Document Id:

MEMORANDUM

To:	**Matthew McCallum-Clark**
From:	**Jason Augspurger**
Date:	**23/02/2024**
Re:	**GMP and GMP+ reduction magnitude relative to network target attribute states for periphyton nutrient criteria**

Name	Role	Date Completed
Rachel Ozanne	Reviewer 1	28 February 2024
Helen Manly	Reviewer 2	7 March 2024

Purpose

The purpose of this memo is to inform the size of nitrogen and phosphorus reductions required to comply with the proposed network-based target attribute states for periphyton nutrients and how these reductions compare to those achieved through GMP and GMP+ scenarios.

Context

To provide context on the magnitude of change needed to comply with different target attribute states, Augspurger (2024a) modelled the progress achieved under a GMP and GMP+ scenario toward reaching different potential target attribute states. Based on this information, and the recommended approach for developing target attribute states (Augspurger, 2024b), policy have identified target attribute states for mountain, hill, and lowland class streams for each freshwater management unit (FMU) (Table 1).

Table 1: Proposed periphyton target attribute state based on management class.

FMU/Rohe	Mountain	Hill	Lowland
North Otago	B	C	C
Dunedin & Coast	B	C	C
Taieri	B	C	C

FMU/Rohe	Mountain	Hill	Lowland
Upper Lakes	B	B	C
Dunstan	B	C	C
Roxburgh	B	C	C
Manuherekia	B	C	C
Lower Clutha	B	C	C
Catlins	B	C	C

Methods

To determine progress toward the periphyton target attribute state, a variation on the approach from Augspurger (2024a) was used. This analysis links a suite of four models together to assess (1) the percent of river segments and likelihood that segments may comply with the selected target attribute state or better, (2) the likelihood a given receiving environment complies with the target attribute state under different emission reduction/mitigation scenarios and (3) the visualization of the target attribute state compliance spatially.

To link the models and assess receiving environment outcomes under the mitigation scenarios, the reductions achieved through the mitigation scenarios are summed in catchments upstream of all receiving environments (each river segment, lake, or estuary). A GIS-based drainage network (the River Environment Classification (REC)), and the associated watersheds, enables the catchment upstream of an individual river segment to be identified. The total load reduction for a given receiving environment is calculated by summing the new load achieved under the GMP and GMP+ scenarios across all land parcels and dividing by the original unmitigated load for the upstream area of every segment in the drainage network. The reduction is expressed as a proportion of the estimated source loss (%) on each receiving environment.

Upstream reductions achieved, and the required reductions to achieve the potential target attribute state are calculated for each segment and as a result the analysis can be reported at any spatial scale from individual river segment to FMU or the entire region. Due to the limitations of monitoring data input into model two, and for computational ease, outcome assessments were limited to Strahler order 3 and above.

In comparing the GMP and GMP+ reductions achieved to the required receiving environment reductions (model 2) a "1:1" reduction is assumed (e.g., a 25% reduction achieved across the upstream land parcels would correspond to a 25% reduction in the current load at receiving environment). The assumption of the "1:1" reduction is a simplification because the processes involved in the transport of contaminants (such as N or P) from a land parcel source to a receiving environment are complex, with multiple possible pathways, time frames and biophysical processes at play. Contaminants can be reduced between a land parcel and receiving environment (attenuated) by processes such as de-nitrification. The attenuation or reduction of contaminant loads as they are transported from the land parcel to receiving environments is an area of active research, and there is limited data to quantify this process. The uncertainty present in the relationship is currently unquantifiable. Alongside a "1:1"

reduction, implementation of the GMP and GMP+ mitigations are assumed to be 100% and all reductions are realized immediately and not subject to staged uptake by land users or lags. GMP and GMP+ are also assumed to be unimplemented in Otago under the current scenario which means realized improvements under these scenarios may be less than those modelled here. Thus, results here are likely to form an "upper end" estimate of reductions achieved.

Incorporation of uncertainty

The outcomes are expressed, for any FMU, as the mean (i.e., best estimate) and 90% confidence interval (i.e., 5-95 levels of confidence) of "percent receiving environments complying with target attribute band". This process is carried out across all potential target attribute state and spatial units. To account for heterogeneity within different types of streams, the results are presented by management class.

To convey the magnitude of reduction required beyond GMP or GMP+, each segment's percent required reduction is compared to the percent reduction achieved in its upstream catchment under the GMP and GMP+ scenarios. Due to the approach used for conveying uncertainty (see Augspurger, 2023 and Snelder and Fraser, 2023), results are expressed as the mean reduction required for each segment, which is considered the best estimate. To simplify communication of the required reductions the terminology in Table 2 was used.

Table 2: Terminology used to discuss required reductions.

Reduction (%)	Terminology
0%	No reduction required
0-20%	Low
20-40%	Moderation
>40%	High

To simplify communication of confidence interval results for river outcomes, four categories were considered:

•   First, if both confidence intervals and the mean approach 100% (e.g., 99%; 100-100), there is high confidence no reduction is required to comply.

•   Where the upper confidence overlaps 100%, the lower confidence interval does not, and the mean percent of segments comply is high (e.g., 95%; 43-100), a reduction may be required to comply.

•   Similarly, where the upper confidence interval overlaps 100%, the lower does not, and the mean is low, a reduction is likely required (75%; 20-100).

•   When neither confidence interval overlaps 100%, there is high confidence a reduction is required to comply (50%; 40-80).

Using this approach, a segment near a catchment's terminus may indicate a required reduction while those upstream may not. This means the upstream segments comply with their respective criteria. However, this does not mean reductions are not needed in these areas. To

