Impacts of the 2019 bushfires on Macleay River water quality

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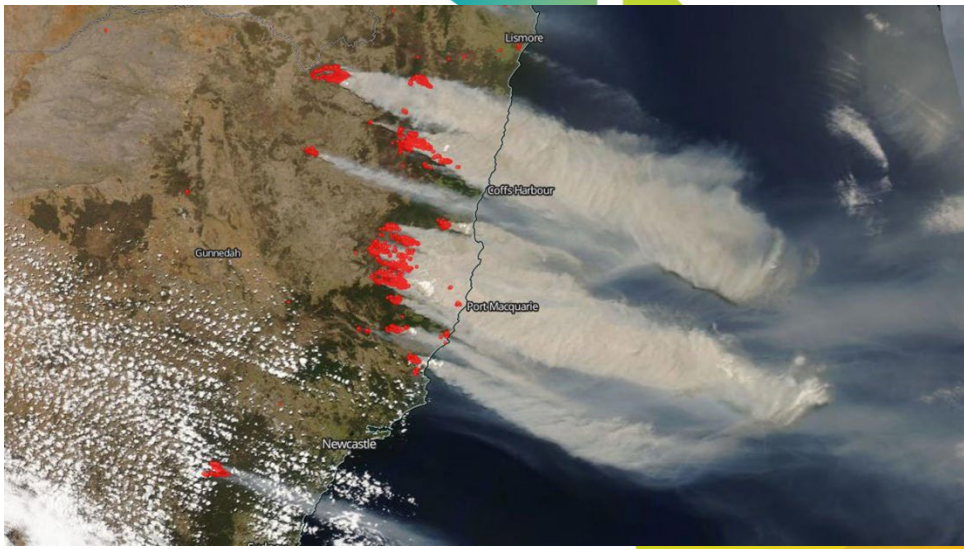
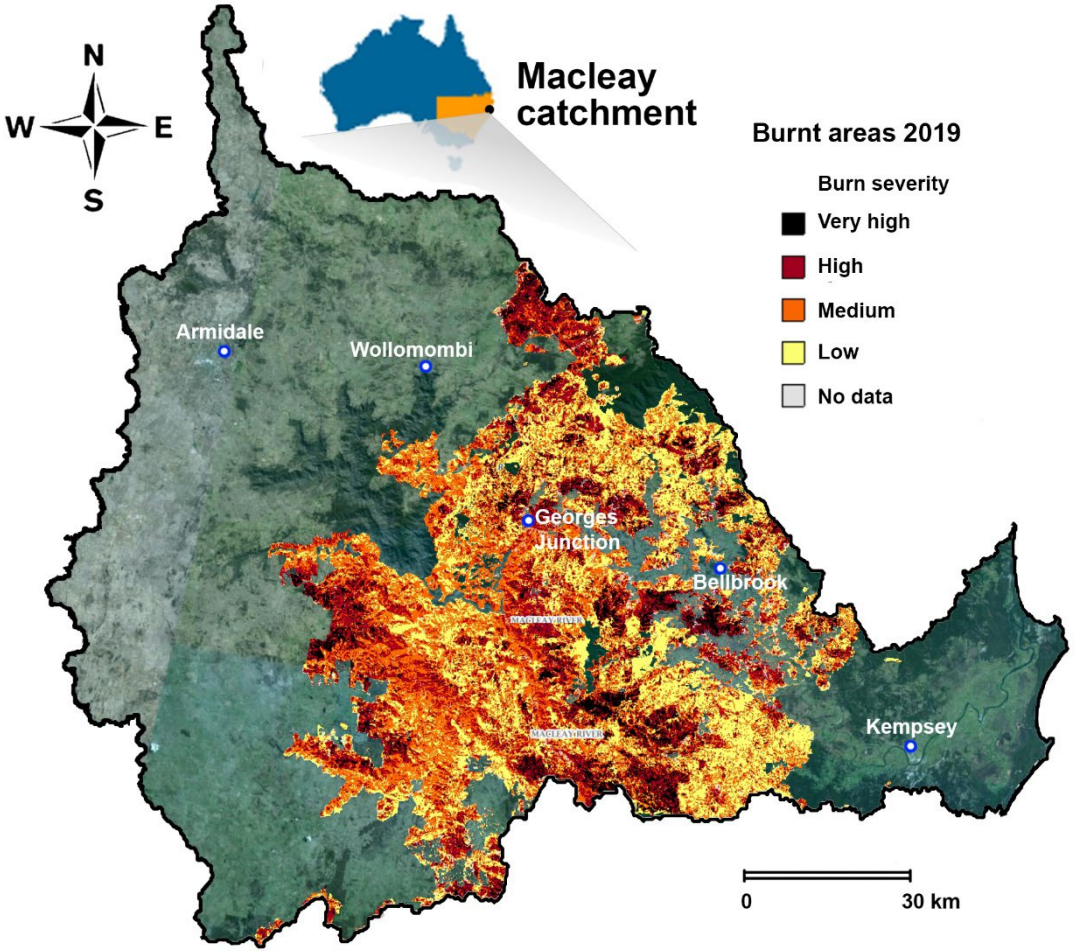
Overview

- 2019 Bushfires – scale and context
- Acute impacts on water quality and recovery
  - Fishkills at Bellbrook
  - Sediments, Carbon
  - Nutrients – N and P
  - Manganese
  - Other metals / trace elements
- Conclusions – recovery and resilience



