Tākou Awa

Water quality 2019-2020

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Contents

1 Introduction

Tākou Bay is a māhinga mātaitai site of cultural importance to Ngāti Rēhia and the final resting place for the Mātaatua waka. Ngāti Rēhia approached Northland Regional Council (Council) about the possibility of working together to better understand the health of the Tākou Estuary and the River. Subsequently kaitiaki from Ngāti Rēhia collected water samples each month for one year from an estuary site and a river site.

Catchment

The Tākou Estuary is a small tidal lagoon estuary on the east coast of the Northland Peninsula. It receives freshwater flow from the Tākou River, which drains a catchment of approximately 73 km^2. Analysis of land use in the catchment, based on New Zealand Land Cover Database LCDB v5.0 (New Zealand Land Cover Database 2020), indicated that 67% of the catchment was covered by high producing exotic grassland and that native forest and regenerating manuka kanuka scrub covered a further 20%, and exotic forest 8% of the catchment (Figure 1 & Table 1).

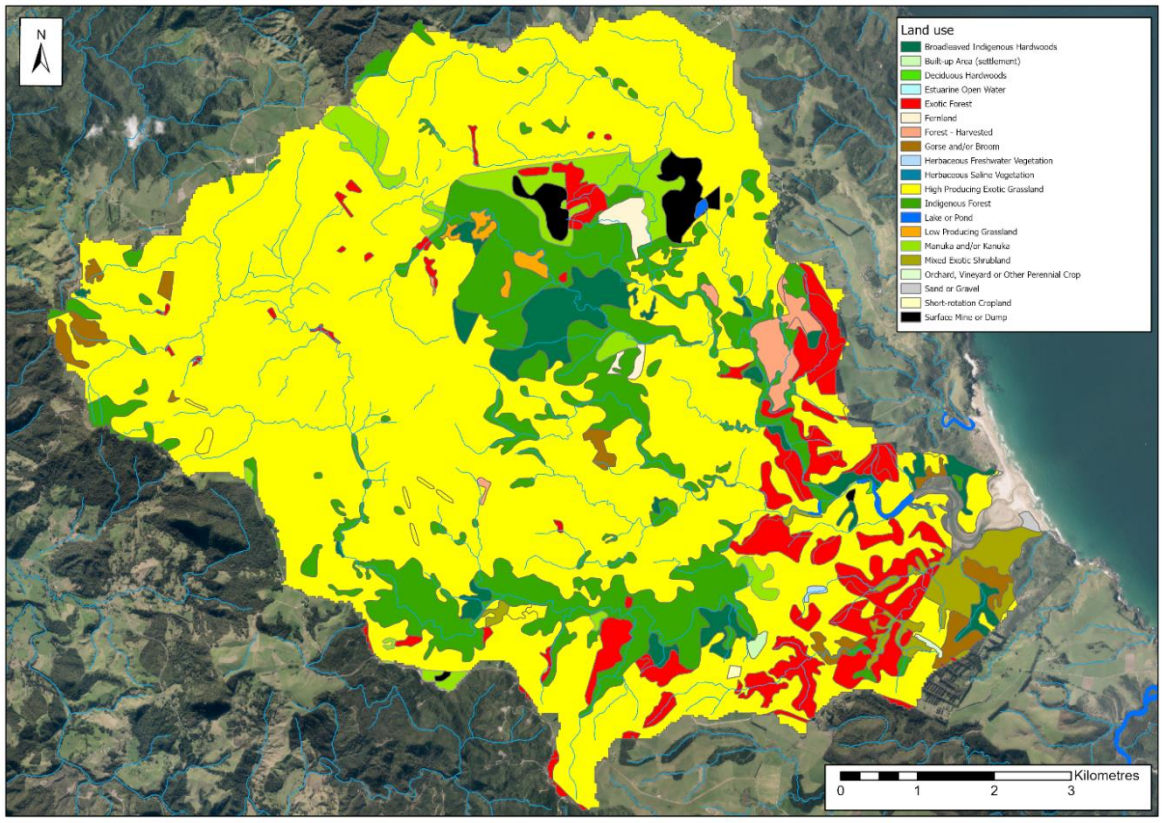

Figure 1. Distribution of major land use classes in the Tākou River catchment, from the New Zealand Land Cover Database v5.0 (2020).

