Otago Regional Council

Document Id:

MEMORANDUM

To:	**Matthew McCallum-Clark**
From:	**Jason Augspurger**
Date:	**01/02/2024**
Re:	**Comparison of threshold values to reference condition from McDowell et al., 2012**

Purpose

The purpose of this memo is to compare reference state (natural) of rivers to potential target attribute state bands for ammoniacal nitrogen (Table 5), nitrate toxicity (Table 6), *E. coli* (Table 9) dissolved reactive phosphorus (Table 20) and, through total nitrogen and total phosphorus, periphyton biomass (Table 2).

Context

New Zealand's freshwater environments are under pressure from land use intensification resulting in deteriorating water quality and ecosystem health. To halt, and reverse, declines in freshwater ecosystem health, an amended National Policy Statement for Freshwater Management was released in 2020. This policy statement provides ecosystem health bottom lines for a suite of attributes and requires that ecosystem health be maintained, or improved, above these bottom lines. To do so, ORC must set freshwater visions, outcomes and target attribute states (Ministry for the Environment 2020).

To facilitate aligning freshwater outcomes with the target attribute state that achieves them, it is useful to understand what state occurs under reference conditions. This memo compares previously published estimates (McDowell et al. 2012) for reference conditions to potential target attribute states.

Methods

Previously published reference estimates for the median value are plotted and compared to attribute bands in the NPSFM 2020 for ammoniacal nitrogen (Table 5), nitrate toxicity (Table 6), *E. coli* (Table 9) dissolved reactive phosphorus (Table 20) and, through total nitrogen and total phosphorus, periphyton biomass (Table 2). Total phosphorus and total nitrogen are compared to the 20% under protection risk non-shaded periphyton nutrient criteria (Snelder 2023) as previously selected by policy (Augspurger 2024; De Pelsemaeker 2024). For more information on under protection risk, see Augspurger (2024a,b).

To provide for natural heterogeneity that occurs within catchments, reference estimates are provided for different river classes based on the River Environment Classification (Snelder and Biggs 2007). Otago's river network is pre-dominantly comprised of cool-dry hill (CD/H), cool-dry low (CD/L), cool-wet mountain (CW/M) and cool-wet hill (CW/H) fed rivers.

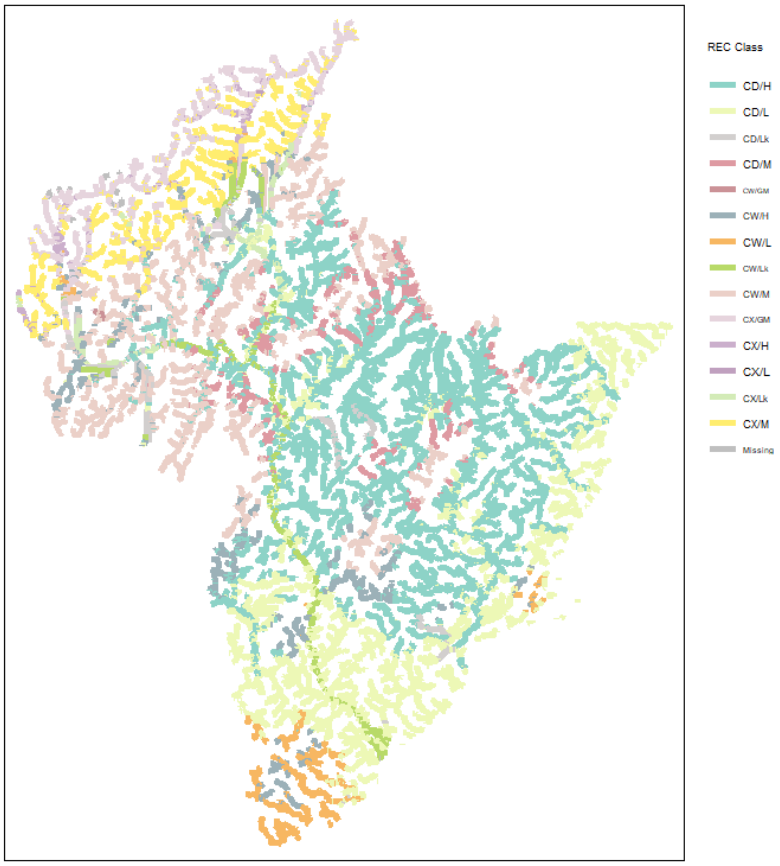

Figure 1: REC classes of Otago's river network

Table 1: Proportion of Otago's river network made up by reach REC, source of flow (SoF), class. A small proportion of the network does not have a source of flow class defined (1.1%).