comply in downstream segments, the entire catchment upstream of a given segment may need to reduce.
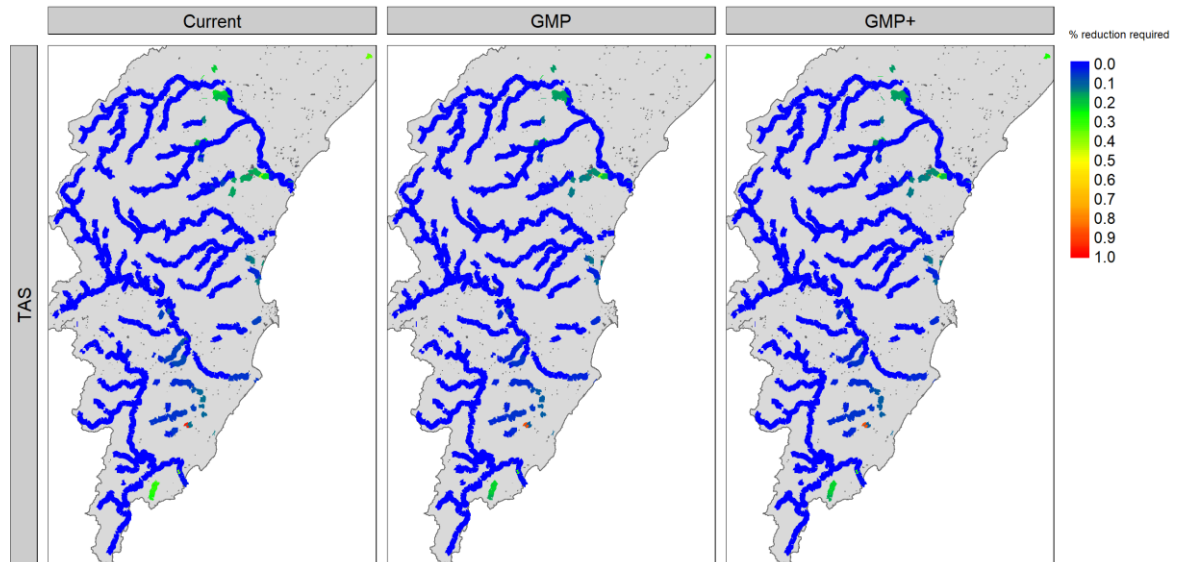
Results

North Otago

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (Table 3), 96% of segments currently comply. Confidence intervals indicate reductions are required for all segments to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly. Confidence intervals indicate reductions beyond GMP are required for all segments to comply. Under the GMP+ scenario, the upper confidence interval indicates all segments may comply. However, the mean and lower confidence interval indicate further reductions beyond GMP+ may be required.

For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (Table 3), 96% of segments currently comply. Confidence intervals indicate reductions may be required for all segments to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly however further reductions may be required for all segments to comply.

Table 3: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

Total Nitrogen			Total Phosphorus			
Current	**GMP**	**GMP+**	**Current**	**GMP**	**GMP+**	**Total segments**
96 (92 - 99)	96 (93 - 99)	97 (93 - 100)	96 (88 - 100)	97 (90 - 100)	98 (93 - 100)	1,111

For both total nitrogen (Figure 1) and total phosphorus (Figure 2), the majority of segments within the FMU require low reductions. However, some moderate reductions are also required. Under the GMP and GMP+ scenario or total nitrogen, the upstream catchments do not achieve the reductions required in these segments. As a result, reduction beyond GMP+ may be required for all segments to comply. The GMP and GMP+ scenario reduce the required phosphorus reduction to near 0 indicating reductions beyond GMP+ may not be required.

Figure 1: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.
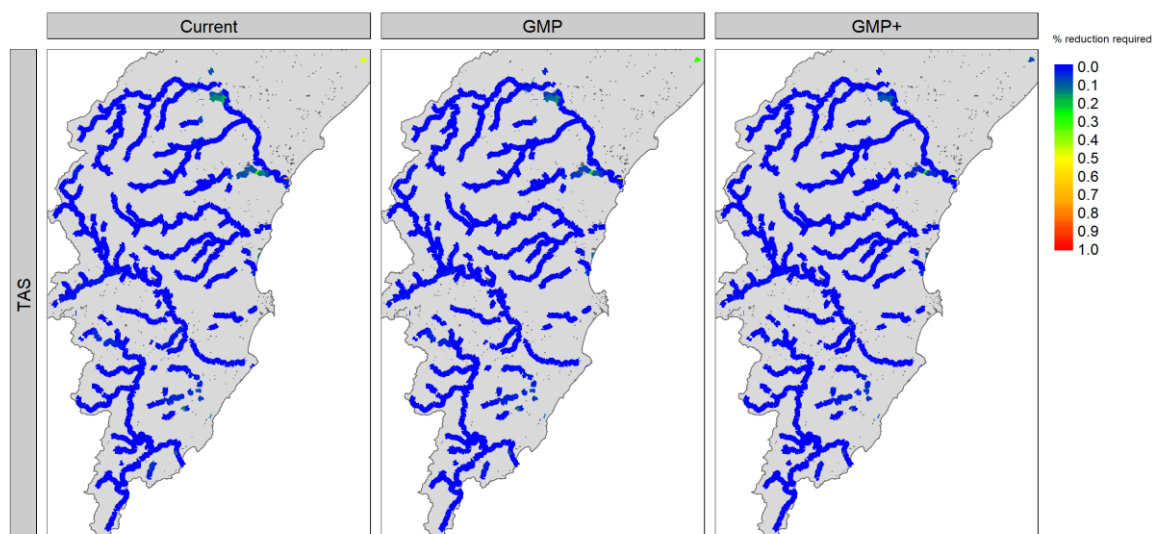
Figure 2: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Dunedin & Coast

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

Table 4), 64% of segments currently comply. Confidence intervals indicate reductions are required for all segments to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly however confidence intervals indicate reductions beyond GMP+ are required for all segments to comply.

For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (
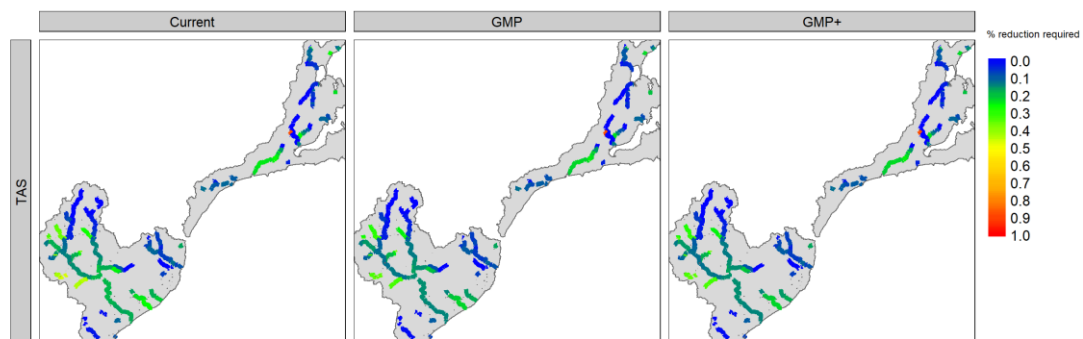
Table 4), 72% of segments currently comply. Confidence intervals indicate reductions are required for all segments to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly, but the confidence interval still fails to overlap 100%. This indicates with 95% confidence a reduction beyond GMP+ is required for all segments to comply with their target attribute state nutrient criteria.

