environment SOUTHLAND
REGIONAL COUNCIL
Te Taiao Tonga

Memorandum
For Your Information

To:	PWL Steering Group, Bonny Lawrence, Elaine Moriarty
CC:	Lucy Hicks, Emma Moran
From:	Karen Wilson and Ned Norton (Kaituitui Science Co-Leads)
Date:	26th February 2021
Subject:	***Recommended actions arising from stakeholder feedback on science reports estimating nutrient load reductions to achieve freshwater objectives***

1 Purpose and decisions required

The purpose of this memo is to summarise our recommended actions following consideration of feedback from stakeholders on the science reports that estimate nutrient load reductions needed to achieve freshwater objectives. The summarised recommendations in this memo draw on a separate document co-authored by Dr Ton Snelder (LWP) and Roger Hodson (ES) with input from Dr David Plew (NIWA), which contains more detailed technical responses to the feedback from stakeholders.

Our recommendations include:

- Some areas where further work suggested by stakeholders would be useful and we suggest is justified to do now;
- Some areas where further work could be useful but we suggest should be planned for the medium term (3 to 5 years) because it is either not possible to do quickly and/or is not highest priority to do right now;
- Some areas we don't think the further work suggested is justified.

We also recommend that this memo and the more detailed technical response companion document be provided to stakeholders so they can form a view on whether there are outstanding matters of contention.

Once stakeholders have had the opportunity to consider our response to their feedback, we recommend that any outstanding matters of contention be subject to external independent peer review.

Our list of recommendations and the reasons we think they are useful are summarised in section 6.

Decisions are needed on whether to proceed with our recommendations.

2 Background and stakeholder feedback process

In December 2020, Environment Southland (ES) completed a first round of consultation with stakeholders on work associated with assessment of nutrient (nitrogen and phosphorus) load reductions required to achieve draft freshwater objectives (FWOs) in the rivers, lakes and estuaries of Southland Murihiku. The purpose of the nutrient load reduction assessment is to inform the Southland Regional Forum and regional planning processes, which is considering how FWO can be achieved in the Southland Region.

The consultation involved four Zoom meetings with stakeholders and the circulation of the following reports for feedback:

- Snelder (2020): Assessment of Nutrient Load Reductions to Achieve Freshwater Objectives in the Rivers, Lakes and Estuaries of Southland.
- Cox et al., (2020): Southland Region Catchment Nutrient Models (CASM).
- Rodway (in preparation): Contaminant Losses to Water from Agricultural Land Uses in Murihiku.
- Plew (2020): Models for evaluating impacts of nutrient and sediment loads to Southland estuaries.

Additional reports were provided for context and further information:

- De Silva and Hodson (2020): Drivers of periphyton in the Southland region
- Wilson et al., (2019): Community values for Southland's freshwater management units
- Wilson and Norton (2020): Key early messages from contaminant loads modelling for ES executive
- Norton and Wilson (2019): Developing draft freshwater objectives for Southland
- Norton et al., (2019): Current environmental state and the "gap" to draft freshwater objectives for Southland

Written feedback was provided to ES by DairyNZ, Beef and Lamb and Meridian Energy Ltd. The following organisations elected not to provide written feedback but were part of the stakeholder group that received material and participated in the Zoom meeting discussions: Department of Conservation, Fish and Game (Southland), Southern Health Board, Ballance and Deer NZ. Federated Farmers and Ravensdown were also subsequently provided recordings of the Zoom meetings and reports, and were invited to provide feedback with none being received.

3 How we have structured this response

In this memo we refer to the issues raised by the stakeholders collectively and by topic area, rather than by identifying every individual detailed point and its associated stakeholder author(s). This is because we think the feedback can be logically grouped into topics, and because some topics were raised by more than one stakeholder.

Our goal has been to cut through some of the technical detail and focus on identifying the stakeholder suggestions that we recommend be addressed with further work. A more detailed technical response has been prepared separately to help more fully justify our recommendations. It is intended that both this memo and the more detailed technical response will be provided to the stakeholders so they can form a view on whether there are outstanding matters of contention.

We think the feedback can be divided into two themes:

i) issues associated with uncertainty of scientific information for decision making on limits; and

ii) a list of other discrete issues that can be addressed one by one.

We will address the uncertainty-related issues as a group first, and then the list of other issues.

4 Issues related to uncertainty and using 'best information available'[1]

Uncertainty with the scientific information that will inform limit-setting decisions is inevitable. This seems to be accepted, in general terms, by all stakeholders. What we think seems to be at some contention is:

i) the level of uncertainty that can be tolerated;
ii) the degree to which uncertainty can be reduced;
iii) the scientific methods used to reduce and/or better communicate uncertainty for decision making, and
iv) the degree of precaution that should be taken in the face of uncertainty by decision makers when they ultimately make their decisions on limits.

