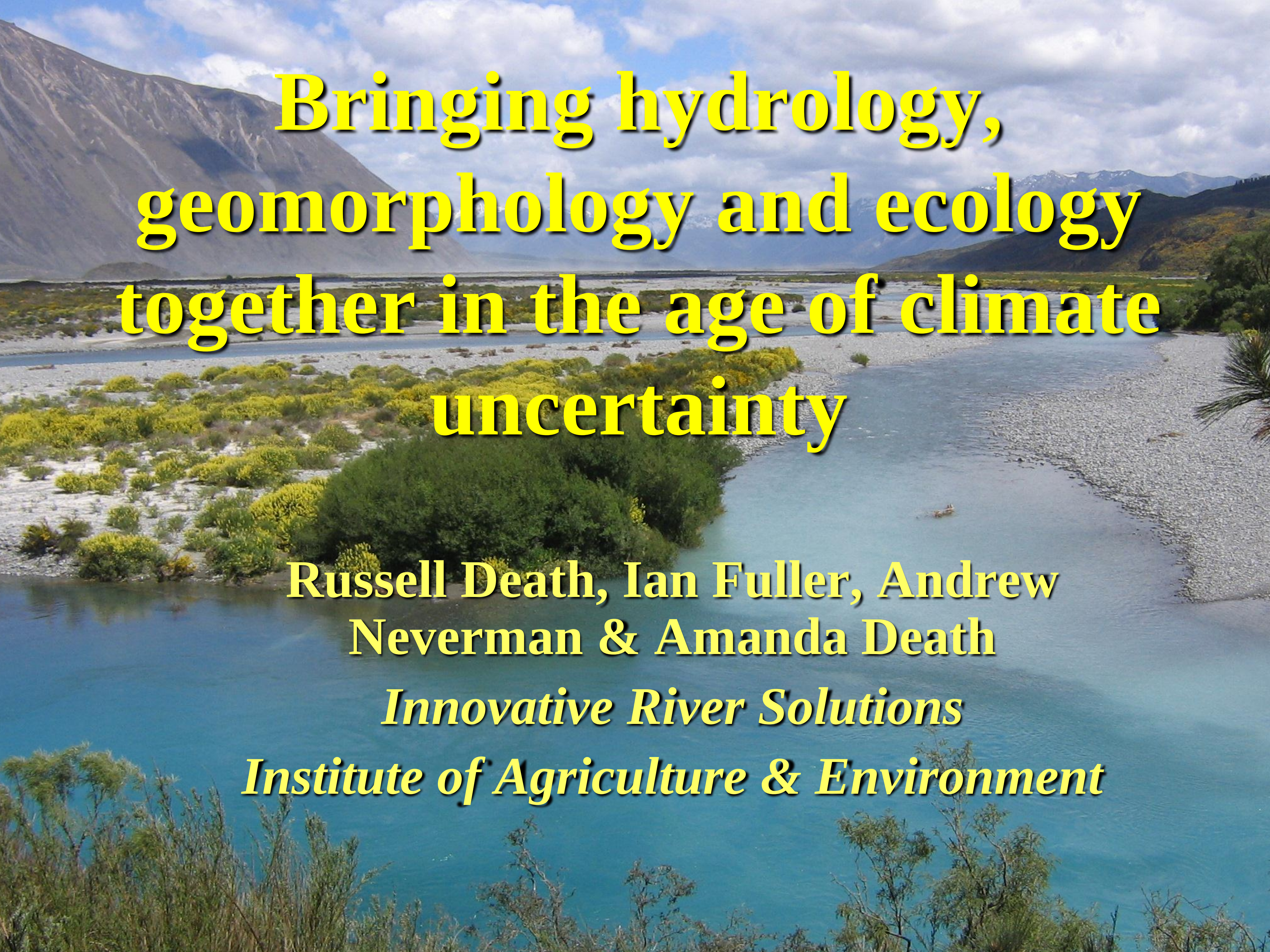

Bringing hydrology, geomorphology and ecology together in the age of climate uncertainty

Russell Death, Ian Fuller, Andrew Neverman & Amanda Death

Innovative River Solutions

Institute of Agriculture & Environment


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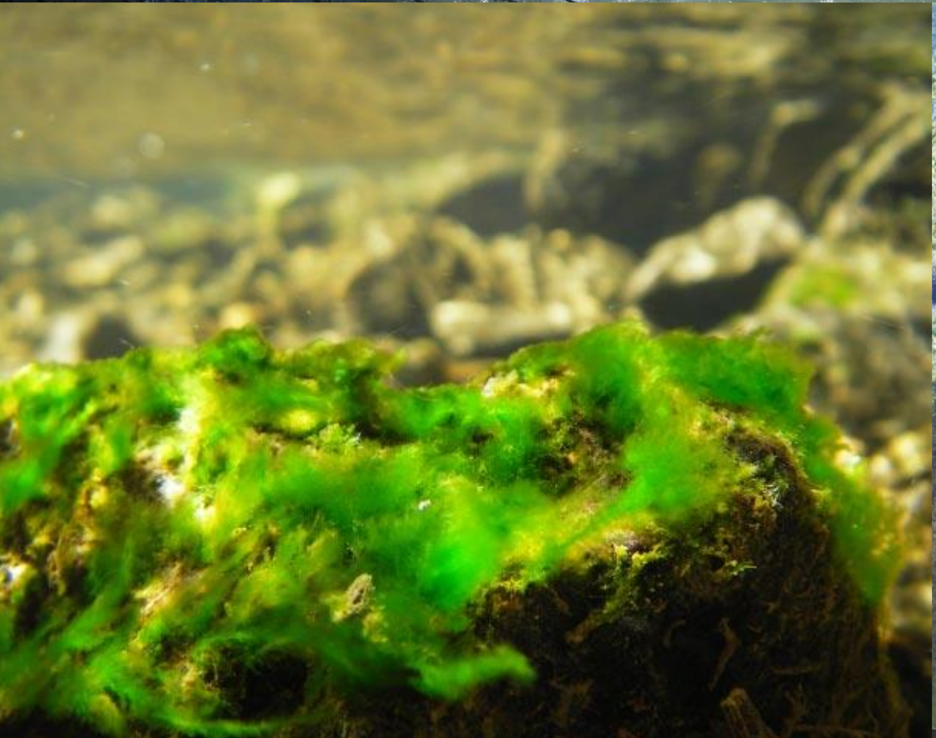



The Timaru Herald
timaruherald.co.nz

Dam blamed for river ruin

Michael Bisset examines a slimy rock below the Opuha Dam, which anglers say is the source of a toxic algae bloom of phormidium

Manawatu Standard

River gradually on mend

MATHEW GROCOTT

ROBERT KIT

A protest sign against Fonterra
placed in the Manawatu River r
Fitzherbert Bridge.

THE DOMINION
Thursday, November 26, 2009
www.dompost.co.nz

Our river of shame

Manawatu 'among worst in the West'

Jon Morgan and Kelly Burns

THE Manawatu River is one of the most polluted in the Western world, according to new research.

The Manawatu tops a new pollution measurement of 300 rivers and streams across North America, Europe, Australia and New Zealand, research by the Cawthron Institute has found.

The waterway is fouled with treated sewage, industrial waste and farm runoff.

Under a system measuring oxygen changes in water, the Manawatu has by far the highest reading, almost twice as much as the next worst. The Manawatu measured 107. Anything over eight is considered indicative of an unhealthy river ecosystem. A measurement of 0-4 is considered healthy.

Roger Young, a freshwater ecologist with the Nelson-based independent scientific institute, was amazed at the readings from water samples taken at Hopelands, north of Woodville.

"To see a count of 100 was just ridiculous," he said.

Tests further south at Palmerston North were not as high but still indicated an unhealthy ecosystem.

Checks internationally found the closest pollution reading to be 59, for a site on a river near Berlin, downstream from a sewage outfall.

The Manawatu was affected by leaching farm nutrients and treated town sewage, Dr Young said.

"Agricultural use is most of it; nitrogen runoff, mainly."

Other factors were the shallowness and width of the slow-moving river, which exposed it to sunlight that encouraged algae growth.

Massey University ecologist Mike Joy said the research showed the river was "a basket case".

"I've been aware for some time that the river was a pretty sad case but even I was shocked at this research. It's not just farm nutrients; it's sewage, sediment and river modification issues with stopbanking."

Environment Minister Nick Smith said it was well known the

"No matter what way you look at it, the Manawatu River needs cleaning up."

Palmerston North Mayor Jono Naylor was concerned with the findings.

"No-one likes the idea of having a polluted river running through their city."

The council had invested $15 million upgrading the wastewater system, so the quality of sewage discharged had improved.

