Freshwater Science and Technical Advisory Group:

Paper compilation for 29 November

Paper Author	Various	Classification	**Confidential**

Meeting date	29 November 2018	Agenda item (number)	1, 3, 4, 5, 6

Contents:

Science and Technical Advisory Group Meeting

Agenda

Dates and Location: Thursday 29 November 10am-4.30pm, Room 1A (Matairangi), Ministry for the Environment, 23 Kate Sheppard Place, Thorndon.

STAG Members present: Bryce Cooper, Chris Daughney, Clive Howard-Williams, Bev Clarkson, Graham Sevicke-Jones, Jon Roygard, Ken Taylor, Marc Schallenberg, Mike Joy, Russell Death, Joanne Clapcott, Ra Smith, Tanira Kingi, Mahina-a-rangi Baker

Apologies: Jenny Webster-Brown, Ian Hawes, Adam Canning, Dan Hikuroa

Items:

	9.30 am	*Coffee and tea*	(30 mins)
1.	10.00 am	Previous meeting minutes and actions arising, Terms of Reference, apologies, conflict of interest (Ken Taylor)	(30 mins)
2.	10.30 am	State and trends (Ton Snelder)	(30 mins)
3.	11 am	Maintaining/improving water quality (Carl Howarth)	(1 hour)
	12.00 pm	*Lunch*	(30 mins)
4.	12.30 pm	Sediment (Stephen Fragaszy)	(1 hour)
5.	1.30 pm	Wetlands (Helli Ward)	(1 hour)
6.	2.30 pm	Updates/shorter sessions: cultural indicators, nitrate, copper and zinc, dissolved oxygen	(30 mins)
	3.00 pm	*Afternoon tea*	(10 mins)
	3.10 pm	Updates continued	(50 mins)
	4.00 pm	*Meeting close*	

Papers distributed:

Agenda item (number)	Paper title	Classification - confidential yes/no?
1	STAG Meeting Minutes – 18 & 19 October	No
2	No paper	-
3	Setting planning objectives to 'maintain' water quality. What constitutes 'maintain' at a site?	Yes
4	Sediment discussion document	Yes
5	Wetlands	Yes
6	A summary of attributes relating to nitrogen	Yes
6	Update on package to address copper and zinc	Yes
6	A summary of attribute development to date: dissolved oxygen	Yes
1, 3, 4, 5, 6	Paper compilation	See above

Science and Technical Advisory Group (STAG) Meeting

Minutes

Thursday 18 October 2018 10am-5pm, Thorndon 1 Room, Terrace Conference Centre, Levels 2-4, St John House, 114 The Terrace.

Attendees: STAG: Ken Taylor – Chair; Dr Bryce Cooper; Dr Clive Howard-Williams; Dr Chris Daughney; Dr Bev Clarkson; Graham Sevicke-Jones; Prof. Ian Hawes; Prof. Jenny Webster-Brown; Dr Joanne Clapcott; Dr Jon Roygard; Dr Marc Schallenberg; Ra Smith (11am onwards); Prof. Russell Death; **Ministry for the Environment (MfE) officials:** Lucy Bolton; Jo Burton; Nik Andic; Ton Snelder; Vicky Addison; Jen Price; Helli Ward; Kirsten Forsyth; Oscar Montes De Oca Munguia (afternoon)

Friday 19 October 2018 9am-3pm, Ahumairangi Room (1C), MfE, 23 Kate Sheppard Place, Thorndon.

Attendees: STAG: Ken Taylor – Chair; Dr Bryce Cooper; Dr Clive Howard-Williams; Dr Chris Daughney; Dr Bev Clarkson; Prof. Ian Hawes; Prof. Jenny Webster-Brown; Dr Joanne Clapcott; Dr Jon Roygard; Dr Marc Schallenberg; Dr Mike Joy (11am onwards); Ra Smith; Prof. Russell Death (morning); **MfE officials:** Lucy Bolton; Jo Burton; Nik Andic; Ton Snelder; Vicky Addison; Jen Price; Helli Ward; Kirsten Forsyth; Stephen Fragazsy; Carl Howarth

Apologies: Dr Adam Canning; Dr Dan Hikuroa

Items: Thursday 18 October

7. Welcome and introduction

Ken Taylor welcomed the group members, thanked them for their participation and acknowledged the important work they are doing.

8. Group introductions

9. Introductions:

a) Vicky Robertson – Secretary for the Environment, MfE
b) Martin Workman – Director – Water, MfE
c) Hon David Parker – Minister for the Environment

The Committee introduced themselves to the Minister.

The Minister thanked the group and talked about the role of science in informing policy and resolving controversy. He spoke about areas of focus in the current Essential Freshwater programme such as sediment, wetlands and estuaries.

Questions from the Group included:

- What is the Government's appetite for risk and uncertainty? The Minister mentioned the need for a precautionary approach and talked about management of sediment in Southland as an example. We need to make a call and take action. Adjustments can be made at a later date if required.
- How do we go about fixing past damage? The best solutions need to fix past damage as well as put into place policies going forward. In Southland for example, there is a legacy of wetland drainage and the landscape has little water holding capacity. There is a need for

landscape scale management. This is also a social-economic problem. There is a limit to what can be achieved, e.g. major infrastructure such as airports cannot be moved. We need a spatial planning approach in these cases. How can we support regional councils to achieve this?

- What is the level of receptiveness to alternatives to attributes? Feedback from Regional Councils is "tell us what to do, and we'll do it, but don't keep changing what we need to do". We will look into a range of tools. But, if the current approach is working, we'll keep it.
- How do we deal with threatened species? The National Policy Statement for Freshwater Management (NPS-FM) doesn't address species extinctions. We need options for managing pest species, this is currently not in the NPS. The Minister said he would not oversee the extinction of freshwater species. The perspective of Fish & Game needs to be taken into account. No further introductions (i.e. range expansions) are being carried out. A spatial planning approach is needed to protect threatened species. The Minister is alarmed how out of control carp are.
- Is it the role of the STAG to make purely science-based decisions or take economic considerations into account? The Minister asked the group to leave the wider economic decisions to him. Swimmability of rivers is an example of where there is an overall target for all rivers to ensure that no river should decline in water quality.
- Lag times mean that even if we stopped all the pressures now, the state of freshwaters wouldn't improve within 5 years. The Minister responded that to see changes within 5 years, changes to inputs are required.

Further discussion points:

- Pests affect resilience of freshwaters, land use is not the only problem.
- Flow allocation is important. The river can't "flush itself" if there is no flow.
- The NPS – Indigenous Biodiversity is being developed and will be released soon, Jo Burton has a role in this work. There is a need to make sure the NPS-FM aligns with this.
- Climate change policy and the Emissions Trading Scheme will also affect freshwaters and may even have a larger impact than the NPS-FM. Officials need to inform STAG of climate change policy developments. Horizons hill country management plans were cited as an example of where the effects of climate change will overwhelm the effects of good practice.
- This group is not expected to reach consensus, and it's important that any disagreements are noted when advice is communicated to Ministers.

10. Terms of Reference (TOR), working with Freshwater Leaders Group and Kahui Wai Māori

Lucy Bolton gave an overview of the TOR, which are still in draft, and the STAG members were invited to comment. Discussion points included:

- A key point to consider is how STAG will work together with FLG and KWM – more detail is needed on this in the TOR.
- MfE will set up a regular newsletter as well as an online portal for discussions.
- There was discussion around whether the group should focus purely on science, noting that it is difficult to only talk about science without considering policy and economics. Policy analysts can play a key role in helping guide where discussions go.
- A key role for officials is to report back to the group with policy that incorporates science advice, to keep the group informed.
- Members serve in the group in a personal capacity and are not representatives of their organisation.

- There may be a role for other disciplines that are not yet included in the group; other members can be co-opted in as required. The group can identify knowledge gaps where necessary.
- Why isn't kaupapa Māori being looked at? There was discussion around the scope of the group being focussed on biophysical science, but also being informed by kaupapa Māori approaches.

Discussion on confidentiality:

- There was general agreement among group members that they would need to have discussions with others to be able to effectively contribute to the group. This is important to reflect in the TOR.
- Minutes are to be high-level and will not attribute names to discussion.
- In order for the Group to operate effectively, members must maintain the confidence of the group, including maintaining confidentiality of matters discussed at meetings, and any information or documents provided to the group.
- MfE will indicate which documents are confidential due to their draft nature.
- The confidentiality clauses in the Terms of Reference do not affect the ability of members to talk to the media in their capacity as experts.
- If required, meetings can include a regular time slot to address confidentiality questions.

The procedure for identifying and declaring conflicts of interest was outlined.

Actions:	**To be completed by:**
Update TOR and circulate next week.	Jen/Lucy
Officials to work out logistics of how three groups will work together.	Lucy
Officials to keep STAG up to date with climate policy developments.	MfE officials
Conflict of Interest forms to be sent separately to members.	Jen

11. Te Mana o te Wai

Lucy Bolton outlined the concept of Te Mana o te Wai as an overarching concept for the NPS-FM. There was discussion on how to integrate Te Mana o te Wai into a biophysical framework. It was discussed that community values sit at the top of the NPS-FM as a guide to objectives and limit setting.

12. NPS overview

Vicki Addison gave a presentation on the NPS-FM and how it works by directing regional plans while allowing flexibility. Limits are placed on resource use to achieve freshwater objectives which are measurable in-stream. Vicky is working on providing more direction to Councils on how to set limits.

Discussion points included:

- It takes 5-10 years for the NPS to filter down to regional plans. Group members noted that the process is long and the courts are heavily involved.
- The NPS-FM does not provide for restoration. Actions can be carried out in the non-regulatory space that can achieve action quickly, e.g. catchment accords.

13. Discussion on NPS-FM

Jo Burton provided an outline of the feedback received on the NPS-FM by Fish & Game NZ, Land and Water Forum, and others. Clive Howard-Williams summarised the feedback given to MfE outlined in

the briefing "Resolving Freshwater Science Differences" (included under Agenda Item 7 in the meeting materials).

It was noted that MfE was prioritising addressing this feedback, but would not be able to address everything within the current round of changes due to time restraints.

Key points discussed in relation to "Resolving science differences" were:

- N toxicity attribute is sometimes being used inappropriately as it is sometimes perceived as a limiting factor for ecological processes in rivers (such as setting nitrate levels for plant growth)
- The NPS-FM is a good mechanism and was appropriate for its time, but needs improvement.
- In formulating the "Resolving science differences" letter, there was disagreement among the scientists about how to best derive dissolved inorganic nitrogen limits – whether through its effects on periphyton, or macroinvertbrates and fish.
- There is a clear need for a clear and transparent process of engaging with scientists, including feedback on the process.
- The definition of "maintain and improve" water quality (relating to being maintained within a band) is problematic. Bands were originally devised as a way for communities to set objectives, not as a way of defining "maintain or improve". Movement within a band may represent a significant shift in the ecosystem.
- Guidance is needed on the use of statistics to define "maintaining" water quality. The group felt this would be an important area to discuss.
- An important consideration for "maintaining" water quality is defining reference condition when this may change over time. To address this it would be important to know the natural rates of change in freshwater systems. Chris Daughney has done a similar piece of work for groundwaters.
- An example of defining reference conditions is provided by the Wetland Condition Index, which uses historical information to define the reference state.
- A question was asked whether other countries had dealt with the same problems, and how. Lucy Bolton outlined the UK experience, where certain EU objectives were unachievable, which resulted in communities eventually setting their own objectives for local waterbodies.
- It was noted that giving a wide range of options including regulatory and non-regulatory solutions would result in faster progress.
- Science information can be enabling for communities.
- Research is needed into the effectiveness of mitigations.