We believe that items (i) and (iv) are matters for consideration by planners and then ultimately decision makers. We therefore do not address these further in this memo.

On item (ii) we think there is very limited opportunity at this time to actually reduce the scientific uncertainty around estimates of nutrient load reductions needed to achieve freshwater objectives. This is due to fundamental limitations of currently available data and scientific knowledge. We consider that the modelling approach taken by ES has made best use of the data and modelling tools available at this time. We do not consider that the stakeholder feedback has offered any alternative scientifically better quantify data or modelling tools that will significantly reduce the uncertainty at this time around estimates of required nutrient load reductions.

However, in terms of item (iii), we certainly agree with stakeholder feedback that there is considerable uncertainty with the nutrient load reduction estimates and that further work could help better explore and communicate that uncertainty for decision makers. All the following topic areas suggested by stakeholders contribute to better exploration and communication of this uncertainty. We address each of the following topics with recommendations in sub-sections 4.1 to 4.5:

- Quantitative uncertainty analysis
- Alternative load reduction estimates for alternative "choice of spatial exceedance"
- Considering measured versus modelled data
- Considering alternative nutrient criteria
- Longer term studies to reduce uncertainty with nutrient criteria and required load reductions.

4.1 Quantitative uncertainty analysis

Stakeholders expressed concern that the Southland study did not include an analysis of uncertainties associated with the load reductions, whereas a national scale study published in the New Zealand Journal of Marine and Freshwater Research (Snelder et al., 2020 – notably the same lead author who conducted the Southland nutrient load reduction study) did include an uncertainty analysis. This was not undertaken at the time due to resource constraints, although an indication of the approximate scale of some aspects of uncertainty were provided by reference to the Snelder et al., (2020) results in the "key messages" memo for the ES executive (Wilson and Norton 2020).

[1] We note that the National Policy Statement for Freshwater Management (NPS-FM) 2020 (clause 1.6) lays out particular requirements concerning what is to be considered "best information available at the time".

Recommendation

- We recommend that the scope of the Southland nutrient reduction requirement study be increased to include estimation of the quantifiable aspects of uncertainty (as upper and lower 95% confidence levels) using the methodology used by the published national scale analysis (Snelder et al., 2020).

4.2 Alternative load reduction estimates for alternative "choice of spatial exceedance"

Stakeholders have requested that we redo the load reduction analysis using periphyton nutrient criteria corresponding to a "30% spatial exceedance". The concept of a "spatial exceedance criterion" is comprehensively explained in an appendix dedicated to that purpose in the more detailed technical response document (see Appendix A of that document). In brief, deciding what spatial exceedance criterion to use is a necessary part of using nutrient criteria to estimate nutrient load reduction requirements to achieve stated objectives. The spatial exceedance criterion sets the assumed tolerable risk for spatial extent of compliance with the periphyton objective; for example, setting a 30% spatial exceedance produces nutrient concentration criteria that are designed to achieve the designated periphyton objective in all but 30% of river segments (i.e., river length). In other words, the designated periphyton biomass objective is assumed to be met in 70% of the river's length; notably the risk that 30% of river length has biomass higher than the designated objective is deemed tolerable.

The existing load reduction estimates in the Southland study used a 20% spatial exceedance criterion (i.e., the risk that 20% river length exceeding the designated periphyton objective is assumed to be tolerable). This 20% spatial exceedance assumption is the same as used in several previous similar studies including the published national scale study mentioned above (Snelder et al., 2020), as well as earlier work to support the Ministry for Environment's (MFE) regulatory impact statement for the NPSFM (2020), and in recent national scale load reduction estimates released in December 2020 by the Our Land and Water National Science Challenge, a multi research agency government funded research programme[2].

Despite the precedent for using a 20% spatial exceedance criterion in the previous national studies described above, there has been no national decision on an appropriate spatial exceedance criterion to use when setting limits under the NPS-FM (2020). As we understand it, this remains a matter for discretion by regional councils as they set nutrient criteria and associated limits required under the NPS-FM (2020) to meet periphyton objectives. The Southland load reduction work simply followed the earlier precedents in using the 20% spatial exceedance. We note that the compulsory periphyton attribute expressed in the NPS-FM (2020)[3] applies in all rivers. No spatial exceedance allowance is given but there is a defined allowance for 8% or 17% (depending on river class) of monthly collected samples to exceed the biomass thresholds and still be deemed to meet the target attribute state (i.e., freshwater objective). We have assumed the same applies to draft Murihiku Southland objectives for periphyton. The need to consider a spatial exceedance criterion (e.g., 20% or 30%) arises when councils define nutrient criteria to help achieve the periphyton objectives. The choice of spatial exceedance criterion expresses options for the level of risk that the nutrient criteria will be sufficient to achieve the periphyton objectives. Our opinion is that the choice of spatial exceedance criterion appears to be a matter for discretion by regional councils and their decision-makers[4].