Table 1. Land cover in the Tākou Estuary catchment, from the New Zealand Land Cover Database v5.0 (2020).

Land Use	Area (hectare)	Percentage
High producing exotic grassland	4890.4	66.9
Indigenous forest	1039	14.2
Exotic forest	503.4	6.9
Broadleaved indigenous hardwoods	240.8	3.3
Manuka and/or kanuka	201.0	2.8
Mixed exotic shrubland	117.2	1.6
Gorse and/or broom	99.6	1.4
Surface mine or dump	76.3	1.0
Forest - harvested	62.8	0.9
Fernland	31.9	0.4
Low producing grassland	23.3	0.3
Built-up area (settlement)	5.3	0.1
Sand or gravel	4.9	0.1
Herbaceous freshwater vegetation	3.0	0
Orchard, vineyard or other perennial crop	2.7	0
Lake or pond	2.5	0
Short-rotation cropland	2.4	0
Deciduous hardwoods	1.8	0
Herbaceous saline vegetation	0.1	0
Total	**7308.4**	

2 Methods

Sampling

Water samples were collected each month, for one year between May 2019 and May 2020. Samples were not collected in April 2020 due to COVID-19 restrictions. Samples were collected by Kaitiaki from Ngāti Rēhia following an initial site visit and training session with Council staff.

Water samples were collected from the top 0.5m depth of the water column, using a gripper pole and appropriate sample bottles. The labelled samples were stored in a chilly bin packed with ice and couriered to Watercare Laboratory for analysis.

Samples were analysed for a suite of 15 parameters which included indicators of nutrient enrichment, water clarity and microbial contamination bacteria (Table 2).

Water Clarity

Water clarity is important for the healthy functioning of marine ecosystems. Increased suspended solid loads that reduce water clarity can affect the amount of photosynthesis (primary production) of aquatic plants. Reduced water clarity can also affect the feeding efficiency of visual predators like fish and sea birds and sediment particles can clog the feeding structures and gills of fish and suspension feeding animals like huangi (cockles) and kōkota (pipi). Water clarity is also an important attribute for recreation and aesthetic values. Poor water clarity makes the water less desirable for swimming and recreational activities.

Nutrients and chlorophyll-*a*

While nutrients are essential for all forms of life, nutrients that enter the environment from human sources, such as fertiliser, stormwater, treated wastewater, sewage overflows and failing septic systems, may exceed the needs of an ecosystem. Elevated nutrients in the water can cause excessive plant growth leading to algal blooms, which in turn can cause lowered levels of dissolved oxygen and water clarity. This can reduce the life-supporting capacity of the water and pose a significant human health risk through contact with toxic algal blooms and eating contaminated shellfish. Excessive plant growth can also look unattractive and can cause an unpleasant odour when it dies and decays.

Microbial contamination

Microbial indicator organisms such as enterococci and faecal coliforms are used to measure the faecal contamination of the water and therefore its suitability for recreational activities and shellfish consumption.

Rainfall

Rainfall data was obtained from Council's rainfall gauge at Towai, to help with the analysis and interpretation of the results. The rainfall over the preceding 24 hours, 48 hours and 30 day period prior to the sampling was calculated. Rainfall can cause runoff of sediment, nutrients and faecal contaminants from the land, affecting river and coastal water quality.

Table 2. Water quality parameters.

