Science and Technical Advisory Group Meeting

Agenda - DRAFT

Dates:

Wednesday 22 January 2020, 10am – 5pm

Thursday 23 January 2020, 9am – 5pm

Location: Terrace Conference Centre, 114 The Terrace, Wellington.

STAG Members RSVPed: Joanne Clapcott, Clive Howard-Williams, Jenny Webster-Brown, Ken Taylor (chair), Bev Clarkson, Bryce Cooper, Jon Roygard, Adam Canning, Marc Schallenberg, Ra Smith, Graham Sevicke-Jones, Russell Death

TBC: Tanira Kingi, Mahina-a-Rangi Baker, Jamie Ataria

Apologies: Mike Joy, Chris Daughney, Dan Hikuroa, Ian Hawes

Wednesday 22 January

	Time	Topic	Duration	See page
	9.45 am	*Coffee and morning tea*	15 min	
1.	10.00 am	Overview of MfE process Discuss and approve minutes from November meeting Confirm agenda	30 min	
2.	10.30 am	Maintain or Improve	30 min	Info provided at meeting
3.	11.00 am	Wetlands	1 hr	18
	12.00 pm	*Lunch*	30 min	
4.	12.30 pm	Sediment	2 hr	21
	2.30 pm	*Afternoon tea*	15 min	
	2.45 pm	Sediment (continued)	45 min	
5.	3.30 pm	Schedule 1 of NES (identifying catchments impacted by N)	30 min	
6.	4.00 pm	Stock exclusion	1 hr	
	5.00 pm	*Meeting close*		

Thursday 23 January

	Time	Topic	Duration	See page
	8.45 am	*Coffee and tea*	15 min	
7.	9.00 am	Re-cap of yesterday's proceedings Confirm plan for today	15 min	
8.	9.15 am	DIN and DRP attributes for ecosystem health	1 hr 15	
	10.30 am	*Morning tea*	10 min	
	10.40 am	DIN and DRP attributes for ecosystem health (continued)	1 hr 20	
9.	12 pm	Impact analysis update	30 min	
	12.30 pm	*Lunch*	45 min	
10.	1.15 pm	Ecosystem Health	1 hr 30	Info provided at meeting
	2.45 pm	*Afternoon tea*	15 min	
	3.00 pm	Any other topics	2 hr	
	5.00 pm	*Meeting close*		

Science and Technical Advisory Group Meeting

Minutes – DRAFT

Dates and Location: Wednesday 27 November 2019 9.00am-5.00pm, Terrace Conference Centre, 114 The Terrace, Wellington.

STAG Members Present: Joanne Clapcott, Ian Hawes, Clive Howard-Williams, Jenny Webster-Brown, Ken Taylor (chair), Bev Clarkson, Bryce Cooper, Jon Roygard, Adam Canning, Marc Schallenberg, Russell Death, Mike Joy, Chris Daughney, Graham Sevicke-Jones

Officials: Jennifer Price, Kohji Muraoka, Karwin Perez, Nik Andic, Stephen Fragaszy, Martin Workman, James Hogan, Carl Howarth (from 2:15pm)

Apologies: Jamie Ataria, Ra Smith, Tanira Kingi, Dan Hikuroa, Mahina-a-Rangi Baker

Items:

1. Consultation Debrief

Officials and STAG members provided an overview of their experiences with the consultation process for the Essential Freshwater Package.

- Misunderstandings and misconceptions around the rules, indicate a need for better science communication. In particular:
  - Nutrient rules were unclear for people. There is confusion about where the 1mg/L requirement applies.
  - Questions were raised about the sediment regulations and their application to different river types, in relation to natural variation.
- Concerns were raised about the impacts of the proposals on the individual farm level
  - STAG members suggested a more focussed consultation with farmers would have been helpful.
- A horticulturalist in the Manawatu raised concerns about conflicting requirements between the National Policy Statements for freshwater management, urban development and highly productive land.

Marc Schallenberg gave a summary of the recent Freshwater Leaders Group (FLG) meeting.

- FLG prepared a letter about how they might change points of view in light of submissions
- For technical issues in submissions, would like to hear back from STAG.

2. Plan for the next few months

Martin outlined the plan for STAG, and the wider MfE work programme over the next few months.

Clarifying the role of STAG:

- STAG is a group of specialists whose role is to provide science advice. It is the role of the Independent Advisory Panel (IAP) to make recommendations based on the submissions.
- It is not within STAG's ambit to consider the costs of implementing or meeting the policy.

- However, it is STAG's job to consider the technical details of how the policy is implemented.

Plan for the next few months:

- The current policy must be passed within tight timeframes. The major milestones in the next few months are expected to be:
  - The IAP report due in the middle of February
  - The Cabinet paper due in late March/early April
- STAG will need to provide targeted advice by forming into subgroups with specific tasks. The groups will provide written advice to the panel. The larger group will then meet again in January.
- The IAP may also question STAG members directly.

Action	For
Book meetings	Jen Price

3. Sediment

Stephen summarised the issues raised in the submissions as well as the ones for discussion on the day. Key questions about sediment attributes were included in the paper circulated to the members.

Key Questions for STAG:

1. Does STAG wish to consider technical issues about the attributes other than those described in this section?
2. Is STAG willing to participate in a workshop with council and research stakeholders as described above? If so, what process would STAG suggest for member involvement and reporting back?
3. Does the aquatic community deviation method require further review, validation, or explanation before results using the method are adequately robust for use in setting public policy?
4. Are results from the extirpation analysis appropriate for setting bottom lines? If so, are the ecological impact thresholds used in the extirpation analyses from Franklin et al (2019) appropriate for setting bottom lines and bands?

Discussion points for sediment attributes:

- The attribute thresholds proposed in the regulations come from a report that MfE commissioned from NIWA and Cawthron.
- The NIWA/Cawthron approach used available water quality and ecological data (with their attendant limitations) for determining ecological health outcomes due to increasing suspended and deposited fine sediment.
- As such, STAG needs to consider how the attributes will be implemented.
- Classification can be revisited, but reducing the number of classes can introduce an 'unders and overs' issue.
- Scientists always operate under a level of uncertainty. It is unlikely that STAG would want to change assessment of technical work.
- STAG's work to date has been responding to existing technical work. Does STAG have the expertise to comment in a meaningful way to Stephen's questions?
- General discussion ensued about the sending questions back to the original authors.
- The method on which proposed sediment bottom lines and bands was selected based on a documented decision making process. There is a need for STAG to focus on defining good

ecosystem health. The Dairy NZ submission stated a preference to use the bottom lines and bands resultant from the extirpation method as presented in the NIWA/Cawthron report. Use of one method versus another relates to the appropriate ecological end-points for the regulation.

- It was suggested that detailed technical submissions should go back to the original authors, and that STAG should act as a reviewer of the authors' responses. Similar to the process in place for academic journals.
- The chairman furthered this line of thought, stating that where the work was done by others, it makes sense to send it back to them for comment.
- The integration of the multiple lines of evidence presented in the NIWA/Cawthron report was undertaken through a two day workshop. A United States EPA expert facilitated this process, and the process and outcome is laid out clearly in the NIWA/Cawthron report. Six researchers were involved in the weight of evidence process.
- STAG agrees that suspended sediment is a major issue for assessment of stream health and turbidity was chosen to measure suspended sediment.
- Issues with turbidity can be dealt with via stricter NEMS standards. Work is currently ongoing, eg, there is an Envirolink proposal on benchmarking turbidity meters.

Outcome:

- It was agreed that MFE would commission a peer review of the aquatic community deviation method. This review would be provided to MFE, STAG, and the original authors, and the authors would have the opportunity to provide a written response, which would be provided to STAG. Adam and Jenny offered to support this process.
- Stephen suggested that a workshop should be conducted in January to discuss technical aspects of the proposals with council technical staff. STAG supported this and member attendance can be confirmed when the workshop plans are made.

Discussion points for 20% deviation:

- Discussion about what the aquatic community change bottom line should be for sediment.
- Currently, it is stated to be a 20% "change" in a community.
- Questions arose about where the 20% figure came from, and whether it's an arbitrary number.
- According to one member – there is support for the 20% figure, as it is used both in New Zealand and overseas. What is the sensitivity of the score that 20% is applied to?
- The Australian Guidelines for Marine and Freshwater Quality (ANZG – formerly ANZECC) use this approach.
- Is the 20% consistent across attributes? Percent deviations have not been done across other attributes.
- Should 20% change across the board be tolerated? It is important to remember that different attributes need to be treated differently.
- 20% community change for sediment is different to 20% effects for toxic compounds. For this reason, several members argued that an 80% bottom-line for nitrate is too lenient.
- There was discussion about the level of precaution that has been included in the 20% community change. The community change metric is based on a regression incorporating predicted reference state, which is taken from the median model output indicator value.
- Some members argued that this was not precautionary enough as it would mean that half of the measurements would be worse than the median. It was recommended to ask the report authors to explore using a percentile approach.

- One member commented that there is wider consideration needed of where and how precaution is built into the attributes, ideally this should be consistent among attributes.
- It was raised that the 20% threshold may be under-protective for some river classes.
- A STAG member raised that the MCI bottom-line of 90 lines up with a 22% deviation from the reference state. A more precautionary confidence interval could be applied.
- 20% deviation must be reviewed further. Is this the principle that STAG is adopting?
- The chair raised that the 20% deviance figure would be relevant for harmonising attributes, and as such should be dealt with by a STAG subgroup.

Outcomes:

- Evidence that STAG discussed and agreed to the 20% deviation of community change will be sought.
- Further work on deposited sediment classes will be requested from the report authors.

River Environment Classification discussion points:

- One member thinks that all parts of the digital network should be included.
- This may require the amalgamation of some river classes to get enough data, as well as to capture rare river types that are missing from the current classification.
- This has been discussed with the authors of the original river environment classification report. It can be done.
- STAG agrees on the uniform offset approach in relation to the community deviation method, but is divided on the level of precaution.
- Questions of precaution will be sent back to the original authors.

