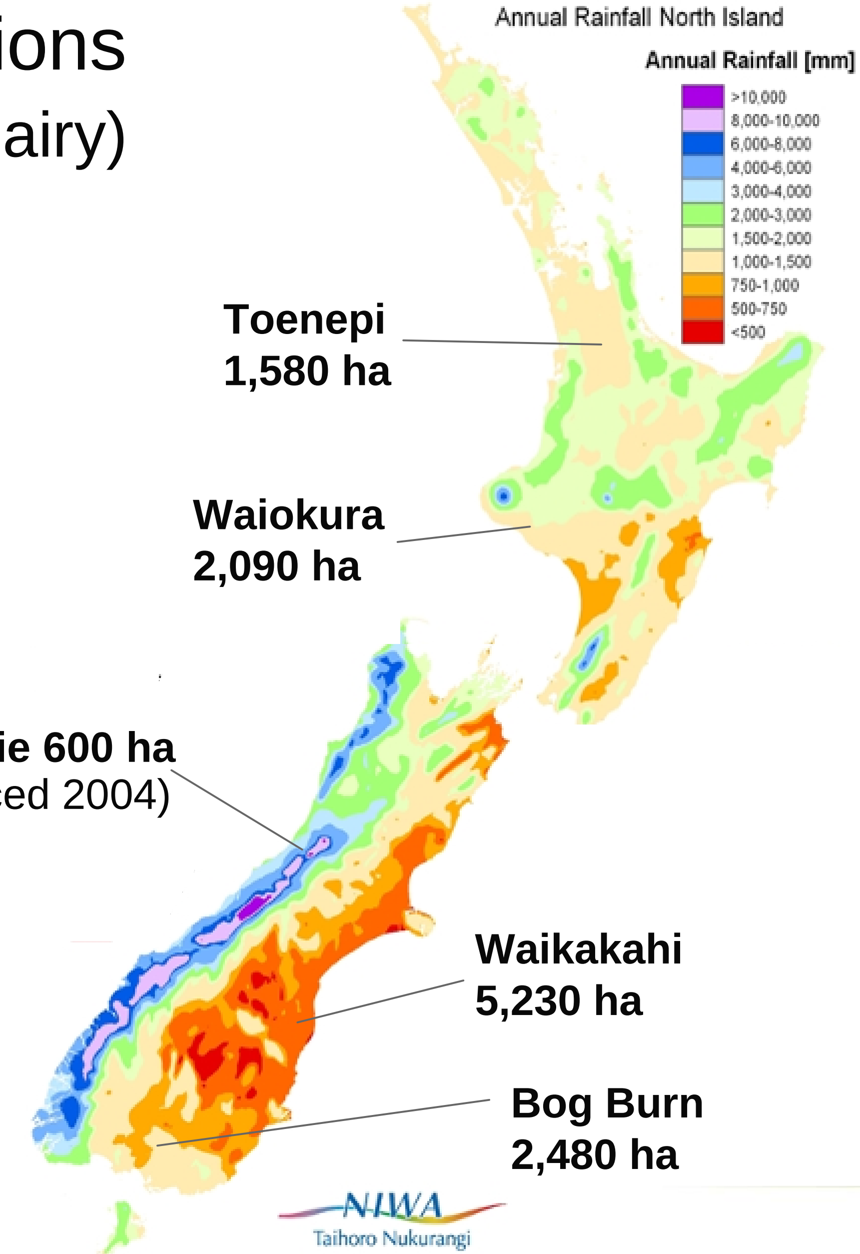
Voluntary Industry-driven initiative commitment to:

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

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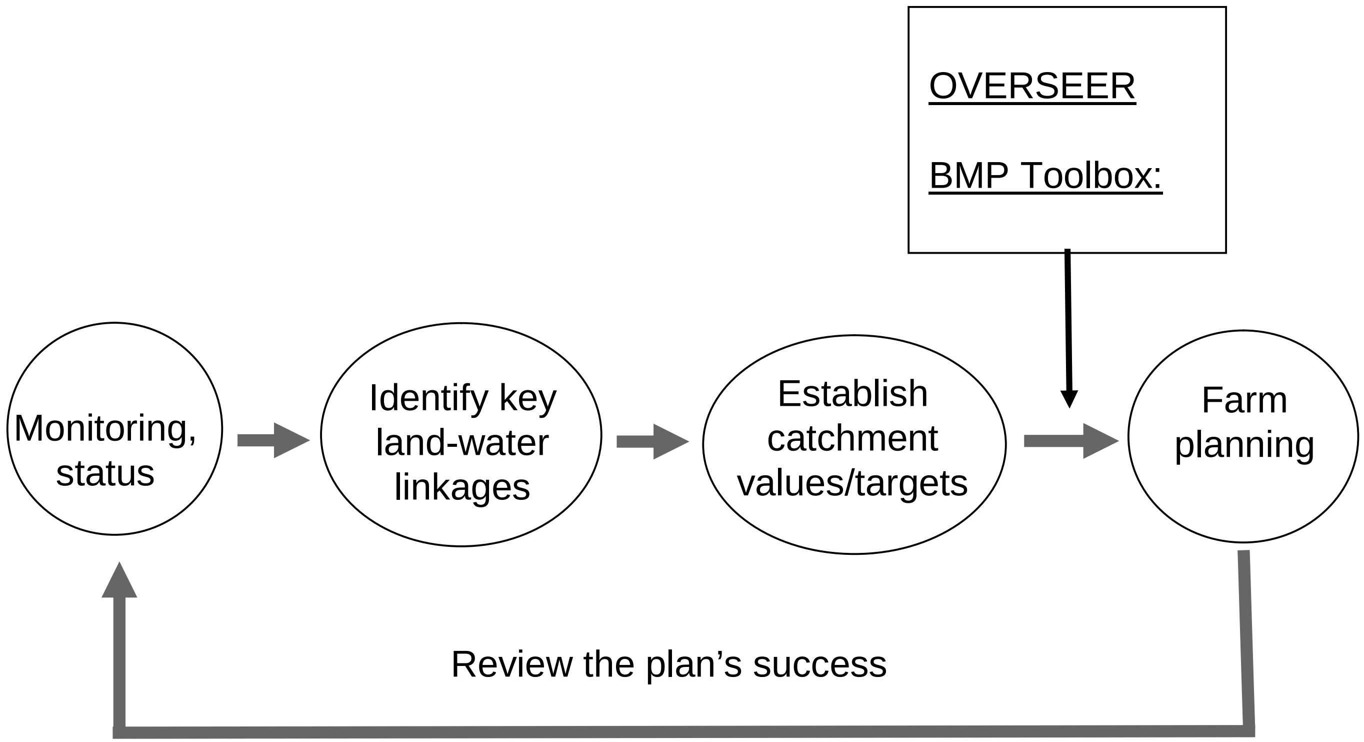
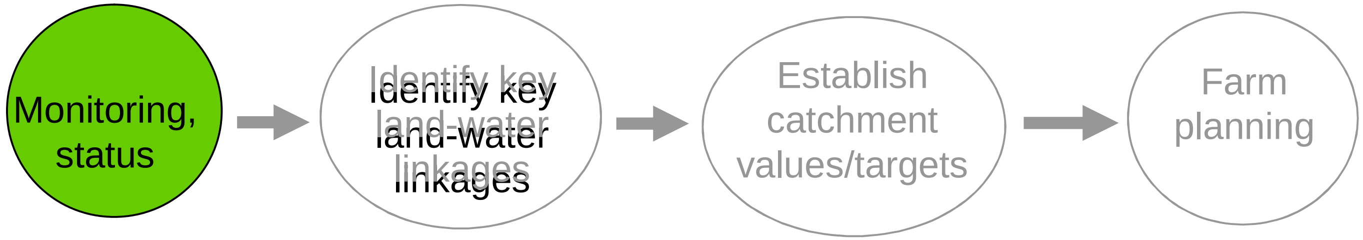
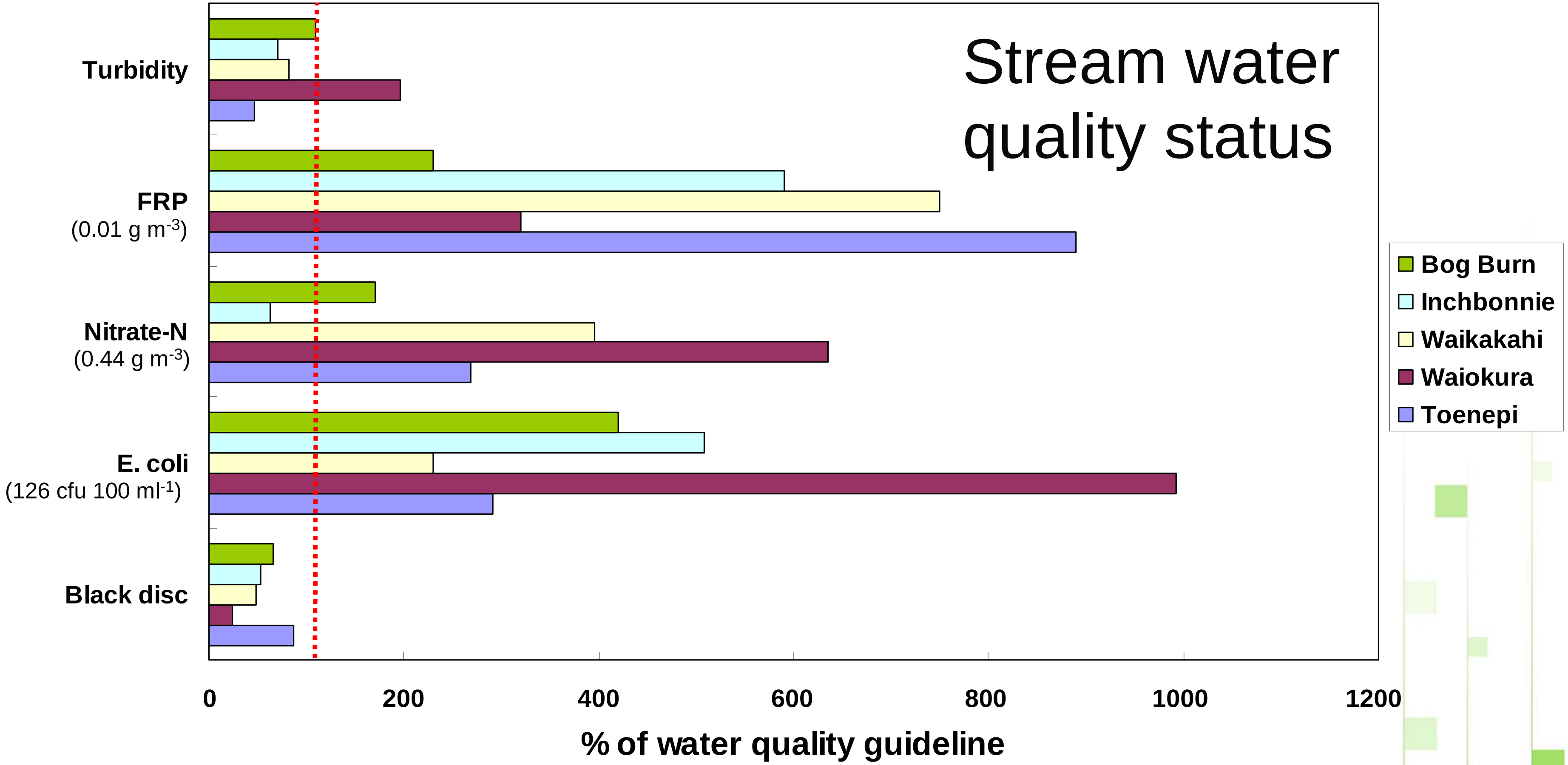
The catchment management planning process





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



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
0
200
400
600
800
1000
1200
% of water quality guideline
Bog Burn
Inchbonnie
Waikakahi
Waiokura
Toenepi

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

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Toenepi and Waiokura catchments

