



Lower Mokau & Mokauiti – Aria
2021 Freshwater Monitoring Results
Merrin Whatley (PhD) – 26 July 2022

Overview

- Indicators of freshwater health
- Monitoring results
- On farm actions





Photo: Susan Stoddard

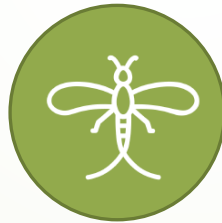
Indicators of Freshwater Health



Habitat



Flow




Wildlife



Energy & Nutrient
Dynamics



Water Quality



Identifying drivers of Health/Mauri of our Waterways



The key resources, attribute/indicator?



Where in the catchment are they coming from?



Are there seasonal changes or changes over time?



What are the underlying processes or practices contributing to contaminant loss?



Tailor catchment-based interventions to target resource loss over time and space.

Natural Influences


- Climate
- Topography
- Geology
- Soils
- Hydrology
- Land cover



Topography

-  Elevation & Slope
LINZ, Regional Councils, International Space Agencies

Climate

-  Temperature & Precipitation
NIWA

Soils

-  Soil Maps SMap & Fundamental Soils
Manaaki Whenua
-  Soil Quality Data
Regional Councils
-  Soil Geochemistry
GNS Science
-  Soil Quality Data
Regional Councils

Land Cover

-  Land Cover Database
Manaaki Whenua, LCDBv5
-  Satellite Imagery
LINZ




Geology

-  Geological Map QMap
GNS Science
-  NZ Land Resource Inventory
Manaaki Whenua
-  Rock & Mineral Database
GNS Science



Land Use

-  Land Use Map LUCAS
Ministry for the Environment
-  Conservation Estate
DOC, LINZ, QEII
-  Land Use Data
Regional Councils



Hydrogeology

-  Aquifers
GNS Science, Regional Councils
-  Water Table Depth
GNS Science
-  Geothermal Inputs
GNS Science

Water Quality

-  Surface water quality
Regional Councils, LAWA, NIWA
-  Groundwater Quality
Regional Councils, GNS Science

Hydrology

-  River Environment Classification
NIWA
-  Lakes and Rivers
LINZ



Lower Mokau

Map Information

 Weak Bedrock

Variants

Overland flow	High
Artificial drainage	Not applicable
Natural soil bypass	Not applicable

Key Information

Hydrological Pathway	Lateral drainage
Contaminant Risk	Sediment, Particulate phosphorus
Surface water catchment	Mokau River

Description

- Typically occurs across rolling to steep topography where shallow soil overlies weak bedrock (also exists across plateaus where shallow soils overlie bedrock without significant relief).

Mokauiti - Aria

Map Information

 Oxidising Soil & Aquifer

Variants

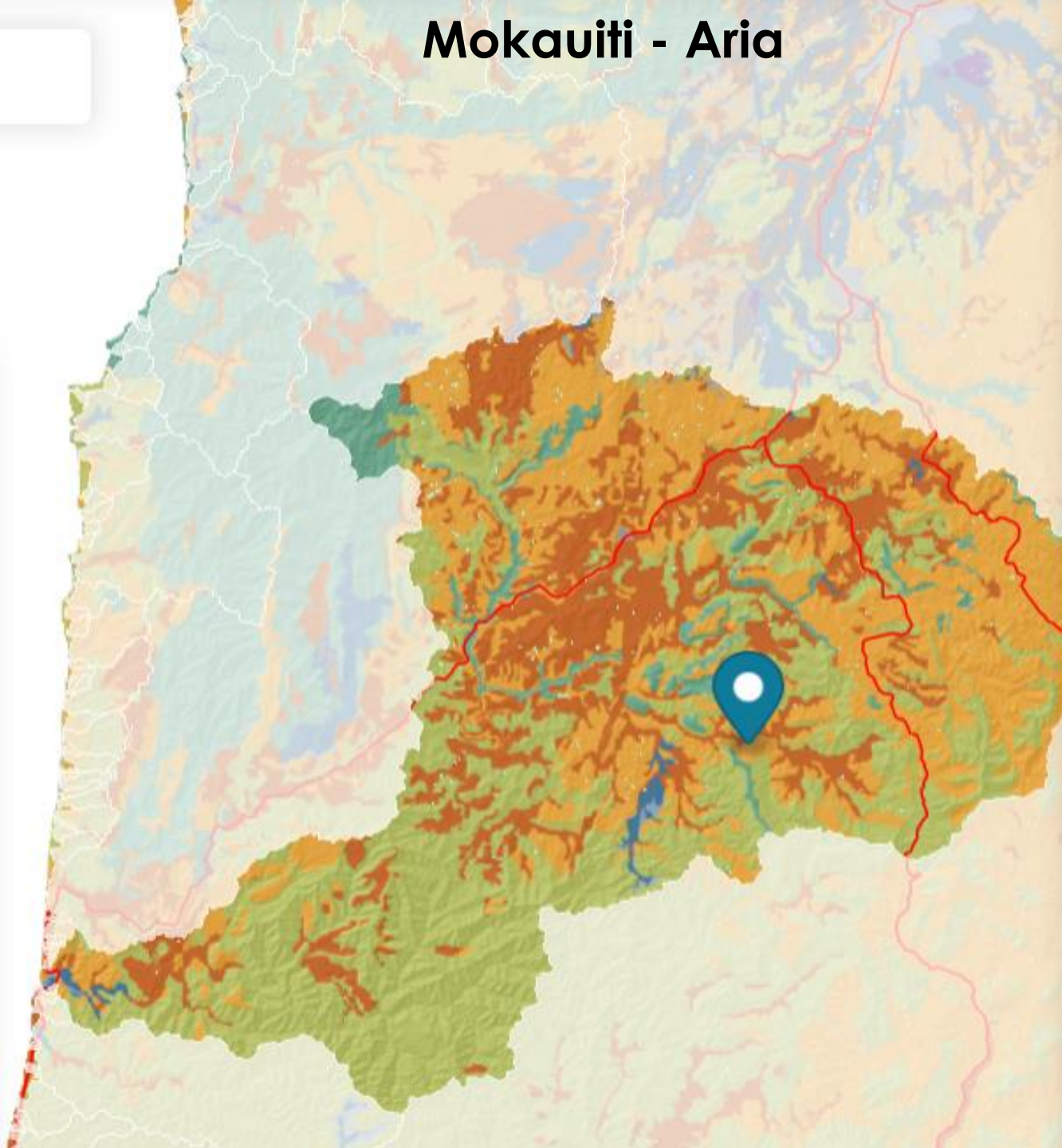
Overland flow	Moderate
Artificial drainage	Not applicable
Natural soil bypass	Not applicable

Key Information

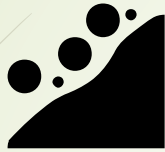
Hydrological Pathway	Deep drainage
Contaminant Risk	Nitrate nitrogen
Surface water catchment	Mokau River

Description

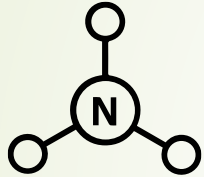
- Predominantly occurs in lowland, low relief areas where there are moderately-well to well drained soils and oxygen-rich (oxidising) underlying aquifers.
- Runoff risk is elevated in areas of sloping or slowly permeable soils.
- Environment is oxidising.



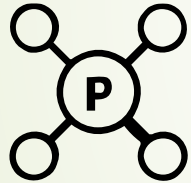
Attribute Descriptions



Water Clarity – Suspended Particles Including Sediment



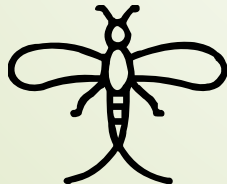
Nitrate



Dissolved Reactive Phosphorus (DRP)



Pathogens/E. coli (short for Escherichia coli)



Freshwater Macroinvertebrate Community Index (MCI)



Monitoring in Lower Mokau

Waikato Regional Council Sites

- Mid Mokau – 6 sites in total
 - 3 Water quality sites
 - 1 River flow site
 - 2 Ecology sites

Frequency of Measurements

- WQ collected by monthly grab sample
- Ecology site visited every 3 years
- Continuous river flow recorded every 15 minutes