[2] See https://ourlandandwater.nz/

[3] In the National Objectives Framework (NOF), Appendix 2A (Table 2) of the NPS-FM (2020).

[4] For example, see NPS-FM (2020) Clause 3.13.

It is possible to redo the load reduction analysis using a 30% spatial exceedance to produce a second, alternative set of nutrient load reduction estimates that can be compared with the existing load reductions. The 30% spatial exceedance criterion will produce smaller load reduction requirements than the existing load reduction estimates. This is because smaller load reductions are necessary if more risk of spatial exceedance is deemed tolerable (i.e., more river length above the designated periphyton objective threshold and, importantly, more length exceeding the designated periphyton objective threshold by larger margins). It is important to be clear that the choice of spatial exceedance criterion is a normative decision – i.e., a "subjective" one that needs to be ultimately made by the decision makers.

Recommendation

- We recommend that the load reduction analysis be repeated using a 30% spatial exceedance criterion, to produce a second, alternative set of nutrient load reduction estimates that can be compared with the existing load reductions that were based on 20% spatial exceedance. To be clear we are not recommending replacement of the existing set of nutrient load reduction estimates. This work will help make the implications of choices for decision-makers more transparent. It could also inform options for setting identifiable steps to progressively reduce nutrient loads through time. It could also help describe, in risk-based terms, what might be achieved through nutrient load reductions at each progressive step through time.

4.3 Considering measured versus modelled data

Stakeholders expressed the concern that the nutrient load reduction study has placed an over-emphasis on modelled data rather than site measurements. For example, one stakeholder suggested that the "*emphasis [needs to be] firmly on the need for limit setting to be informed by periphyton monitoring data collected from relevant locations that are representative of periphyton pressure / susceptibility at FMU (and sub-FMU) scales*". We have considered this feedback and conclude that an appropriate combination of modelling and use of all available Southland data has been made in the study. There are two main justifications for this:

1. Modelled data is needed to conduct a spatially comprehensive assessment of the entire study area.
2. Modelling is always needed to make sense of, and generalise, the information contained within the available data.

Further to point 1, detailed measurements of nutrient concentrations and loads are available for approximately 60 sites, measurements of monthly periphyton are made at 28 sites and measurements of biomass are restricted to a small number of the region's many lakes and estuaries. However, in responding to the requirements of the NPS-FM, Environment Southland must consider the relevant issues across the whole region. The only way to comprehensively understand the current conditions and issues in rivers, lakes and estuaries across the region is by appropriate modelling.

Further to point 2, biological measures such as periphyton biomass are the outcome of combinations of environmental conditions. For example, periphyton is strongly influenced by at least: nutrient concentrations, light, temperature, high flow frequency, and substrate conditions. The only way to understand and make sense of measurements of periphyton at different sites is to use modelling to elucidate the underlying patterns. Modelling is a fundamental approach in science and is the basis for the observation that "data without models is chaos".

We agree with the stakeholders' position that the best possible use should be made of the available data. It is our opinion that the study has done this.

We also agree that more periphyton and nutrient data would be useful. In section 4.5 below we discuss this aspect further and provide recommendations to continue current monitoring efforts and consider expanding the number of monitoring sites in collaboration with other regional councils over the next five years. In addition, we think it would be worthwhile gathering this summer any further possible field observations of periphyton beyond the monitoring network sites available for the modelling work.

Recommendation

- We recommend that, depending on stakeholder's positions after receiving our detailed technical response to their review of the load reduction requirements study, that any remaining points of contention on the use of measured versus modelled data be subject to external independent peer review.

- We also recommend that further opportunities be taken this summer to observe periphyton growth beyond just the existing monitoring network sites.

4.4 Considering alternative nutrient criteria

Stakeholder feedback expressed concern about the instream nutrient concentration criteria used in the Southland study. Three issues were raised:

1. that the criteria are fundamentally incorrect and are too conservative;
2. that they are based on a national dataset, are not Southland specific and do not use Southland data; and,
3. that an alternative Random Forest[5] model can be used to define the criteria.