Discussion points for measurements:

- It was elaborated by a STAG member that using visual clarity as a measure means that it becomes more complex to get measures from larger and faster rivers using black disc measurements.
- Turbidity is easier to measure, and can be monitored continuously.
- Questions were raised about how to continuously measure turbidity. Accurate measurements are lacking.
- It is reported that there is up to a 5 fold difference in analysis between turbidity measuring instruments.
- Guidance would be welcomed in applying continuous monitoring regimes.
- MfE officials clarified that the intent is to refine the definition in the attributes to allow for continuous monitoring, but not require it.
- Further work would have to be done to refine the technical details for any methods of continuous monitoring.

Outcome:

- It was decided that discrepancies in measuring techniques should be discussed at the implementation workshop that has been raised as an action for January.

Action	**For**
Commission a peer review and, subsequent to its completion, return to original authors with core questions about method robustness and sensitivity as well as to respond to comments from submissions.	Stephen Fragaszy

Commission analysis of deposited sediment classes and, using observation dataset, assess whether there is systematic or class-specific under- or over-protection.	Stephen Fragaszy
Aggregate documents to send to original authors.	Joanne Clapcott
Set up a workshop in January to discuss indicators (visual clarity and turbidity through NTU or FNU), monitoring methods for deposited sediment, attribute measurement statistics and timeframes along w/ technical issues like regional council implementation.	Stephen Fragaszy

4. Nutrients

Jen gave a summary of the key points from the consultation process.

Key questions for STAG:

1) For the bottom lines of 1 mg/L for DIN and 0.018 mg/L for DRP, in how many places will we be overestimating or underestimating the impact on ecosystem health?
2) What is the ecological benefit of further reducing DIN and DRP if good 'ecological status' (e.g. ecosystem health components in a healthy state) can already be demonstrated?
3) The Freshwater NPS contains an exception for naturally occurring processes. What methods and approaches does STAG recommend for separating the human-induced and natural components of water quality measures? Is the method in McDowell et al. (2018) suitable?

Discussion points:

- Key concerns arose regarding the current management regime, particularly around the use of exceptions. When regional variation is accounted for, there is concern that blanket rules may be too permissive in certain catchments and too restrictive in others.
- Anecdotally, there are reports of sites where high nutrient levels are reported alongside good ecosystem health, however these reports are unconfirmed. This point was discussed in the context of MCI.
- This point needs further clarification as there is a general acceptance across the scientific community that high nutrient levels are related to low MCI scores. However this isn't a 1:1 relationship.
- It was underscored that MCI values does not summarise everything in a river, and that it is also important to understand flow-on effects on receiving environments.
- Nutrients have a variety of effects on different organisms from heterotrophic bacteria to invertebrates. For example, studies in Australia showed that shredders, when exposed to high nutrient concentrations increased in size by up to 60%. It was highlighted that this could have flow on effects across fish and other organisms along the trophic chain.
- As per Liebig's law of the minimum, the limiting factors in a system may not always be nitrogen or phosphorus.
- There are a number of 'levers' for managing ecosystems and there isn't always a clear linear/mechanistic relationship between particular variables in an ecosystem.
- There will always be anomalies, for example in Horizons, sites where high periphyton would be predicted don't always exhibit it because of cold water temperatures and steep topography.
- There was agreement that anomalous sites should be treated with caution.

- One member emphasised that even if the ecosystems in high nutrient environments are nominally healthy, their nutrient loads may still negatively affect downstream linked systems.

This discussion led into questions about peer reviewing, data transparency and communication:

- STAG agrees that aside from a peer review process, there needs to be clear documentation with all the technical detail, including reasons for choosing particular regression methods etc. STAG will collate a technical paper detailing the derivation of the DIN and DRP attributes, including the data sources and methods that were used. The paper will also include responses to technical issues raised in submissions.
- The group discussed the process for writing and reviewing the technical paper on the derivation of the DIN and DRP attributes. The paper will be written up by a sub-group, then reviewed by STAG. STAG will then make a decision about further peer review.
- The group is supportive of seeking peer review for all recommendations and prioritising the attributes that received the most feedback.

Outcome:

- Group agreement that peer review is critical.
- Work on the DIN and DRP attributes will continue in a small group comprised of Russell, Adam, Clive, Chris, Ian and Jon. Adam and Russell will lead preparation of the technical paper to present back to STAG for review.

Discussion points on DIN bottom-line:

- A member expressed confidence in the DIN limit of 1 mg/L in relation to the toxic effects of nitrate, due to the rigours of the ANZG process that had led to the derivation of the nitrate toxicity guideline.
- Some submissions argued that the bottom-line should be raised 3.8 mg/L, as this would still allow for protection of 90% of species from toxic effects.
- It was underscored nitrate toxicity is not an issue in isolation.
- STAG clarified that the intent behind this limit was wider ecosystem health and that the number was derived from multiple lines of evidence.
- Since ANZG have already tested for toxicity, why not copy it across into the regulations? Further questions were raised about the applicability to NZ ecosystems in particular.
- There is also interest in clarifying the ecosystem impacts of DIN at lower concentrations.

Outcome:

- Parallel process for reviewing toxicity was suggested.

Discussion on DRP and regional variation:

- Jen raised submissions feedback about DRP and reference state.
- There are clear differences between North and South Island rivers, in terms of geomorphic character and underlying soil/bedrock characteristics.
- A member of the STAG raised that there should be separate categories for North and South Island rivers, but is uncomfortable with the REC approach because not all classes have adequate data representation.
- The chairman clarified that this was considered by STAG, but also that this can be managed through the exceptions regime.
- Issue of volcanic soils and their relationship to the natural levels of DRP in a catchment.
- There is conflicting evidence over the relationship between DRP and underlying rock types.

- A general discussion ensued about how to categorise different DRP bottom lines.
- Some rivers had DRP concentrations well below the bottom line. However, many of these would not have a lot of headroom to increase discharges of P under the Maintain or Improve proposals.

Periphyton

- Some councils have suggested that they manage their periphyton using other means such as shading.
- STAG however, does not endorse this position, as it does not address the nutrient imbalances in the system.
- STAG supports Ton's approach to estimate nutrient loads to manage periphyton.
- However, STAG members suggested that a review of the periphyton attribute should be conducted.
- The major studies feeding into the existing periphyton attribute were conducted in 2003/2004 and a lot of periphyton data has been collected since then.
- As such both the earlier and later data should be subject to a review, particularly in regards to the levels for attributes like chlorophyll a, in Appendix 2 of the NPS.

Action	For
Set up a peer review process for STAG recommendations	STAG and MfE
Set up a subgroup to collate data into a technical report	Russell Death, Adam Canning, Clive Howard-Williams, Chris Daughney, Ian Hawes and Jon Roygard MfE to support
Send key science questions, around DIN and DRP, to Adam and Russell	Jen Price
Conduct further discussion on the periphyton attribute, at a later date	STAG

5. Nutrient Impact Analysis

James outlined the approach to the impact modelling and provided a paper[1] which showed the approach taken. The model includes impact assessments across various domains from regional economies and environment outcomes to factors like social, community and cultural enjoyment.

Discussion Points:

- Change in land use was put forward as a key mitigation strategy.
- A member pointed out that while the model includes nutrient impacts from various land use change regimes, it does not account for any potential benefits to farm profitability associated with reductions in stock numbers. Literature shows that reducing stocking rate in some situations improves profitability and reduces GHG emissions, as such this should be included as a mitigation measure.
- A few other members agreed with this assessment, further elaborating that in order to provide for positive outcomes, the right mitigations must be in place.

[1] Hogan, J. 2019. Memo: Science Technical Advisory Group – Proof of concept model for Essential Freshwater environmental impact assessment. Paper provided to STAG as additional meeting document.

- Further evidence to support this assessment was provided, outlining Our Land & Water Science Challenge's research that profits can increase alongside a decrease in stocking rates.
- It was further elaborated that the focus of the model was to show how to work the proposals into existing land use activities.
- This drew some criticism about promoting 'business as usual'.
- How do you define catchments? Previous work has used FENZ 4th order catchments to look at where leaching comes from.
- It was clarified that data feeding into analysis came from NIWA's modelled water quality state 2013 - 2017.
- It was brought up that the modelled data is good at showing regional variations at a coarse level, but is not accurate at a river scale.
- A member raised a question about the level at which tributaries (eg, Waikato sub-catchments) are being addressed in the model. Do the maintain/improve requirements apply to individual river reaches?
- The same member has already worked out land use in catchments all throughout the country. They volunteered to share their data.
- The chair then raised questions about when the analysis stops. Does it end once all mitigations have been attempted?
- The response was that in that case, there will be further assessment about how much the mitigations had improved water quality, and how much improvement was still required.
- A few members forwarded critiques, citing that the model does not take into account GHG's nor human health impacts.
- Further, the point was raised that an output is based in dollars and that it would be prudent to incorporate uncertainty into the equation to give a range of results.
- Monetary costs of mitigations were taken from Richard McDowell's estimates.
- Points were raised about attenuation, particularly in how the model accounts for lag time and loads to come.
- This is another source of uncertainty, as regional intercepts in McDowell's estimates are variable.
- Would be good not to include the regional intercepts as fitted parameters.
- One member offered to help further, as they have layers regarding stock density.
- Lakes and estuaries as receiving environments - they might be the most sensitive and drive objective setting.
- It was underscored that the model is a spatial regression. Load to come currently can't be included, and the model has to be based on existing information.
- It was underscored that that the model uses a Pollution Export Coefficient model, which is a type of modelling that connects pollution to land activity.
- Further questioning arose around the variability of leaching present across different farm, soil and land use types. How does the model handle that amount of variability?
- One member suggested looking at and incorporating other models from NIWA and Motu.
- For the current model, LUCI was looked into, but the timeframes precluded inclusion of Motu's models.
- There has been a lot of work done relating N and P in rivers to land use and some work done on the effects of mitigations, and what the hot spots are. There's unease that this analysis will be following a different methodology. STAG would like to see the terms of reference.
- The model is a prototype and is open to change, with suggestions on what to include and what data to incorporate being accepted.

Outcome:

- The critiques will be noted, and considered during further development of the model.
- Adam will share his data regarding land uses around tributaries throughout the country.

- Members will discuss the model further after the meeting.