Table 4: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

Total Nitrogen			Total Phosphorus			
Current	GMP	GMP+	Current	GMP	GMP+	Total segments
64 (34 - 88)	66 (35 - 91)	68 (36 - 91)	72 (48 - 97)	73 (48 - 98)	74 (49 - 98)	351

For both total nitrogen and total phosphorus, the required reductions in the Dunedin & Coast FMU range from low (i.e., <20%) to moderate (20-50%). Under the GMP and GMP+ the required reductions remain moderate in many locations indicating reductions beyond GMP+ are required for all segments to be expected to comply.

Figure 3: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.
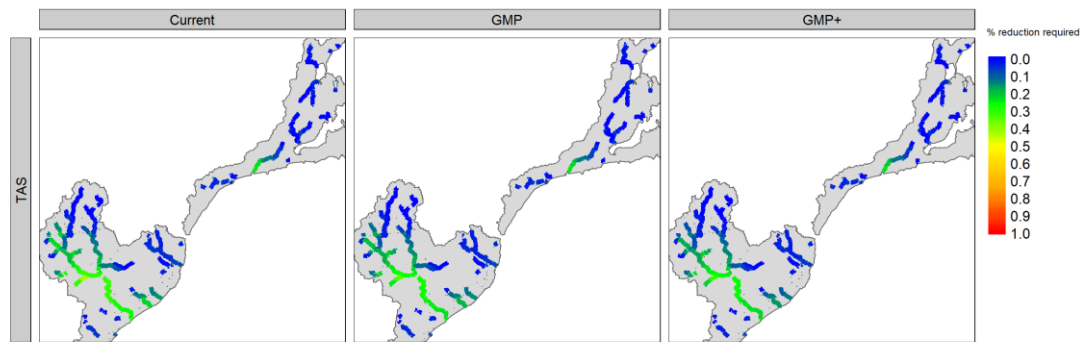
Figure 4: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Taieri

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

Table 5), 97% of segments currently comply. Confidence intervals indicate reductions may be required for all segments to comply. Under the GMP and GMP+ scenario, the proportion of segments complying improves slightly with no difference between the GMP and GMP+ scenarios. The mean estimate and confidence intervals indicate reductions beyond GMP+ may be required for all segments to comply.

For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (

Table 5), 81% of segments currently comply. The upper confidence interval fails to overlap 100% indicating reductions are required. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly with the upper confidence interval overlapping 100%. However, the mean estimate and lower confidence interval indicate further reductions may be required for all segments to comply.

Table 5: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

| Total Nitrogen			Total Phosphorus			Total segments
Current	**GMP**	**GMP+**	**Current**	**GMP**	**GMP+**	
97 (93 - 100)	98 (94 - 100)	98 (94 - 100)	81 (28 - 99)	84 (35 - 100)	86 (42 - 100)	2,710

Mean required reductions for total nitrogen in the Taieri FMU (Figure 5) indicate no reduction is required for most segments in the FMU. However, on the lower Taieri plain, moderate to high reductions are required. These decrease under the GMP and GMP+ scenario but remain moderate.
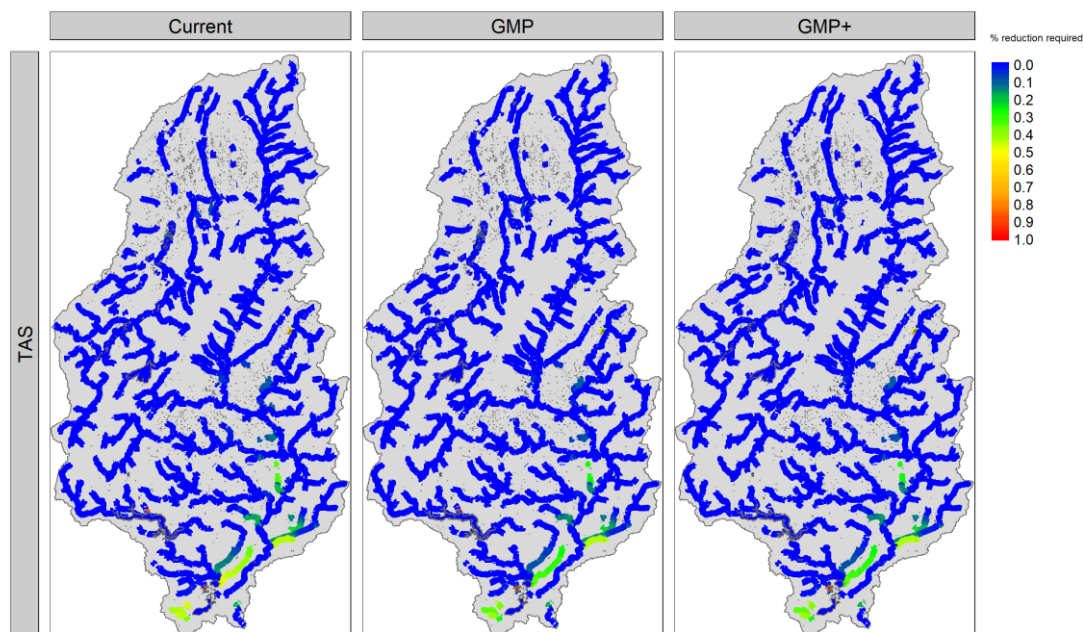
Figure 5: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Mean required reductions for total phosphorus in the Taieri FMU (Figure 6Figure 5) indicate no reduction is required for most segments in the FMU. However, the mainstem requires moderate reductions and segments in the lower Taieri plain require moderate to high levels of

reduction. These decrease under the GMP and GMP+ scenario with much of the mainstem requiring no or low reduction under the GMP+ scenario.
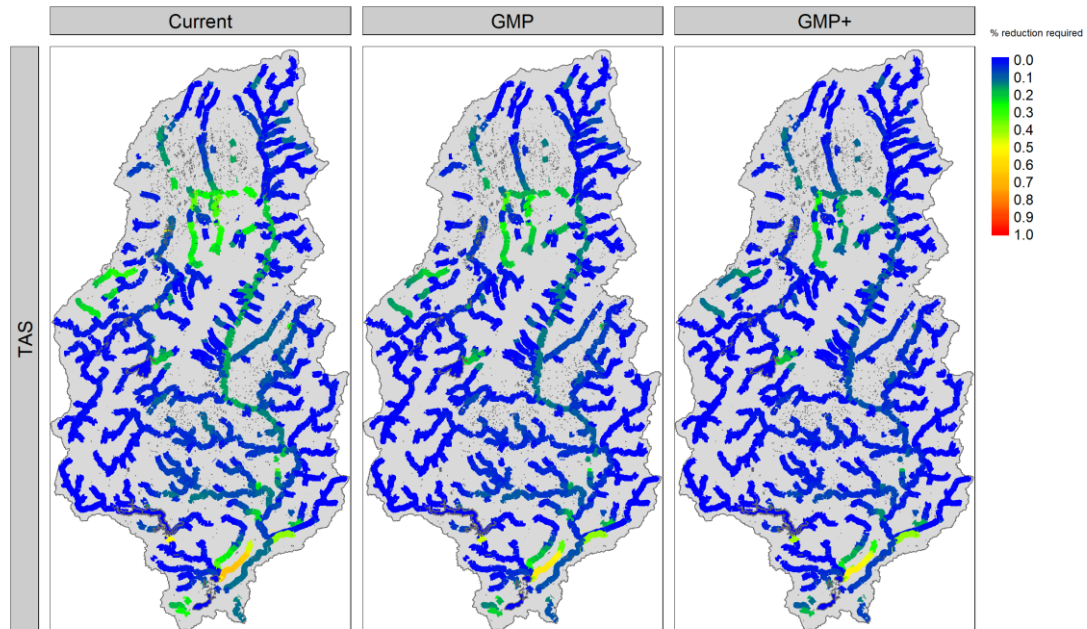
Figure 6: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Upper Lakes Rohe