14. At-Risk Catchments update

Oscar Montes de Oca Munguia gave a presentation on the progress to date of the At-Risk Catchments programme.

This programme of work picks up on the Land and Water Forum's recommendations to identify 'at-risk' catchments, ensure plans are in place for those catchments, and take action where necessary to stop further degradation and start reversing the damage that has occurred. In their advice to the Minister for the Environment on 18 May 2018, the Land and Water Forum noted that:

> *'There is a need to take greater action in 'at-risk' catchments. 'At-risk' catchments are those where:*
>
> - *There is a clear decline in water quality in the catchment or downstream receiving waterbody;*

- *Where the water resource is under pressure from existing or anticipated future land use change, leading to a likely decline in water quality; or*
- *Where the waterbody is vulnerable to irreversible detrimental change, and urgent action is needed.'*

Councils have provided a list of at-risk catchments around the country and there is also a number of existing lists compiled by various organisations (e.g. Fonterra, DOC). The next step will be prioritising these catchments in consultation with a range of stakeholders. A subset of the group indicated they would be willing to help further with the project; Oscar will follow up with more information. Potential areas where the group could contribute included a method of determining what is "at-risk" and ensuring all at-risk catchments had been captured by the list.

The group agreed it would be useful for officials to give a summary of the latest water quality state and trends work, recently commissioned by MfE.

Actions:	**To be completed by:**
Present to group at next meeting on state and trends	Ton
Provide further information about participating in At-Risk Catchments project	Oscar

15. General discussion

Ken asked for any suggestions from the group. It was suggested that:

- The group could consider bringing in some international expertise (it was generally considered by the group that this would not be progressed as there was not a clear need; however, advice from international experts may be sought if required for specific matters)
- The group could include early-career scientists as observers (the group was in general agreement with this idea)

Actions:	**To be completed by:**
Explore ways to include early-career scientists as observers	MfE officials

Items: Friday 19 October

16. Summary of previous day and introduction

Ken reiterated some of the broad themes from Minister's talk, then referred to the Essential Freshwater work programme document, and highlighted its timeline with key themes, encompassing regulatory changes as well as work on at-risk catchments. He discussed the work programme of STAG as being focussed on testing and advising on scientific aspects of the NPS-FM.

Discussion points included:

- Group members identified a need to reflect more detail on the operation of the group in the Terms of Reference.
- It was noted that officials will define a schedule of work and goals for the upcoming meetings.
- Officials will also provide an online portal as a collaborative space to share work between meetings.

Actions:	**To be completed by:**
Define forward work programme and schedule of meeting goals	MfE officials

Provide further information on group operation in Terms of Reference	Lucy, Jen
Set up online portal for information sharing	MfE officials

17. Different options for managing stressors (e.g. attributes, guidance, rules, NES)

Nik Andic presented an overview of the function of attributes within the NPS-FM and how the intervention logic works by limiting resource use. He explained that this mechanism may not be suitable for some stressors such as pest plants and aimals, but that other approaches could be required. Restoration is another example where other approaches might be necessary. The group was asked to consider other approaches than attributes, but it was noted that the group wasn't expected to make decisions around which regulatory mechanism would work best – that is the job of the policy analysts.

Group discussion included:

- Catchment approaches require a tailored combination of regulatory and non-regulatory mechanisms; regulation on its own may not drive behaviour change.
- Relationships are key to enable good practice. Te Mana o te Wai encompasses this idea. The term whakamana describes the need to build up the mana of the water as well as limiting negative effects.
- The group discussed the possibility of narrative objectives rather than numerical ones. MfE officials asked the group to consider these, and not to limit thinking to numerical attributes. It was noted that narratives can aid in understanding of numerical attributes and processes.
- The group was asked to identify where further work is needed if things cannot be dealt with within the first tranche of work.
- Biosecurity was identified as a key gap in the NPS-FM and different ways of managing freshwater pests were discussed. A need was identified to ensure that anything recommended is consistent with the NPS- Indigenous Biodiversity.

18. Evidence requirements for policy development

Ton Snelder and Nik Andic discussed the criteria that were applied to the existing attributes developed in the National Objectives Framework. NPS attributes are compulsory, which has driven the need for due diligence to ensure that attributes can be applied nationally. For example, the first criteria is that the attribute is linked to a national value.

There was discussion on other non-compulsory values that can also have attributes. Mauri is one of these non-compulsory attributes. Criteria for attribute development need to align with community values. How can we give community values and attributes equal value, when different places will have different criteria?

Adam Canning provided comments via email; his comments on the first three criteria were read to the group.

Nik outlined the regulatory impact statement process that Cabinet needs to go through to change any regulations. We therefore need to allow ministers to assess the impact of any regulatory changes. STAG should keep this in mind, but not focus on economic impacts. STAG can assess the level and quality of information for each issue to help the Minister make decisions.

An ecosystem health approach requires us to assess all components of the ecosystem e.g. water quantity, habitat and fish passage as well as water quality indicators.

NPS-FM is not the only tool for managing freshwater – e.g. regional plans often include objectives that will require consideration of attributes such as turbidity or clarity that are not currently in the NOF.

The intervention logic of the NPS-FM was discussed. Attributes that meet the existing attribute development criteria can drive limits on resource use (e.g. nitrogen), but if we were going to include more holistic ecosystem attributes we would need to assess how the intervention logic would work, because not all ecosystem attributes can be managed by limiting resource use.

If attributes were nationally applicable but not nationally definable, a guidance approach could work. Guidance can then be updated as necessary. Guidance can be formally referenced in the NPS-FM; it then becomes part of the legislation. The guidance would need to be quite directive and couldn't have too much ambiguity. This could be an option for incorporating a more holistic view of ecosystem health.

It was discussed that it would be helpful for the group to identify which ecosystem health components can't be managed by way of an Appendix 2 attribute. Officials will then make the call on what is the best mechanism.

Adam's comments around bands and the definition of "maintaining" were discussed. Nik informed the group that this definition is being looked at as part of the Essential Freshwater work programme. Bands were not originally set up as a way to define "maintain or improve" but as a way for communities to set objectives. However, they are now being used to define whether water quality is being maintained. "Maintain or improve" is a complicated measure, and assessing whether a change is ecologically meaningful or statistically significant are different matters.

The group agreed that it would be useful to discuss "maintain or improve" at the next meeting.

Adam's comments on criteria 3 and 4 were read out. It was discussed that requiring absolute certainty about the drivers of potential attributes may mean that we miss out on taking action. For example, MCI is not included at the moment because it doesn't meet criteria 3. An approach could be to be aware of the attribute criteria without using them as strict binary decision tools. However, we need to keep in mind what outcomes we want to achieve. The strength of attributes in the NPS-FM is in directing councils how to achieve the outcome by limiting resource use. MCI remains difficult to improve within an attribute framework (i.e. by limiting resource use) but these kinds of measures can be incorporated in a different way. Is there room for a new mechanism that monitors certain factors closely?

There was discussion on whether we are measuring attributes for assessing values or pressures. Sediment, for example, affects value of ecosystem health and also relates to pressures, e.g. livestock in streams. It is more complex than nitrogen as it doesn't have a 1:1 relationship to land use pressures like nitrogen does. For upholding values, existing attributes in the National Objectives Framework (NOF) don't tell the whole story. On the other hand, MCI, which is not currently an attribute, measures value, but isn't directly linked to pressure.

There was discussion around the point that economic implications are not a key consideration for the group; however, the implications of decisions, e.g. actions required to be taken by regional councils, do need to be understood.

It was discussed that the group should also consider emerging issues. It was noted that the NPS-FM tries to address emerging issues by proactively setting limits rather than dealing with specific land uses.

It was noted that compulsory monitoring is useful as a learning process, and could be expanded to consider new important variables that may not be suitable as attributes, e.g. Matauranga Māori is a compulsory monitoring requirement. In different FMUs, different values and monitoring requirements may apply.

It was suggested that looking at ecosystem health as a whole can tell us more about ecosystem declines than just assessing attributes. This approach requires whole systems thinking, rather than focussing on attributes. This relates to a combination of regulatory and non-regulatory approaches that is catchment based and incorporates community values and involvement.

Outcome: The criteria will be framed as things that need to be considered, rather than strict decision gates. It is important for the group to consider the precautionary principle, and understand links between potential attributes and other components of the ecosystem. The group should also consider, should it be an attribute or something else? If it should be an attribute, should it be numerical or narrative?

Actions:	**To be completed by:**
Discuss "maintain or improve" at the next meeting	MfE officials

Joanne Clapcott tabled Figure 10 from the Biophysical Ecosystem Health Framework report (below; tabled under Agenda Item 13) illustrating the link between aspects to be managed, variables, and values. Attributes in the current NPS-FM measure stressors. It was suggested that the focus should be on things that we can manage, and we should have attributes that describe those. The diagram illustrates how we can affect multiple values by managing a handful of aspects. Attributes are necessary in this process, but not sufficient on their own. There was discussion on whether we need different attributes to measure state and stressors, e.g. periphyton can either be an indicator of ecosystem health, or swimmability, and would need to be measured in different ways and have different bands for each purpose. If some variables are correlated with each other, it may not be necessary to measure everything.

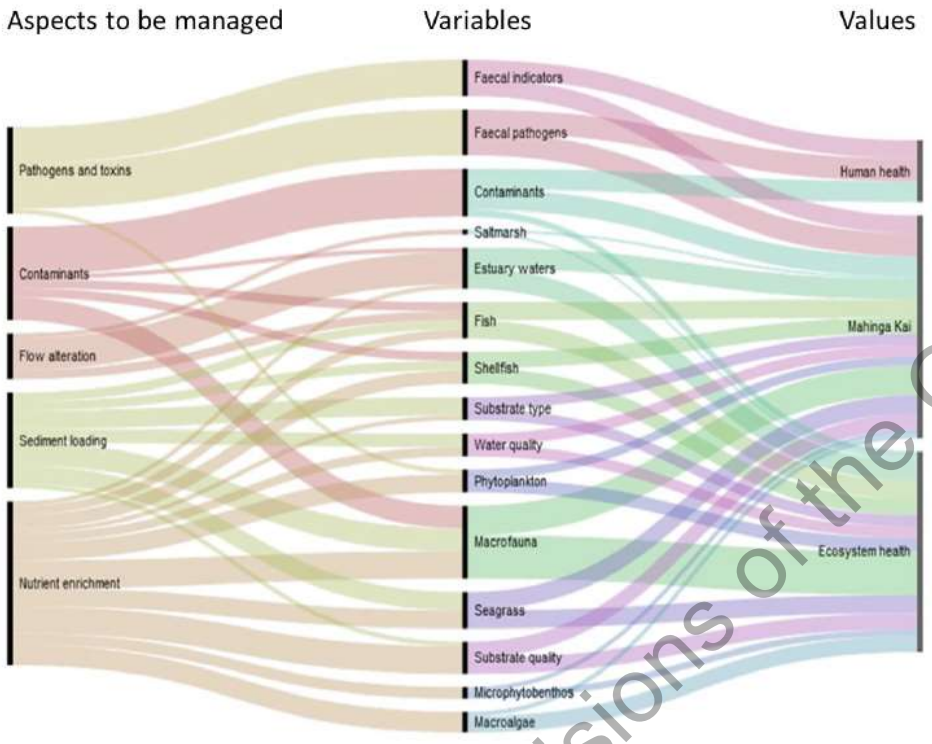


Figure 10. Alluvial diagram showing linkages between aspects to be managed, variables and values identified from an online survey of c. 30 estuarine experts asked to identify characteristics of healthy estuaries (from Cornelisen et al. 2017).

