CAWTHRON INSTITUTE

ECOSYSTEM HEALTH OF TE WAIKOROPUPŪ

SUMMARY OF SCIENCE PANEL DISCUSSIONS

ROGER YOUNG

WORKSHOP OBJECTIVES

- Summarise existing physicochemical and biological data for Te Waikoropupū and connected water bodies to improve understanding of the current state of the springs and changes over the last few decades

- Based on the above, and expert knowledge, describe ecosystem health of the springs and highlight the major anthropogenic risks to spring health

- Provide recommendations on relevant attributes (and bands) that can be used in objective setting processes

PARTICIPANTS

- Roger Young, Cawthron – workshop convenor, freshwater ecology
- Joseph Thomas, TDC – Takaka water resources
- John Stark, Stark Environmental – invertebrate monitoring
- Magali Moreau, GNS – national groundwater network
- Graham Fenwick, NIWA – groundwater biodiversity/ecology
- Andrew Fenemor, Landcare Research – N modelling
- Graham McBride, NIWA – trend analyses, water quality
- Chris Hickey, NIWA – toxicology, water quality

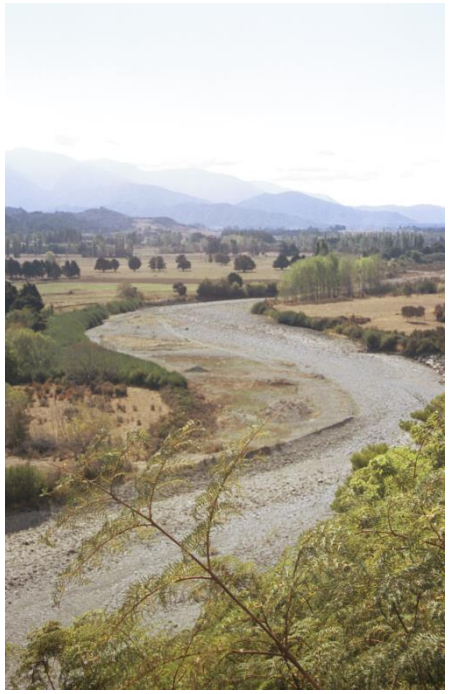
- Justin Kitto, Dairy NZ - observer
- Dairy NZ provided funding to convene the workshop

A BIT ABOUT ME

- PhD in River Ecology, University of Otago 1998
- Freshwater Ecologist, Cawthron Institute for last 18 years
- Coastal and Freshwater Group Manager (Freshwater)

- Provide advice to councils and other stakeholders throughout NZ
- Involved in research relating to water management

- Cobb Power Scheme re-consenting
- Motupipi water quality
- TDC surface water quality reports
- Takaka flow management framework
- Providing advice to FLAG



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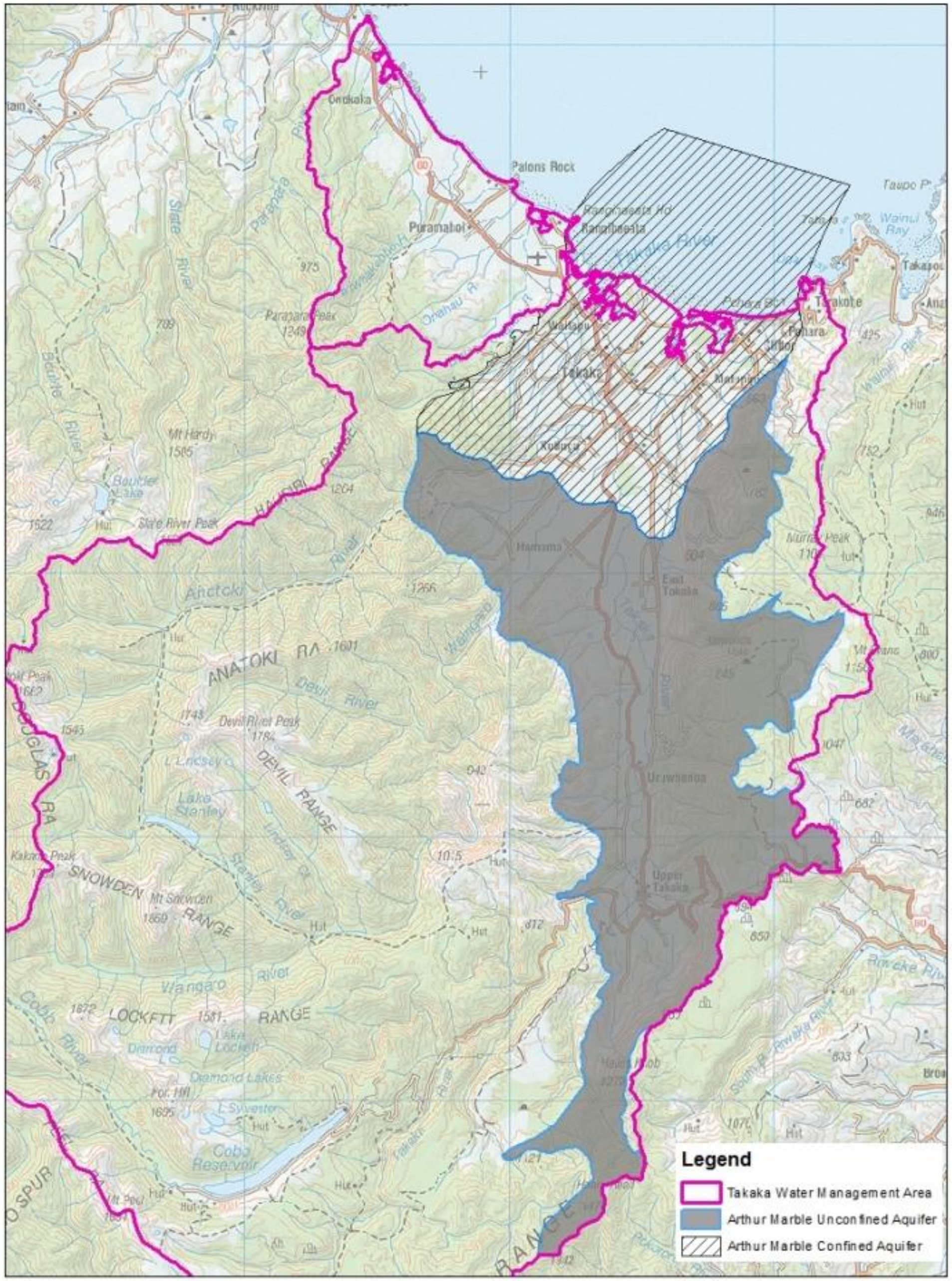
UNCONFINED & CONFINED AQUIFERS – ARTHUR MARBLE AQUIFER