Parameter	Tākou River	Tākou Estuary
Temperature (°C)	✓	✓
Conductivity (mS/m @25 deg °C)	✓	N/A
Salinity	N/A	✓
Total suspended solids (mg/L)	✓	✓
Turbidity (FNU)	✓	✓
Chlorophyll-*a* (mg/L)	N/A	✓
Total nitrogen (mg/L)	✓	✓
Ammoniacal nitrogen (mg/L)	✓	✓
Nitrite-nitrate nitrogen (mg/L)	✓	✓
Dissolved inorganic nitrogen (mg/L)	✓	N/A
Total phosphorus (mg/L)	✓	✓
Dissolved reactive phosphorus (mg/L)	✓	✓
Enterococci (CFU/100mL)	N/A	✓
Faecal coliforms (CFU/100mL)	✓	✓
Escherichia coli (MPN/100mL)	✓	N/A

Study sites

Tākou Estuary

The Tākou Estuary site is located on the southern bank of the estuary just before the channel widens into a wider estuarine lagoon (Figure 2 and 3).

Tākou River

The Tākou River flows eastwards from its source southeast of Kāeo to reach the Pacific Ocean at Tākou Bay, flowing through predominantly pasture but also pine forest and patches of native bush. The Tākou River site is located approximately 2.6 km upstream from the Tākou Estuary site (Figure 2, 4 and 5).

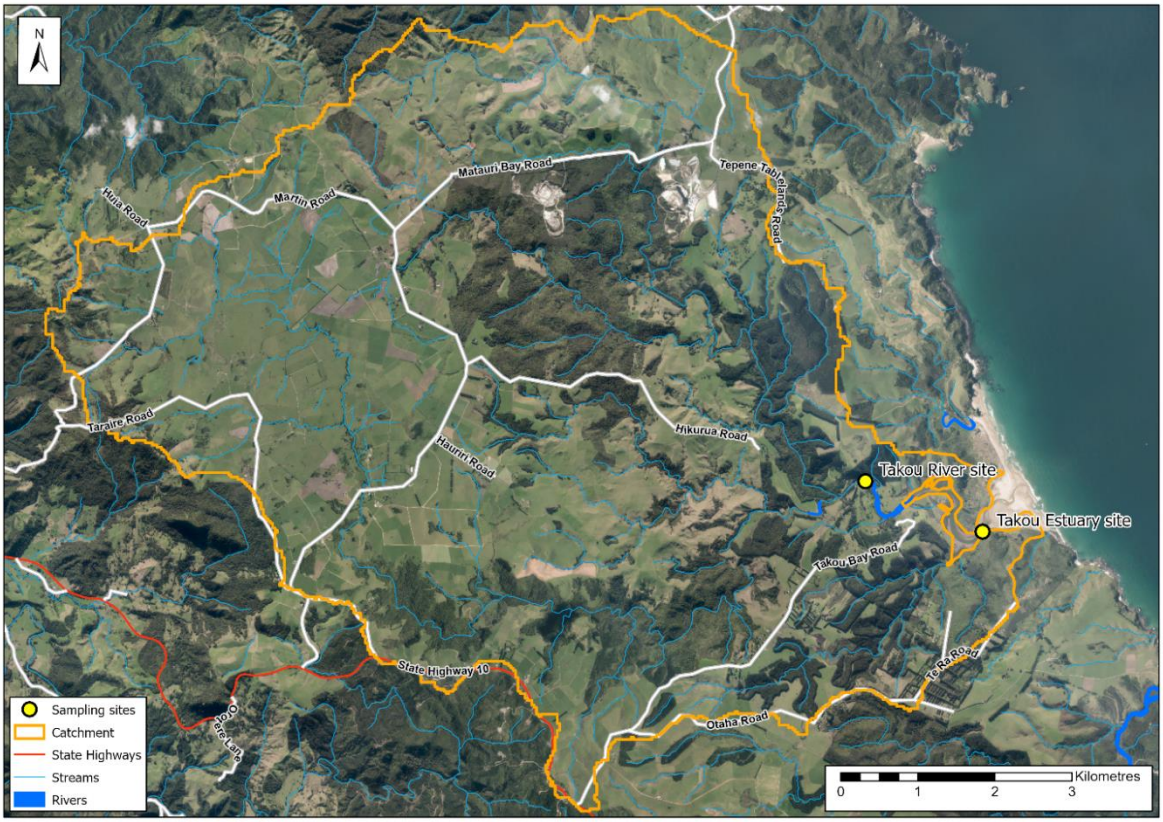

Figure 2. Sampling sites.