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

Inchbonnie, Waikakahi and Bog Burn catchments

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

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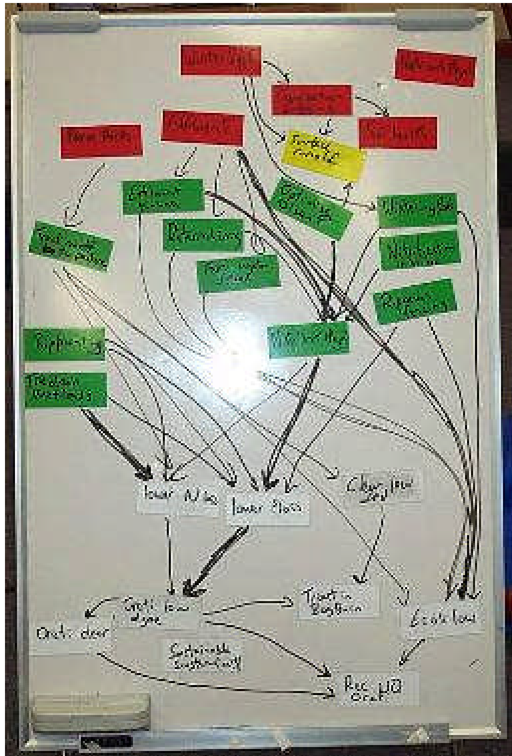
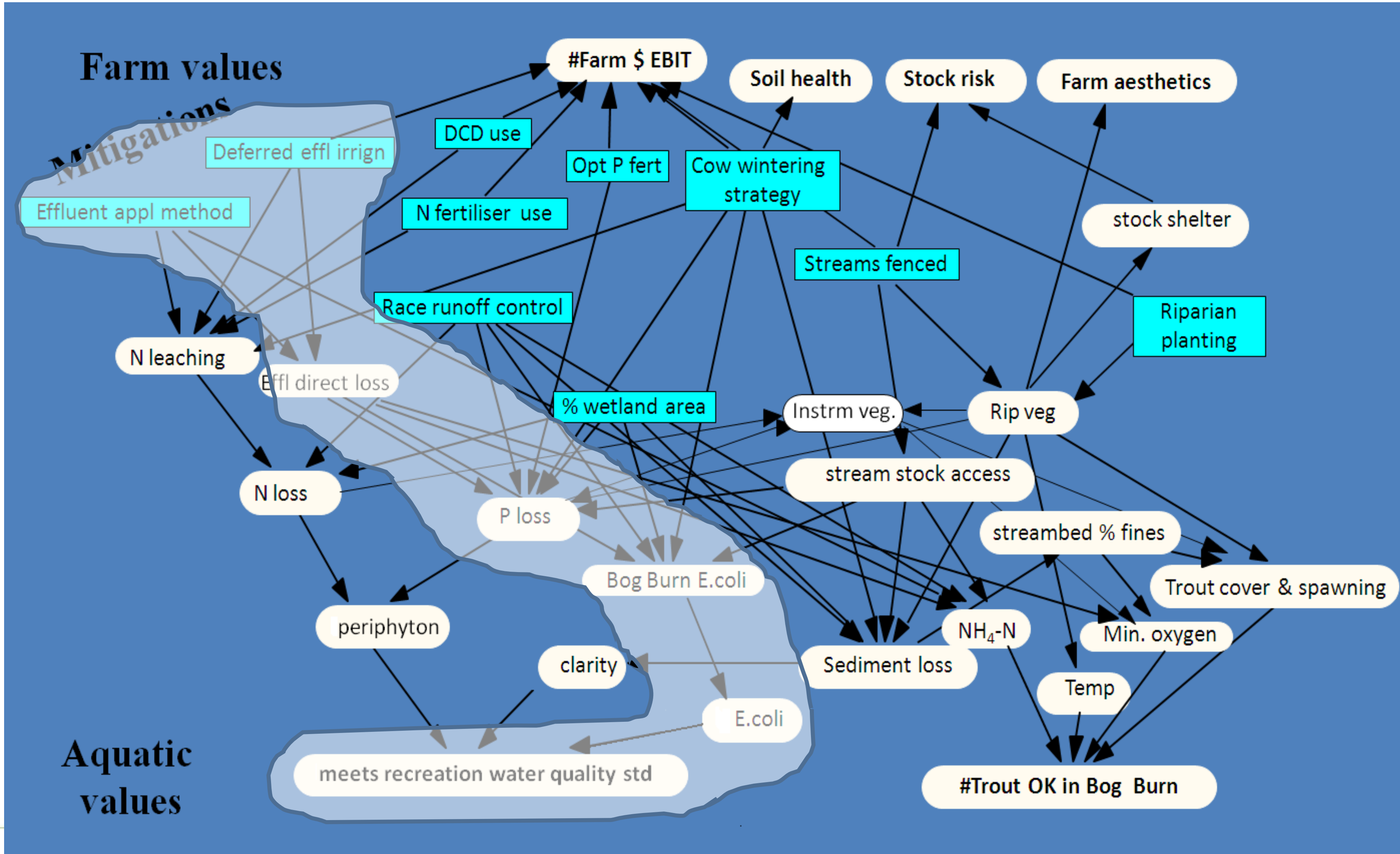
Stakeholder workshop



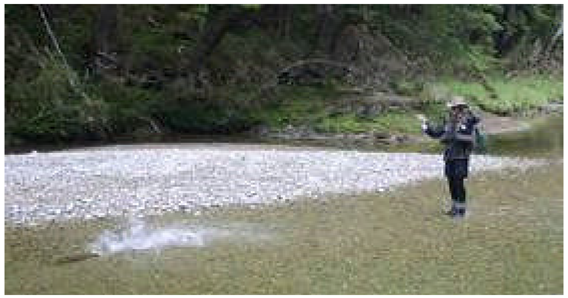
Conceptual linkage model for Bog Burn

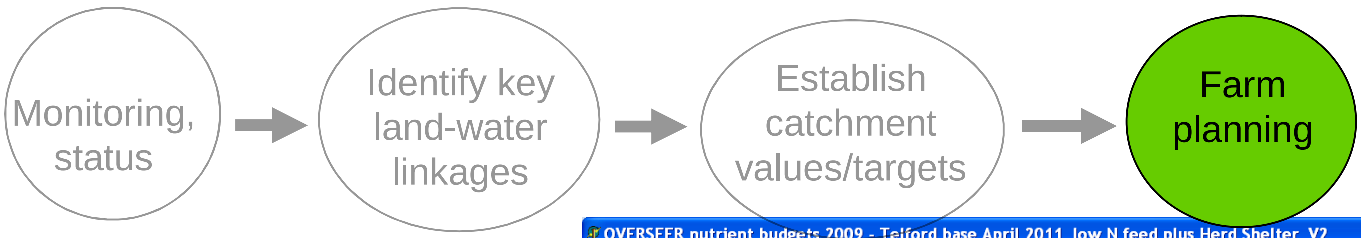


Monitoring, status → Identify key land-water linkages → **Establish catchment values/targets** → Farm planning

Why are these streams important?