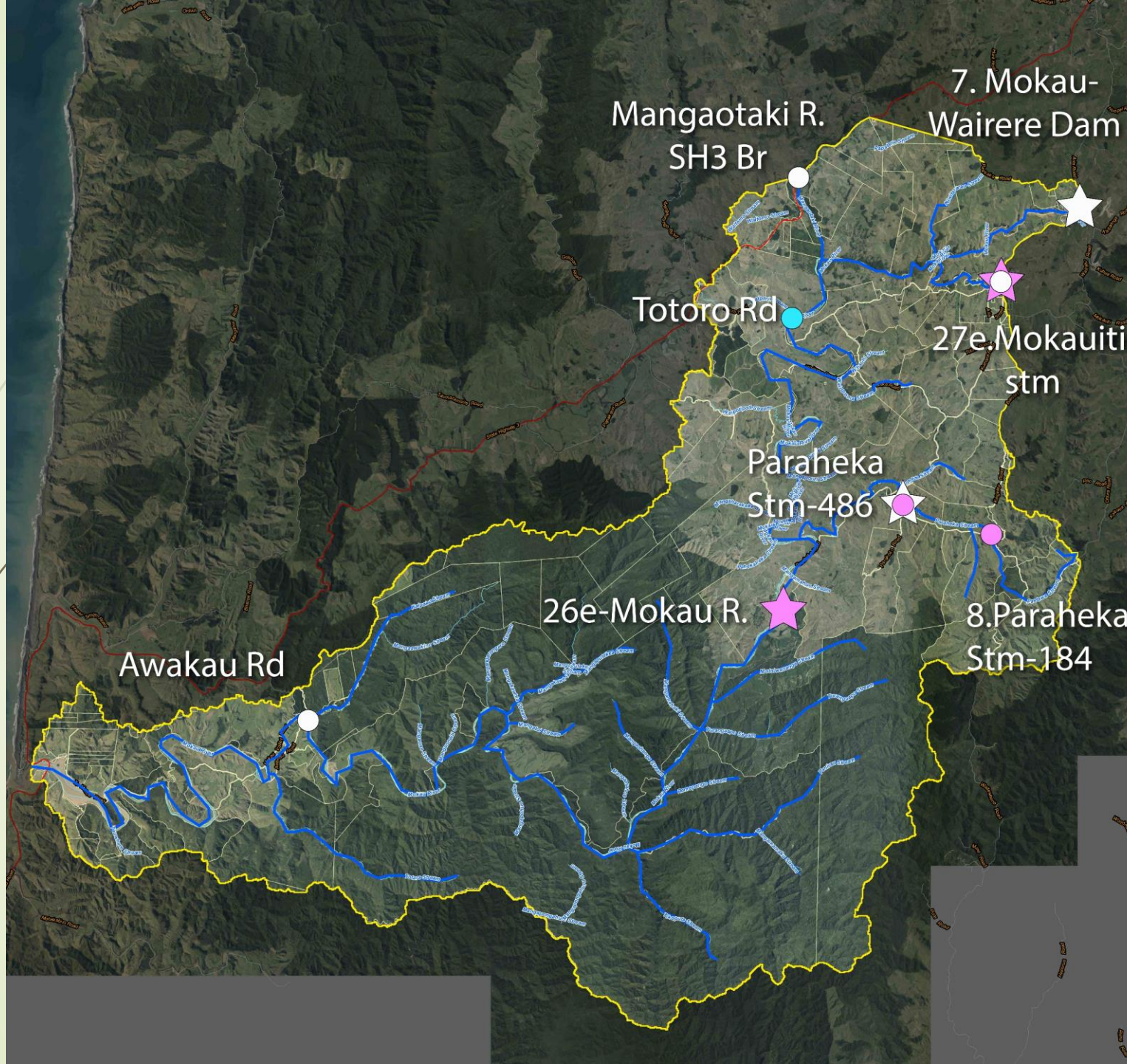
Monitoring in Mid Mokau – Pio Pio






KCRC Sites

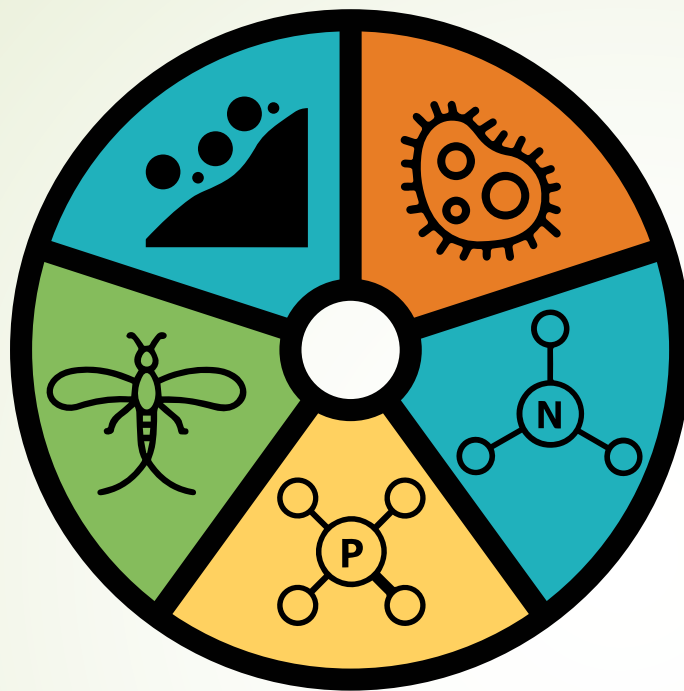
- Upper Mokau-Mangaphei SC – 4 sites in total
- 2 Water Quality sites
- 2 eDNA site

Frequency of Measurements

- Water quality collected by grab sample 4 times a year
- eDNA collected twice, Feb & Nov/Dec 2021



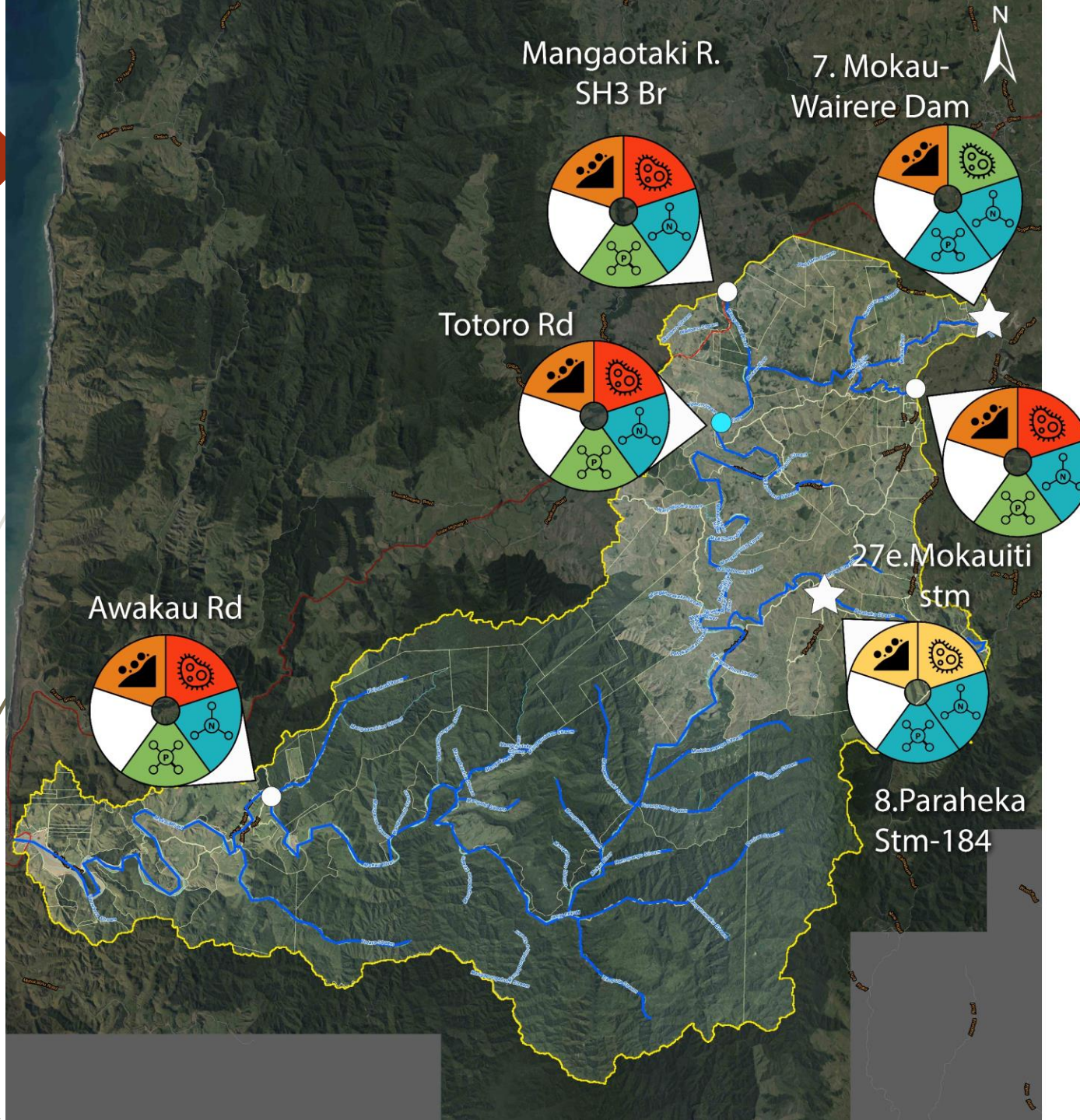
- Monitoring Sites**
-  Aquatic Life - WRC
 -  Water Quality - WRC
 -  River Flow - WRC
 -  Water Quality - KCRC
 -  eDNA - KCRC



Attribute Band - Current State



Attribute Dials



Key Results

- E. coli and water clarity are the attributes to watch

In general:

- Highest water quality at Paraheka Stm
- Lowest water quality at Mangaotaki R.

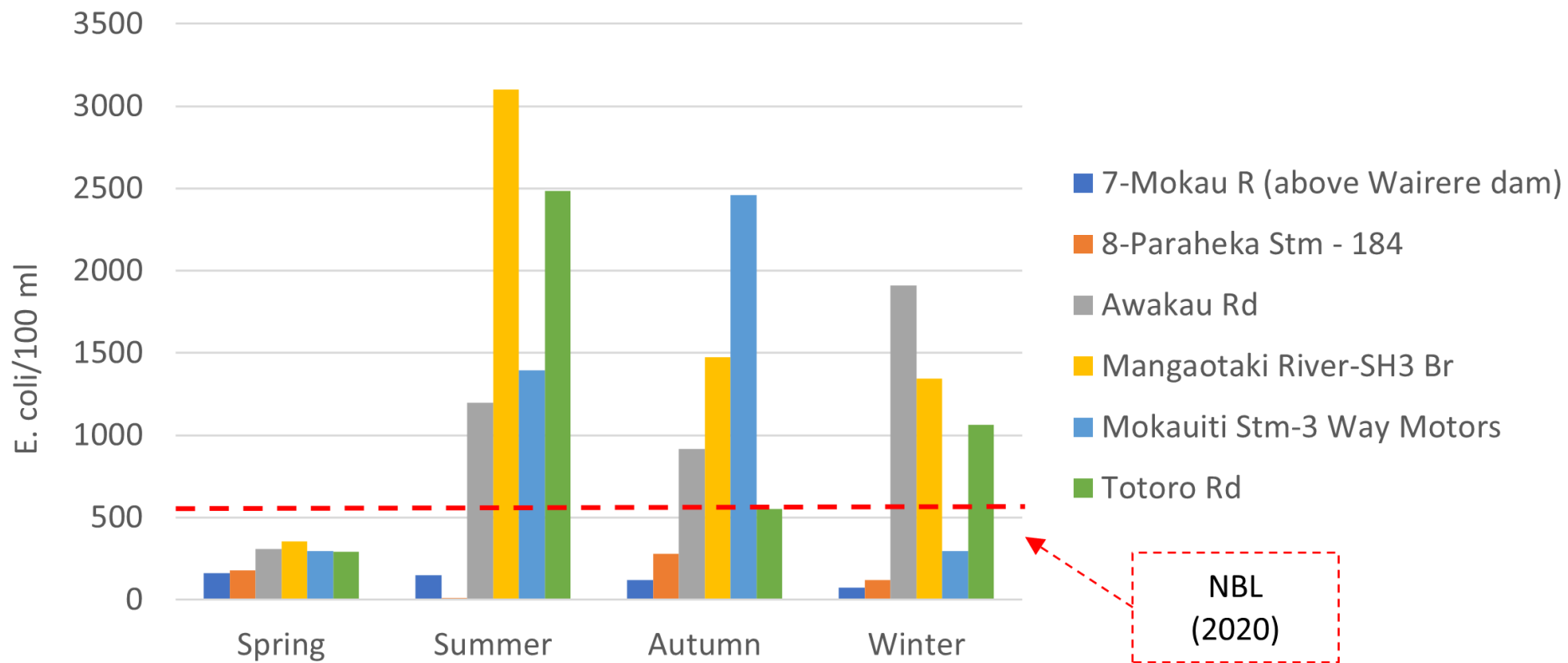
Lower Mokau Annual Summary 2021 Labs: Hill/Analytica	Human Contact E. coli/100 ml ¹	Ecosystem Health							
		Water Quality						Sediment	
		Nitrate Toxicity (TON mg N/L)		Ammonia Toxicity (mg N/L)		Dissolved Reactive Phosphorus (mg P/L)		Water Clarity Value ¹	National Bottom Line
KCRC WQ SITES	95th Percentile	Value	95th Percentile	Value	95th Percentile	Value	95th Percentile	Median	
7-Mokau R, above Wairere Dam*	159 ↓	0.45 ↓	0.95 ↓	0.010	0.018 ↓	0.006 ↓	0.008 ↓	1.27 ↑	1.34
8-Paraheka Stm-184	265 ↓	0.16 ↓	0.48 ↓	0.015	0.020 ↓	0.005 ↓	0.013 ↓	0.71 ↓	0.61
WRC WQ SITES									
Awakau Rd	1685 ↓	0.29 ↓	0.74 ↓	0.019 ↑	0.032 ↓	0.007 ↓	0.010 ↓	0.61 ↓	0.61
Mokauiti Stm-3 Way Motors	2160 ↓	0.29 ↓	0.80 ↓	0.012 ↑	0.044 ↓	0.009 →	0.016 ↓	0.64 ↓	1.34
Mangaotaki River-SH3 Br	2535 ↓	0.61 ↑	0.85 ↓	0.005 ↓	0.014 ↓	0.010 ↑	0.021 ↓	1.02 ↑	1.34
Totoro Rd	1980 ↓	0.46 ↓	0.93 ↓	0.014 ↑	0.019 ↓	0.010 ↑	0.017 ↓	0.87 ↑	1.34
Mokau R. Baseline (Jan-2015 to Aug-2020)	5000	0.54	1.00	0.009	0.047	0.009	0.022	0.79	1.34