The health of the river could affect swimmers' health, and warning signs were erected at some spots.

Horowhenua District Council admitted in September pumping 5.1 million litres of partially treated sewage – including tampons, condoms and toilet paper – into the river over 48 hours in October 2007.

Dr Joy said: "At the high levels, you virtually have to get some in your mouth and you'll get sick."

Dr Young's research is to be presented to a panel which next week begins hearing submissions on Horizons Regional Council's One Plan.

The plan proposes tight rules to govern nitrogen leaching from farms. Farmers will get limits on the amount of nitrogen allowed in their soils, depending on their soil type.

Many farmers fear they will be forced to reduce cow numbers and take a substantial cut in earnings.

Federated Farmers regional president Gordon McKellar said the council was taking a big stick to farmers unnecessarily.

"Farmers are prepared to do a reasonable amount to manage their nutrients – after all, they've paid a lot of money for them and don't want to lose them – but regulation is not the way to get their support."

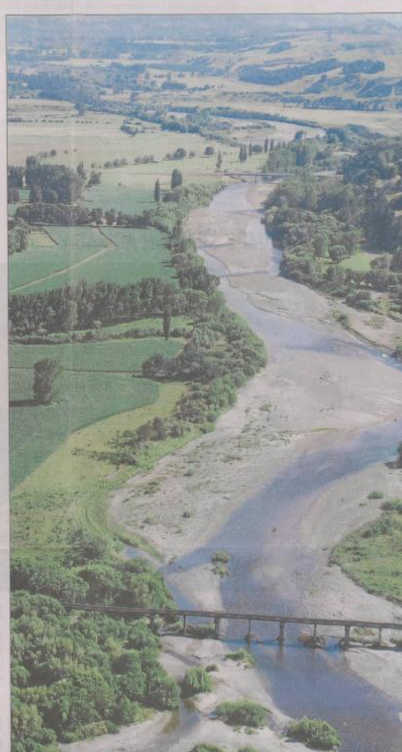
Horizons planning and regulatory manager Greg Carlyon said the nitrogen caps would get the river only halfway to swimming quality over 30 years.

BY THE NUMBERS

- 25 resource consents to discharge into the Manawatu River have been granted.
- 75,600 cubic metres can be discharged daily.
- Palmerston North, Manawatu, Horowhenua and Tararua councils have consents to discharge treated sewage and wastewater.
- Horizons Regional Council has taken four prosecutions and 36 fine actions over illegal discharges this year.
- The top five resource consents for daily discharge:
  - 46,600 cubic metres, Palmerston North City Council
  - 24,000 cu m, Feilding sewerage plant.
  - 6370 cu m, Dannevirke.
  - 6000 cu m, Fonterra at Longburn.
  - 4600 cu m, Ashhurst.

WHAT IS POLLUTING THE RIVER?

- Farm runoff from fertilisers, and animal waste such as cow dung and urine, leaching into the river.
- Treated sewage discharged by councils.
- Treated industrial effluent including wastewater from Fonterra, New Zealand



Dairy farming – export profits high

1. From 1990 to 2012 the dairy herd has almost doubled from 3.4 million to 6.5 million
2. Land in dairy farm area increased by 46% between 1993 and 2012
3. One cow = same waste as 14 humans. 6.5 m cows = equivalent waste of a 90 million humans.

To facilitate this there are 22 planned irrigations schemes for NZ

- Tukituki/Ruataniwha water storage scheme first example.
- Planned to build a 70 m high dam on the Makaroro River.
- Then release 10 cumecs as a flushing flow (fre3 for Makaroro River)

Plenty of evidence dams constructed with ecology/hydrology/ geomorphology input

Environmental Management
DOI 10.1007/s00267-012-9971-x

Dam Design can Impede Adaptive Management of Environmental Flows: A Case Study from the Opuha Dam, New Zealand

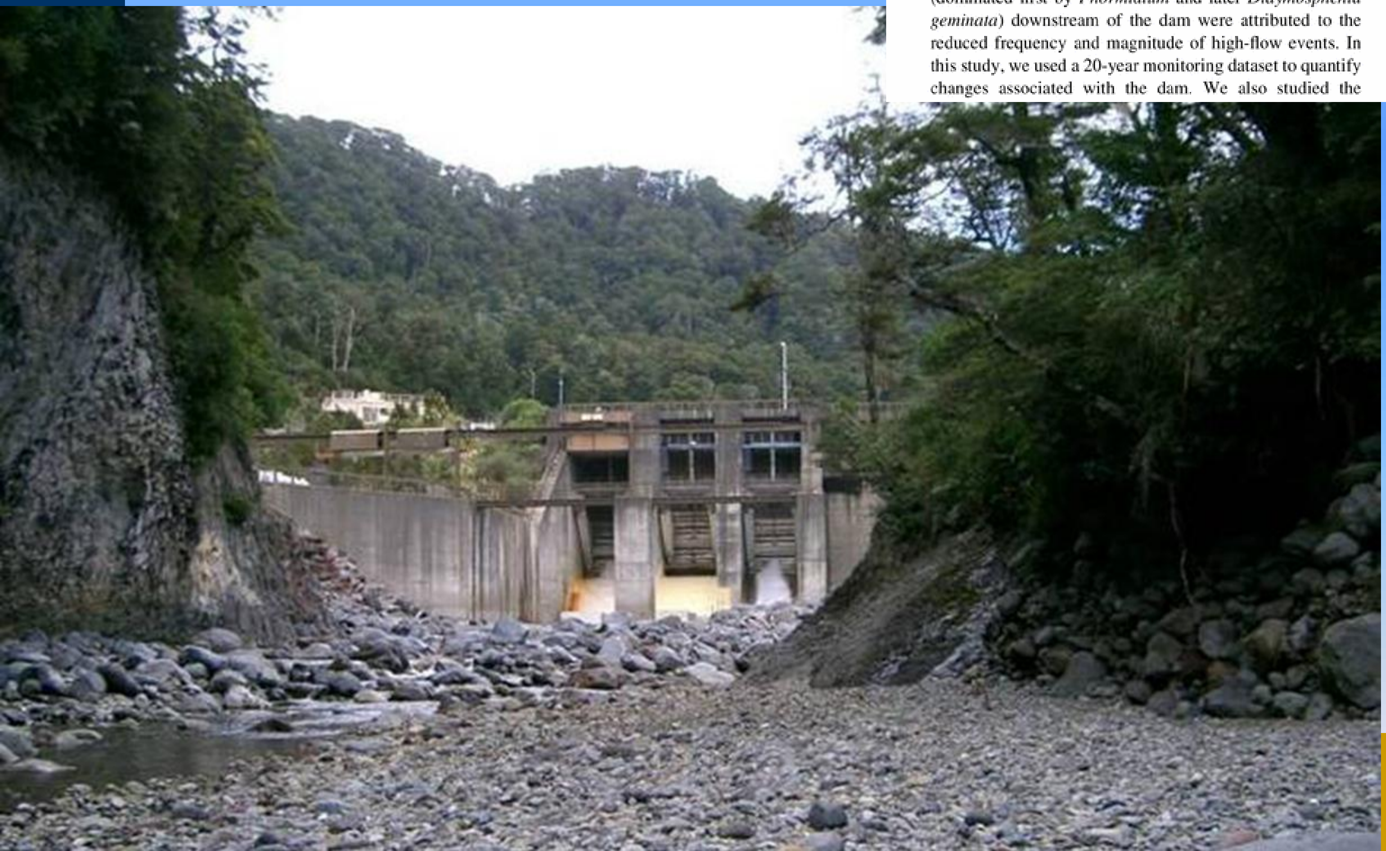
JoAnna Lessard · D. Murray Hicks ·
Ton H. Snelder · David B. Arscott ·
Scott T. Larned · Doug Booker · Alastair M. Suren

Received: 14 December 2011 / Accepted: 13 October 2012

Abstract The Opuha Dam was designed for water storage, hydropower, and to augment summer low flows. Following its commissioning in 1999, algal blooms (dominated first by *Phormidium* and later *Didymosphenia geminata*) downstream of the dam were attributed to the reduced frequency and magnitude of high-flow events. In this study, we used a 20-year monitoring dataset to quantify changes associated with the dam. We also studied the ... provide the natural range of flows for adaptive management, particularly high flows.

Keywords Dam re-operation · Adaptive management · Flushing flows · Periphyton · Hydraulic modeling

Introduction



Te Kunenga ki Pūrehuroa

Ecology/hydrology/geomorphology

- Should in theory have the solutions.
- But not working in practice.
- Brief overview of some simple tools we are developing to help with the integration.