SoF	Percent
CD/H	31.67
CD/L	23.69
CD/Lk	0.61
CD/M	3.06
CW/GM	0.01
CW/H	5.87
CW/L	3.11
CW/Lk	0.91
CW/M	15.58
CX/GM	3.93
CX/H	1.45
CX/L	0.03
CX/Lk	0.37
CX/M	8.61
	1.10

Results

Ammoniacal nitrogen (Table 5)

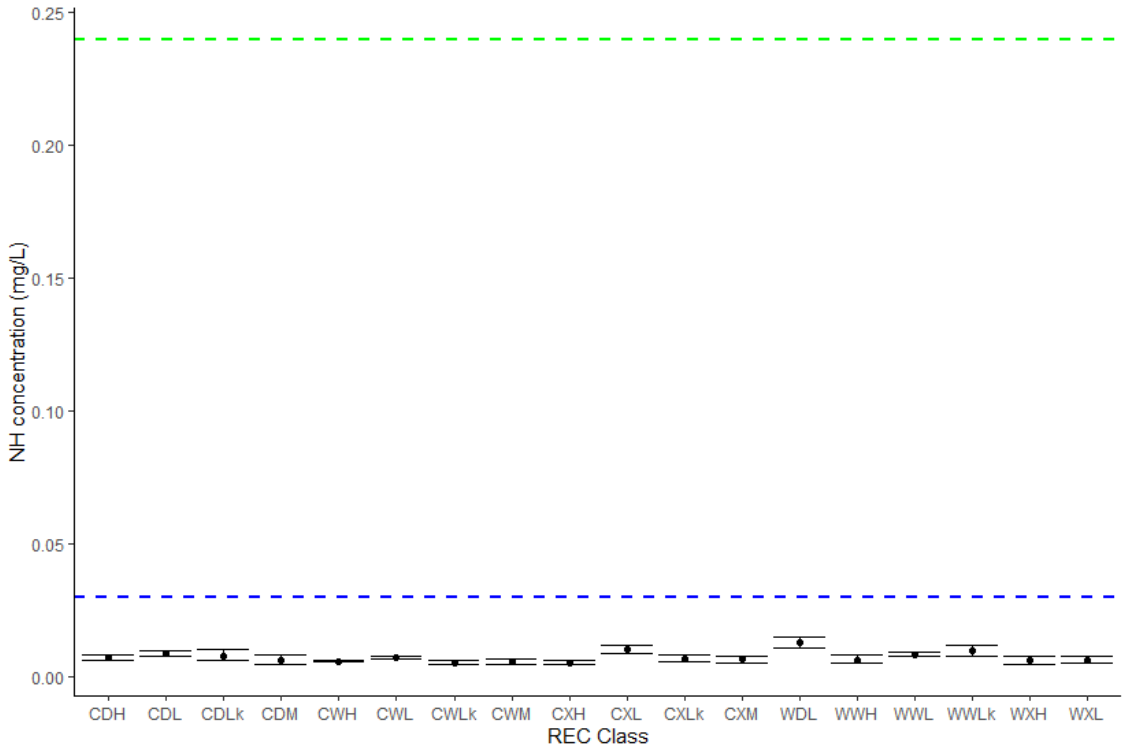

Figure 2: Predicted median ammoniacal nitrogen reference state with standard error. The median thresholds from NPSFM 2020 Table 5 are presented for the A (blue), and B (green) bands.

Comparisons with the median ammoniacal nitrogen reference state value show all classes would naturally comply with the A-band nutrient threshold.

Nitrate Toxicity (Table 6)