Establishing robust nutrient concentration criteria is a difficult task and is a topic of significant scientific effort and controversy in New Zealand and internationally. We have considered the stakeholder feedback, but it is our opinion that the criteria are robust and are the best that are currently available for this type of study. It is our opinion that at least one stakeholder misunderstands the approach and is making incorrect inferences about the criteria. We think that stakeholder believes that the criteria should describe the relationship between periphyton biomass and nutrient concentrations at individual sites. However, this is not how the criteria are defined. The criteria define nutrient concentrations such that a stated periphyton biomass objective will fail to be achieved at a "minority" of sites. The criteria specify the proportion of sites for which the periphyton biomass objective will not be achieved and call this the "spatial exceedance" as already discussed above. In the Southland load reduction study, the allowable spatial exceedance was 20%. This means that based on the nutrient criteria, there is an expectation that 20% of locations will have periphyton biomass that exceeds the objective[6]). This may be an area where peer review could be beneficial. However, we note that the approach we are using has been extensively peer reviewed through three studies:

1. The approach to defining the periphyton criteria has been published in an international peer reviewed journal[7];

2. The periphyton criteria and load reduction analysis has been used to support MFE's regulatory impact statement for the NPSFM (2020) and that load reduction study was independently

[5] Kilroy, C., A. Whitehead, S. Howard, and M.T. Greenwood, 2019. Modelling Periphyton in New Zealand Rivers Part 1. An Analysis of Current Data and Development of National Predictions. NIWA Client Report, NIWA, Christchurch, New Zealand.

[6] Note that this means the biomass will exceed a stated threshold "occasionally", where occasionally has a specific frequency defined by the NPSFM periphyton attribute.

[7] Snelder TH, Moore C, Kilroy C (2019) 'Nutrient Concentration Targets to Achieve Periphyton Biomass Objectives Incorporating Uncertainties' JAWRA Journal of the American Water Resources Association 55, 1443–1463.

reviewed by NIWA following criticism. That review upheld the approach and endorsed the study finding; and,

3. The periphyton criteria and a national scale nitrogen load reduction analysis has been published in the peer reviewed journal New Zealand Marine and Freshwater Research[8].

We consider the modelling made the best possible use of the Southland data, but also used the national data to best advantage. Environment Southland has a small but useful dataset (28 sites) of periphyton-nutrient data. Part of our confidence that the best possible use of all data was made is that a simple quantile regression analysis based on just the Southland data broadly corroborates the criteria used in the study (see further explanation in the detailed technical response). In addition, a published report Instream Plant and Nutrient Guidelines[9] also used a quantile regression approach to develop simple national criteria (i.e., single values that apply nationally) that is approximately in the middle of the range of the criteria used in the load reduction study (see further explanation in the detailed technical response). The criteria used in the load reduction study were variable across Southland because the method accounted for variability in the sensitivity of rivers to nutrient enrichment that is associated with factors such as the frequency of flood flows that remove periphyton biomass. Therefore, these national Instream Plant and Nutrient Guidelines criteria broadly corroborate the criteria used by the load reduction study.

We have considered the use of the alternative Random Forest model to define the criteria as suggested by one stakeholder. The purpose of the Random Forest model was to predict current levels of periphyton biomass; it was not developed for defining nutrient criteria. It is our opinion that the Random Forest model cannot be used to define nutrient criteria.

Recommendation

- We recommend that, depending on stakeholder's positions after receiving our detailed technical response to their review of the load reduction requirements study, that any remaining points of contention on the use of alternative nutrient criteria be subject to external independent peer review.

4.5 Considering how estuaries were represented in the load reduction study

Stakeholder feedback raised concerns about how estuaries were represented in the load reduction study. The relevant nutrient criteria for each Southland estuary were provided by a NIWA report authored by Plew (2020). Stakeholder feedback did not raise concerns about the way that Plew's (2020) criteria were incorporated into the load reduction requirement study. Rather, the feedback raised concerns regarding the derivation of the nutrient criteria and the way that the available data describing estuaries had been used in the load reduction requirement study. NIWA have responded to these concerns and their response is included in the more detailed technical response document.

The author of the ES load reduction study (Dr Ton Snelder) agrees with the NIWA response (see detailed technical response) and so do we. As a result, we consider that the estuary nutrient criteria used in the Southland study are appropriate and make best use of the available information. We

[8] Snelder TH, Whitehead AL, Fraser C, Larned ST, Schallenberg M (2020) 'Nitrogen loads to New Zealand aquatic receiving environments: comparison with regulatory criteria' New Zealand Journal of Marine and Freshwater Research 54, 527–550.