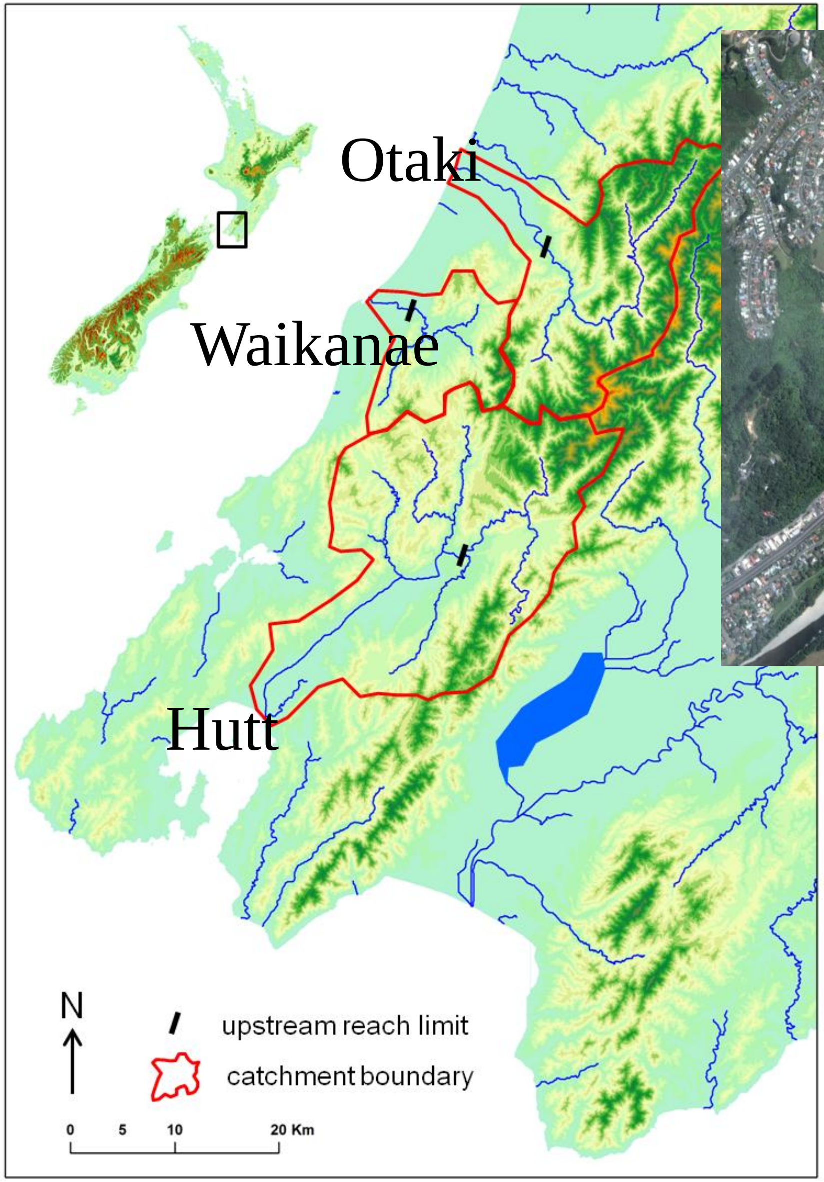
Rivers are “managed” to avoid flooding houses, farms etc.

Can this be done to avoid habitat loss?

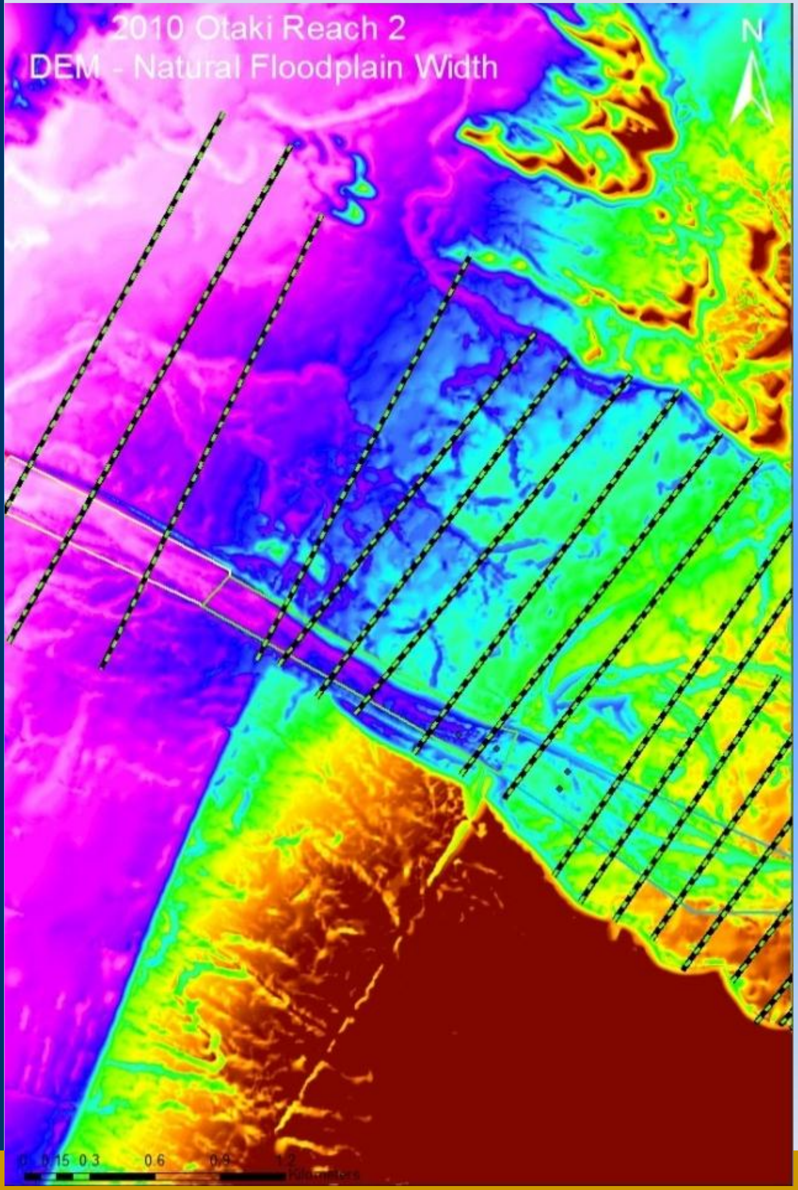
To balance flood control with ecological health?

- We need a measure of change in geomorphological variation – NCI natural character index
- Assess geomorphological characteristics (e.g., percent pools, sinuosity, substrate size, permitted flood channel width).
- Compare to the reference condition e.g., pre-engineered state or simply even before and after.