19. Ecosystem Health Framework

Carl Howarth tabled the Biophysical Ecosystem Health Framework report as well as a summary document. He summarised the report for the group and provided some starter questions.

Discussion focussed on:

- The importance of reference conditions. Reference conditions need to be the pre-human condition. Benchmarks may shift along with global changes. They also need to take into account natural temporal and spatial variation and natural system evolution. Some ecosystem components are more advanced in terms of reference condition knowledge. Modelling can be used to predict reference state where this cannot be measured directly. Existing methods don't take into account temporal change in reference conditions.
- How does mauri fit into the Framework? This is not dealt with specifically as the Framework is focussed on biophysical aspects, but there are mauri aspects in all of the components. However, the Framework would not be sufficient on its own to measure mauri or other values. The NPS-FM makes reference to the other values.
- The Framework allows the observed/expected (O/E) method to assess ecosystem health components, and is a valuable contribution.
- The Framework has parallels to the Wetland Condition Index (WCI), which uses historical information to assess the pre-human reference state. Some relevant learnings from the application of the WCI include: the method needs to be rapid to keep costs at a manageable level (it takes a day to assess a wetland); and training is important to maintain consistency of scores.

- It was noted that the Framework has not yet been trialled, but the report provides a worked example of using the Framework for rivers.
- To provide consistency across the country it would be important for MfE to give an approach for aggregation and harmonisation now, before the method is taken up by regional councils.
- Aggregation approaches need to be clear and transparent to ensure that granularity of information is not lost. The report recommends that aggregation would only be done to the highest level for environmental reporting, not setting limits.
- How would be Framework be used in the NPS-FM? You can use the indicator components in the same way the WCI does. Attributes would apply to the more detailed measures. The current attributes in the NOF monitor several components of the Framework, but not all of them.
- Can NOF bands be expressed as O/E? The group agreed that this was possible (but see further discussion points below). How can we then work out what is the national bottom line? There are international examples of this, such as RIVPACS (an aquatic biomonitoring system for assessing water quality in freshwater rivers in the United Kingdom) and AUSRIVAS (Australian River Assessment System).

Key areas where STAG could contribute could be:

- Consistent ways to aggregate and harmonise data
- How to convert O/E ratios into bands
- How do we make the Framework a nationally applicable instrument? How do we scale it up? (it was noted that might not be a priority because we need to focus on the Essential Freshwater programme)
- Considering how the Framework could be applied to the NPS-FM

There was discussion around the use of observed/expected ratios, including:

- Observed and expected values are both variable, so dividing one number by another may not be statistically robust. However, it was pointed out that other countries use this approach despite inherent variability. Models will always have inaccuracies, and regulations need to take errors into account. Errors also apply to the existing numeric attributes. *E. coli* is an example where risk and uncertainty has been built into the attribute states.
- It was also pointed out that just because a system is not like the reference condition, doesn't mean that people don't value it. The other values could then be measured in different ways. Could "expected" be defined in different ways – would it be more accurate to call it "desired" or "reference"?. How do you measure community aspirations when deciding what "expected" is?
- This approach needs to be tested in an NPS-FM context. A risk approach would help councils identify where interventions are required most urgently.
- River systems evolve naturally over time, and it might not be realistic to measure rivers against the pre-human condition. On the other hand, using lower standards might lead to further degradation. There was some discussion around different ways to deal with this. An example would be the Otaki River, which has good water quality, moderately good biological values, but the floodplain is constrained to make way for Otaki town. It has therefore been modified from a braided river to a meandering river. But people still value it for fishing, whitebaiting etc. Therefore, it would score badly in O/E for geomorphology but not other ecosystem health components. Getting a low score in this case wouldn't necessarily indicate that action needs to be taken. To manage this you could report each aspect separately.
- It was reiterated that O/E measures have been used successfully overseas. There are different ways of defining reference state, and the important thing is to make sure reference states are consistently defined.

- How does an Ecological Integrity approach[1] fit into the Framework? It was explained that the Framework uses the NPS-FM definition of healthy ecosystems as well as the definition of the Resource Management Act (RMA). If you measure core components, you can comment on emergent properties referenced in the Ecological Integrity report, such as resilience and ecosystem integrity. An O/E approach captures nativeness and pristineness which are parts of the Ecological Integrity approach.
- Measuring the state of water holistically and incorporating community values would involve a wider view and would need to take into account more components than are incorporated into the Framework. Narratives describing the computations can help people understand processes at the Freshwater Management Unit/local level.

Outcome: Statement from group: We are comfortable with the five components of the Ecosystem Health Framework to proceed with further work, noting that there is a caveat around Te Mana o te Wai and Maori views which are not measured directly by the framework.

Additional agenda item: Brief introductions from Alison Dewes and Corina Jordan from Freshwater Leaders Group (FLG)

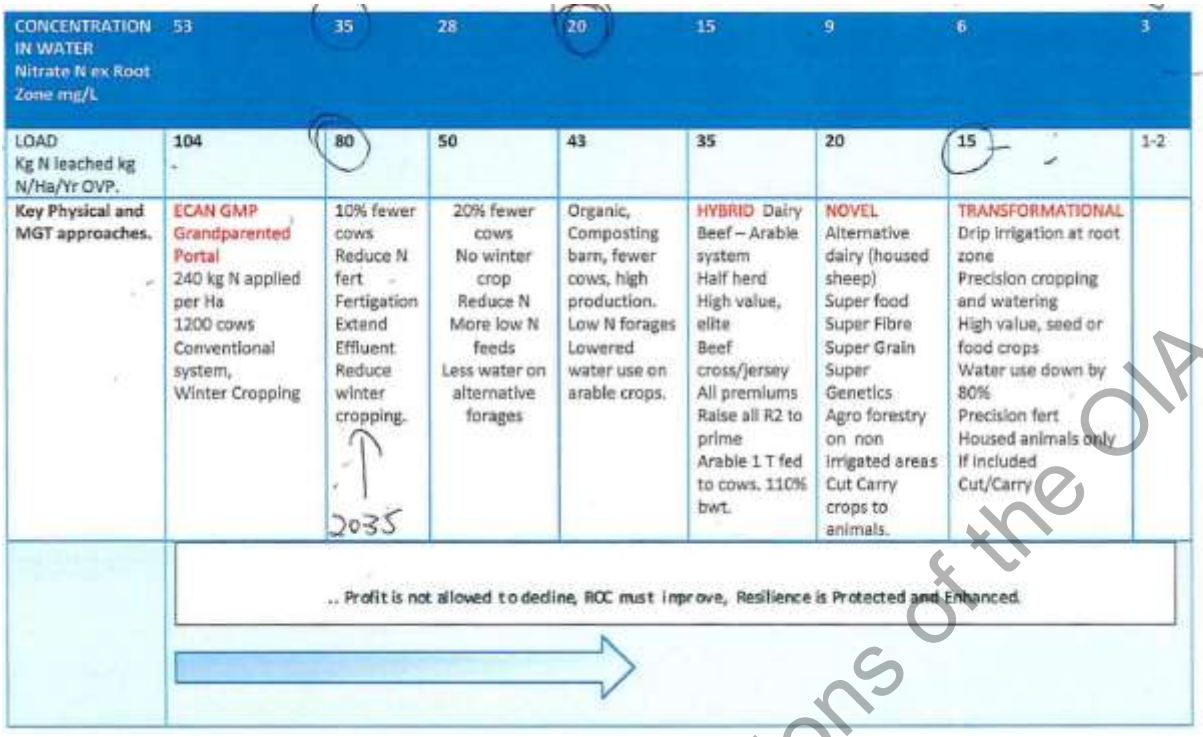
Martin introduced Alison Dewes and Corina Jordan from FLG. They are looking into the effectiveness of good management practices and how we are defining our long-term target. It was emphasised that we need clear policies so that we can provide businesses with certainty for the future.

Corina emphasised the importance of the group providing an unsanitised scientific opinion and clear definition of ecosystem health to feed into the policy making process.

Alison pointed out the importance of certainty for communities. Alison passed around a table (below). She explained that the Environment Canterbury system of grandparenting is not related to ecosystem health, and that it is important to understand the relationship between nitrogen in water leaving the root zone and what goes into drinking water aquifers and ecosystems. Optimizing dairy systems will not be sufficient on its own for meeting targets, we need novel land use systems. Drinking water guidelines are being used as targets for groundwater nitrate concentrations because these are currently the only guidelines available.

It was discussed among the group that we need to have a feedback mechanism for policy work to come back to STAG to reassess. It is an iterative process.

[1] Schallenberg, M., Kelly, D., Clapcott, J., Death, R., MacNeil, C., Young, R., ... & Scarsbrook, M. (2011). Approaches to assessing ecological integrity of New Zealand freshwaters. Department of Conservation. Available from https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc307entire.pdf



CONCENTRATION IN WATER Nitrate N ex Root Zone mg/L	53	35	28	20	15	9	6	3
LOAD Kg N leached kg N/Ha/Yr OVP.	104	80	50	43	35	20	15	1-2
Key Physical and MGT approaches.	ECAN GMP Grandparented Portal 240 kg N applied per Ha 1200 cows Conventional system, Winter Cropping	10% fewer cows Reduce N fert Fertigation Extend Effluent Reduce winter cropping. 2035	20% fewer cows No winter crop Reduce N More low N feeds Less water on alternative forages	Organic, Composting barn, fewer cows, high production. Low N forages Lowered water use on arable crops.	HYBRID Dairy Beef – Arable system Half herd High value, elite Beef cross/jersey All premiums Raise all R2 to prime Arable 1 T fed to cows. 110% bwt.	NOVEL Alternative dairy (housed sheep) Super food Super Fibre Super Grain Super Genetics Agro forestry on non irrigated areas Cut Carry crops to animals.	TRANSFORMATIONAL Drip irrigation at root zone Precision cropping and watering High value, seed or food crops Water use down by 80% Precision fert Housed animals only If included Cut/Carry	
	.. Profit is not allowed to decline, ROC must improve, Resilience is Protected and Enhanced							

20. Wetlands update

Helli Ward gave a brief update about wetlands to signal future work. In 2015, an expert panel discussed wetland attributes, and came up with a range of aspects to be managed along with potential attributes. Lack of data was flagged as an issue affecting progress. It was outlined that a policy response was required to stop loss and decline of wetlands, and that different options are being considered.

