# Looking back to inform the future

## Hindcasting estuary ecological states using sediment cores, modelled historic nutrient loads, and a Bayesian network for informed management.

Rachel Hale, John Zeldis, Bruce D. Dudley, Arman Haddadchi, David Plew, Ude Shankar, Andrew Swales, Keryn Roberts, Sorrel O'Connell-Milne and Piet Verburg

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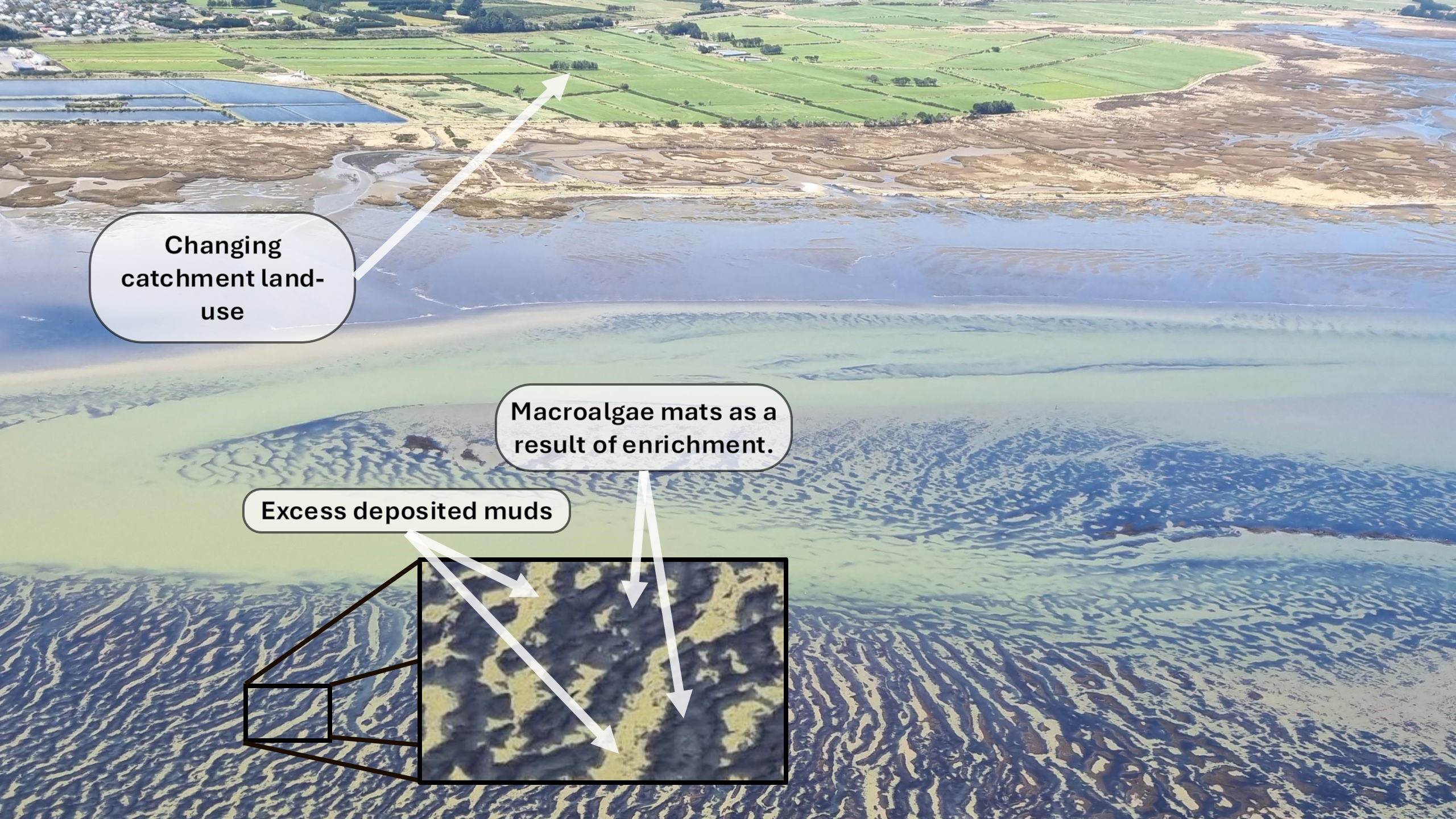
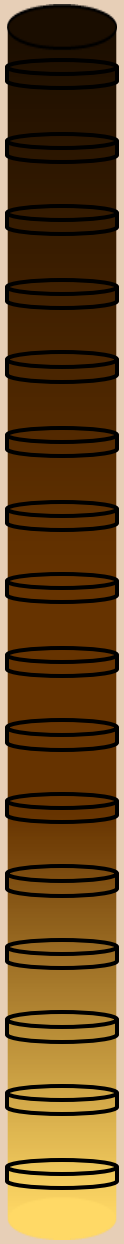

Changing catchment land-use
Macroalgae mats as a result of enrichment.
Excess deposited muds

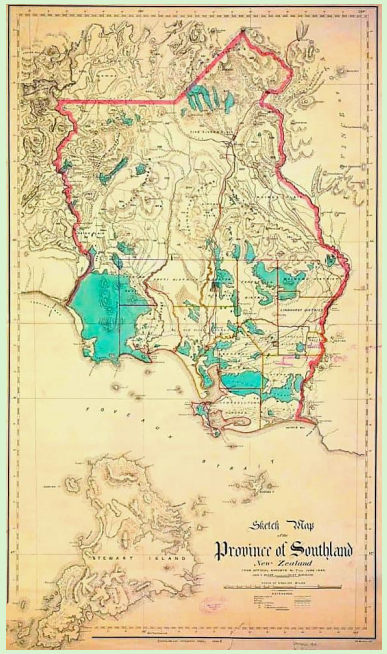


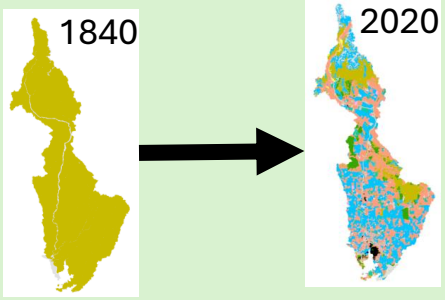
Now

Sediment biogeochemical parameters from dated layers.

