Monitoring to detect changes in river water quality across New Zealand

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2020 Overview of the Essential Freshwater package (viz. NPS-FM) aims…..

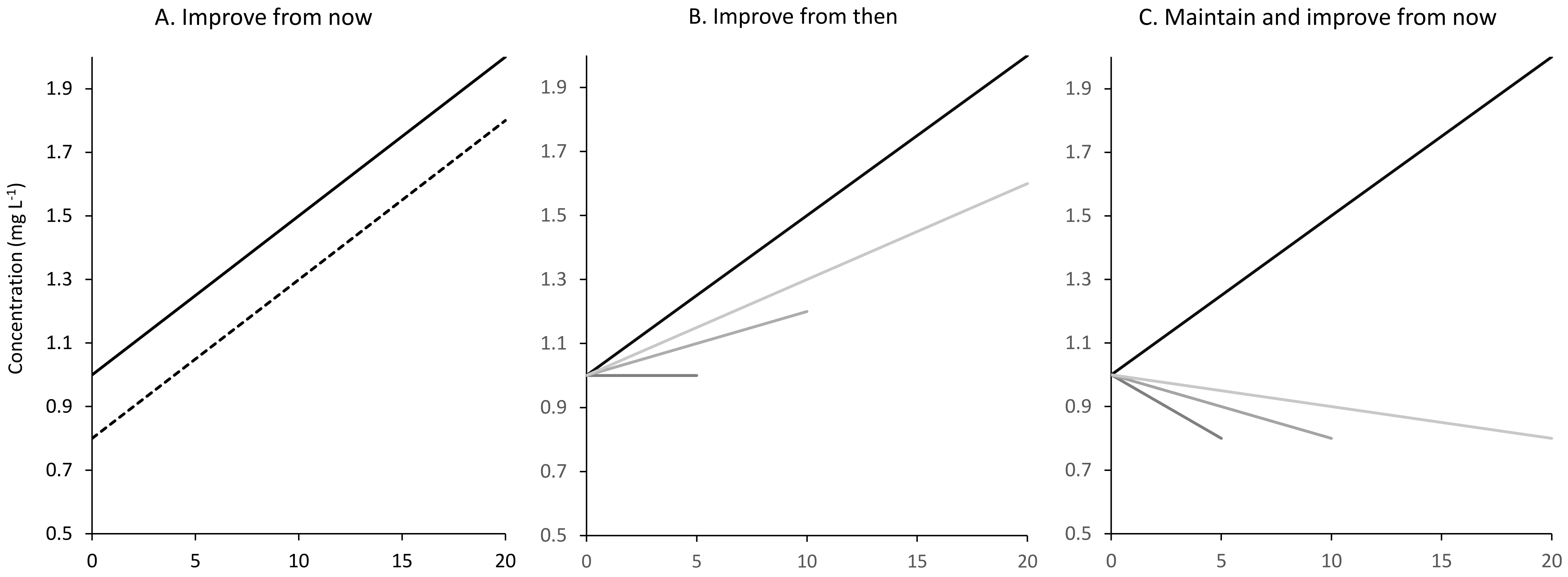
…to:

- Stop further degradation of our freshwater.
- Start making immediate improvements so water quality improves within five years.
- Reverse past damage to bring our waterways and ecosystems to a healthy state within a generation (e.g., 20 years).

But how do we know we're taking the right action, in the right place and at the right time?

How do we detect change and how much will it cost?

What is change?



Questions of power…

The likelihood of detecting change can be determined by estimating power (at an assumed level of significance; e.g., $P<0.05$) for a known sample frequency and duration.

Or, if the power is set (e.g., commonly to 80%) then the number of samples (over a known period) can be calculated.

If you can predict power in unmonitored sites, it gives you information about where to potentially detect change quickly and cheaply.

Aim

For all currently monitored streams and rivers with adequate data (n = 856):

Scenario 1: calculate the minimum number of samples and cost to meet policy thresholds (bottom lines, action plans) in 5 and 20 year for NO_3-N, NH_4-N, DRP, clarity and *E. coli.* Assume current sampling adequate for TN and TP.

Scenario 2: calculate the minimum number of samples and cost to meet a 30% reduction in concentrations in 5 and 20 years.

Modelling steps

Have only used sites with 15 years data and > 8 samples per year.