Discussion points included:

- Can a condition index be an attribute? This is a topic for further discussion.
- How can wetlands be restored in areas where there aren't any left? MfE is looking at options.
- NPS – Indigenous Biodiversity – Helli is working with the Department of Conservation on this.
- Jon R indicated that Horizons can provide data on wetland extent and loss.
- It's important to halt drainage of wetlands.
- Delineation and definition of wetlands are ongoing issues. Landcare Research is working on methods. Wetlands have significant values other than indigenous vegetation, such as carbon storage and flood attenuation.
- Wetlands can be assets for dairy farms and DairyNZ is advocating for the retention of natural wetlands. They have excellent denitrifying potential.

Outcome: It was flagged that this topic is to be discussed further at a subsequent meeting.

21. Sediment

Stephen Fragaszy gave a presentation about the attribute development programme (detailed in tabled materials for this agenda item), which is not the only policy option being looked at, but is the most helpful place to focus our attention for the first few meetings. Stephen explained that the draft attributes were developed using long term averages/medians rather than event loads. There was discussion about the reasons for this:

- Under the RMA and NPS-FM only human use activities can be managed rather than natural events such as heavy rainfall, which result in elevated sediment loads (though the effects of these events can be mitigated somewhat).
- There is no good information on how to set loads and durations for short term events in relation to their effects on macroinvertebrates and fish.
- Life-cycle scale impacts are more predictive for effects, e.g. loss of habitat by filling of interstitial spaces over time. There was some disagreement among the group here. It was noted that short-term events have significant effects on nutrients.
- Stephen noted after the meeting that point source event loads are often managed using consent conditions, e.g. for stormwater discharges.
- Practical points were raised:
    - 1. We monitor the environmental state variables (clarity, turbidity, deposited sediment) and the ecosystem response randomly in time. Therefore it is only valid to examine measures of central tendency.
    - 2. The analytical chain applied to connect sediment supply to catchment to environmental state variables is based on measures of central tendency. Measuring event loading would be much more complex, because it would involve dealing with magnitude and duration of events. There is also an assumption that the central tendency measures are highly correlated with the extreme events, therefore we are capturing the effects of extreme events (this correlation could potentially be tested).

Stephen summarised the new work being carried out, which aims to ensure consistency and comparability of classifications so that thresholds from different lines of evidence align, are comparable and have robust and transparent information behind them. This work will also examine whether bands can be introduced. He plans to talk through this work with STAG in subsequent meetings.

A regulatory impact assessment will be commissioned, that will be predicated upon: how much sediment reduction is needed in a particular catchment to meet bottom line? What are costs and co-benefits of mitigation options? This would be finished next year before any significant decisions are made.

The focus for the next meetings will be where attribute and classification systems apply. Attribute bands will also be discussed. The focus will be on determining if the numbers were derived in a robust way. A question to be considered by the group is how to progress management mechanisms when there isn't a clear relationship between deposited sediment coverage and sediment loading.

Further discussion points included:

- There have been recent breakthroughs in connecting land use to sediment in rivers. Horizons has identified high risk areas and priced mitigation options.
- How do you address the timing factor (noting Minister Parker's desire for change in next 5 years)? Time frames for change can be long, and there is a need to be truthful about the requirements of the attribute when communicating to the public and politicians.
- There is policy work progressing currently on identifying high risk areas.
- The NPS-FM doesn't specify time frames for improvement.
- Climate change will also cause an increase in sediment load. There is a huge amount of mitigation work being done in the Horizons region for example, but climate change will affect how effective it is. There are parallels with intermittently closed and open lakes and lagoons (ICOLLs) – management is challenging when attributes are not being met.
- Expected state changes with time. Should these be shifted to take climate change into account, and can the group advise on this? It was noted that species protection percentages

form the bottom lines at the moment and these will not change with climate change. There is a need to be realistic about scale of improvements or declines that will happen in the future.

- Can we measure behaviour change as an indicator of the success of the policy?
- Measurement is done by means of visual clarity and turbidity for suspended sediment, and deposited sediment uses the SAM2 – visual assessment protocol[2]. Also looked at using Quorer; while it is more closely related to sediment load, it's quite resource intensive and variable. SAM2 and Quorer are quite well correlated. It was suggested that the impact on ecosystems is in the first stages when the interstitial spaces are first filled up.
- The draft attribute table mentions statistics to be used and frequency of measurement – what is evidence base for these? How will implementation of catchment mitigations affect relationships between land use and in-stream sediment? There's a strong relationship between catchment load and visual clarity or turbidity – this is related to grain size distribution. Mitigations can affect grain size distribution.
- The value of high-frequency data was pointed out; Horizons has long-term high frequency data available.
- It's important to remember that episodic events are correlated with rainfall, and there is no way of controlling frequency of rainfall.
- There are logistical issues around capacity to install stream fencing and providing plants as sediment mitigation measures. There was discussion around the fact that these are not the principal concern of the group, but that we need to identify these constraints to manage expectations.
- It was suggested that there is a role for social science and community buy-in as a way of speeding up the restoration process.

Outcome: The focus of the group going forward (relating to sediment) will be to:

- Test the validity of current work and the newly contracted work; the first part will be ready around mid-December and the second part will be ready around mid-February.
- It was identified that there is a short time frame to adequately assess attributes, and that the group will need examples and more information to properly assess the data.
- Attribute tables need to address issues around time frames and statistics. The group can address this at next meeting along with classification systems.
- The group will consider Stephen's focussed questions at the next meeting.

22. Summary

Ken outlined potential agenda items for 29 November:

- Current state and trends
- Sediment
- Wetlands
- Maintain/improve

[2] Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand. Available at http://www.cawthron.org.nz/media_new/publications/pdf/2014_01/SAM_FINAL_LOW.pdf

Papers distributed:

Agenda item (number)	Paper title	Classification - confidential yes/no?
1	No paper	-
2	No paper	-
3	Shared Interests in Freshwater: A new approach to the Crown/Māori relationship for freshwater	No
3	Essential Freshwater: Healthy water, fairly allocated	No
4	Terms of Reference	No
5	No paper	
6	National Policy Statement for Freshwater Management	No
6	The Freshwater NPS NOF – 1 page summary	No
7	Land and Water Forum advice on improving water quality: preventing degradation and addressing sediment and nitrogen	No
7	Briefing note: "Resolving freshwater science differences"	No
7	Fish & Game proposed NPS-FM: "New nps-freshwater-management July 2018 Final – Clean"	No
7	Fish & Game proposed NPS-FM companion document: "F&G NOF justification 31.07.18"	No
7	Letter from the Parliamentary Commissioner for the Environment – the quality of water science	Yes
8	No paper	-
9	No paper	-
10	No paper	-
11	The intervention logic behind the NPSFM	Yes
12	Past criteria used to develop attributes	Yes
13	Ecosystem Health Framework: "CawRpt_3194_Freshwater ecosystem health framework report 21 Sep 2018"	No
15	Sediment summary	Yes
15	Sediment technical collation	Yes
15	Sediment full report: MfE sediment NOF project_revised draft_29 may 2018.docx	Yes
4,6,11,12,13,15	Priority paper compilation	Yes

Adam Canning's comments on Agenda Item 12 for STAG meeting 18th Oct 2018

I seek that any new criteria used by the group:

a. **Adopt the Precautionary Principle, specifically accepting that management should not wait for perfection but be guided by the best available knowledge at the time, even if there is uncertainty.**
b. **Recognise that "The economy is a wholly owned subsidiary of the environment, not the other way around" – Herman Daly.**

Kriebel *et al.* (2001) provides an excellent summary of the precautionary principle:

> *"The precautionary principle... has four central components: taking preventive action in the face of uncertainty; shifting the burden of proof to the proponents of an activity; exploring a wide range of alternatives to possibly harmful actions; and increasing public participation in decision making."*

In reviewing the past criteria, the first two criteria ('Link to National Value' & 'Measurement and band thresholds') seem appropriate and necessary. Though if maintain is defined as permitting movement within a band, then an additional point is needed along the lines of:

"Do the experts agree that the range of each band represents a less than minor ecological difference?"

Another approach (and my preferred option) would be for 'maintain' to be defined along the lines of no detectable statistical decline.

Criteria three and four seems devoid of the precautionary principle because they seek that management levers, drivers and links to limits are well understood and current state is well understood – essentially they seek certainty. More often than not we do not know that a desired outcome will be achieved by manipulating x, y and z; but driving improvement in the right direction will get us much closer than doing nothing while we wait for certainty. It is also important to remember that good environmental management is adaptive in nature, objectives set now using the best available knowledge (even if uncertain) can and should be updated in the future as knowledge develops.

Criteria four and five seem too focussed on being able to assess the economic impact of criteria, such that if the management implications are not readily understood then they are not included. These criteria rank the economy above the environment, in stark contrast to Herman Daly's quote above.

I do not support the retention of past criteria 3-5 in their current form in deriving new NOF attribute criteria.

Adam Canning's comments on Agenda Item 15 for STAG meeting 19th Oct 2018

Response to specific the questions:

1. *How strong do you consider the evidence for the climate-based source of flow classification for suspended sediment?*

   Weak – the classes should be combined.

2. *Do you consider the indicator "offset" proposed for the suspended sediment classification system warranted given the evidence provided?*

   No.

   The warm climate class separation is only made from nine sites. At the very least there should have been some statistical testing to see if this difference is significant or not. One way could be to randomly select nine cool sites and compare with the nine warm sites, repeat many times and examine.

   Whilst the regressions of SS vs land use also suggested a widening gap with increasing human influence, could this be driven by warm areas attracting more erosion prone land-uses? Also, at the 0% human influence end of the regression, the difference between cool and warm was very small. In any case, reference sites for both climate classes are well within the cool bottom lines. There is also no ecological evidence presented that suggests the species in warm classes are somehow more tolerant to high SS than those in cool classes. If warm classes do indeed have a slightly higher SS than cool classes, then to me this represents less 'head room' for human degradation, rather than justification for a more liberal bottom-line.

3. *How strong do you consider the evidence for reference-state classification for deposited sediment?*

   Moderate-strong

   The authors used two approaches, one using reference only sites (A) and one using all sites (B). Both have pros and cons, and both were modelled well.

   Approach A is good in that it only uses reference sites; the downside is that some areas have very reference sites potentially resulting in misleading over-extrapolations. It is, however, the best dataset we have available and the representation issue is unlikely to be resolved unless whole catchments in Canterbury etc are completely restored and all legacy impacts passed.

   Approach B has the advantage of covering many more sites across a range of impacts and river types. For areas depauperate in reference sites, the model may have learned the relationship between SS and human stressors (eg landuse) and could correct for these whilst retaining underlying relationships with flow and rock type etc. One downside with Approach B is that the authors *seemed* to use all NZFFD sediment data. This database has thousands

of entries spanning decades. How can we be confident that data collected in 1970s is still useful for training a model today? If there has been degradation (highly likely) then won't this confuse model learning? I accept the case that reference sites are unlikely to have changed so old data is suitable for approach A, but it may be more prudent to restrict to recent data for approach B.

