Technical Memorandum
Draft Baseline State for Periphyton in Taranaki Rivers

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Purpose

The purpose of this memo is to provide an assessment of the baseline state of periphyton, as required by the National Policy Statement for Freshwater Management 2020 (NPS-FM). The memo also addresses nutrient criteria to support the achievement of periphyton outcomes.

Overview of periphyton

Periphyton is the 'slime' and algae found on the beds of lakes and rivers. The periphyton community is composed predominantly of algae and cyanobacteria (blue-green algae) but also contains heterotrophic bacteria and fungi. Periphyton is a component of a healthy ecosystem and forms the base of the food web. However, under certain conditions excessive growth of periphyton can occur, forming a nuisance bloom. Such blooms may have negative impacts on ecosystem health and water quality as well as on a range of values including aesthetics, contact recreation, fishing, irrigation, industrial uses and potable water supply.

There are a number of factors that have the potential to influence periphyton growth. At the larger scale, factors include the catchment geology and climate. Whereas at a reach scale, factors such as stream flow, light, nutrients, water temperature, substrate composition and grazer density influence periphyton growth.

Periphyton is measured by the concentration of chlorophyll-*a* per square metre (a pigment that plants use for photosynthesis). Periphyton is also measured visually so that it can be compared to guidelines for ecological health or aesthetic values. Weighted composite cover measures the combined cover of some of the less desirable forms of periphyton, such as long filaments and thick mats. Monitoring is carried out where periphyton is likely to grow. This includes sites with rocky or sandy streambeds where periphyton can attach, and where the water is shallow enough for light to penetrate.

Periphyton and the National Objectives Framework

The NPS-FM sets out requirements for councils and communities to maintain or improve freshwater (where it is degraded). The NPS-FM provides a National Objectives Framework (NOF) that specifies nationally applicable standards for particular water quality parameters (referred to as 'attributes'). Periphyton is one of those attributes.

Table 1 sets out the NOF attribute criteria for periphyton biomass, which is measured in chlorophyll-*a* concentration (mg chl-*a*/m^2). There are two numeric attribute states: a default class and a productive class. The productive class applies to streams and rivers which have naturally high levels of nutrient enrichment, or experience dry climate – as defined by the River Environment Classification (REC).

Table 1: Periphyton NOF attribute. Source: MfE, (2020).

Value (and component)	Ecosystem health (Aquatic life)	
Freshwater body type	Rivers	
Attribute unit	mg chl-*a*/ m^2 (milligrams chlorophyll-*a* per square metre)	
Attribute band and description	**Numeric attribute state (default class)**	**Numeric attribute state (productive class)**
	Exceeded in no more than 8% of samples	Exceeded in no more than 17% of samples
A Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.	≤50	≤50
B Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat.	>50 and ≤120	>50 and ≤120
C Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat.	>120 and ≤200	> 120 and ≤200
National Bottom Line	**200**	**200**
D Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.	>200	>200
At low risk sites monitoring may be conducted using visual estimates of periphyton cover. Should monitoring based on visual cover estimates indicate that a site is approaching the relevant periphyton abundance threshold, monitoring should then be upgraded to include measurement of chlorophyll-*a*. Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC "Dry" Climate categories (that is, Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (that is, Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class. Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chlorophyll-*a*) is 3 years.		

* The productive class is defined by River Environment Classification (REC) types, with a combination of dry climate categories and soft-sedimentary, volcanic acidic and volcanic basic geology. All sites that do not fall in these categories are in the default class.

Further, as the maximum amount of periphyton biomass is affected by the amount of nutrients in the water column, the NPS-FM also requires councils to set appropriate in-stream concentrations and exceedance criteria for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) to regulate periphyton biomass growth (Ministry for the Environment, 2020).

Periphyton monitoring in the Taranaki region

In 2018, Taranaki Regional Council (TRC) initiated a monthly State of Environment (SoE) periphyton monitoring programme, tailored to the requirements of the NPS-FM. Twelve sites are included in this monitoring programme, many of which were selected to align with sites monitored in the state of the environment physicochemical monitoring programme and/or sites which had flow monitoring in place. Of these twelve sites, six are located in the Volcanic Ring Plain Freshwater Management Unit (FMU), three are located in the Waitara FMU, and there is one site located in each of the Pātea, Southern Hill Country and Northern Hill Country FMUs. There is currently no SoE periphyton monitoring undertaken in the Coastal Terraces FMU.

Monthly sampling is undertaken at these sites, involving the collection of periphyton biomass samples using a modified version of quantitative method 1b (QM-1b) of the Stream Periphyton Monitoring Manual (Biggs & Kilroy, 2000). Periphyton biomass samples are subsequently analysed for chlorophyll-*a*.

The first three years of monitoring data has been analysed and reported in TRC Technical Report 2022-103 (Taranaki Regional Council, 2022). The analysis of this data found that there were five sites graded within band A, four sites in band B, and three sites in band C of the NOF attribute criteria (see Table 1). The report also included preliminary analyses of the relationship between periphyton biomass, and key drivers such as flow, and nutrients. Analysis of the supporting nutrient water quality data found that periphyton growth was limited by one nutrient (either dissolved inorganic nitrogen; DIN, or dissolved reactive phosphorous; DRP), at five sites. Both nutrients were likely limiting periphyton growth at two sites, while concentrations of both nutrients were above saturation thresholds, and were therefore not limiting periphyton growth at the remaining five sites. The attribute grades at these five sites were A (one site), B (three sites) and C (one site). Therefore, these results suggest that other factors, such as flow regime and shading, likely play an important role at limiting periphyton growth at these sites. Further analysis is required to better understand the influence of these factors, and other variables such as temperature, on periphyton growth throughout the region. A complete description of the site selection criteria, monitoring methodology, results and analysis is documented in the full technical report.