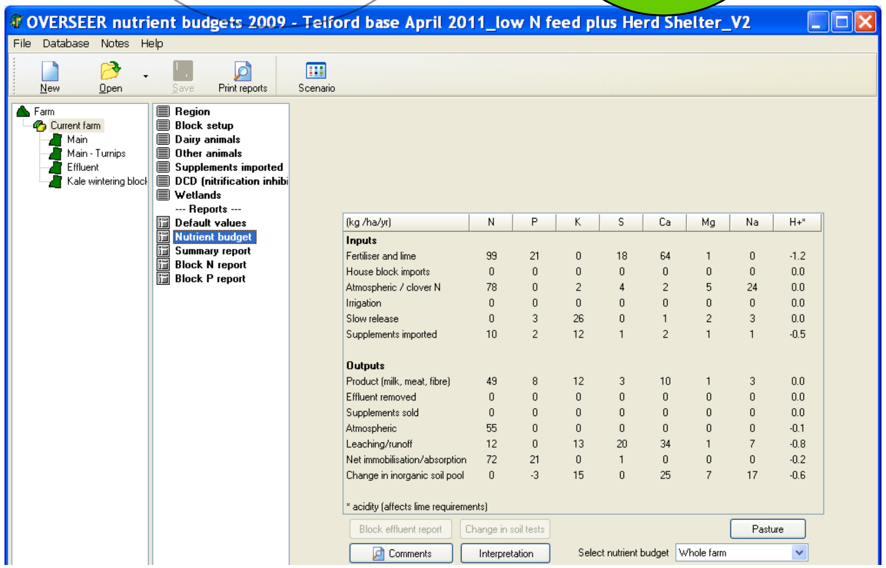
	Recreation	Fishing	Domestic water	Artificial drainage
Bog Burn	✓	✓	✓	✓
Waikakahi		✓		✓
Waiokura	✓	✓		
Toenepi	✓			✓

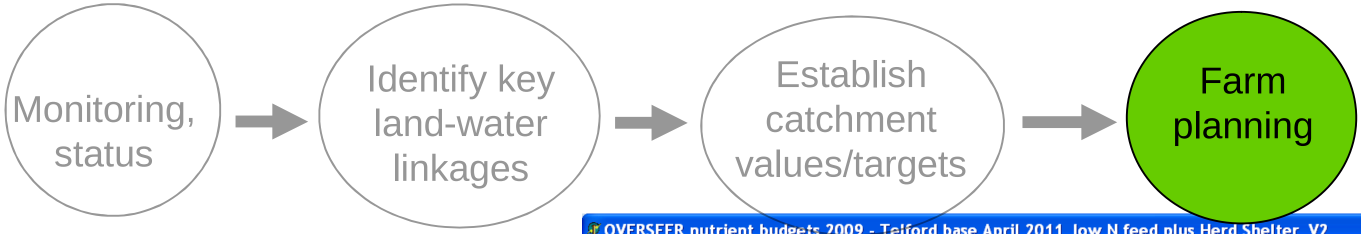
Decision tools

1. Overseer® Nutrient Budgets



(kg /ha/yr)	N	P	K	S	Ca	Mg	Na	H+*
Inputs								
Fertiliser and lime	99	21	0	18	64	1	0	-1.2
House block imports	0	0	0	0	0	0	0	0.0
Atmospheric / clover N	78	0	2	4	2	5	24	0.0
Irrigation	0	0	0	0	0	0	0	0.0
Slow release	0	3	26	0	1	2	3	0.0
Supplements imported	10	2	12	1	2	1	1	-0.5
Outputs								
Product (milk, meat, fibre)	49	8	12	3	10	1	3	0.0
Effluent removed	0	0	0	0	0	0	0	0.0
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	55	0	0	0	0	0	0	-0.1
Leaching/runoff	12	0	13	20	34	1	7	-0.8
Net immobilisation/absorption	72	21	0	1	0	0	0	-0.2
Change in inorganic soil pool	0	-3	15	0	25	7	17	-0.6

* acidity (affects lime requirements)



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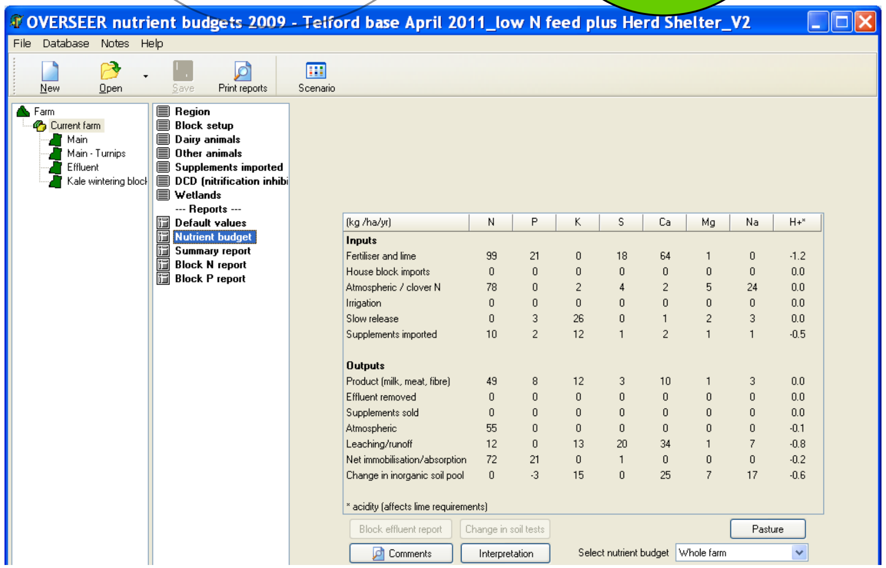