As a sensibility check, the agreement between outputs should be checked.

4. *Is it problematic that the SS and Deposited Sediment attribute classification systems have different framings?*

   No.

   Section beginning: *In relation to regulatory impact testing…*

   - I struggle to make sense of this question.
   - Why those three land uses?
   - In "costing" exercise, it should account for the loss of soil natural capital due to not acting.

5. *How suitable are the range of methods used for determining ecological impact thresholds?*

   Very suitable.

   Quantile Regressions are great for ascertaining worst-case limiting variables. Where as BRT and GF are great for understanding potential interactions between stressors/variables.

   If the authors want to add further robustness to justify their identified thresholds, then they may wish to consider trying change-point analysis or natural breaks to the BRT predictions rather than simply eye-balling them

   I do, however, question the validity of the conclusions from The 2017 Field Study of 16 sites. The rivers chosen do not seem comparable at all and the authors do not appear to have accounted for the other environment differences in their test. Even if they have, I don't think 16 sites would be enough to adequately control for the other factors.

   Section 3.5.1 also needs more explanation of the gradient forest analysis including a list of the predictors used etc. Otherwise, GF is a good approach.

Overall, the authors have done a thorough job of reviewing the literature and exploring potential thresholds using a variety of valid approaches that do seem to converge at similar bottom-lines.

A final comment on the attribute tables. Currently they are designed without A and B bands. If this is retained then sites with naturally 31% deposited sediment could be degraded to 60% cover, whereas

sites with 29% natural cover could only be degraded to 30%. This seems irrational. A few potential ways of getting around this could be:

1. Add in A & B bands that restrict large movements. Whilst the authors have suggested that future work could identify 'thresholds' (if they exist) for A & B bands, I don't think this is entirely necessary because the bands could be defined in a way that is sufficiently tight to mean that maintain actually means maintain, rather than some level of degradation that we pretend is maintain.
2. Keep with bottom-lines and say that anything within the bottom-lines must be maintained, whereby maintained is defined as no statistical change detected.
3. Replace the table with one that prevents degradation from being more than X% different from that in reference state.

Freshwater Science and Technical Advisory Group:

Setting planning objectives to 'maintain' water quality. What constitutes 'maintain' at a site?

Paper Author	Carl Howarth	Classification	**Confidential**

Meeting date	29 November 2018	Agenda item (number)	3

Paper summary:
This paper outlines background information, issues and options relating to setting planning objectives to 'maintain' water quality.

Setting planning objectives to ‘maintain’ water quality. What constitutes ‘maintain’ at a site?

STAG: November 2018 – Carl Howarth

1. We seek advice on potential policy changes directing how councils set objectives to ‘maintain’ the state of an Appendix 2 attribute, and how success is demonstrated.
2. Consider this in terms of a single water quality variable, at a single site.
3. Existing Policy CA2(e)(iia) explains that freshwater objectives are considered to have been set at a level to maintain water quality if they are set *within the same attribute band* as existing water quality[3] (the bands test).
4. The “bands test” theoretically means Regional Councils are able to plan for water quality to decline, within the constraints of the band. For example, where water quality is currently at the top of the C band, an objective could be set for it to decline to the bottom of the C band.
5. Some feedback suggested that such a decline might constitute a material (i.e. more than minor[4] or significant) decline in ecosystem health, for at least some existing attributes.
6. **Questions**
    1. Do you agree with the above feedback statement?
    2. If yes, which Appendix 2 NOF attributes are most problematic? What evidence is available to support this?

<u>Possible amendments to the NPS requirement to ‘maintain water quality’</u>

7. Options include:
    i. **Option A:** Maintain precise attribute state, remove the bands test,
    ii. **Option B:** Reassess the problematic bands and adjust them accordingly.

Option A: Maintain precise attribute state, remove the bands test

8. Remove the ability to maintain within a band (the bands test). Regional councils would be directed to set objectives to at least maintain the precise (existing) state within an FMU, for each of their attributes (for example, maintain existing Chl-a as established by an annual median). This is consistent with the simplest interpretation of maintain, which is to keep something at the same level.
9. **Questions**
    1. If the above policy change was made, how could councils demonstrate they have at least maintained water quality? For example: Sampling data is variable (“noisy”), so Councils or Government could:

1. [3] “Existing water quality” is defined as the water quality measured at the time the regional council begins the process of setting or reviewing freshwater objectives and limits. Regional councils have until 2025 to implement the Freshwater NPS (or 2030, if earlier implementation is impractical or will result in poor quality planning). This means that in some areas regional councils are yet to begin implementing the Freshwater NPS.

[4] The assessment of whether an effect is minor is one of fact and degree. It is at the lower end of the scale of major, moderate and minor effects, but must be something more than *de minimus*. King v Auckland City Council [2000] NZRMA 145

i. require a statistical confidence test to indicate the strength of evidence for concluding an attribute state has been maintained.

ii. introduce a reasonable percent variation that still constitutes ‘maintain’, while being sufficiently narrow to avoid any material degradation of ecosystem health

2. What considerations are there if this option was to be developed further? For example, setting the minimum number of samples for establishing existing and current state, and the confidence level, nationally?

Option B: Reassess the problematic bands and adjust them accordingly

10. Address those problematically wide bands by adjusting their boundaries, or by adding more bands. Science advice is sought to inform any changes, although note the location and width of bands is a subjective value judgement[5].

11. This option would retain a smaller amount of flexibility for some level of numeric decline within a band, although only to the extent decided. The intention would be to set bands so they avoid material degradation in the value being managed (ecosystem health).

Questions

12. How many bands would be required so that the attribute table describes points where there would be a meaningful difference in what is provided for?

Useful Background Reading

McBride G, 2016. *National Objectives Framework: Statistical considerations for design and assessment*: http://www.mfe.govt.nz/publications/fresh-water/national-objectives-framework-statistical-considerations-design-and

[5] Current band thresholds were recommended by the NOF Reference Group and, wherever possible, attempt to describe points where members thought there would be a meaningful difference in what is provided for.

Freshwater Science and Technical Advisory Group:

Sediment discussion document

Paper Author	Stephen Fragaszy	Classification	**Confidential**

Meeting date	29 November 2018	Agenda item (number)	3

Paper summary:
This paper provides STAG members with background information and questions for discussion relating to 1) metrics and exceedance criteria for potential sediment attributes, and 2) policy principles to guide bottom-line attribute development.

Sediment discussion document for STAG – November 2018

We aim to discuss two themes during the sediment agenda item:

1. Sediment attribute components – metrics and exceedance criteria for potential attributes
2. Policy principles to guide bottom-line attribute development

At the next meeting we intend to discuss proposed environmental classification systems for the attributes and potentially the exceptions criteria.

Attribute components

NPS-FM attributes incorporate specific indicators and exceedance criteria. To date, all ecosystem health attribute indicators are quantitative, and most attributes' exceedance criteria include temporal components in their assessment. For example, the periphyton attribute indicator is milligrams cholorophyll-a per square meter, and the exceedance criteria (200mg chl-a/m2 exceeded in no more than 8% of samples) is based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chl-a) is 3 years.[6]

The draft sediment attributes include the following quantitative indicators:

1. Suspended sediment (rivers OR wadeable rivers is unclear in the draft table): the more sensitive of turbidity (NTU) or visual clarity (m);
    i. "interconversion of visual clarity and turbidity is acceptable as derivation based on database of annual median data for these parameters (i.e., not concurrent instantaneous measurements). The more sensitive of the visual clarity or turbidity measures will determine the site grading. Visual clarity will be a more sensitive measure of changes in river particulate organic material and inorganic SS in high quality (i.e., low turbidity) waters"[7].
2. Deposited sediment (wadeable rivers only): % fine (<2mm) sediment streambed cover in a run habitat determined by the instream visual method (SAM2[8]); attribute applies in wadeable streams only.

The attributes' proposed temporal exceedance criteria are:

- Suspended sediment: annual medians based on a monthly monitoring regime. The minimum record length for grading a site based on the indicators is two years.
- Deposited sediment: Annual means based on a monthly monitoring regime. The minimum record length for grading a site based on an instream visual assessment of % fine sediment cover (SAM2; Clapcott et al 2011) is two years.

At the last meeting, several panel members expressed the desire to discuss the basis and rationale for choosing measures of central tendency rather than exceedance criteria that reflect event-loading such as that following a storm. On this issue in particular, we direct you to the literature review of

[6] NPS-FM 2017: http://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/nps-freshwater-ameneded-2017_0.pdf
[7] The reports outline inter-conversion calculations and approaches to determine whether turbidity or visual clarity is the more sensitive indicator. This type of issue will be included in guidance materials.
[8] Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M., Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute. Nelson, New Zealand.

ecological effects (Sections 3.1 and 3.2 in particular) and relationships between sediment loads and in-stream indicators (Section 4.3 in particular) that informed subsequent research on attribute development.[9] In addition, we direct your attention to the sections of the Stage 2 draft report that describe deposited sediment thresholds metrics (Section 4.1), numeric standards and surrogates for thresholds (Section 5.2.4) and the event-based (and long-term) ecological effects of suspended sediment on fish (Section 6.2.3). These are not the only sections that address this concern, but in my judgment, they will provide you helpful context for the discussion on the day.

Guiding questions:

Both suspended and deposited sediment: Does the evidence in the reports support the decision to base attributes on rolling medium-term (~2 years) measures of central tendency?

Suspended sediment: What is your opinion on the attribute indicators chosen and the possibility of their interconversion?

Deposited sediment: What is your opinion on the attribute indicator and monitoring method?

Policy principles for development of NPS-FM ecosystem health attribute bottom lines

An attribute is defined in the NPS-FM as "a measurable characteristic of fresh water, including physical, chemical and biological properties, which supports particular values." The minimum acceptable state of any attribute is defined in the NPS-FM as "the minimum level at which a freshwater objective may be set in a regional plan in order to provide for the associated national value."

"Values" includes the compulsory values and other values. Where the value is a compulsory value, the minimum acceptable state is the national bottom line.

For ecosystem health, an attribute may apply to any of the components of ecological integrity (aquatic life, water quality, ecological processes, habitat or water quantity).

These principles are intended to support researchers working on behalf of MfE to develop NPS-FM attributes or similar national direction mechanisms.

Principles

1. Recognise Te Mana o Te Wai by putting the needs of the waterbody first; attributes contribute to how councils safeguard the life-supporting capacity of the waterbody and associated ecosystems with regard to national values.
    a. NPS-FM – national significance of Te Mana o te Wai
    b. RMA purpose (S5(1); S5(2), especially S5(2)b); RMA s7d, NPS-FM objectives A1 and B1

[9] https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/fine-sediment-effects-on-freshwaters.pdf

2. Prioritise recognition of the needs of indigenous species over introduced species.
    a. RMA S6c, RMAs7d

3. Describe bottom lines for ecosystem health in terms of ecological effects and/or departure from an estimated natural state free from alterations resulting from human activity.
    a. Existing attributes and possible future attributes;
    b. Judge Sheppard NPS

4. Base bottom lines on the least acceptable state of ecosystem health and/or the state prior to irreversible degradation occurring (the former is a normative and subjective judgment, the latter, given adequate information, is not).
    a. Existing attributes

5. Note that information will never be perfect, and in the face of uncertainty and on the balance of probability, avoid potentially significant[10] adverse ecosystem effects.
    a. S 6(a); NPS-FM objectives (A1, B1, and C1, CA1, CB1, CC1, and D1)

6. Be transparent about what the bottom line does, and does not, protect as well as the multiple sources of evidence used in their development.
    a. Policy communication

Guiding questions:

Would these principles support the research process and an approach to develop bottom lines for ecosystem health attributes?

