

# Why can't I see the forest for the cows?

## Arboreal solutions for New Zealand's water quality crisis

Professor Russell Death  
Innovative River Solutions Massey University



Selywn River, Canterbury



Kahuterawa Stream, Manawatu

# Its not easy giving public talks as a river ecologist ☹

Highest  
percentage of  
endangered  
freshwater fish  
species in the  
world ☹

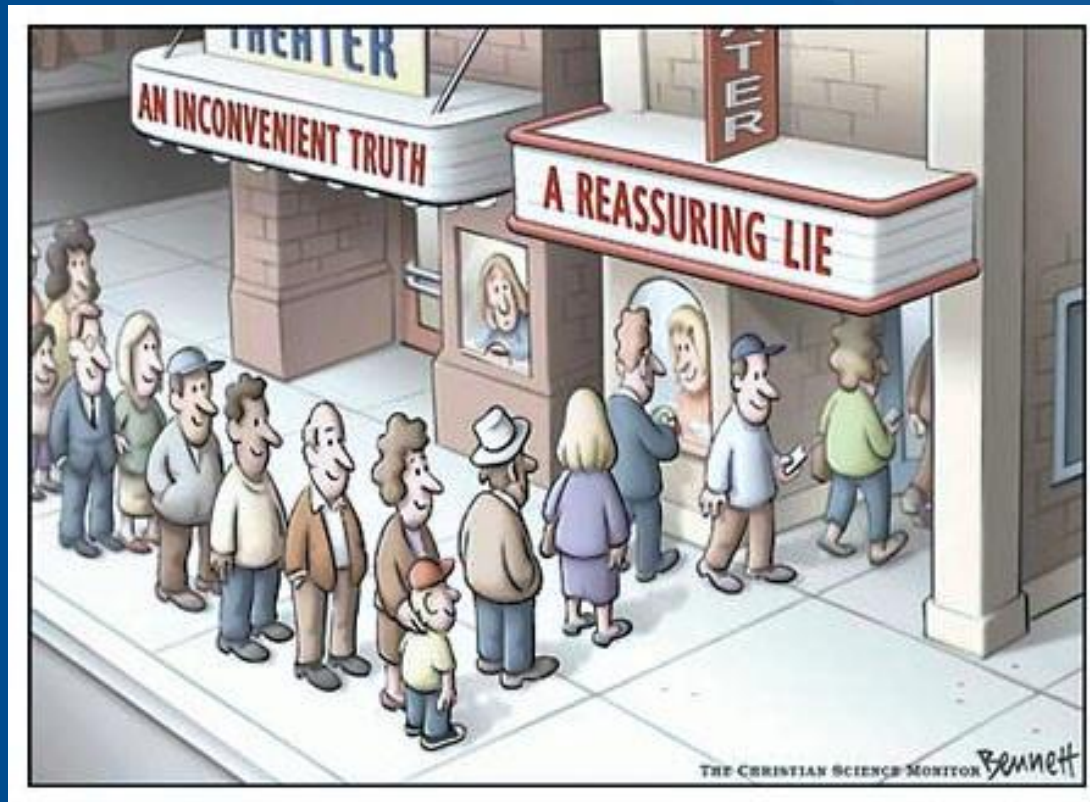
Most polluted  
river in the  
Western world  
☹

Giving water  
(from National  
Parks) to bottling  
companies to  
sell :-(

No monitoring of  
any endangered  
freshwater  
invertebrates ☹

Increasing  
nitrate  
levels in  
our  
waterways  
☹

Highest level  
of some  
waterborne  
diseases in  
the world ☹













# Unprecedented public concern about our waterways – even an election issue



# Three reports this year already say – water quality is “declining”



OFFICE OF THE PRIME MINISTER'S CHIEF SCIENCE ADVISOR  
Professor Sir Peter Gluckman, KNZM FRSNZ FMedSci FRS  
Chief Science Advisor