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

Table 6), 100% of segments currently comply indicating no reduction is required.

For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (

Table 6), 98% of segments currently comply. The upper confidence interval reaches 100% indicating that there is less than 95% confidence a reduction is required for all segments to comply. The lower confidence interval indicates with 95% confidence that 98% of segments comply.

For both total nitrogen and total phosphorus the percent of segments complying does not change under the GMP or GMP+ scenario. This occurs for two reasons. First, most segments already comply. Second, the pastoral mitigation suite applies to a relatively small proportion of land use in this Rohe.

Table 6: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

Total Nitrogen			Total Phosphorus			Total segments
Current	GMP	GMP+	Current	GMP	GMP+	
100 (99 - 100)	100 (99 - 100)	100 (99 - 100)	98 (97 - 100)	98 (97 - 100)	98 (97 - 100)	4,165

For both total nitrogen and total phosphorus, most segments require no reduction (Figure 7). Some segments nearby the urban areas within the FMU require moderate phosphorus reductions (Figure 8). These do not improve under the GMP and GMP+ scenario as these mitigations are not suitable for these areas. However, measures which reduce loads in these segments are needed.
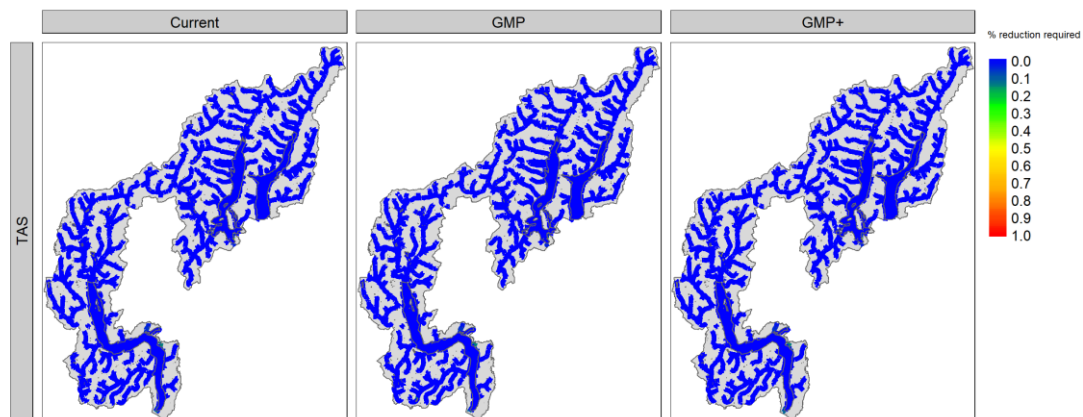
Figure 7: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.
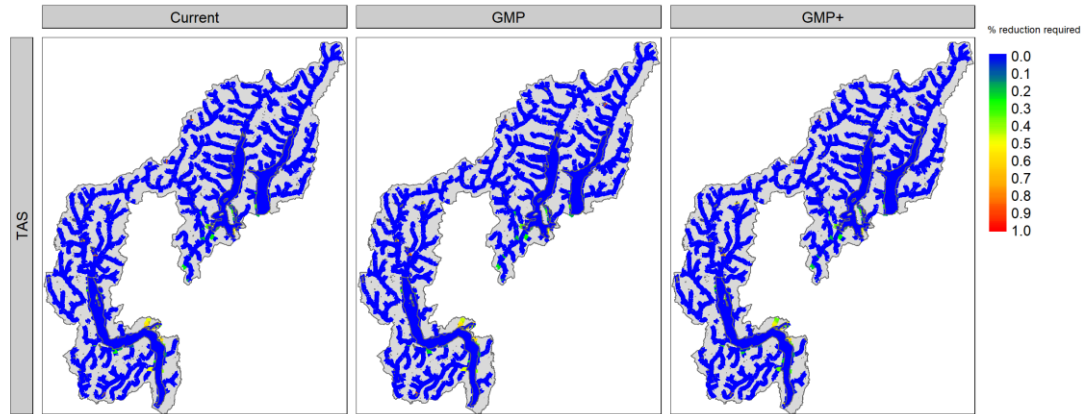
Figure 8: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Dunstan Rohe

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

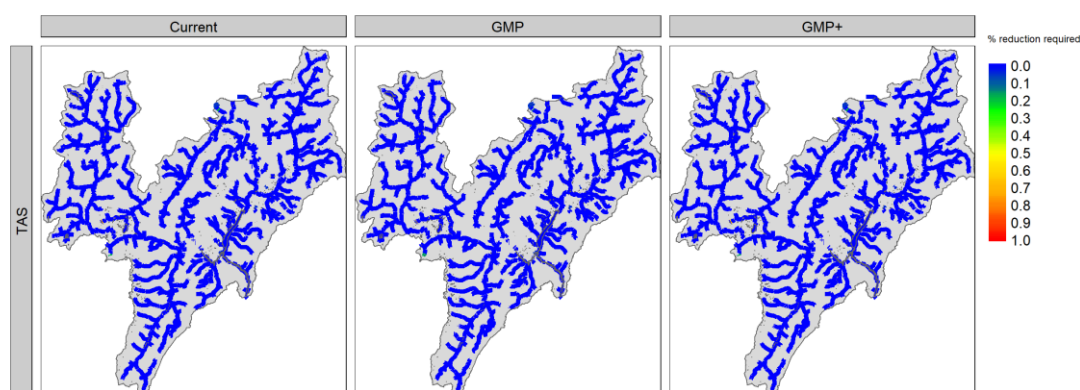Table 7), 100% of segments currently comply indicating no reduction is required.