Are they clear and directive?

Do you see any major gaps?

[10] Significance is based on irreversibility, severity, duration, frequency, and spatial extent of the effect of which the national bottom line applies.

Freshwater Science and Technical Advisory Group:

Wetlands

Paper Author	Helli Ward	Classification	**Confidential**

Meeting date	29 November 2018	Agenda item (number)	**5**

Paper summary:

Historic and ongoing loss and degradation of New Zealand's wetlands is extensive. This has resulted in the loss of unique biodiversity and ecosystem services.

The wetlands package is primarily focussed on stopping wetland loss and degradation through national direction of clear objectives, directive policies on how no further loss and degradation should be achieved and explicit rules on specific activities in and around wetlands. We are working closely with policy development of the National Policy Statement for Indigenous Biodiversity, which also includes direction on wetlands, so that these are complimentary.

Questions for the STAG to help the policy development for wetlands relate to:

- Wetland identification and delineation
- Water level changes
- Wetland size considerations
- Setbacks for activities in the catchment that may degrade wetlands
- The Wetland Condition Index

Problem Statement

Historic and ongoing loss and degradation of New Zealand's wetlands is extensive. This has resulted in the loss of unique biodiversity and ecosystem services.

Since human settlement, New Zealand has lost an estimated 90% of wetlands, predominantly occurred in lowland and coastal areas. This equates to a reduction from approximately 2.4 million ha pre-settlement to around 250,000 ha by 2008 (Ausseil *et al.* 2008).

A more recent study using 2001 – 2016 data shows that loss of wetlands is continuing to varying degrees across New Zealand (Beyliss *et al.* 2017). A total of 214 wetlands (nearly 1,250 ha) were shown to have been lost, with a further 746 wetlands declining in size. Of greatest concern is that substantial wetland loss is still occurring in regions that have a very small proportion of original extent remaining. For example Waikato and Southland have already lost over 92% and 89% of their respective pre human wetland area but have been shown to be recently experiencing complete wetland loss at an average rate of ~22 ha/yr and ~19 ha/yr (Ausseil *et al.* 2008; Beyliss *et al.* 2017).

While loss of wetlands is a concern, the condition of those that remain is also declining. Wetlands in poor or degraded condition for biodiversity or as habitats may still provide some level of ecosystem functioning and service, for example reducing nutrients through plant uptake or flood attenuation. Degraded wetlands are, however, less likely to be valued and more likely to be further degraded or lost altogether.

Wetlands on public and private land

Currently around 60% (by area) of remaining wetlands are, administered by the Department of Conservation (DOC), although some wetland types (eg, swamps, fens, and marshes) are underrepresented in these protected areas. While wetlands within public conservation land are legally protected[11], they are not necessarily protected from degradation that might be caused by adjacent land uses. Approximately 40% (by area) of our remaining wetlands are on private land with the majority of these being New Zealand's smaller wetlands (under 100 ha in size). There is approximately 10,157 ha of wetlands on Māori land nationwide, making up just 4% of total remaining wetland area or 10% of wetlands left on private land. There are highly variable levels of protection of wetlands on private land given regional and district plans and rules that presently apply across New Zealand.

Fish and Game Councils own approximately 2880 ha of wetland at some 45 sites nationally and administer a further 655 ha at 25 sites[12]. These are mostly managed as game bird habitat and hunting opportunity but also provide biodiversity and other community benefits. Approximately 9,200 ha of wetlands on private land are protected under QEII covenants, which is about 5 % of the total area of land protected under the QEII.

Drivers

Wetland loss and degradation is driven by multiple factors including economic and land use pressures and activities, insufficient or competing national legislation with different policy objectives, inconsistent or inadequate regional or district plans, and lack of mapping, monitoring, compliance and enforcement.

National Policy Statement for Freshwater Management

The National Policy Statement for Freshwater Management (NPS-FM) includes objectives and policies for wetlands but these are insufficient.

[11]Note wetlands on public conservation land have varying levels of legal protection under the Conservation Act.
[12] Fish and Game Council unpublished data from 2005 with updates.

Objectives A2b and B4 respectively requires that the 'significant values of wetlands' be protected in terms of both water quality and quantity. The NPS-FM remains silent on what the significant values of wetlands are, with some councils interpreting this as relating to the Appendix 1 National Values, or regionally significant wetlands. In practice some councils focus only on larger and more intact wetlands.

Policy A4 requires regard be given to the effects of discharge into fresh water and associated ecosystems. Policy B7 requires regard be given to any change in taking, damming or diverting freshwater or draining of any wetland that is likely to result in any more than minor adverse change in the natural variability of flows or levels of any freshwater compared to that which immediately preceded the commencement of the new activity.

There is no guidance about what constitutes "no more than minor" (which in the absence of a wetland inventory or clear thresholds or limits in regional plans can be subjective) nor whether existing water levels are a good benchmark to sustain wetland values.

Parallel policy work

The Biodiversity Collaborative Group (BCG)[13] have also provided a Draft National Policy Statement for Indigenous Biodiversity (NPS-IB) (Biodiversity Collaborative Group, 2018). This includes wetlands policies that require identification, providing a tool to facilitate this, require avoidance of all effects that would cause degradation or loss of extent, and promotes enhancement and reconstruction of degraded wetlands. The development and finalisation of the NPS-IB is on a slightly different timeframes and is Minister Mahuta's responsibility. Ministers are meeting to discuss preferred options for wetlands under each policy package.

Proposed wetlands package

Our immediate focus for the wetlands protection is on national direction (i.e., objectives, policies, and rules).

There are three types of tools that we propose to address the problem of ongoing loss and degradation of wetlands in New Zealand. These tools are not mutually exclusive and the final package may require a combination of them:

- Provide within NPS/s clear objectives and directive policies on how no further loss and degradation should be achieved, and specify criteria for wetland identification and delineation.
- Provide within a Freshwater NES explicit rules on specific activities in and around wetlands to prevent further loss and degradation.
- Provide supporting measures such as developing a national wetland baseline mapping, developing the hydrological tool for wetland delineation, and developing an online national wetland inventory.

Other non-regulatory approaches within a longer term wetland programme will further support councils and communities to achieve good outcomes for wetlands. These include a more co-ordinated and effective programme of restoration and protection drawing on DOC and council programmes, partnerships with industry, MfE funding, as well as developing scientific information to improve restoration and better inform best practice.

[13] Core members of the BCG include Forest and Bird, Federated Farmers, New Zealand Forest Owners Association, Environmental Defence Society, Iwi Chairs Forum, and a representative from the extractive/ infrastructure industries.

We are in the early stages of policy development and there are some decisions to be made on how wetland policies fit and complement each other through the NPS-FM and NPS-IB. We do have some questions for the Science and Technical Advisory Group and others to help with policy decisions.

Questions

Wetland identification and delineation

The need to protect and manage wetland extent and regulate activities within and adjacent to wetlands requires more accurate delineation of wetland boundaries. Often it is the wetland margins that are eroded through activities which degrade the wetland.

The BCG has provided a proposed rapid method for wetland identification and delineation (see Appendix A), this rapid method is also useful for the Essential Freshwater package. It is based on a more detailed procedure originally developed and used in the USA assessing vegetation, soils and hydrology to identify and delineate wetlands. Manaaki Whenua/ Landcare Trust have developed New Zealand specific vegetation (Clarkson, 2014) and soils (Fraser *et al.,* 2018) tools based on the USA methods. A New Zealand specific hydrology tool has yet to be undertaken.

Providing a nationally consistent criteria and process for wetland identification and delineation would be useful. It would provide uniformity and certainty where necessary and remove an avenue for appeal.

Question:

- What are your thoughts on the proposed BCG rapid method?

Water level changes

The proposed National Environmental Standard on Ecological Flows and Water Levels 2008 (Ministry for the Environment, 2008) (the NES) included the following proposed interim limit for wetlands.

> *No change in water level, beyond the water level variation that has already been provided for by existing resource consent on the date the Standard comes into force.*

The NES further proposes the potential risk of ecological change associated with water level changes to be:

- **Low.** Less than 0.2 m change in median water level; and, patterns of water level seasonality (summer vs. winter levels) remain unchanged from the natural state (summer relative to winter).
- **Medium.** Greater than 0.2 m and less than 0.3 m change to median water level; and, patterns of water level seasonality shows a reverse from the natural state (summer relative to winter).
- **High.** Greater than 0.3 m change to median water level; and, patterns of water level seasonality show a reverse from the natural state (summer relative to winter).

The NES then stipulated that risks for potential change to wetland level must also be defined in relation to seasonal and inter-annual variability in hydroperiod as determined by using one or more methods shown in Table 1. The choice of methods would be determined dependent on the degree of hydrological alteration and significance of wetland values.

Table 1: Methods used in the assessment of ecological flow and water level requirements for degrees of hydrological alteration and significance of wetland values

Degree of hydrological alteration	Wetlands: Significance of values		
	Low	Medium	High
Low (< 20 cm change)	Historical water level records Expert panel Remote delineation of site and catchment Wetland record sheet (MfE methodology)	Historical water level records Expert panel Remote delineation of site and catchment Wetland record sheet (MfE methodology)	Detailed local delineation Wetland hydrological condition assessment and model change (MfE methodology) Species-environment models Habitat assessment Water quality modelling
Medium (20–30 cm change)	Historical water level records Expert panel Remote delineation of site and catchment Wetland record sheet (MfE methodology)	Detailed local delineation Wetland hydrological condition assessment and model change (MfE methodology) Species-environment models Habitat assessment Water quality modelling	Full ecohydrological assessment Groundwater /surface water interaction Process-based water quality models Microtopographic survey
High (> 30 cm change)	Detailed local delineation Wetland hydrological condition assessment and model change (MfE methodology) Species-environment models Habitat assessment Water quality modelling	Full ecohydrological assessment Groundwater /surface water interaction Process-based water quality models Microtopographic survey	Full ecohydrological assessment Groundwater /surface water interaction Process-based water quality models Microtopographic survey

Questions:

- What are your thoughts on this provision, do you see any issues?
- What are the scientific practicalities with it?
- Are the levels potential risk of ecological change still relevant given they are over 10 years old?

Setbacks

We are interested in explicitly restricting activity types and requiring setbacks from wetlands to minimise their adverse effects. Activities could include drainage, earthworks, stock incursions, urban development contamination, vegetation clearance or planting, spraying etc.

The National Environmental Standard for Plantation Forestry (NES-PF) provides rules for activities in and around wetlands in relation to forestry including setbacks from wetlands > 0.25 ha for example:

- 5 m setback for operating machinery, mechanical land preparation, or replanting.
- 10 m setback for refuelling machinery, fuel storage, or oil changing.
- 20 m for quarrying.