Action	For
Provide STAG with more background material with specific questions, detailed methods and data layers	James Hogan
Provide spatial data	Adam Canning
Provide written feedback on James' model	MfE to follow up with all of STAG

6. Brief Items: maintain or improve, stock exclusion

Maintain or Improve

Nik provided an overview of the key themes from the submissions.

Key points of discussion:

- Submissions raised questions around this policy meaning that we are fully allocated. How can we account for urban growth, consent activities etc.
- Fish & Game suggested that water quality should be maintained as at 1991 level, which led to questions about the adequacy of data to calculate the 1991 state.
- MfE will seek advice from STAG about the representativeness of available data to calculate 1991 state.
- A key question is, what are the data requirements for determining the current state of a waterbody? Will require engagement from CRI's and councils for further modelling and the acquisition of past monitoring data.
- Further questions arose about how to target policy to account for lag-time effects on waterbodies, and differing levels of attenuation across and between catchments.
- This theme will likely be explored further, in later meetings.

Action	For
Send questions to STAG subgroup before December	Nik Andic
Set up a sub-group meeting by, either by Skype or in person, for January	Nik Andic

Stock Exclusion

(Apologies: Kirsten)

Stephen provided an overview of the key points from the submissions on stock exclusion. MfE is progressing work on the pathogen and sediment reduction implications of the proposals.

Discussion points:

- Questions arose about the origin of the 5 m setback distance. There is no justification from published research for a single uniform setback figure, but a table of setback distances has been published, which includes circumstances where 5 m might be appropriate.
- Stephen clarified that 5 m is not a blanket setback distance, but an average setback goal. The distances may be wider in some areas and narrower in others, depending on the conditions.
- Questions arose about why the setback requirements focus on streams wider than 1 m, since smaller streams account for a greater contaminant load overall.

- Officials responded that setbacks for narrower streams would be addressed in individual Farm Environment Plans.
- A member commented that there's a lot of existing science to support the setbacks; however, difficulties arise when it comes to applying policy effectively.
- The Australian EPA has a set of rules for managing setback distances and there are tools available to assist with planning setbacks, like a riparian planner for farmers. However, regional councils have attempted to include these in previous plans, and have found that they are complicated to apply as planning rules.
- Likewise, planners find it difficult to apply complex land and slope equations into their plans.
- Further discussion occurred about what techniques could be applied to give effect to the policy. Further work is needed, but different suggestions were put forward, such as mapping rivers to target the setbacks, and creating trigger criteria for works to be done.

Outcome:

- STAG is willing to engage in a targeted way, but must first understand the objectives of the policy. STAG recommended that a sub-group, which includes FLG, farming and STAG representatives, be set up to engage with this topic.

Action	For
Prepare targeted questions for a meeting in January	MfE

7. Ecosystem Health

Dissolved Oxygen (DO)

Key Questions:

1. For dissolved oxygen in rivers, is there sufficient natural variation to warrant the creation of different attribute states for different river types? Is the evidence base sufficient to do so? (see Hawkes Bay Regional Council submission below)
2. Would percent saturation be a more suitable measure of dissolved oxygen than concentration? Why/why not?
3. Lake dissolved oxygen – we think that the topics raised in submissions have been discussed by STAG, and have no specific questions. Is there anything else STAG wants to add?

Jen provided an overview of the submissions regarding DO

General DO discussion points:

- Discussion about whether to classify rivers by DO
- Wetland DO is dependent on wetland type. This is due to factors like flow and groundwater upwelling.
- DO would depend on geography, as well as on macrophytes and deposition
- A member would like to see data supporting the argument re: depositional environments; particularly at a national scale (may indicate whether any issue could be dealt with by exception).
- There is probably not enough information to do that.
- A member replied that there probably aren't enough naturally anoxic streams in the country to warrant an exception.
- HBRC submits that there are many rivers that are naturally anoxic.
- The natural exceptions regime in the NPS would come into play in this case.

- STAG recommends that naturally low DO can be managed by the existing exemption in the NPS.
- A member observed that low DO depositional streams may in fact be drained wetlands (as stated in HBRC submission), as opposed to naturally low.
- Submissions also raised calls to express the attribute in units of oxygen saturation, as this is what fish respond to.
- One member noted a NIWA report prepared for the 2014 NPS was relevant (Davies-Colley et al 2013: https://www.mfe.govt.nz/sites/default/files/national-objective-framework-temperature-dissolved-oxygen-ph.pdf)
- STAG members disagreed that saturation is more relevant, and noted that this issue had been addressed when the DO attribute was introduced. Temperature changes saturation, therefore concentration would be more relevant than saturation at higher temperatures.

Action	For
Write up a statement addressing points made by submitters relating to DO	Clive Howard-Williams, Marc Schallenberg, Jon Roygard

Lake DO discussion points:

- Some submissions say there isn't enough information already, therefore it shouldn't be in the NPS.
- Discussion about the level of existing monitoring data required to introduce an attribute, and whether it is justified to have attributes in the NPSFM to drive monitoring.
- Uncertainty about how to use thermal profiles to work out hypolimnetic boundaries. Could be addressed in guidance.
- Could specify that people need to use published methods. Submissions say that more work is needed, but one member's view is that this is easy to address.
- The chair summarised that STAG still recommends that we measure and manage these attributes. STAG had several caveats relating to this attribute that have not been included in the draft NPS - these will go into guidance.

Outcome:

- STAG will not deviate from its original recommendations on lake DO.

General Ecosystem Health

Carl gave a summary of the issues raised in submissions.

Discussion Points:

- Are there redundant attributes that could be removed?
- While not all attributes need to be measured at every site, it is still vital to include the 5 core measures of ecosystem health.
- At different sites, some attributes will be more important than others.
- Not everything needs to be measured at all sites – there may be different monitoring programmes for different attributes within an FMU.

Ecosystem Metabolism

Key Questions:

1. We think that the topics raised in submissions have been discussed by STAG already and we have no specific questions. Is there anything else STAG wants to add?

Discussion points:

- A few STAG members queried the status of this attribute. MfE has included an attribute in the draft NPS with no attribute bands or bottom line.
- In their report, STAG recommended an attribute table with bands but without a bottom line. The group was not certain about where the bottom line should be, and noted that this recommendation will need to be revisited as more data becomes available.
- No substantial reason to change recommendation.

Outcome:

- STAG retains its recommendations regarding Ecosystem Metabolism

Fish

Key Questions:

1. We think that the topics raised in submissions have been discussed by STAG already and we have no specific questions. Is there anything else STAG wants to add?

Discussion points:

- Discussions about whether introduced salmonids should be included in the measures of Fish IBI.
- One member argued that salmonids fill ecological niches that require a high level of ecosystem health. Since Fish IBI is a measurement of ecosystem health – not nativeness – salmonids should be included in the attribute.
- Another member countered that there may be conflict between providing habitat for salmonids and providing it for indigenous species. If salmonids were part of the attribute, then this would cause issues with managing those sites.
- STAG's approach to the Aquatic Life component of the Biophysical Ecosystem Health Framework was to focus on indigeneity, and that was reflected in their original recommendations to exclude salmonids from the IBI.
- A compromise was suggested. Two columns would be used, one for areas where there are no salmonids, one for areas where there are salmonids.
- Salmonids could be seen a positive in areas where there is a fishery, and negative in areas where there isn't.
- Members expressed support for the two column approach, recognising that in some ecosystems their presence is positive because it indicates healthy habitats while in others their presence is negative because of their predation of indigenous aquatic species.
- There was a discussion about the role of sport fishery management plans.
- What are the requirements for DOC to sign off management plans, do they weigh up the values? What are the effects of the new indigenous fish conservation regulations?
- There was discussion about the ecological impacts of salmonids.
    - Despite filling ecological niches, they may still compete with and/or predate on native species.
    - One member states that impacts on invertebrates is probably only an issue in selected locations.
- Discussion ensued about the responsibilities of regional councils, DOC, and Fish & Game.
- STAG requested further information on this topic.

Caveats:

- The chair cautioned that there are still caveats surrounding the inclusion of salmonids.
- Further work is needed around 1) policy settings and 2) ecological impacts.
- Despite the fisheries management plans surrounding catchments with salmonids, there may be a suite of interactions between them and the wider ecosystem.

Action	For
Provide more info on fish management plans and ecological impacts of salmonids for STAG meeting in January	MfE

Hydroelectric Scheme Exceptions

Discussion points:

- STAG has not had the chance to consider in detail the proposal to exempt the six largest hydro schemes from some of the NPS provisions.
- Members expressed concern about the impact of the existing hydroelectric schemes on stream health.
- Clarified that the exceptions relate to six specific hydro schemes. These rivers are still under the obligation to maintain or improve.
- It was brought up that this policy applies to 60% of the river volume in New Zealand.
- The policy applies to where the dam is causing the river to exhibit values below the bottom line.
- Questions raised about how far upstream/downstream the effects of the hydro scheme start and end.

Action	For
Send hydro exception RIS back to the group	Jen Price

Wetlands

Discussion points:

- One member questioned the exclusion of geothermal wetlands from the regulations.
- MfE will follow this up with the wetlands policy lead.

Action	For
Provide further information about geothermal wetlands	Jen Price

LakeSPI

Key Questions:

1. We think that the topics raised in submissions have been discussed by STAG already and we have no specific questions. Is there anything else STAG wants to add?

Discussion Points:

- LakeSPI includes a measure of % cover based on transects. Though it doesn't include a vegetation cover map for the entire lake.

- No issues with adding an attribute that measures vegetation composition.
- NIWA recommends an assessment every 3 years for at-risk lakes, and a 5-10 year assessment for lower risk lakes. STAG is happy with NIWA's recommendations around monitoring frequency.
- Discussion about what technologies can be applied used to aid assessment. There is an Envirolink proposal to examine the potential for remote sensing (ie, underwater camera systems).
- Queries about how risk is determined.
- A STAG member replied that a risk management framework for LakeSPI is currently being developed for regional councils.
- It was raised that some councils may want to leave exotic macrophytes in place, as they may have ecological benefits. Lake Horowhenua was put forward as an example of this principle.
- Discussion about what actions can be done to improve LakeSPI.
- Management plans could be put in place that involve the removal/spraying of exotic macrophytes.
- Eradicating exotic macrophytes entirely is unnecessary to reach the bottom lines. Active management is suitable
- Raising the score usually involves increasing the percentage of natives. There was discussion about how that would work across native and exotic species attributes. Would this work with the two separate tables?
- One member raised that taking the LakeSPI from 100 to 90 might not be that beneficial for the ecosystem. Improvement could be difficult.
- There is a need to provide more research and guidance on restoring native plants.
- The chairman cautioned that the attributes may have consequences for some lakes where it may be preferable to leave exotics in.