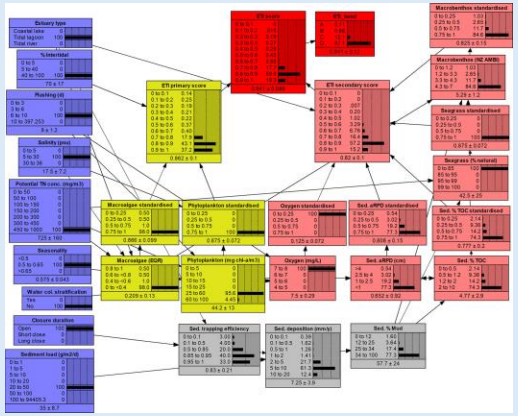
Early colonisation

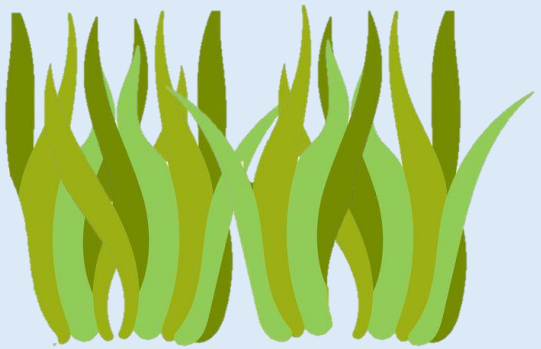
Recreating historic catchment inputs with the CLUES model:



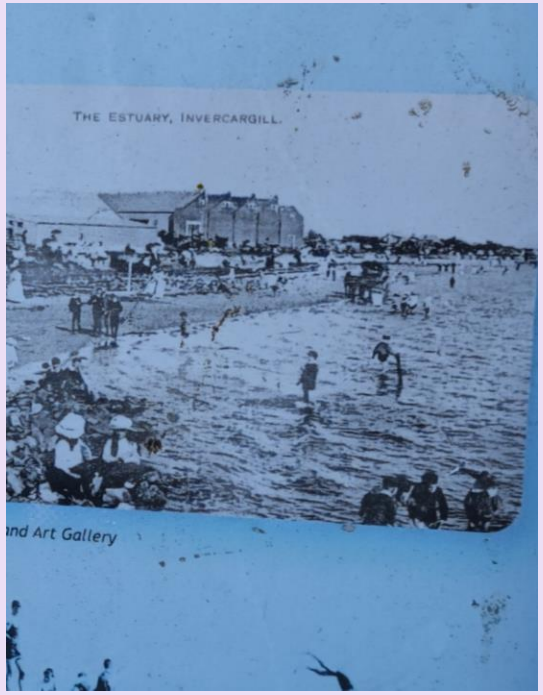



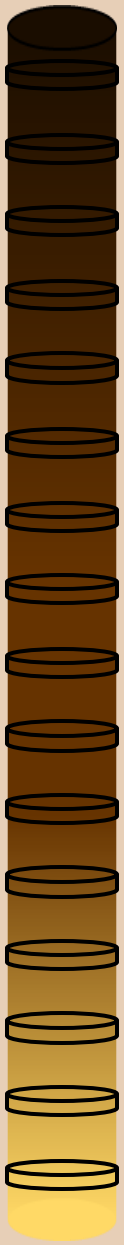

Reconstructing historic ecologies with a Bayesian Belief Network (BBN)





Comparison with known estuarine history: Memories and Mātauranga.