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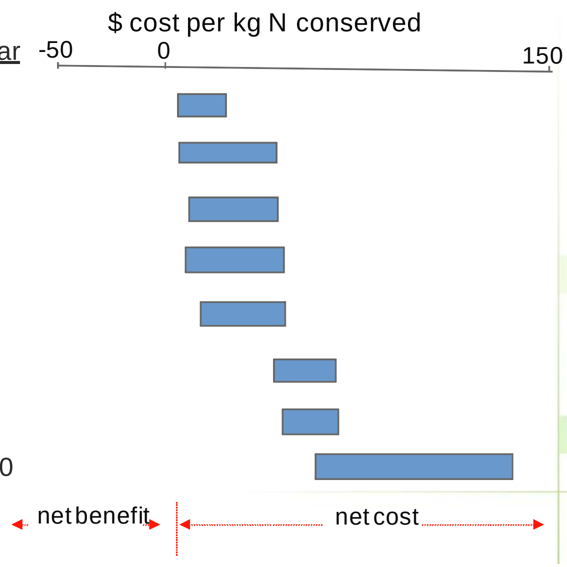
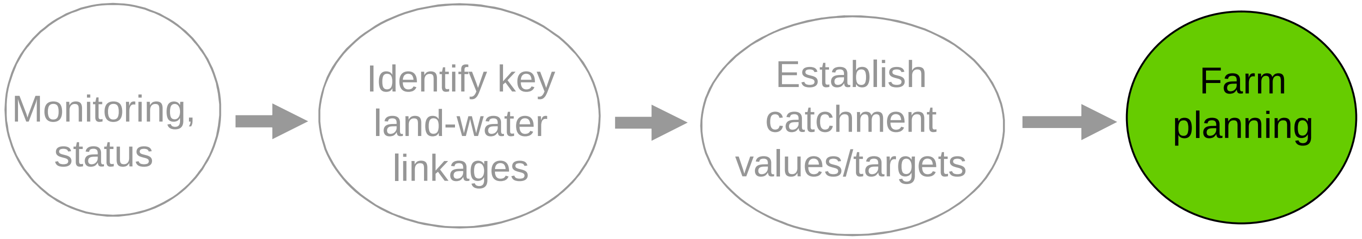
2. BMP Toolbox

	Effectiveness %	Cost $/cow/year
Nitrification inhibitors	25 -35	10 – 30
Stream fencing	3 – 13	6
Optimal effluent mgmt	2 – 6	6
Wintering shelter	25 – 35	13 – 73
Restricted aut grazing	30 – 50	65
Low N feed	10 – 15	40
Nil N fertiliser	20 – 30	73
Dry stock farming	55 - 65	160 – 700





1. Whole-farm plans
   - Toenepi

2. Riparian plans
   - Waiokura

3. “Accord + 1”
   - Waikakahi: + 1 = border dyke wash
   - Bog Burn: + 1= effluent management

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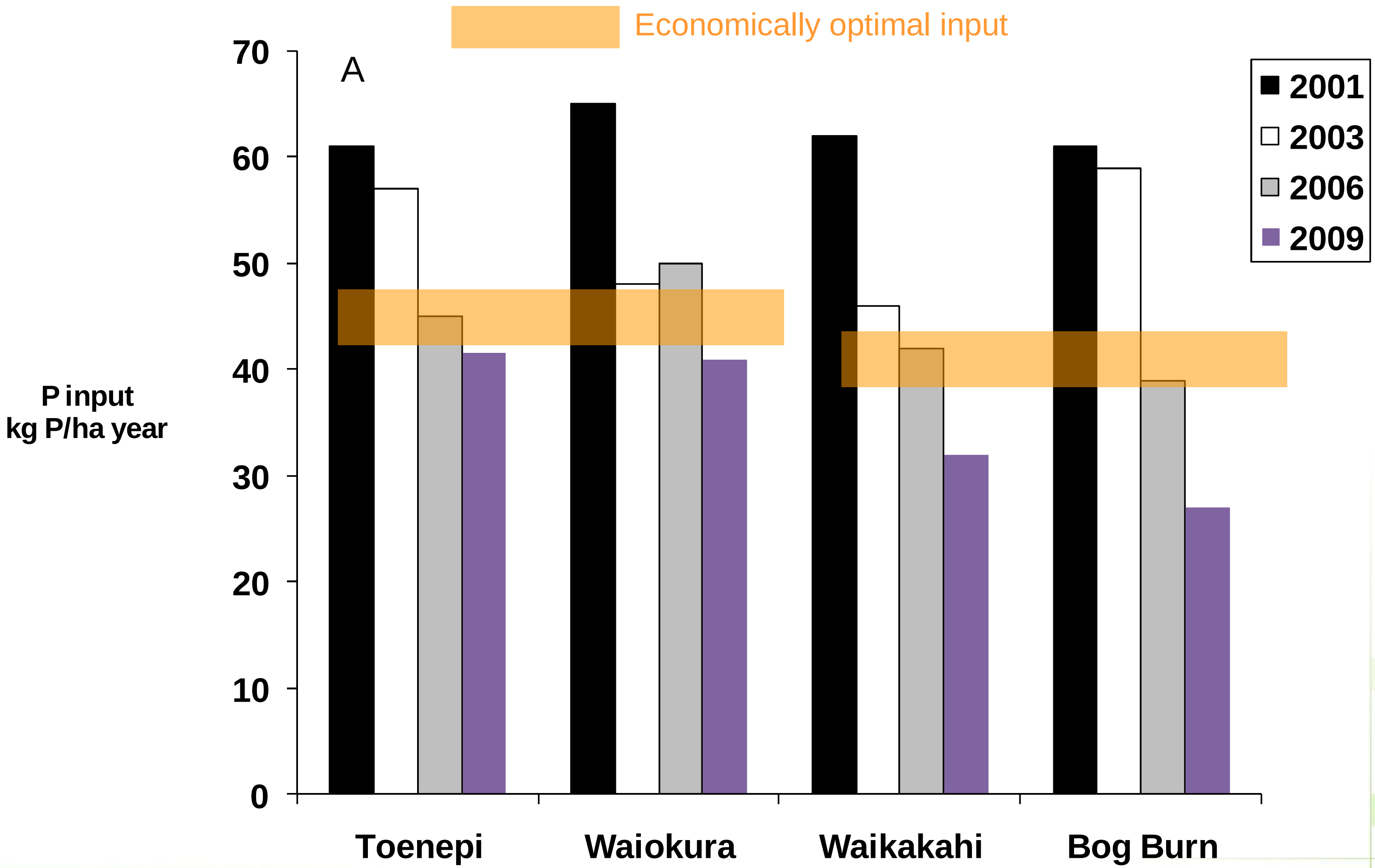
Whole farm P fertiliser inputs



Toenepi catchment
Water quality trends: 2001-2010

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Focus	TN	TP	Water clarity	*E.coli*	%DO
Recreation			↑	=	