Model is only for reaches on ≥3rd order streams (rep of > 80% of sites in database)

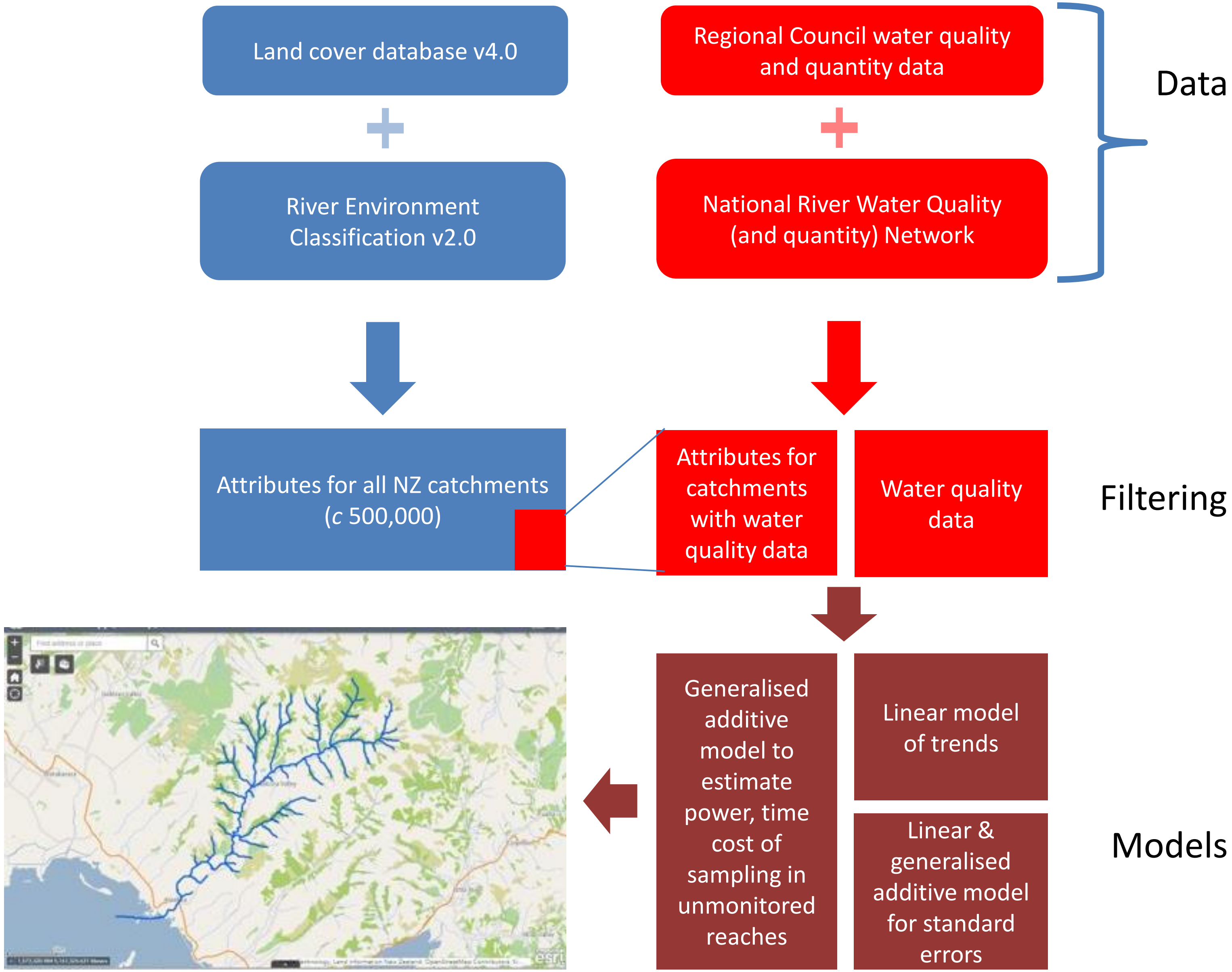
Estimates derived for:

- NO_3-N, NH_4-N, Total N
- DRP, Total P
- *E. Coli*
- Clarity and turbidity

Frequencies of daily, weekly, fortnightly, monthly

Reductions of 5, 10, 20, 30 and 50%.

Periods of 2, 5, 10, 20 and 30 years.