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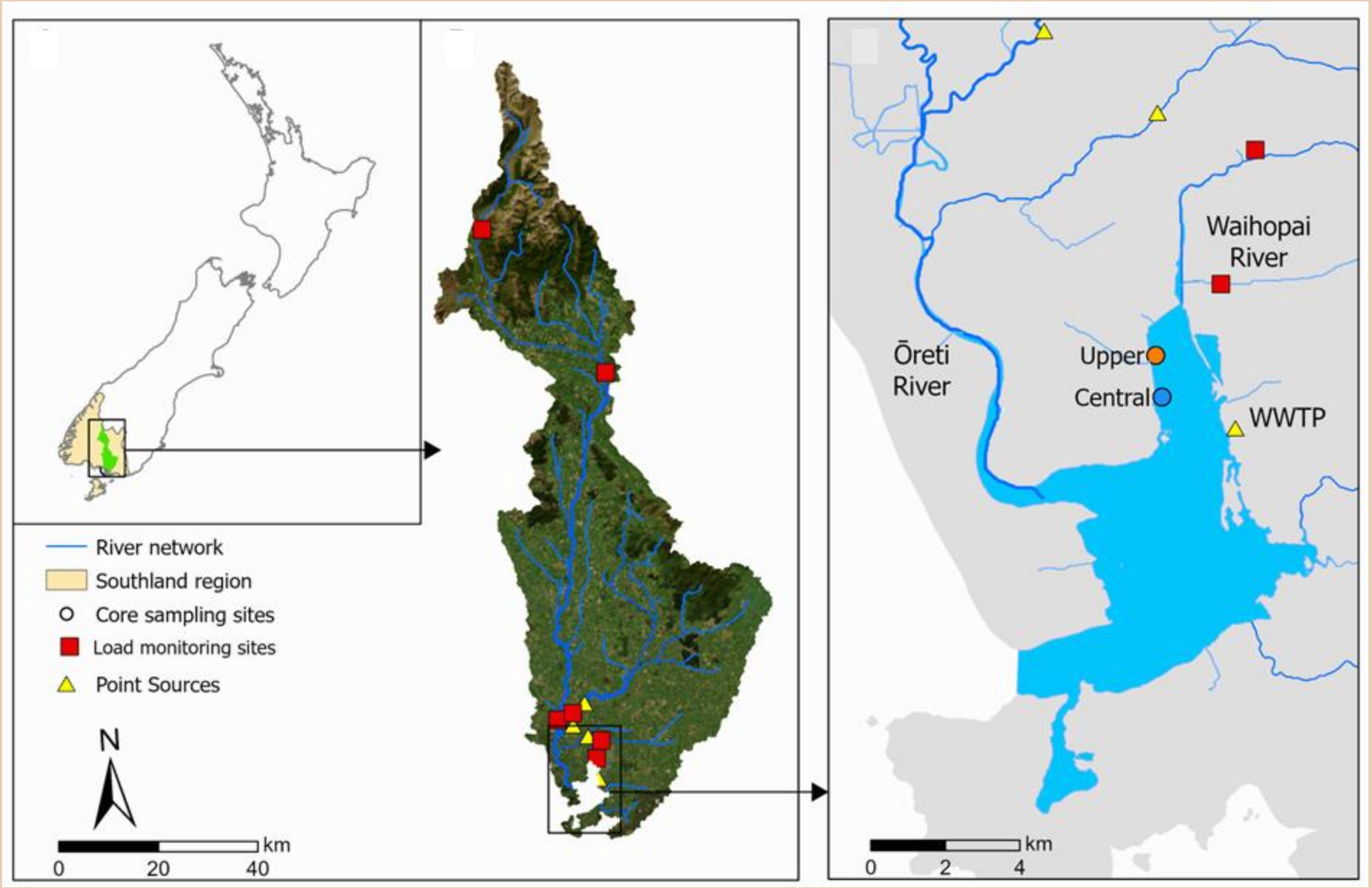
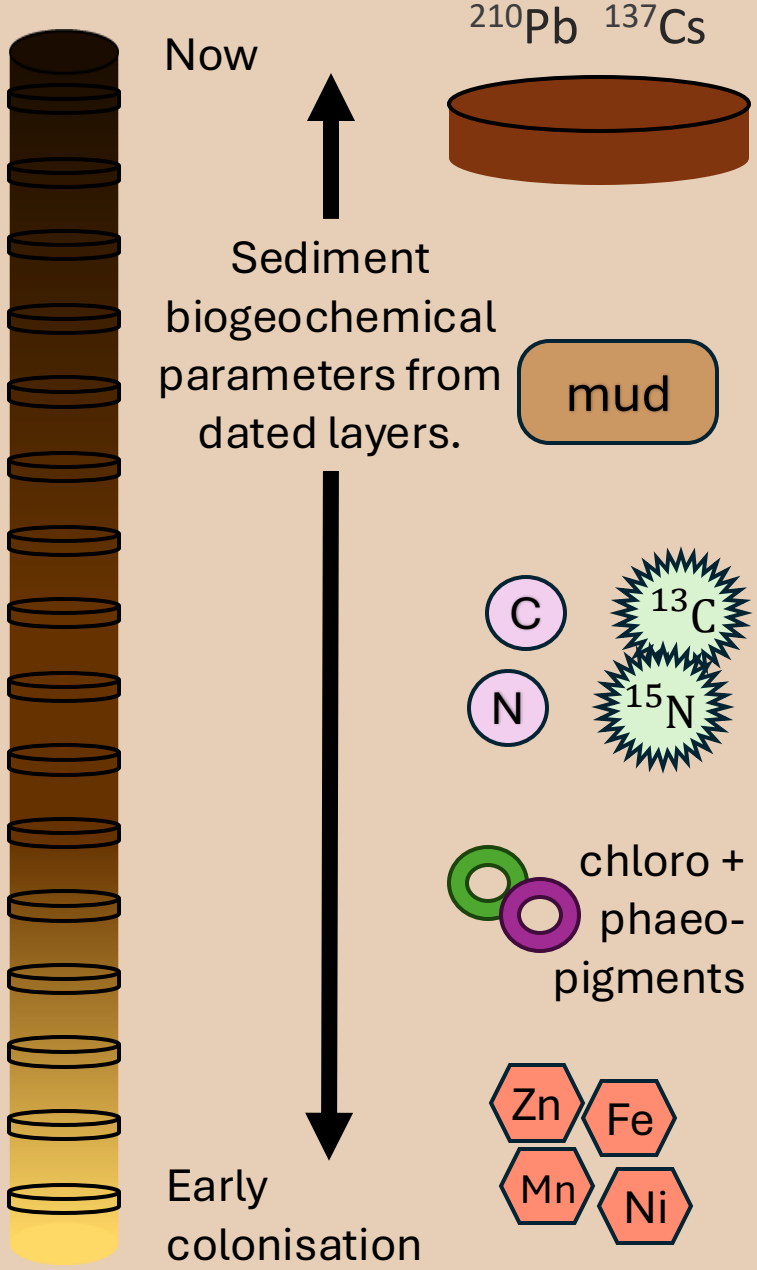
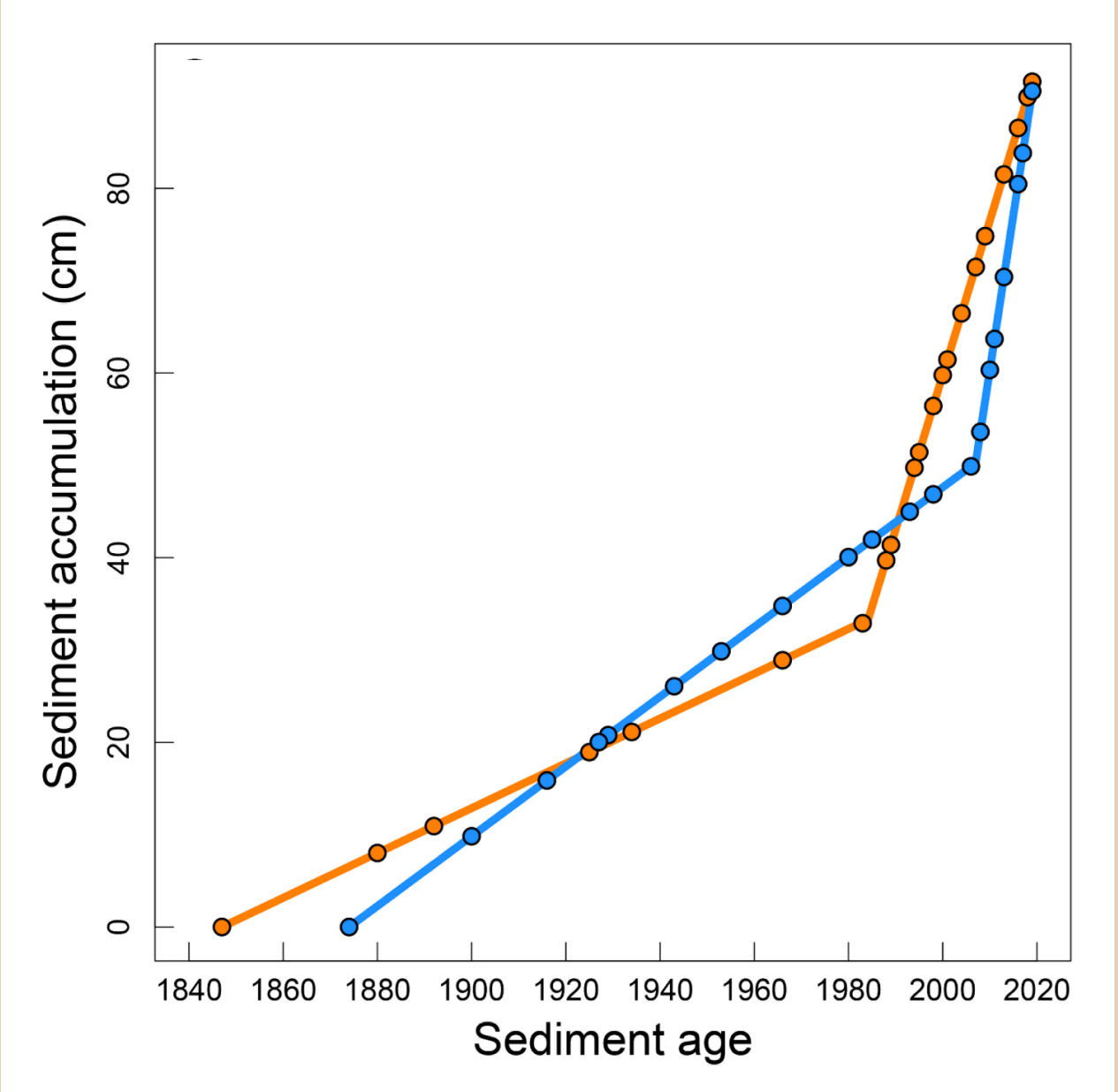
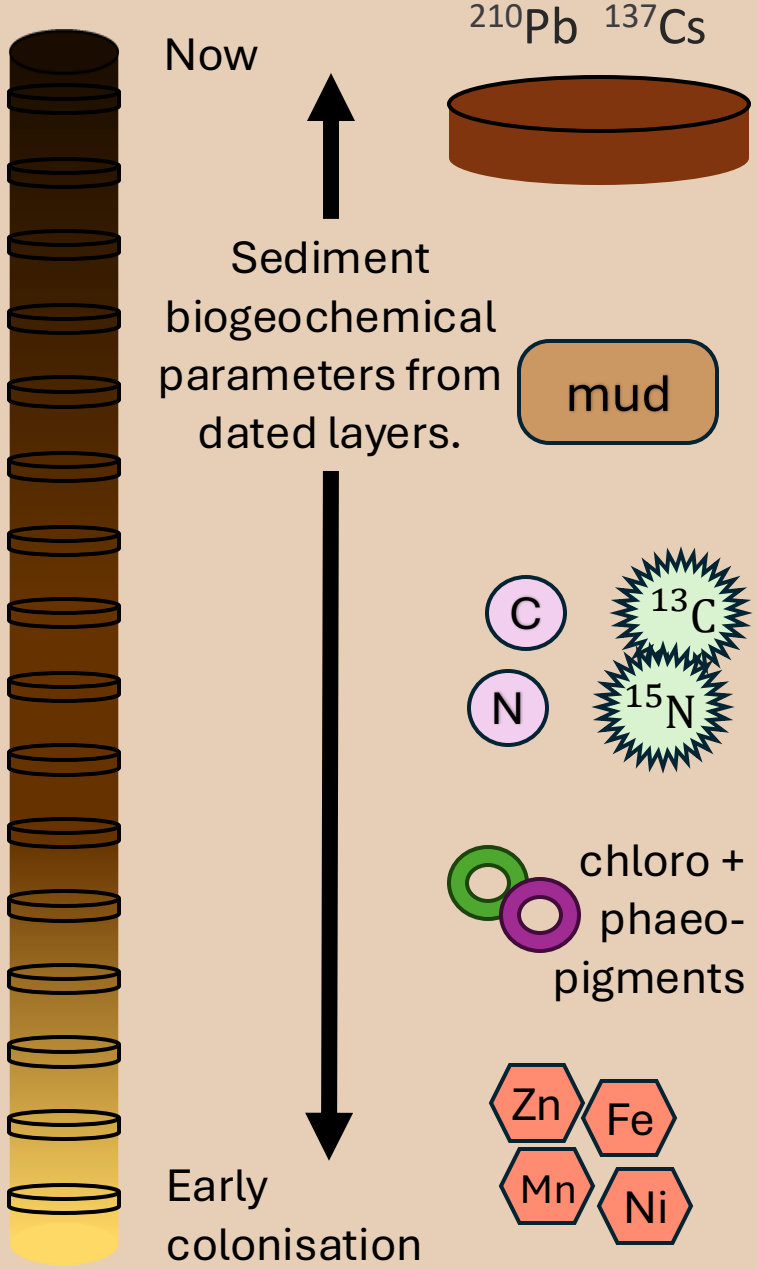