Action	**For**
Check the mechanics of LakeSPI scores and follow up at the next meeting	MfE

Macroinvertebrates

Key Questions:

1. Is the bottom line of 90 achievable in urban streams? How much more rehabilitation would be required to get 90 as opposed to 80?

Discussion points:

- Some regional councils have their own versions of the MCI. This needs to be standardised, a NEMS for macroinvertebrates is required urgently.
- The standard can be met within urban streams, as such they should be applied equally in urban areas.
- An MCI score of 80 – the boundary for severely degraded – is not good enough as a bottom line.
- Issues rose around standardising calculations. Should you use MCI, QMCI and ASPM together, or should you use only the worst?
- STAG recommends using the updated MCI scores; this is a point MfE should address in the final version of the NPS.
- MCI and QMCI should be assessed together, and the lower of the two results should apply.
- ASPM is a separate metric and should be assessed separately.

- One member summarised that MCI measures organic enrichment while the other metrics are about overall change.
- To move from 80 to 90, habitat rehabilitation needs would vary between sites.
- STAG is not in a position to fully answer the question as it will depend on local site factors. Some streams would require habitat restoration, and some would not.
- STAG should cross reference previous work done. For instance, there is an Auckland City Council report on the MCI bottom line authored by Martin Neale.
- NIWA raised issues around soft bottomed streams. Soft bottom scores should only be used in streams with naturally soft sediments.
- In summary, more work is needed on how much work will need to be done to get from 80-90

Attribute statistics and ecosystem health report card

- There was a discussion on how to progress work on the attribute statistics and ecosystem health report card.
- It was noted that the attribute statistics need to have an FMU focus. This work is related to the Maintain or Improve sub-group work and can be done after January.
- The group were also keen to have input into the ecosystem health report template work and suggested sub-group members.

Action	For
Work on FMU ecosystem health framework, draft a national report card, and make a template for how councils can achieve the policy	Joanne Clapcott, Bryce Cooper, Chris Daughney, Graham Sevicke-Jones
Work on attribute statistics with an FMU focus	Jon Roygard, Maintain or Improve sub-group

Next meeting

- The next meeting will be in January.

The Wetland Condition Index (WCI)

The Wetland Condition Index has been previously described in STAG papers[2] for the 29 November 2018 meeting.

Background

Recommendation 14 of the September 2019 STAG report to the Minister for the Environment advises the following:

> Amend the national framework for freshwater management to require regional councils to:
> a. identify the extent and evaluate the condition of existing wetlands
> b. prevent any further reductions in the extent of existing wetlands
> c. address the management of wetlands with reference to specified numeric bands, introducing a requirement to lift the wetland condition index to at least 10 and to maintain or improve the condition of existing wetlands where the condition score is greater than 10

We consider that recommendation 14(a) is covered by the proposed mapping and monitoring policies (3.15(5) and 3.15(9) respectively), and recommendation 14(b) is covered by the proposed avoid policy ((3.15(2)) and the NES rules.

As stated at the 24th June 2019 STAG meeting we consider including the WCI as an attribute is likely to set councils up to fail because there is limited ability under the RMA for councils to enter private land for monitoring other than for compliance and enforcement purposes. This means that councils do not have the rights to enter private land to monitor wetlands where a resource consent condition has not been triggered. Through the submissions process several people have also bought this up as an issue for the proposed monitoring policy (3.15(9)) and we are looking into options.

The proposed monitoring policy includes the list of the general components of the WCI within the monitoring policy, ie, extent, vegetation, hydrology, and nutrients, but stops short of explicitly naming the WCI. The intent was to refer to it, and possibly the proposed attribute table, in guidance.

Questions

We are currently looking into options around wetlands monitoring requirements which includes policy intent, legal, and scientific matters. We would like the STAG to address the following questions:

Version control – the WCI methodology was published in 2004, but some councils use more recent iterations of it adapted especially for their regions. As such it is unclear which version would prevail at a national scale.

- What are the differences in the regional versions and if these were used in preference over the 2004 version how would this affect the results when comparing to establish a national picture i.e., consistency of indicators and scores?

Detecting real change over time – some councils have found that different experts were scoring the WCI indicators differently at the same place and time which limits ability to detect real change. There is a council project underway revising and clarifying the indicators, score descriptions and the record sheets. When this is finalised it could add to afore mentioned version control issue.

[2] https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/2-STAG-meeting-docs-29-November-2018.pdf

- How subjective are the scores and how far does this influence the results?
- Are there instances where a relatively degraded wetland still achieve a high score?

Other measures of wetland condition – given that the WCI requires fieldwork and that access to private land has issues, there might be other methods using remote sensing to assess wetland condition that could trigger an investigation and management response.

- What is you level of comfort with this idea?

Regional Differences

Background

Our remaining wetlands (including the different wetland types) are unevenly distributed across the regions. As such several regions have more wetland area than others (see Table 1).

Region	Percent area remaining from historic coverage
New Zealand	10.1
Northland	5.5
Auckland	4.6
Waikato	7.9
Bay of Plenty	7.7
Gisborne	
Hawke's Bay	1.9
Taranaki	7.6
Manawatu-Wanganui	2.6
Wellington	2.3
Tasman	19.1
Nelson	
Marlborough	12.1
West Coast	23.6
Canterbury	10.6
Otago	24.4
Southland	10.8

Table 1 – percentage of current wetland area remaining compared to historical extent (source WONI, 2008)

The September 2019 STAG report to the Minister for the Environment notes that the thresholds for species extinction are 10–30% of original extent and 60% for percolation (persistence/ ecological processes) (Desmet 2018). Table 1 shows that the total area of wetlands remaining is only just above 10% for New Zealand as a whole, and only 5 of the 16 regions are above the 10% mark (with none reaching 30%): Otago (24.4%), West Coast (23.6%), Tasman (19.1%), Marlborough (12.1%) and Canterbury (10.6%). Most other regions have significantly less wetland area remaining.

This analysis is based on the FENZ data layer of Historical versus Current (2008) wetland by political region. It does not include recent wetland loss nor take into account wetland areas under conservation estate or other protection.

The STAG made no recommendation on the composition of wetlands (in relation to restoration), but understood that there may be a need to consider regions-specific direction given the varying pattern and extent of wetland loss across the regions.

Several submissions have raised concerns that the policy approach is unequitable with costs and obligations landing unfairly across the regions, and have suggested a regional approach to policies/ rules taking into account these regional differences.

Questions

If we were to consider an option where regional differences were accounted for:

- Do you think using a threshold of wetland remaining within regions is a rational way to do it?
- Do you think an analysis based on political regions are appropriate? Or would something like biogeographical units[3] be preferable?
- What thresholds would you consider appropriate?
- Do you think wetland type should be included in such an analysis?

[3] FENZ database Biogeographical Units are modelled based on environmental factors and biological character specific to freshwater ecosystems.

Sediment

The purpose of this paper is to structure STAG's conversation on the sediment attribute proposals. This paper first provides a summary statement from officials responding to the peer reviews. It then provides brief context and questions for options officials are exploring in relation to major aspects of the suspended sediment attribute, the deposited sediment attribute, and finally indicators for the suspended sediment attribute.

The attached supplementary papers include:

1. MFE's request for peer review of the community deviation method
2. Peer review responses from Prof. Gerry Closs and Prof. Angus McIntosh

1. Peer review response – summary statement from officials and discussion questions

Officials will use the peer review commentary, STAG discussion, submissions content, and other inputs to inform final advice on proposed sediment attributes. Therefore, we would like to get your views on core issues the review identified as well as your final views on the robustness of the method(s) used to determine the proposed sediment bottom lines and bands.

This response to the peer review focuses on three themes in the peer reviews of the community deviation method: spatial classification, modelling and uncertainty, and the meaningfulness of band thresholds.

Spatial classification

The Ministry stipulated since the outset of the sediment attribute research programme that reflection of natural variation in environmental state variables (ESVs) and their variable effect on ecological communities is a core guiding principle of the work. Franklin et al 2019, and other reports from the research programme, reflect this explicitly as it was part of the researchers' commissioning briefs.

We consider the various lines of evidence assembled in Franklin et al 2019 to be conclusive about the variation of ecological effects of sediment ESVs in relation to spatial variation. However, officials consider the secondary but related questions of "what level of uncertainty and potential 'overs and unders' stemming from the spatial classification is appropriate" to be a critical component of STAG's conversation on the sediment proposals. This question segues neatly into peer review comments related to measuring and modelling uncertainty and how they propagate through the analyses.

Modelling and uncertainty

The peer reviewers and submitters had comments on underpinning technical aspects of the work related to the use of sediment and ecological modelling, and their interactions. Comments primarily related to the use of models for estimating predicted reference state for sediment ESVs and/or ecological indicators as well as the use of models for estimating current state for sediment ESVs.

In relation to comments in both reviews on the uncertainty in model estimates of current state sediment ESVs, MFE notes that Hicks et al (2017) and Hicks et al (2019) cover this theme at length for turbidity and visual clarity. Clapcott and Goodwin (2017) and Franklin et al (2019) both cover model uncertainty in relation to predicted reference deposited sediment states, and Clapcott and Goodwin also cover uncertainty in relation to estimates of current state deposited sediment cover.

We note that the Ministry and researchers discussed the appropriateness of developing bottom lines and/or bands globally (non-spatial) *or* spatially (ESV and ecological consideration) through assessment of *either* absolute ecological changes or ecological changes relative to reference ESV state. The commissioning brief for Franklin et al included development of attribute bands, which focused the research efforts on methods that could accomplish that requirement.