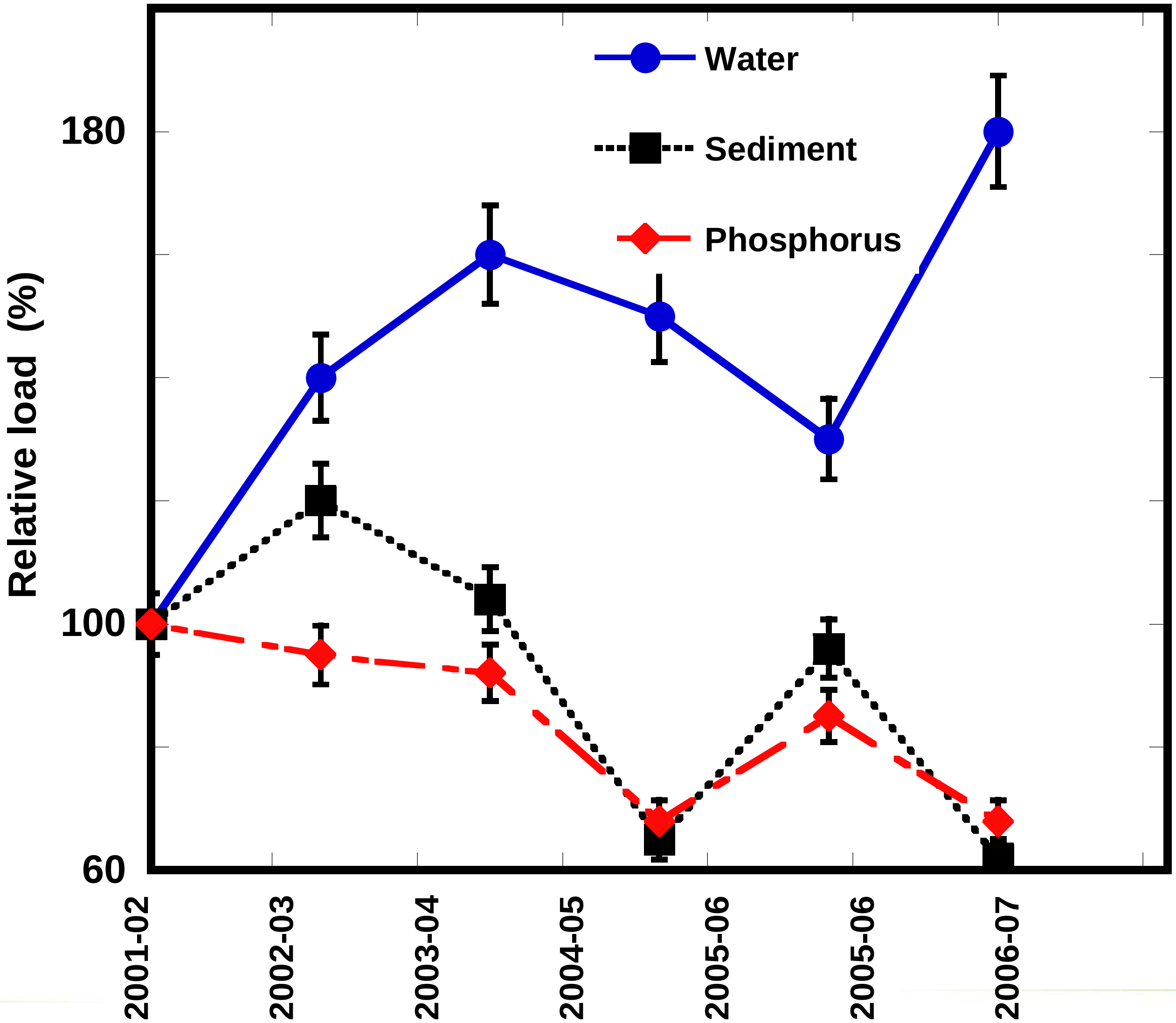
Improvements:
Land application of effluent
P balance
Some riparian protection

Pressures:
Increasing stocking rate

Waiokura catchment
Water quality trends: 2001-2010

Focus	TN	TP	Water clarity	*E.coli*	%DO
Recreation		↓	↑	↓	
Fishing		↓	↑	↓	=

Waiokura riparian protection:



Waikakahi catchment
Water quality trends: 2001-2010

Focus	TN	TP	Water clarity	*E.coli*	%DO
Fishing		=	↑	↓	↑

Bog Burn catchment
Water quality trends: 2001-2010

Focus	TN	TP	Water clarity	*E.coli*	%DO
Recreation		=	=	↑	
Fishing		=	=		=
Domestic water	↑			↑	