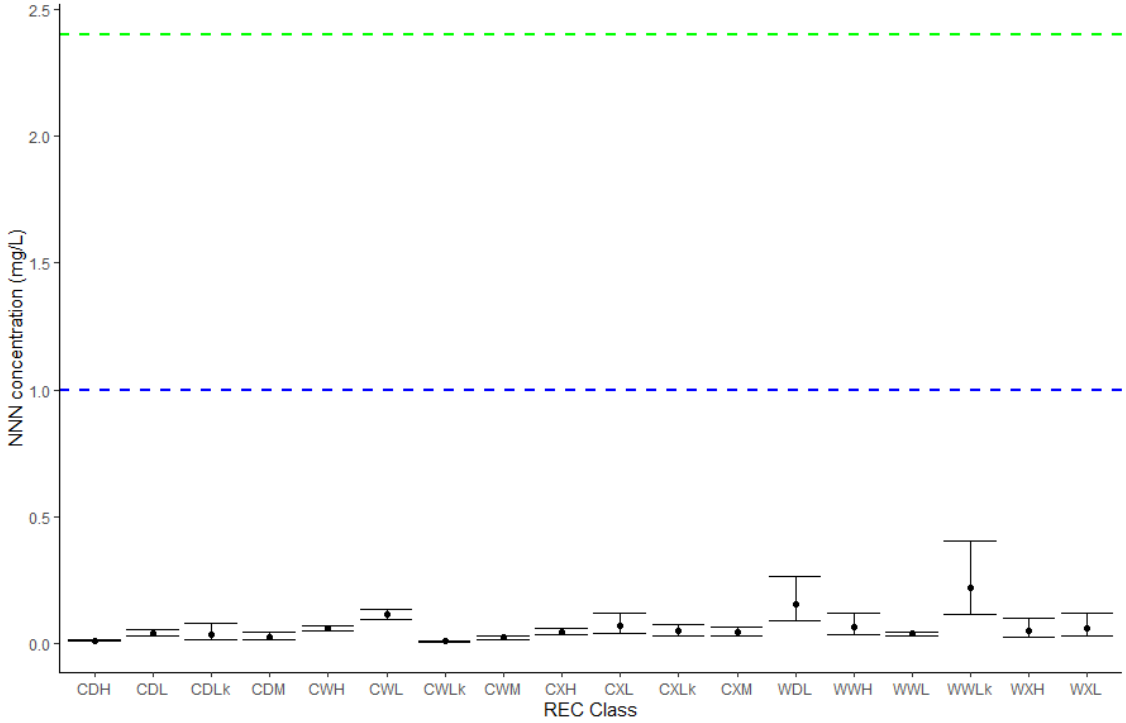

Figure 3: Predicted median nitrate-nitrogen reference state with standard error. The median thresholds from NPSFM 2020 Table 6 are presented for the A (blue), and B (green) bands.

Comparisons with the median nitrate nitrogen reference state value show all classes would naturally comply with the A-band nutrient threshold.