[9] Matheson F, Quinn J, Unwin M (2016) Instream plant and nutrient guidelines. Review and development of an extended decision-making framework Phase 3. NIWA Client Report HAM2015-064. NIWA, Hamilton, New Zealand.

therefore do not recommend further work or changes to the existing load reduction estimates in response to stakeholders' comments on estuaries.

However, we do note NIWA's suggestion concerning the relevance of an existing three-compartment model specifically for just the Toetoes (Fortrose) Estuary. This more detailed model would allow the study to consider nutrient loads in greater spatial detail than the one-compartment model that was used in the existing load reduction requirement study. We agree that analysis at greater levels of spatial detail can be useful. However, we have considered the ES load reduction study author's response comments (see detailed technical response), which highlight the need for careful prioritization of when and where to spend resources on more spatially refined load reduction estimates. We certainly think the Toetoes Estuary three-compartment model is potentially useful and merits for its use may become clearer in the coming scenario assessment phase of the Regional Forum process. At this stage we agree it would be premature to invest time focusing more closely on the spatial detail of one estuary while the others are represented by one-compartment models.

Recommendation

- We recommend that, depending on stakeholder's positions after receiving our detailed technical response to their review comments, that any remaining points of contention on the way estuaries have been represented in the load reduction study be subject to external independent peer review.
- We recommend that decisions on whether to invest resources on more spatially nuanced load reduction estimates for the Toetoes Estuary be delayed until later in the process.

4.6 Longer term studies to reduce uncertainty of nutrient criteria and load reductions

In section 4.4 above we referred to two examples of the use of a quantile regression approach, one using the currently available Southland dataset and one using a national dataset available at the time the 2016 Instream plant and nutrient guideline was developed. Both those existing approaches generally corroborated the criteria used for the load reduction estimates for Southland, but both were constrained by the size of the datasets available. We think there would be value in collaborating with some other South Island regional councils to gather periphyton and nutrient data from a greater number of sites over the next few years to allow an updated more powerful quantile regression study with greater spatial discrimination. This could reduce uncertainty and provide greater confidence in periphyton nutrient criteria, and thus load reduction estimates that depend on the criteria, for the next round of freshwater planning beyond 5 years.

We note that the problem of uncertainty with nutrient criteria and load reduction estimates is a nation-wide challenge and we anticipate that longer term studies like the one we propose here will be needed for other regions as well as Southland. We also think there is considerable value in consolidating the contribution that has been made by Environment Southland's work on nutrient criteria by supporting the additional effort to publish it in a recognised science journal. We think the work already reported and in progress by Roger Hodson and Nuwan DeSilva (both of ES) could, in collaboration with input from Ton Snelder (LWP) produce a co-authored a journal paper.

Recommendation

- We recommend that such a study be scoped and costed for further consideration. In round terms it would involve 5 years gathering data (in collaboration with other Councils) for at least 70 sites (compared to Southlands current 30 sites), in order to have sufficient statistical power for the analysis required. We note that reducing uncertainty with nutrient criteria is going to

be a key issue for all dairy regions in New Zealand and we anticipate there would be appetite for collaboration and co-funding opportunities. As an interim measure, the annual biomass sampling programme could be reprioritised into an additional 25 monthly periphyton monitoring sites depending on ETO availability and/or use of contractors. We note that additional periphyton sampling will likely be required to meet the amendments to the NPS-FM (2020).

- We recommend that ES supports the additional work necessary to consolidate on existing Environment Southland work and submit a science journal paper for publication, co-authored by Roger Hodson and Nuwan DeSilva (both of ES) and Ton Snelder (LWP). We think this would contribute to the Southland and nation-wide challenge of reducing uncertainty with nutrient criteria and associated load reduction estimates.

5 Other issues by topic area

5.1 Alternative classification of the mainstem of the lower Waiau River

Stakeholders have raised the issue that the current classification of the main stem of the lower Waiau River as a "Lake-fed" river class may not be appropriate due to the existence of the Manapōuri Power Scheme. The current management classification of the Waiau River derives from the national River Environment Classification (REC). This classification is based on the natural catchment and assigns the Waiau main stem as a "Lake-fed" river due to the flow moderating influence of Lakes Manapōuri and Te Anau. An inappropriate classification would mean that both the FWOs and the nutrient concentration criteria that have been applied in the nutrient load reduction studies would need to be reviewed. We note that this issue has been raised through the Environment Court proceedings on the proposed Southland Water and Land Plan (pSWLP) appeals.