Now
$^{210}$Pb $^{137}$Cs
Sediment biogeochemical parameters from dated layers.
mud
C
N
$^{13}$C
$^{15}$N
chloro + phaeo-pigments
Zn
Fe
Mn
Ni
Early colonisation


Sediment accumulation (cm)
0
20
40
60
80
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020
Sediment age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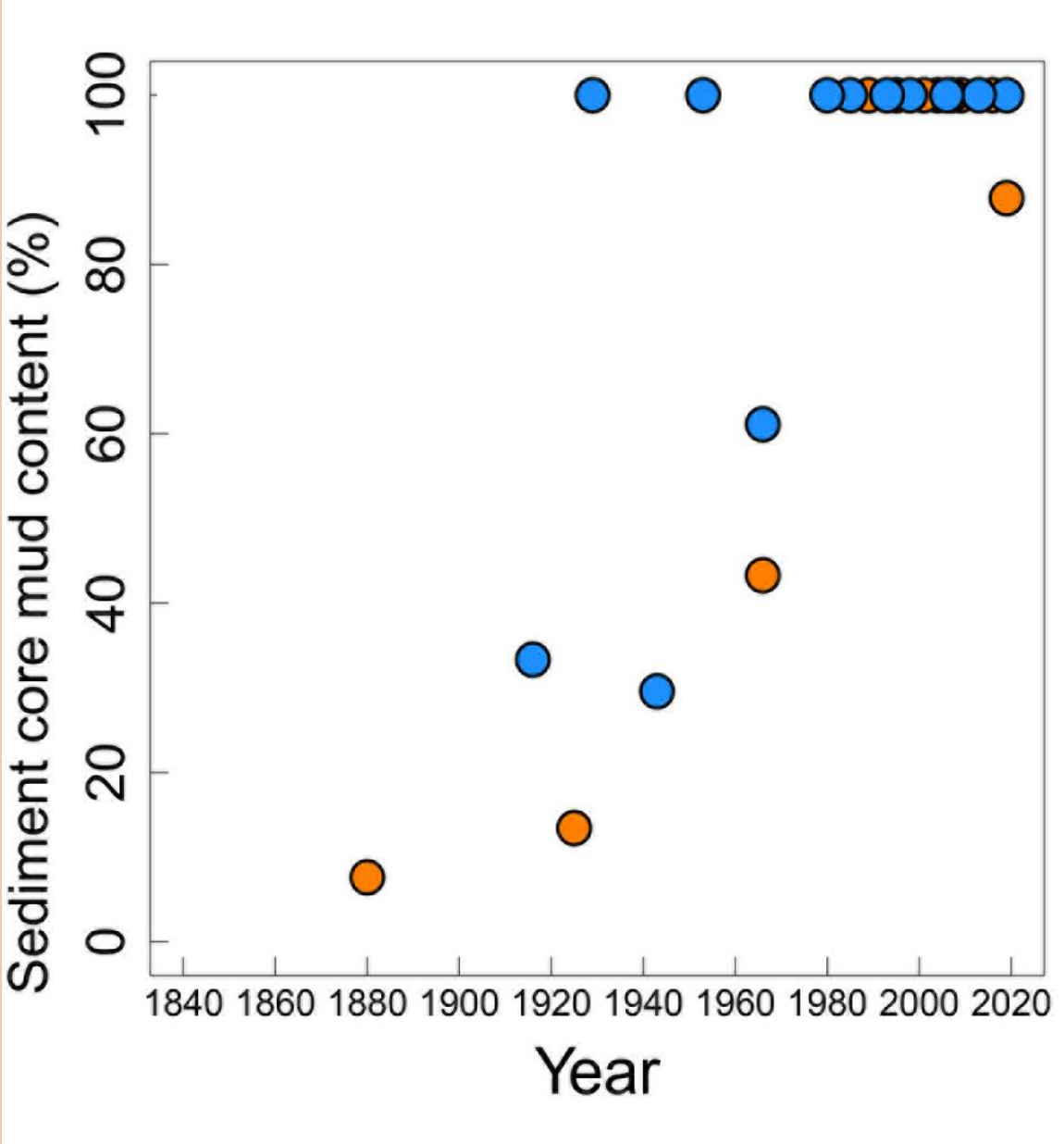
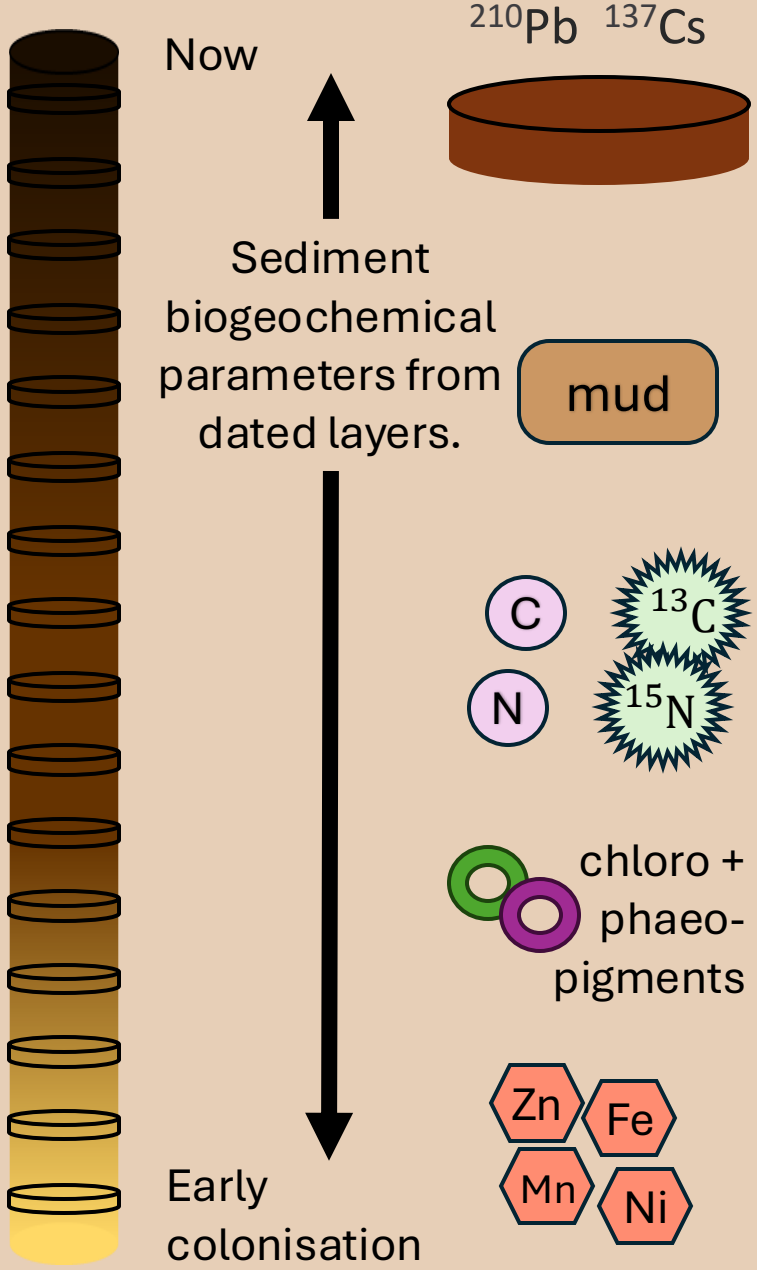