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

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FRST

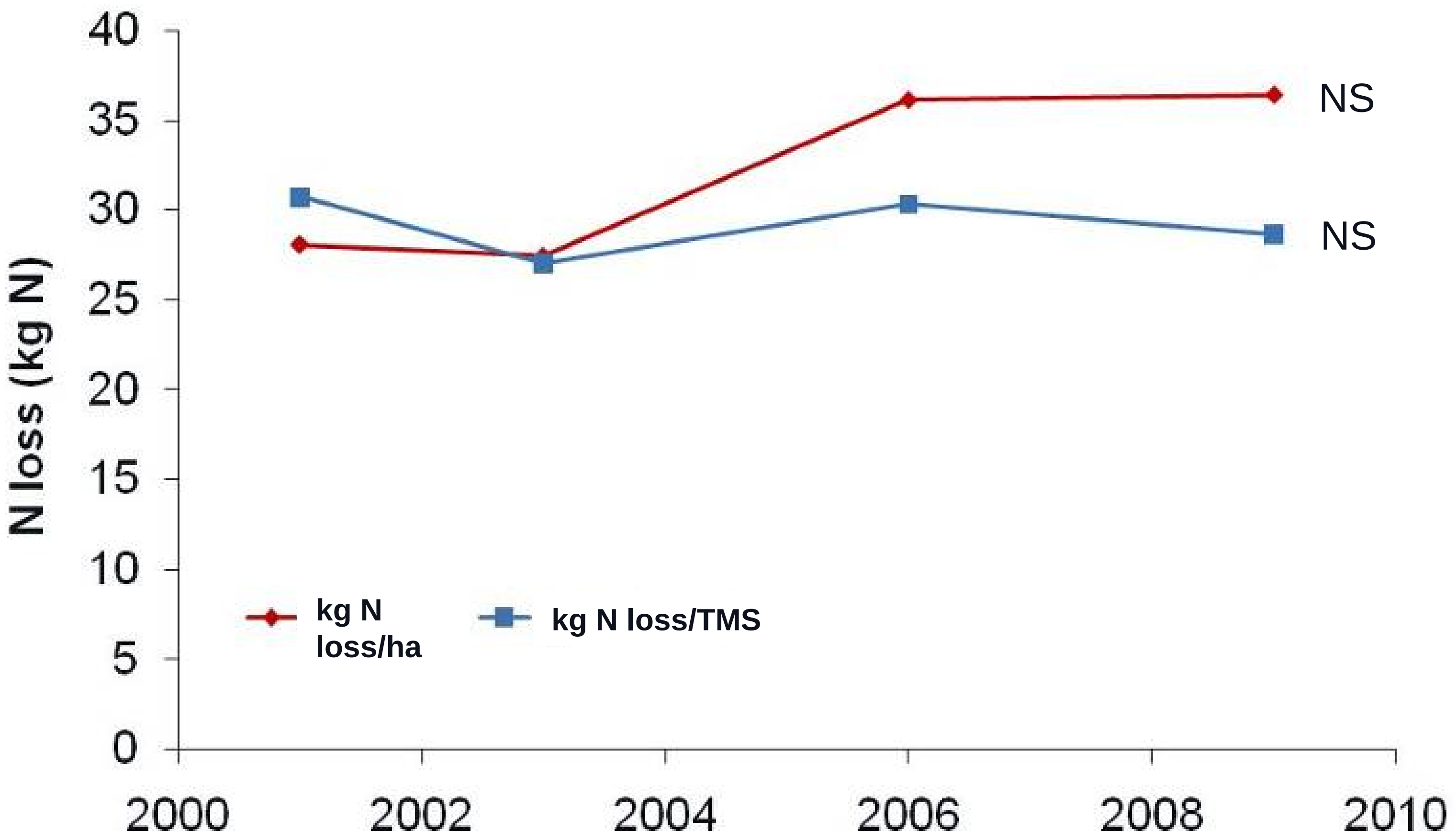
Toolbox of BMPs

e.g. Bog Burn dairy farms

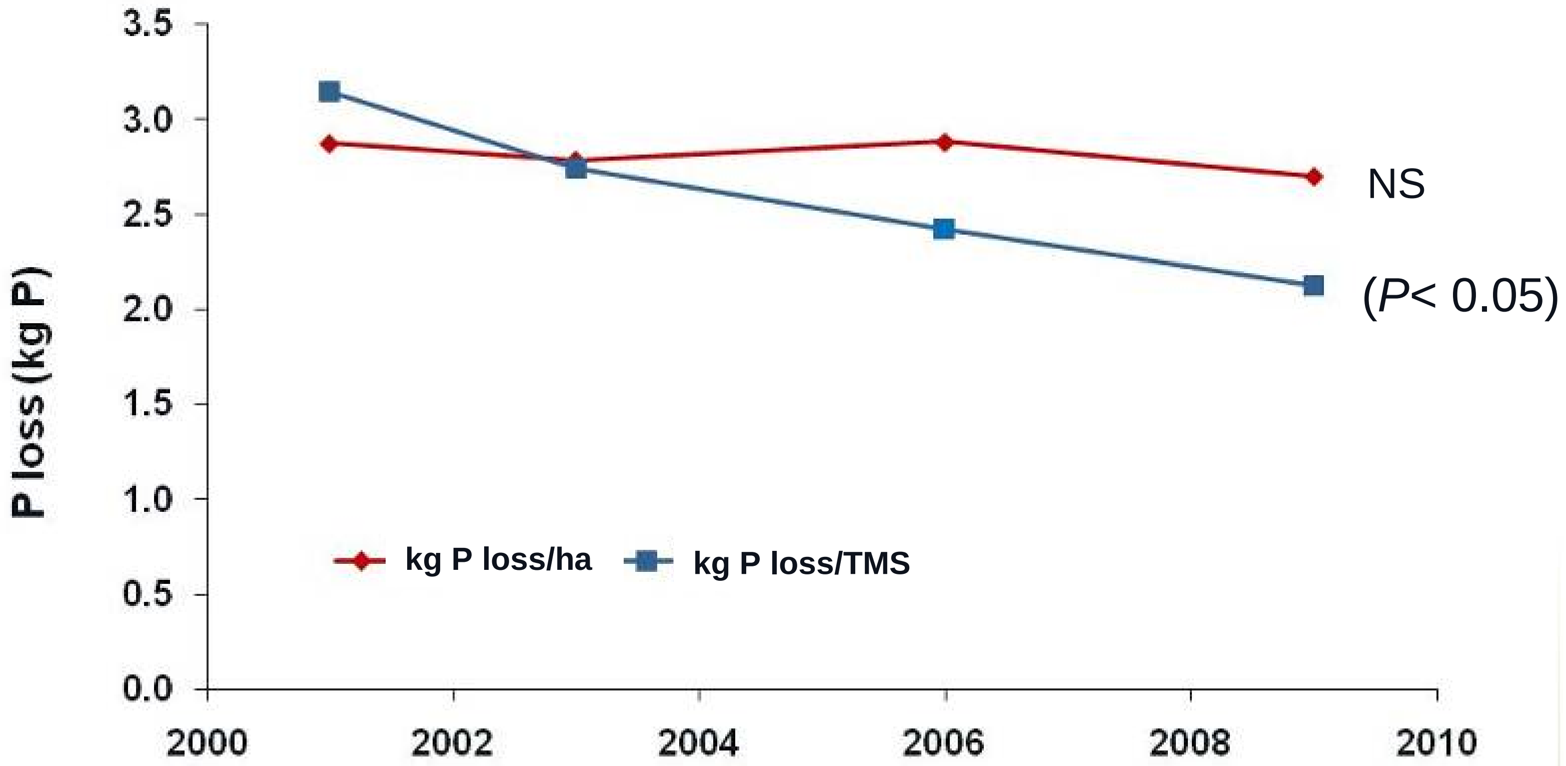
	Reduction in N loss %	Cost-effectiveness $/kg reduced N leaching
Nitrification inhibitors	10	-45
Wintering barns	28	-2
Maximising the value of effluent nutrients	6	1
Restricted autumn grazing*	56	2
Wetlands	30	(8-23)
Nil N fertiliser	25	16
Low N feed	10	41