E. coli (Table 9)

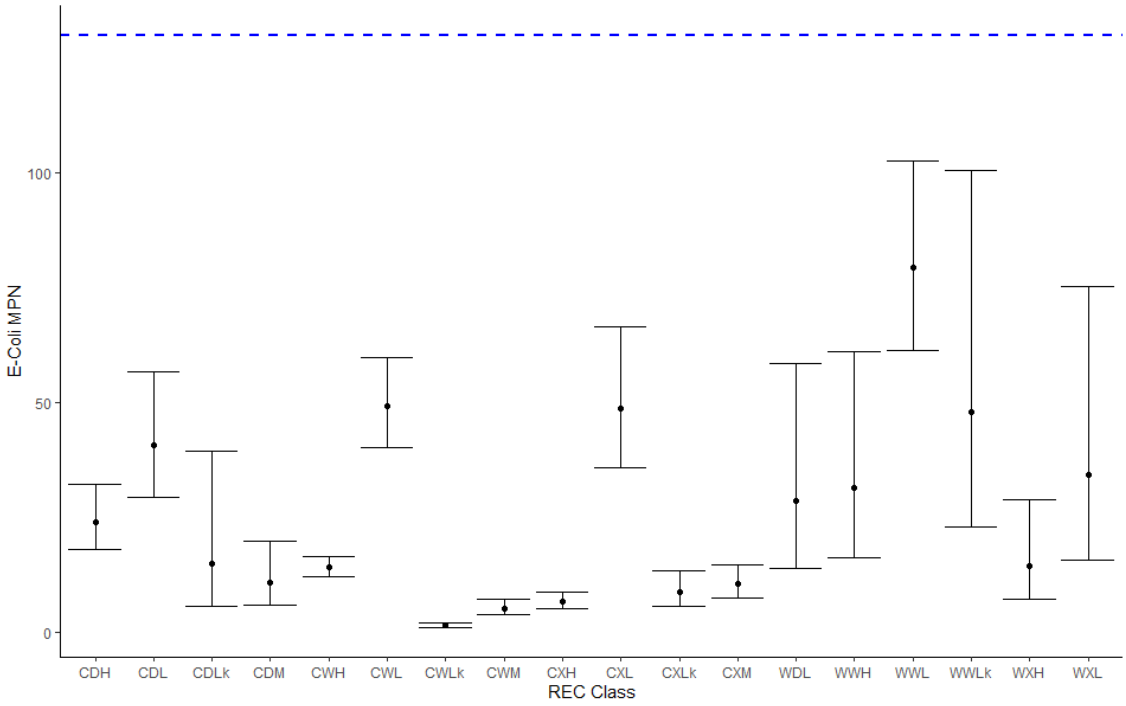

Figure 4: Predicted median E. coli reference state with standard error. The median threshold from the NPSFM 2020 Table 9 is presented as a blue line. The median comparison is binary representing the bottom of the A/B/C threshold.

Comparisons with the median *E. coli* reference state value show all classes would naturally comply with A/B/C-band nutrient threshold.

Dissolved Reactive Phosphorus

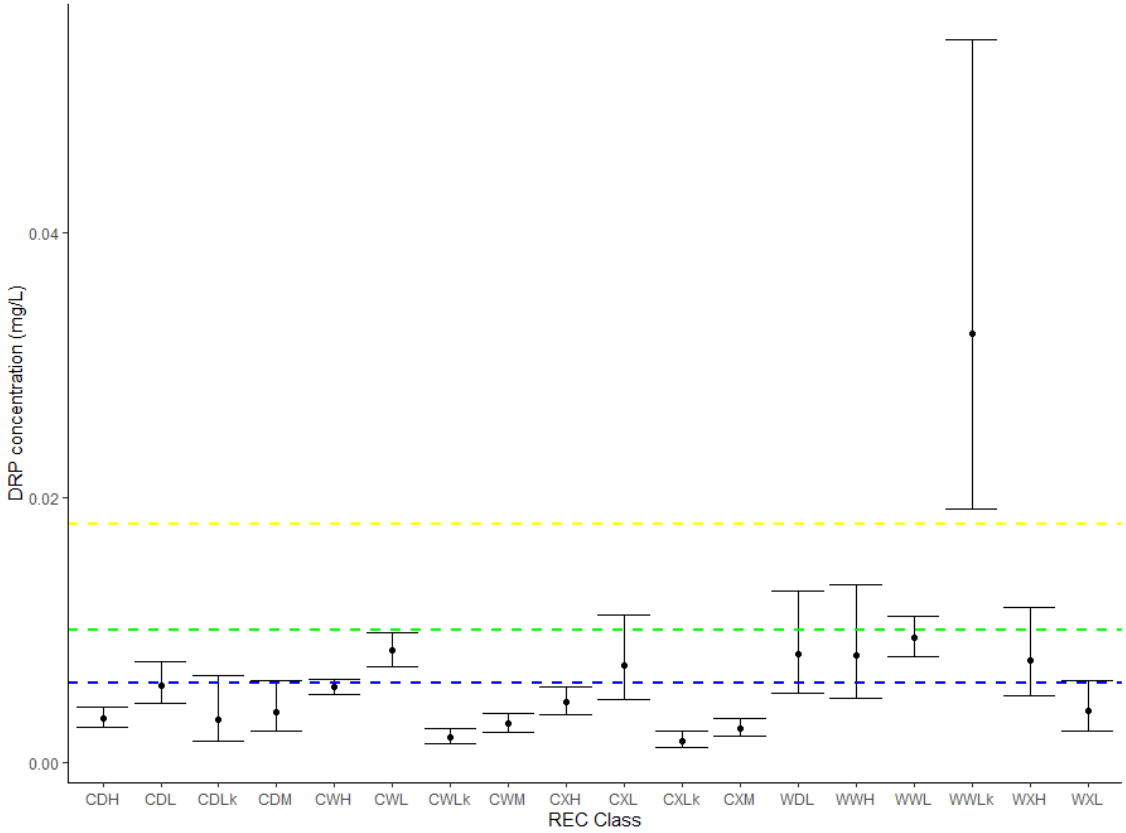

Figure 5: Predicted median dissolved reactive phosphorus (DRP) reference state with standard error. The median thresholds from NPSFM 2020 Table 20 are presented for the A (blue), B (green), and C (yellow) bands.