Annual Summary

Attribute Band - Current State

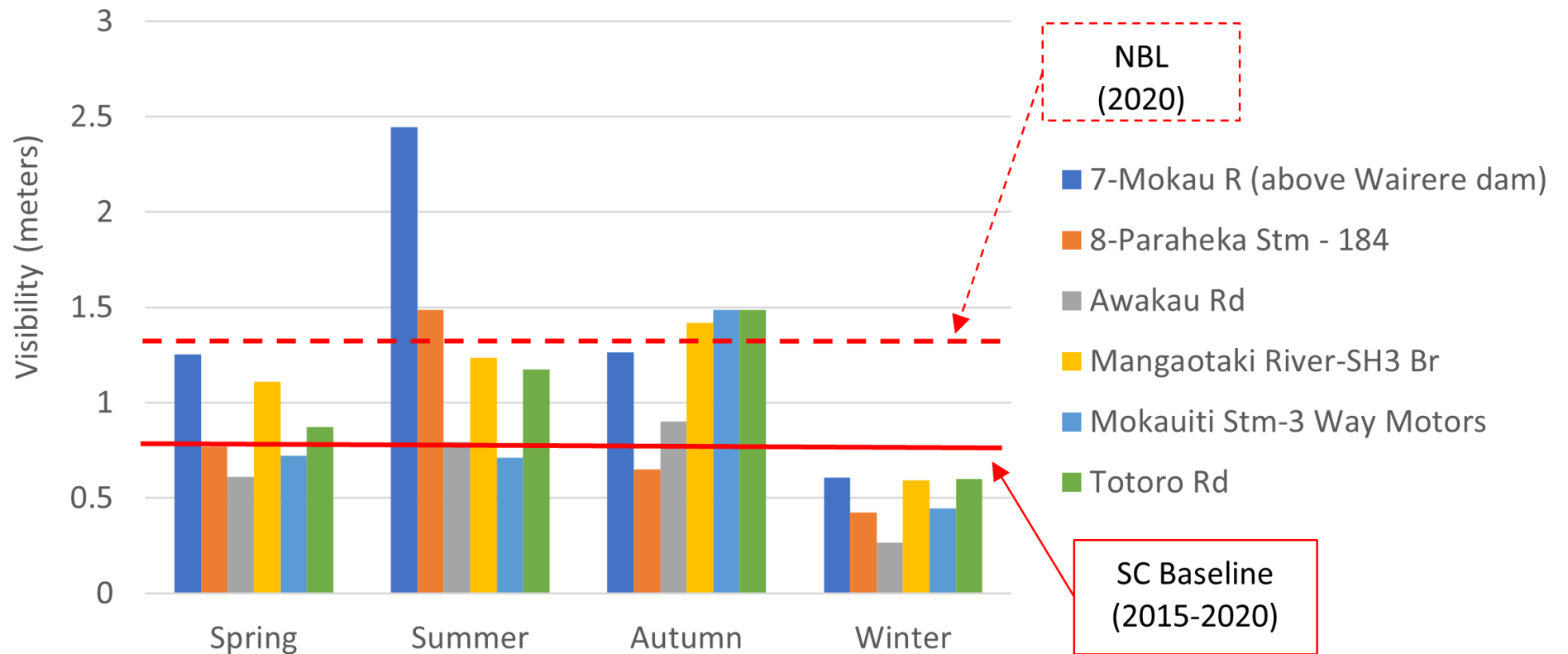


Lower Mokau E. coli - 95th Percentile



E. Coli – Seasonal Results

Lower Mokau Sediment/Water Clarity - Median



Water Clarity – Seasonal Results



Monitoring in Mokauiti - Aria

Waikato Regional Council Sites

- 6 sites in total
- 1 River Water Quality
- 5 Ecology sites

Frequency of Measurements

- WQ collected by monthly grab sample
- Ecology site visited every 3 years
- Continuous river flow recorded every 15 minutes



Monitoring in Mokauiti - Aria

KCRC Sites

- 3 sites in total
- 3 Water Quality sites
- 1 eDNA site

Frequency of Measurements

- Water quality collected by grab sample 4 times a year
- eDNA collected twice, Feb & Nov/Dec 2021

27e.Mokauiti
stm

24.Mangawhata
Stm - Puhunga Rd






22. Huioteko
Stm-248

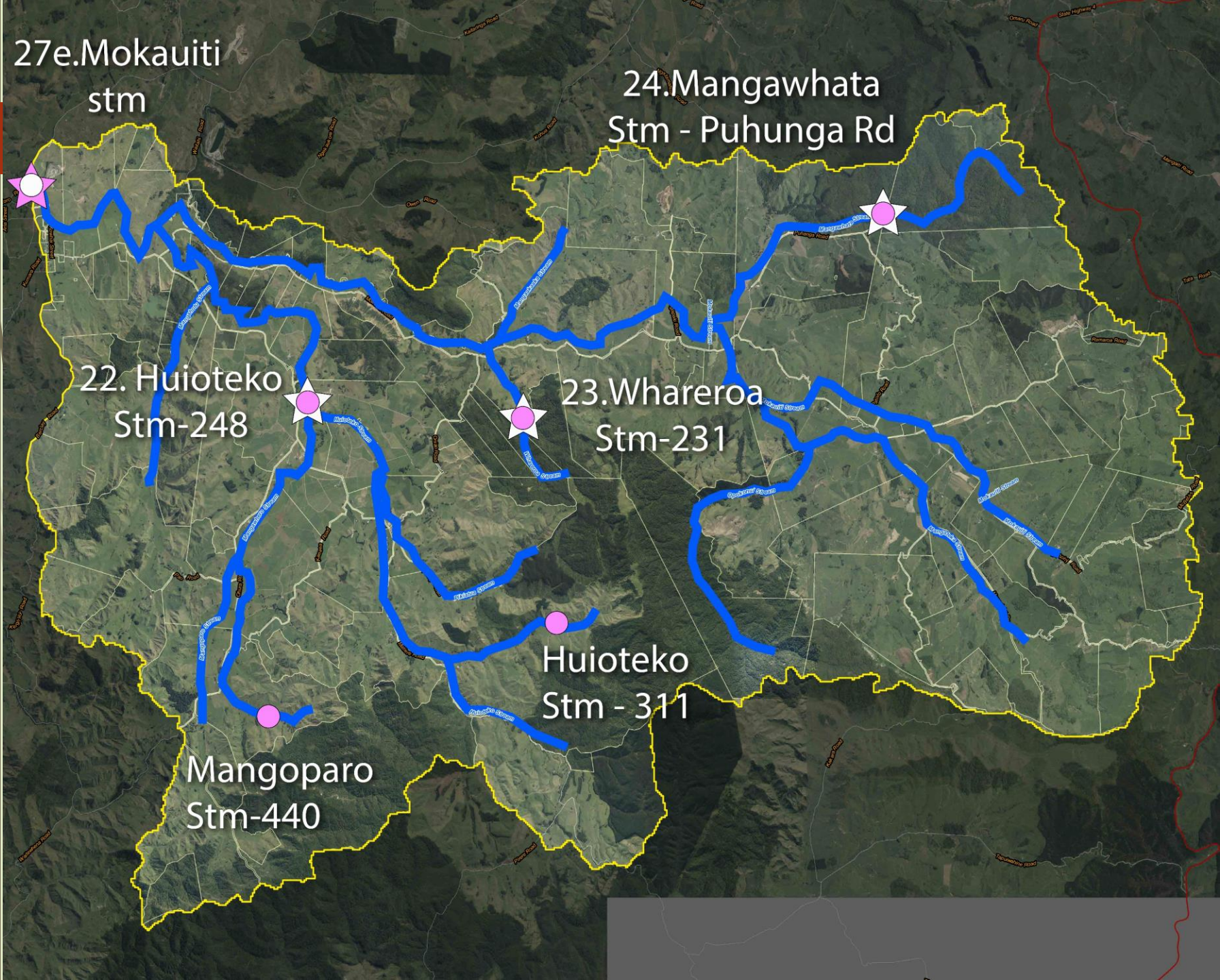
23.Whareroa
Stm-231

Huioteko
Stm - 311

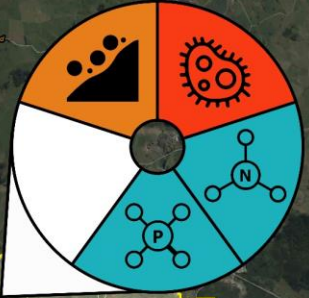
Mangoparo
Stm-440

Monitoring Sites

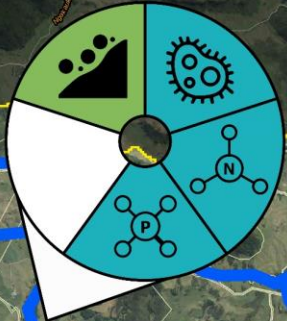
-  Aquatic Life - WRC
-  Water Quality - WRC
-  River Flow - WRC
-  Water Quality - KCRC
-  eDNA - KCRC



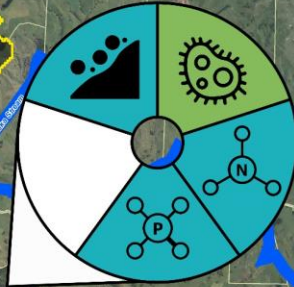
27e.Mokauiti
stm



22. Huioteko
Stm-248



23.Whareroa
Stm-231



24.Mangawhata
Stm - Puhunga Rd



Key Results

- Water clarity and E. coli are the attributes to address

In general:

- highest water quality at 22.Huioteko stm
- Lowest water quality at 27. Mokauiti Stm