Figure 3. Photograph of Tākou Estuary sampling site.

Figure 4. Photograph of Tākou River sampling site.

Figure 5. Photograph of Tākou River immediately upstream of the sampling site.

Data Analysis

The annual maximum, minimum, 95th percentile and median values were calculated for each parameter at both sites. In addition, the 90th percentile was calculated for faecal coliforms. All exceedances above 540 MPN/100mL and 260 MPN/100mL for *E. coli* were calculated. All the data is presented in appendix 1.

Water Quality Standards

Results were assessed against the relevant standards for each parameter at the two sites.

Coastal

In the Proposed Regional Plan for Northland (Northland Regional Council 2018), the coastal marine environment has been classified into four management units: open coast, estuaries, tidal creeks and the Hātea River. This is an acknowledgement that water quality varies significantly in these different zones and there are different resource uses and values in the different zones (Griffiths 2016). For example, tidal creeks are the immediate receiving environment for streams and rivers so concentrations of contaminants, such as nutrients and micro-bacteria will be higher and more variable than estuarine and open coast environments. Consequently, there are different water quality standards for each of the management zones. The Tākou Estuary site is located in the 'tidal creek' management zone so the results from this study have been assessed against the standards for the tidal creek management zone (Table 3).

In the tidal creek management zone, there is no standard for shellfish consumption, as tidal creeks do not typically support harvestable shellfish beds. As there are shellfish beds located closer to the entrance of the estuary, results from this study have been assessed against the standards for shellfish consumption. However, it should be noted that water quality is likely to be better closer to the entrance of the estuary as there will be more flushing and exchange with oceanic water. The Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (Ministry for the Environment 2003) set the following guideline for recreational shellfish-gathering: "*Median faecal coliform content of samples taken over a shellfish gathering seasons shall not exceed a most probable number (MPN) of 14 per 100mL and not more than 10% of samples should exceed an MPN of 43 per 100mL*".

Freshwater

Results were assessed against the 'National bottom line' in the National Policy Statement for Freshwater Management 2020 (NPSFM 2020) (Ministry for the Environment 2020). However, there are no standards for turbidity and dissolved inorganic nitrogen (DIN) in the NPSFM 2020. Therefore, the turbidity and DIN results have been assessed against the draft National Policy Statement for Freshwater Management 2019 (NPSFM 2019) (Ministry for the Environment 2019) (Table 4).

Table 3. Relevant coastal water quality standards.

Values	Water Quality Parameter	Compliance metric	Tidal creek
Ecosystem Health - Water clarity	Turbidity (NTU)	Annual median	<10.8
	Chlorophyll-*a* (mg/L)	Annual median	<0.004
	Total nitrogen (mg/L)	Annual median	<0.600
	Total phosphorus (mg/L)	Annual median	<0.040
	Dissolved reactive phosphorus (mg/L)	Annual median	<0.021
Recreation	Enterococci (CFU per 100mL)	Annual 95th percentile	≤200
Shellfish consumption	Faecal coliforms (CFU per 100mL)	Annual median	Not applicable
	Faecal coliforms (CFU per 100mL)	Annual 90th percentile	Not applicable

Table 4. Relevant freshwater quality standards.