Comparisons with the median reference dissolved reactive phosphorus criteria result in about half of classes complying the A-band concentration (CDH, CDLk, CDM, CWH, CWLk, ,CWM, CXH, CXLk, CXM, WXL,). The CDL class complies with the A, or B-band, concentration and CWL complies with the B-band. C or B-band compliance occurs in the CXL, WDL, WWH, WWL, and WXH classes. The WWLk class naturally does not comply with the C-band.

Periphyton Nutrient Criteria

Total Nitrogen

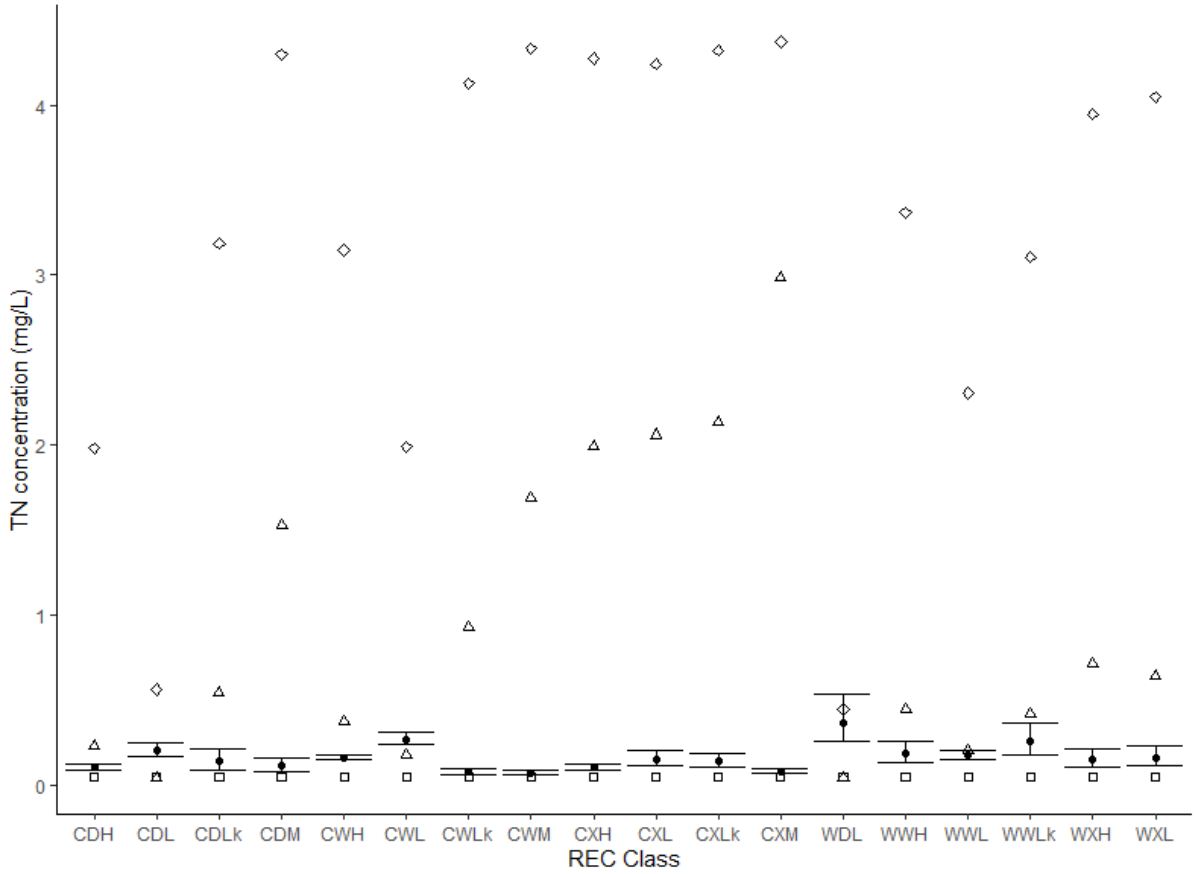

Figure 6: Predicted median total nitrogen (TN) reference state with standard error. The periphyton biomass criteria derived by Snelder et al., 2023 presented for a 20% under-protection risk for the A (square), B (triangle), and C (diamond) bands.

All classes comply with the C-band criteria apart from WDL which overlaps the criteria. The B-band criteria is also complied with by all classes except for CDL, CWL, and WDL. No class complies with the A-band criteria though some classes nearly overlap.