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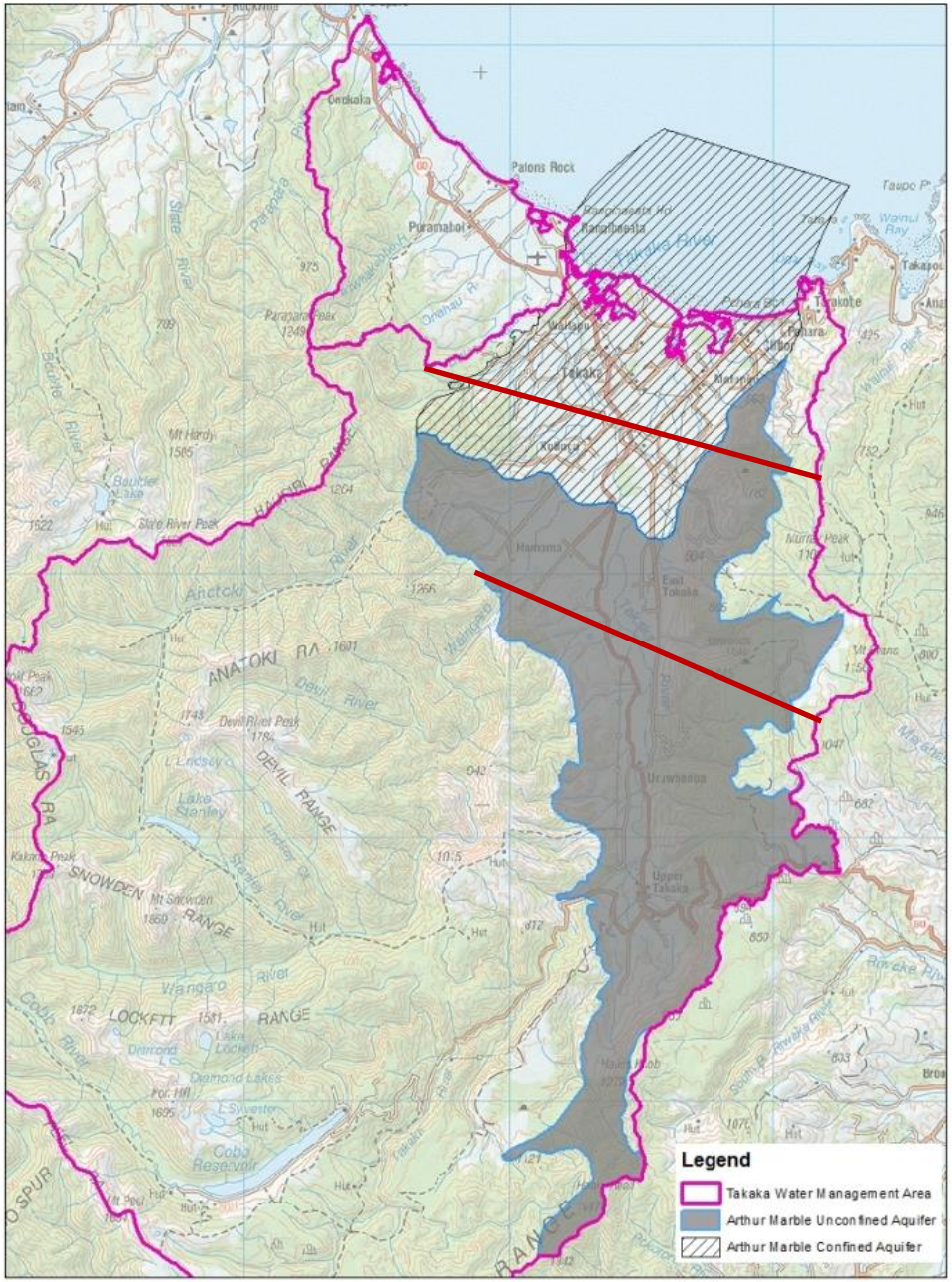
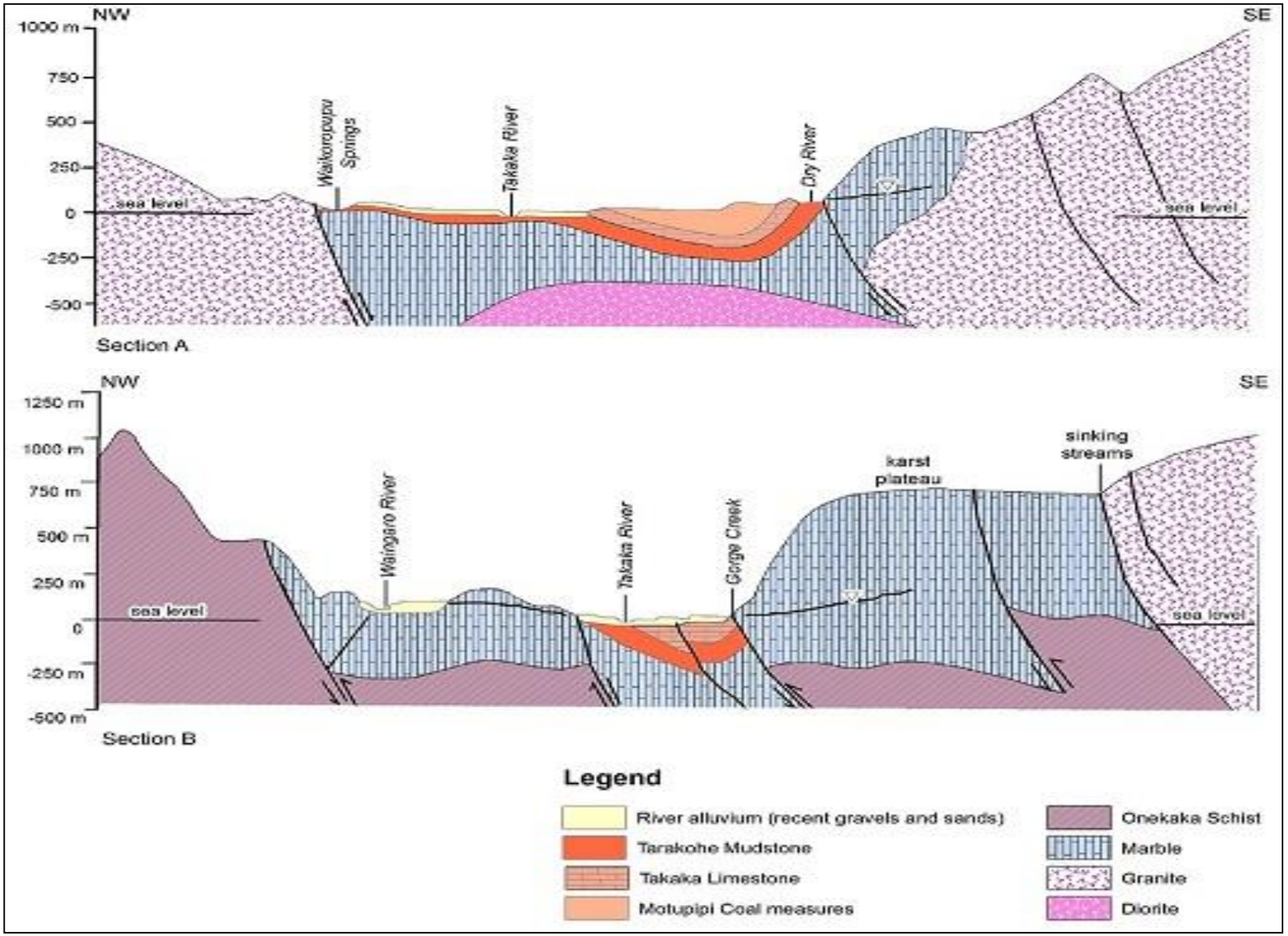
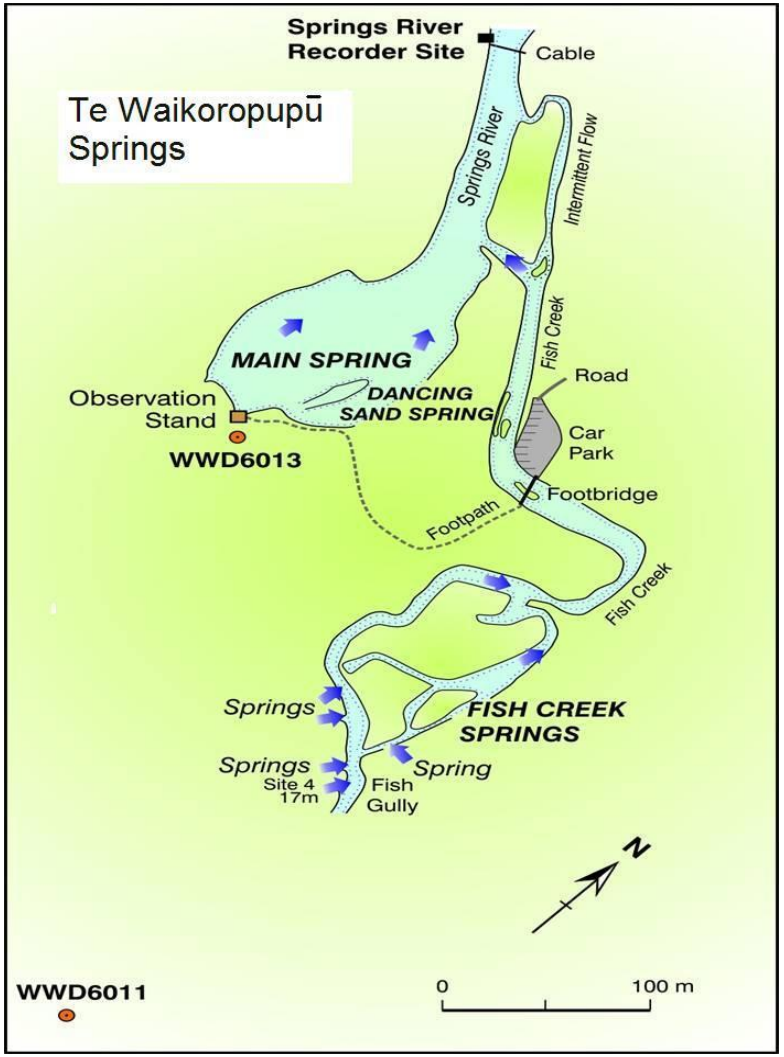