Sites & Methods



Permitted to Natural Floodplain Width

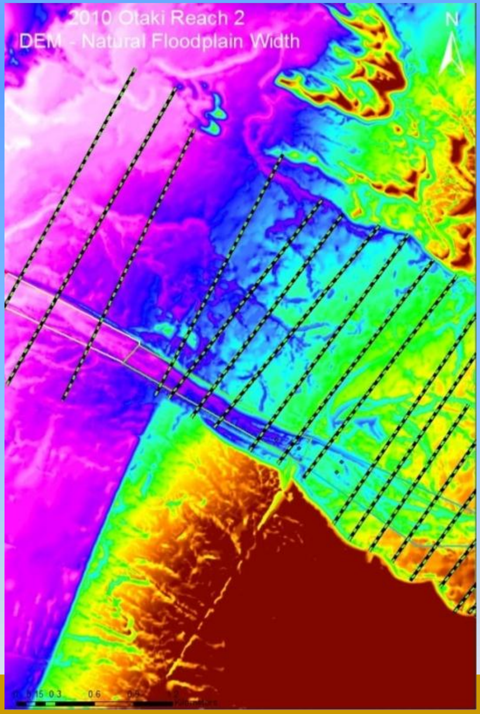


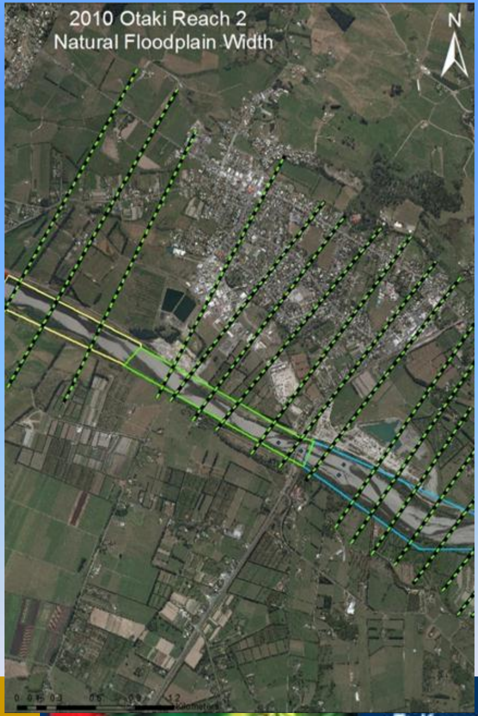
Permitted Floodplain width: NCI

Permitted floodplain (2010) width = 223 m

Natural flood plain width (1939) = 2001 m

$$NCI_{pf} = 223 / 2001 = 0.11$$





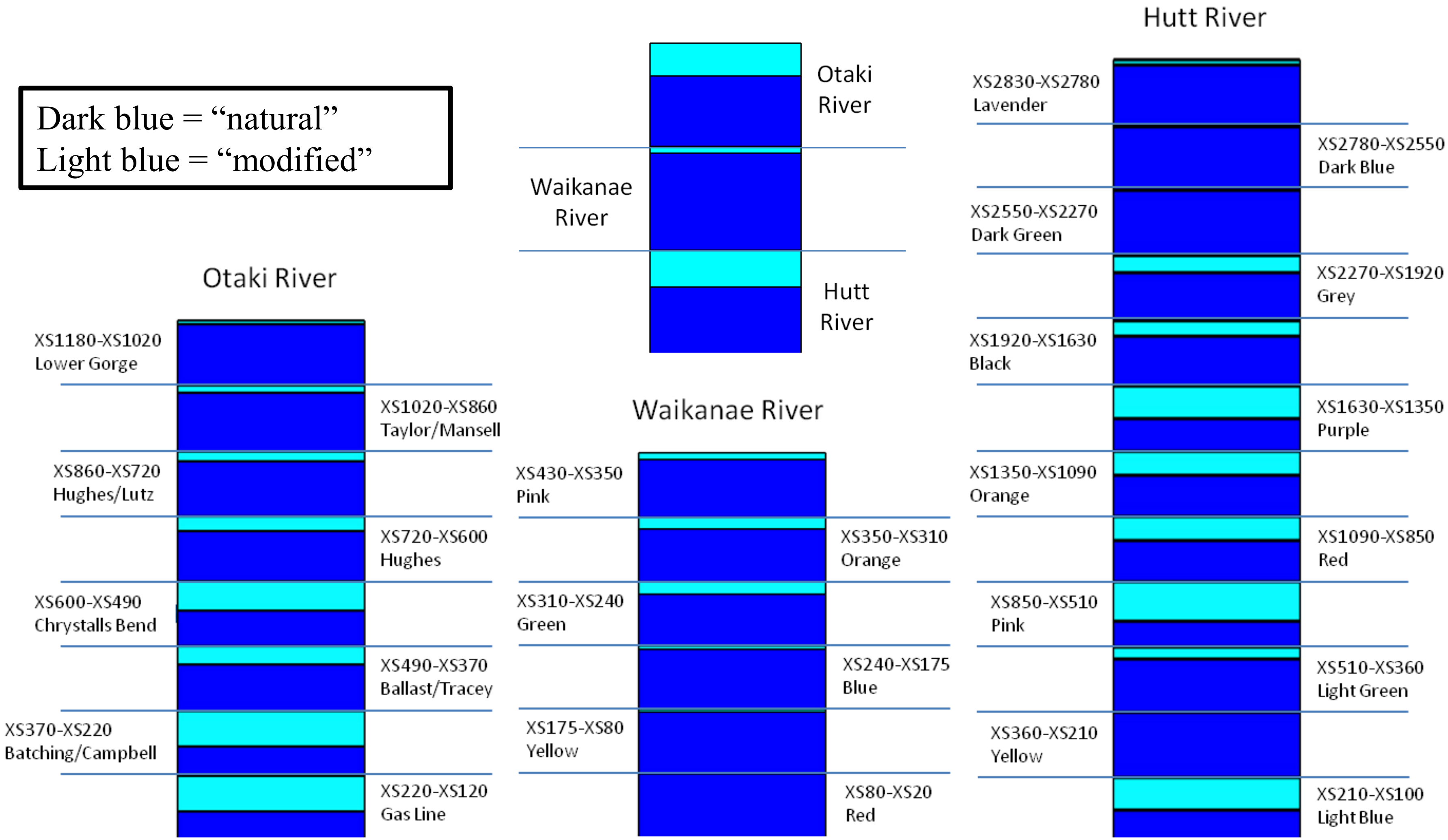
Overall NCI (Natural Character Index)

The median for each reach characteristic then gives an overall NCI score for how much the reach has been modified.

NCI for Green Reach (XS370-220) on the Otaki River	
Sinuosity	0.91
Active channel width	1.13
Bankfull channel width	0.26
Permitted floodplain width	0.11
Thalweg length	0.59
Pools	0.32
NCI =	**0.32**

NCI – each river & reach compared

Dark blue = "natural"
Light blue = "modified"



Substrate stability

- Key determinate of ecological health – but hard to measure and model in relation to flow

Freshwater Biology

Freshwater Biology (2010) 55, 261–281 doi:10.1111/j.1365-2427.20

SPECIAL REVIEW

The assessment of shear stress and bed stability in stream ecology

ARVED C. SCHWENDEL*, RUSSELL G. DEATH* AND IAN C. FULLER[†]
*Ecology Group, Institute of Natural Resources, Massey University, Palmerston North, New Zealand
[†]Geography Programme, School of People, Environment & Planning, Massey University,

SUMMARY

1. Substratum stability and shear stress exerted by flowin
influence on the structure of benthic communities. Bed st
variety of ways, e.g. flow competence, threshold of partic
erosion and deposition, particle transport distance, abrasi
This paper reviews methods for the quantification of bed
streams and rivers that are relevant for the examination o
stream biota and bed stability.

6

Effects of Floods on Aquatic Invertebrate Communities

RUSSELL G. DEATH

Institute of Natural Resources - Ecology, Massey University, Private Bag 11-222, Palmerston North, New Zealand
E-mail: r.g.death@massey.ac.nz

Ecology, 76(5), 1995, pp. 1446–1460

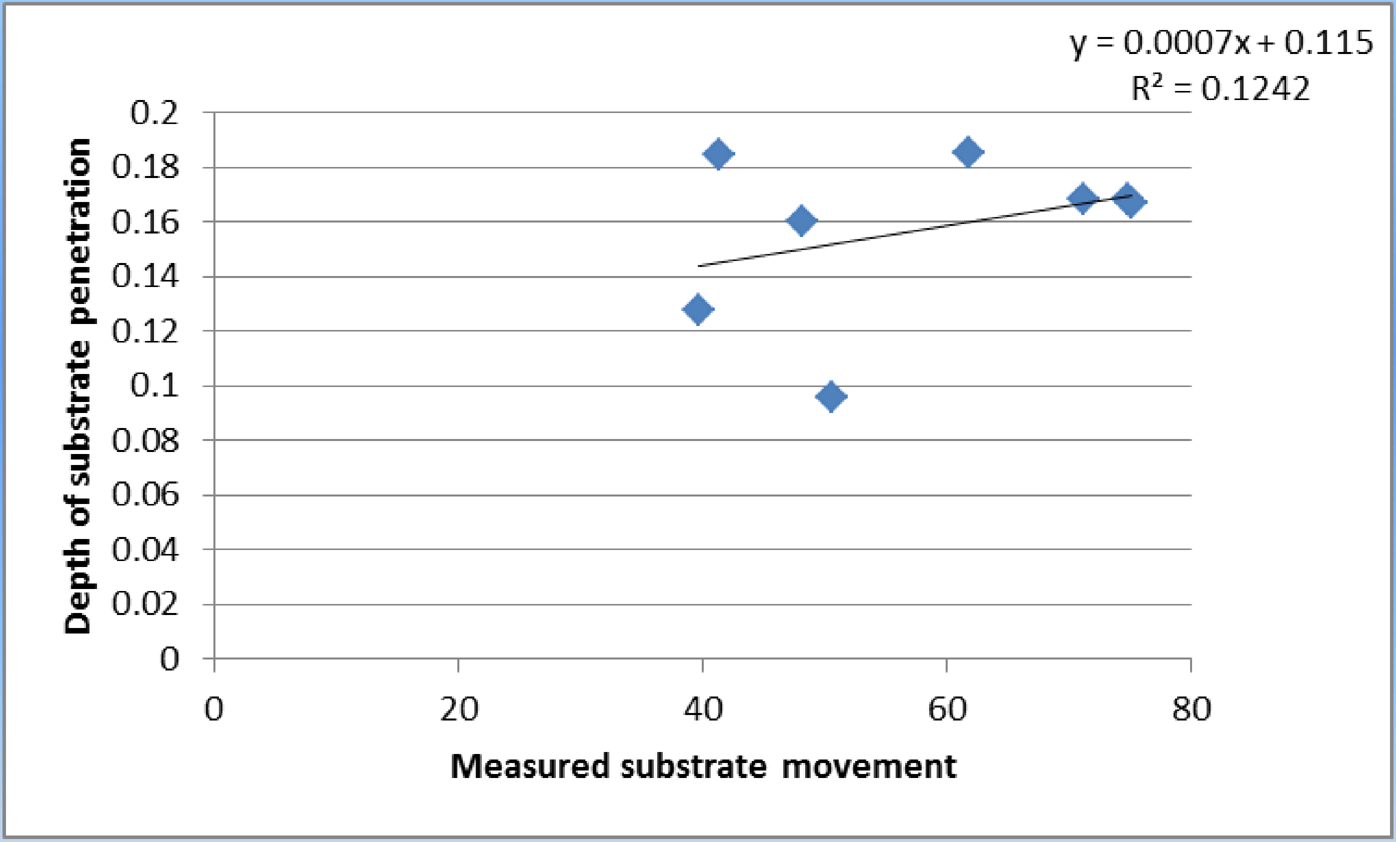
DIVERSITY PATTERNS IN STREAM BENTHIC INVERTEBRATE COMMUNITIES: THE INFLUENCE OF HABITAT STABILITY[1]