Total Phosphorus

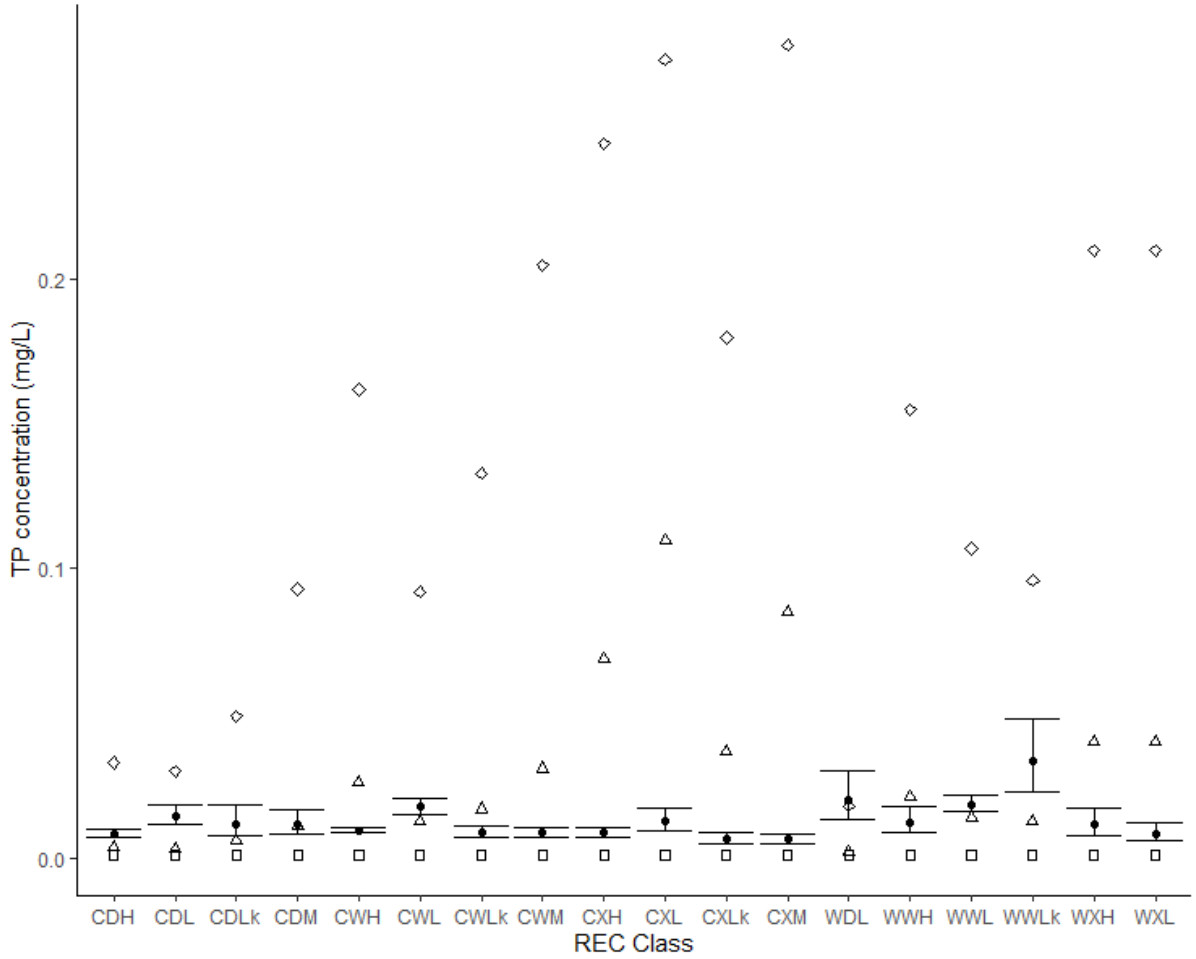

Figure 7: Predicted median total phosphorus (TP) reference state with standard error. The periphyton biomass criteria derived by Snelder et al., 2023 presented for a 20% under-protection risk for the A (square), B (triangle), and C (diamond) bands.

Except for WDL, all classes comply with the C-band criteria. The CWH, CWLk, CWM, CXH, CXL, CXM, WWH, WXH, WXL, and CXLk classes comply with the B-band criteria. No classes comply with the A-band criteria.

Discussion

Ammoniacal nitrogen, nitrate nitrogen and *E. coli*

The modelled reference median concentration for these attributes complies with the A-band across river classes. Given all classes comply with the A-band for median, all target attribute bands could be considered for the median statistics. These tables have other statistics, such as 95th percentiles, which were not modelled in the study used.