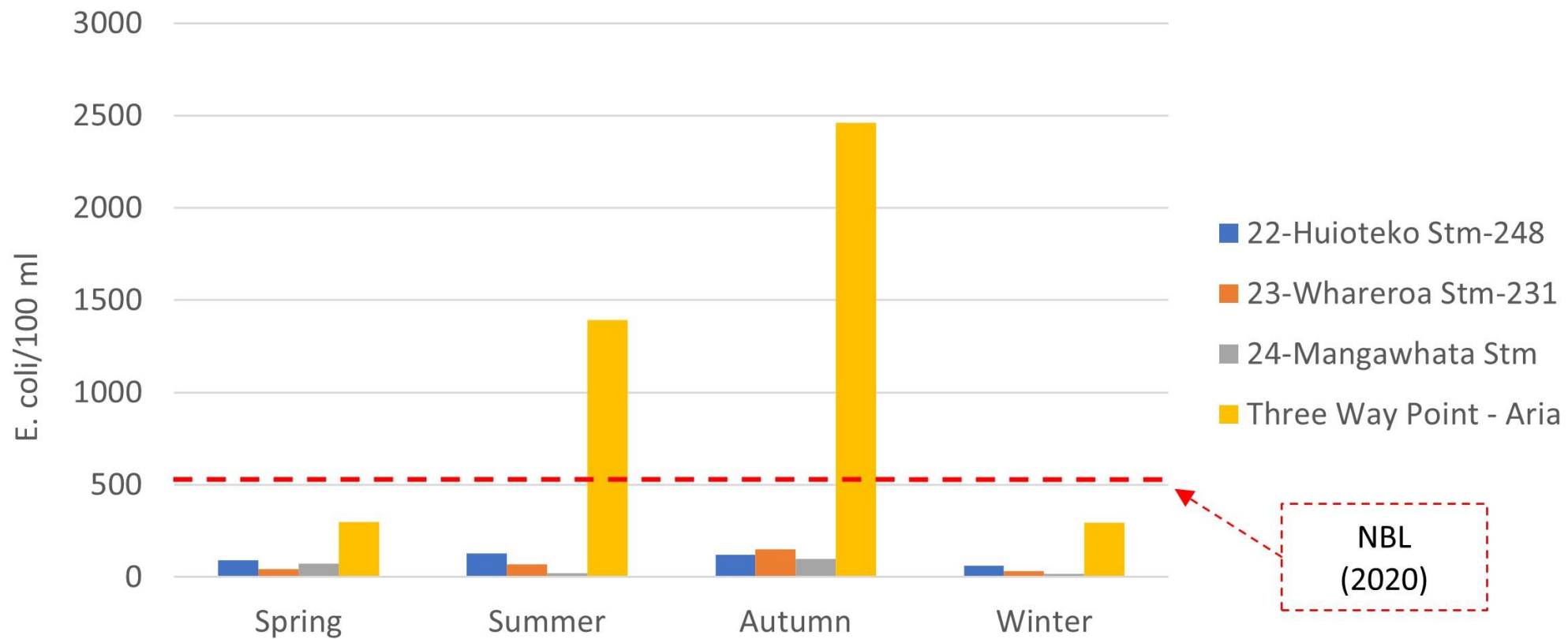
Mokauiti-Aria Annual Summary 2021 Labs: Hill/Analytica	Human Contact E. coli/100 ml	Ecosystem Health							
		Water Quality							
		Nitrate Toxicity (TON mg N/L)		Ammonia Toxicity (mg N/L)		Dissolved Reactive Phosphorus (mg P/L)		Sediment	
		Water Clarity Value ¹	National Bottom Line						
KCRC WQ SITES	95th Percentile	Median	95th Percentile	Median	95th Percentile	Median	95th Percentile	Median	
22-Huioteko Stm-248	129 ↓	0.23 ↓	0.66 ↓	0.02 ↑	0.060 ↑	0.005 ↓	0.009 ↓	0.85 ↑	0.61
23-Whareroa Stm-231	138 ↓	0.10 ↓	0.17 ↓	0.004 ↓	0.005 ↓	0.001 ↓	0.001 ↓	1.23 ↑	0.61
24-Mangawhata Stm	96 ↓	0.13 ↓	0.39 ↓	0.005 ↓	0.001 ↓	0.001 ↓	0.001 ↓	1.24 ↑	1.34
WRC WQ SITES									
27. Mokauiti Stm-3 Way Motors	2160 ↓	0.29 ↓	0.80 ↓	0.012 ↑	0.044 ↓	0.009 →	0.016 ↓	0.64 ↓	1.34
Mokau R. Baseline (Jan-2015 to Aug-2020)	5000	0.54	1.00	0.009	0.047	0.009	0.022	0.79	1.34

Annual Summary

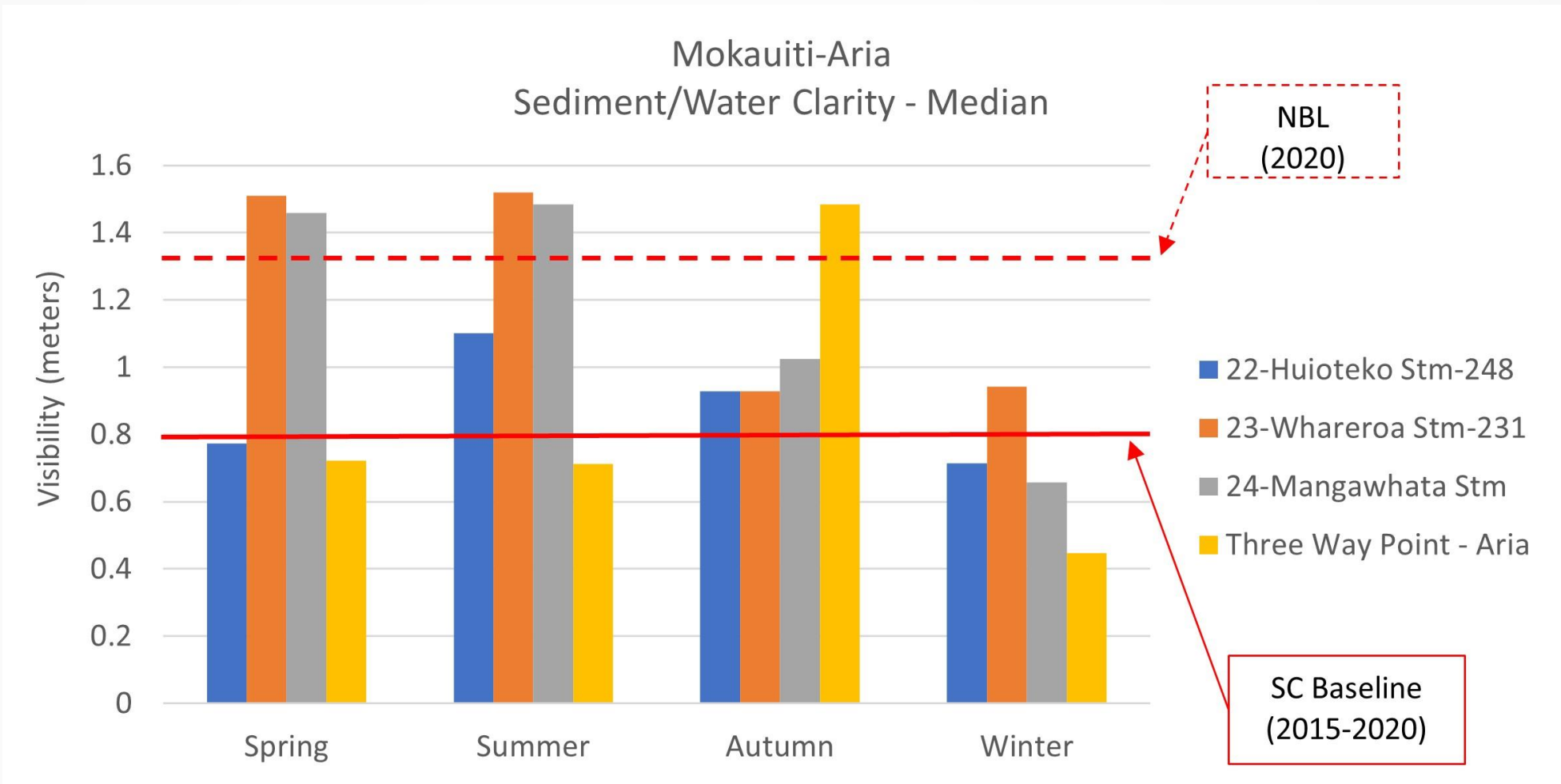
Attribute Band - Current State



Mokauiti-Aria E. coli - 95th Percentile



E. Coli – Seasonal Results



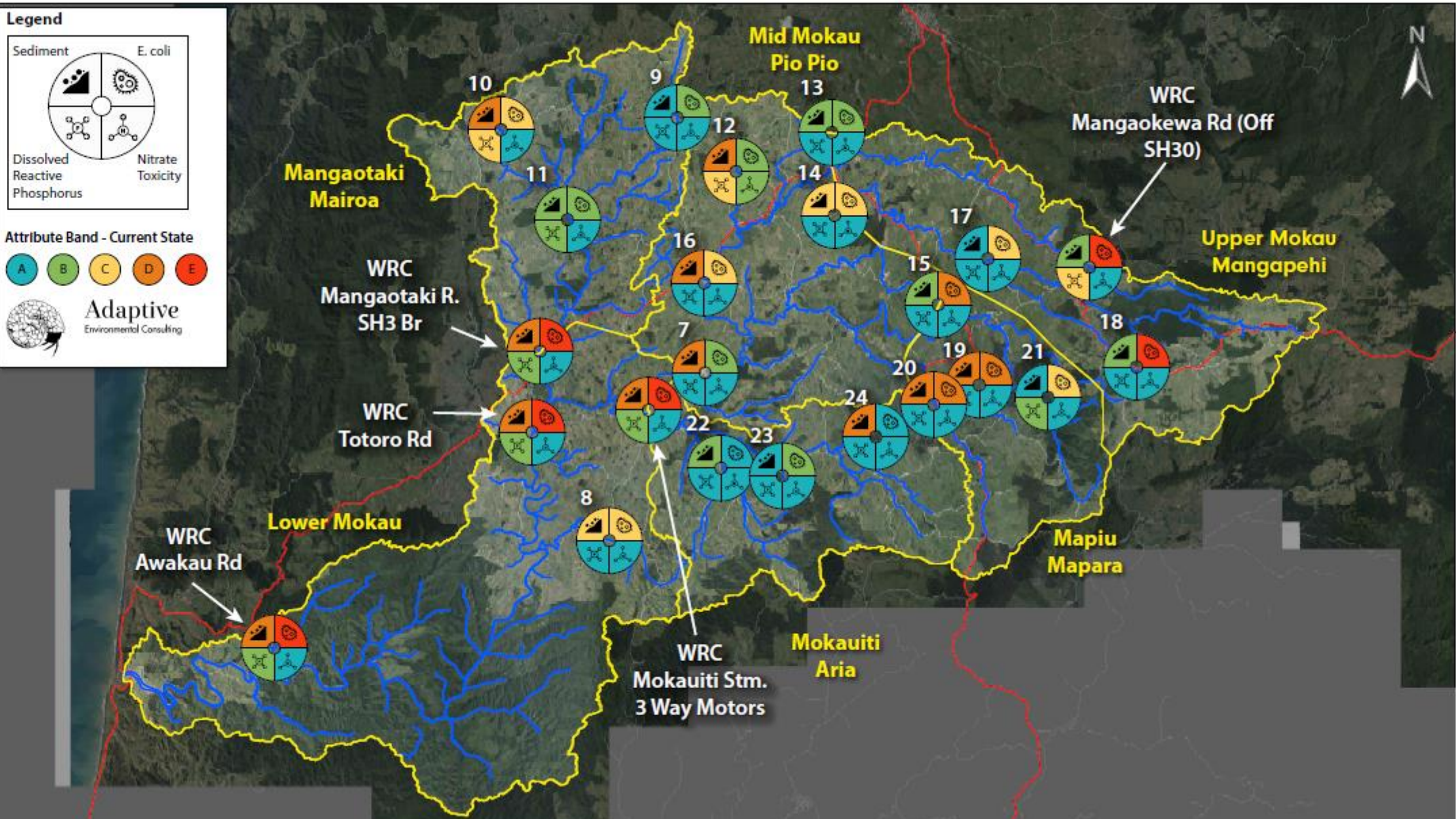
Water Clarity – Seasonal Results

Legend

Sediment	E. coli
Dissolved Reactive Phosphorus	Nitrate Toxicity

Attribute Band - Current State

A B C D E



Mangaotaki Mairoa

Mid Mokau Pio Pio

Upper Mokau Mangapehi

Lower Mokau

Mapiu Mapara

Mokauiti Aria

WRC Mangaotaki R. SH3 Br

WRC Totoro Rd

WRC Awakau Rd

WRC Mokauiti Stm. 3 Way Motors

WRC Mangaokewa Rd (Off SH30)