Site names, codes, coordinates and corresponding FMUs for the Council's SoE periphyton monitoring sites are listed below in Table 2.

Table 2: Periphyton monitoring sites in the Taranaki region

FMU	Site name	Site	Easting	Northing
Southern Hill Country	Tawhiti Stream at Duffy's water level recorder	TWH000435	1714287	5615551
Pātea	Makuri Stream 30 m downstream of Raupuha Road	MKR000495	1723795	5641478
Volcanic Ring Plain	Kapoaiaia Stream 900 m from coast	KPA000950	1665690	5652452
Volcanic Ring Plain	Punehu Stream at Wiremu Road	PNH000200	16873232	5637020
Volcanic Ring Plain	Punehu Stream at State Highway 45	PNH000900	1677946	5627786
Volcanic Ring Plain	Hangahatua (Stony) River at Mangatete Road	STY000300	1677420	5657868
Volcanic Ring Plain	Waingongoro River at Eltham Road bridge	WGG000500	1710694	5634849
Volcanic Ring Plain	Waiwhakaiho River at State Highway 3	WKH000500	1698297	5666893
Waitara	Manganui River upstream of rail bridge	MGN000195	1708871	5651282
Waitara	Maketawa Stream at Tarata Road	MKW000300	1708784	5665231
Waitara	Matau Stream upstream of confluence with unnamed tributary	MTA000068	1733965	5661062
Northern Hill Country	Waikaramarama Stream at Waikaramarama Road	WMR000100	1730866	5692865

Baseline state for periphyton

The NPS-FM requires all regional councils to identify baseline states for all attributes described in Appendix 2A and 2B of the NPS-FM within each FMU. When compared against national bottom lines and the relevant objectives for an FMU, baselines provide the reference point from which councils must either maintain or improve an attribute, which in turn will contribute toward achieving freshwater objectives for each compulsory and non-compulsory value. Waterbodies must not be allowed to degrade, or remain below an identified baseline state unless that state is determined to be naturally occurring. If a waterbody is already at or below the national bottom line, then it must be improved to either achieve the national bottom line or better.

Under Clause 1.4 of the NPS-FM, the baseline state, in relation to an attribute, is the best state out of the following:

a) the state of the attribute on the date it is first identified by a regional council under Clause 3.10(1)(b) or (c);

b) the state of the attribute on the date on which a regional council set a freshwater objective for the attribute under the National Policy Statement for Freshwater Management 2014 (as amended in 2017);

c) the state of the attribute on 7 September 2017.

The Council has not previously set freshwater objectives under the NPS-FM 2014 (amended 2017) for periphyton, so the state of the attribute under 1.4 (b) could not be calculated, and was excluded from identification of baseline states. Therefore, the best state out of Clause 1.4 (a) and (c) was used to identify the baseline states for periphyton.

Under Clause 1.6 of the NPS-FM, local authorities must use the best information available at the time (and if practicable, using complete and robust data) to give effect to the NPS-FM. In the absence of complete and robust data, the best information available should be use which may include modelling, partial data, and local knowledge, and preferably use sources that provide the greatest level of certainty (or take all practicable steps necessary to reduce uncertainty).

Under the NPS-FM, periphyton is associated with the 'Ecosystem Health' value, which is a compulsory value within the NOF (NPS-FM, Appendix 1A). Furthermore, periphyton is included as an attribute requiring limits to be set on resource use (NPS-FM, Appendix 2A). It is necessary for baseline states to be identified by TRC for the Taranaki region to ensure that target attribute states are set at a level that either achieve or exceed the best baseline state for that attribute and (at a minimum) achieve the national bottom line[1]

The remainder of this memo summarises the monitoring and work carried out by TRC to identify baseline states for periphyton.

Criteria for identifying site-based baseline states for periphyton

Draft baseline states for periphyton have been identified for individual monitoring sites. These site-specific baseline states correspond to the NOF attribute bands set out in NPS-FM, Table 2, and have been identified using data from the SoE monitoring programme described above. Representativeness of these sites and attribute bands within each Freshwater Management Unit (FMU) are critically discussed later in this memo.

The NPS-FM requires periphyton attribute grades to be determined using three years of monthly samples (i.e. 36 samples per site). Baseline grades are determined based on the threshold reached by the top 8% of

[1] See NPS-FM clauses 3.31, 3.32, and 3.33 for exceptions to this.

sample results for each site (for sites classified within the "default" category, based on river environment classification (REC)). When 36 monthly samples are collected over a three year period, this is equivalent to a maximum of three samples (or one sample per year) exceeding the threshold and is the same as comparing the 92nd percentile (MfE, 2022). For sites classified within the "productive" REC category, the 83rd percentile is calculated instead. A review of periphyton monitoring sites for which baseline states have been calculated has confirmed that all 12 sites are categorised within the default REC category.