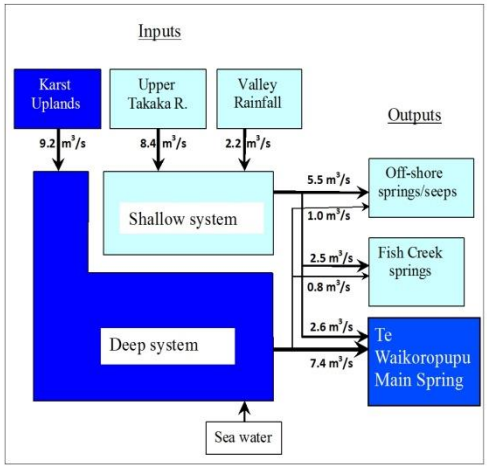
UNDERGROUND GEOLOGY



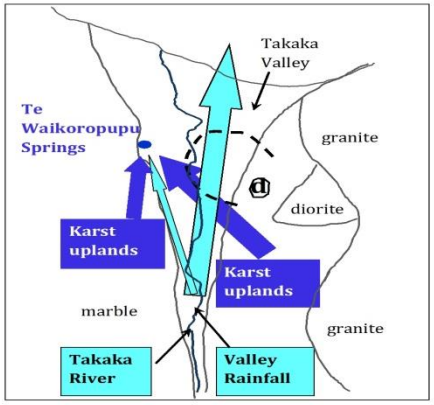
TE WAIKOROPUPŪ SPRINGS

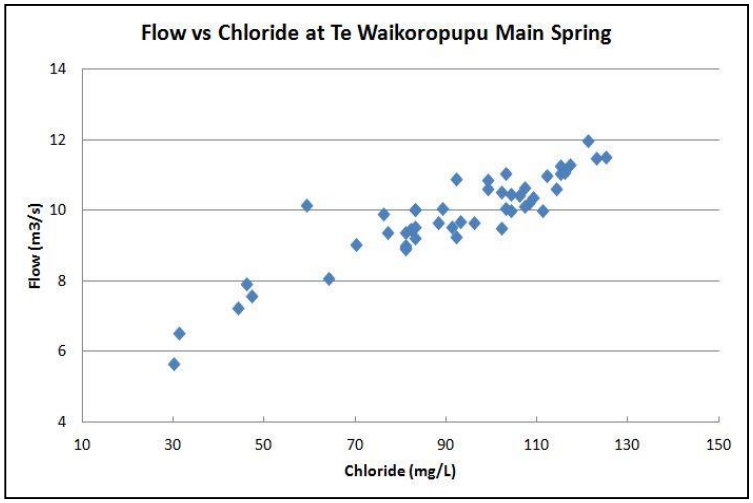


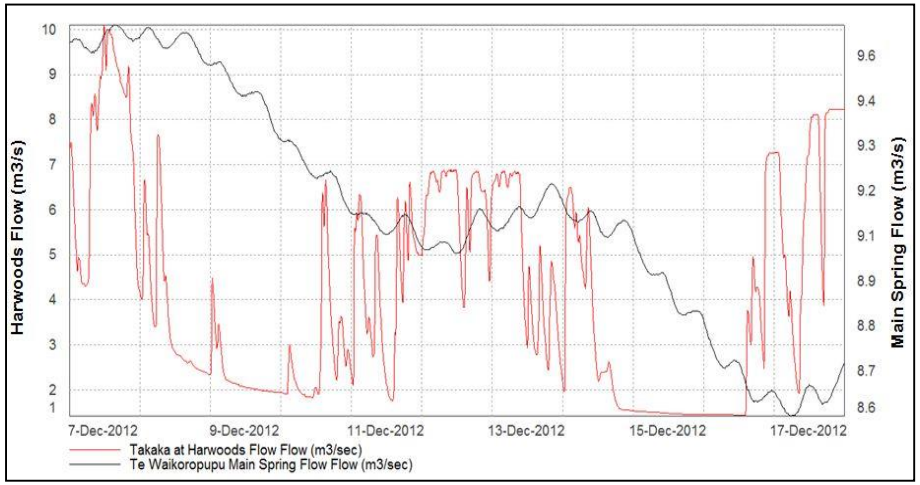
TE WAIKOROPUPŪ SPRINGS



Conceptual model of flow in the Arthur Marble Aquifer







KEY WORKSHOP DISCUSSIONS

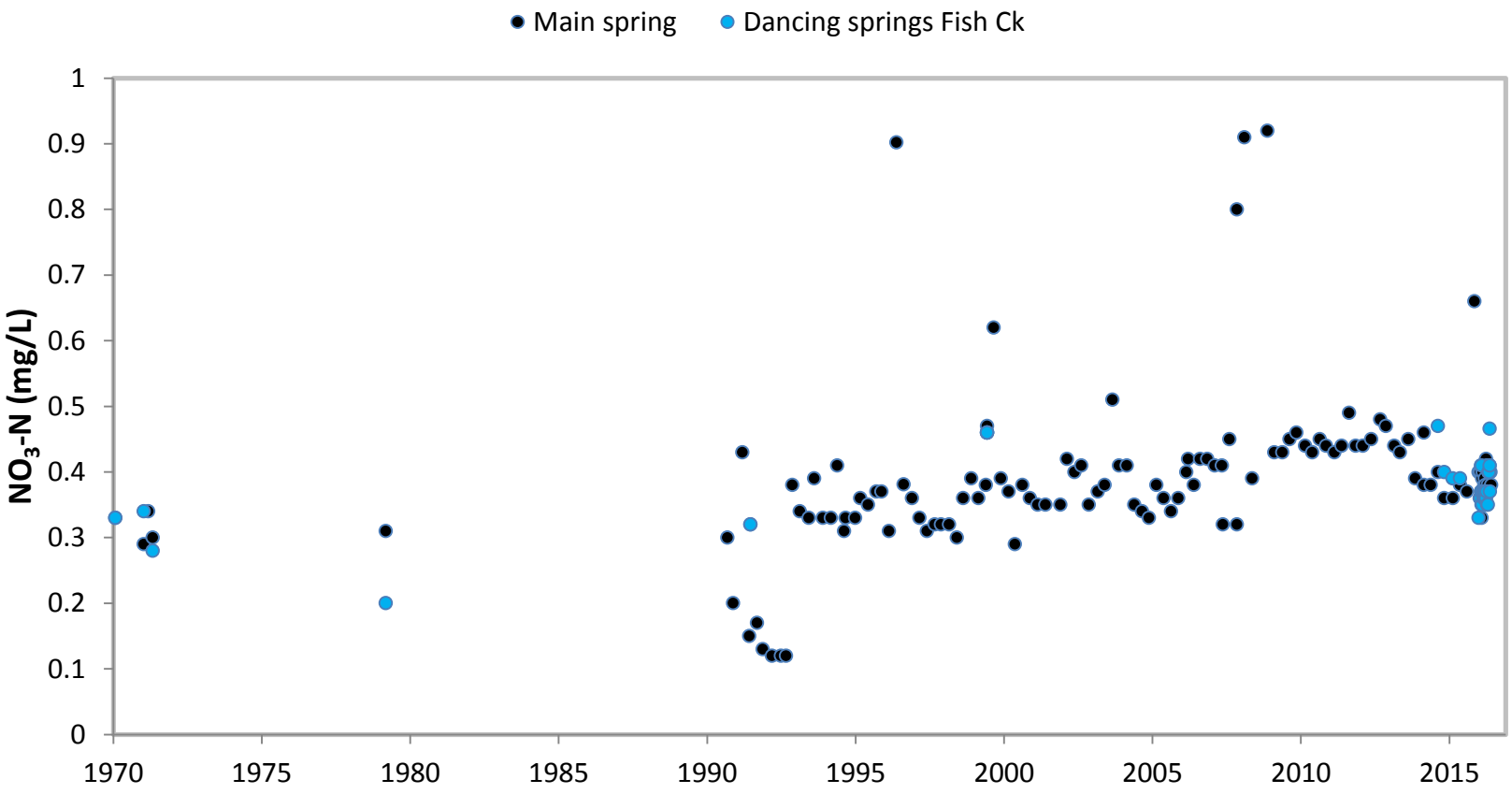
- Long-term data and trends
  - Nitrate nitrogen
  - Dissolved reactive phosphorus
  - Dissolved oxygen
  - Water temperature
  - Water clarity
  - Dissolved organic carbon
  - Faecal bacteria
  - Aquatic plants
  - Invertebrates
- Current health
  - Comparisons with relevant guidelines
- Risks
- Critical attributes and triggers

Data availability
Data quality issues
Trend analyses

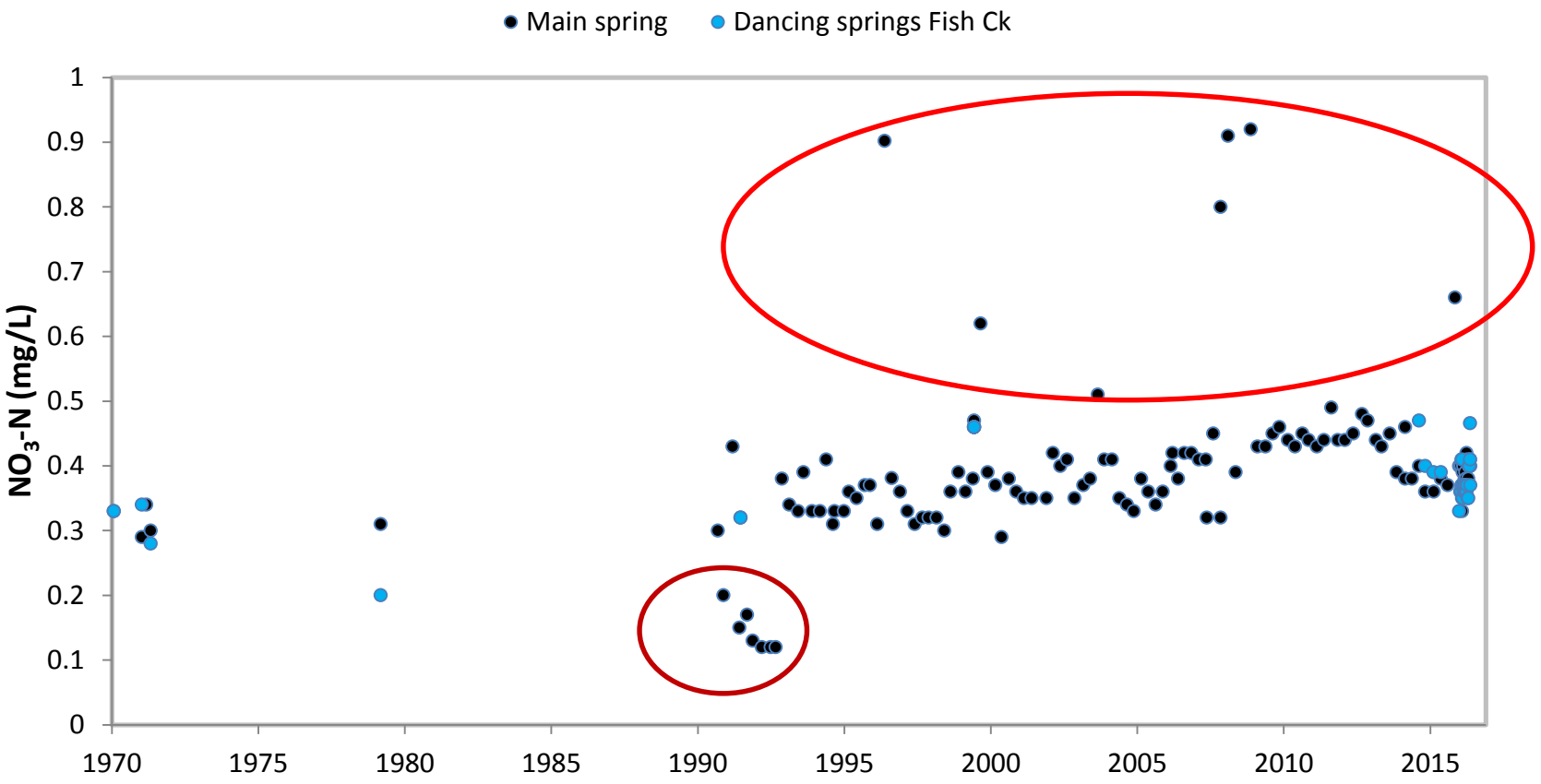
WATER QUALITY DATA

- Michaelis thesis 1970-71
  - Main spring and Dancing Sands
- Stewart & Downes 1979
- Mueller 1992
- Other occasional one-off samples TDC
- Davies-Colley & Smith 1995 – water clarity measured
- National Groundwater Monitoring Programme 1990-present
  - Main Spring:
  - Quarterly samples
  - Temperature, conductivity, Ca, Na, Mg, K, Fe, Mn, Cl, Br, NO_3-N, SO_4, NH_4-N, SiO_2, F.
  - Dissolved phosphorus analyses annually, quarterly since 2015.
- Friends of Golden Bay 2015-16
  - temperature, conductivity, chloride, nitrate nitrogen, dissolved phosphorus
- DOC
  - Monitoring of aquatic plants 1991-2012
  - Spot sampling for faecal bacteria in 2014