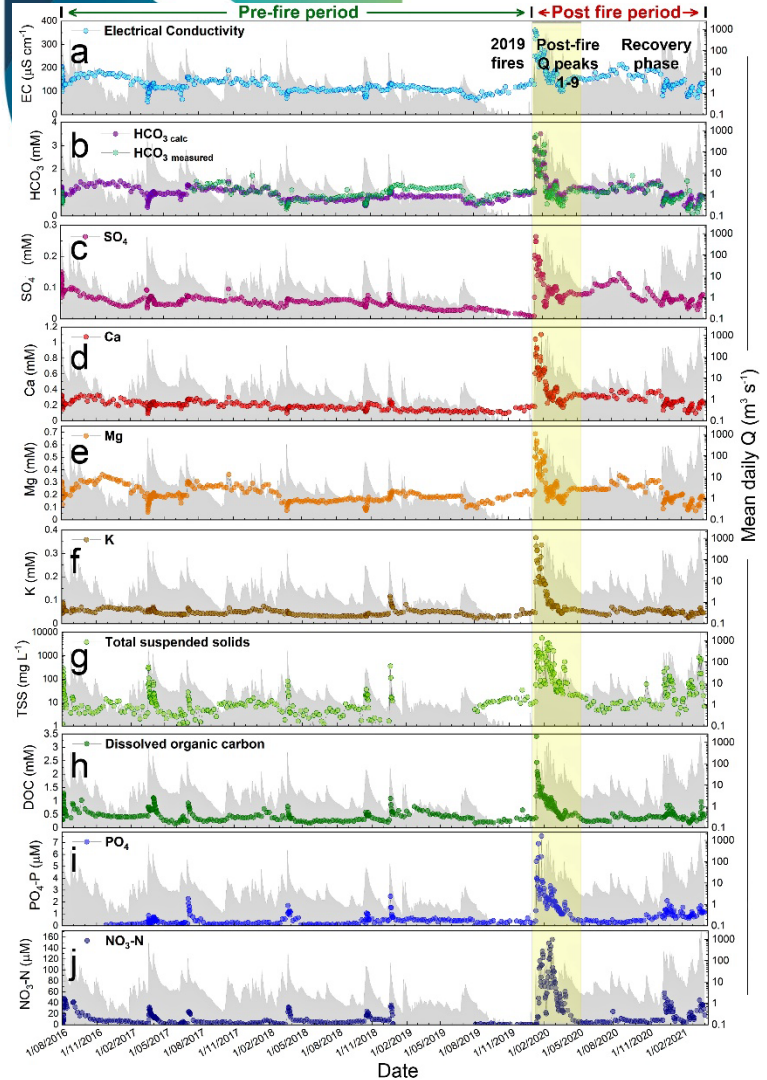
2019-2020 Bushfires

- Spring 2019 - burnt area ~35% of catchment
- Mostly mid-catchment - steep escarpment, forest cover
- Mostly upstream of Bellbrook



Citizen science sampling

- 1st substantial rainfall around ~10th January 2020.
- SOMR ~**daily sampling** for >2.5 months after first-flush
- Early 2020 – COVID-19; most other water quality monitoring programs around the state were shut down or suspended.
- Citizen science – University collaboration = unique data-set



Acute water quality impacts

- Large fish kills during days following initial first flush
- Fish behaviour consistent with hypoxia (low dissolved oxygen)

Bushfires cause deaths of thousands of fish in NSW river as rain washes in ash

Warren Barnsley · 7NEWS Published: Friday, 17 January 2020 12:22 pm AEDT

An estimated thousands of fish have died from ash washed into northern NSW's Macleay River. Credit: Arthur Bain/Supplied/Facebook

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Hundreds of thousands of fish dead in NSW as bushfire ash washed into river

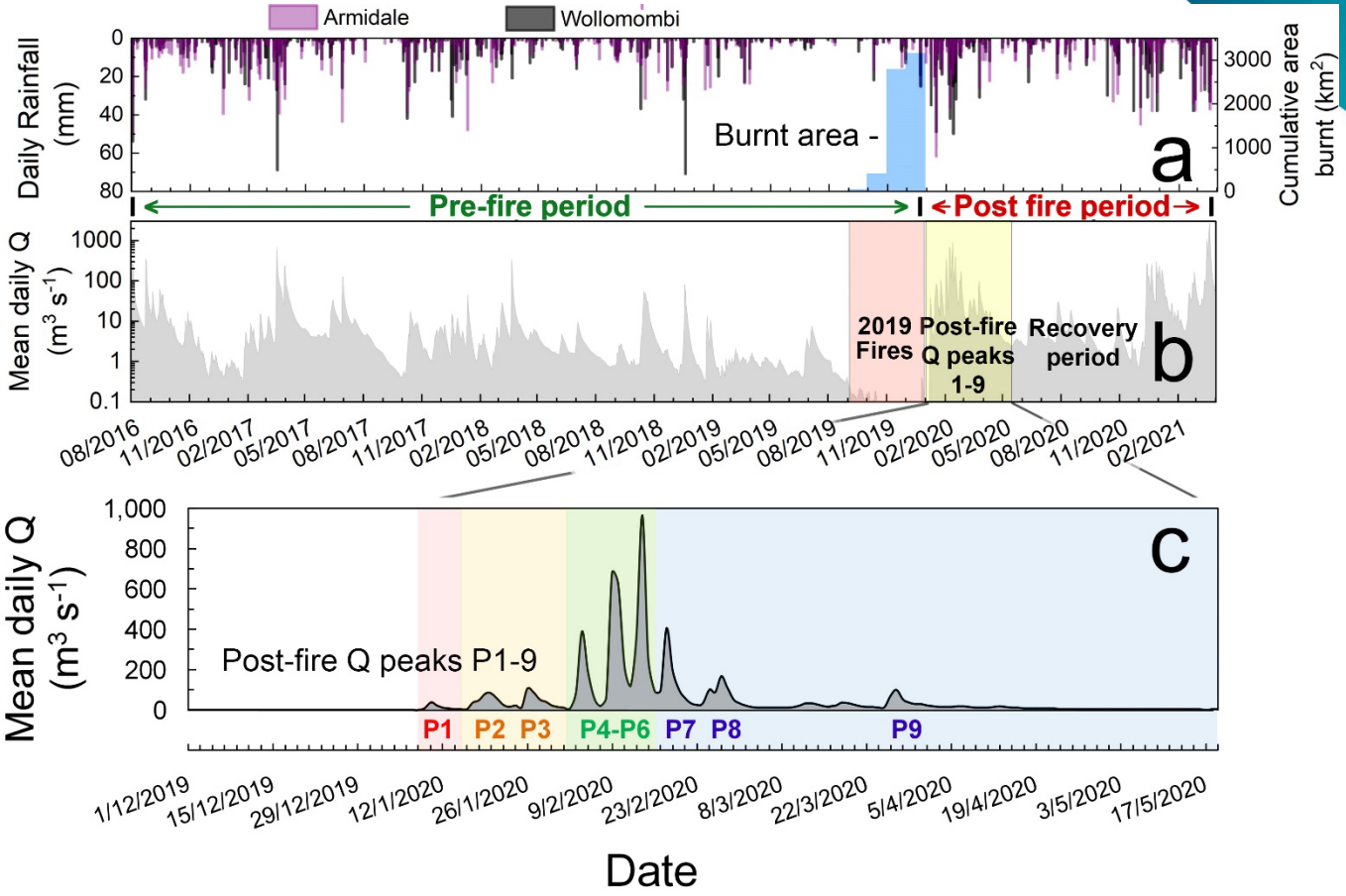
Ecologist fears the Macleay River may take decades to recover, with heavy rains likely to affect other waterways

▲ Results of a fish kill in the Macleay River in northern New South Wales, which locals said was like 'cake mix'. Photograph: Larry Newberry