Sediment core mud content (%)
0
20
40
60
80
100
1840 1860 1880 1900 1920 1940 1960 1980 2000 2020
Year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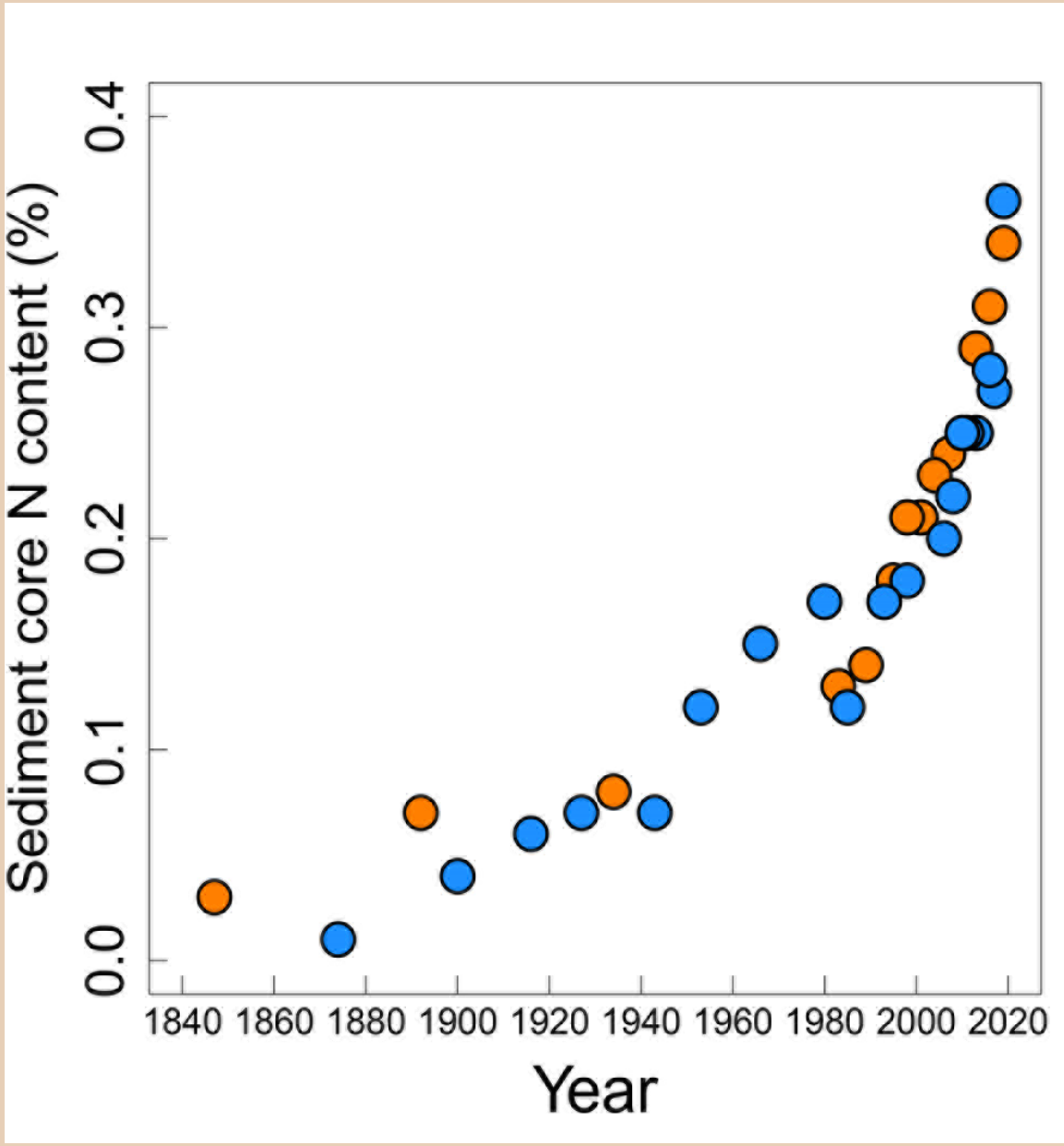
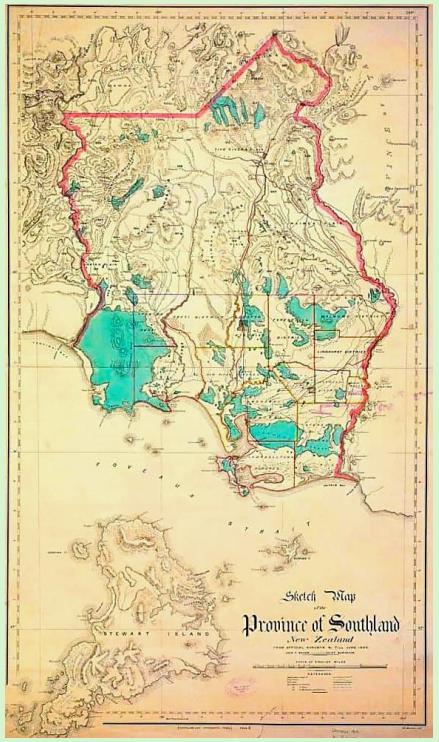