RUSSELL G. DEATH AND MICHAEL J. WINTERBOURN
Department of Zoology, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

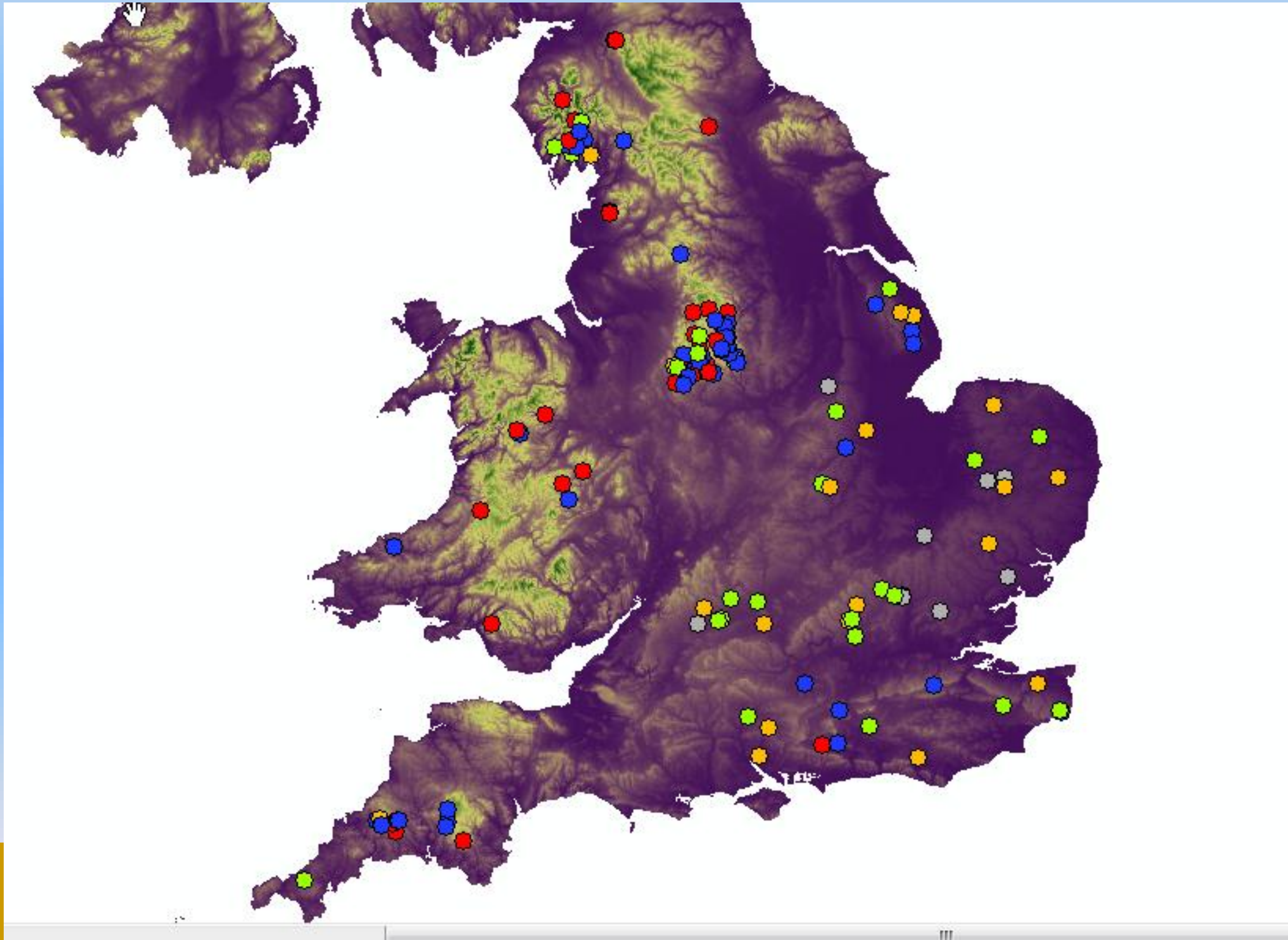
Abstract. Invertebrate diversity patterns were examined in 11 freshwater habitats (10 streams and a windswept lake shore) of similar physicochemical nature but different thermal and hydrologic stability in the Cass-Craigieburn region, New Zealand. Species richness and density were markedly higher at the more stable sites, but species evenness peaked at sites of intermediate stability. Of the 20 environmental variables examined, a multivariate instability index incorporating temporal variation in depth, temporal variation in current speed, substrate stability, the Pfankuch channel stability index, temperature range, and stream reach tractive force was the single best predictor of the number of species, whereas epilithic pigment concentration was the single best predictor of invertebrate density. The