Search The Guardian Australian edition

Water quality impacts

- Period of study – pre-fire + post-fire



Water quality impacts

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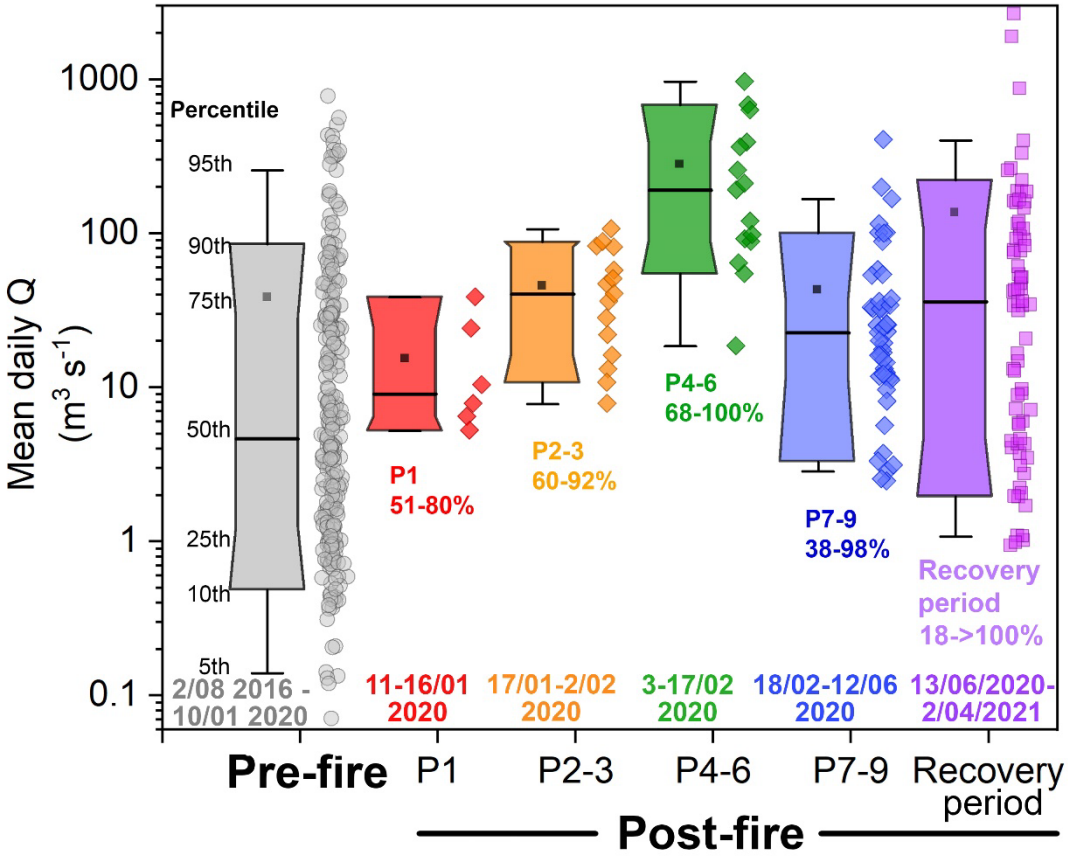
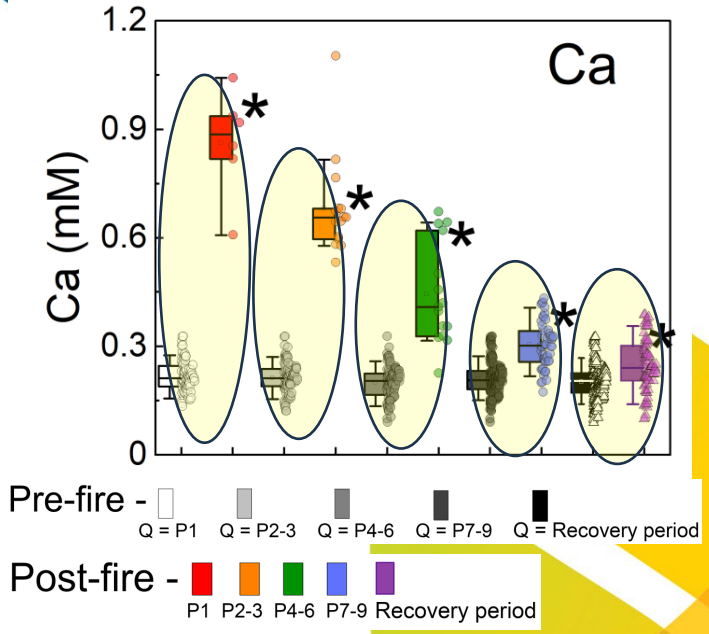