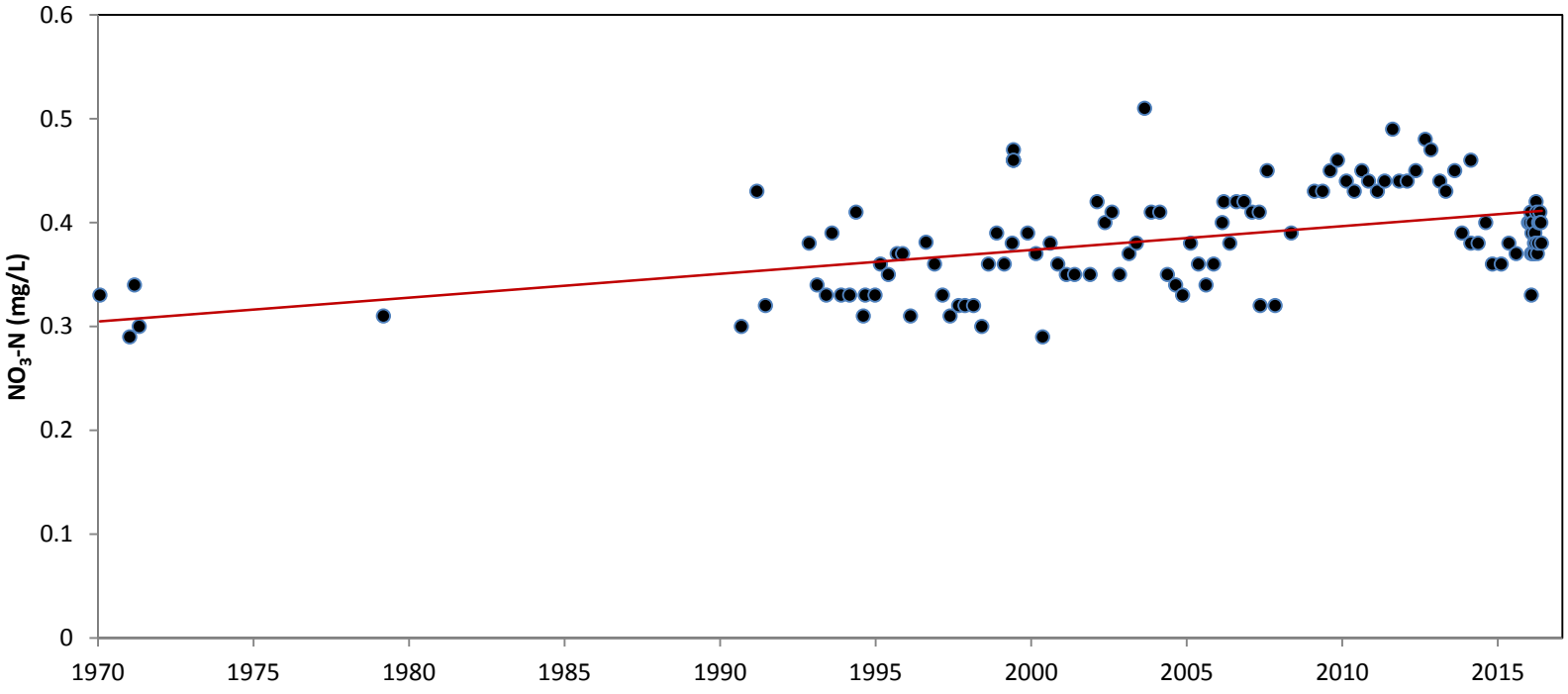
NITRATE NITROGEN



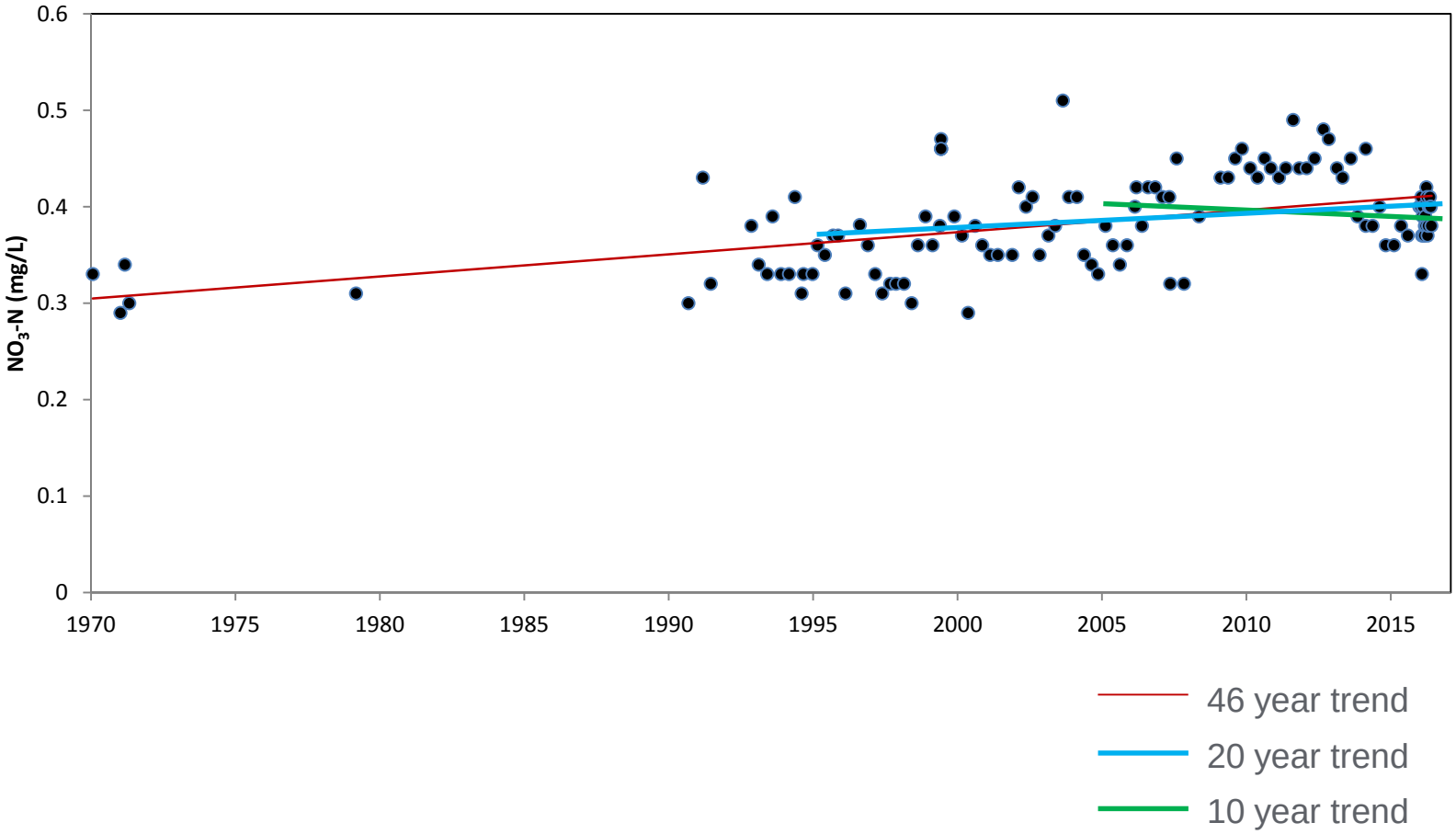
NITRATE NITROGEN



NITRATE NITROGEN TRENDS



NITRATE NITROGEN TRENDS



NITRATE TRENDS

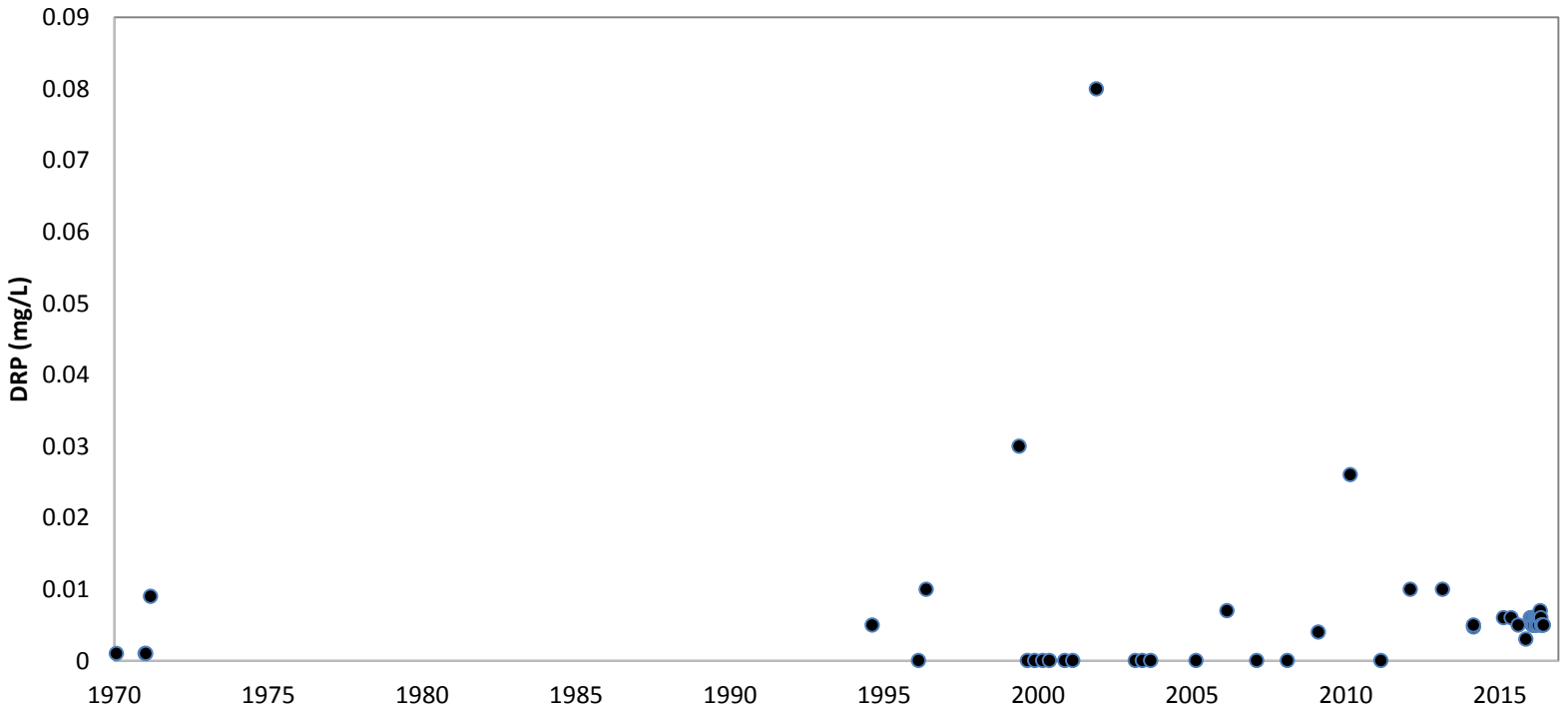
- There is a ‘statistically’ significant increase over the full data record. The change is 0.9% per year