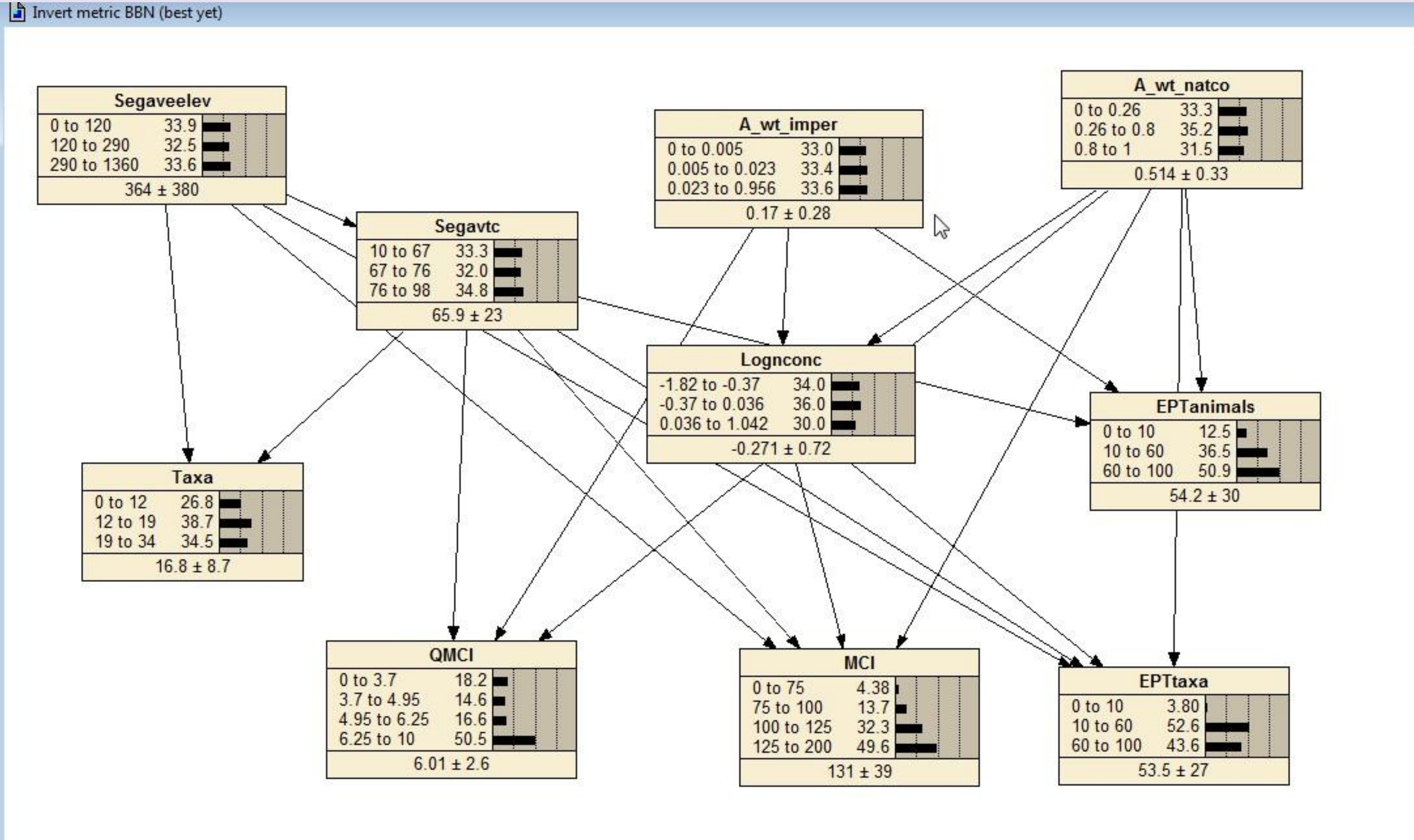
Penetrometer may prove useful

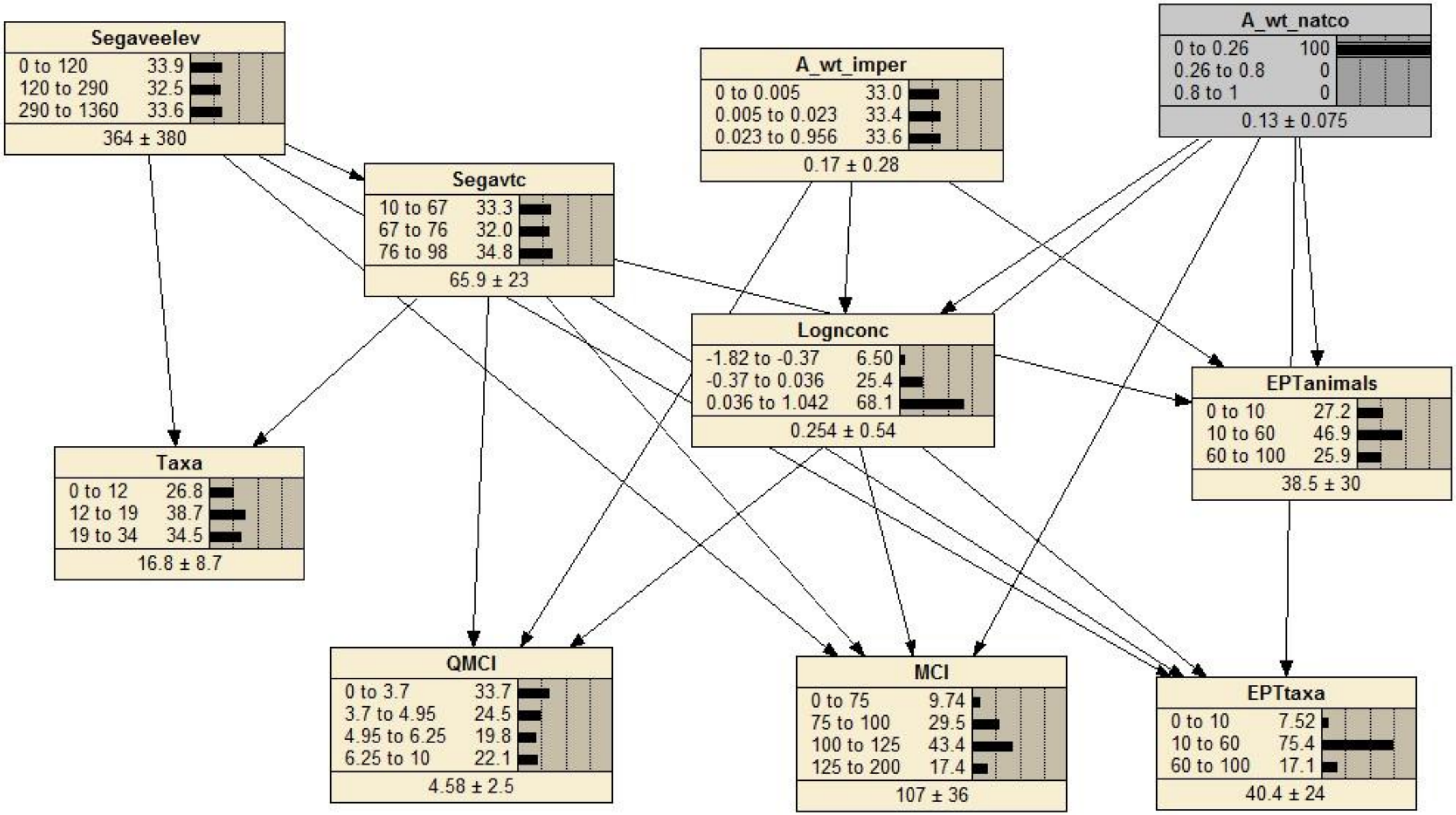
Promising early results



Modelling hydrology biology linkages




Invert metric BBN (best yet)
Segaveelev
0 to 120 33.9
120 to 290 32.5
290 to 1360 33.6
364 ± 380
A_wt_imper
0 to 0.005 33.0
0.005 to 0.023 33.4
0.023 to 0.956 33.6
0.17 ± 0.28
A_wt_natco
0 to 0.26 33.3
0.26 to 0.8 35.2
0.8 to 1 31.5
0.514 ± 0.33
Segavtc
10 to 67 33.3
67 to 76 32.0
76 to 98 34.8
65.9 ± 23
Lognconc
-1.82 to -0.37 34.0
-0.37 to 0.036 36.0
0.036 to 1.042 30.0
-0.271 ± 0.72
EPTanimals
0 to 10 12.5
10 to 60 36.5
60 to 100 50.9
54.2 ± 30
Taxa
0 to 12 26.8
12 to 19 38.7
19 to 34 34.5
16.8 ± 8.7
QMCI
0 to 3.7 18.2
3.7 to 4.95 14.6
4.95 to 6.25 16.6
6.25 to 10 50.5
6.01 ± 2.6
MCI
0 to 75 4.38
75 to 100 13.7
100 to 125 32.3
125 to 200 49.6
131 ± 39
EPTtaxa
0 to 10 3.80
10 to 60 52.6
60 to 100 43.6
53.5 ± 27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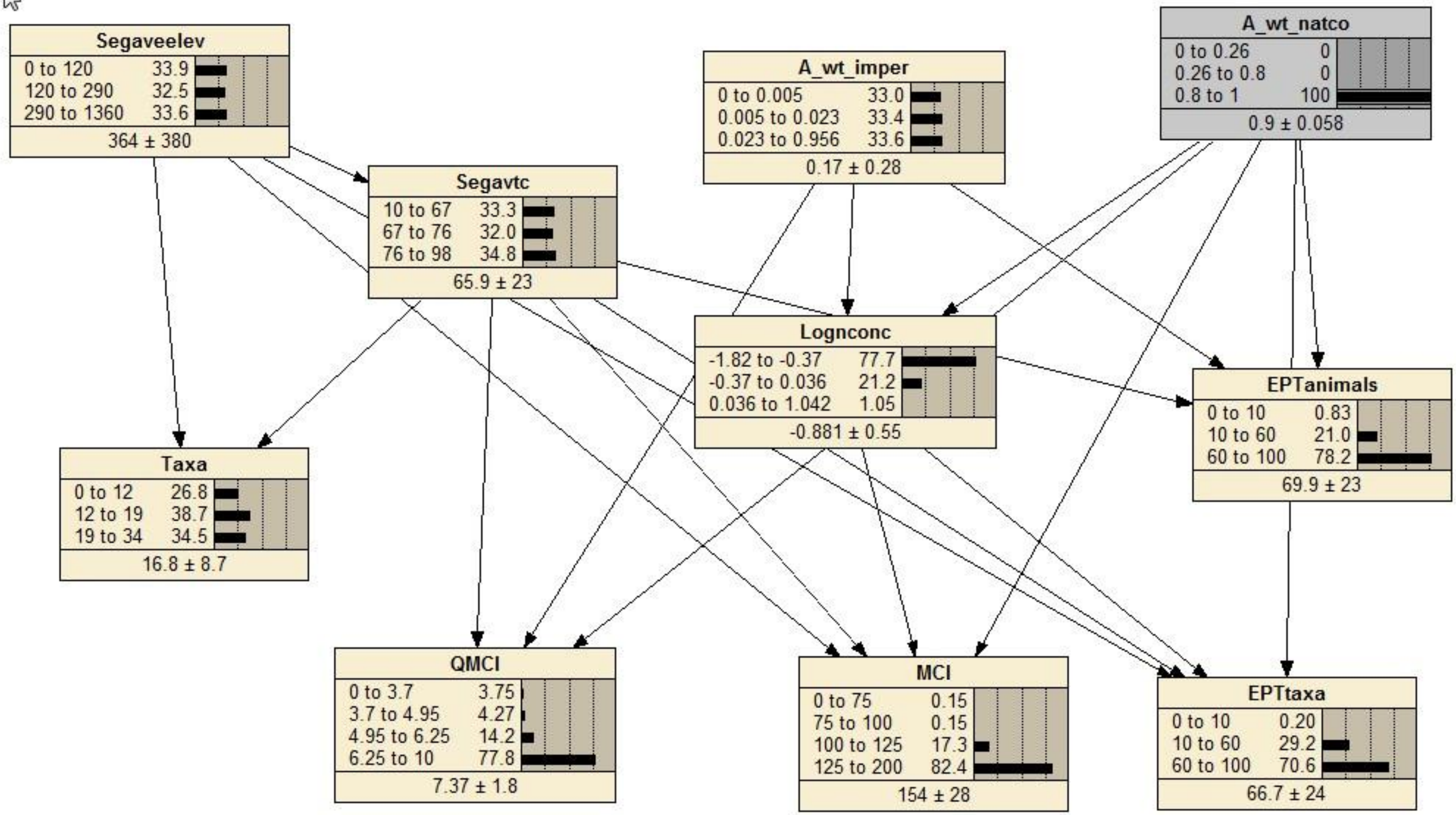
0.005 to 0.023 33.4
0.023 to 0.956 33.6
0.17 ± 0.28
A_wt_natco
0 to 0.26 100
0.26 to 0.8 0
0.8 to 1 0
0.13 ± 0.075
Segavtc
10 to 67 33.3
67 to 76 32.0
76 to 98 34.8
65.9 ± 23
Lognconc