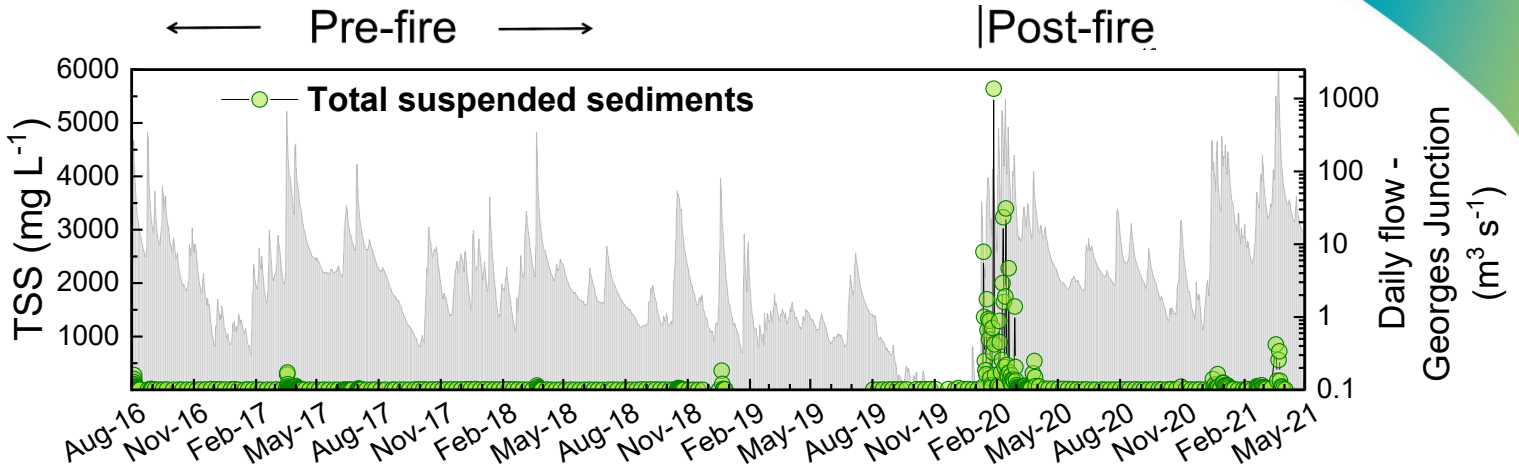
Suspended sediments

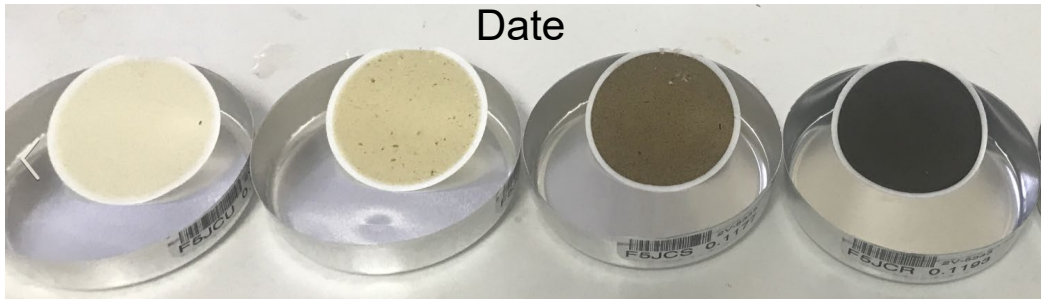
Fire = loss of vegetation > enhanced soil erosion

- Especially if high rainfall soon after bushfire

Suspended sediments

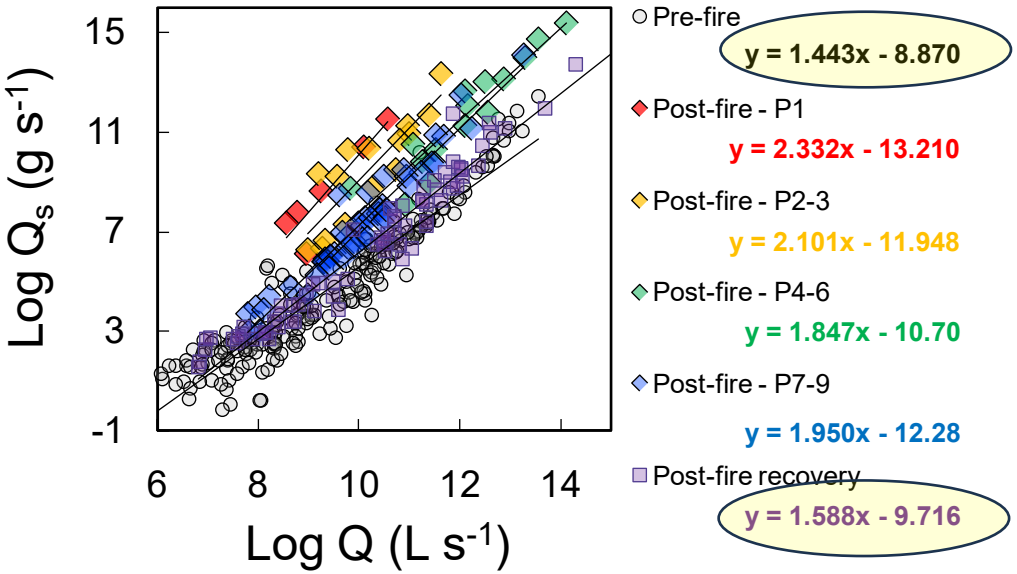
- Large increases (~2-3 orders of magnitude)
- Post-fire maximum >5000 mg L^{-1}