For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (

Table 7), 97% of segments currently comply. Confidence intervals indicate reductions may be required. Under the GMP scenario no improvement in the proportion of segments expected to comply is seen, whereas under GMP+ a slight improvement occurs. However, reductions beyond GMP+ may be required for all segments to comply.

Table 7: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

Total Nitrogen			Total Phosphorus			Total segments
Current	GMP	GMP+	Current	GMP	GMP+	
100 (99 - 100)	100 (99 - 100)	100 (100 - 100)	97 (89 - 100)	97 (89 - 100)	98 (89 - 100)	2,920

For both total nitrogen and total phosphorus, most segments require no reduction (Figure 9). Some segments near the urban areas within the FMU require moderate or high phosphorus reductions (Figure 10Figure 8). These do not improve under the GMP and GMP+ scenario as these mitigations are not suitable for these areas. Measures which reduce loads in these areas are required.

Figure 9: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.
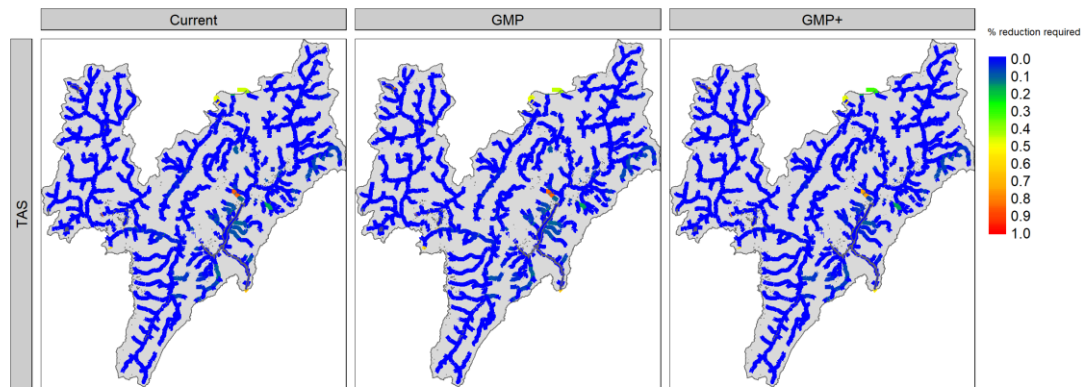
Figure 10: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Roxburgh Rohe

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

Table 8

Table 5), 99% of segments currently comply indicating no reductions are required. Under the GMP and GMP+ scenarios, the proportion of segments complying does not change.

For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (

Table 8

Table 5), 91% of segments currently comply. Confidence intervals indicate reductions may be required for all segments in this Rohe to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly. However, confidence intervals indicate reductions beyond GMP+ may be require for all segments to comply.

Table 8: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

Total Nitrogen			Total Phosphorus			Total segments
Current	**GMP**	**GMP+**	**Current**	**GMP**	**GMP+**	
99 (96 - 100)	99 (96 - 100)	99 (96 - 100)	91 (65 - 100)	91 (67 - 100)	93 (73 - 100)	826

For total nitrogen, most segments in the Roxburgh Rohe require no reduction to comply, however isolated segments require low to moderate reductions. For total phosphorus, the majority of the Rohe requires no reduction. However, some areas (the Fraser catchment and others) require low to moderate levels of reduction. Under the GMP and GMP+ scenarios these decrease but are still low to moderate indicating reductions beyond GMP+ may be required for all segments to comply.
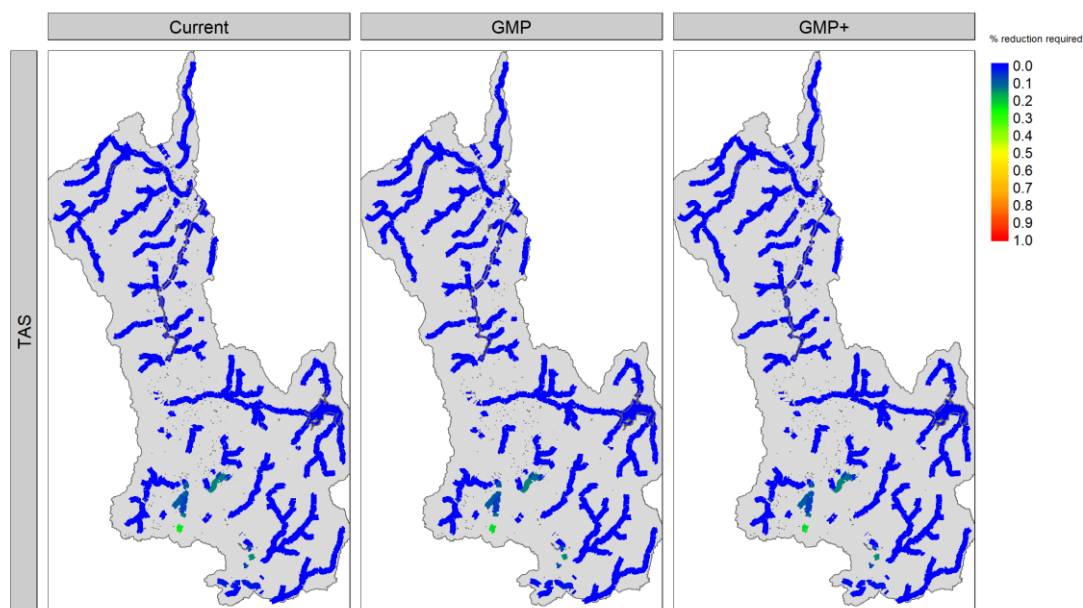
Figure 11: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.
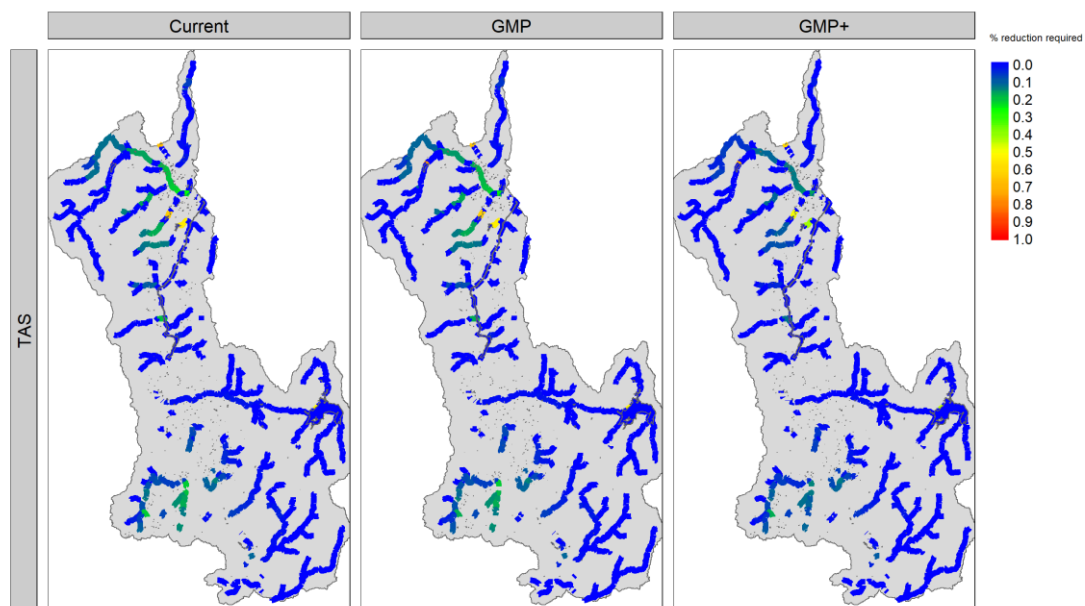
Figure 12: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Manuherekia Rohe