The Hazen method was used for calculating the 92nd percentile when assessing the results from each site against the NOF attribute criteria. Hazen percentiles are non-parametric and provide a more precautionary approach than parametric methods for percentile calculations. Hazen percentiles are widely used in freshwater reporting in New Zealand.

When high flow conditions prevent sampling, missing data points are replaced with an imputed data point for chlorophyll-*a*. Samples that were missed for other reasons are not imputed. The underlying assumption behind this is that flow conditions that are high enough to prevent sampling will cause algal removal, and thus the missing sample can be imputed with a low value. This approach is used in several publications and is recommended in the NEMS (Kilroy & Stoffels, 2019; NEMS, 2022). The NEMS recommends that data points missing due to high flows are substituted with a chlorophyll value of <5 mg/m^2 (NEMS, 2022). However, in recognition that several monitored sites have particularly low overall chlorophyll levels, an alternative approach taken by Northland Regional Council (Kilroy & Stoffels, 2019) was to instead substitute the 5th percentile of data for a particular site. This is considered to be more appropriate, particularly for sites that have a 92nd percentile value below 5 mg/m^2.

When assessing the first three years of data from the Council's state of the environment periphyton programme, there were four sites that had less than 36 results, even after values were imputed for high flow sampling occasions. The reasons for missing data were due to sites being added to the programme after July 2018 (Makuri Stream at Raupaha Road was added in November 2018), as well as health and safety or site access issues which also prevented sampling on occasion. Therefore, it was necessary to incorporate a longer dataset, in order to have sufficient data for the 92nd percentile calculation. As such, it was decided to assess four years of monitoring data to identify site-based baseline state. Sites that have less than 48 total sample results are those where sampling was unable to take place for reasons other than high river flows. A complete summary of this data, including number of collected and imputed samples is presented in Appendix 1.

Site-based baseline state

An assessment of periphyton biomass results against the corresponding NOF attribute grades from 12 monitored river sites showed that five sites are categorised as achieving band A, four sites achieving band B and three sites achieving band C. None of the monitored sites fall below the national bottom line for the NOF periphyton attribute (band D).

Three sites had extremely low 92nd percentiles that were less than 10 mg chl-*a*/m^2, with no single samples exceeding the 50 mg chl-*a*/m^2 band B threshold; Hangahatua (Stony) River at Mangatete Road, Punehu Stream at Wiremu Road, and Manganui River upstream of rail bridge. These three sites are all in the mid to upper reaches of streams arising in Te Papa-Kura-o-Taranaki (formerly Egmont National Park). Manganui River recorded the lowest 92nd percentile out of all sites, at 3.2 mg chl-*a*/m^2. The remaining two sites in band A fell within the mid to upper range of this band (Punehu Stream at State Highway 45 and Waikaramarama Stream at Waikaramarama Road). Both of these sites are located near the coast, at the bottom of their respective catchments.

The results of this assessment are summarised below in Table 3 and shown spatially in Figure 1, with further detail provided in Appendix 1.

Table 3: Site-based baseline state assessments for periphyton biomass.

FMU	Site name	Site code	No. samples	92nd percentile (mg chl-*a*/m²)	NOF grade
Southern Hill Country	Tawhiti Stream at Duffy's water level recorder	TWH000435	40	95.5	B
Pātea	Makuri Stream 30 m downstream of Raupuha Road	MKR000495	48	100.6	B
Volcanic Ring Plain	Kapoaiaia Stream 900 m from coast	KPA000950	47	65.5	B
Volcanic Ring Plain	Punehu Stream at Wiremu Road	PNH000200	48	8.8	A
Volcanic Ring Plain	Punehu Stream at State Highway 45	PNH000900	48	38.9	A
Volcanic Ring Plain	Hangahatua (Stony) River at Mangatete Road	STY000300	48	7.0	A
Volcanic Ring Plain	Waingongoro River at Eltham Road bridge	WGG000500	47	136.8	C
Volcanic Ring Plain	Waiwhakaiho River at State Highway 3	WKH000500	48	161.3	C
Waitara	Manganui River upstream of rail bridge	MGN000195	48	3.2	A
Waitara	Maketawa Stream at Tarata Road	MKW000300	48	102.4	B
Waitara	Matau Stream upstream of confluence with unnamed tributary	MTA000068	47	151.3	C
Northern Hill Country	Waikaramarama Stream at Waikaramarama Road	WMR000100	48	30.3	A

The four sites in band B were graded in the lower to mid-range of the band; none were approaching the band C threshold (120 mg chl-*a*/m²). These four sites were Tawhiti Stream at Duffy's water level recorder, Makuri Stream 30 m downstream of Raupuha Road, Kapoaiaia Stream 900 m from coast, and Maketawa Stream at Tarata Road. These sites are spread across four different FMUs, and are located in the mid to lower reaches of their respective catchments.

None of the three sites graded within the C band had 92nd percentiles that were close to exceeding the D band threshold (200 mg chl-*a*/m²). These three sites included Waiwhakaiho River at State Highway 3, Waingongoro River at Eltham Road bridge, and Matau Stream upstream of the confluence with the unnamed tributary. These sites cover three FMUs, and are located in the mid to upper reaches of their respective catchments. Waiwhakaiho River recorded the highest overall 92nd percentile, at 161.3 mg chl-*a*/m².