Sediment core N content (%)
0.0
0.1
0.2
0.3
0.4
1840 1860 1880 1900 1920 1940 1960 1980 2000 2020
Year

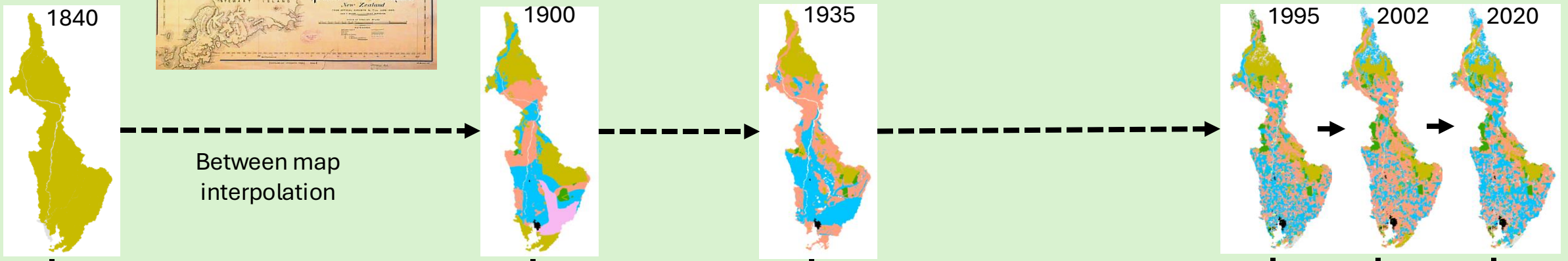
Recreating historic catchment inputs with the CLUES (catchment land-use for environmental sustainability) model:

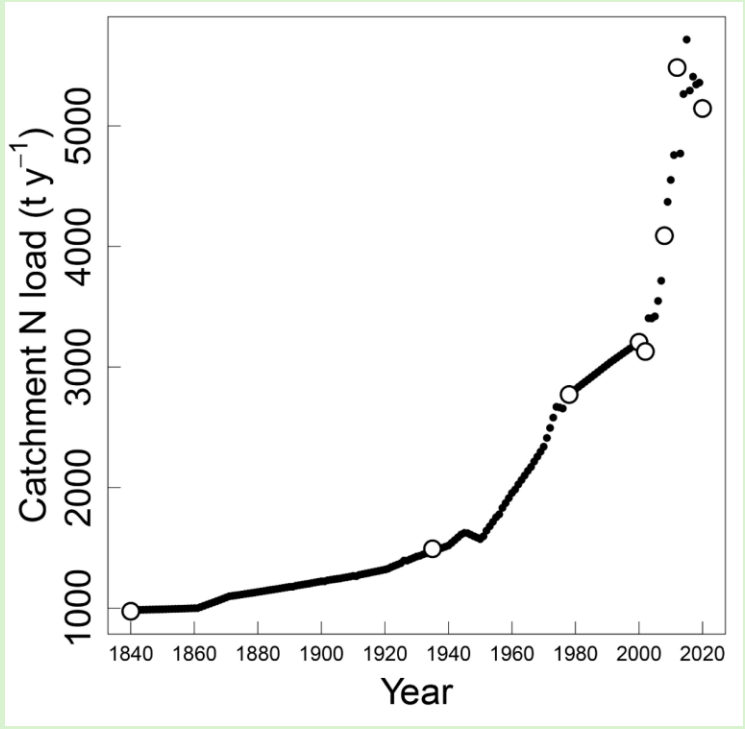


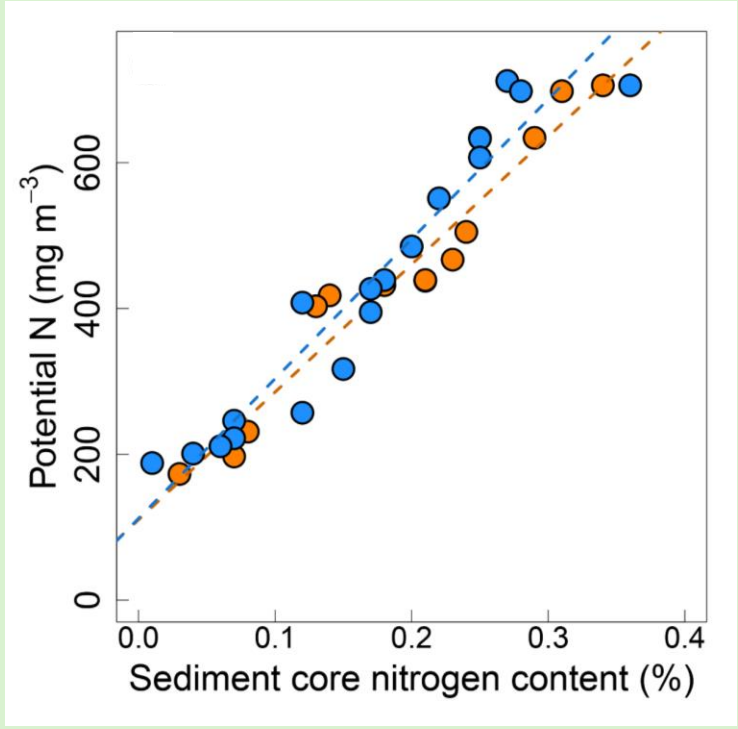

Source and digitise historic maps → Land-use characterisation → Estuarine inputs

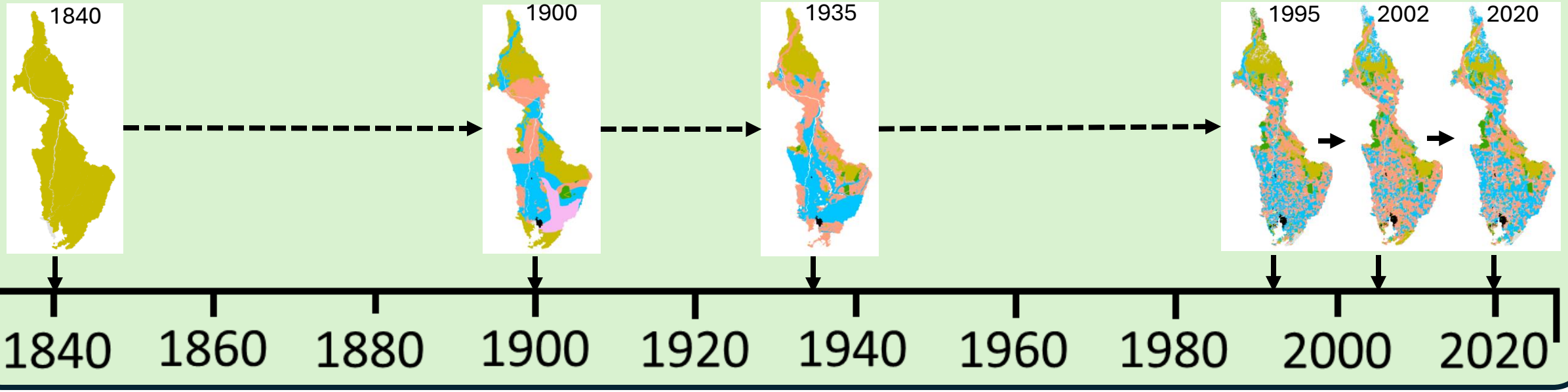
- Arable crops
- Dairy
- Deer
- Horticulture
- Native forest/Scrub
- Other animals
- Plantation forest
- Sheep and Beef
- Ungrazed pasture
- Urban

N

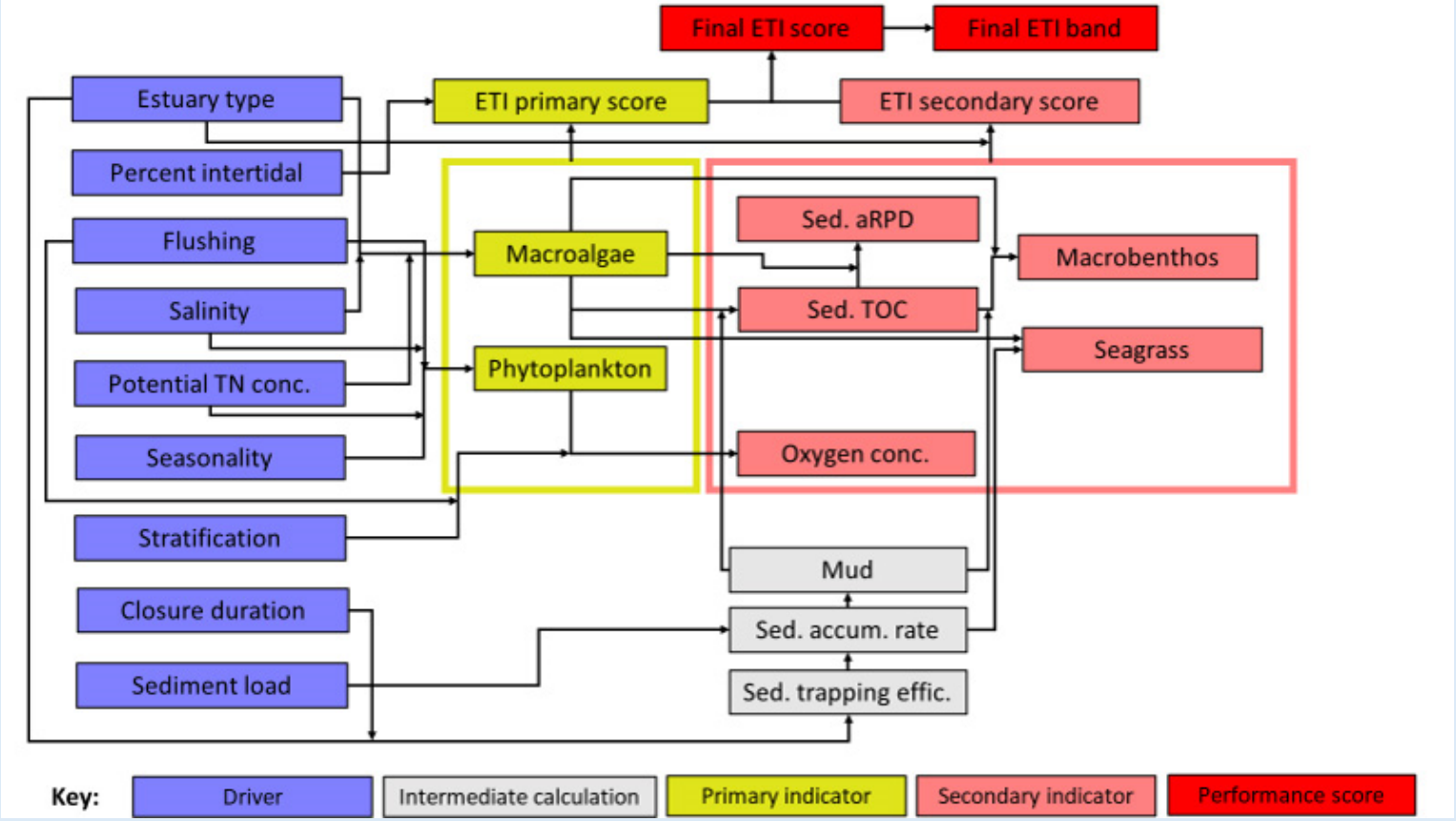


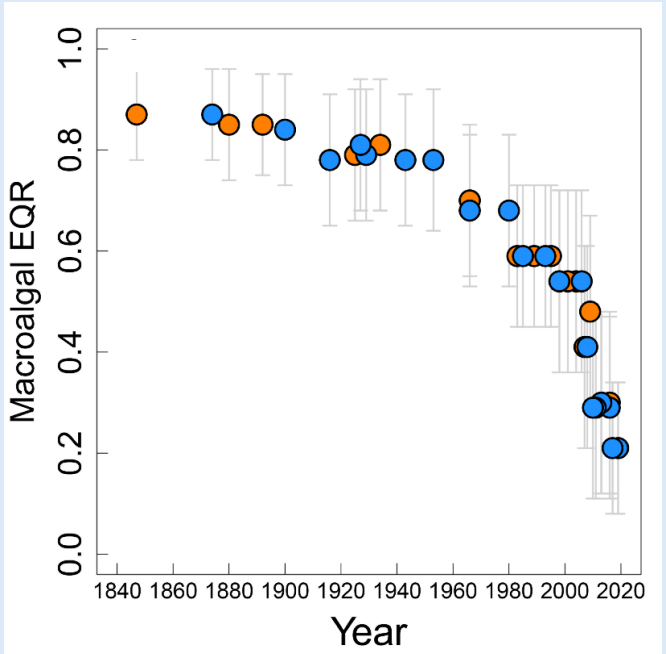

Catchment N load (t y$^{-1}$)
1000
2000
3000
4000
5000
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020
Year