10

9

13

11

12

14

17

16

15

18

7

19

20

21

8

22

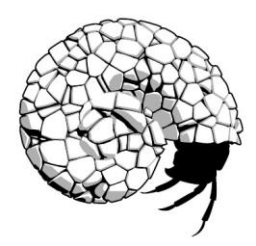
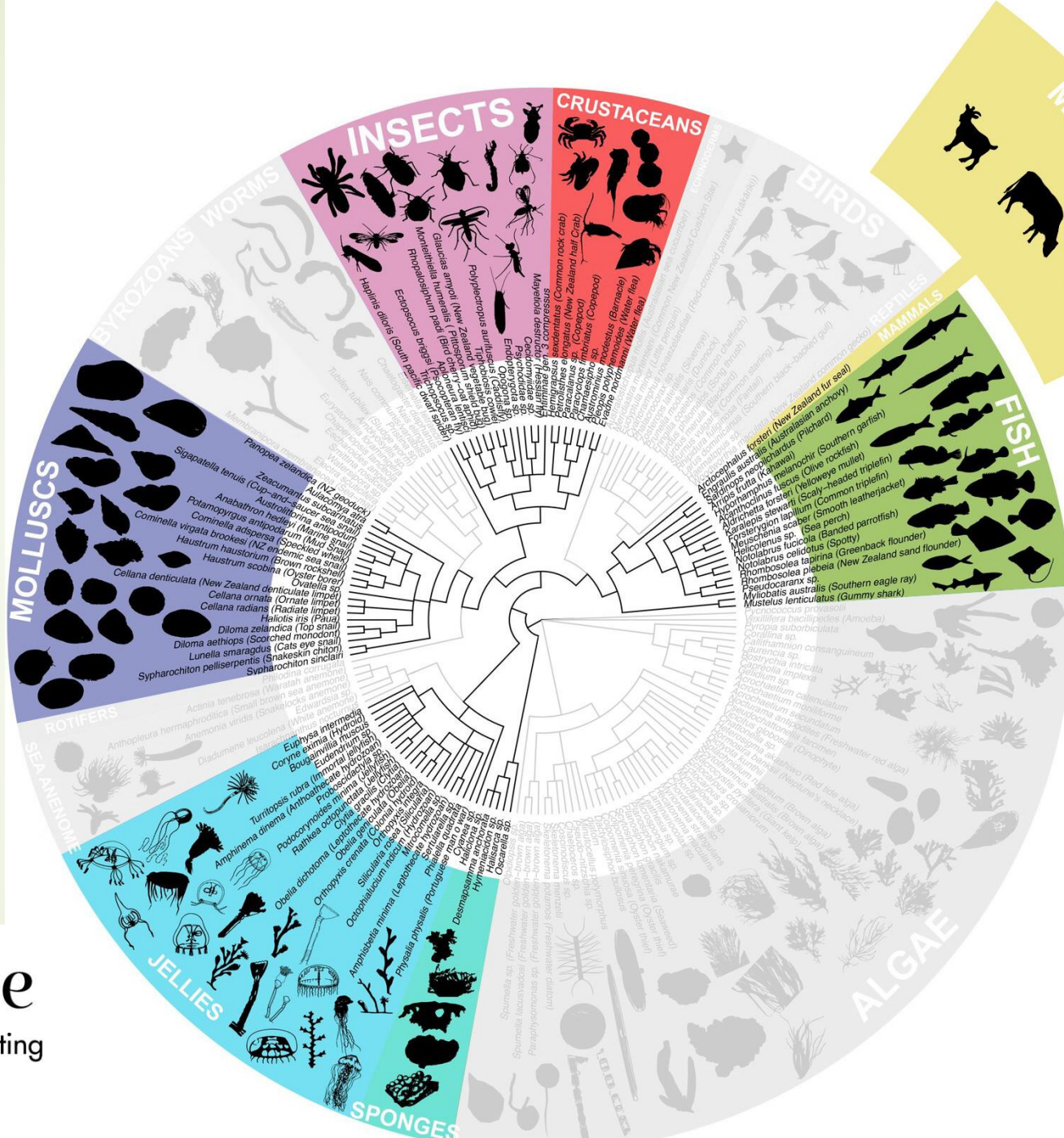
23

24

Environmental DNA (eDNA)



WILDERLAB

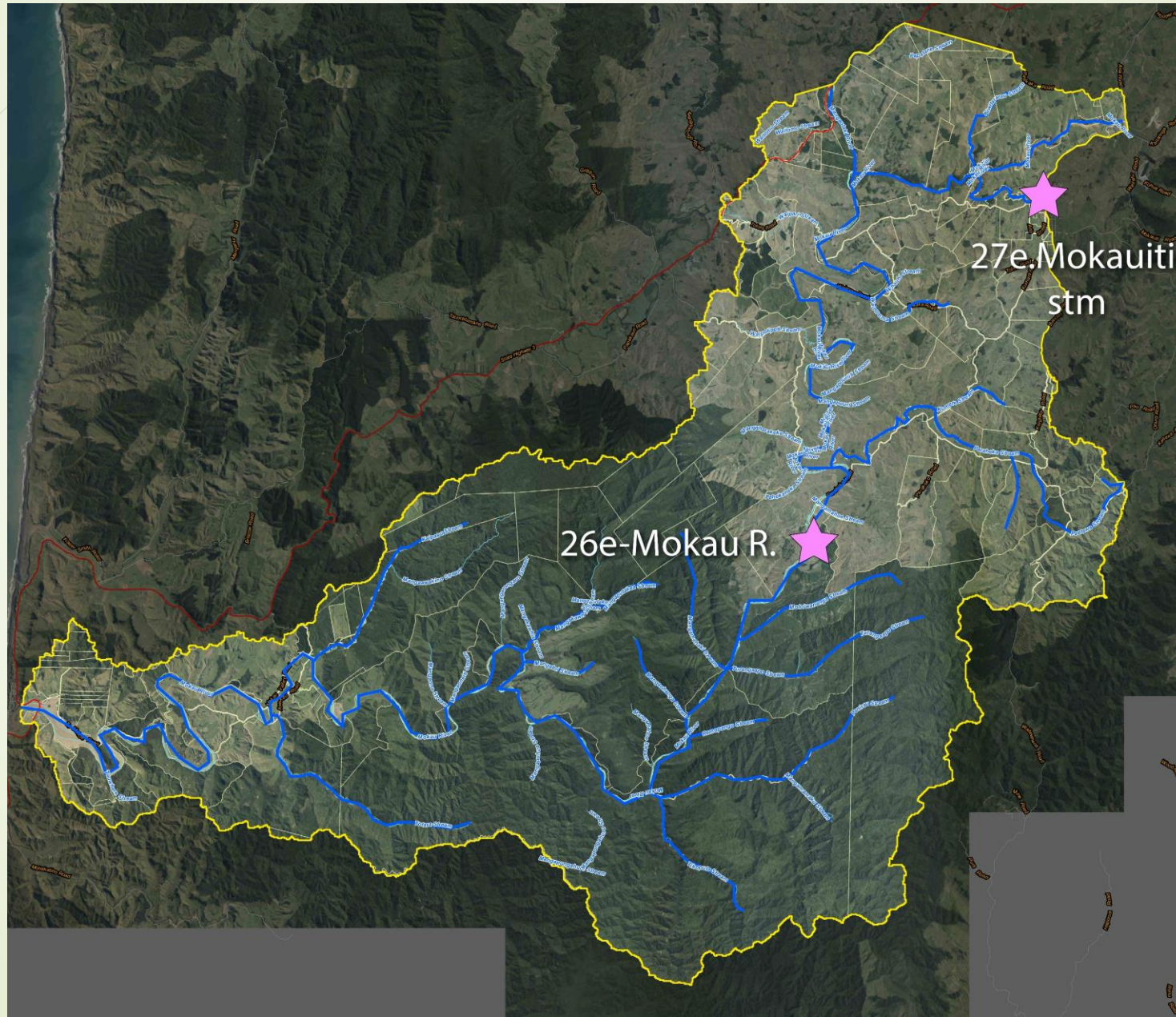


Adaptive
Environmental Consulting

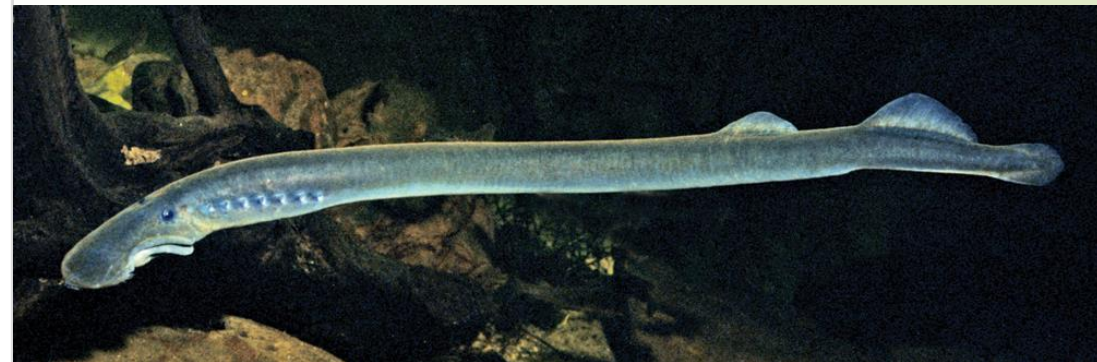
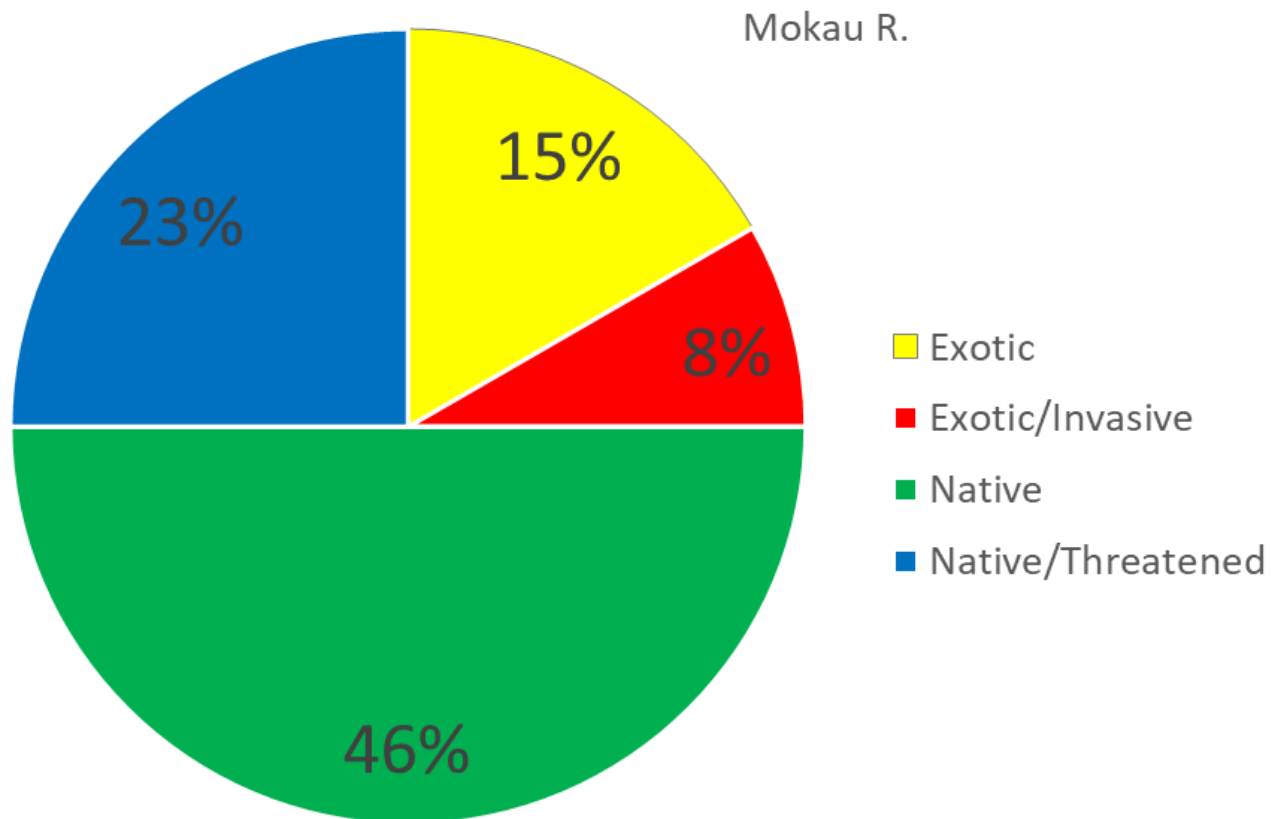