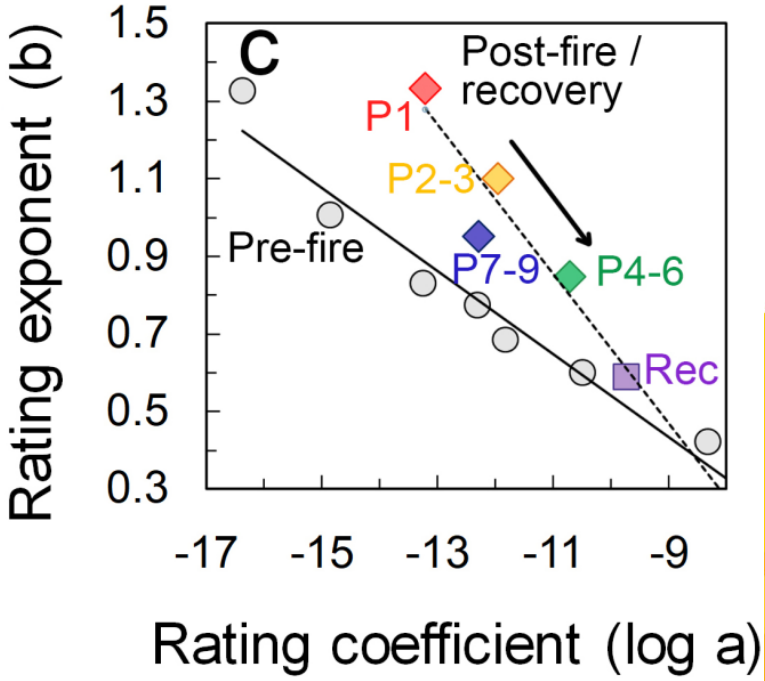




Suspended sediments

- Highly distorted sediment rating curves

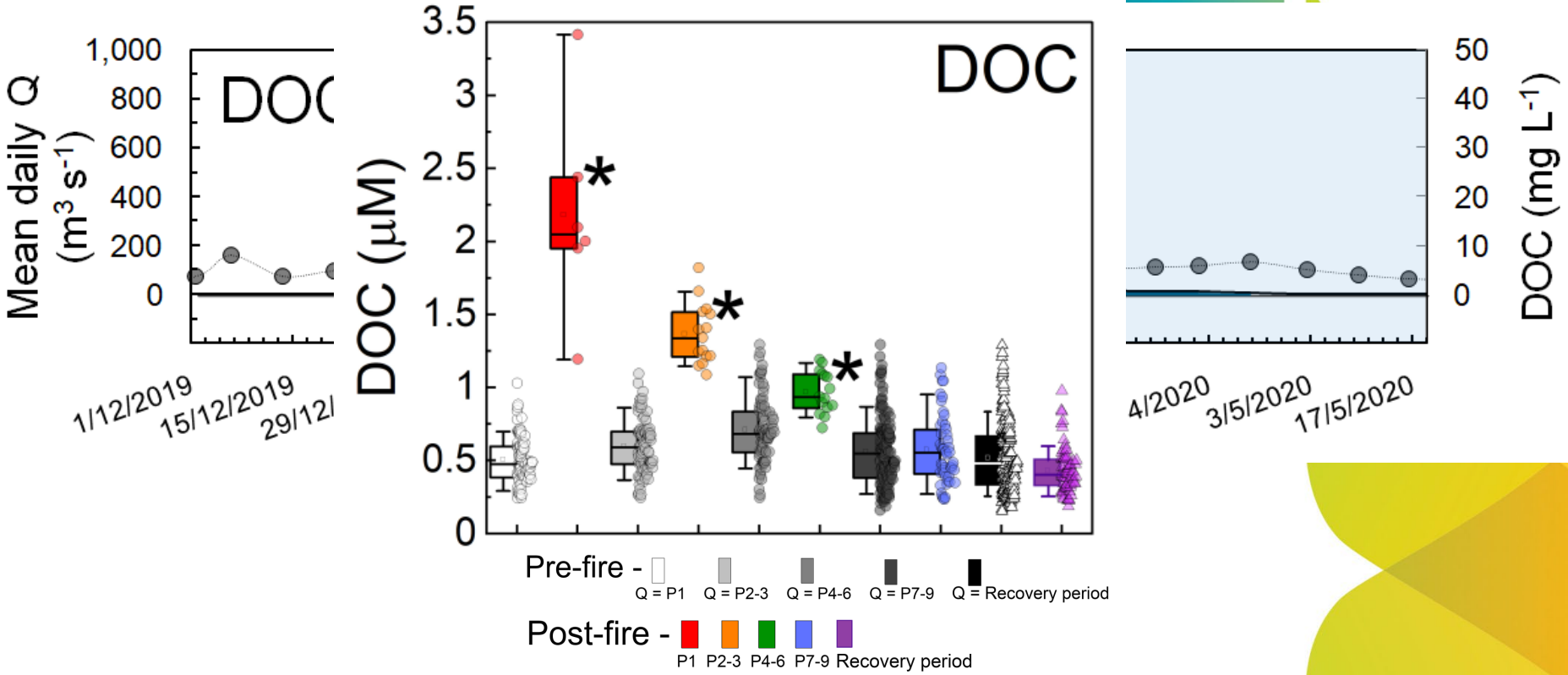




- Steady recovery over ~12-18 months

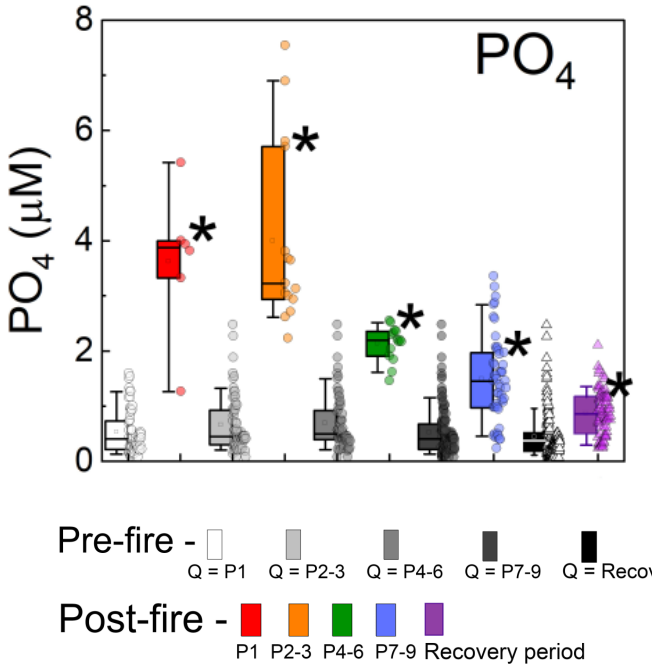
Dissolved Organic Carbon (DOC)

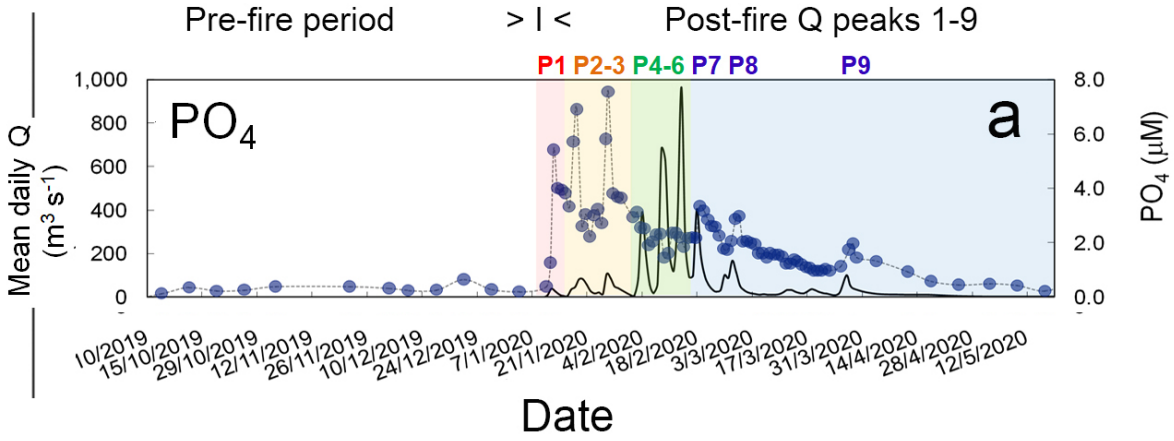
- Initial sharp peak (~6-8x)
- Recovery ~3-6 months



Nutrients – P

- P – phosphate >20x increase
- > ANZECC freshwater ecosystem guidelines
- Recovery ~12-18 months