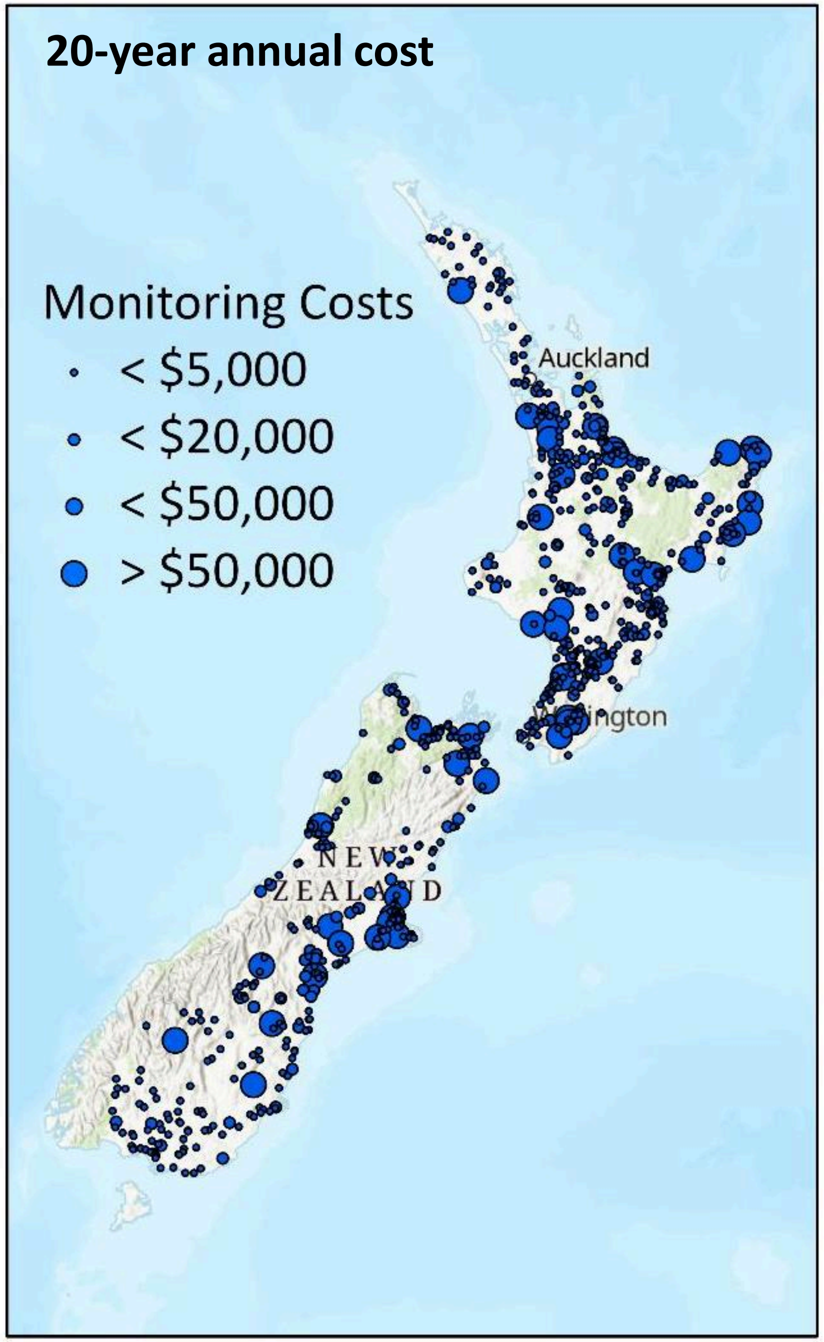
Estimating costs

Mean costs (from four regional authorities)

Cost per analyte, measurement and visit	Capex	Opex	Labour	Laboratory	Total
Turbidity	8.65	18.91	140.32	9.34	177.22
Nitrate-N	8.65	18.91	140.32	11.79	179.67
Ammoniacal-N	8.65	18.91	140.32	15.51	183.39
Total Nitrogen	8.65	18.91	140.32	24.85	192.72
Dissolved Reactive Phosphorus	8.65	18.91	140.32	19.55	187.42
Total Phosphorus	8.65	18.91	140.32	24.69	192.57
E. coli	8.65	18.91	140.32	35.32	203.20
Clarity	0.41	18.91	140.32	-	132.76