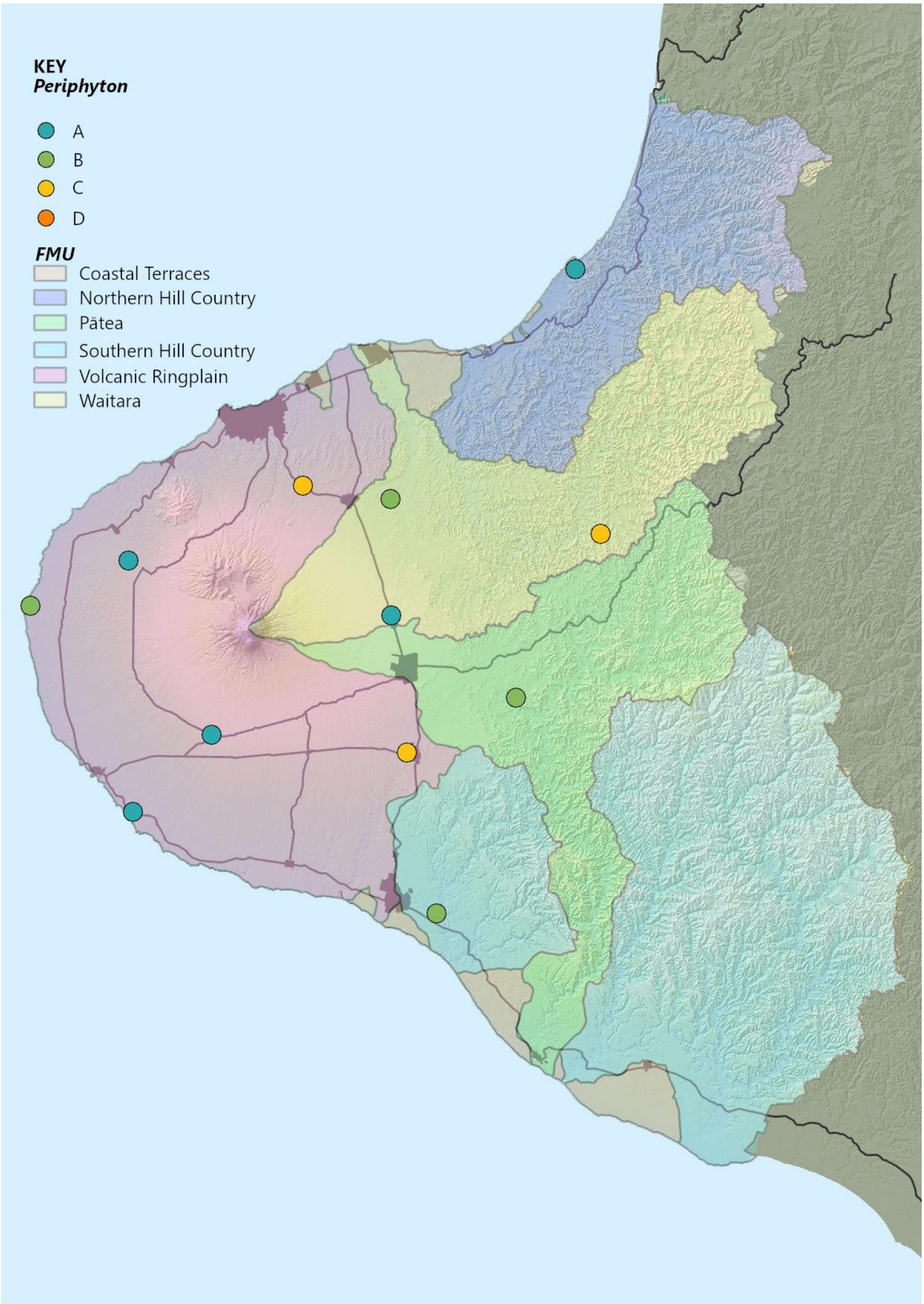

Figure 1: Site-based baseline state assessments for periphyton biomass.

Baseline period and temporal state variability

This baseline assessment has been carried out using data that demonstrates the best state, out of the baseline periods defined in the NPS-FM (2020). The council has not previously set freshwater objectives for this periphyton attribute, and therefore sub-clause 1.4(b) is not applicable.

For the 12 monitoring sites, data records are limited, with the earliest monitoring at most sites only commencing in July 2018. Therefore, baselines have been identified using the earliest available data (sub-clause 1.4(a). Sub-clause 1.4(c) was not applicable in this instance as there was no suitable monitoring data prior to September 2017. Details of the baseline data ranges at each site are included in Appendix 1.

As described earlier, the NPS-FM requires periphyton attribute grades to be determined using three years of monthly samples (i.e. 36 samples per site). However, there were less than 36 results available at four sites based on the first three years of monitoring, for various reasons. Therefore, it was decided to utilize a longer baseline period of four years (i.e. up to 48 samples per site), in order to ensure that each site had more than 36 results which would enable a robust calculation of the 92nd percentile for determining baseline grades.

In summary, a sufficient data record is available for determining baseline grades at all 12 monitoring sites. However, it should be noted that the monitoring record is not long enough to understand temporal patterns and state variability at these sites.