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

Table 9), 100% of segments currently comply indicating no reduction is required.
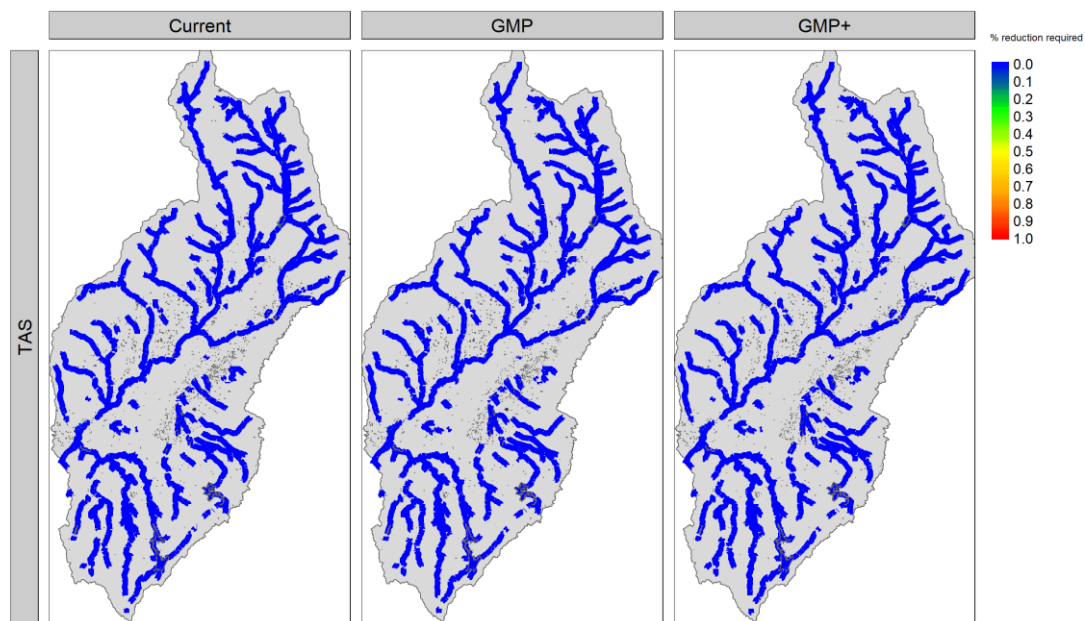
For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (

Table 9), 86% of segments currently comply with confidence intervals indicating a reduction may be required. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly, but the confidence interval still fails to reach 100%. This indicates reductions beyond GMP+ may be required for all segments to comply.

Table 9: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

Total Nitrogen			Total Phosphorus			Total segments
Current	**GMP**	**GMP+**	**Current**	**GMP**	**GMP+**	
100 (100 - 100)	100 (100 - 100)	100 (100 - 100)	86 (59 - 100)	87 (61 - 100)	89 (66 - 100)	1,343

For total nitrogen, no segments require reductions (Figure 13). For total phosphorus (Figure 14), the mainstem requires low reductions and to comply. The Manor burn and Pool burn require high reductions under the current scenario which decreases to moderate reduction under the GMP+ scenario. This indicates while improvement occurs, reduction beyond GMP+ would be necessary for these segments to comply.

Figure 13: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.
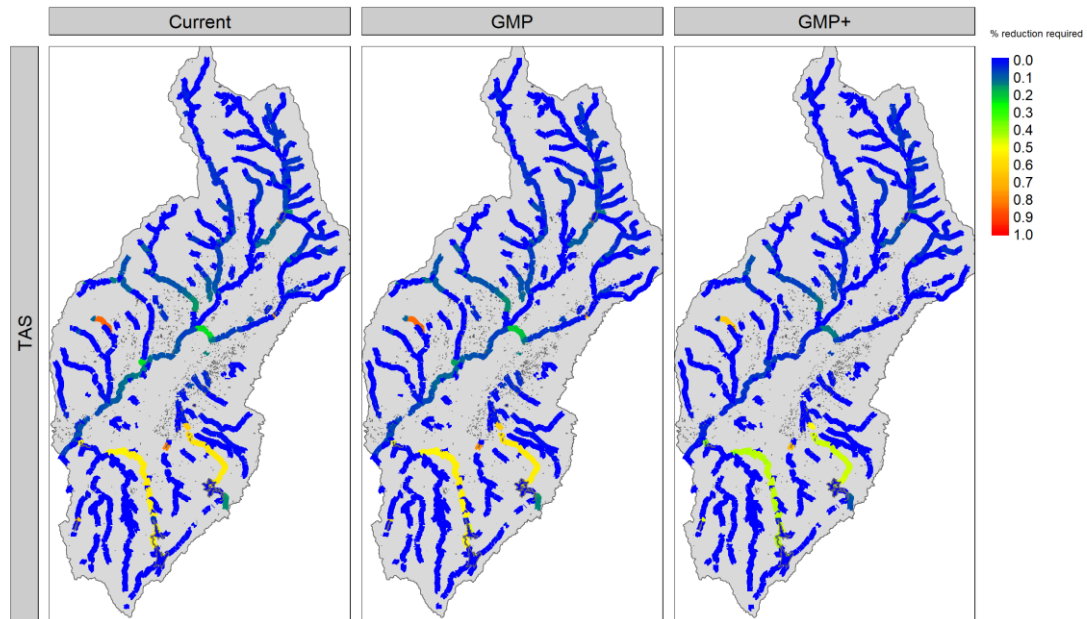
Figure 14: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Lower Clutha Rohe