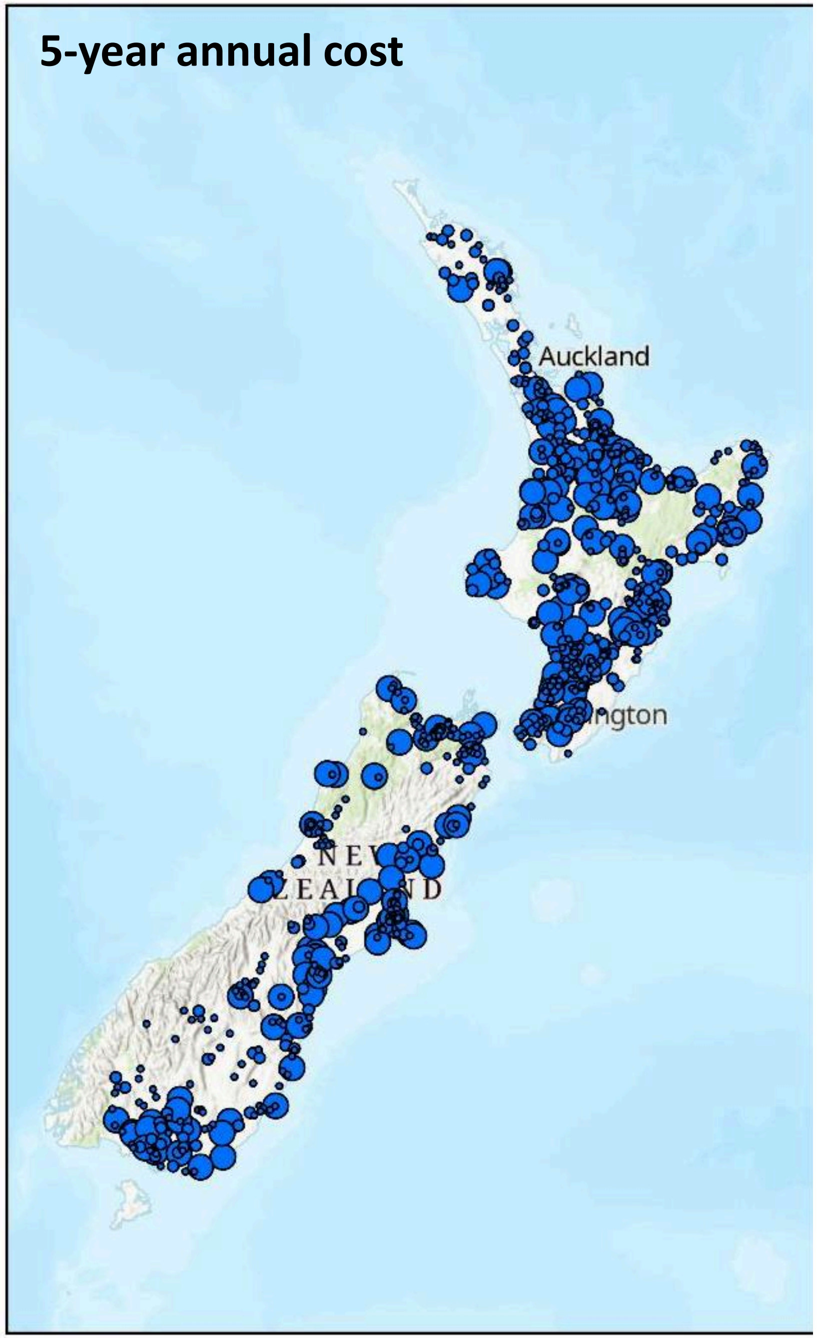
Scenario 1: cost to meet minimum policy thresholds