Values/Attribute	Water Quality Parameter	Compliance metric	Standard
Ecosystem Health	Ammonia toxicity (mg/L)	Annual median	≤0.24
		Annual maximum	≤0.4
	Nitrate (toxicity) (mg/L)	Annual median	≤2.4
		Annual 95th Percentile	≤3.5
	Dissolved inorganic nitrogen (mg/L)	Annual median	≤1
		Annual 95th Percentile	≤2.05
	Dissolved reactive phosphorous (mg/L)	Annual median	≤0.018
		Annual 95th Percentile	≤0.054
Water clarity	Turbidity (FNU)	Annual median	<3.2
Human contact	*Escherichia coli* (MPN/100 mL)	Annual median	≤130
		Annual 95th Percentile	<1200
		Exceedances over 540/100mL	<20%
		Exceedances over 260/100mL	<34%

3 Results – Tākou Estuary site

Water clarity

Results indicate that water clarity at the site was good at all times during the study (Table 5). The median turbidity (4.45 FNU) was below the coastal water quality standard and even the highest turbidity value recorded (10.7 FNU) was still below the standard (Table 5). The highest result was recorded during the September sampling event at low tide after rain (36mm in 48 hours). Although there are currently no standards for total suspended solids a median value of 5.0 g/m^3 is low compared to other coastal monitoring sites in Northland (NRC unpublished data).

Table 5. Turbidity data collected from Tākou Estuary 2019/2020.

	Min	Max	Median	Standard (median)	Standard achieved
Total suspended solids (mg/L)	2	12	5.0	No Standard	N/A
Turbidity (FNU)	0.86	10.7	4.45	<10.8	✓

Nutrients and chlorophyll-*a*

Concentrations of total nitrogen, nitrate-nitrite nitrogen, ammoniacal nitrogen, total phosphorus and dissolved reactive phosphorus are direct measures of nutrient concentrations which may be responsible for over-enrichment, while chlorophyll-*a* is a response indicator of nutrient enrichment. Results indicate that nutrient concentrations were below the relevant coastal water quality standards (Table 6). The highest results were recorded in September 2019 at low tide after a rain event (36mm of rain was recorded at Towai in the preceding 48 hours).

Table 6. Nutrient and chlorophyll-*a* data collected from Tākou Estuary 2019/2020.

	Min	Max	Median	Standard (median)	Standard achieved
Chlorophyll-*a* (mg/L)	0.0003	0.0017	0.0013	<0.004	✓
Total nitrogen (mg/L)	0.100	0.750	0.175	<0.600	✓
Ammoniacal nitrogen (mg/L)	0.020	0.083	0.0425	<0.043	✓
Nitrate-nitrite nitrogen (mg/L)	<0.02	0.42	0.042	<0.218	✓
Total phosphorus (mg/L)	0.010	0.062	0.016	<0.040	✓
Dissolved reactive phosphorus (mg/L)	0.008	0.03	0.011	<0.021	✓

Microbial contamination

The Ministry for the Environment's Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (Ministry for the Environment 2003) recommends that enterococci be used as the faecal indicator bacteria in marine waters. The 95th percentile of data collected in this study (1990 enterococci/100mL) indicates that the water is not suitable for contact recreation (Table 7). Most results were below 200 enterococci/100mL but two elevated results were recorded in September 2019 (590 enterococci/100mL) and March 2020 (3700 enterococci/100mL). Both these elevated results were recorded after rain events. In September 2019, 36mm had fallen in the preceding 48 hours and in March 2020, 39mm had fallen.

Table 7. Enterococci data collected from Tākou Estuary 2019/2020.

	Min	Max	Median	95th percentile	Standard achieved
Enterococci (CFU/100mL)	0.8	3700	18	1990	✗

Faecal coliforms are used as an indicator of the suitability of coastal water for shellfish consumption. The median and the 90th percentile of data collected in this study both indicate that the water is not suitable for shellfish consumption (Table 8). Again, most samples were below 43 CFU/100mL but two high results recorded in September 2019 (2600 CFU/100mL) and March 2020 (2900 CFU/100mL), following rain events, were well above the standard. However, it should be noted that the shellfish beds in Tākou Estuary are located closer to the entrance of the estuary, where water quality is likely to be better as there will be more flushing and exchange with oceanic water.