-1.82 to -0.37 6.50
-0.37 to 0.036 25.4
0.036 to 1.042 68.1
0.254 ± 0.54
EPTanimals
0 to 10 27.2
10 to 60 46.9
60 to 100 25.9
38.5 ± 30
Taxa
0 to 12 26.8
12 to 19 38.7
19 to 34 34.5
16.8 ± 8.7
QMCI
0 to 3.7 33.7
3.7 to 4.95 24.5
4.95 to 6.25 19.8
6.25 to 10 22.1
4.58 ± 2.5
MCI
0 to 75 9.74
75 to 100 29.5
100 to 125 43.4
125 to 200 17.4
107 ± 36
EPTtaxa
0 to 10 7.52
10 to 60 75.4
60 to 100 17.1
40.4 ± 24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290 to 1360 33.6
364 ± 380
Segavtc
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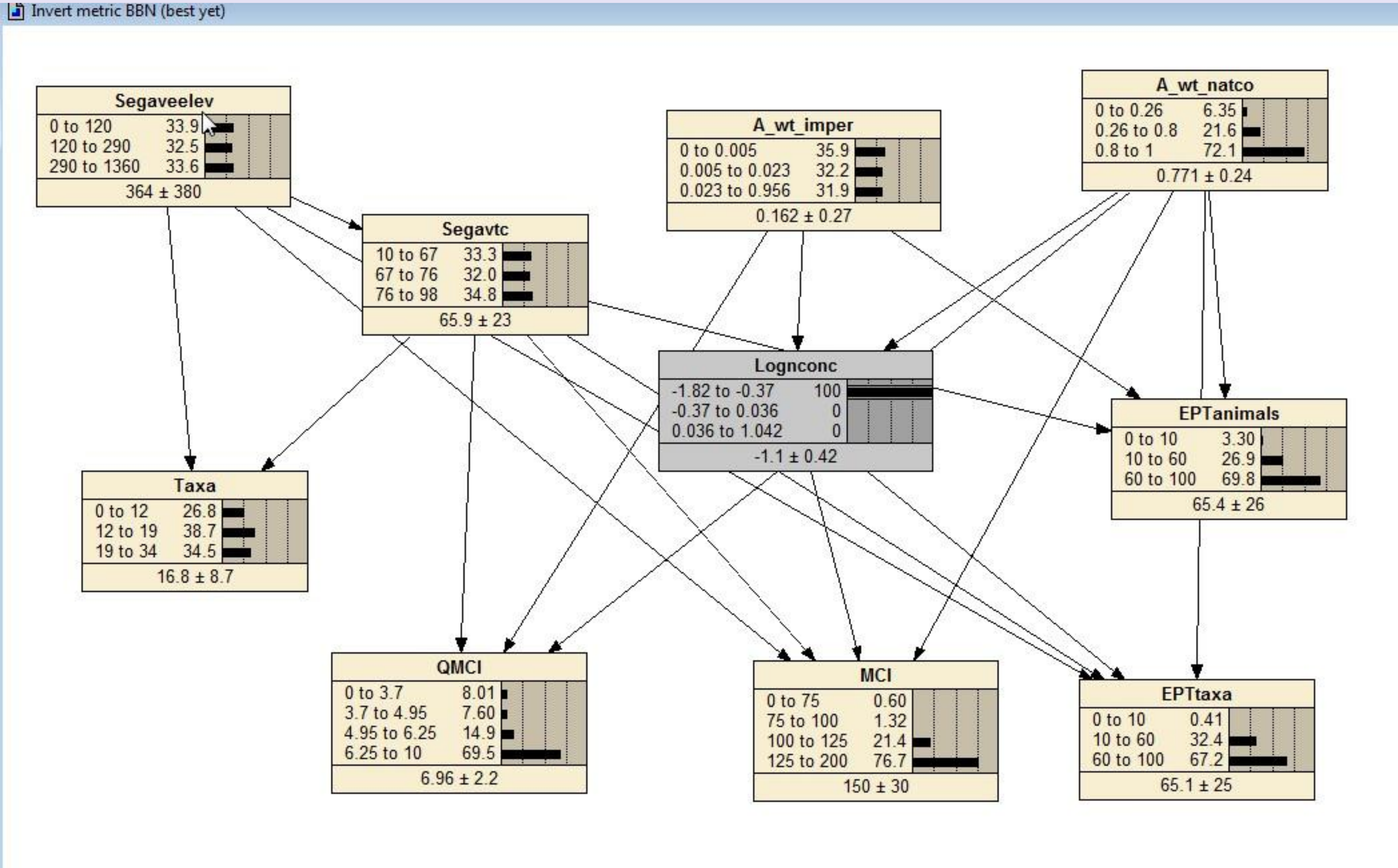
67 to 76 32.0
76 to 98 34.8
65.9 ± 23
A_wt_imper
0 to 0.005 33.0
0.005 to 0.023 33.4
0.023 to 0.956 33.6
0.17 ± 0.28
A_wt_natco
0 to 0.26 0
0.26 to 0.8 0
0.8 to 1 100
0.9 ± 0.058
Lognconc
-1.82 to -0.37 77.7
-0.37 to 0.036 21.2
0.036 to 1.042 1.05
-0.881 ± 0.55
EPTanimals
0 to 10 0.83
10 to 60 21.0
60 to 100 78.2
69.9 ± 23
Taxa
0 to 12 26.8
12 to 19 38.7
19 to 34 34.5
16.8 ± 8.7
QMCI
0 to 3.7 3.75
3.7 to 4.95 4.27
4.95 to 6.25 14.2
6.25 to 10 77.8
7.37 ± 1.8
MCI
0 to 75 0.15
75 to 100 0.15
100 to 125 17.3
125 to 200 82.4
154 ± 28
EPTtaxa
0 to 10 0.20
10 to 60 29.2
60 to 100 70.6
66.7 ± 24