Freshwater Management Unit (FMU) coverage and representativeness

An overarching requirement of the NOF framework is for councils to identify Freshwater Management Units (FMUs). This extends to monitoring programmes needing to include a sufficient number of sites so as to be representative of that FMU. Should periphyton biomass within an FMU, or periphyton biomass at monitoring sites representing an FMU become excessive (indicative of degraded conditions), the Council must take action to stop or reverse degradation and reduce periphyton biomass towards natural levels.

Aside from the Coastal Terraces, data from at least one monitoring site in each FMU has been used to inform this baseline assessment. The Volcanic Ring Plain has the highest representation, with six sites located within this FMU (half of the total number of sites). Waitara has the next highest number of monitoring sites (three; a quarter of all sites). The Northern Hill Country, Southern Hill Country and Pātea FMUs have one site each. One of the reasons why there are currently no monitoring sites in the Coastal Terraces, is that the existing monitoring network was designed based on previous FMU boundaries, which have since been revised. Further information regarding site selection criteria is provided in TRC Technical Report 2022-103 (TRC, 2022). It should be noted that the monitoring network is currently under review to ensure each FMU is appropriately represented.

Another important factor that must be considered when assessing monitoring site representativeness, is stream bed suitability. Soft-bottomed streams are not capable of supporting conspicuous periphyton growth, due to a lack of hard substrate for the algae to grow on. Therefore, an assessment of monitoring site representativeness should only be based on the coverage of hard-bottomed streams that are capable of supporting conspicuous periphyton growth, rather than the entire stream network within the region of interest (e.g. each FMU). Based on REC data, 7.6% of stream reach in Taranaki is categorised as being naturally soft-bottomed (Figure 2). These streams are concentrated in South Taranaki, and overlap with the Volcanic Ring Plain, Pātea, Coastal Terraces and Southern Hill Country FMUs. Further investigation is necessary to verify the accuracy of this REC data, and to understand the spatial extent of naturally hard-bottomed streams that have transitioned to soft-bottomed due to increased deposition of fine sediment.

As previously discussed, there are two numeric attribute criteria for periphyton biomass depending on whether the site is categorised within the default or productive class. The productive class applies to streams and rivers which have naturally high levels of nutrient enrichment, or experience dry climate. Accordingly, the attribute bands are less stringent for these sites. An assessment of the Taranaki stream network determined that the majority of stream reaches in Taranaki which would be classed as productive were soft-bottomed and therefore not capable of supporting conspicuous periphyton growth (Figure 2 and Figure 3). One monitoring site, Tawhiti Stream at Duffy's water level recorder (which can be seen in the figures below as the southernmost monitoring site), is surrounded by stream reaches categorised in the productive class. However, the main stem of the Tawhiti Stream (which this monitoring site is located on), is categorised in the default class. Overall, the current monitoring network is considered suitably representative of stream classification, as it relates to the default and productive categories.

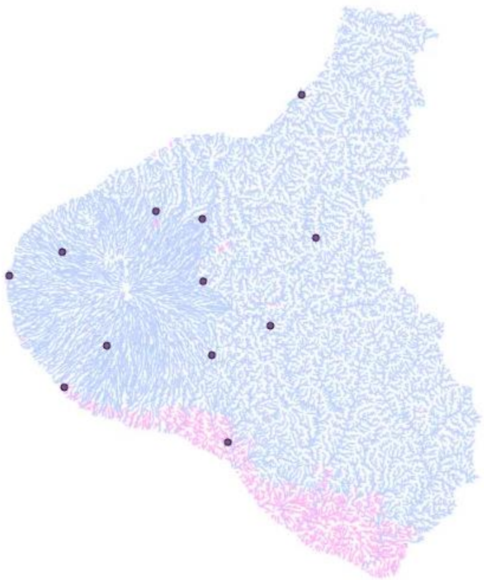

Figure 2: Spatial illustration of Taranaki stream segments falling into hard-bottomed classes (blue; 92.4% of total stream segments) and into the naturally soft-bottomed class (pink; 7.6% of total stream segments), with the current periphyton monitoring sites (black dots). Retrieved from REC2.

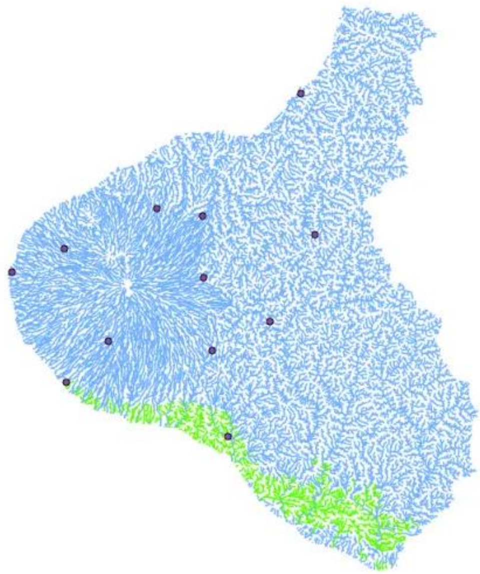

Figure 3: Spatial illustration of Taranaki stream segments falling into the NOF default class (blue; 94.3% of total stream segments) and into the NOF productive class (green; 5.7% of total stream segments), with the current periphyton monitoring sites (black dots). Retrieved from REC2

The spatial representativeness of the current sampling sites in each FMU is illustrated in Figure 1, and a comparison of percentage total stream reach and proportionate monitoring coverage is presented below in Figure 4. The figures demonstrate that the Volcanic Ringplain and Waitara FMUs are proportionately overrepresented and the Southern Hill country FMU is underrepresented. Representation of the Northern Hill Country and Pātea FMUs fairly closely reflects the proportion of total stream reach in these FMUs. Currently there are no sampling sites in the Coastal Terrace FMU (though this is being addressed through a review of the monitoring network).