All contaminants



Scenario 1: cost to meet minimum policy thresholds

E. coli



Costs for Scenario 1: minimum policy thresholds

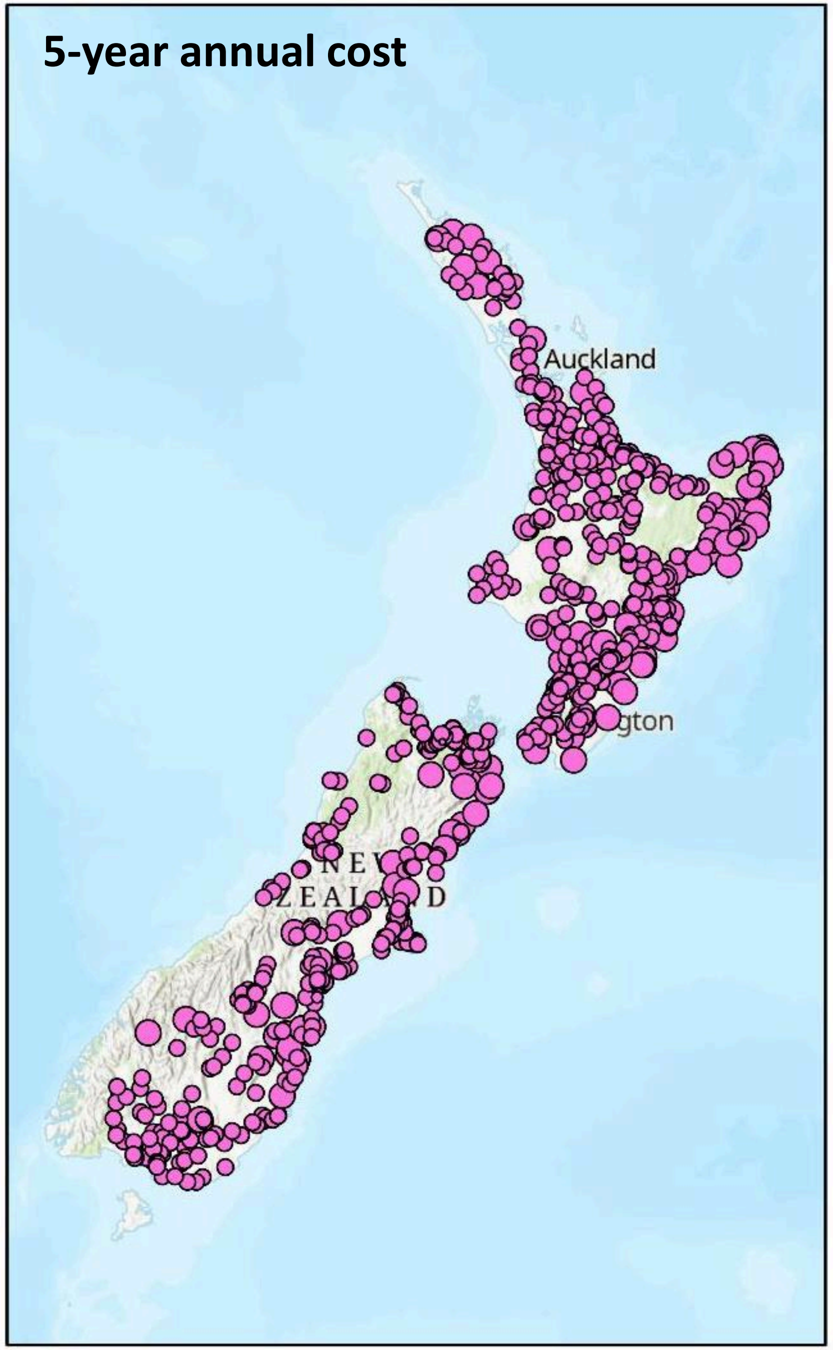
Analyte (percentage of sites not meeting thresholds)	Mean minimum number of samples per year	Mean minimum number of samples per year
Nitrate-N (49)	17	15
Ammoniacal-N (14)	13	13
Dissolved Reactive Phosphorus (270)	41	26
E. coli (470)	80	45
Clarity (247)	49	37
Annual cost all analytes ($M NZD)	15.8	10.2