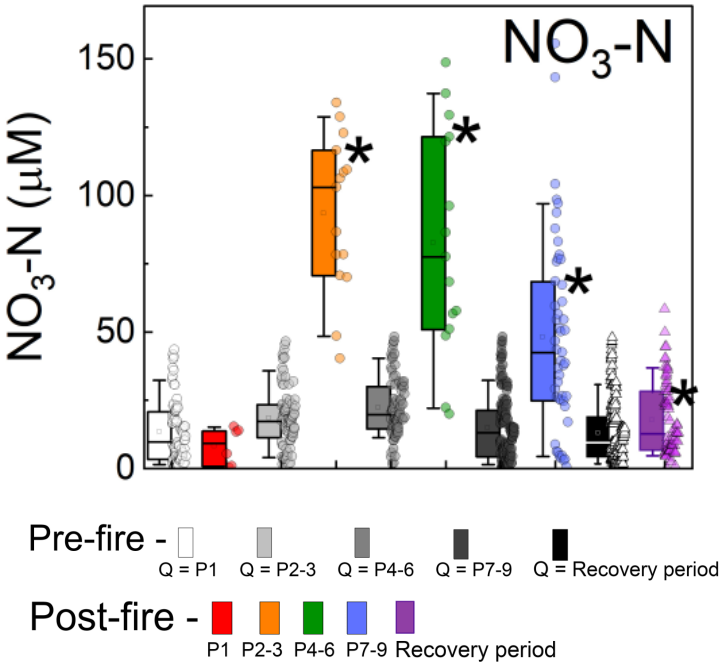


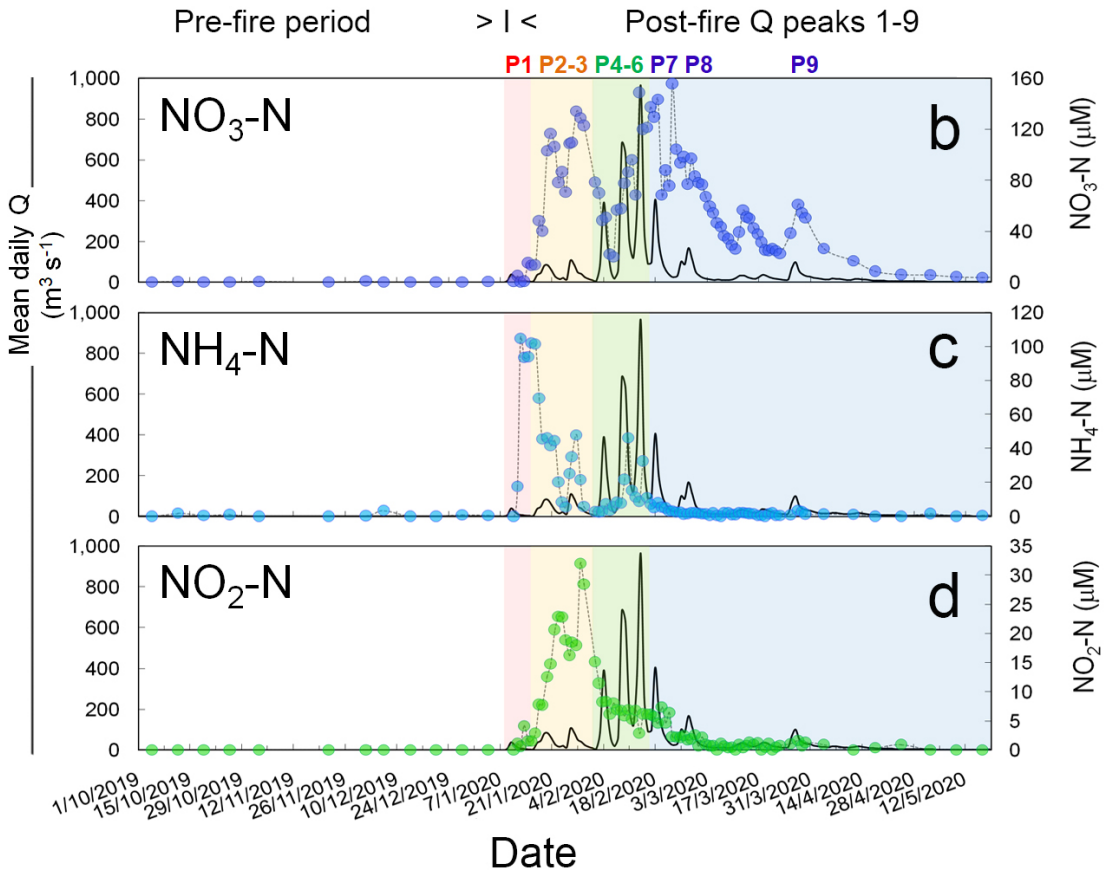


Nutrients – Nitrogen species

Ammonium (NH_4^+) >180x, initial spike ** **low DO**

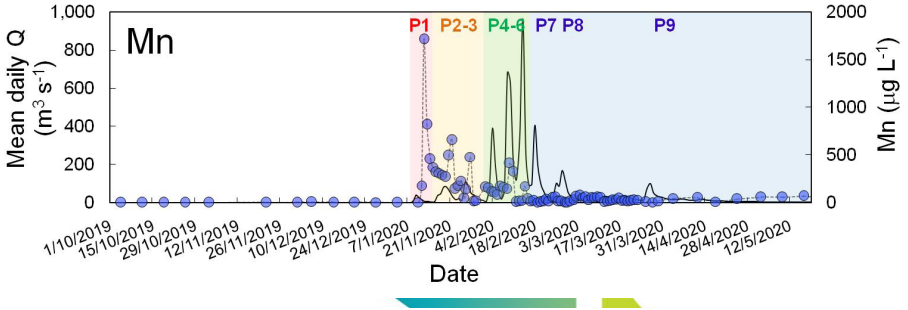
- Nitrate (NO_3) >12x, lag
- Recovery ~12+ months