WILDERLAB

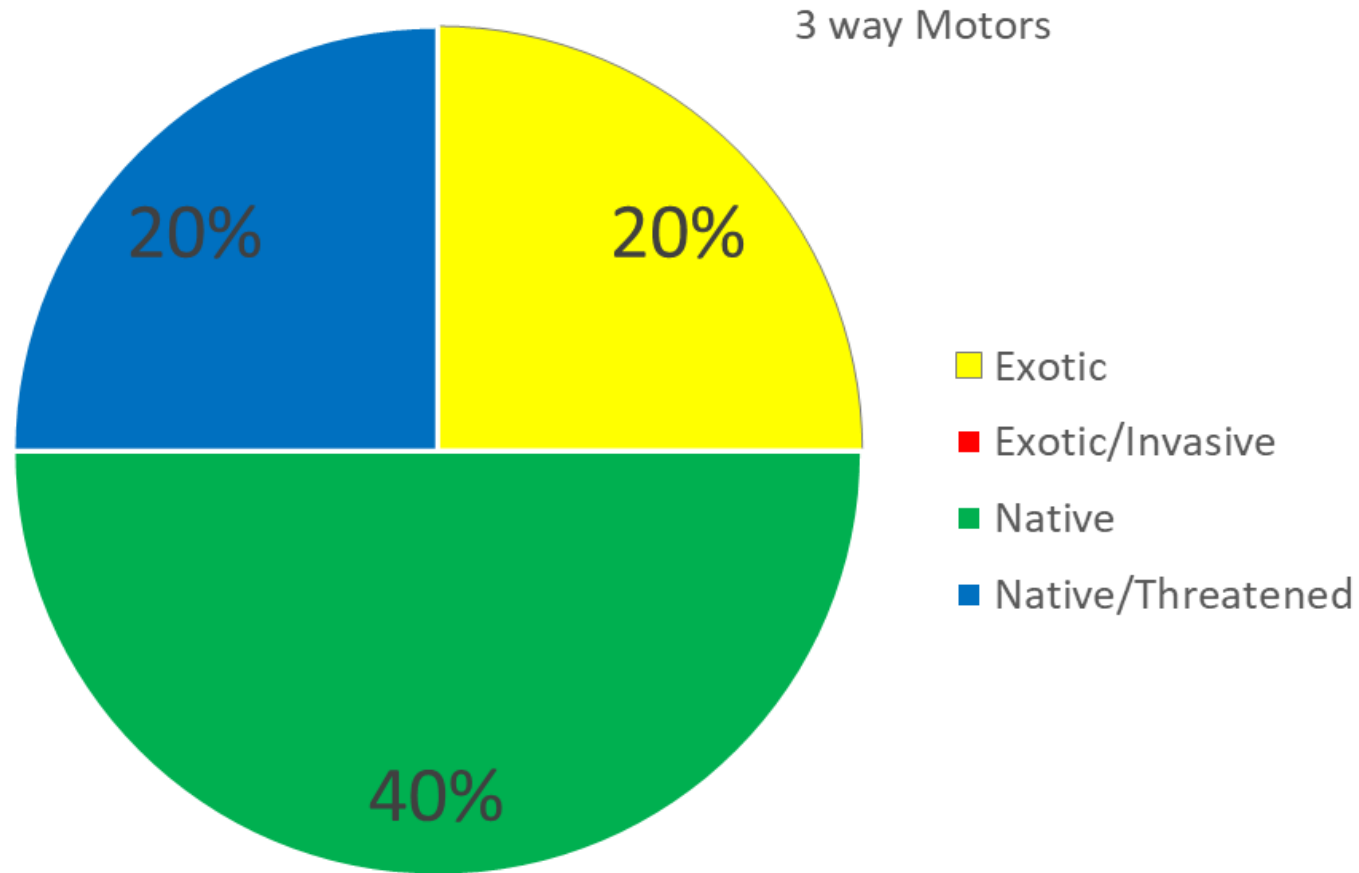
eDNA site Lower Mokau & Mokauiti River

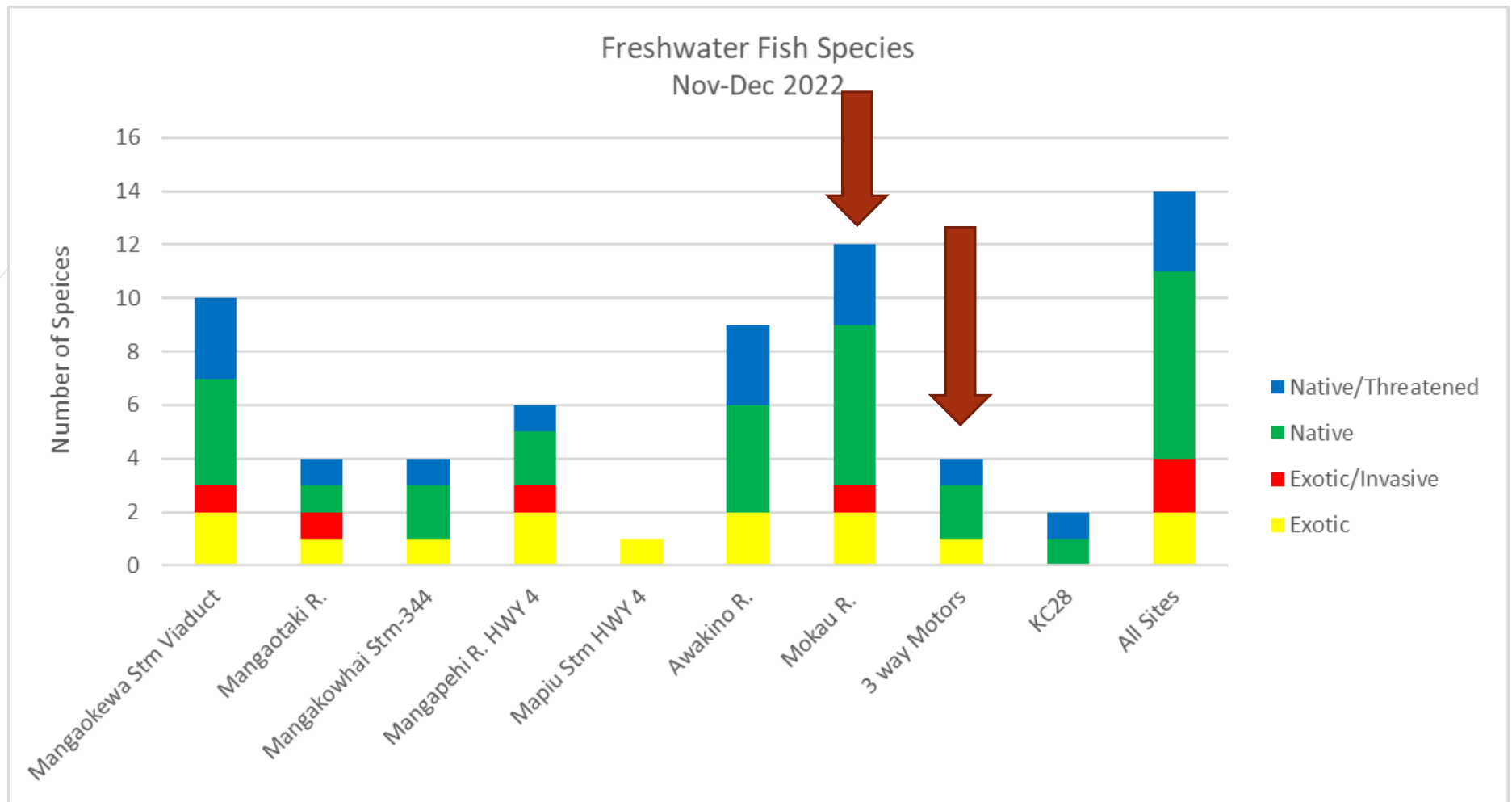


Lower Mokau - Freshwater Fish Species Threat status



Mokauiti Stream - Freshwater Fish Species Threat status





Freshwater Fish Number of species detected and their threat status



Sensitive taxa (values of 8 or more)



Double gill mayfly
(*Tepakia*)

Mayflies

Green stonefly
(*Stenoperla*)

Stoneflies

Spiral cased caddis
(*Helicopsyche*)

Cased caddisflies

Swimming mayfly
(*Nesameletus*)

Mayflies

Stonefly (*Zelandoperla*)

Stoneflies

FACTSHEET

Tolerant taxa (values of 3 or less)



Oligochaete worms
(*Oligochaeta*)

Segmented worms

Snail (*Physa*)

Snails

FACTSHEET

Chironomid midge
(*Chironomus*)