**New Zealand's fresh waters:  
Values, state, trends and human impacts**

12 April 2017



>> New Zealand's Environmental Reporting Series



**Our fresh water 2017**

DATA TO 2016





# Not to mention 20 + years of science research

Environ  
© 2007 b

Freshw

Do  
in  
Zea

ALEX  
Institute

The influence  
and

Alexander E  
Institute of

**Abstract.** Demand for water from streams for protecting the ecological few experimental studies reduced discharge by 8 channels/pipes and during a 2-mo period of drift distance in control measured the head caps to influence drift distance reduction, but drift return of some taxa was elevated reduced-flow condition concluded that some to the drift or increased d that, in turn, initiated individual can travel in for rapid escape of unf

**Key words:** macroin aquatic invertebrates.

Water use has risen exponentially population growth in the last Jackson et al. 2001). Approp surface water for human use aquatic biota. The ecological water from aquatic environ interest to water management public, but few experimental on the impacts of flow reduction (Dewson et al. 2007a). Mo observational surveys that drought (e.g., Cowx et al. 1 compared reaches above and b

<sup>1</sup> Present address: ELS.H. Aqu Place, Palmerston North 4412, N james@ihug.co.nz

<sup>2</sup> E-mail addresses: zoe.dewson@massey.ac.nz

<sup>3</sup> E-mail addresses: zoe.dewson@massey.ac.nz

J. N. Am. Benthol. Soc., 2007, 26(4):754–766  
© 2007 by The North American Benthological  
DOI: 10.1899/07-0038.1  
Published online 16 October 2007

Invertebrate  
discharge

Zoe S. Dewson  
Institute of

**Abstract.** Water abstraction suitability of habitat for invertebrate community manipulations to imitate >85% in 3 small New Zealand to moderately polluted, each stream before and the diversions in operation of flow reduction. E velocity and depth also and temperature were Ephemeroptera, Plecopt taxonomic richness decreased invertebrate community changed in response to composition involved Our results indicate th streams that vary in water changes in the physical

**Key words:** water abstraction

Understanding of the impact stream ecosystems is crucial to because global demand for water likelihood of modification of climate change are increasing. Urbanization of the human populationally expanding area of irrig many factors leading to increased usage (Postel 1997, Amell 1999 climate-change scenarios predicted on the expected direction and magnitude precipitation (Amell and Reyna al. 2004). In any case, the global water is expected to change further affecting the balance b

<sup>1</sup> E-mail addresses: zoe.dewson@massey.ac.nz  
<sup>2</sup> alex.james@ihug.co.nz  
<sup>3</sup> E-mail addresses: zoe.dewson@massey.ac.nz

Freshwater Biology (2007)

APPLIED ISS

Invertebrate  
in small

ZOE S. DEWSON  
Institute of Natural

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## Introduction

There has been a over the last century and a corresponding (Jackson et al., 2001 ing to predicted a

Correspondence: Zoe Ecology, Massey University Palmerston North, New Zealand; zoe.dewson@massey.ac.nz

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Hydrol. Earth Syst. Sci., 21, 1149–1171, 2017  
www.hydrol-earth-syst-sci.net/21/1149/2017/  
doi:10.5194/hess-21-1149-2017  
© Author(s) 2017. CC Attribution 3.0 License.

Hydrology and  
Earth System  
Sciences



## River water quality changes in New Zealand over 26 years: response to land use intensity

Jason P. Julian<sup>1,5</sup>, Kirsten M. de Beurs<sup>2,5</sup>, Braden Owsley<sup>2,5</sup>, Robert J. Davies-Colley<sup>3</sup>, and Anne-Gaelle E. Aussel<sup>4</sup>

<sup>1</sup>Department of Geography, Texas State University, San Marcos, TX, USA

<sup>2</sup>Department of Geography and Environmental Sustainability, The University of Oklahoma, Norman, OK, USA

<sup>3</sup>National Institute of Water and Atmospheric Research (NIWA), Hamilton, New Zealand

<sup>4</sup>Landcare Research, Palmerston North, New Zealand

<sup>5</sup>Landscape & Land Use Change Institute (LLUCI), University of Oklahoma and Texas State University, Oklahoma, Texas, USA

Correspondence to: Jason P. Julian (jason.julian@txstate.edu)