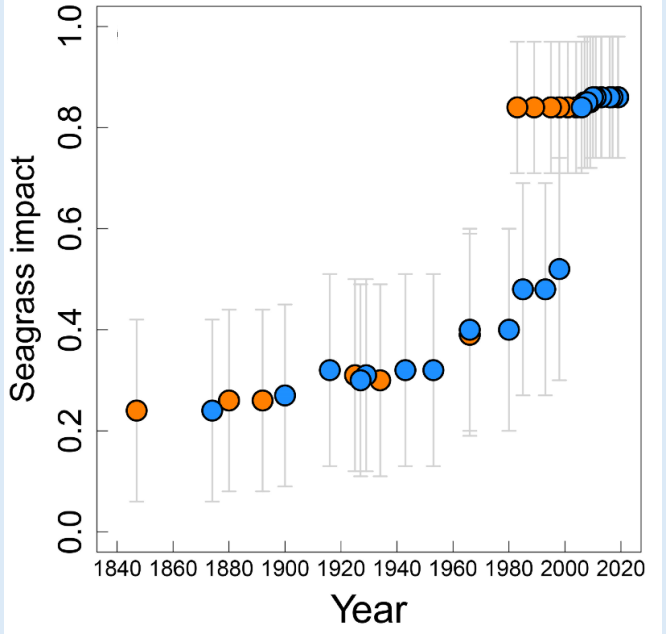

Potential N (mg m$^{-3}$)
0
200
400
600
0.0
0.1
0.2
0.3
0.4
Sediment core nitrogen content (%)


1840
1900
1935
1995
2002
2020
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020

# Reconstructing historic ecologies with a Bayesian Belief Network




Zeldis & Plew, Frontiers in Marine Science, DOI: 10.3389/fmars.2022.898992

Comparison with known estuarine history: Memories and Mātauranga.


Swimming at Pleasure Bay

Pleasure Bay becomes rubbish dump

Rapid population growth

Te Tiriti o Waitangi

Settled by Europeans

Sewerage installed

Invercargill declared a city

Rapid dairy expansion

Estuary no longer provides cultural values or suitable for mahinga kai


4 Friday, January 11, 2013 NEWS www.southlandtimes.co.nz The Southland Times

**Rush on to save estuaries**

Alex Fensome

Work dealing with Southland's sick estuaries will restart next month, with scientists and local government hoping they can identify the cause of the drastic decline and find out how to prevent it getting worse.

A report presented to Environment Southland's environmental management committee in November shows large areas of the New River estuary, in Invercargill, and the Jacobs River estuary, in Riverton, are close to environmental collapse.

Findings included the loss of vast swathes of seagrass, choked by sediment washed down the rivers, and increasing levels of noxious hydrogen sulphide, which smells of rotten eggs, caused by matter breaking down without oxygen.

The Waihopai Arm of the New River estuary has seen its supratidal area – largely intertidal, without oxygen and algae-dominated – increase from three hectares in 2000 to 123ha last year.

Large areas of deep, polluted sediment are smothering life in the Waihopai Arm and at the popular recreation spot of Daffodil Bay.

The Jacobs River estuary faces similar problems.

The regional council has employed coastal specialists Wriggle Coastal Management to monitor estuaries since 2000.

Its work will continue in February, targeting the sources of the pollution.

Environment Southland coastal scientist Nick Ward said Wriggle would narrow its focus and build on the work it had already done.

"Specifically, they'll be looking at the Waihopai Arm, its sedimentation rates, and doing seagrass mapping," he said. "Also doing some ecological assessment, looking at what we call the benthic community, the organisms that live in the sediment."

Other work could include comparing the makeup of estuary water to the contents of fertiliser and sprays to work out where most of the nutrients were coming from, and also calculating how much nutrient and sediment the estuary could take before being damaged.

Council principal scientist Karen Wilson said working that out was a complex task facing scientists around the world.

"It's not a Southland-specific issue," she said. "It is a national, or international, challenge for us... there will need to be some national consistency, potentially national direction."

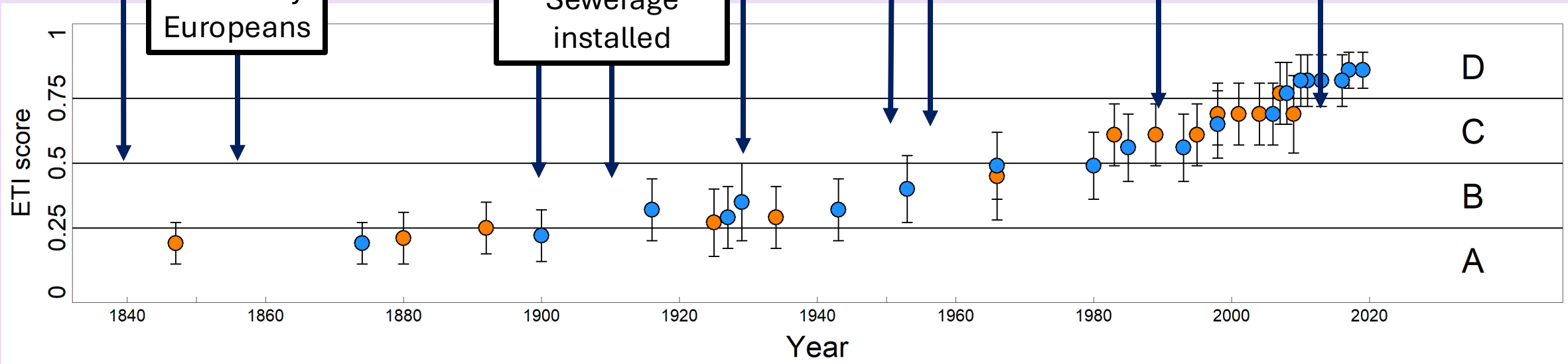
The data gathered this summer can be used to help the council come up with policies to try to arrest the decline. "We need to respond pretty quickly," Ms Wilson said. "We want to try and get a halt, or some improvement, in quite a short space of time."

In the longer term, scientists wanted to work out the nutrient load each catchment could sustain and take action, she said.

Senior resources planner Kylie Galbraith said the regional council hoped policies introduced last year, including the new resource consent requirement for dairy conversions, would have some effect on the amount of pollution entering the estuaries. It would also look to prioritise regional plan changes which would assist the estuaries and general water quality, she said.

alex.fensome@sli.co.nz

**Estuary check:** Wriggle Coastal Management scientist Barry Robertson at work monitoring Southland's declining estuaries for Environment Southland.



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