- **If the trend continues at this rate** the Springs would get to the lowest level of concern for nitrate toxicity for fish and surface water invertebrates (1.0 mg/L) by 2124. If you set a ‘trigger’ at 0.5 mg/L, then if the trend continued at the current rate we’d get to this trigger by 2047.

- If you look at just the last 20 years of data you still get a statistically significant upwards trend, but the slope is very low (0.25% per year – **if it continued** it would reach 0.5 mg/L by 2106).

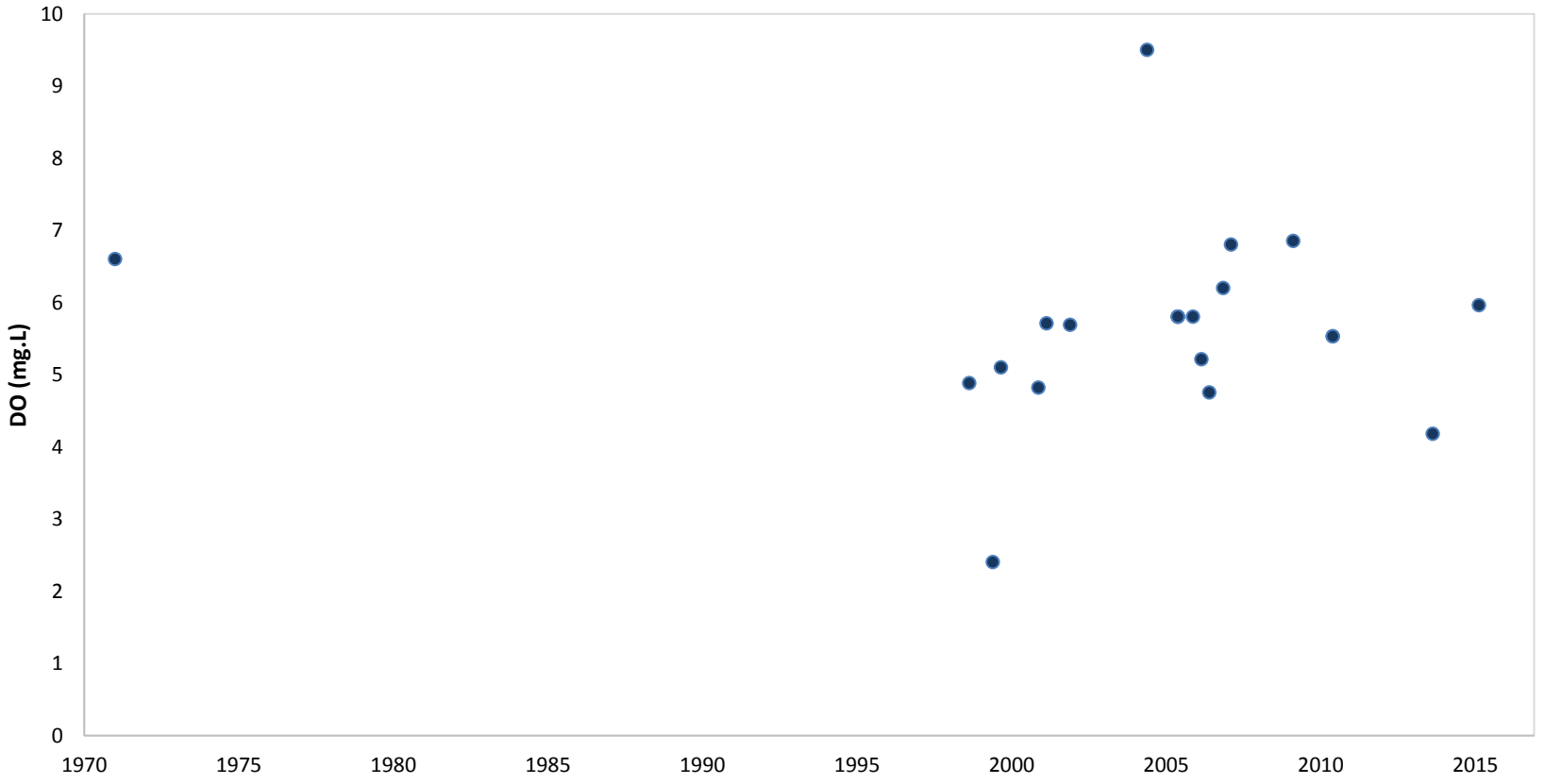
- If you look at the last 10 years of data you get a statistically significant downwards trend with a slope of 1.5% per year.

DISSOLVED REACTIVE PHOSPHORUS

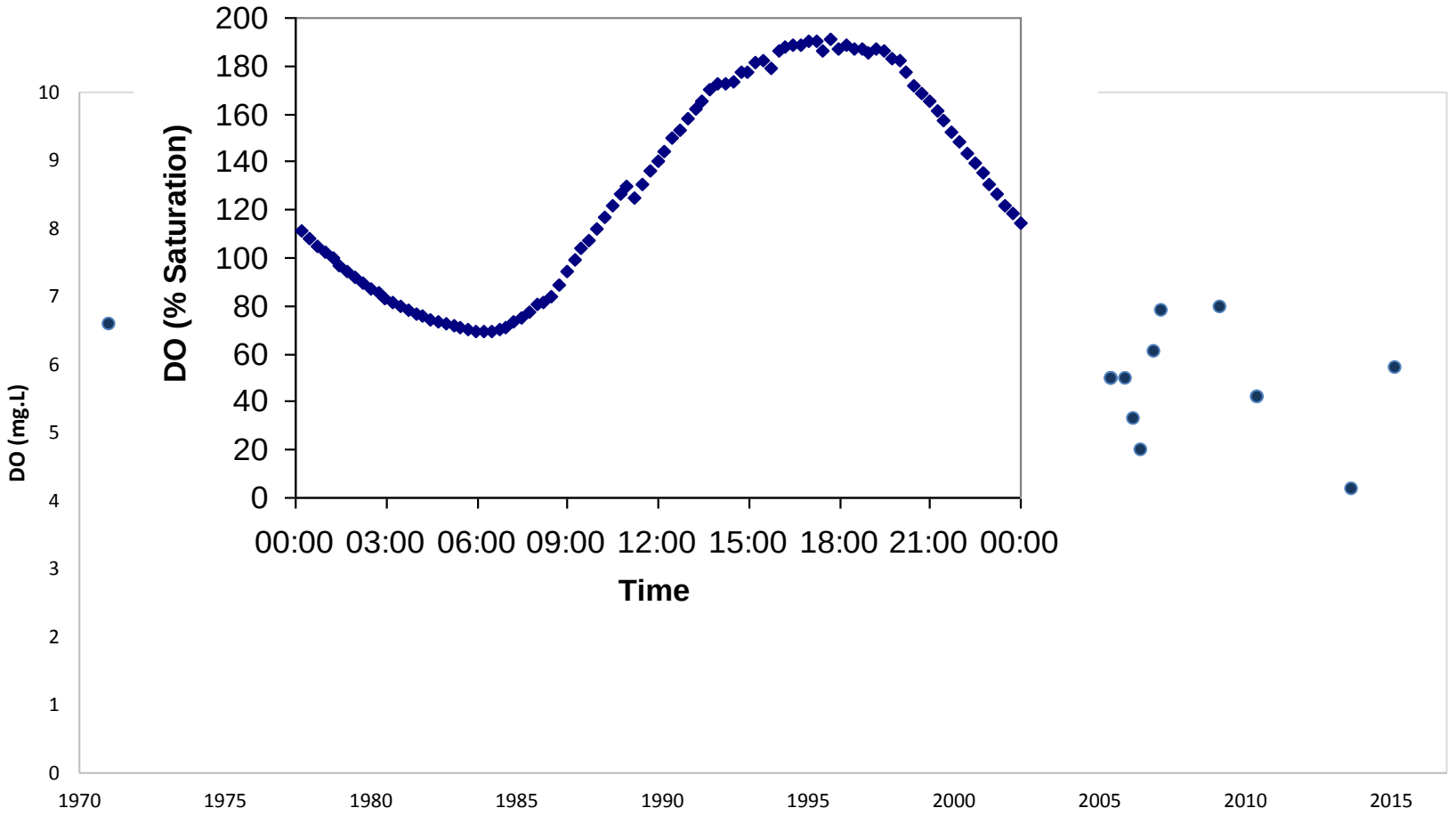


- Phosphorus concentrations generally very low
- No indication of change
- Ratio of N:P suggests that phosphorus likely to be controlling algal growth