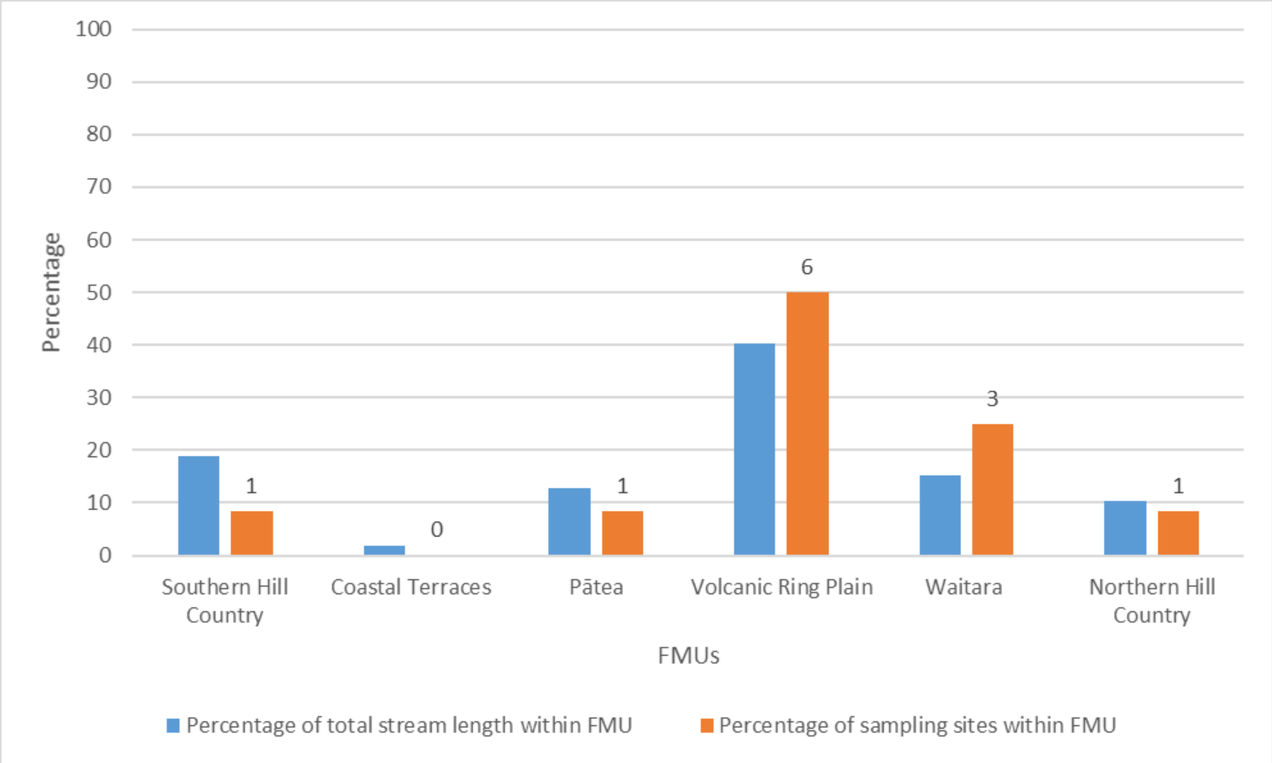

Figure 4: The percentage of total stream length compared with the percentage of sampling sites in each FMU. The data labels indicate the number of sites in each FMU.

However, the above assessment does not take into account the variability of land cover within each FMU. When examining site representativeness in relation to land cover classes, as shown in Figure 5, it can be noted that:

- Indigenous forest (IF) land cover in the Northern Hill Country, Pātea and Southern Hill Country FMUs is not represented.
- The main land cover types in the Volcanic Ringplain FMU are represented, though scrub (S) land cover is overrepresented.
- The main land cover types in the Waitara FMU are represented.