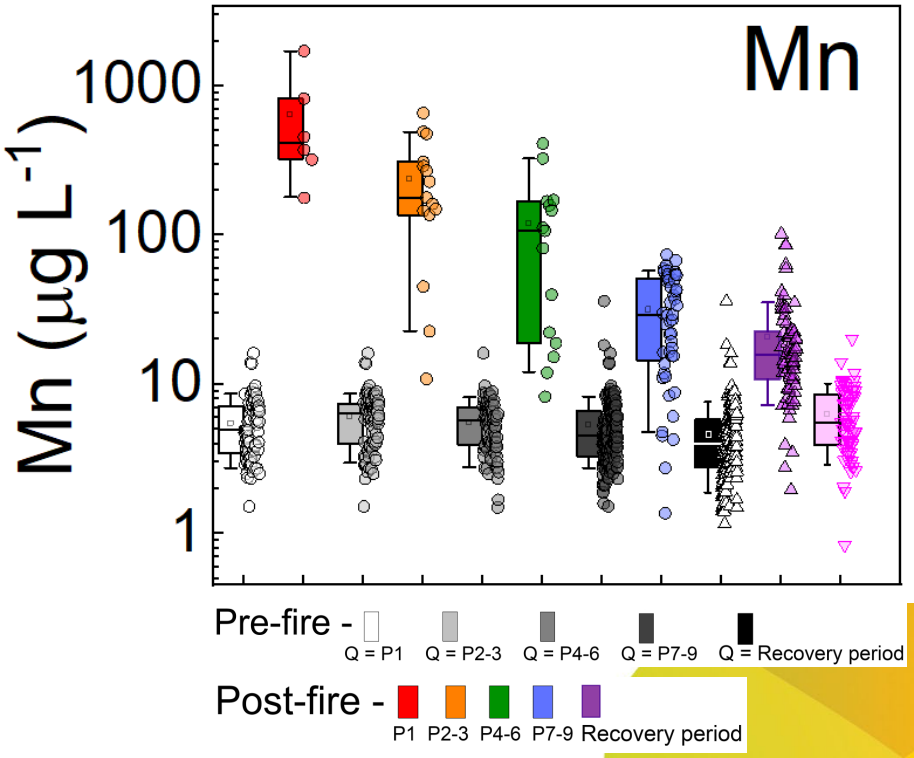




Manganese

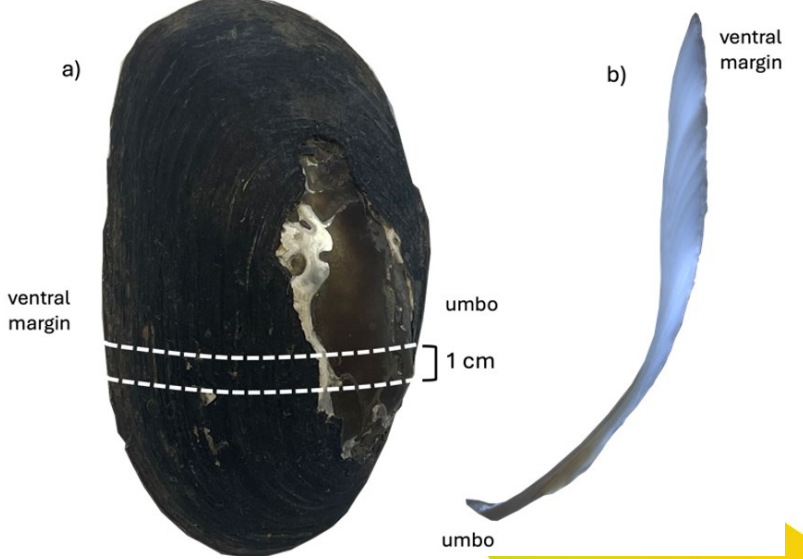
- Extremely elevated > 300x
- **Initial spike > Low oxygen water >** Mn^{2+} > highly soluble
- Slow recovery, >2 yrs
- Persistence of Mn > fine sediments deposited in bed of river(?)

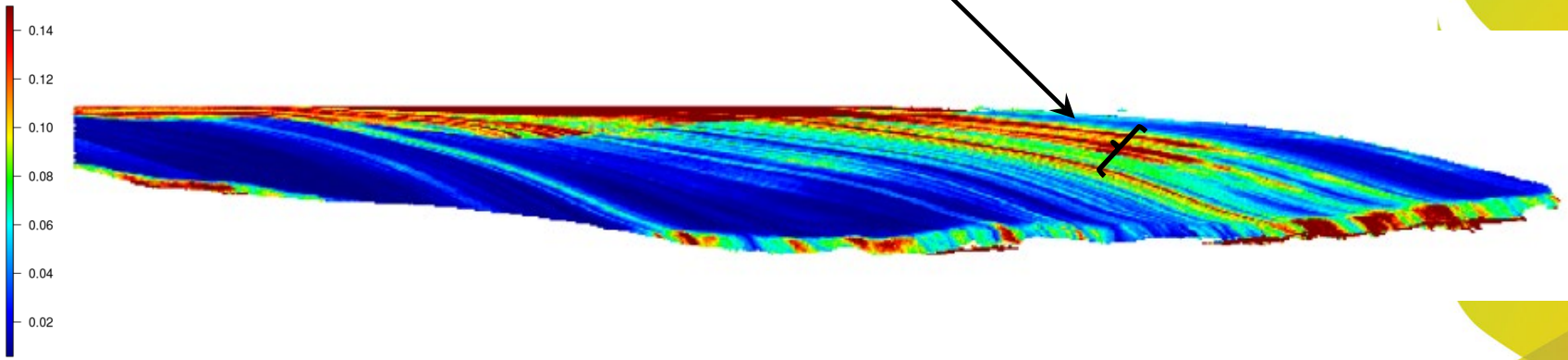




Manganese in freshwater mussels…

- Elevated Mn in shell of freshwater mussels – timing match
- Clear “fire” signal
- Use a water quality archive?





Example trace element - Vanadium

- Fire alters soil properties > mobilise metals
- Fire can generate V^{5+} species in soil
- V^{5+} species more soluble than V^{3+} > readily leached and mobilised

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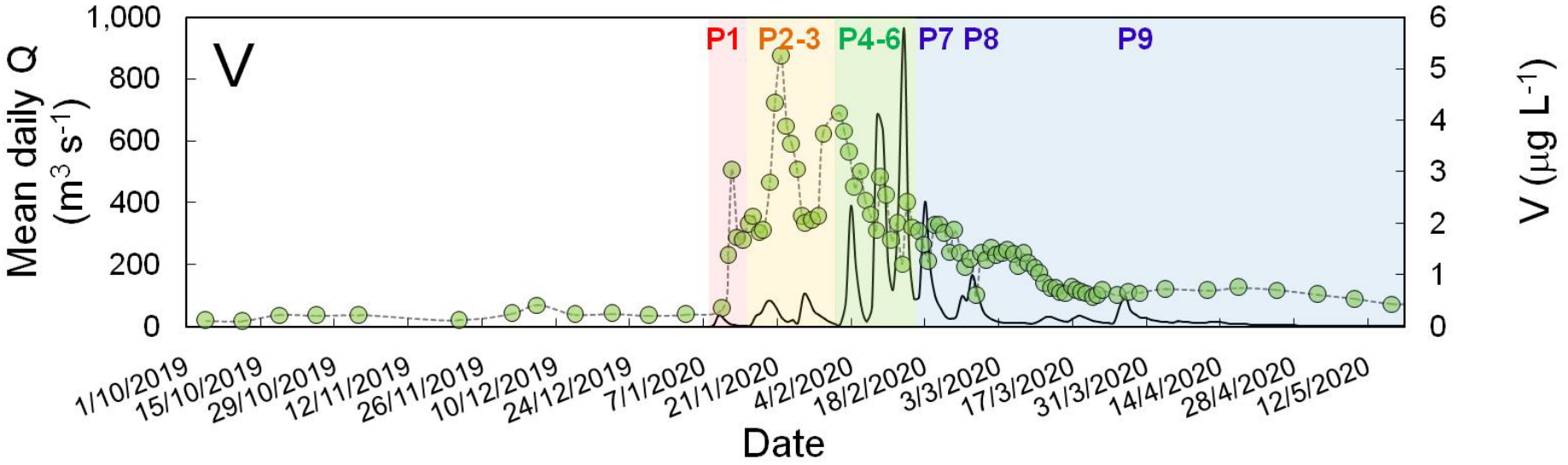
Vanadium in the massive coral *Porites*: A potential proxy for historical wood clearing and burning