Received: 25 June 2016 – Discussion started: 21 July 2016

Revised: 22 January 2017 – Accepted: 25 January 2017 – Published: 23 February 2017

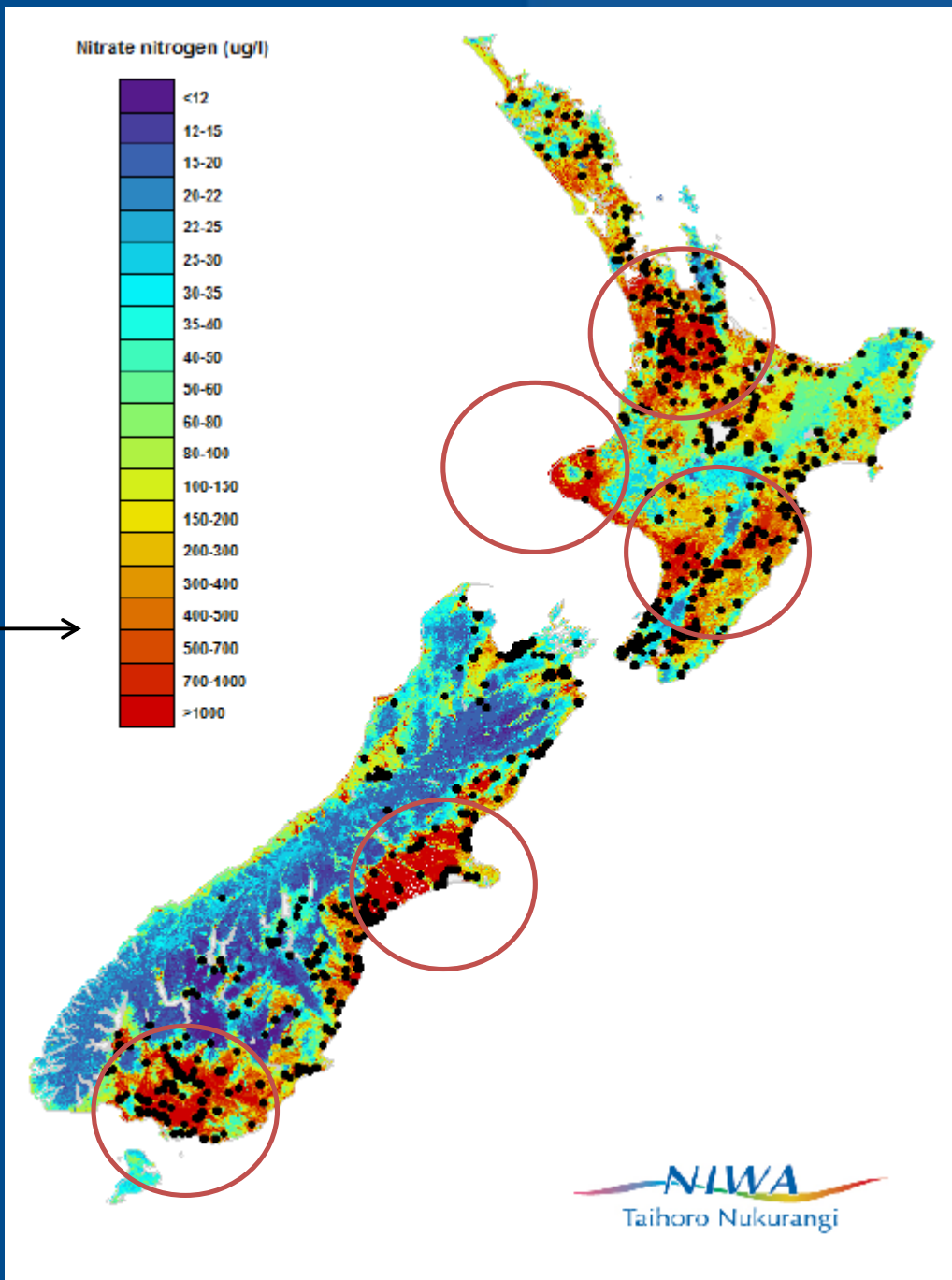
**Abstract.** Relationships between land use and water quality are complex with interdependencies, feedbacks, and legacy effects. Most river water quality studies have assessed catchment land use as areal coverage, but here, we hypothesize and test whether land use intensity – the inputs (fertilizer, livestock) and activities (vegetation removal) of land use – is a better predictor of environmental impact. We use New Zealand (NZ) as a case study because it has had one of the highest rates of agricultural land intensification globally over recent decades. We interpreted water quality state and trends for the 26 years from 1989 to 2014 in the National Rivers Water Quality Network (NRWQN) – consisting of 77 sites on 35 mostly large river systems. To characterize land use intensity, we analyzed spatial and temporal changes in livestock density and land disturbance (i.e., bare soil resulting from vegetation loss by either grazing or forest harvesting) at the catchment scale, as well as fertilizer inputs at the national scale. Using simple multivariate statistical analyses across the 77 catchments, we found that median visual water clarity was best predicted inversely by areal coverage of intensively managed pastures. The primary predictor for all four nutrient variables (TN, NO<sub>3</sub>–N, TP, DRP), however, was cattle density, with plantation forest coverage as the secondary predictor variable. While land disturbance was not itself a strong predictor of water quality, it did help explain outliers of land use–water quality relationships. From 1990 to 2014, visual clarity significantly improved in 35 out of 77 (34/77) catchments, which we attribute mainly to increased