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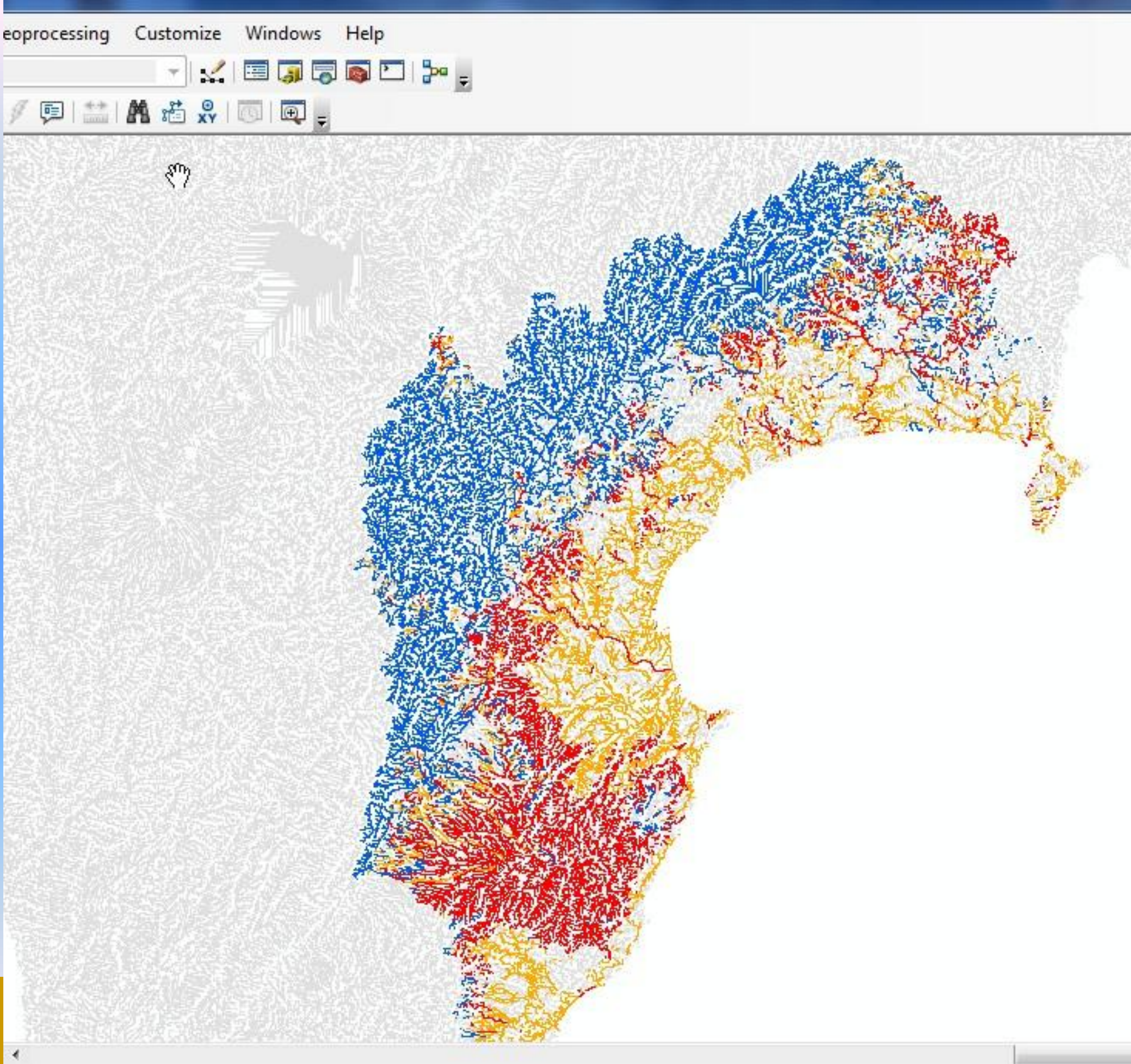
364 ± 380
A_wt_imper
0 to 0.005 35.9
0.005 to 0.023 32.2
0.023 to 0.956 31.9
0.162 ± 0.27
A_wt_natco
0 to 0.26 6.35
0.26 to 0.8 21.6
0.8 to 1 72.1
0.771 ± 0.24
Segavtc
10 to 67 33.3
67 to 76 32.0
76 to 98 34.8
65.9 ± 23
Lognconc
-1.82 to -0.37 100
-0.37 to 0.036 0
0.036 to 1.042 0
-1.1 ± 0.42
EPTanimals
0 to 10 3.30
10 to 60 26.9
60 to 100 69.8
65.4 ± 26
Taxa
0 to 12 26.8
12 to 19 38.7
19 to 34 34.5
16.8 ± 8.7
QMCI
0 to 3.7 8.01
3.7 to 4.95 7.60
4.95 to 6.25 14.9
6.25 to 10 69.5
6.96 ± 2.2
MCI
0 to 75 0.60
75 to 100 1.32
100 to 125 21.4
125 to 200 76.7
150 ± 30
EPTtaxa
0 to 10 0.41
10 to 60 32.4
60 to 100 67.2
65.1 ± 25

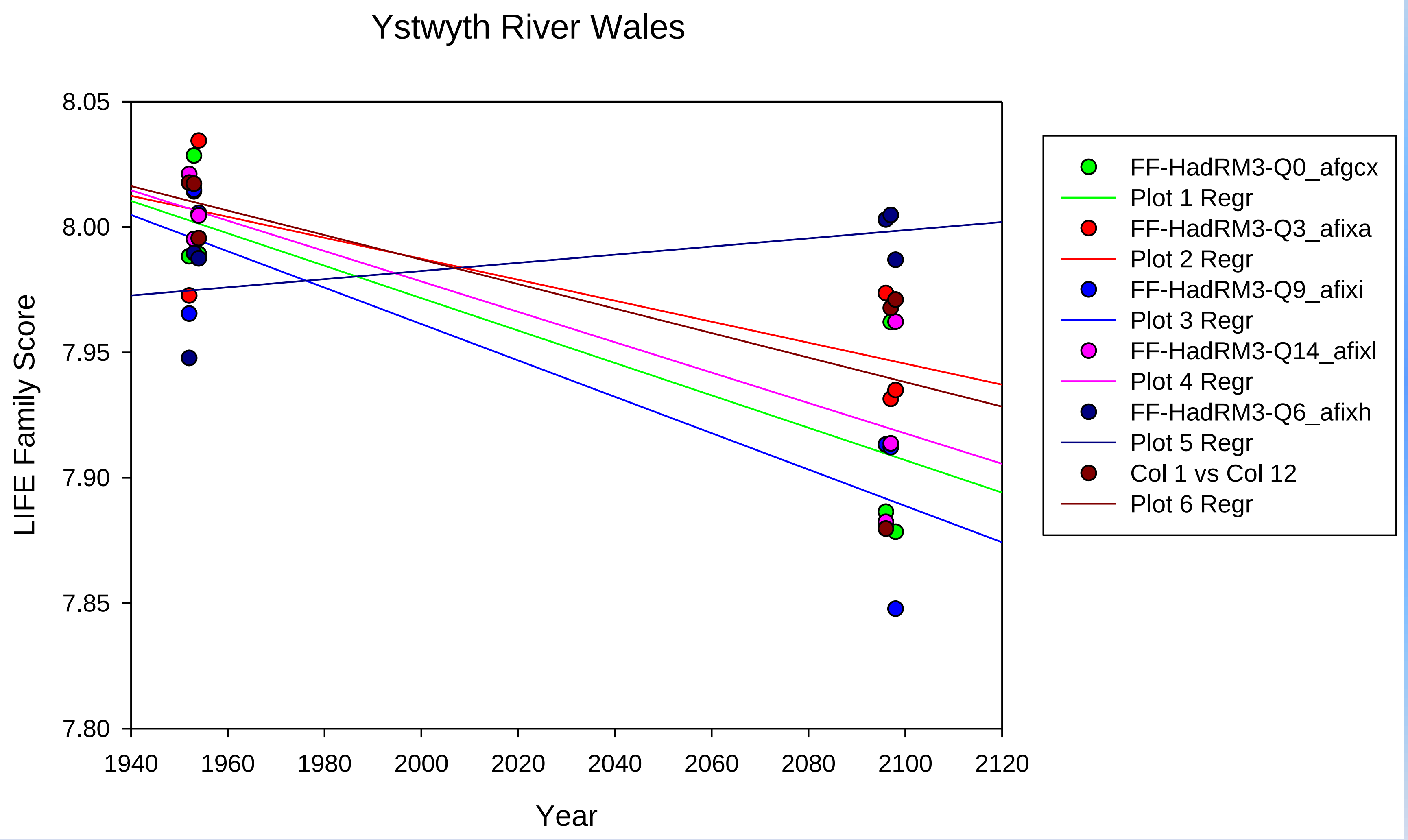


Te Kunenga
ki Pūrehuroa

Progress

- Model predictions very good.
- Would like to use GIS to extrapolate predictions
- Then explore under changing climate scenarios

Early findings



Conclusion

- We need to do more to integrate hydrology, geomorphology and ecology
- Solutions for many environmental problems lie in the nexus between them.
- Need more practical mechanisms for that integration.
- Given a few examples of how we are attempting to do that.

Acknowledgements

- Thanks to BHS for inviting me to present.
- Institute of Advanced Studies, University of Birmingham for funding my visit.
- Mark Ledger for keeping my feet on the ground as a Distinguished Visiting Fellow.