Table 8. Faecal coliform data collected from Tākou Estuary 2019/2020.

	Min	Max	Median	90th percentile	Standard achieved
Faecal coliforms (CFU/100mL)	11	2900	44	2352	✗

4 Results – Tākou River site

Water clarity

Results indicate that water clarity at the site was good for most of the time during the study (Table 9). The median turbidity (2.57 FNU) was within attribute C band, when assessed against the draft NPSFM 2019. C band indicates that there is "*moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost"* (draft NPSFM 2019). The highest turbidity result (10.1 FNU) was recorded during September 2019 after 36mm of rain had fallen in the preceding 48 hours.

Table 9. Turbidity data collected from Tākou River in 2019/2020.

	Min	Max	Median	Standard (median)	Standard achieved
Total suspended solids (mg/L)	0.71	5.6	1.6	N/A	N/A
Turbidity (mg/L)	0.77	10.1	2.57	3.2	✓

Ammonia and nitrate toxicity

The site is within the A band of the NPSFM 2020 for nitrate toxicity (the annual median is ≤1.0 mg/L and the annual 95th percentile is ≤1.5mg/L) (Table 10). For ammonia toxicity the median value is within the A band (≤0.03 mg/L) but the annual maximum is within the B band (>0.05 and ≤0.40). In band A, there are unlikely to be effects even on sensitive species. In band B, concentrations start impacting occasionally on the 5% most sensitive species (NPSFM 2020). The highest results (ammonia 0.11 mg/L and nitrate 0.59 mg/L) were recorded in September 2019 after a rainfall event of 36mm in the preceding 48 hours.

Table 10. Ammonia and nitrate data collected from Tākou River in 2019/2020.

	Median	Standard	Standard achieved
Ammonia (toxicity) (mg/L)	0.0185	≤0.24	✓
	Maximum	**Standard**	
	0.11	≤0.4	✓
	Median	**Standard**	
Nitrate (toxicity) (mg/L)	0.295	≤1.0	✓
	95th Percentile	**Standard**	
	0.56	≤1.5	✓

Nutrients

At the river site, results for dissolved inorganic nitrogen indicated that the site was within band B, when assessed against the draft NPSFM 2019. In band B "*Ecological communities are slightly impacted by minor DIN elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates.*"

The median and 95th percentile for dissolved reactive phosphorus indicates that the site was within band C (Table 11), when assessed against the draft NPSFM 2019. In band C "*Ecological communities are impacted by moderate DRP elevation above natural reference conditions. If other conditions also favour eutrophication, DRP enrichment may cause increased algal and plant growth, loss of sensitive macro-invertebrate and fish taxa, and high rates of respiration and decay*."

Table 11. Nutrient data collected from Tākou River in 2019/2020.

	Median	Standard	Standard achieved
Dissolved reactive phosphorous (mg/L)	0.014	≤0.018	✓
	95th Percentile	**Standard**	
	0.030	≤0.054	✓
	Median	**Standard**	
Dissolved inorganic nitrogen (mg/L)	0.304	≤1	✓
	95th Percentile	**Standard**	
	0.619	≤2.05	✓
	Median	**Standard**	
Total nitrogen (mg/L)	0.52	N/A	N/A
	95th Percentile	**Standard**	
	1.02	N/A	N/A
	Median	**Standard**	
Total phosphorous (mg/L)	0.31	N/A	N/A
	95th Percentile	**Standard**	
	0.06	N/A	N/A

Microbial contamination

The 95th percentile for *E. coli* and the number of exceedances over 540/100mL both indicate that the river was not suitable for contact recreation with four results out of 12 samples (i.e. >30% of the times) exceeding 540 MPN/100mL (Table 12). Under the NPSFM 2020, the results place the site into band E. In band E more than 30% of the time the risk is greater or equal to 50 in 1,000 (>5% risk) and the predicted average infection risk is greater than 7%. The predicted average infection risk is the overall average infection to swimmers based on a random day. However, the actual risk will generally be less if a person does not swim following rain events. The two highest results were recorded in September 2019 (2000 CFU/100mL) and March 2020 (3100 CFU/100mL), both after rain events.