dairy cattle exclusion from rivers (despite dairy expansion) and the considerable decrease in sheep numbers across the NZ landscape, from 58 million sheep in 1990 to 31 million in 2012. Nutrient concentrations increased in many of NZ's rivers with dissolved oxidized nitrogen significantly increasing in 27/77 catchments, which we largely attribute to increased cattle density and legacy nutrients that have built up on intensively managed grasslands and plantation forests since the 1950s and are slowly leaking to the rivers. Despite recent improvements in water quality for some NZ rivers, these legacy nutrients and continued agricultural intensification are expected to pose broad-scale environmental problems for decades to come.

## 1 Introduction

River water quality reflects multiple activities and processes within its catchment, including geomorphic processes, vegetation characteristics, climate, and anthropogenic land uses (Brierley, 2010). Relationships between water quality and these catchment characteristics are not straightforward because all of these factors interact over both space and time. For example, if intensive livestock grazing occurs on steep slopes, surface runoff and consequently river turbidity is expected to be greater than if grazing occurs on flatter areas; in other respects, if fertilizers are heavily applied to sandy soils with high drainage density, rivers will likely become

Is water  
quality  
declining  
in New  
Zealand?  
ANZECC  
trigger level



## Nitrate

### 2017 MfE report

Nitrate:

Worse = 55%

Improve = 28%

DRP:

Worse = 25%

Improve = 42%





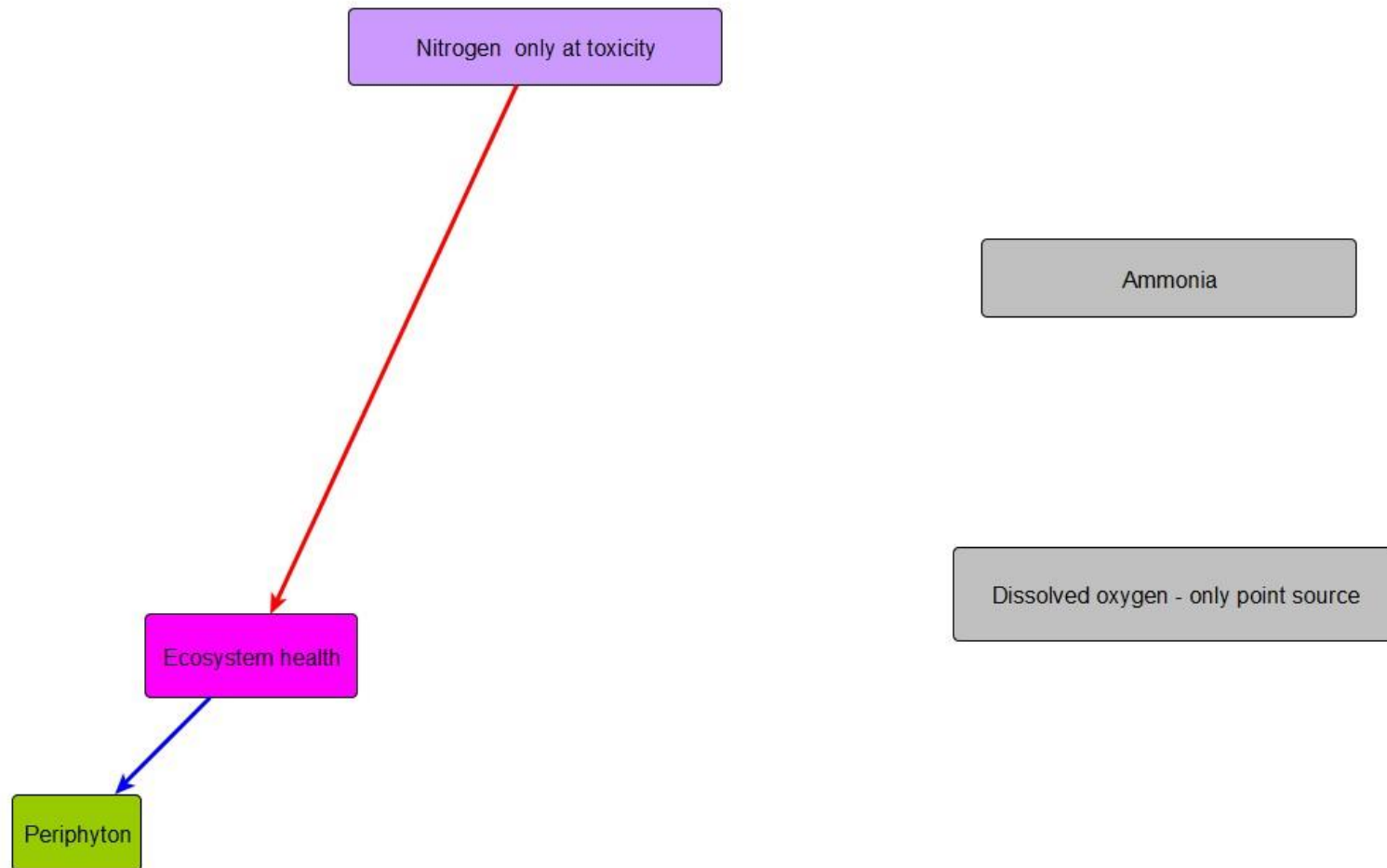
*Just as dirty as  
before Water  
reforms 2017*

Clean  
Water

90% of rivers and  
lakes swimmable  
by 2040



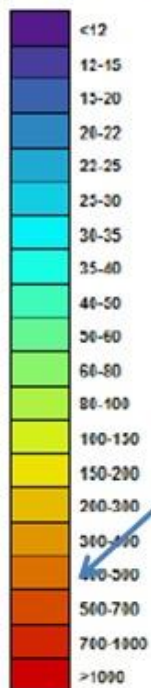






# "A fresh start for freshwater" NPS objectives 2014: (making the problem disappear)

Nitrate nitrogen (ug/l)



All red areas exceed the ANZECC guideline to protect ecosystem health

**Before**

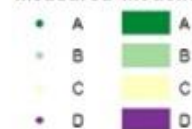
**NIWA**  
Taihoro Nukurangi

Sampling site locations



Band of current state  
Nitrate Toxicity

Measured Modelled



**After**



# Why is water quality bad?

~~“its complicated”~~



# The main drivers of poor ecological health in New Zealand rivers?

1. Too many nutrients – nitrogen and phosphorus causing too much periphyton.
2. Too much sediment.



Good



Crawling/swimming bugs

"Bad"