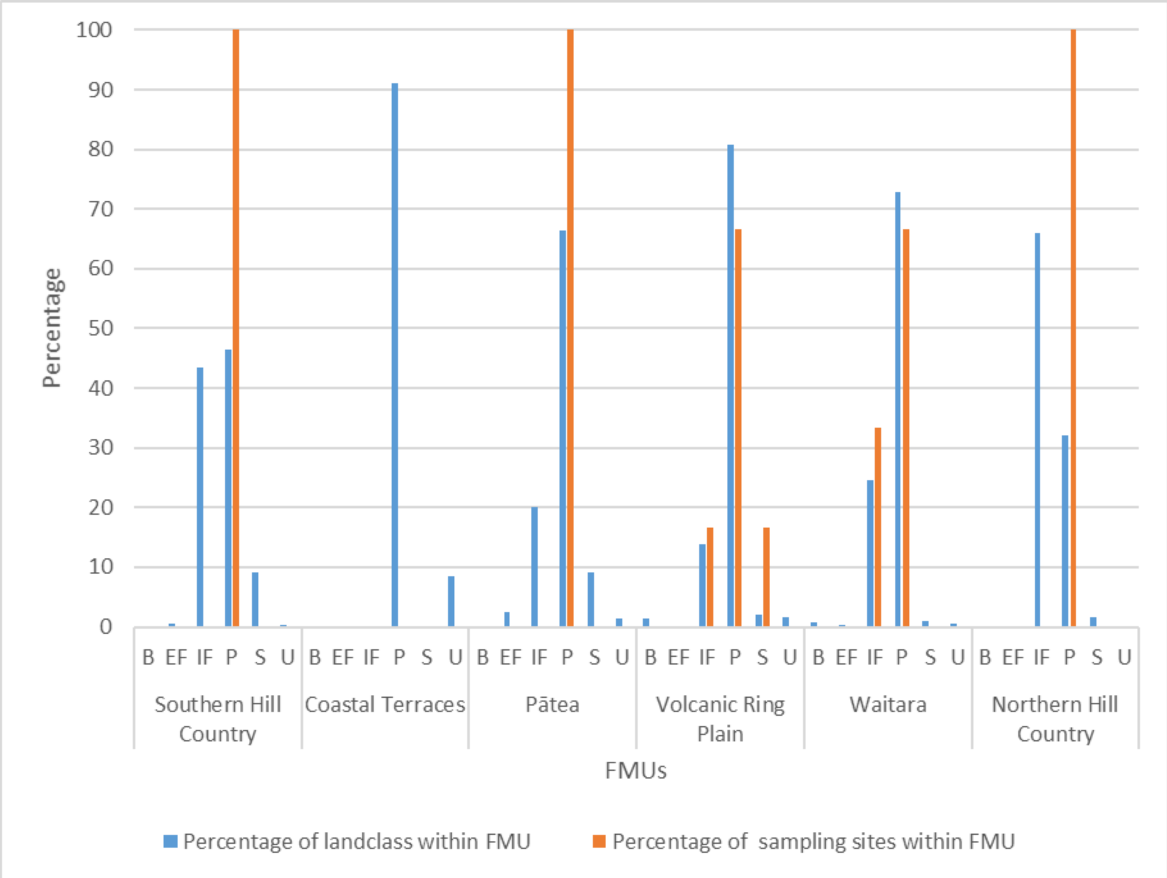

Figure 5 The percentage of land classes compared with the percentage of sampling sites within each FMU. Land cover class: Bare (B), Exotic Forest (EF), Indigenous Forest (IF), Pastoral (P), Scrub (S), Urban (U).

In Taranaki, the most common land cover classes are pasture and indigenous forest. Despite the fact that the proportion of urban land cover in Taranaki is low, urban areas can have a disproportional negative impact on the environment (Miserendino et al., 2011). As a result, site representativeness in this monitoring programme should be focused on these three land cover classes. However, the monitoring programme does not currently include any urban sampling sites, and as such, urban land cover is not represented in this baseline assessment.

FMU-based baseline states

There are limitations as to how well the monitoring data can describe current state at the FMU scale. The use of monitoring data alone has the potential to lead to biased conclusions given individual monitoring sites are non-random and are not entirely representative of the regional landscape and the pressures impacting on the health of the region's waterbodies. To help address these limitations, the use of modelled data allows for an assessment of baseline states across both monitored and unmonitored waterways in the Taranaki region. Using modelled data, baseline states can be identified for each FMU, expressed as percentage waterway length in each FMU within each NOF attribute band. Furthermore, spatial models can be used to test the impacts of different management approaches, interventions and actions on freshwater outcomes in Taranaki.

Spatial models have been developed for Taranaki encompassing a range of water quality parameters. Due to the limited available data, it was not possible to model periphyton biomass across the total stream reach in each FMU. Once more data becomes available, this site-based baseline assessment may be supplemented with an FMU-based modelling approach.

Periphyton nutrient criteria for target attribute states

The NPS-FM requires councils to set appropriate in-stream concentrations and exceedance criteria for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) to regulate periphyton biomass growth (Ministry for the Environment, 2020).

The Ministry for the Environment has provided guidance on how to achieve desired periphyton target attribute states through the use of look-up tables of nutrient concentrations and exceedance criteria (Ministry for the Environment, 2022), although this resource is now under review. The look-up tables provide a range of nutrient concentrations that are likely to achieve different levels of periphyton biomass. For example, if a regional council wishes to set a target of 50 mg/m^2 of chlorophyll-*a*, the tables can be used to identify the nutrient concentration that is likely to achieve this target.

The look up tables allow the user to determine the instream nutrient concentrations required to achieve the desired NOF periphyton attribute band for a given site, by selecting the applicable REC classification (regarding climate and source of flow), and shading status. Nutrient concentrations can also be modified by an 'under-protection risk' factor, which accounts for the likelihood that a river or lake will not meet its target nutrient concentration, even if the nutrient concentration is within the required limits. This risk is due to the uncertainty inherent in the statistical models used to determine the target nutrient concentration.