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

Table 10), 60% of segments currently comply. The upper confidence interval does not reach 100% indicating reductions are required for all segments to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly. However, confidence intervals indicate reductions beyond GMP+ are required for all segments to comply.
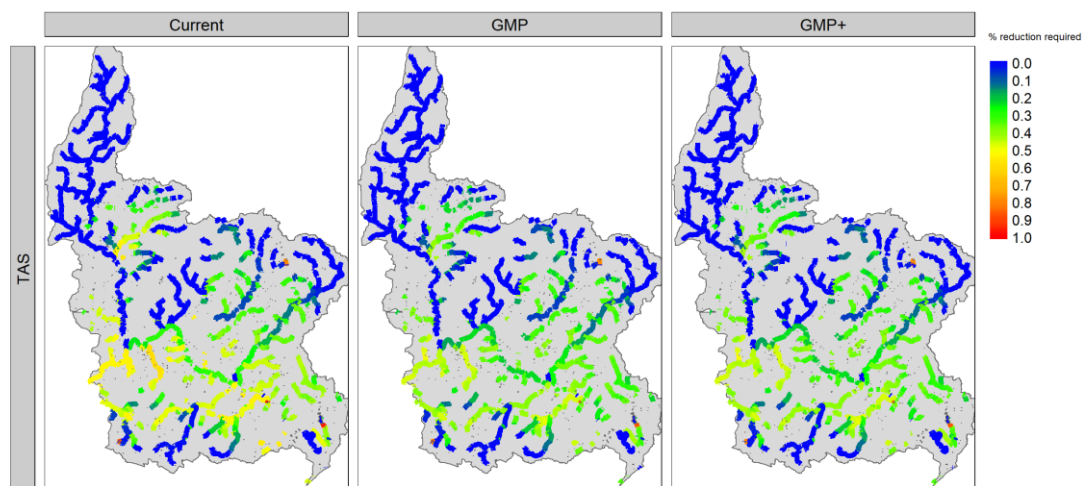
For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (

Table 10), 64% of segments currently comply with confidence intervals indicating a reduction is required for all segments to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly with the upper confidence interval overlapping 100%. However, the mean and lower confidence interval indicate a reduction beyond GMP+ is likely required for all segments to comply.

Table 10: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

Total Nitrogen			Total Phosphorus			
Current	GMP	GMP+	Current	GMP	GMP+	Total segments
60 (46 - 91)	62 (47 - 95)	65 (48 - 99)	64 (39 - 98)	66 (39 - 100)	66 (40 - 100)	1,685

For both total nitrogen (Figure 15) and total phosphorus (Figure 16) in the Lower Clutha Rohe moderate to high reductions are required. Under the GMP and GMP+ scenarios this reduces to predominantly moderate reductions being required. This indicates reductions beyond GMP+ would likely be necessary for all segments to comply.

Figure 15: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.
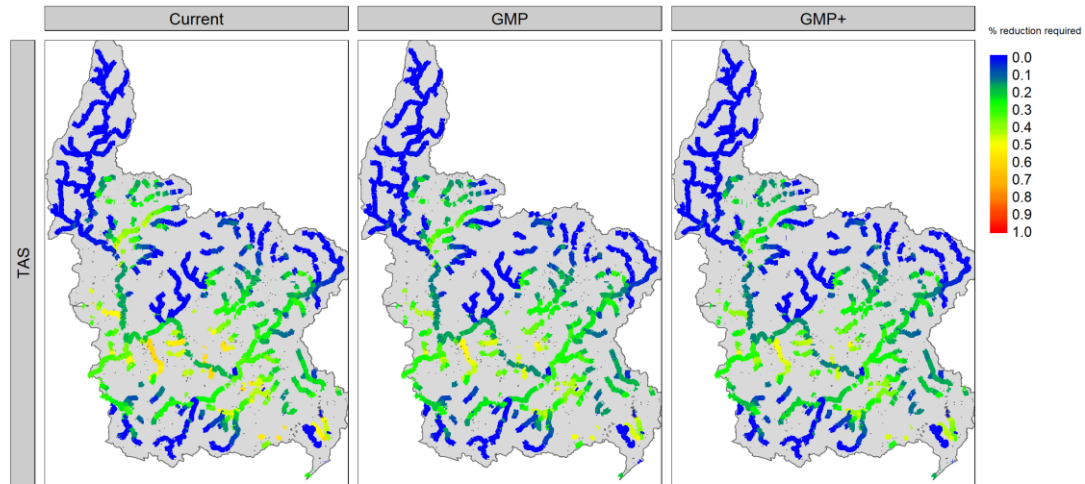
Figure 16: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Catlins

For total nitrogen in relation to the proposed network target attribute states and associated nutrient criteria (

Table 11Table 3), 85% of segments currently comply with confidence intervals indicating reductions are required for all segments to be expected to comply. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly. However, confidence intervals indicate reductions beyond GMP+ are required for all segments to comply.

For total phosphorus in relation to the proposed network target attribute states and associated nutrient criteria (

Table 11Table 3), 92% of segments currently comply with confidence intervals indicating a reduction is required. Under the GMP and GMP+ scenarios, the proportion of segments expected to comply improves slightly with the upper confidence interval overlapping 100% under the GMP+ scenario. However, the mean estimate and lower confidence interval indicate reductions beyond GMP+ may be required for all segments to comply.

Table 11: Percent of river segments complying with proposed network target attribute states and associated criteria from Snelder et al., 2023 using a 20% UPR with 90 percent confidence intervals for current, GMP and GMP+ scenarios. Segments which do not support periphyton growth have been removed prior to analysis.

| Total Nitrogen			Total Phosphorus			Total segments
Current	GMP	GMP+	Current	GMP	GMP+	
85 (73 - 95)	87 (75 - 96)	88 (75 - 98)	92 (85 - 99)	94 (86 - 99)	95 (87 - 100)	647

For total nitrogen (Figure 17), southern areas of the FMU require no reduction whereas northern areas (the Owaka and Puerua) require moderate to high levels of reduction for all segments to comply. Under the GMP and GMP+ scenario these decrease to moderate levels of reduction. This indicates reductions beyond GMP+ may be necessary for all segments to comply.
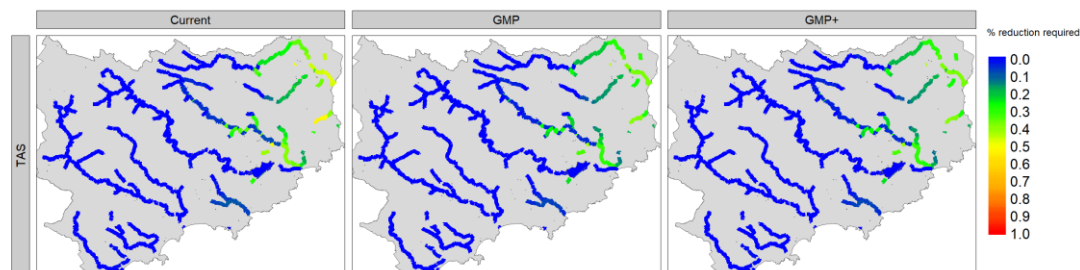
Figure 17: Mean percent load reduction required for total nitrogen to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