Question:

- Do you think setbacks akin to the NES-PF would be appropriate for the NPS-FM?

Wetland Mapping and size

Wetland mapping is useful for council planning purposes and also for Central Government to test policy impact and Environmental Reporting. Currently New Zealand has several databases representing national wetland coverage, although these have shortcomings in terms of comprehensiveness, resolution and accuracy (Belliss, 2017). These include:

- Landcover database (LCDB) – national coverage and updated, however has shortcomings in wetland delineation, detection and thematic detail – minimum mapped wetland resolution of 1 hectare
- Waters of National Importance (WONI) – national coverage and detailed, however this is not updated and also has shortcomings in delineation and detection – minimum mapped wetland resolution of 0.5 hectare
- Regional council datasets – local coverage and variable in terms of geographic extent, comprehensiveness, polygon fidelity, thematic detail and updating – variable minimum mapped wetland resolution.

As such NZ does not have an adequate structure for mapping and delineating national wetland coverage and we do not have a good understanding of wetlands especially small ones on private land that collectively represent a substantial proportion of remaining wetlands.

As a wider package will need to look at updating national wetland maps and/or providing a nationally consistent method to do so. This brings into question the matter of wetland size in relation to mapping and rules. Small wetlands are unlikely to be scheduled in regional plans and therefore 'fly under the radar' for protection. The NPS-FM currently is silent on size of wetlands to be protected as is the NPS-IB, although the NPS-PF includes certain rules and mapping requirements for wetlands >0.25 ha and also a provision for wetlands >0.01 ha.

Question:

- Do you have a thoughts on the practicalities of minimum size of wetlands in relation to wetland mapping and rules?

National Targets

We received a recommendation to set national targets to increase the areal extent of wetlands so that the total extent of wetland increases from the current 8% of their pre human extent (249610 ha) to 20% of their pre-human extent (592500 ha), by 2040, with 50% of that target to be achieved by 2030. The composition of different wetland types should reflect the relative pre–human proportions (see **Table 2**).

Table 2: Pre-human proportions of different wetland types

Wetland type	***% of total wetland cover***
Pakihi	*10*
Bog	*9*
Swamp	*59*
Marsh	*9*
Fen	*7*
Gumland	*5*

Note: The remaining wetland types are disproportionality situated across New Zealand, for example the West Coast has the highest proportion of swamps and pakihi, Waikato the highest proportion of bogs.

The Essential Freshwater package is primarily focussed on stopping wetland loss and degradation. Setting very specific national targets for councils, who operate independently, to achieve is problematic but we want to test if the suggested targets for each wetland type are feasible.

Questions:

- As a concept what are your thoughts on increasing the areal extent of each wetland type?
- How viable is it for tricky wetland types such as pakihi (consisting of skeletal infertile soils)?
- Would a national target to restore the health of the wetlands we have left be more achievable?

Wetland Condition Index

We received a recommendation for the inclusion of the Wetland Condition Index (WCI) (Clarkson et al. 2003) as an attribute (see Appendix B).

The WCI is a set of science-based indicators for monitoring New Zealand estuarine and palustrine wetlands. The WCI was initially developed as part of an Environmental Performance Indicator and is based on the following five indicators with sub-indicators (also summarised in Figure 1):

- Change in hydrological integrity
    - Impact of manmade structures
    - Water table depth
    - Dryland plant invasion
- Change in physicochemical parameters
    - Fire damage
    - Degree of sedimentation/erosion
    - Nutrient levels
    - von Post decomposition index (peat bog soils only)
- Change in ecosystem intactness
    - Loss in area of original wetland
    - Connectivity barriers
- Change in browsing, predation and harvesting regimes
    - Damage by domestic or feral animals
    - Introduced predator impacts on wildlife
    - Harvesting levels
- Change in dominance of native plants
    - Introduced plant canopy cover
    - Introduced plant understorey cover.

There is also a wetland pressure index calculated separately, which records external factors that threaten future condition and scores them on a scale of 0 to 5. The pressures are:

- Modifications to catchment hydrology
- Water quality within the catchment
- Animal access

- Key undesirable species
- % catchment in introduced vegetation
- Other pressures.

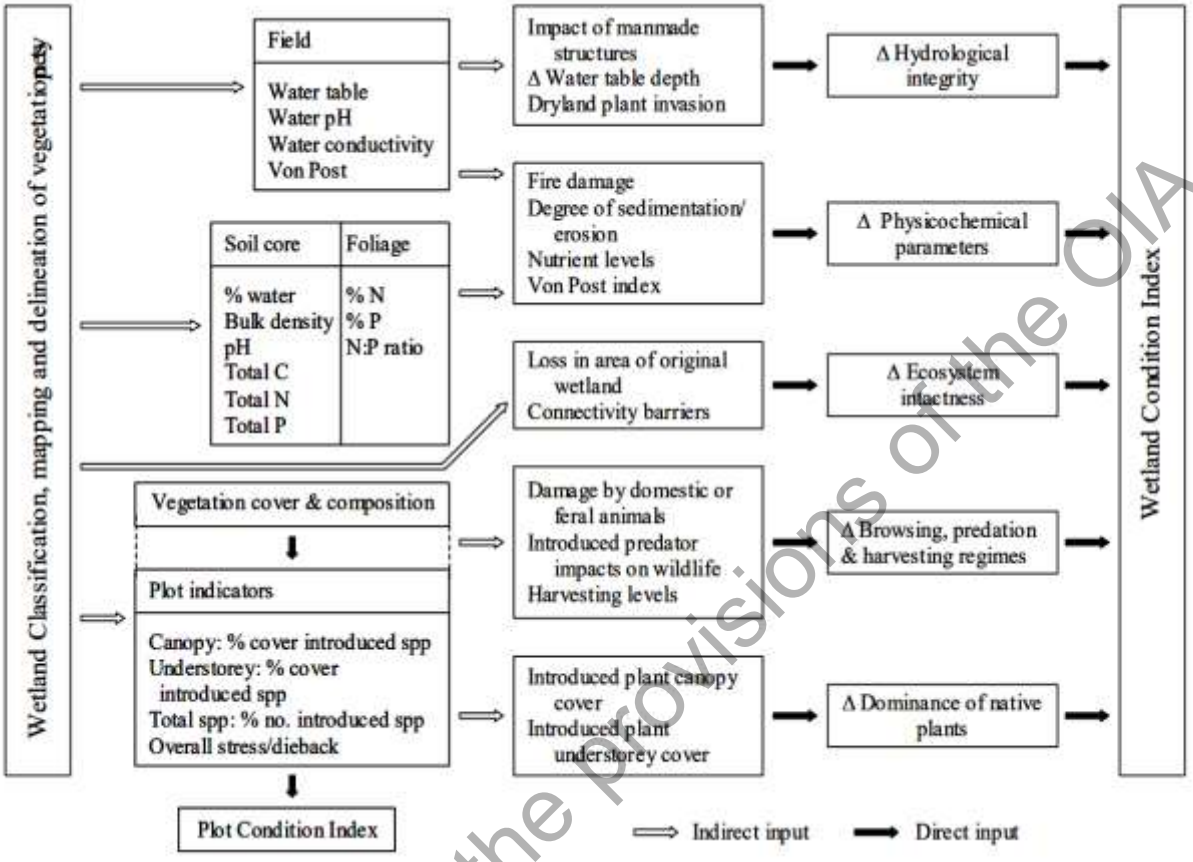


Figure 1: Links between wetland and plot indicators and Phase 1 of the Co-ordinated Monitoring of New Zealand Wetlands project (Clarkson et al. 2003)

Initial mapping of the vegetation types and habitats is used to select representative plots. Quantitative data from the plots are used to assess and score the plot vegetation, providing a baseline for future comparison. Wetland scale indicator components are scored on a 0-5 scale incorporating all field data as well as historical information. The indicator components are then averaged to produce a sub-index for each wetland indicator, and the sub-indices can be summed to give a condition index for the whole wetland, out of 25. Lower scores indicate more degraded conditions. Examples of how the index is reported is provided in Table 2 and Figure 2.

The baseline for comparison is the estimated regime that would have existed in the absence of human-induced modification.

Table 3. Example of using the index to determine wetland condition: Cockayne Reserve (Clarkson et al. 2003).

Indicator	Indicator components	Specify and Comment	Score 0– 5[1]	Mean score
Change in hydro-logical integrity	Impact of manmade structures	Extreme: Stopbanks, roads, housing have completely modified original hydrology. One small connection to estuary remains.	1	0.67
	Water table depth	No water supply.	0	
	Dryland plant invasion	Dry soils have allowed extensive invasion.	1	
Change in physico-chemical parameters	Fire damage	Entire area repeatedly burnt due to vandalism.	0	0.5
	Degree of sedimentation/erosion	Little wetland character now remains in soils.	1	
	Nutrient levels	No data available.	-	
	von Post index	Not applicable	-	
Change in ecosystem intactness	Loss in area of original wetland	Extreme – almost all natural character lost.	0	0.5
	Connectivity barriers	Extreme – no connections upstream, many barriers downstream.	1	
Change in browsing, predation and harvesting regimes	Damage by domestic or feral animals	No stock access. Potential access by small feral animals but no evidence of impacts.	5	3.67
	Introduced predator impacts on wildlife	Little habitat remains for wildlife, and drying of wetland allows full access to predators.	1	
	Harvesting levels	None.	5	
Change in dominance of native plants	Introduced plant canopy cover	Tall fescue and yellow flag iris have almost replaced all native species.	1	1
	Introduced plant understorey cover	Tall fescue and yellow flag iris have almost replaced all native species.	1	
Total wetland condition index /25				6.34

[1]Assign degree of modification as follows: 0=extreme, 1=v high, 2=high, 3=medium, 4=low, 5=v low/none

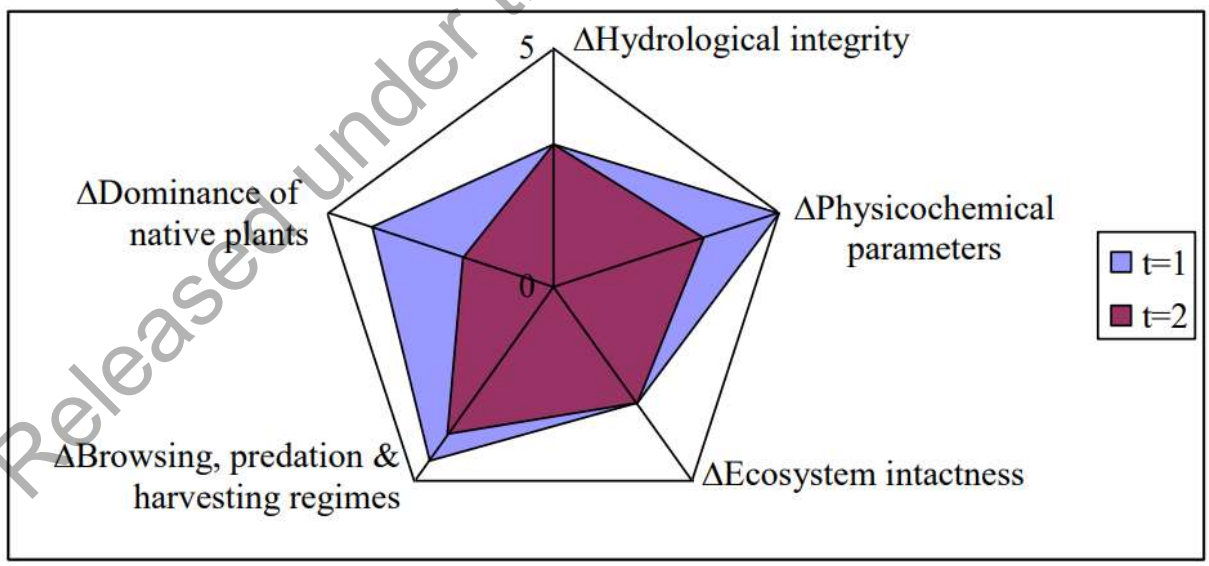


Figure 2: Representing change in condition over time using a radar chart (pentagon represents the unmodified condition). Here, t=1 represents an initial sampling time and t=2 a later sampling time. Deterioration in scores for changes in physicochemical parameters, browsing, predation & harvesting levels, and dominance of native plants, have lowered the overall condition index from 19.5 to 15.1 (Clarkson et al. 2003).