Dissolved reactive phosphorus

Compliance with NOF band of the modelled reference median concentration is more varied for DRP. However, in the classes which comprise the majority of Otago's river network (CDH, CDL, CWH, CWM, CXM), natural median would comply with the A or B band. The CDH, CWM and CXM classes all comply with the A-band. The CDL and CXH classes comply with the A or B band. Therefore, all target attribute bands could be considered for these classes.

Periphyton nutrient criteria

When compared to the modelled reference state, periphyton criteria compliance varied between river classes. However, no class complied with the A-band criteria for either total nitrogen or phosphorus. This suggests 80% of segments would not naturally comply with the A-band nutrient criteria in any management class. This does not mean 80% would not achieve A-band biomass as factors other than nutrients can limit periphyton biomass. However, the A-band nutrient criteria at a 20% UPR is not a realistic target as it would not be complied with naturally.

For total nitrogen the modelled reference median in the common mountain and hill classes in Otago (CDH, CWH, CWM, CXM) complies with the B band criteria whereas common lowland classes comply with the C-band. For total phosphorus, the modelled reference median value in CDH and CDL comply with the C-band nutrient criteria. The CWH, CWM and CXM classes comply with the B-band nutrient criteria. As a result, B or C band targets could be complied with in many mountain and hill fed classes whereas the B-band would not naturally be complied with in lowland classes. This suggests 80% of segments would not naturally comply with the B-band nutrient criteria. Therefore, the C-band is the highest band lowland segments could be expected to comply with at this UPR.

Application to network vs. sites

The estimates derived in McDowell et al., 2012 provide median reference values for river classes based on a national dataset. As a result, comparisons with other nationally derived or river class-based models, such as the periphyton guidelines, would be consistent with this approach. Application of the reference values to a particular monitoring site is highly uncertain.

References

Augspurger J. 2024. Under-protection risk with updated periphyton criteria. Dunedin, New Zealand: Otago Regional Council.

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Snelder T. 2023. Guidance on look-up tables for setting nutrient targets for periphyton: 2023 draft. Wellington: Ministry for the Environment.

Snelder T, Biggs B. 2007. Multi-Scale River Environment Classification for Water Resources Management. JAWRA Journal of the American Water Resources Association. 38:1225–1239. https://doi.org/10.1111/j.1752-1688.2002.tb04344.x

Periphyton Nutrient Criteria as at 1/2/2024

Table 2: 20% under-protection risk (UPR) periphyton nutrient criteria for total nitrogen from Snelder et al., 2023 with amended Otago/Southland specific A band criteria.

Class	A	B	C
CDH	0.047	0.231	1.981
CDL	0.047	0.047	0.562
CDLk	0.047	0.542	3.187
CDM	0.047	1.532	4.297
CWH	0.047	0.376	3.147
CWL	0.047	0.179	1.990
CWLk	0.047	0.934	4.127
CWM	0.047	1.693	4.333
CXH	0.047	1.994	4.272
CXL	0.047	2.061	4.241
CXLk	0.047	2.138	4.322
CXM	0.047	2.988	4.372
WDL	0.047	0.047	0.447
WWH	0.047	0.445	3.369
WWL	0.047	0.207	2.307
WWLk	0.047	0.419	3.105
WXH	0.047	0.715	3.947
WXL	0.047	0.644	4.046

Table 3: 20% under-protection risk (UPR) periphyton nutrient criteria for total phosphorus from Snelder et al., 2023 with amended Otago/Southland specific A band criteria.

Class	A	B	C
CDH	0.001	0.004	0.033
CDL	0.001	0.003	0.030
CDLk	0.001	0.006	0.049
CDM	0.001	0.011	0.093

CWH	0.001	0.026	0.162
CWL	0.001	0.013	0.092
CWLk	0.001	0.017	0.133
CWM	0.001	0.031	0.205
CXH	0.001	0.069	0.247
CXL	0.001	0.110	0.276
CXLk	0.001	0.037	0.180
CXM	0.001	0.085	0.281
WDL	0.001	0.002	0.018
WWH	0.001	0.021	0.155
WWL	0.001	0.014	0.107
WWLk	0.001	0.013	0.096
WXH	0.001	0.036	0.209
WXL	0.001	0.035	0.206