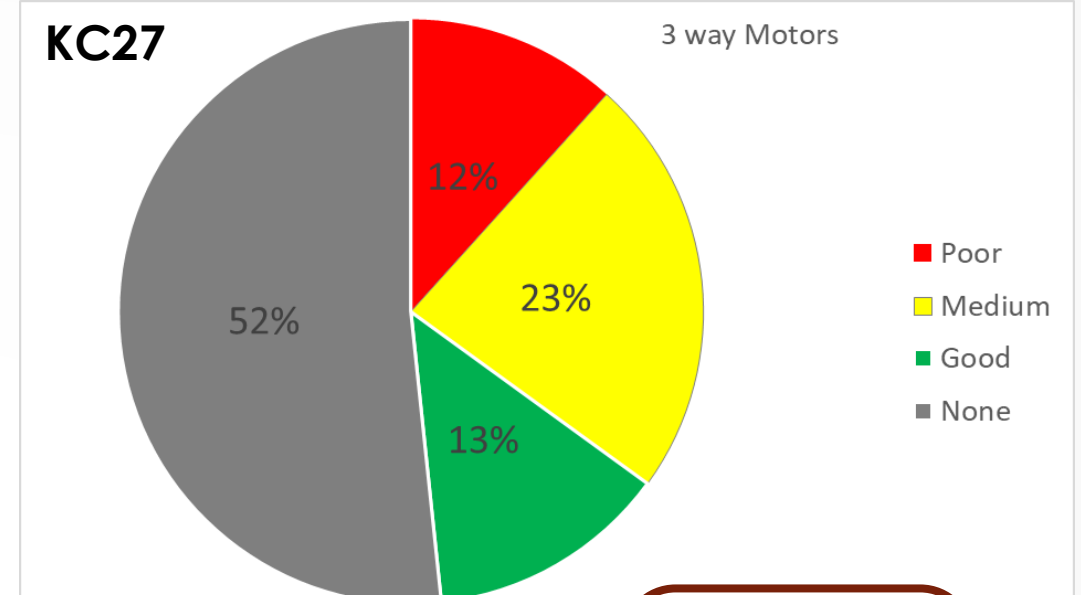
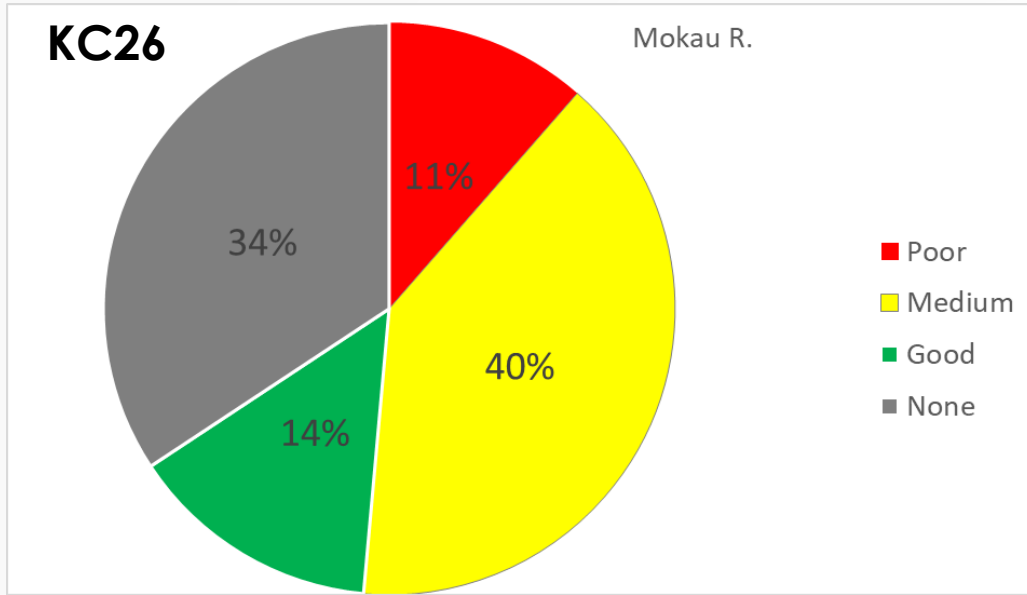
Midges

Rat tail maggots
(*Syrphidae*)

Other true flies

**Macroinvertebrate
Community Index
Scores
(MCI)
1 - 10**

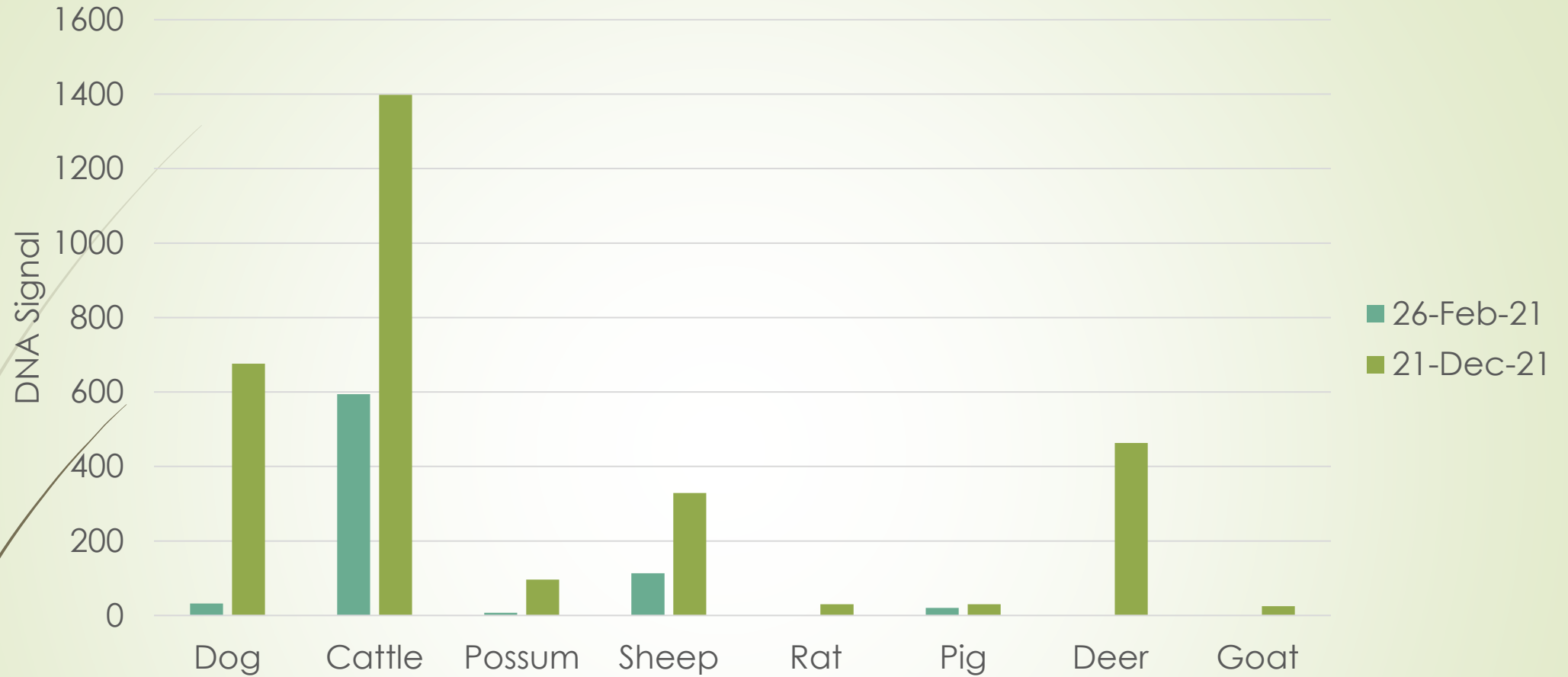
Dec 2021 – All Invertebrates



Sites	KC4	KC11	KC12	KC14	KC20	KC25	KC26	KC27	KC28
	Mangaokewa Stm Viaduct	Mangaotaki R.	Mangakowhai Stm-344	Mangapehi R. HWY 4	Mapiu Stm HWY 4	Awaking R.	Mokau R.	3 way Motors	KC28
MCI Score	119	126	109	112	112	127	105	101	121
National Grade	B	B	C	B	B	B	C	C	B

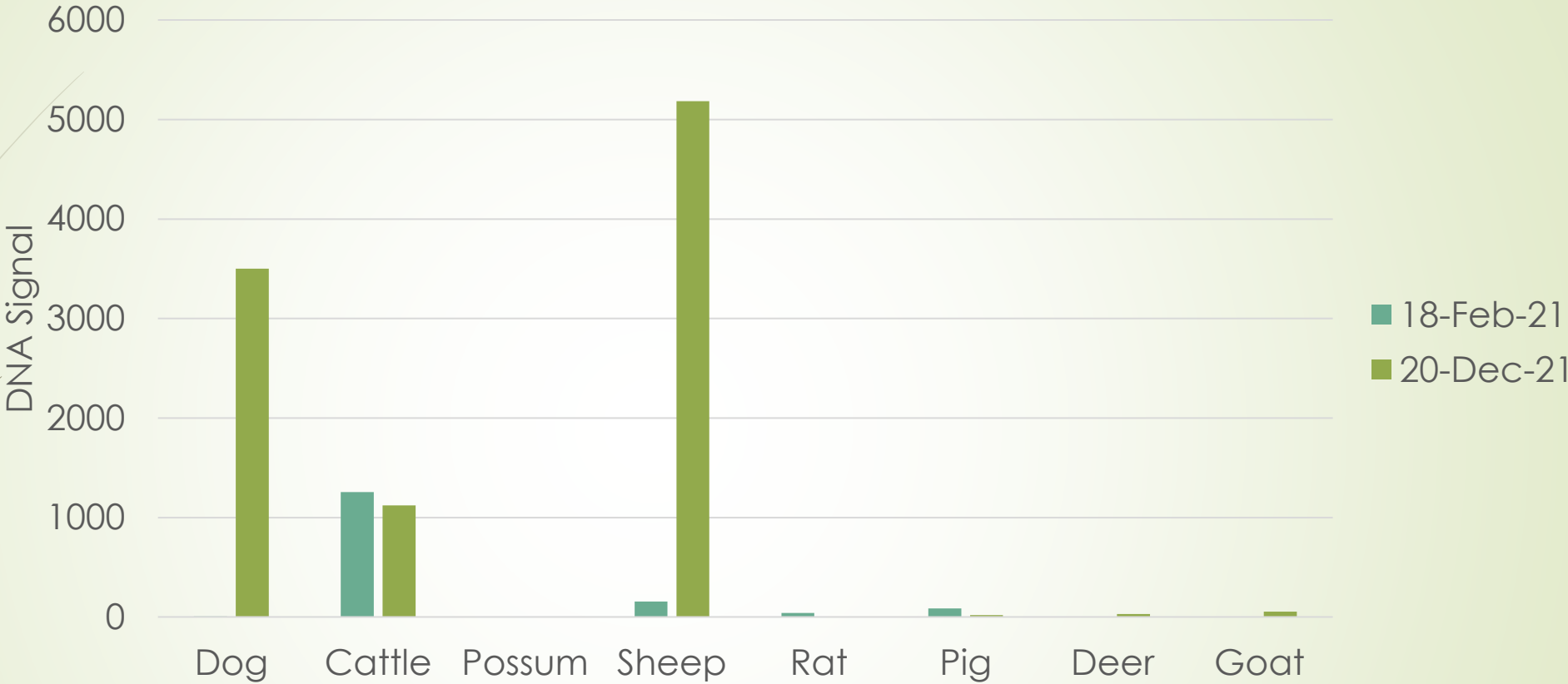
Freshwater Invertebrate Community Health Index (MCI) eDNA Results 2021