Recommendation

- We recommend that the load reduction analysis be repeated under alternative assumptions for the class applied to the lower Waiau mainstem. At this stage we have identified that contenders for an alternative classification are likely to be either Hill or Lowland class, but further work will confirm which of these are to be assessed. The model re-runs will provide an alternative set of nutrient load reductions for the Waiau catchment that can be considered alongside the set of nutrient load reductions already produced based on the Waiau being classed as Lake-fed. These alternative results could inform discussions about how estimates of load reductions required would change under different Waiau classifications. The results could be used if the Environment Court decides to change the Waiau classification during proceedings of the pSWLP.

5.2 Comparison with other comparable nutrient load reduction studies

The nutrient load reduction study used the same methodology as two previous national studies;

1. a published journal article[10]; and,
2. an assessment of the impact of existing periphyton and proposed dissolved inorganic nitrogen bottom lines conducted by the Ministry for the Environment (MFE)[11].

[10] Snelder, T.H., A.L. Whitehead, C. Fraser, S.T. Larned, and M. Schallenberg, 2020. Nitrogen Loads to New Zealand Aquatic Receiving Environments: Comparison with Regulatory Criteria. New Zealand Journal of Marine and Freshwater Research:1–24.

[11] MFE, 2019. Essential Freshwater: Impact of Existing Periphyton and Proposed Dissolved Inorganic Nitrogen Bottom Lines. Ministry for the Environment & Statistics NZ, Wellington, New Zealand.

The national studies produced estimated nitrogen load reduction requirements for each region of New Zealand that were associated with national bottom lines. In contrast, the Southland study assessed load reduction requirements associated with the national bottom lines but also assessed reductions for more aspirational FWOs – the draft Murihiku Southland freshwater objectives (referred to as the "bottom of hauora envelope" scenario in the report), and the proposed Southland Water and Land Plan (pSWLP) water quality standards (referred to as the "bottom of decision envelope" scenario in the report).

Feedback from stakeholders expressed concerns about apparent discrepancies between the load reductions produced by the national studies compared to those produced by the Southland study. In broad terms, the national studies indicated a Southland region load reduction of ~20% would be required to achieve national bottom lines whereas the Southland study indicated a load reduction of 49% would be required to achieve national bottom lines and up to 64% to achieve the pSWLP water quality standards.

As already explained in both the report and in the "key early messages" memo prepared for the ES executive (Wilson and Norton 2020), the main explanation for the differences in load reductions between the national and Southland studies is that the latter did not include Fiordland and the Islands of the region, whereas the former studies included the entire region (i.e., including Fiordland and the Islands). We consider this adequately explains the differences.

Recommendation

- No further work needs to be done on comparison with other nutrient load reductions studies.

5.3 Reconsideration of periphyton numeric freshwater objectives (target attribute states)

Stakeholders raised concerns around the appropriateness of some of the numeric periphyton FWOs set for different river classes and recommended revising some of them for the Spring-fed and Lake-fed classes. Stakeholders may have misunderstood the scope of the technical load reductions work because it did not include setting the desired state for FWOs. The setting of those states involves value judgements and has been undertaken via a process as laid out in the report titled *Draft Murihiku Southland Freshwater Objectives – providing for hauora, the health and well-being of waterbodies in Murihiku Southland* (Bartlett et al., 2020), and an underlying report on the process of developing draft numeric freshwater objectives (Norton and Wilson 2019).

Recommendation

- No further work needs to be done on technical reconsiderations of the level at which numeric periphyton objectives (i.e., target attribute states) are set. Any reconsideration on this will be a matter for decision makers as the process proceeds.

5.4 Application of periphyton nutrient criteria to lowland soft bed class streams

Stakeholders raised the concern that periphyton nutrient criteria should not be applied to streams that could not support conspicuous periphyton growth, which we recognise comes from guidance provided by the Ministry for the Environment[12] for setting nutrient targets for periphyton under the NPSFM (2020). Stakeholders also suggested that ES's Lowland soft bed class constituted such streams and therefore should not be subject to the nutrient concentration criteria associated with achieving periphyton objectives.

For various reasons that we acknowledge were not explained in detail in the reports, we consider the Southland Lowland soft bed class does comprise of streams that can support unacceptable levels of

[12] MFE (2020) Action for healthy waterways: Guidance on look-up tables for setting nutrient targets for periphyton. ME 1517. Ministry for the Environment, Wellington, New Zealand.

periphyton biomass. We have assembled available periphyton data and other material that supports our view on this (see separate more detailed response to stakeholder feedback). Given this, we consider that it is appropriate to apply the nutrient concentration criteria associated with achieving periphyton objectives to most streams in this class.