Bands and their meaningfulness

The reviewers consider the evidence for bottom lines based on the community deviation method to be adequate, clear, and reflective of current knowledge (notwithstanding the concern Prof McIntosh raised about the classification system). However, in relation to the community deviation method at least, both reviewers and numerous submitters stated that the evidence for differential ecological effects between bands was weak. Also, submitters noted that uncertainty on individual measures using the proposed monitoring methods would be as high as some of the attribute bands.

Again, the research brief influenced the choice of methods and method application in this regard. First, the Ministry set a guiding principle for the research that proposed bottom lines would be based on the "…least acceptable state for ecosystem health, avoiding potentially significant adverse ecosystem effects, and accounting for spatial patterns in both ecological distributions and natural sediment state." Second, another guiding principle was the need to document normative decisions and ensure methods were repeatable. Using data-driven approaches allowed the development of attribute bands, and the specific thresholds chosen were normative decisions as documented in Franklin et al 2019. Thirdly, the possibility of bottom lines and/or bands reflecting *either* absolute ecological changes (e.g. extirpation method) or ecological changes relative to sediment ESV state (e.g. community deviation method), means that the bands proposed from different methods reflect different assessments of interactions between ecology and sediment.

In addition to these comments, we note that given the proposed changes to the maintain or improve requirement in the NPS—FM, and the shift away from requiring "maintenance within a band", attribute bands have reduced regulatory meaning. However, in general councils consider them to be highly useful in discussions with communities for setting objectives.

Question 1: In light of the given critiques of the research outputs and measuring uncertainty, do you still consider band thresholds to be robust?

2. Suspended sediment attribute method

In consideration of the critiques raised in the peer reviews and submissions, officials are exploring options for the suspended sediment attribute based on the extirpation method presented in Appendix H of Franklin et al 2019. The choice of this potential alternative method is based on the weight of evidence results shown below.

Figure 1 - Stage 3 report weight of evidence results - justification for choice of alternative methods

Table 5-5: Summary of weight of evidence scores for the different lines of evidence. A / denotes where scores were between classes, for example */** means between a score of * and **. For details of scores see Appendix L.

	Method	Relevance	Reliability	Suitability
Deposited sediment	BRT	+/++	+/++	+
	GLM	+/++	+/++	++/+++
	Community deviation	++	++	++/+++
Suspended sediment	BRT	+	+/++	+
	QR	+	++	++
	Extirpation	++	++	++/+++
	GLM	+/++	+/++	++/+++
	Community deviation	++	++	+++

This method varies significantly from the community deviation method in input data and analytical approach, and it is less reliant on sediment and ecological modelling inputs. The policy implications of shifting to the extirpation method for bottom lines and/or bands include:

1. Generally comparable but slightly less constraining bottom lines and bands for most classes compared to the community deviation method (Hicks et al 2019 assess this fully).
2. Use of the 4 or 8 level spatial classification system due to limitations of data availability for method application.

Officials have requested key authors of Franklin et al to comment on how the extirpation method's inputs and analytical approach differ from the community deviation method. In particular, we have asked them to comment on how uncertainty propagates through the methods, and the ecological meaning of resultant bottom lines and band thresholds.

Question 2: In light of the peer review critiques and submissions, do you consider that the extirpation method (Franklin et al 2019 Appendix H) is an appropriate alternative to the community deviation method?

We hope that the final STAG recommendations report specifies which method results it prefers for use in setting suspended sediment attribute bottom lines and bands.

3. Deposited sediment attribute method

In consideration of the critiques raised in the peer reviews and submissions, officials are exploring options for the deposited sediment attribute based on the generalised linear modelling (GLM) method using sediment MCI presented in Appendix I of Franklin et al 2019. The choice of this potential alternative method is based on the weight of evidence results shown in Figure 1 and the explanatory power of different ecological metrics shown in Figure 2 below.

The GLM method varies moderately from the community deviation method in input data and analytical approach.

Figure 2 - Stage 3 report figure showing invertebrate metric explanation of variance in the GLM analyses

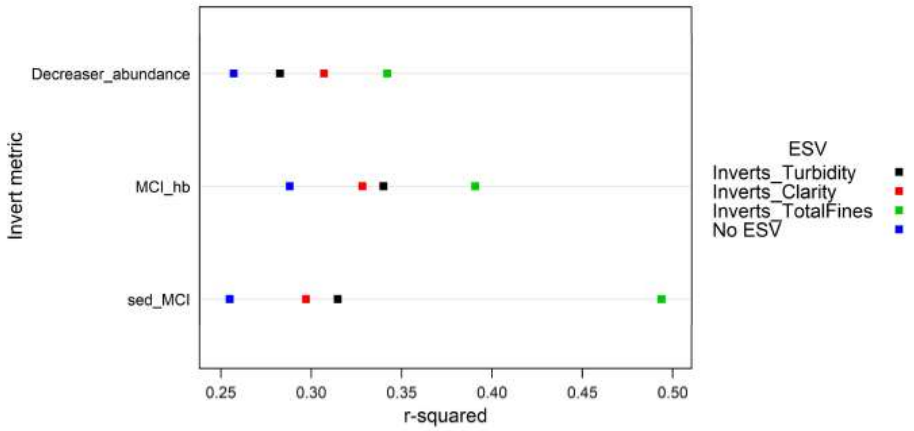

Figure I-1: Variation explained in observed available data for each invert metric and each ESV. "No ESV" represents a reduced model with only landscape setting as predictors.

The policy implications of shifting to the GLM methods for bottom lines and/or bands are not very significant since bottom lines and bands are generally comparable to those from the community deviation method (slightly more constraining in some classes, slightly less constraining in some others, with one outlier class).

Officials have requested key authors of Franklin et al to comment on how the GLM method's inputs and analytical approach differ from the community deviation method. In particular, we have asked them to comment on how uncertainty propagates through the methods, and the ecological meaning of resultant bottom lines and band thresholds.

Question 3: In light of the peer review critiques and submissions, do you consider that the GLM method using sediment MCI (Franklin et al 2019 Appendix I) is an appropriate alternative to the community deviation method?

We hope that the final STAG recommendations report specifies which method results it prefers for use in setting suspended sediment attribute bottom lines and bands.

4. Deposited sediment and soft-bottomed streams

Regional councils and other submitters have major concerns about the use of the proposed deposited sediment attribute indicator (percent fines proportional cover) and monitoring method (SAM2, in-stream visual assessment) for naturally soft-bottomed streams. They consider that other monitoring indicators would be more useful for assessing habitat availability and quality. They also consider that the small attribute band "sizes" and imprecision of the monitoring method, especially in soft-bottomed streams, is problematic.

Approximately 5% of the river network is in naturally soft-bottomed streams (those with predicted reference deposited sediment values above 60%) according to Franklin et al 2019. They include classes 1, 5, and 11 at the 12-class level and classes 1, 2, and 7 if using the 8-class level of the classification system. Officials are considering several options to address these concerns, and the discussion on the deposited sediment method used will also inform our advice on these issues.

Question 4: Is there a clear alternative indicator and monitoring method that would be appropriate in soft-bottomed streams? The proposed indicator and monitoring method is %areal fine coverage as determined using the SAM2 in-stream visual assessment method.

5. Suspended sediment indicators – turbidity and clarity inter-conversion

In addition to a preference for visual clarity, some councils and other stakeholders have questioned the use of FNU for the suspended sediment attribute indicator. The turbidity data used by Franklin et al to derive proposed bottom lines and bands was primarily NTU. However, the National Environmental Monitoring Standard for turbidity recommends use of FNU rather than NTU.

To address concerns raised by numerous stakeholders about the suspended sediment attribute indicator, officials are considering an option to require councils to report against the attribute using FNU but allow inter-conversion between visual clarity and/or NTU in the derivation of that reporting.

Question 5: What might be negative consequences of allowing this inter-conversion?

Peer review of community deviation method shown in Appendix J of Franklin et al. (2019)

Context

Franklin et al. (2019) provide a research framework that:

1.) characterises the relationship between fine sediment indicators and indicators of ecosystem health through a range of analyses, and

2.) uses a formal weight of evidence approach to combine multiple lines of evidence and define regulatory thresholds for National Policy Statement – Freshwater Management (NPS-FM) attribute states.

Through the weight of evidence process, the researchers concluded that the community deviation method (hereafter, the method) produced the weightiest evidence, and, by extension, its results would define the preferred regulatory thresholds.

Submissions on the proposed NPS-FM raised concerns that there was insufficient peer-review, testing, and validation of the method. In response to those concerns, the Science and Technical Advisory Group (STAG) requested a peer-review of the method. This review will support STAG's assessment of the robustness of the method for use in development of regulations.

Documents requiring review

The primary focus of the review is the method described in full in Appendix J of Franklin et al. (2019). The review will require general familiarity with the environmental classification system results shown in Appendix D of the same paper. The reviewer should not require more information on the general context and application of the research than that provided in the executive summary of Franklin et al. (2019).

The review only pertains to the method as described in Appendix J of Franklin et al. (2019). However, in order to understand the development and use of the method in prior research, the reviewer may wish to read Appendices DD and EE from Depree et al. (2019). That research was the forerunner and starting point for Franklin et al. (2019) and is the first publication to describe the method's development.

Purpose of commissioned review:

Review the method robustness, comparable to review for a journal submission.

In addition to any comments arising from the review, provide authors with suggestions on how they could more clearly articulate the following:

1. What ecological outcomes the proposed bottom lines protect/provide.
2. Descriptions of that level of protection in comparison to existing threshold values (e.g. Australia and NZ Guidelines for Freshwater and Marine Water Quality Default Guideline Values).

3. Appropriate statistical tests for, and descriptions of, sensitivity and uncertainty analyses that would improve the transparency of the method and results as well as ease understanding of the method and results in the research community.

The review will be provided to the authors for response. Ultimately, the review is intended to support the STAG when they deliberate on the robustness of the method and its application for the purposes of providing water quality regulatory thresholds.