DISSOLVED OXYGEN

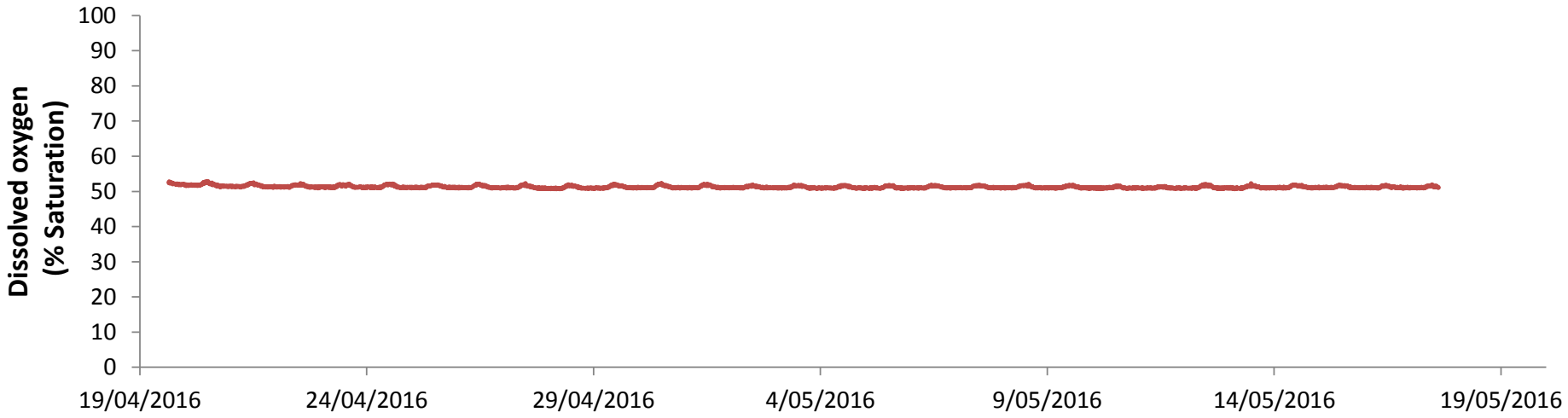


DISSOLVED OXYGEN



Spot measurements of dissolved oxygen of limited value because dissolved oxygen can vary hugely within a single day

DISSOLVED OXYGEN IN MAIN SPRING

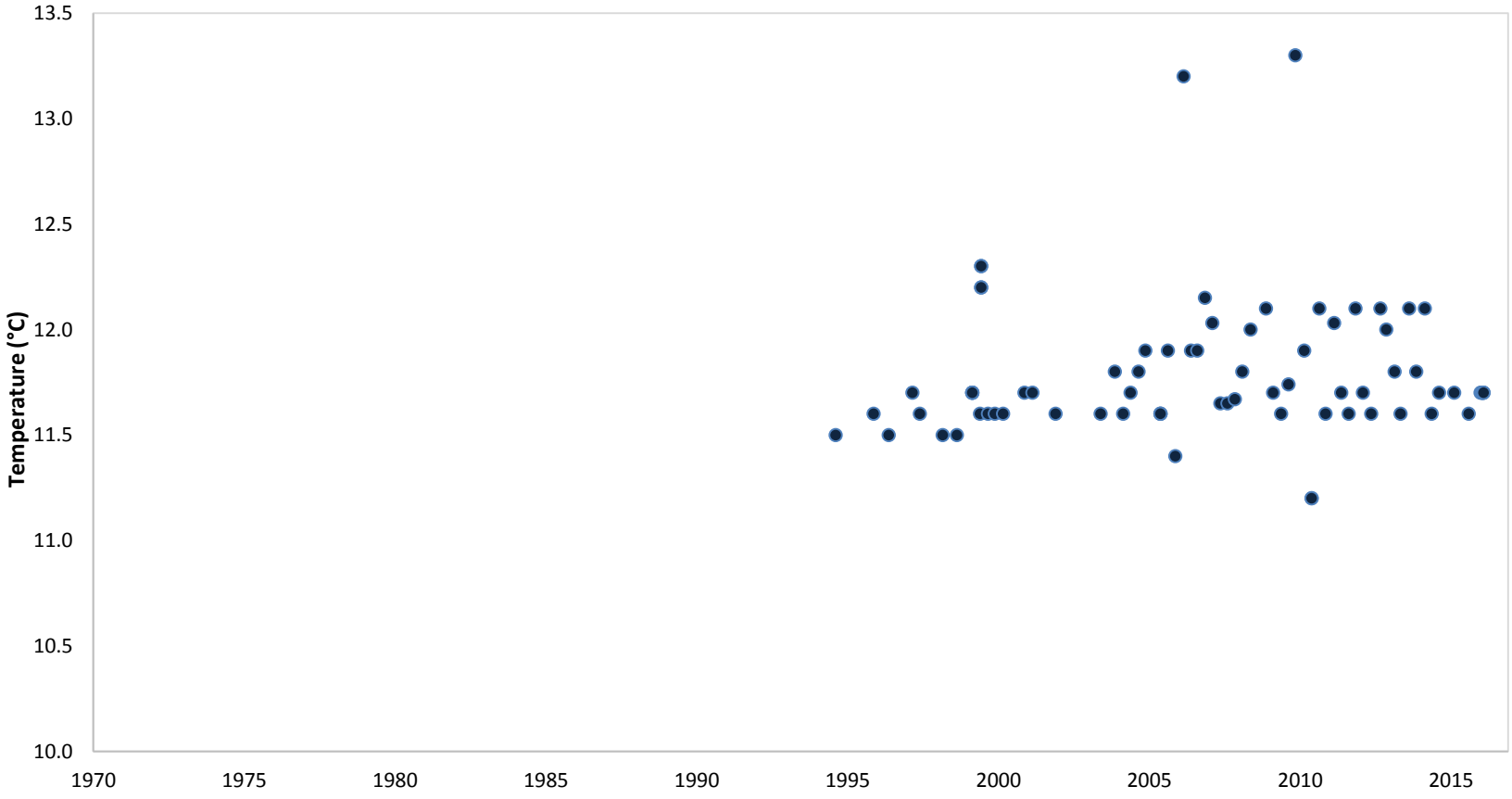


Very little daily variation

DO Saturation early 1970's (Michaelis)	58-64%
DO Saturation April May 2016	50-53%

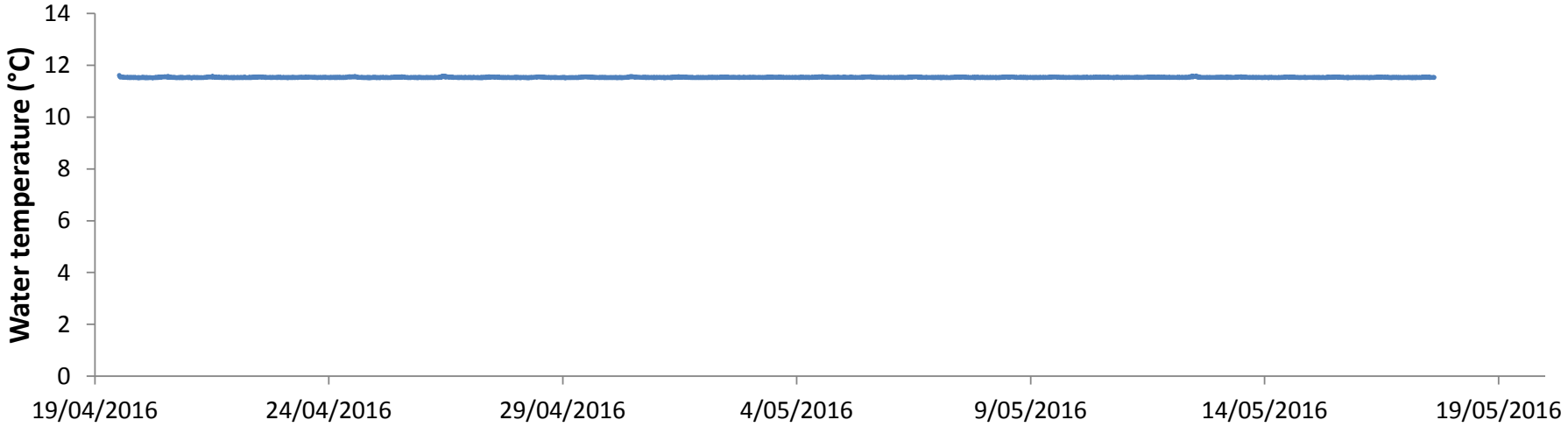
A decrease….but accurate DO measurement is difficult, with difference similar to measurement uncertainty

WATER TEMPERATURE



Spot measurements of temperature of limited value

WATER TEMPERATURE



Michaelis 1971 – 11.7 °C
No change

WATER CLARITY

New Zealand Journal of Marine and Freshwater Research, 1995: Vol. 29: 251–256
0028–8330/95/2902–0251 $2.50/0 © The Royal Society of New Zealand 1995

Optically pure waters in Waikoropupu ('Pupu') Springs, Nelson, New Zealand

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D. G. SMITH
National Institute of Water & Atmospheric Research Ltd
P. O. Box 11–115
Hamilton, New Zealand

Abstract We have made *in situ* observations of the optical properties of Waikoropupu ("Pupu") Springs, Nelson, New Zealand. Visual clarity was measured in the horizontal direction over a sight path "folded" using a plane mirror so as to accommodate the sighting range within the 35 m wide main springs basin. An average black-body visibility of 63 m was obtained, the highest yet reported for any fresh waters, and close to the

surprising given that their clarity is a feature often remarked on. Waikoropupu Springs, generally called Pupu Springs, near Takaka, Nelson, are New Zealand's largest springs (ranked 24th in the world among Karst—carbonate rock aquifer—springs, with an average flow of 15 $m^3 s^{-1}$: Ford & Williams 1989; Williams 1992). These springs have long been renowned for their beauty and water clarity (Williams 1992). Although the general ecology (Michaelis 1977), hydrology (Williams 1977; Stewart & Downes 1982; Stewart & Williams 1981) and chemistry (Michaelis 1976) of the springs have been reasonably well studied, there have been only a few simple measurements of their optical properties (Michaelis 1976). These measurements, made with a filter radiometer, suggested that the spring waters are optically very pure. Here we