We also observe that if it is identified that some streams could not support unacceptable levels of periphyton, the NPSFM (2020) requires regional councils to consider criteria necessary to achieve the periphyton and other target attributes states in downstream receiving environments. We note that many of the Lowland soft bed class streams flow into Lowland hard bed and Hill streams and/or estuaries. Our expectation is that this means there would be little change to the nutrient load reduction estimates even if we identified the small sub-set of the Lowland soft bed class that could not support unacceptable levels of periphyton biomass and alter their criteria accordingly. It would be possible to do a model run check on this to gauge the likely sensitivity of the estimated load reductions to altered nutrient criteria for a small subset of Lowland soft bed streams.

Recommendation

- We recommend that periphyton nutrient criteria should continue to be applied to the currently identified Lowland soft bed class generally as we have done. The material justifying this has already been prepared and is provided for stakeholders in the more detailed technical response.

5.5 Longer term studies to revise mapping of Lowland soft bed and natural state classes

The stakeholder feedback about periphyton in Lowland soft bed class streams (see section 5.4), in combination with some new requirements of the NPS-FM (2020), leads us to suggest there is a longer term need for review and revision of the mapping of the existing 'Lowland soft bed' and 'Natural state' classes. This work will need to consider the new requirements of the NPS-FM (2020) concerning the mandatory identification of 'soft-bottomed' and 'naturally soft-bottomed' streams for the purpose of implementing NPS-FM (2020) management requirements for achieving the new compulsory deposited fine sediment attribute. This is a separate requirement to consideration of the risk of unacceptable levels of periphyton in 'Lowland soft bed' streams discussed in section 5.4.

We see this as a longer-term piece of work to resolve fully because it will take some time to develop and undertake the methodology for identifying and mapping 'soft-bottomed' and 'naturally soft-bottomed' streams for NPS-FM (2020) sediment management purposes. This will be a challenge for all regional councils under the new NPSFM (2020) and it seems possible that national guidance may be developed in time.

It will also take time to develop and undertake methodology to identify and map the few Lowland soft bed class streams (if any) that could not support unacceptable levels of periphyton biomass. In the meantime, we think it may be useful to consider, as an interim step, amalgamating the Lowland soft bed with the Lowland hard bed class to simply form a "Lowland" class. We think such an amalgamated Lowland class may be sufficient at least for the purpose of applying periphyton nutrient criteria to achieve periphyton FWOs, noting that the same periphyton FWOs apply for both the Lowland soft bed and Lowland hard bed classes.

Recommendation

- We recommend that a longer-term study be scoped and costed to identify and map 'soft-bottomed' and 'naturally soft-bottomed' streams for the purpose of implementing NPS-FM (2020) management requirements for achieving the new compulsory deposited fine sediment attribute. This will be a reasonably substantial piece of work.

- We also recommend that some further work be done now to assess the implications of amalgamating the current Lowland soft bed class with the Lowland hard bed class to form a "Lowland" class, as an interim step.

5.6 Revised farm nutrient loss rate estimates

As part of developing the Southland catchment nutrient models (CASM), estimates of farm loss rates of nitrogen (N) and phosphorus (P) were required. In the absence of other information being available at the time, estimates of farm loss rates were made by undertaking a literature search and averaging studies where information was available. The stakeholder feedback has been that this is an inappropriate approach because at least some of the input estimates are out of date, particularly with respect to changing Overseer versions over time, and that averaging across studies is problematic.

We have considered this and agree with stakeholders that it would be preferable to estimate N and P loss rates using one systematic and up to date analysis. We are currently working with DairyNZ, Beef and Lamb and Deer Industry NZ on deriving farm loss estimates based on the case study farms developed for Southland through the Southland Economic Project, including updating these to the latest version of Overseer and/or alternative data sources that use Southland farms. The literature review will be used to sense-check these farm losses and may inform inputs in the scenario testing phase. The implication for this is that the CASM models will need to be updated to incorporate the new loss rates and then be recalibrated to those values.

Recommendation

- We recommend that N and P loss rates are updated using industry derived estimates. These loss rates should then be used to update and recalibrate the CASM models.

6 Summary of recommendations

6.1 Issues related to uncertainty and using 'best information available

We recommend that:

1. The scope of the Southland nutrient reduction requirement study be increased to include estimation of the quantifiable aspects of uncertainty (as upper and lower 95% confidence levels) using the methodology used by the published national scale analysis (Snelder et al., 2020).

2. The load reduction analysis be repeated using a 30% spatial exceedance criterion, to produce a second, alternative set of nutrient load reduction estimates that can be compared with the existing load reductions that were based on 20% spatial exceedance. To be clear we are not recommending replacement of the existing set of nutrient load reduction estimates.