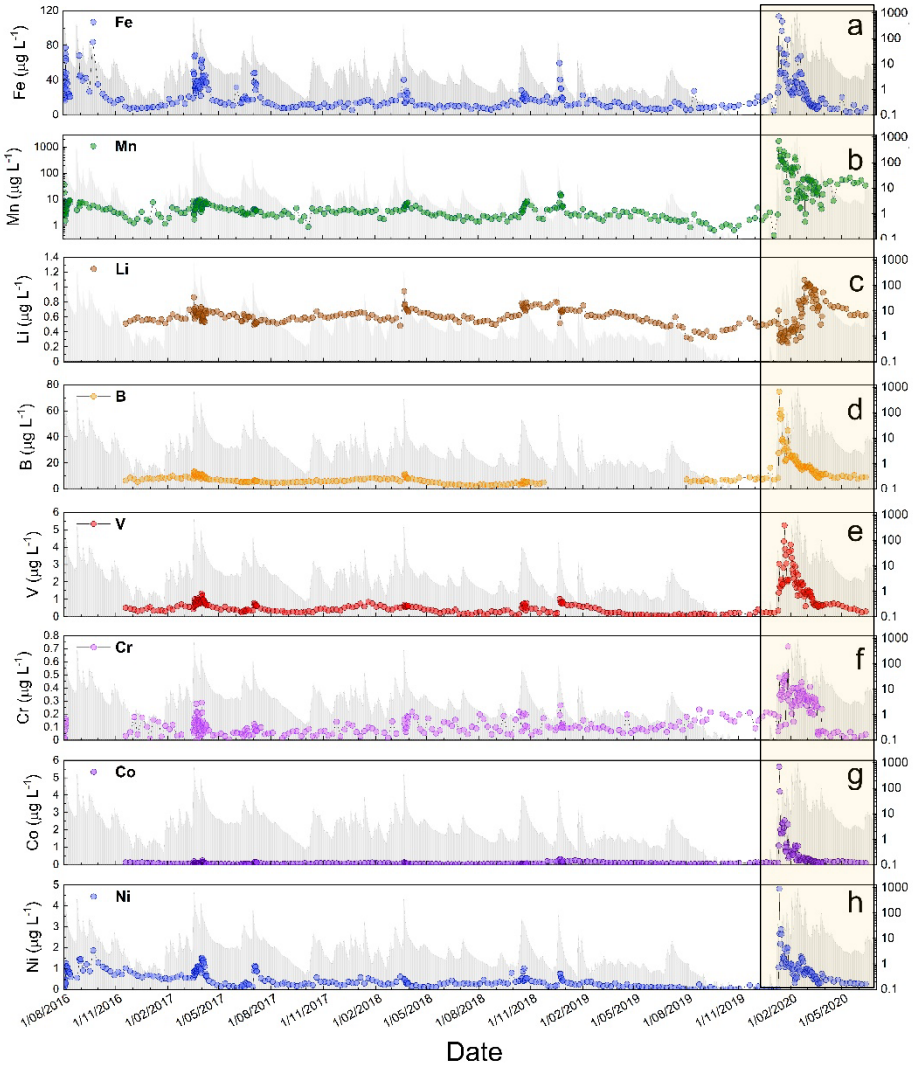
Narottam Saha [a,b,*], Gregory E. Webb [a], Andrew G. Christy [a,c], Jian-xin Zhao [a]



Other Metals

Distinct spikes during first-flush

- **Mn (>300x)**
- **Co (66x)**
- **Mo (36x)**
- **U (31x)**
- V, Cr (8x)
- Ni (7x)
- Pb (6x)
- Cu, Fe (4x)

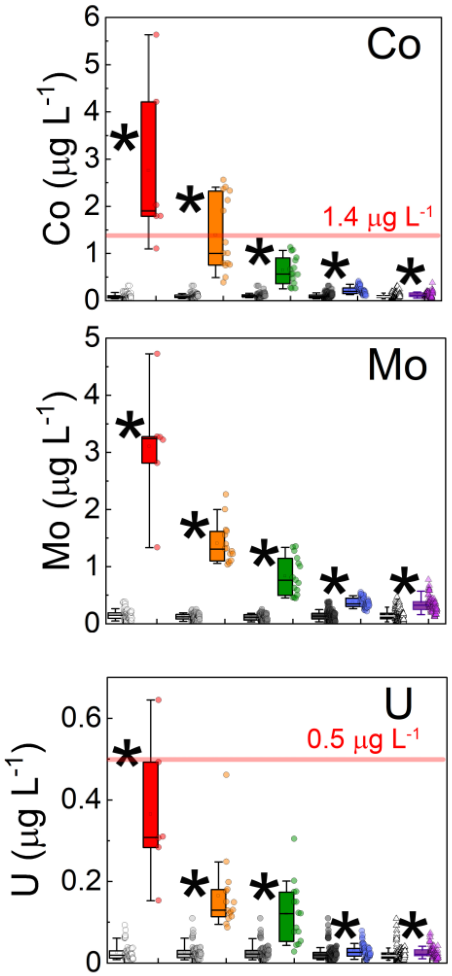


Trace elements

Distinct spikes during first-flush

- **Co (66x)**
- **Mo (36x)**
- **U (31x)**

Steady recovery, mostly within 3-12 months



Pre-fire - Q = P1 Q = P2-3 Q = P4-6 Q = P7-9 Q = Recovery period

Post-fire - P1 P2-3 P4-6 P7-9 Recovery period

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Conclusions

- Large increases in many WQ parameters
  - Element specific behaviour - complex
- Mostly rapid recovery, ~3-12 months
- Chemistry consistent with low oxygen in first flush
- Fast changes > importance of frequent sampling
  - Highlights value of local citizen science / University collaboration
- Drinking WQ guidelines – not exceeded (except Mn, NH_4)
- Ecological impacts? (invertebrates, fish, food web etc)
- Benefit from long-term research linking WQ + ecology

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Building resilience

- Australia > fire, drought, flood, ENSO
- Rivers adapted to fire impacts
- Rivers subject to multiple new stressors already
  - Riparian vegetation loss, eutrophication, invasives, geomorphology, water extraction, land use, mining etc
  - Warming climate context
- Increasing likelihood of extremes
- Building resilience
  - Episodic fire / flood / drought…..
  - Build a healthy catchment, reducing other stressors – (e.g. riparian zone regeneration etc)