decreasing cost-effectiveness

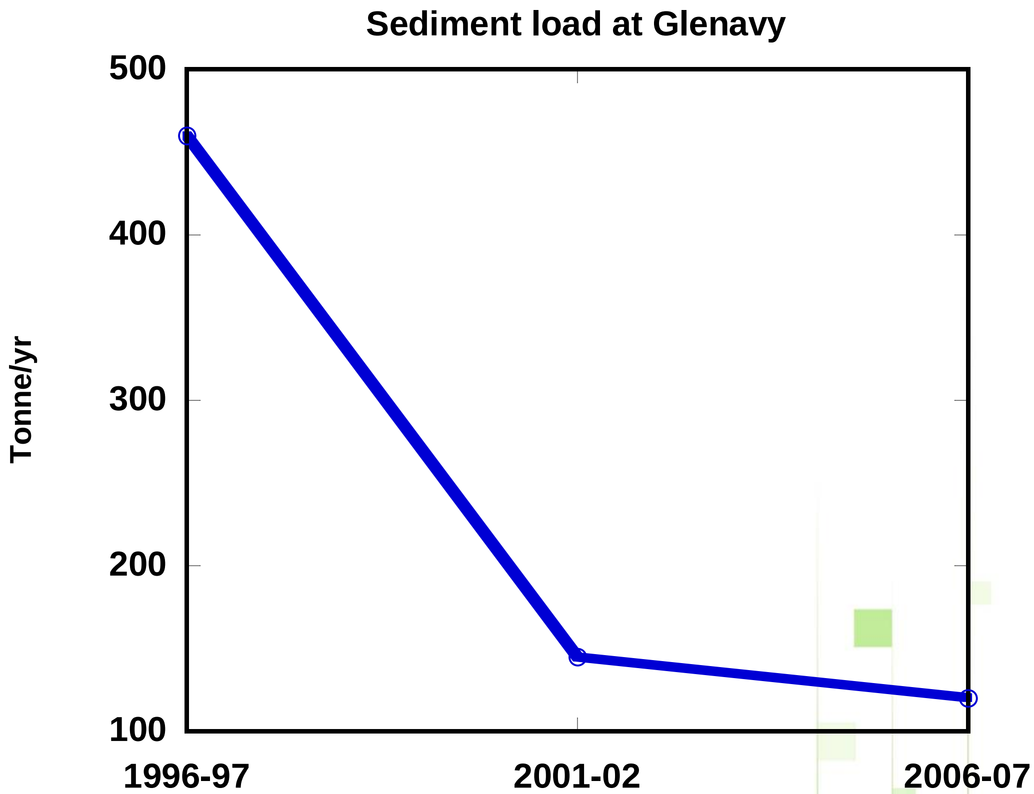
Trends in modelled N loss and production efficiency

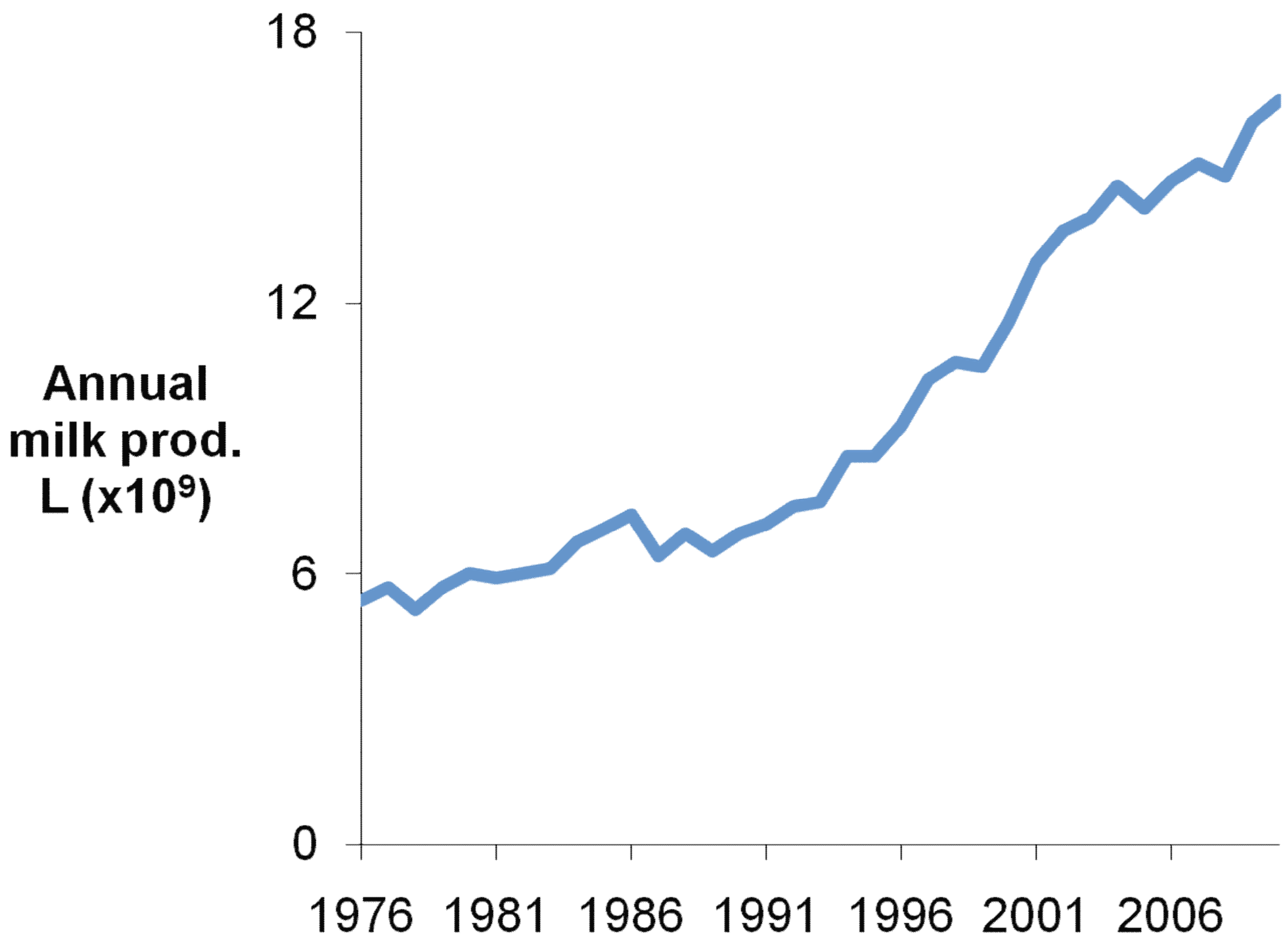


Trends in modelled P loss and production efficiency



Best Management Practices Do Work




Annual
milk prod.
L (x10⁹)
18
12
6
0
1976
1981
1986
1991
1996
2001
2006