Mammals - 26 Mokau River



Mammalian eDNA Signal Strength

Mammals - 27 Mokauiti River



Mammalian eDNA Signal Strength

Summary
Points -
Lower Mokau
& Mokauiti -
Aria

2021 Water Quality

- E. coli and water clarity are the attributes to address

Water Quality Baseline 2015-20

- E.coli and Sediment were elevated in Mokau River

How Farm Management Influences Catchment Health



Management Actions

<https://www.farmmenus.org.nz/drystock-farms/>

Impact	N	P, Sed, E. coli
High	>25%	>50%
Medium	10-25%	20-50%
Low	<10%	<20%

Actions - Drystock Farms	Greatest Potential Reduction/WQ Benefit			
	Sediment	E. coli	N	P
Nutrient Management	20-50%	-	10-25%	>50%
Stock Management	>50%	20-50%	10-25%	>50%
- To improve herd fertility and finishing rate	-	-	10-25%	<20%
- To reduce erosion & soil damage	>50%	20-50%	<10%	>50%
Planting to Reduce Erosion	>50%	20-50%	10-25%	20-50%
Managing Critical Source Areas	>50%	>50%	<10%	>50%
Riparian Management	>50%	>50%	10-25%	>50%
- Sediment Traps	>50%	<20%	<10%	>50%
- Provide deer wallows away from waterways	>50%	>50%	<10%	20-50%
Management of Fodder Crop Areas	>50%	20-50%	>25%	>50%
FEP - Good farmer buy-in	>50%	>50%	>25%	>50%
FEP - Poor buy-in	<20%	<20%	<10%	<20%

Management Actions

<https://www.farmmenus.org.nz/dairy-farms/>

Impact	N	P, Sed, E. coli
High	>25%	>50%
Medium	10-25%	20-50%
Low	<10%	<20%

Actions - Dairy Farms	Greatest Potential Reduction/WQ Benefit			
	Sediment	E. coli	N	P
Nutrient Management	-	-	10-25%	20-50%
Riparian Management	>50%	>50%	10-25%	20-50%
- Sediment Traps	20-50%	<20%	<10%	20-50%
- Constructed wetlands	20-50%	20-50%	10-25%	20-50%
Effluent management	20-50%	>50%	10-25%	>50%
Feed pads - Off Pasture Options	>50%	>50%	>25%	>50%
Good Grazing Management - On Pasture Options	20-50%	20-50%	<10%	20-50%
Managing Critical Source Areas	>50%	>50%	>25%	>50%
Cropping Management	>50%	20-50%	>25%	>50%
FEP - Good farmer buy-in	>50%	>50%	>25%	>50%
FEP - Poor buy-in	<20%	<20%	<10%	<20%

► Reference

Menu

Menu of practices to improve water quality: dairy farms

Menu of practices to improve water quality: drystock farms

Menu of practices to improve water quality: cropping land

These menus provide a range of practices targeting cropping land, dairy and drystock farms to improve nutrient management and reduce impacts on water quality. [About these menus](#)



Healthy Farms
Healthy Rivers
ACTIONS FOR CHANGE



Dairy for life



Headlands
minimise. Surplus. optimise profit.



<https://www.farmmenus.org.nz/>



Click on the arrows on the variables in the header row to reorder the farm practices based on that variable. Use this menu in conjunction with your consultant or your Land Environment Plan.

Management area	On farm practice	N	P	Sed	Pa	Cost	Benefit	Factors to consider
Cropping management	Actively manage grazing of winter crop areas to reduce risk of N leaching, run off, soil loss and compaction	L	M	M	M	\$\$	\$\$\$	Graze from top to bottom of paddock contour. Avoid leaving stock on during wet periods, for long periods, or concentrated on small sections of the crop.
Planting to reduce erosion	Afforestation of steep southern faces (above Land Use Capability 6e)	M	M	M	-	\$\$ - \$\$\$	\$ - \$\$	Protects areas of greatest erosion risk and replaces low growing slopes with long term productive investment. Best suited to areas with large weed burdens and minimal profitability. Profitability depends on forestry regime and market. Any afforestation plan should include a harvest plan to ensure all land is harvestable.

Soil Damage - Pugging



Source: Keith Betteridge, AgResearch



Source: Keith Betteridge, AgResearch

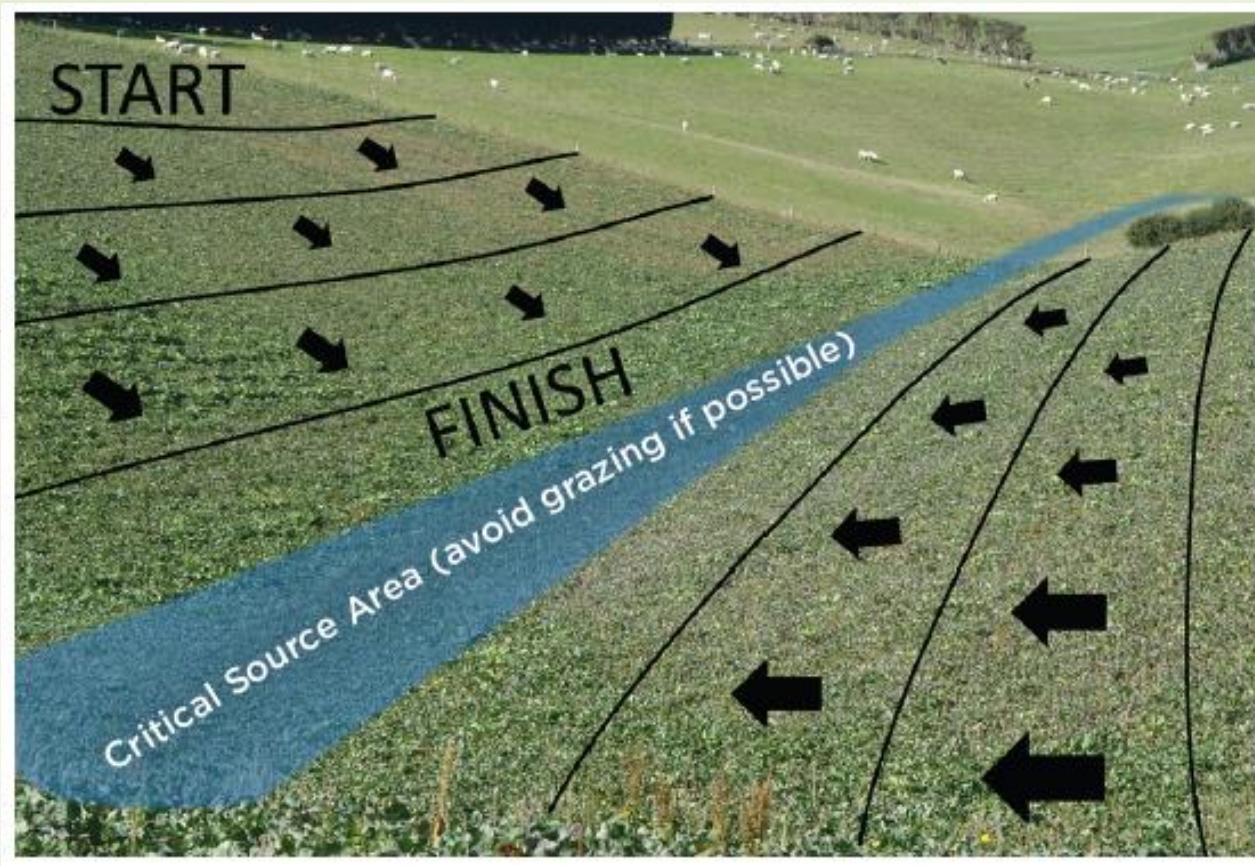
Overgrazing & soil damage

- Reduces spring pasture production by up to 80%
- Can take 3 or more years to recover.

[Click here to find out more about soil erosion processes in New Zealand](#)

[Click here to find out more about soil and pasture management](#)

[Click here to learn about 11 ways to reduce pugging in your pasture](#)

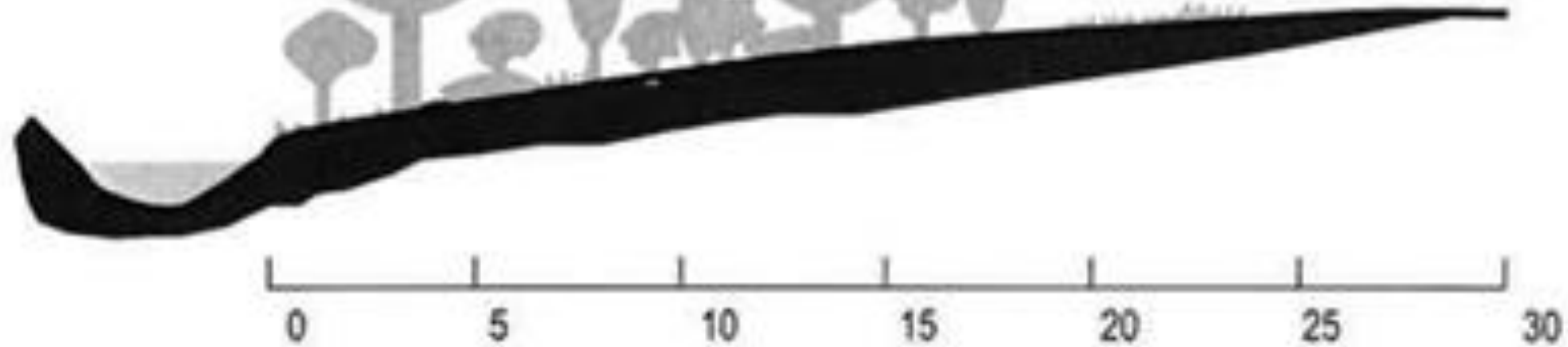


<https://beeflambnz.com/wintergrazing/pre-grazing>

Take action to reduce potential losses of sediment, nutrients and E. coli to waterways during wetter months

Functions of riparian buffers

[Click here to learn more about the role riparian setback distances](#)



Livestock damage

Fish habitat

Bank stability

Flood control

Shade

Leaf input

Filtration

Wood input

Nutrient uptake

Wildlife habitat



Diagram from conference paper by J Quinn (2012)

Riparian management - results from New Zealand

Riparian management schemes assessed, showing measures of water quality and stream health recorded as better (+), worse (-), or no change (=) in the buffer compared to the control reach for each variable.

Site	Time since planting (yr)	Planted length (m)	Average buffer width (m)	Difference in buffer relative to pasture control reach						
				Phosphorus (over 10% change in dissolved P)	Nitrogen (over 10% change in dissolved N)	Faecal inputs (over 10% change in <i>E. coli</i>)	Visual clarity (over 10% change)	Mean temperature (more than 1 deg change)	Stability (change in Pfankuch class)**	Invertebrates (change in QMCI class)***
Raglan	2	200	12.7	+	+	-	=	=	+	=
Matarawa	3	300	3.5	-	=	+	+	=	+	-
Little Waipa	4	660	10.6	+	=	+	+	-	=	=
Waitetuna	6	1600	7.2	=	-	nd	-	=	=	=
Mangawara	8	200	15.5	=	=	=	=	nd	=	+
Tapapakanga	10	2000	11.4	+	+	+	+	-	=	-
Kakahu*	20	3600	21	+	+	nd	+	+	=	+
Waitomo	20	100	18.8	=	=	-	-	=	=	=
Taupo*	24	4200	75	+	-	nd	+	+	+	+

[Click here to view source publication](#)

What can we do to improve catchment health?

- Retire & plant marginal land
- Exclude stock from streams, wetlands & boggy areas
- Plant retired riparian margins
- Manage nutrients & effluent conservatively
- Identify and address CSAs





Thank You