Outputs and timeframes

1. The review will consist of a stand-alone memorandum of less than 3,000 words as well as comments and, if appropriate, track changes on the text of Appendix J. The review will be provided to the Ministry, STAG, and the authors by close of business 10 January 2020. The review memorandum will be made public on the Ministry's website at a time of the Ministry's choice. Payment for the review will be fixed.

2. Subsequent to the delivery of the review, the reviewer will be available for up to 4 hours to discuss and clarify comments with the authors and the Ministry. The reviewer will also be available to meet with STAG at a meeting date of STAG's choice in January or early February 2020. The reviewer's attendance may be in-person in Wellington (with travel expenses paid for by the Ministry) or via skype. Payment for reviewer attendance at meetings after delivery for the review will be invoiced according to billable hours.

Improving Schedule 1 of the NES

Method used to derive the current Schedule 1

Action for Healthy Waterways includes three options for a short-term intervention to address excessive nitrogen losses from farming sources. Options 1 and 3 propose to apply regulations only in Schedule 1 catchments. The purpose of Schedule 1 is to target the intervention *where high nitrogen levels matter most.* Initially we trialled an approach using modelling that takes account of the receiving environment[4] but this proved to be insufficiently accurate. We then used an approach that used five year median water quality monitoring data to identify catchments with nitrate levels over the 90th percentile. Regional council advice was sought and obtained to identify and exclude those catchments where the nitrate levels are significantly influenced by non-pastoral discharges (usually science staff). Other exclusions were made based on the regional policy regime.

Many submitters thought Schedule 1 should be amended

Some regional council and primary sector submitters raised concerns about the catchments targeted by the proposals, including:

- "natural" sources of nitrogen causing the high nitrate levels (e.g. Motupipi, Taharua)
- improving water quality trends in some Schedule 1 catchments
- good ecological health in some Schedule 1 catchments
- consideration of the receiving environment
- narrow focus on nitrogen compared with the range of stressors.

Some ENGO submitters thought all catchments, or all catchments worse than the new DIN bottom lines should be included in Schedule 1.

A revised technical basis for selecting Schedule 1 catchments is needed

A potential new basis for selecting a "long list" of catchments would amend the existing set of catchments with high nitrate levels by:

1. adding catchments with a sensitive receiving environment (estuaries only) from David Plew's work[5] e.g. selecting catchments that were modelled to fall at least 2 categories in the ETI between pre-human and current levels
2. adding catchments significantly worse than the new DIN bottom lines (from CLUES modelling)
3. removing catchments with significantly improving trends[6]
4. removing catchments based on ground-truthing with a wider set of regional council staff e.g. catchments with significant non-pastoral sources of nitrogen.

Questions for STAG:

1. Any comments on the proposed approach? What extra data sources could usefully be drawn on? What should be excluded?
2. How could lakes be included in the sensitive receiving environments?
3. What is a robust method of deriving the final set of catchments, based on the long list?

[4] Snelder, Whitehead, Larned and Schallenberg: *Environmental nitrogen loads in New Zealand in comparison to regulatory limits: analysis of catchment nitrogen pressure.*

[5] https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/assessment-of-eutrophication-susceptibility-in-nz-estauries.pdf

[6] https://statisticsnz.shinyapps.io/river_water_quality_nitrogen/

Stock exclusion

Officials seek STAG's advice on two issues related to stock exclusion proposals.

1. We have developed a potential method for the application of stock exclusion regulations that could either supplement or be an alternative to the static map as proposed in consultation. We seek your input on several technical matters related to the validation of this method and its potential implementation.

2. We are considering possible exemptions from the stock exclusion proposals without reducing their effectiveness in delivering environmental benefits. We seek your input on criteria for circumstances when stock access to a water body may be allowed (for example, submitters have suggested that some hill country wetlands benefit from seasonal grazing).

1. Use of river slope for stock exclusion regulations

This option would replace the proposed method for identifying lowland farms where we mapped the average land slope at the land parcel scale. Here we describe:

1. issues with the proposed static map that consultation helped officials identify;
2. the potential alternative method and how it addresses the issues noted;
3. summary overview of methods and analysis of consistency of the proposed alternative method with the proposals on which the Ministry consulted;
4. our conclusions from the analysis.

The supplementary paper describes the methods and results in detail.

1a. Issues with the static map arising from consultation

This map showed the average slope of land parcels based on land cover (e.g. productive grasses). It did not include any Crown land. The problems with the use of the map and land parcels are:

1. **Policy intent:** the policy intent is to require heavy stock to be excluded from water bodies, in particular where stocking rates are likely to contribute to degraded freshwater ecosystems. Officials have used land cover and slope as a proxy for stocking rate intensity. In practice, large land parcels can include both wide river flats and steeper hills. Aggregating these areas into one unit sometimes does not reflect the actual or likely environmental risk of stock accessing the water body.
2. **Inequity:** stock owners would not be required to exclude stock from water bodies on Crown land.
3. **Illogical application:** stock would be required to be excluded on one bank of a stream because of the average slope on that parcel and not on the other.
4. **Imprecision:** The underpinning elevation data limits the precision of the mapping method (a higher resolution digital elevation model would likely lead to different results in some cases). Submitters suggested using Lidar data and/or other technologies that can be more accurate.

To address these concerns we are investigating an alternative method for determining slope that captures the intent of the slope thresholds consulted on and is easy to implement.

1b. River channel slope as a potential alternative method for defining low slope land:

River channel slope (hereafter river slope) is a potential alternative to land parcel slope to identify "lowland" rivers where stock exclusion should occur. If this approach were adopted, the national regulation would require stock to be excluded from rivers according to a river slope threshold rather than (or in addition to) a single static map. At present, we are considering using a single threshold, for example defining low slope areas where the rules apply as stream slope under 10 degree river slope as measured across a paddock.

Use of river slope addresses the problems with the static map identified above because it would:

1. address the policy intent, inequity, and illogical application issues by more accurately identifying water bodies vulnerable to degradation from heavy stock access
2. the imprecision issue by not relying on modelling data for its application.

We think that river slope would be easy and practical to assess in the field, which is an absolutely critical component of a proposed stock exclusion regulation. It only requires knowledge of elevation (or at least difference in elevation) at two points, the top and bottom of a given river reach and the length of the given reach. Also, our analyses indicate that river slope has a predictable relationship with land slope (as described below), and is therefore consistent with the intent of the regulations as proposed for consultation.

Question 1 – ease of application: Do you think that measurement of river channel slope is straightforward and simple to assess in the field in comparison to land slope?

Question 2 – area of application:

A. Would you recommend use of the "straight-line" distance between top and bottom of a reach for calculation of slope or the "river meander" distance between top and bottom of reach for calculation of slope?
B. Can you think of a reason to apply the regulation at a scale other than across a paddock?

1c. Testing relationship between river slope and land slope

To ensure that the river slope method is consistent with the intent of the proposals consulted on in Healthy Waterways, the Ministry evaluated the relationship between river and land slope characteristics. The supplementary paper provides technical detail of this analysis, and here we present summary methods and results.

The Ministry conducted statistical analyses of land and river slope using River Environment Classification (REC) attributes and digital elevation model outputs as follows:

Step 1 (gather segments): Randomly choose ~20% of REC segments (n=124,964)

Step 2 (land "buffers"): Using the REC catchment contributing area, put a 100m buffer on the left and right side of the segment river line.

Step 3 (land buffer slope): Overlay digital elevation model data to the buffer zones and calculate average slope of the left and right buffer zone. (Figure 1 below as an example)

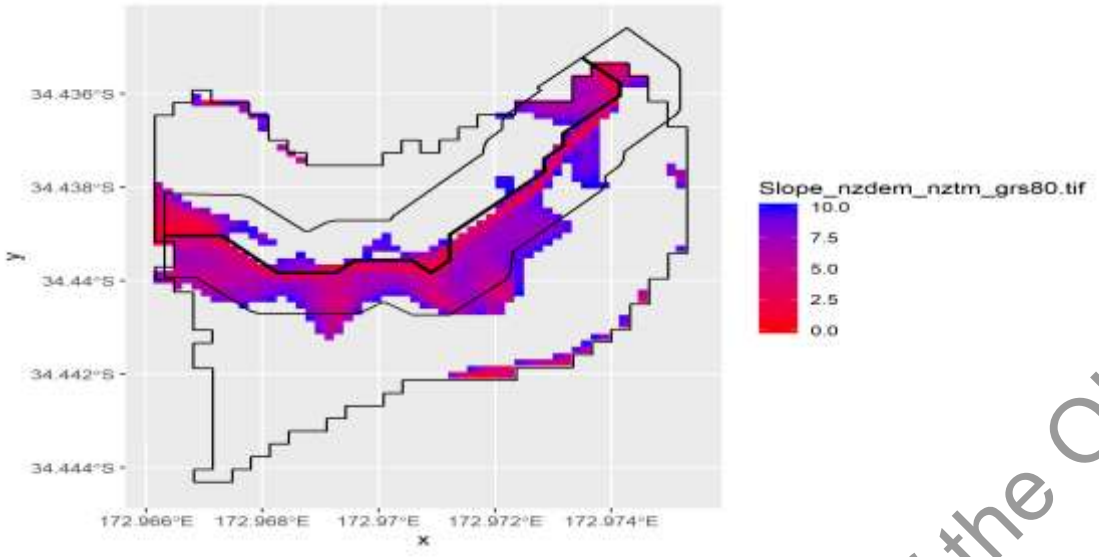

Figure 3 – Example river segment with left/right land buffer zone and pixel average slope value (note grey colour means the pixel average slope is above 10 degrees)

Step 4 (determine river/land buffer slope relationship): Plot river slope and buffer zone slope and provide regression relationships. Results shown in Figure 2 below for all data.