For total phosphorus (Figure 18), southern areas of the FMU require no reduction whereas northern areas require moderate reductions. Under the GMP and GMP+ scenarios these

improve to low to moderate reductions. This indicates reductions beyond GMP+ may be necessary for all segments to comply.
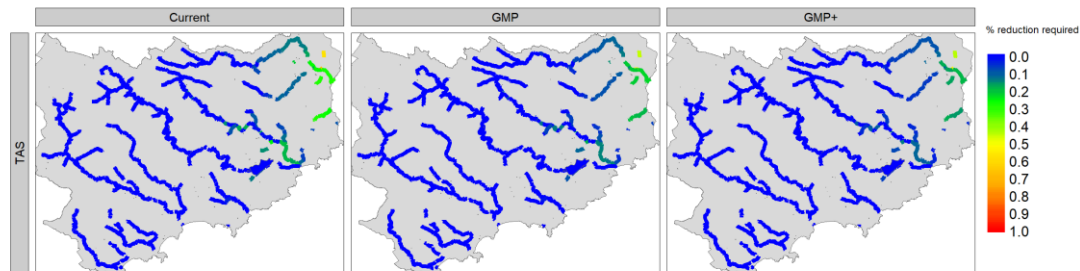
Figure 18: Mean percent load reduction required for total phosphorus to comply with the periphyton proposed target attribute state using the Snelder et al., 2023 nutrient criteria with a 20% UPR under the current, GMP and GMP+ scenarios.

Discussion

The results of this study have high level of both statistical and non-statistical uncertainty which are more fully discussed in the original scenario report (Augspurger 2024a). As a result, some caution is needed when interpreting results. To aid in understanding the uncertainties, a compliance framework can be used. While arbitrary and qualitative, the framework below indicates the risk that a proportion of the FMU does not comply with the target attribute state. Where the upper confidence interval and mean reach 100% of segments complying, there is little risk of non-compliance and the FMU could be considered to fully comply. Where the mean is less than 100% but greater than 90%, there is low non-compliance. For FMUs with a mean of less than 90% of segments complying but more than 70%, noncompliance is moderate. For FMUs with a mean of less than 70% complying, noncompliance could be considered high as the lower confidence interval is also less than 50%. Further when paired with a 20% under protection risk, this means less than 50% of segments in the FMU may comply with the biomass objective.

For total nitrogen, four FMUs/Rohe can be considered fully compliant, two have low non-compliance, one has moderate compliance and two are considered as high non-compliance. For total phosphorus, 1 Rohe has high non-compliance, 3 FMUs/Rohe have moderate non-compliance and the remaining have low non-compliance.

Aligning with the results of the original study (Augspurger 2024a), under the GMP and GMP+ scenario relatively minor improvements are seen in the proportion of segments complying; no FMUs improve to a new category. This is indicative of within band improvement or, where degrading trends are occurring, improvement in trend slope. As a result, the compliance table represents both current state but also expected state under the GMP and GMP+ scenarios. Therefore, where target attribute is set at, or near, baseline state the mitigation scenarios are likely to result in compliance. Where target attribute is set above the baseline state band, reductions beyond GMP+ may be required to comply.

Table 12: FMU compliance table

FMU/Rohe	TN	TP
North Otago	Low non-compliance	Low non-compliance
Dunedin & Coast	High non-compliance	Moderate non-compliance
Taieri	Low non-compliance	Moderate non-compliance
Upper Lakes	Full compliance	Low non-compliance
Dunstan	Full compliance	Low non-compliance
Roxburgh	Full compliance	Low non-compliance
Manuherekia	Full compliance	Moderate non-compliance
Lower Clutha	High non-compliance	High non-compliance
Catlins	Moderate non-compliance	Low non-compliance

Additional considerations

As outlined in Augspurger (2024a) the analysis presented here has both quantified, and unquantified, uncertainty. These uncertainties should be considered when interpreting results. Results for individual segments are highly uncertain, but broad-scale patterns and relativities between scenarios are more likely to be useful in a planning context.

A pragmatic response to the uncertainty present is to consider the magnitude of relativities under the different scenarios and adaptively manage where results indicate target attribute state may be achieved. For example, if the FMUs upper confidence interval overlaps 100% and the mean nears 100% for the class under the GMP scenario, it may be logical to implement the scenario and measure the results before implementing further actions. Where the upper confidence interval and mean do not approach or overlap 100% for the target attribute state under the GMP+ scenario, further reductions are likely to be required in the future. In this case, it is important to consider whether the additional investment required under a GMP+ scenario is justified when more change is likely to be required.

Alongside the modelling results presented here, site-based state and trend as well as receiving environments such as estuaries and lakes must also be considered. While network modelling may indicate no reductions are required, sites with degrading trends or sites which fail to comply with the target attribute state may require reductions. Therefore, these results must be considered alongside those presented in the baseline state report (Augspurger 2024b).

Where sites comply with a state above that represented here, they would be expected to improve within the current band. Where a site currently hovers on threshold between bands, it may improve to the better band. Where sites are degrading, the outcome of the GMP and GMP+ scenario is likely to an improvement in trend direction.

Conclusion

To aid in understanding whether suites of limits achieve the periphyton nutrient criteria target attribute states, this study linked nitrogen and phosphorus reductions through two mitigation scenarios to the in-stream reductions required to comply with the proposed target attribute states. Given the uncertainty and limitations present, our findings are best interpreted as indicating the magnitude of instream and on-land change likely to occur under these scenarios. Comparisons of reductions in nitrogen and phosphorus achieved through the GMP and GMP+ packages indicate that while large "on-land" reductions can be achieved, these reductions generally to do not result in multi-band changes in receiving environments. Instead, these scenarios are likely to result in within band improvement. Therefore, where target attribute is set at, or near, baseline state the mitigation scenarios are likely to result in compliance. Where target attribute is set above the baseline state band, reductions beyond GMP+ may be required to comply.

References

Augspurger J. 2024a. LWRP Nitrogen and Phosphorus Reduction Scenarios. Dunedin, New Zealand: Otago Regional Council.

Augspurger J. 2024b. Water Quality Baseline State. Dunedin, New Zealand: Otago Regional Council.