3. Further opportunities be taken this summer to observe periphyton growth beyond just the existing monitoring network sites.

4. Depending on stakeholder's positions after receiving our technical response to their review of the load reduction requirements study, that any remaining points of contention on the use of measured versus modelled data and/or the use of freshwater nutrient criteria, be subject to external independent peer review.

5. Depending on stakeholder's positions after receiving our technical response to their review, that any remaining points of contention on the way estuaries have been represented in the load reduction study be subject to external independent peer review. Note this would likely

need to be a different peer reviewer to that needed for periphyton nutrient criteria issues identified above.

6. Decisions on whether to invest resources on more spatially nuanced load reduction estimates for the two major Toetoes estuary catchments be delayed until later in the process (see section 4.5)

7. There would be value in collaborating with some other South Island regional councils to gather periphyton and nutrient data from a greater number of sites over the next 5 years to allow an updated more powerful quantile regression study with greater spatial discrimination. This could reduce uncertainty and provide greater confidence in periphyton nutrient criteria, and thus load reduction estimates that depend on the criteria, for the next round of freshwater planning beyond 5 years out. We note that the problem of uncertainty with nutrient criteria and load reduction estimates is a nation-wide challenge and we anticipate that longer term studies like the one we propose here will be needed for other regions as well as Southland. We recommend that such a Southland-focussed study be scoped and costed for further consideration.

8. ES supports the additional work necessary to consolidate existing Environment Southland work and submit a science journal paper for publication, co-authored by Roger Hodson and Nuwan DeSilva (both of ES), and Ton Snelder (LWP). We think this would contribute to the Southland and nation-wide challenge of reducing uncertainty with nutrient criteria and associated load reduction estimates.

6.2 Main outputs related to uncertainty and why we think they will be useful

The main outputs from the above recommendations will be:

i) A clearer description and quantitative assessment of the uncertainty around the existing load reduction estimates (i.e., upper and lower 95% confidence levels); and

ii) An alternative set of load reduction estimates that could be considered if decision-makers were prepared to choose tolerance for the risk of a greater percentage of river segments (i.e., river length) exceeding the periphyton objective (i.e., 30% of river locations compared to the 20% of locations assumed for the existing load reduction requirements).

We think these outputs will help improve the visibility of uncertainty around load reduction estimates and the implications of different choices of limits. They could also contribute to consideration of options for setting identifiable steps to progressively reduce nutrient loads through time. They could also help describe, in risk-based terms, what might be achieved through nutrient load reductions at each progressive step through time.

6.3 Other issues

We recommend that:

9. The load reduction analysis be repeated under alternative assumptions for the class applied to the lower Waiau mainstem. At this stage we have identified that contenders for an alternative classification are likely to be either Hill or Lowland but further work will confirm which of these are to be assessed. The model re-runs will provide an alternative set of nutrient load reductions for the Waiau catchment that can be considered alongside the set of nutrient load reductions already produced based on the Waiau being classed as Lake-fed. These alternative results could be used if the Environment Court decides to change the Waiau classification during proceedings of the pSWLP.

10. No further work needs to be done on comparison with other nutrient load reductions studies (see section 5.2)

11. No further work needs to be done on technical reconsiderations of the level at which numeric periphyton objectives (i.e., target attribute states) are set. Any reconsideration on this will be a matter for decision makers as the process proceeds (see section 5.3)

12. Periphyton nutrient criteria should continue to be applied to the currently identified Lowland soft bed class generally as we have done (see section 5.4)

13. A longer-term study be scoped and costed to identify and map 'soft-bottomed' and 'naturally soft-bottomed' streams for the purpose of implementing NPS-FM (2020) management requirements for achieving the new compulsory deposited fine sediment attribute. This will be a reasonably substantial piece of work and take months rather than weeks to work through (see section 5.5)

14. Some further work be done now to assess the implications of amalgamating the current Lowland soft bed class with the Lowland hard bed class to form a "Lowland" class, as an interim step (see section 5.5)

15. Nitrogen (N) and phosphorus (P) loss rates are updated using industry derived estimates. These loss rates should then be used to update and recalibrate the CASM models (see section 5.6)

6.4 Recommendations for further stakeholder interaction and independent peer review

Finally, we also recommend that:

16. This memo and the more detailed technical response companion document be provided to stakeholders so they can form a view on whether there are outstanding matters of contention.

17. Once stakeholders have had the opportunity to consider our response to their feedback, we recommend any outstanding matters of contention be subject to external independent peer review (see section 6.1).

7 References

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