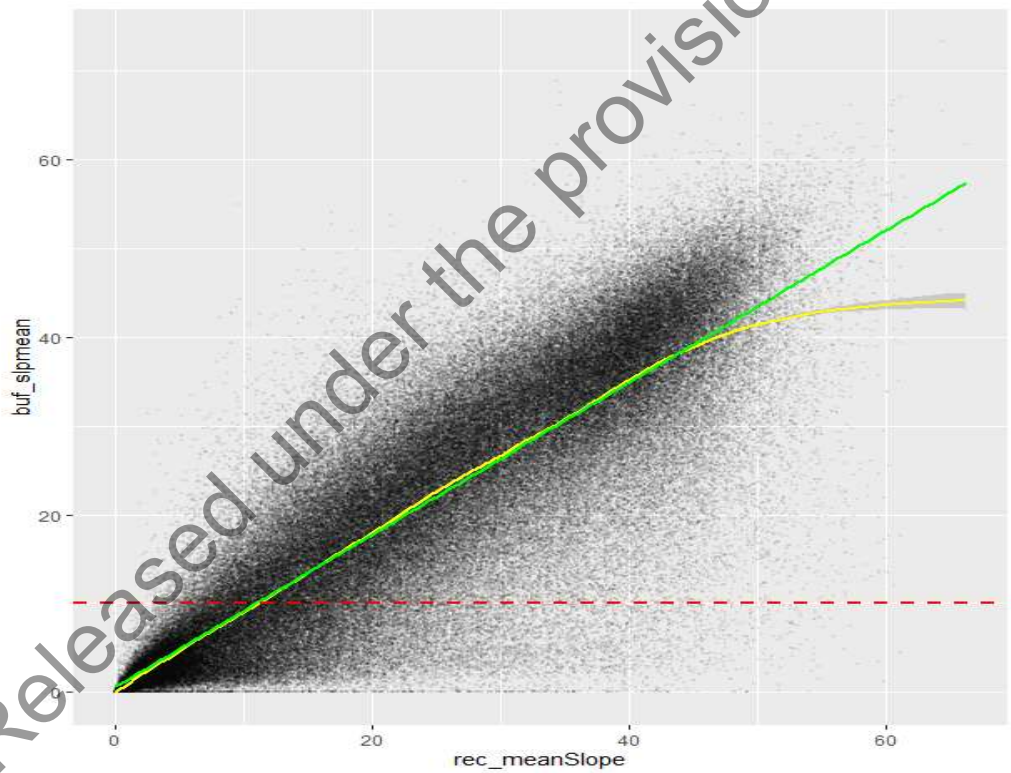

Figure 4 Buffer slope and rec mean slope plotted for all data; green line (y=0.67 + 0.86x) is least-squares linear model (r2=0.734); yellow line is LOESS approximation. Note that left and right land buffers are plotted independently.

Step 5a (compare river slope and land buffer slope): Using conditional rules for each segment given its river slope value, evaluate whether it reflects the intended exclusion requirement or not:

- Met condition means for a given segment with the given river slope, the corresponding buffer slope is greater than 10 degrees (*this represents no intended exclusion requirement*)

- Unmet condition means for a given segment with the given river slope, the corresponding buffer slope is less than 10 degrees (*this represents the intended exclusion requirement*)

Results are shown in Figure 3 below.

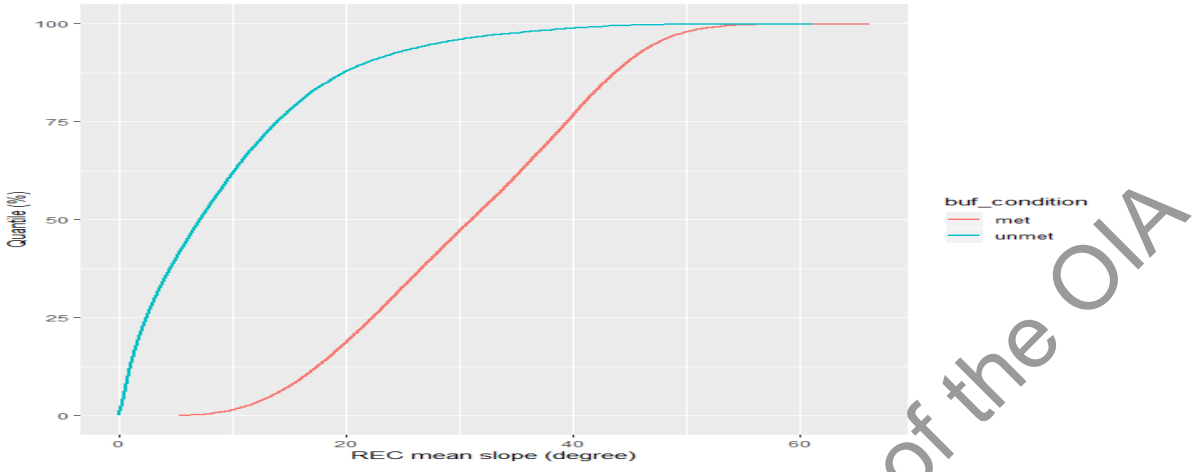

Figure 5 - Cumulative proportion of REC segments that reflect the "met" conditions and "unmet" conditions described above

Step 5b (compare river slope and land buffer slope): Use conditional rules to assess how different river slope thresholds reflect the intended exclusion requirement. Conditional rules are visualised in an example in Figure 4 below, and the results of the analysis are shown in Table 1 using ratio values.

- True positive (TP): For a given river slope threshold, all data for which greater than threshold river slope corresponds to land slope > 10 degrees in the buffer zone.
- True negative (TN): For a given river slope threshold, all data for which less than threshold river slope corresponds to land slope < 10 degrees in the buffer zone.
- False positive (FP): For a given river slope threshold, all data for which greater than threshold river slope corresponds to land slope < 10 degrees in the buffer zone.
- False negative (FN): For a given river slope threshold, all data for which less than threshold river slope corresponds to land slope < 10 degrees in the buffer zone.

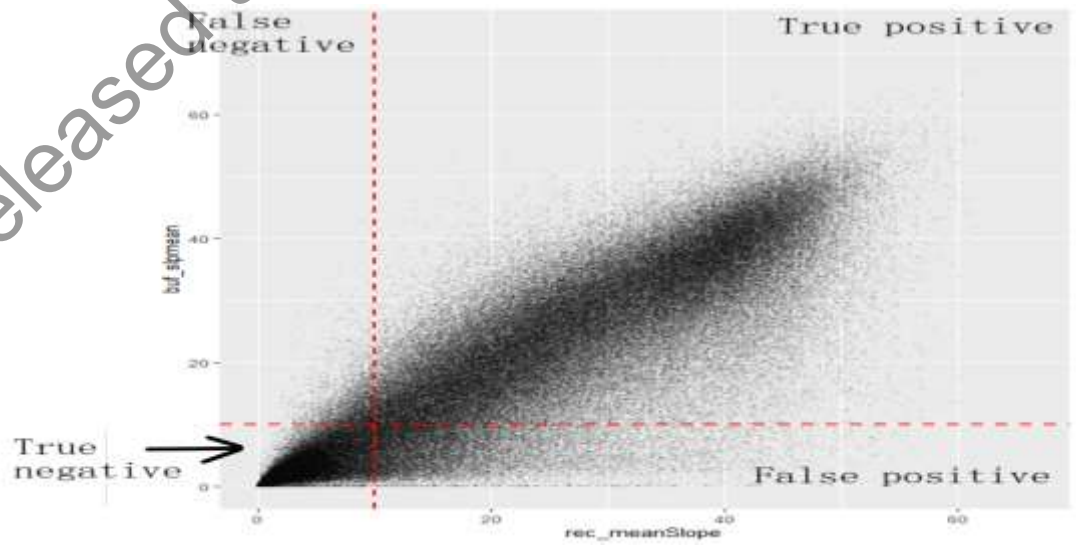

Figure 6 - Example analysis of river slope (10 degrees) concordance with 10 degrees land slope

Results from this assessment are produced as ratios and shown in Table 1 below:

- TPR = (TP/(TP+FN))
- TNR = (TN/(TN+FP))
- FNR = (FN/(TP+FN))
- FPR = (FP/(TN+FP))

Table 1 – confusion matrix evaluating concordance of various river slope thresholds with 10 degrees land slope

REC segment slope	TPR	TNR	FNR	FPR
5	100	40	0	60
6	100	45	0	55
7	100	49	0	51
8	99	54	1	46
9	99	58	1	42
10	98	62	2	38
11	98	65	2	35
12	97	69	3	31
13	96	72	4	28
14	94	75	6	25
15	92	78	8	22
16	91	80	9	20
17	89	80	11	20
18	86	84	14	16
19	84	86	16	14
20	81	88	19	12

1d. Summary conclusions on analyses:

Given these results, we conclude there is strong concordance between river slope and land slope as assessed by buffer zones. Therefore, we consider river slope a viable alternative method by which to define stock exclusion regulations and consistent with the stated intention of the Healthy Waters consultation.

Question 3 – concordance of river and land slope: Do you consider the evidence presented above supports our conclusion of concordance between river and land slope, and if so, with what caveats or qualifiers?

Question 4 – testing river slope relationship with land slope: Can you think of specific statistical tests or other category of validation analysis that would be particularly useful to test and demonstrate such concordance and otherwise "sense check" the proposed method?

2. Potential criteria for exemptions from hill country wetland stock exclusion requirements

We are exploring potential avenues to phase stock exclusion requirements and thereby ease their burden on regulated parties. Submissions from many parties, and especially farm businesses, focused a great deal on the impact of stock exclusion proposals with many commenting on the rules in relation to hill country wetlands. Therefore, we are considering whether there could be specific criteria for exemptions to regulations on beef cattle and deer access to wetlands in hill country areas.

The intention of any such option would be to not compromise the intent of the regulations to reduce the impact of stock on water bodies while easing the burden of the proposals on regulated parties. Specifying criteria for exemptions is one avenue to meet this objective, and we would like your inputs on what types of criteria to explore further. Likewise, there may be specific criteria by which we could effectively constrain the applicability of exemptions to reduce potential degradation.

Question 4 – exemption criteria for beef cattle and deer hill country wetland access: What types of criteria could we explore for exemptions, and what types of specific constraints could/should apply to those criteria?

DIN and DRP attributes for ecosystem health

Context

At the last STAG meeting in November 2019, STAG members requested that a technical report should be written detailing the derivation of the DIN and DRP attributes ("the technical report"). Adam Canning will provide the technical report for STAG to discuss at the January meeting.

Questions

1. Is sufficient information and justification provided in the technical report to resolve questions and issues raised by STAG members?