Slimy/wiggly bugs





# Agricultural industry solution

**Dairynz**

FARM  
BUSINESS  
ENVIRONMENT  
FEED  
PEOPLE  
ANIMAL  
MILKING  
EVENTS  
NEWS  
ABOUT US  
CONTACT US

**DAIRY FARMERS SPEND OVER \$1 BILLION ON THE ENVIRONMENT**

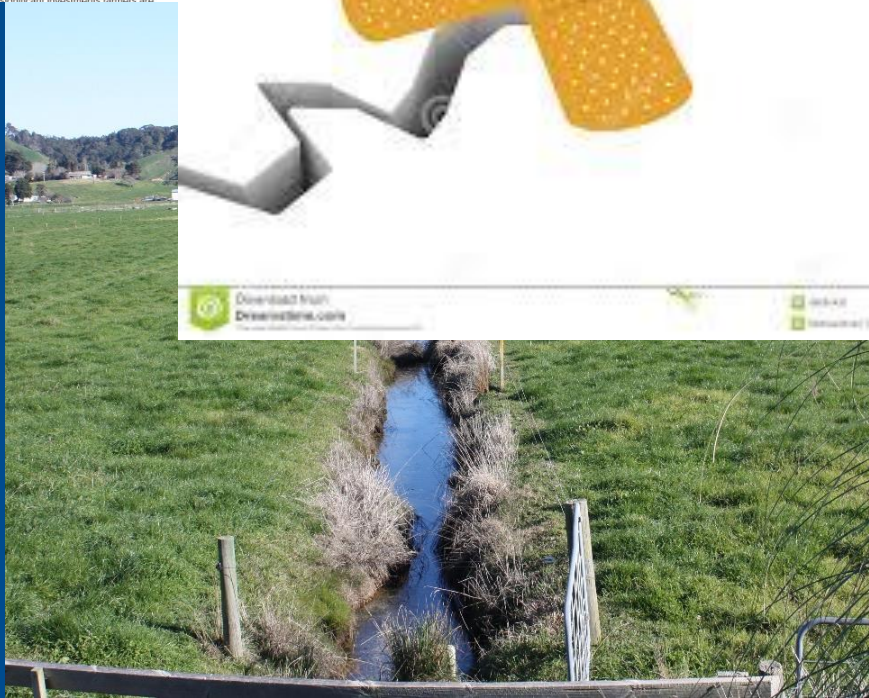
HOME > NEWS > ALL NEWS >  
DAIRY FARMERS SPEND OVER \$1 BILLION ON THE ENVIRONMENT

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Federated Farmers and DairyNZ have conducted a survey on New Zealand dairy farmers' environmental investments, revealing an estimated spend of over \$1 billion over the past five years.

Five percent of the nation's dairy farmers responded to the survey and reported on the environmental initiatives they had invested in such as effluent management, stock exclusion, riparian planting, upgrading systems and investing in technology, retiring land and developing wetlands.