- 63 m visibility
- Highest ever reported at the time

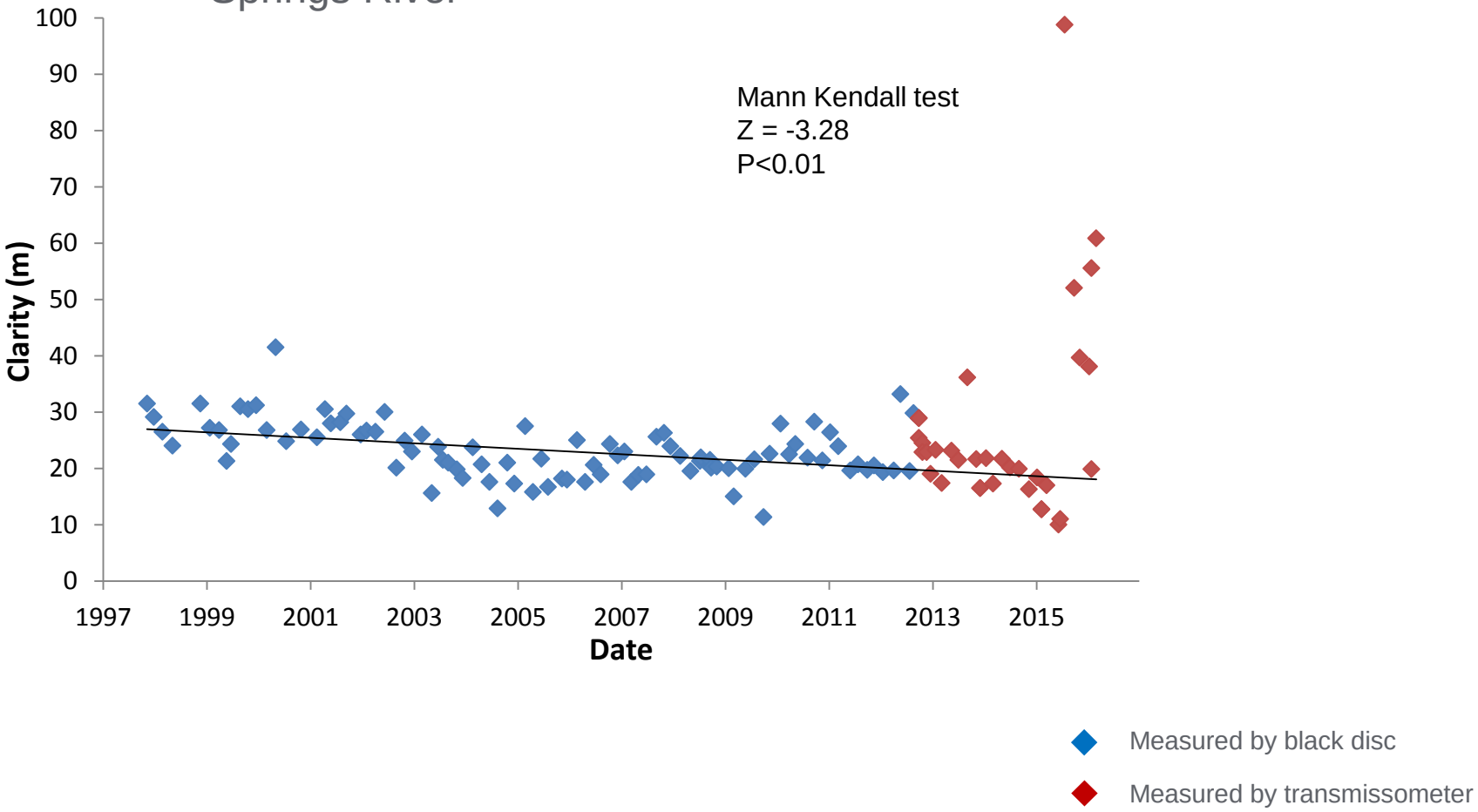
WATER CLARITY

Monitoring data available in the Springs River relating to the salmon farm

WATER CLARITY UPSTREAM OF SALMON FARM

A decline BUT…..data not necessarily reflecting main spring clarity

- Monitoring location downstream of Fish Creek's influence and affected by natural entrainment of dissolved and particulate material from Springs River



DISSOLVED ORGANIC CARBON

- Undetectable concentrations in the springs = very clear water

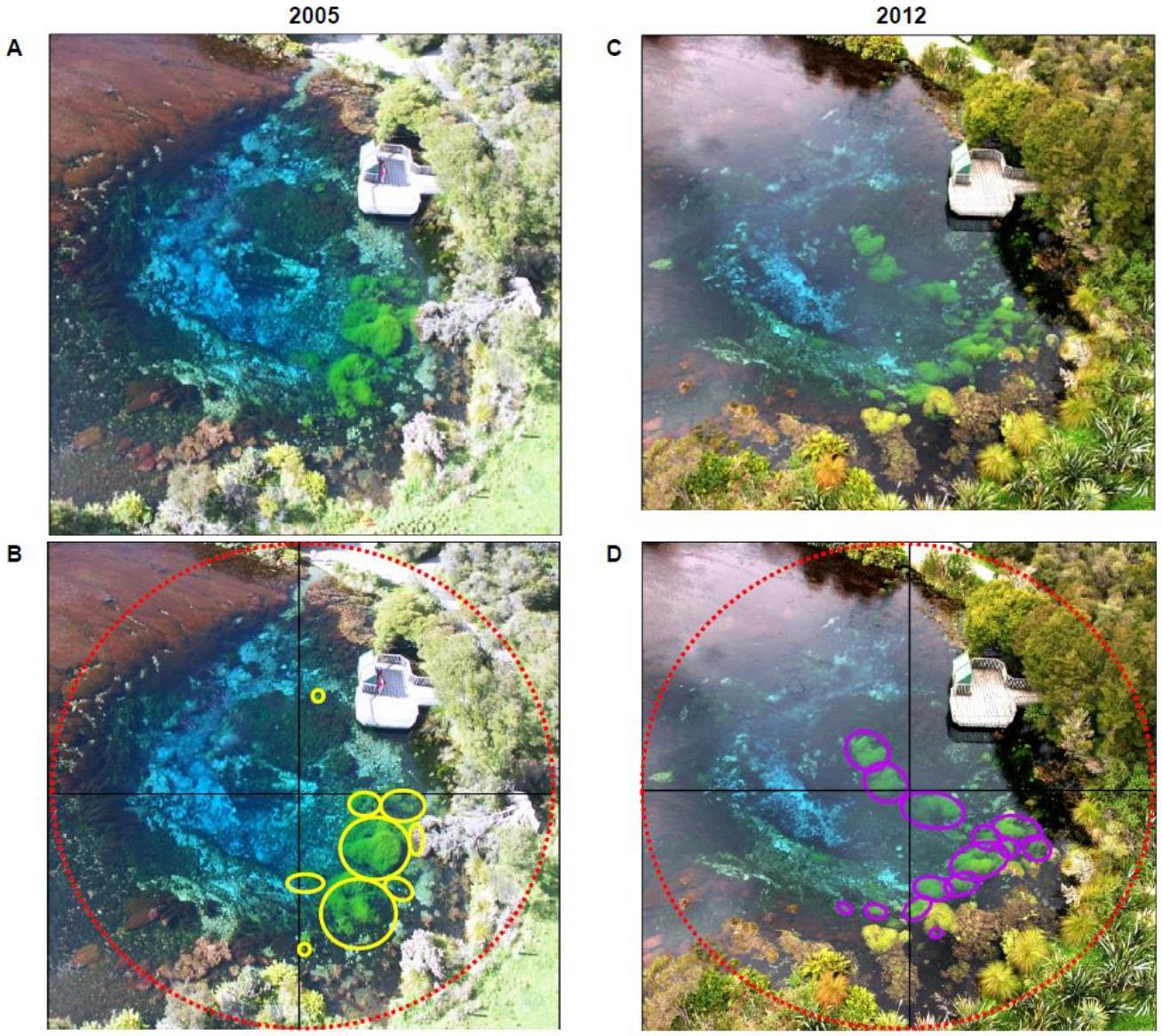
- Measured in upper Takaka River during Cobb reconsenting 1999
  - 2 mg/L
  - Relatively low and not a concern

FAECAL BACTERIA

- Main Spring and Dancing Sands <1 MPN/100mL
- Fish Creek Spring 2 MPN/100mL
- Further downstream 1-23 MPN/100mL

Very good water quality at springs (drinkable)
Some minor contamination further downstream

AQUATIC PLANTS



- *Galium palustre*
- Non-native aquatic plant
- First recorded in springs in 2005