Starter questions based on previous STAG comments:

	Issue/question	**Source of question**	**See also**
A	How to weight evidence	STAG meeting, 26 February 2019	Summary of nutrient sub-group proceedings
B	How and where to set bands in relation to ecological responses	STAG meeting, 26 February 2019	Summary of nutrient sub-group proceedings
C	Whether attributes should vary spatially	STAG meeting, 26 February 2019	Summary of nutrient sub-group proceedings
D	Whether TN and TP attributes for ecosystem health are more appropriate than nitrate and DRP	STAG meeting, 26 February 2019	Summary of nutrient sub-group proceedings
E	There is a concerning difference in the conclusions drawn from the alternative analyses of Drs. Adam Canning and Ton Snelder in the nitrate vs MCI analyses	Summary of responses to Chair's questions (presented to STAG at June 2019 meeting) – see Appendix 1	Comparison of Macroinvertebrate Community Index ns nutrient relationship
F	We are unable to adequately peer review the analytical steps used in constructing the WoE table.	Appendix 1	
G	Some members have difficulty in the logic of including periphyton in the WoE analysis when the periphyton attribute table will remain in the NOF.	Appendix 1	

Key questions/ issues raised by submitters:

	Issue	Submitter
H	Submitters were concerned about the scatter in relationships between ecosystem health components and nutrient concentrations, leading to 'false positives' and 'false negatives' (i.e. healthy macroinvertebrate populations in some places that have high nutrient concentrations, and vice versa). Some were concerned that nutrients account for a small proportion of the observed variation in ecosystem health components	LGNZ, DairyNZ, Bay of Plenty Regional Council
I	The 95th percentile is difficult to calculate precisely, one submitter thought that there was not enough evidence that it is a relevant indicator for ecosystem health	LGNZ
J	Requests for more detail on derivation of the attributes and detail behind decisions made	NIWA
K	The DRP bottom line is exceeded in many native forest cover catchments, and the bottom line is more stringent than other bottom lines	LGNZ

2. Is any further peer review needed, and if so, what should the focus be?

Appendix 1: Summary of responses to Chair's questions (emailed to STAG for June 2019 meeting)

Nitrogen attribute table: Cautious STAG members' SYNTHESIS of combined comments and responses to STAG Chair Ken Taylor's questions.

Introduction:

We acknowledge the highly professional and collegial discussions that have taken place in the STAG since its inception in 2018 and we have been pleased to contribute to this very useful and important Advisory Group.

The STAG Chair (Ken Taylor) made it clear at the opening meeting of the Group that recommendations would not necessarily be by consensus and that, in the event that consensus could not be reached on a particular matter, that the minority views would be recorded.

The STAG discussed nutrient attribute tables at its meeting on 26th February 2019, including an option presented for nitrate-N (subsequently changed to DIN) and DRP based on a Weight of Evidence approach. Two members of the group supported the incorporation of these tables into the NPS-FM as presented but twelve members requested "further work to answer outstanding questions". We acknowledge the further work that has subsequently been done by the nutrient sub-group of STAG, individual STAG members, and MfE staff.

More recently, the STAG received a new paper on the Weight of Evidence approach used to derive the proposed DIN attribute table. Five of the twelve members that had requested "further work to answer outstanding questions" still expressed concerns under the heading: 'The science is unresolved'. Officials agreed to receiving commentary from these cautious STAG members relating to this new paper. The Chair suggested that it would be useful if those who had outstanding issues with the Weight of Evidence approach prepare a combined response, and to assist with this, provided a series of questions with which to focus the discussion.

This document is in two parts:

i) a synthesis of the main points of the 'cautious' members' concerns arranged under the set of seven questions specifically posed by the Chair and

ii) the individual responses from each of those members. The latter contain more detail and are compiled in an appendix attached [APPENDIX 1].

The 'cautious members' have agreed on this summary statement although not all provided comments to each of the seven questions. Whilst our synthesis and individual comments are directly in response to the questions on nitrogen posed by the Chair, we note that the principles of our concerns will also relate to the phosphorus attribute as well. We also note that while the questions are aimed at the Weight of Evidence approach, our concerns are focussed on the proposed attribute tables, the numbers in them and the derivation of those numbers.

Question 1. I don't have a clear understanding of exactly what data were used in the WoE approach, and how the data were used to derive the levels.

SYNTHESIS OF COMMENTS

Data Used: Recalling that we have been asked to support a set of concentrations for DIN that are presented to the second decimal place of a mg/L of N (ie to 10 micrograms/L), there is a concerning difference in the conclusions drawn from the alternative analyses of Drs. Adam Canning and Ton Snelder in the nitrate vs MCI analyses. These differences remain unresolved but are significant. For instance, if Snelder is correct and his C/D value for nitrate-N is used then the overall proposed attribute table's C/D Band (i.e., bottom line) would increase 3-fold from 0.88 to 2.3 mg/L. These differences are such that they may have used different data sets for their analyses. As a result, we lack confidence in the veracity of the DIN numbers used in the proposed attribute table.

Derivation of levels:
The paper supporting the proposed attribute tables, (Adam Canning's 21.05.19) lacks necessary detail from which to conduct a peer review, with several of the logic steps to derive the attribute bands (bottom lines and A/B, B/C band thresholds) missing from the multiple lines of evidence (i.e., how the bands have been identified). It therefore lacks the expected scientific robustness.
We observe that a range of approaches to determine the bands has been used across the metrics. We wonder why this is necessary? We are unable to adequately peer review the analytical steps used in constructing the WoE table.

Question 2. I am uncomfortable with the WoE approach in general, because….

SYNTHESIS OF COMMENTS
We are **not uncomfortable** with the WoE approach in general. It is accepted as a valid methodology provided that each line of evidence is robustly developed and the way the lines of evidence are combined is logical and appropriate to its use. In this case, from the information presented, we are of the view that these conditions have not been met (see Question 1 above and the external peer review conducted by Professor David Hamilton (Deputy Director, Australian Rivers Institute).

Question 3. I have other scientific or logical concerns with the WoE approach in the context of the NPS as a whole because…

SYNTHESIS OF COMMENTS
Some members have difficulty in the logic of including periphyton in the WoE analysis when the periphyton attribute table will remain in the NOF. It seems that the NPS will then 'double-count' periphyton. This needs further discussion as the periphyton attribute is likely to apply in around 60% of NZ rivers.

The WoE approach uses correlative relationships with ecosystem health rather than mechanistic or causative relationships. These WoE relationships are often weak, and the Canning 21.05.19 paper recognises that "nationally correlative relationships do not always translate to site-specific thresholds".

One member voiced concern over what the proposed nutrient attribute tables will achieve in terms of ecosystem health outcomes alongside other attributes and requirements in the NPS-FM.

Question 4. I think the WoE approach is fundamentally unsupportable, because…

SYNTHESIS OF COMMENTS
We do **not** think the WoE approach is unsupportable. See the response to Question 2.

Question 5. Any other issues?

SYNTHESIS OF COMMENTS

Nitrate/DIN and DRP do not seem to be emerging naturally as overwhelming variables for unifying EH. We share concerns over the data, inconsistency of numbers presented and very different modelling results presented to us on MCI-Nitrate correlations (see response to Question 1).

Any proposed nutrient attribute tables will need to consider effects on downstream ecosystems as required by the NPS-FM. We have not discussed this in the STAG yet but an approach similar to that of the existing Periphyton Note may be applicable.

Question 6. In the event that issues around the WoE approach remain unresolved, my preferred approach for deriving N thresholds would be …

SYNTHESIS OF COMMENTS

There were different views on a preferred approach to 'deriving nitrogen thresholds'. Three are presented here for consideration should the Minister wish to restrict the nitrogen levels in rivers.

1. Noting that the current NPS-FM has a NOF Attribute Table for nitrate toxicity the 'cautious members' suggest that options could be:
   a) 'Raising the bar' for the level of species protection from the effects of nitrate toxicity by shifting the national bottom line to either the B/C threshold (2.4 mg/L) or the A/B threshold (1.0 mg/L)
   b) including nitrate as a "national monitoring requirement" in the NPS with a minimum value of 1.0 mg/L NO_3-N until such time as satisfactory agreement is reached on a full attribute table.

   If a) or b) are chosen then consideration to account for sensitive downstream environments is needed and the most stringent concentration (for toxicity based or the requirement for downstream environments) option taken. It is also noted that if the thresholds for nitrate toxicity are revisited, the thresholds for ammonia toxicity should also be reviewed. (We believe that the science is clear on the impacts of setting policy thresholds for nitrate toxicity. The call on what level (concentration) to put in policy is not a science call).

2. We agree that ecosystem metrics are important to monitor in their own right and, two members suggested that the attribute table be replaced by monitoring requirements in the NPS for each of the ecosystem health metrics in an analogous manner to the MCI that is currently included in Policy CB3. Given that a Periphyton Attribute is in place and that MCI is already covered by a monitoring requirement, new thresholds would be needed for IBI and the three ecosystem processing metrics that the STAG is likely to be recommending in future advice. (We note that STAG discussion on thresholds for these ecosystem health metrics are well-advanced). If these ecosystem health metrics are declining or below the thresholds, then (as per Policy CB3), regional councils would be required to investigate the causes and develop action plans to halt the declining trends and improve.

3. In the absence of the unresolved issues of EH and nutrients, a suggested approach would be: Use the periphyton attribute table and the spatially discriminated nutrient tables for periphyton derived by the recent Snelder analysis to determine N thresholds for hard-bottomed rivers, choosing the more stringent (lower concentration) of this (which could be A/B, B/C, or C/D thresholds), a new nitrate toxicity bottom line (e.g., 1 mg/l), or the current state (maintain criterion). For soft-bottomed rivers use the more restrictive of a new nitrate-N toxicity bottom line (e.g., 1 mg/l) or the current state (maintain criterion).

Question 7. In the event that we conclude that the current state of knowledge is not yet mature enough to support nationally applicable N thresholds for ecosystem health protection (even if I favour the concept of a single table), my preferred approach for managing N would be…

SYNTHESIS OF COMMENTS

No additional comments that have not been covered in Question 6 above.