Table 12. *E. coli* data collected from Tākou River 2019/2020.

	Median	Standard	Standard achieved
E. coli (MPN/100mL)	130	≤130	✓
	95th Percentile	**Standard**	
	2495	≤1200	✗
	% exceedances over 540/100 mL	**Standard**	
	33%	<20%	✗
	% exceedances over 260/100 mL	**Standard**	
	33%	<34	✓

5 Summary

- The Tākou Estuary catchment is dominated by exotic grassland, with smaller areas of native forest and some plantation forestry.
- At the coastal site, results indicated that the water was suitable for ecosystem health. The median turbidity, chlorophyll-*a* and nutrient concentrations were below the coastal water quality standards in the Proposed Regional Plan for Northland.
- At the coastal site, micro-bacteria results indicated that the site was not suitable for contact recreation or shellfish consumption. However, the elevated results were all recorded after rain events.
- At the river site, results indicated that water clarity was fair. The median turbidity was within attribute C band under the draft NPSFM 2019. C band indicates that there is "*moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost".*
- At the river site, the median concentrations of ammonia and nitrate were below the freshwater quality standards in the NPSFM 2020 for ammonia and nitrate toxicity.
- At the river site, results for dissolved inorganic nitrogen indicated that the site was within band B, when assessed against the draft NPSFM 2019. In band B, ecological communities are slightly impacted.
- Results for dissolved reactive phosphorus (DRP) indicated that the site was within band C. In band C, ecological communities are impacted by moderate DRP elevation above natural reference conditions. DRP enrichment may cause nuisance algal and aquatic plant growth and loss of sensitive invertebrate and fish species.
- At the river site, *E. coli* results indicated that the site was not suitable for contact recreation. The results placed the site into band E, under the NPSFM 2020. In band E more than 30% of the time the risk is greater or equal to 50 in 1,000 (>5% risk). The predicted average infection risk is less than 7%. Predicted average infection risk is the overall average infection to swimmers based on a random day. However, the actual risk will generally be less if a person does not swim following rain events.
- At both sites, the highest concentrations for turbidity, nutrients and micro bacteria were recorded after rainfall events in September 2019 and March 2020.

6 References

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7 Acknowledgements

Thanks to Anna and Ian Sizer for their support of the project and for providing access across their property to the Tākou River sampling site.

Appendix 1

Water quality data collected at Tākou Estuary.