ENVIRONMENTAL SPEND BY DAIRY FARMERS  
**\$1 BILLION**  
OVER 5 YEARS



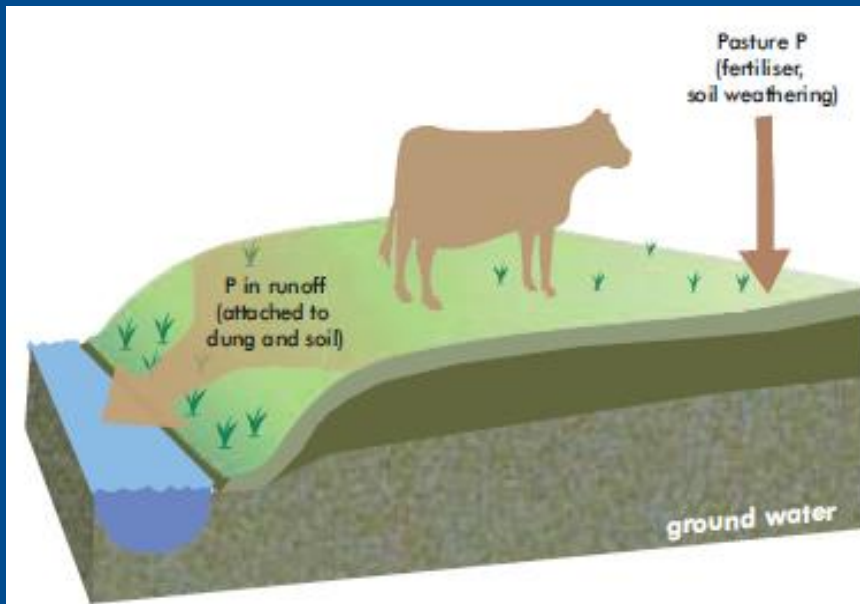
# Sediment, Phosphorus, Pathogens

‘Easily’ mitigated with riparian fencing / planting.

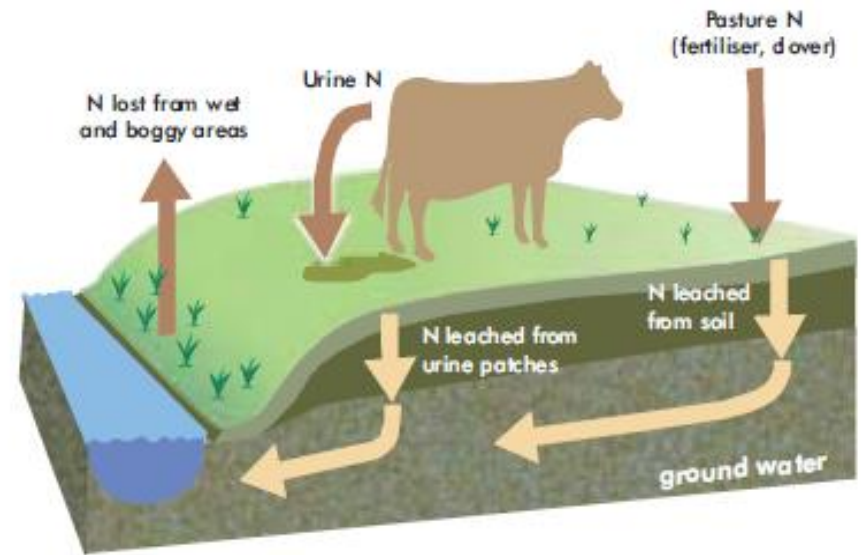




# Phosphorus



# Nitrogen



Phosphorus stopped by riparian planting and fencing streams

But up to 90% of nitrogen from cow urine leaches through soil.

# Science solutions are simple

1. Reduce nitrogen = less cows
2. Increase water = less abstraction = less cows
3. Less fine sediment = less cows

# Management solutions not so simple

1. Less cows = less money ??
2. Less abstraction = irrigation  
= more cows

P.S. dams do not save rivers



# And Forestry?

New Zealand Journal of Marine and Freshwater Research, 2003, Vol. 37: 507–520  
0028–8330/03/3703–0507 \$7.00 © The Royal Society of New Zealand 2003

507

## Effect of *Pinus radiata* logging on stream invertebrate communities in Hawke's Bay, New Zealand

RUSSELL G. DEATH  
Institute of Natural Resources—Ecology  
Massey University  
Private Bag 11 222  
Palmerston North, New Zealand  
email: R.G.Death@massey.ac.nz

BRENDA BAILLIE  
Forest Research  
Private Bag 3020  
Rotorua, New Zealand

PIETER FRANSEN  
Juken Nissho Limited  
P.O. Box 1239  
Gisborne, New Zealand

Macroinvertebrate Community Index and Quantitative Macroinvertebrate Community Index, reflected the change in invertebrate communities at the Pakuratahi sites after harvesting, shifting from impact "sensitive" taxa to more "tolerant" taxa. In April 2001 (1.5–2.5 years after harvesting) invertebrate communities had not recovered to their pre-harvest structure. Recovery of invertebrate communities from a natural disturbance, a major storm in July 1997, was much more rapid (5 months) than the recovery observed from forest harvesting, however. An increase in streambed fine sediment may have been primarily responsible for the changes to invertebrate communities following forest harvesting.