Although these look-up tables are a useful tool for managing periphyton growth, they should be used with caution. The tables are based on data from a limited number of sites, and the results may not be applicable to all rivers. Additionally, the look-up tables are based on data from hard-bottomed streams and rivers, and do not apply to soft-bottomed streams and ≥ 3 order streams. Users should also consider other factors, such as the flow regime and the presence of grazing animals when setting nutrient targets and should be mindful of the underlying assumptions and limitations. The look-up tables do not represent a definitive or mandated method for setting nutrient criteria.

Given that the nutrient criteria and associated look up tables are currently under review, they are not presented here as the current version will soon become out of date.

Council has commissioned the development of a regional nutrient model, using a Simplified Contaminant Allocation and Modelling Platform (SCAMP; Cox et al. 2022). The model has been developed to estimate contaminant loads and concentrations, specifically those of total nitrogen and total phosphorous, under a range of management scenarios related to potential freshwater policy interventions. The SCAMP model estimates contaminant loads and concentrations at designated monitoring points, or nodes, in response to theoretical land use scenarios that are applied to the upstream catchment. The model can also estimate periphyton biomass at designated monitoring points, by using the predicted concentrations of total nitrogen and total phosphorous, and applying the nutrient criteria described above. Council will use this this SCAMP model to assist with the nutrient limit setting process as it relates to periphyton outcomes.

Recommendations

Draft baseline states have been calculated for monitoring sites to provide the best known state for the periphyton attribute as an indicator of ecosystem health across each FMU.

The next step of implementing the NPS-FM is to set target attribute states at a level that (at a minimum) achieves the best baseline state identified for each monitoring site, or exceeds the baseline state where this is necessary to achieve improvement. Consideration should be given as to whether target states should be set at broader spatial scales (e.g. catchments or FMUs) as well as at specific sites, though further information would likely be required to support this approach.

To support the target setting process, possible actions and mitigations that are available to promote the maintenance and improvement of freshwater in relation to periphyton (and ecosystem health more broadly) must be identified and assessed. This work is currently underway, with a contaminant source model for nitrogen and phosphorous under development to assess the impact of various mitigation actions on in-stream concentrations of nitrogen and phosphorous (Cox et al. 2022). As an extension of this modelling, consideration should be given to the contaminant load reductions that are necessary to maintain or improve periphyton attribute state. National nutrient guidelines are currently being developed to assist with setting in-stream concentration limits for managing periphyton.

The SCAMP model that is being developed for Taranaki by LWP Ltd and RMA Science Ltd will help to assess the impacts of a range of mitigation scenarios on nutrient concentrations in rivers and streams. The existing mitigations that are already being investigated include the completion of riparian fencing and planting throughout the region, and redirecting all dairy effluent discharges from water to land. Further scenarios are also being considered, including implementation of other mitigation actions associated with good farm management practise, as well as a range of possible future mitigation measures. Considering a broad range of possible mitigation actions for improving water quality will help to inform the target setting process by providing an indication of what can realistically be achieved under different scenarios.

Finally, additional periphyton monitoring sites will need to be established in order to achieve monitoring coverage in all FMUs, and appropriate representativeness across the region.

References

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Appendix 1: Periphyton site-based baseline assessment

FMU	Site name	Site	REC category	Date range start	Date range end	Baseline defn.	Chlorophyll-*a* biomass samples			92nd percentile (mg chl-*a*/m^2)	Overall grade
							Collected	Imputed	Total		
Southern Hill Country	Tawhiti Stream at Duffy's water level recorder	TWH000435	Default	25/07/2018	9/06/2022	1.4(a)	39	1	40	95.51	B
Pātea	Makuri Stream 30 m downstream of Raupuha Road	MKR000495	Default	14/11/2018	12/10/2022	1.4(a)	38	10	48	100.63	B
Volcanic Ring Plain	Kapoaiaia Stream 900 m from coast	KPA000950	Default	11/07/2018	8/06/2022	1.4(a)	43	4	47	65.49	B
Volcanic Ring Plain	Punehu Stream at Wiremu Road	PNH000200	Default	12/07/2018	9/06/2022	1.4(a)	45	3	48	8.83	A
Volcanic Ring Plain	Punehu Stream at State Highway 45	PNH000900	Default	12/07/2018	9/06/2022	1.4(a)	45	3	48	38.91	A
Volcanic Ring Plain	Hangahatua (Stony) River at Mangatete Road	STY000300	Default	11/07/2018	8/06/2022	1.4(a)	38	10	48	6.96	A
Volcanic Ring Plain	Waingongoro River at Eltham Road bridge	WGG000500	Default	12/07/2018	9/06/2022	1.4(a)	41	6	47	136.82	C
Volcanic Ring Plain	Waiwhakaiho River at State Highway 3	WKH000500	Default	11/07/2018	8/06/2022	1.4(a)	39	9	48	161.34	C
Waitara	Manganui River upstream of rail bridge	MGN000195	Default	17/07/2018	21/06/2022	1.4(a)	43	5	48	3.17	A
Waitara	Maketawa Stream at Tarata Road	MKW000300	Default	11/07/2018	8/06/2022	1.4(a)	41	7	48	102.37	B
Waitara	Matau Stream upstream of confluence with unnamed tributary	MTA000068	Default	17/07/2018	21/06/2022	1.4(a)	47	0	47	151.30	C
Northern Hill Country	Waikaramarama Stream at Waikaramarama Road	WMR000100	Default	17/07/2018	21/06/2022	1.4(a)	47	1	48	30.31	A