	Rainfall (previous 48 hours)	Turbidity (FNU)	Chlorophyll-*a* mg/L	Ammoniacal Nitrogen mg/L	Nitrate-nitrite Nitrogen mg/L	Total Nitrogen mg/L	Total Phosphorus mg/L	DRP mg/L	Enterococci CFU/100mL	Faecal Coliforms (CFU/100mL)
2/05/2019	0.5	1.14	0.0017	0.036	<0.02	0.12	0.023	0.009	11	18
6/06/2019	12.5	0.86	0.0017	0.024	0.055	0.14	0.015	0.011	34	46
2/07/2019	12.5	1.13	0.0014	0.036	0.05	0.17	0.01	0.011	42	44
8/08/2019	3.5	1.56	0.00068	0.047	0.12	0.23	0.012	0.013	3.3	18
5/09/2019	36	10.7	0.00098	0.078	0.42	0.75	0.062	0.03	590	2600
3/10/2019	3.5	1.26	<0.0006	0.028	0.11	0.23	0.02	0.018	0.8	11
7/11/2019	0	2.69	0.0017	0.049	0.06	0.34	0.018	0.01	20	78
5/12/2019	2	2.26	0.0014	0.04	0.0072	0.18	0.015	0.01	16	44
9/01/2020	0	4.38	0.0011	0.02	0.012	0.13	0.016	0.008	15	44
4/02/2020	0	1.33	0.0014	0.083	0.0021	0.1	0.021	0.011	13	120
5/03/2020	39	1.72	0.00098	0.05	0.0081	0.18	0.016	0.008	3700	2900
21/05/2020	0	1.34	0.00088	0.045	0.033	0.1	0.016	0.01	30	27
Min		0.86	0.0003	0.02	<0.02	0.1	0.01	0.008	0.8	11
Max		10.7	0.0017	0.083	0.42	0.75	0.062	0.03	3700	2900
Median		1.45	0.00125	0.0425	0.0415	0.175	0.016	0.0105	18	44
90th percentile		4.211	0.0017	0.0752	0.119	0.329	0.0228	0.0175	535	2352
95th percentile		7.224	0.0017	0.08025	0.255	0.5245	0.04055	0.0234	1990	2735
Standard (median)		<10.8	<0.004	0.043	<0.218	<0.6	<0.04	0.021	<200 (95th %)	14
Compliance		✓	✓	✓	✓	✓	✓	✗	✓	✗

Water quality data collected at Tākou River.

	Rainfall (previous 48 hours)	Turbidity (FNU)	Total suspended solids mg/L	DIN mg/L	Ammoniacal Nitrogen mg/L	Nitrate-nitrite Nitrogen	Total Nitrogen mg/L	Total Phosphorus mg/L	DRP mg/L	*E. coli* MPN/100mL
2/05/2019	0.5	0.77	0.71	0.101	0.021	0.08	0.26	0.034	0.013	68
6/06/2019	12.5	2.75	3.1	0.268	0.008	0.26	0.53	0.034	0.015	770
2/07/2019	12.5	1.88	1.6	0.485	0.015	0.47	0.64	0.028	0.015	180
8/08/2019	3.5	2.06	1.2	0.510	0.010	0.50	0.67	0.028	0.016	120
5/09/2019	36	10.1	5.6	0.700	0.110	0.59	1.10	0.096	0.048	2000
3/10/2019	3.5	1.77	<0.67	0.381	0.021	0.36	0.55	0.030	0.014	140
7/11/2019	0	2.45	1.4	0.339	0.009	0.33	0.50	0.025	0.014	120
5/12/2019	2	5.6	1	0.142	0.022	0.12	0.51	0.032	0.015	51
9/01/2020	0	3.35	1.2	0.035	0.016	0.02	0.19	0.021	0.011	71
4/02/2020	0	0.92	1.6	0.054	0.039	0.02	0.25	0.024	0.010	61
5/03/2020	39	2.69	2.6	0.057	0.027	0.03	0.31	0.032	0.013	3100
21/05/2020	0	2.96	2.4	0.553	0.013	0.54	0.95	0.032	0.013	700
Min		0.77	0.71	0.035	0.008	0.02	0.19	0.021	0.010	51
Max		10.10	5.6	0.700	0.110	0.59	1.10	0.096	0.048	3100
Median		2.57	1.6	0.304	0.019	0.30	0.52	0.031	0.014	130
95th percentile		7.63	4.35	0.619	0.071	0.56	1.02	0.062	0.030	2495
Standard (median)		<3.2	n/a	≤1.0	≤0.24	≤1.0	n/a	n/a	≤0.018	≤130
Standard (95thile)		n/a	n/a	≤2.05	≤0.4	≤1.5	n/a	n/a	≤0.054	≤ 1200
Compliance		✓	n/a	✓	✓	✓	n/a	n/a	✓	✗
Band		Band C	n/a	Band B	Band B	Band A	n/a	n/a	Band C	E

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