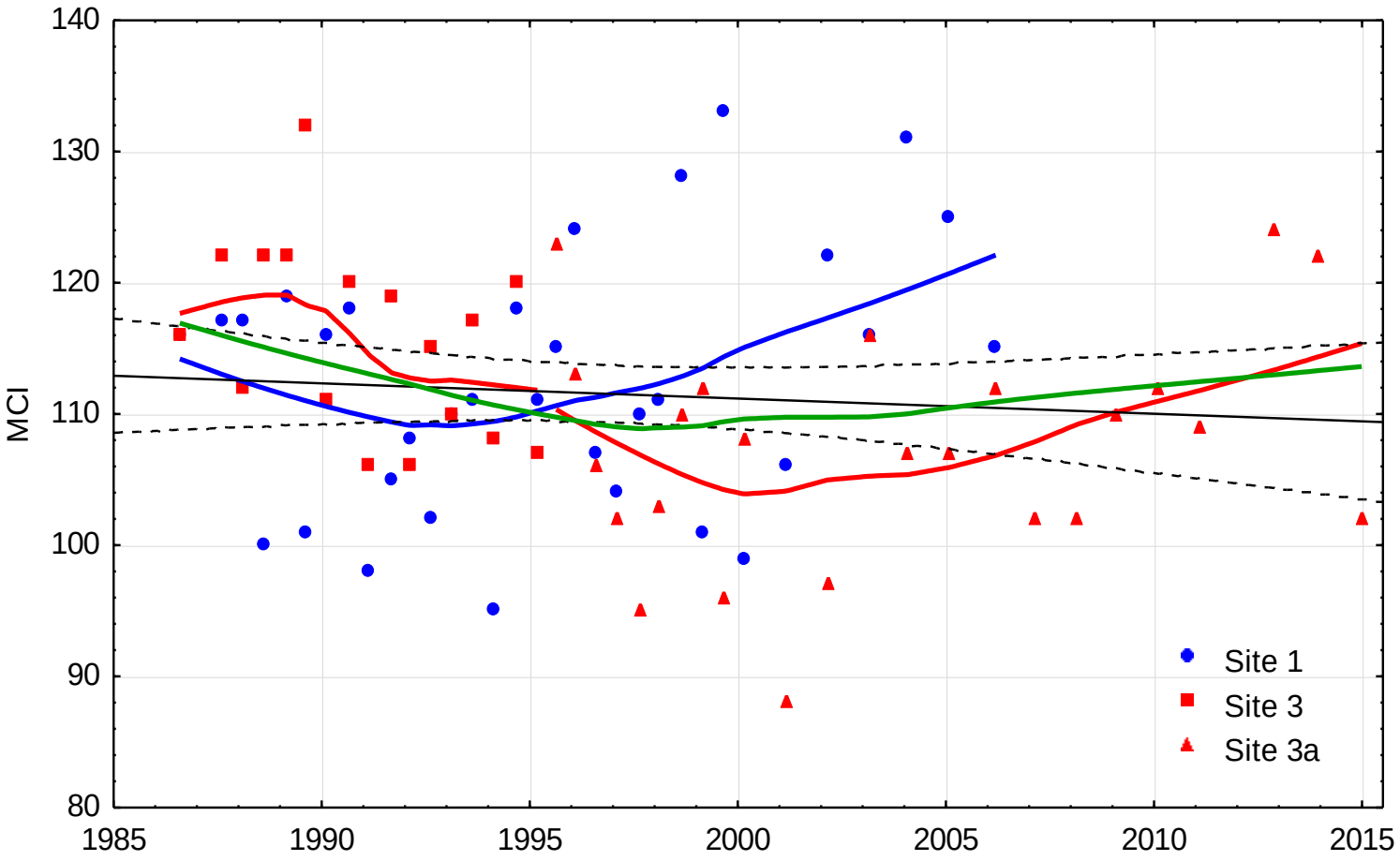
INVERTEBRATES

- MCI
- General measure of river health
- Sensitive species get high scores
- Tolerant species get low scores

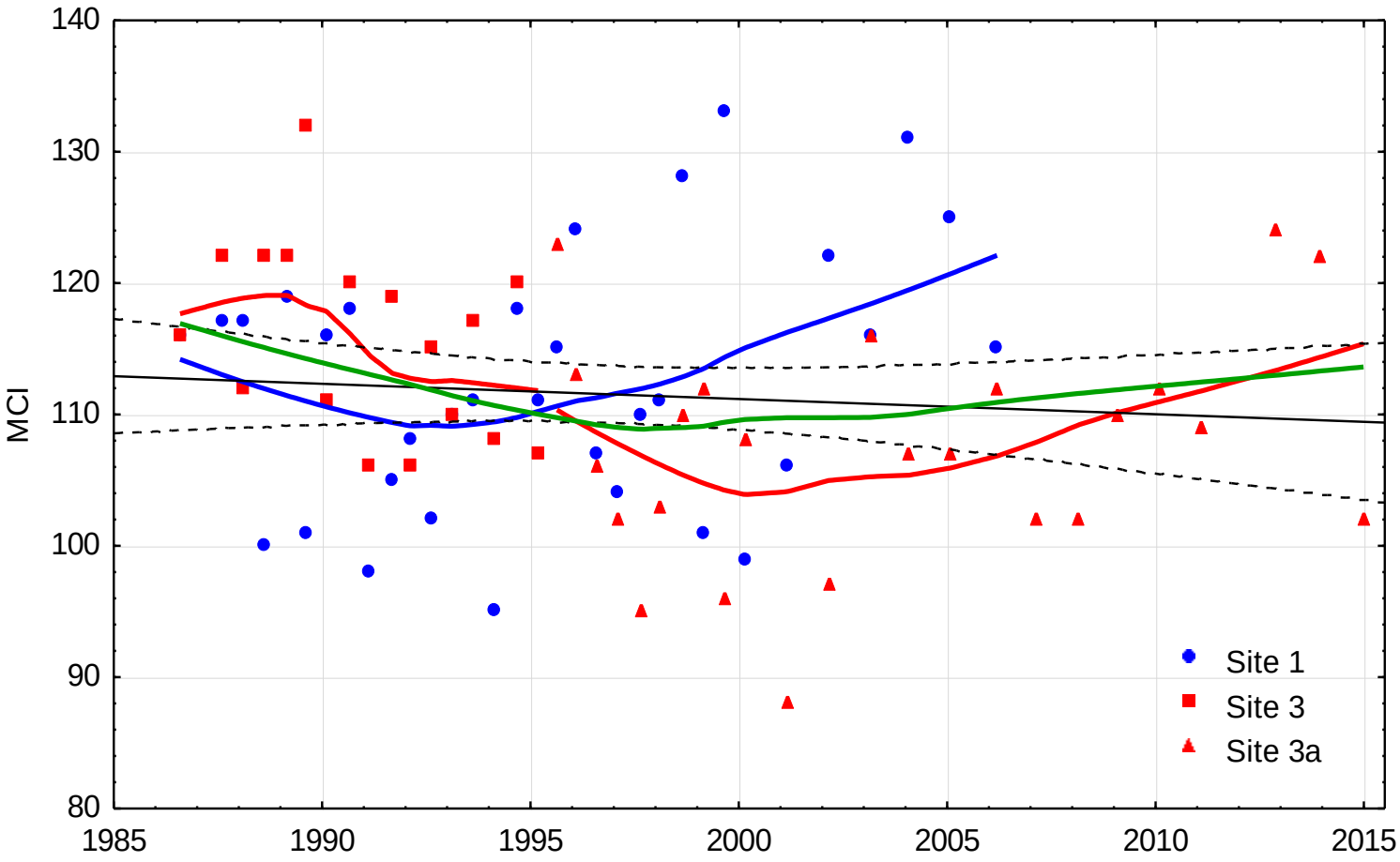
- No monitoring within the main spring

- Regular monitoring in Springs River above and below the salmon hatchery since 1986

INVERTEBRATE COMMUNITY INDEX SCORES



INVERTEBRATE COMMUNITY INDEX SCORES



…the health of Te Waikoropupū Springs and the upper reaches of the Springs River has not changed noticeably from 1986 to 2014 (22 years).

HEALTH STATUS

- ANZECC guidelines
  - Trigger values, not limits

  TP TN NH_4-N pH

  DRP NO_3-N DO Clarity

- NPSFM current NOF attributes for A-band

  Periphyton NO_3-N toxicity NH_4-N toxicity DO *E. coli*

- Drinking water standards

  NO_3-N Hardness Chloride *E. coli*

- Microbiological guidelines for recreation

  E. coli

- 'Natural' state/Status quo

  DRP NO_3-N DO Clarity

  Invertebrates Temperature Aquatic plants Flow NH_4-N

POTENTIAL RISKS TO THE AQUIFER AND SPRINGS

- Sediment – water clarity
- Nutrients – periphyton growth
- Pathogens
- Organic matter – lower dissolved oxygen
- Climate change – temperature, flow fluctuations
- Invasive species – didymo, aquatic weeds
- Abstraction

CRITICAL ATTRIBUTES

- Clarity
- Dissolved oxygen
- Nitrate nitrogen
- Dissolved phosphorus

- Secondary measures
  - Invertebrates
  - Manganese
  - Temperature
  - pH
  - Chloride
  - Macrophyte cover
  - Dissolved organic carbon
  - Nitrite nitrogen
  - Conductivity

RECOMMENDED TRIGGERS FOR ACTION

- Maintenance of natural state/status quo

- Clarity – 50 m [measurement issues]
- Dissolved oxygen – 45% saturation [current seasonal variation unknown]
- Nitrate nitrogen – 0.5 mg/L (annual median)
- Dissolved phosphorus – 0.01 mg/L (annual median)

- Actions
  - Further monitoring
  - Checks on land use controls
    - Improved controls on stock access to waterways and sinkholes
    - Better waste water system management
    - Expanded riparian restoration
    - Enhanced farm management practices

MONITORING SITES

- Te Waikoropupū is more than just the springs, but part of a connected system representing the waters feeding the aquifer, the aquifer/groundwaters and the springs.

- Monitoring required on inflowing waters, aquifer and the springs

- Monitoring site on Takaka River at Lindsays Bridge
- Ongoing monitoring in groundwater wells and upper catchment springs
- Ongoing monitoring at the main spring

SUMMARY

- Science panel collated and summarised existing data on Te Waikoropupū
- In relation to various guidelines the water quality and health of Te Waikoropupū appears to be in good state, but with some concerns around nitrate nitrogen, aquatic plants and possibly about dissolved oxygen and water clarity
- Critical attributes (and action triggers) to monitor are:
  - Water clarity – 50 m
  - Nitrate nitrogen – 0.5 mg/L
  - Dissolved phosphorus – 0.01 mg/L
  - Dissolved oxygen – 45% saturation
- Other secondary indicators should also continue to be measured
- Triggers need to be linked with actions
- Monitoring needs to consider the waters feeding the aquifer, the aquifer/groundwaters and the springs

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