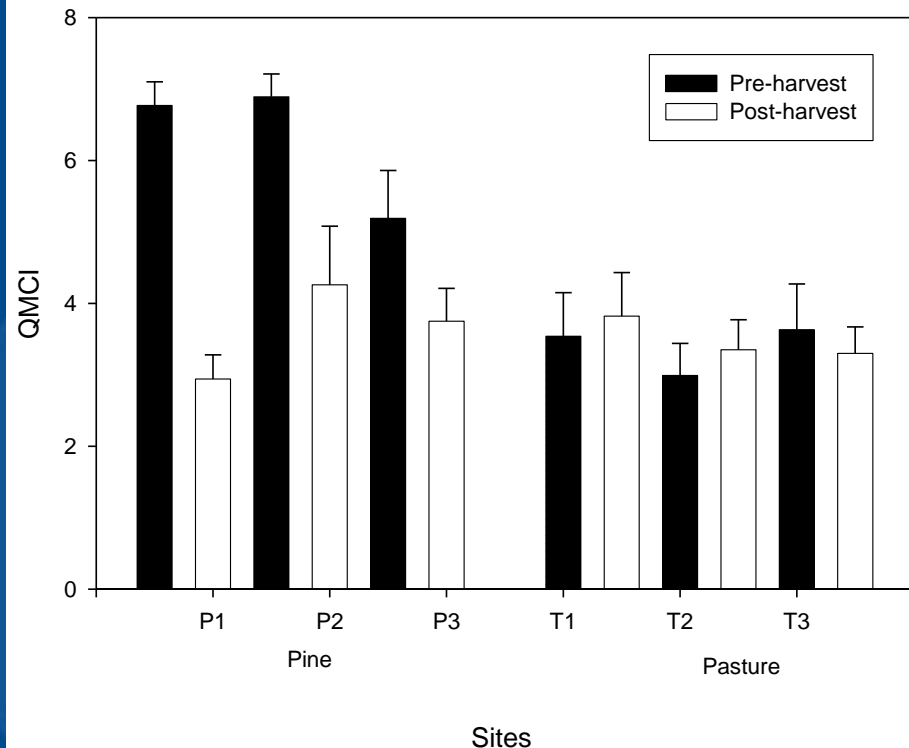
**Keywords** community structure; land use change; logging; macroinvertebrates; pasture streams; *Pinus radiata* forestry

### INTRODUCTION

Exotic forestry is one of New Zealand's largest, and still expanding, natural resource industries, accounting for NZ\$4.2 billion dollars of the national Gross Domestic Product and using 7% of the land area in 1998 (NZFOA 2002). The physico-chemical characteristics of streams and, consequently, in-stream life are affected by the nature of the catchment vegetation and land use associated with that vegetation (Hynes 1975; Biggs et al. 1990; Harding et al. 1998). Changes in vegetation and land use such as forest harvest or conversion to pasture can lead to increases in nutrients, light, temperature, fine sediments, and periphyton abundance; and

**Abstract** Invertebrate communities and associated environmental characteristics were monitored at three *Pinus radiata* and three pasture stream sites in the Pakuratahi and Tamingimangi Stream catchments, New Zealand, respectively, at nine irregular intervals between December 1996 and April 2001. The Pakuratahi sites were logged between May 1998 and September 1999. Following logging the Pakuratahi Stream invertebrate communities changed from being dominated by a diversity of mayfly species to communities dominated by a high abundance of Chironomidae, *Aoteapsyche* sp., Elmidae, Ostracoda, and *Potamopyrgus antipodarum*. Invertebrate communities that developed following the pine forest harvesting closely resembled those at pasture stream sites in the adjoining Tamingimangi catchment. Invertebrate communities at the pasture stream sites were dominated throughout the study by the

Figure 3



# An alternative to more cows?

## Plant trees?

- Reduce nutrient loss from land.
- Reduce sediment loss – assuming you harvest responsibly.
- Improve waterway ecological health.
- Reduce green house gas emissions.
- Win/Win/Win environment / society / economy.



# I'm not a tree hugger

But trees might be the  
solution !



**KEEP  
CALM  
AND  
HUG  
A TREE**

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