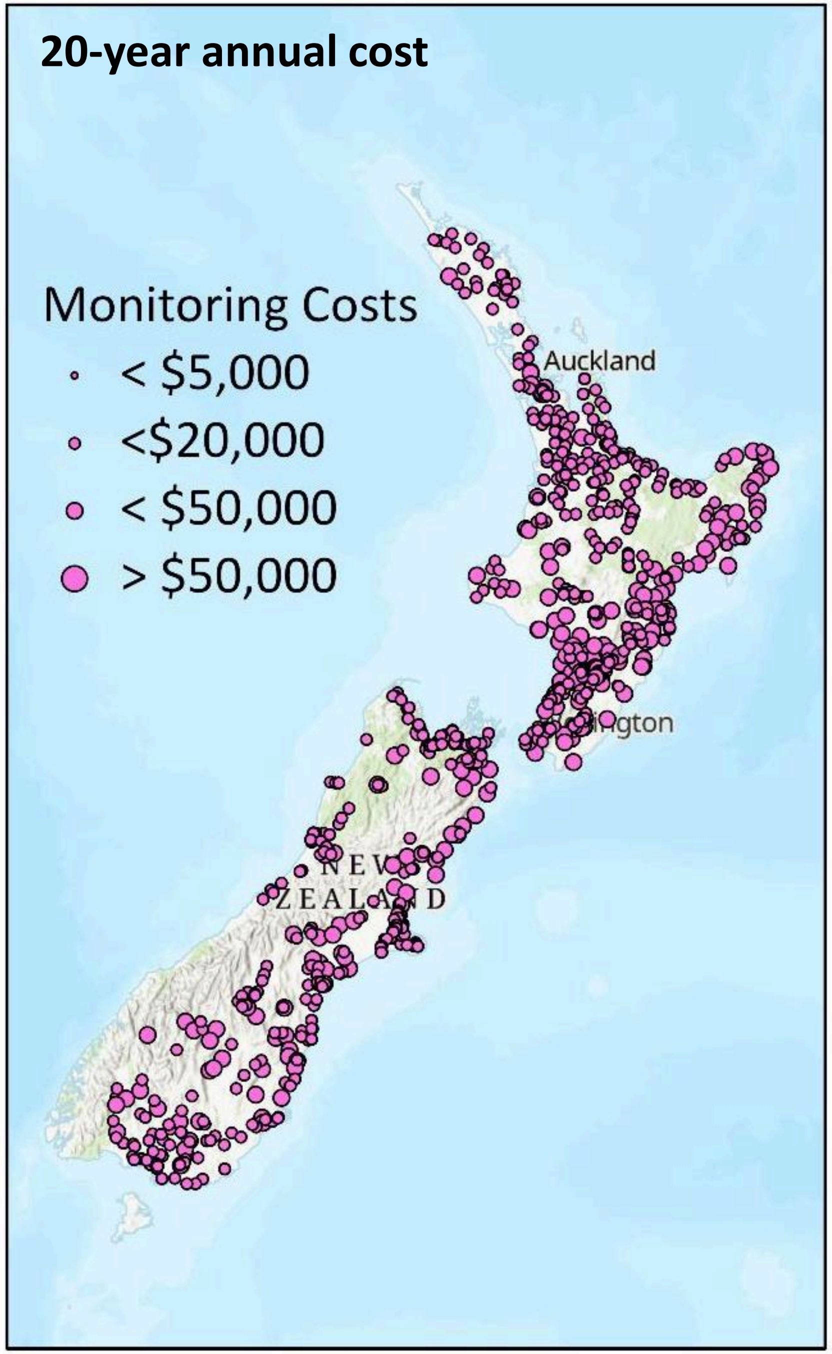
Includes monthly cost of sampling for total N and P, and turbidity

Current cost for monitored sites is $2.9M

Scenario 2: cost to detect 30% reduction

All contaminants





Cost for Scenario 2: 30% decrease

Analyte	Mean minimum number of samples per year	Mean minimum number of samples per year
Nitrate-N	142	28
Ammoniacal-N	40	13
Total N	28	12
Dissolved Reactive Phosphorus	30	12
Total P	72	18
E. coli	363	69
Turbidity	225	41
Clarity	70	18
Annual cost all analytes ($M NZD)	48.3	15.2

Limitations and Conclusions

Limitations:

- Models are only as good as the input data (representativeness and coverage)
- Models represent ≥ 3rd order streams (headwaters may better areas to sample as they will likely respond quickest)
- Outputs should only be used to guide further investigation.
- Labour, equipment and lab charges will change (e.g., with remote technologies)

Conclusions:

- The range of analytes and sample numbers could cross subsidised (e.g., turbidity or suspended sediment for total P).
- To meet the minimum policy thresholds or a uniform 30% improvement, current investment in monitoring must increase greatly.