Many councils use the WCI, or some modification of it specifically created for their region, to assess the condition for some of their wetlands. Therefore different versions of the condition index exist and a single set of indicators needs to be decided on to apply nationally.

The scoring of the different components has been found to be broad with different experts have been found to be scoring indicators differently at the same site at the same time, preventing the ability to detect real change over time. This is the subject of review at council level to see if scoring can be refined and standardised.

Question:

- To date attributes have been single measures. Is this suited for an attribute, or better as something else?

References

Ausseil, A-G., Gerbeaux, P., Chadderton, W., Stephens, T., Brown, D., & Leathwick, J. (2008). Wetland ecosystems of national importance for biodiversity: Criteria, methods and candidate list of nationally important inland wetlands Landcare Research Contract Report LC0708/158 for the Department of Conservation.

Belliss, S., Shepherd, J., Newsome, P., & Dymond, J. (2017). An analysis of wetland loss between 2001/02 and 2015/16. Landcare Research Contract Report LC2798 for the Ministry for the Environment.

Biodiversity Collaborative Group (2018). Report of the Biodiversity Collaborative Group. Prepared for Minister Mahuta October 2018.

Clarkson, B. (2014). A vegetation tool for wetland delineation in New Zealand. Landcare Research Contract Report LC1793.

Clarkson, B., Sorrell, B., Reeves, P., Champion, P., Partridge, T., and Clarkson, B. (2003). Handbook for monitoring wetland condition (Revised October 2004). Hamilton, New Zealand: Landcare Research

Fraser S, Singleton P, Clarkson B (2018). Hydric soils-field identification guide. Envirolink Tools Contract C09X1702. Landcare Research Contract Report LC3233 for Tasman District Council.

Ministry for the Environment (2008). Proposed National Environmental Standard on Ecological Flows and Water Levels: Discussion Document. March 2008 Ministry for the Environment publication number: ME 868.

Myers, S., Clarkson, B., Reeves, P., Clarkson, B. (2013). Wetland management in New Zealand: Are current approaches and policies sustaining wetland ecosystems in agricultural landscapes? *Journal of Ecological Engineering 56 (2013) 107– 120.*

Appendix A: Biodiversity Collaborative Group proposed wetland identification and delineation procedure and supporting definitions - NOT GOVT POLICY

Procedure

1. Determine general project area i.e., putative wetland.
2. Confirm that 'regular' circumstances are present (i.e., typical climatic and hydrologic conditions for the time of year, no recent disturbances such as flooding).
3. Determine whether **off-site methods** or **on-site methods** are to be used.
4. Undertake Hydrophytic vegetation determination by **Rapid Test** to determine if all dominant species are **OBL** or **FACW**.
   a) If the **Rapid Test** finds all **dominant species** are **OBL** or **FACW** the assessed area is a wetland/part of a wetland. Further analysis is not required.
5. If the **Rapid Test** finds not all dominant species are **OBL** or **FACW** then undertake a **Dominance Test**:

a) If **Dominance Test** finds **OBL**, **FACW**, or **FAC** species are >50% the assessed area is a wetland/part of a wetland. Further analysis is not required.

6. If the **Dominance Test** finds:
   a) All or most **dominant species** are **FAC**; or
   b) **OBL**, **FACW**, or **FAC** species are <50%,

   then assess soil type and hydrology.

7. If an assessment of soil type and hydrology confirms:
   a) That **hydric soils** are present; and
   b) That wetland hydrology is present,

   then undertake a **Prevalence Index Test**. If an assessment confirms that **hydric soils** and wetland hydrology are not present the assessed area is not a wetland/part of a wetland.
8. If the **Prevalence Index Test** finds that **hydrophytic** vegetation is ≤3.0 the assessed area is a wetland/part of a wetland. Further analysis is not required
9. If the **Prevalence Index Test** finds that **Hydrophytic** vegetation is >3.0 the assessed area is not a wetland/part of a wetland.

Supporting definitions

Dominant Species: The most abundant plant species (when ranked in descending order of abundance, e.g., in a plot, and cumulatively totalled) that immediately exceed 50% of the total cover for the stratum, plus any additional species comprising 20% or more of the total cover for the stratum. Known as the 50/20 rule. Calculated for three stratum: tree, sapling/shrub, herb.

Dominance Test: More than 50% of dominant species across all strata are rated OBL, FACW, or FAC using the 50/20 rule.

Hydric Soils are soils that have been formed under conditions of saturation, flooding, or ponding and that have caused anaerobic (low oxygen) conditions in at least the upper 30cm of the soil.

Hydrophytes (hydrophytic vegetation)*:* plant species capable of growing in soils that are often or constantly saturated with water during the growing season. The hydrophyte categories are:

- ***Obligate (OBL)****:* Occurs almost always in wetlands (estimated probability >99% in wetlands*)*
- ***Facultative Wetland (FACW)****:* Occurs usually in wetlands (67–99%)

- ***Facultative (FAC)****:* Equally likely to occur in wetlands or non-wetlands (34–66%)
- ***Facultative Upland (FACU)****:* Occurs occasionally in wetlands (1–33%)
- ***Upland (UPL)****:* Rarely occurs in wetlands (<1%), almost always in 'uplands' (non-wetlands)

Off-site methods*:* Methods by which wetland identification and delineation can occur away from the project area. Ability to use off-site methods will depend on:

- Amount and quality of data including aerial photographs, maps, previous reports
- Wetland ecological expertise to interpret data.

On-site methods: Methods by which wetland identification and delineation can occur at the project area:

- For small areas (≤ 2ha), establish a representative plot in each major vegetation type. Record plot vegetation in 3 strata: tree, sapling/shrub, herb
- For large areas (> 2ha) establish representative plots along transects as per Clarkson et al., 2014. Record vegetation in 3 strata: tree, sapling/shrub, herb

Prevalence Index Test: A plot-based algorithm derived from the unique combination of OBL– UPL plants and their cover. The vegetation is considered to be hydrophytic if PI ≤3.0, but values around 3.0 should be used alongside other wetland indicators.

Rapid Test: All dominant species across all strata are rated OBL and/or FACW.

Appendix B: Example Wetland Condition Index – NOT GOVT POLICY

Value	Ecosystem health	
Freshwater Body Type	Wetlands	
Attribute	Wetland Condition Index	
Attribute Unit	Score 0 - 25	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Wetland Condition Index [1]	**Description**
Excellent	≥21	Very low nutrient enrichment and high clarity. No or very minimal impact from hydrological modifications and fire damage. No pest or domestic animal access. Natural plant, invertebrate and fish assemblages essentially intact.
Good	≥18 and <21	Low nutrient enrichment and minor degradation in clarity. Algal blooms are localized or infrequent. Minor impact from hydrological modifications and fire damage. Light damage from pest or domestic animal access. Natural plant, invertebrate and fish assemblages show minor deviation and dryland species are present in up to 25%.
Fair	≥15 and <18	Moderate nutrient enrichment and moderate degradation in clarity. Algal blooms extend up to 50% cover or are semi-frequent. Moderate impact from hydrological modifications and fire damage. Moderate damage from pest or domestic animal access. Natural plant, invertebrate and fish assemblages show moderate deviation and dryland species are present in up to 50%.
National Bottom Line	15	
Poor	≥10 and <15	High nutrient enrichment and turbid waters. Algal blooms extend up to 75% cover or are frequent. High impact from hydrological modifications and fire damage. Heavy damage from pest or domestic animal access. Natural plant, invertebrate and fish assemblages show large deviation and dryland species are common.
Very poor	<10	Very high nutrient enrichment and very turbid waters. Algal blooms may cover entire wetland or are very frequent. Very high impact from hydrological modifications and fire damage. Very high damage from pest or domestic animal access. Natural plant, invertebrate and fish assemblages are largely unrecognizable and dryland species are very common.

[1]To be assessed annually following: Clarkson BR, Sorrell BK, Reeves PN, Champion PD, Partridge TR, and Clarkson BD. *Handbook for monitoring wetland condition (Revised October 2004).* Hamilton, New Zealand: Landcare Research.

Freshwater Science and Technical Advisory Group:

A summary of attributes relating to nitrogen

Paper Author	Jen Price	Classification	**Confidential**

Meeting date	29 November 2018	Agenda item (number)	6

Paper summary:
This paper outlines the different ways that nitrogen is managed in the National Policy Statement for Freshwater Management, and the reasoning behind the attributes chosen.

A summary of attributes relating to nitrogen

Nitrogen in the National Policy Statement for Freshwater Management

The National Policy Statement for Freshwater Management (NPS-FM) manages nitrogen in rivers by way of three National Objectives Framework (NOF) attributes that were introduced in 2014: nitrate (toxicity), ammonia (toxicity) and periphyton (trophic state) (see timeline below). Attribute tables are included in Appendix I. The NPS-FM notes that ammonia and nitrate attributes should not be applied to ecosystem health issues associated with trophic state, as this is covered by the periphyton attribute.

Nitrogen in lakes is managed by way of a total nitrogen attribute that addresses trophic state, and indirectly by a chlorophyll *a* attribute which is analogous to periphyton in rivers.

At the time the NOF was developed, measurement and modelling work indicated that (MfE 2013a):

- no rivers or lakes breached the proposed ammonia toxicity bottom line
- less than 1 per cent of rivers and lakes breached the proposed nitrate toxicity bottom line.

The ammonia attribute was informed by the report "Derivation of indicative ammoniacal nitrogen guidelines for the National Objectives Framework", which proposed numeric ammoniacal-N guideline values for the NOF framework are based on the statistically-derived 'no observed effect concentration' (NOEC) and 'threshold effect concentration' (TEC)1 values for 19 species.

The nitrate attribute was informed by the report "Updating nitrate toxicity effects on freshwater aquatic species", which proposed numeric nitrate guideline values are based on the statistically-derived no observed effect concentration (NOEC) and threshold effect concentration (TEC) effect thresholds for 22 species.

The periphyton attribute was developed in the initial NOF because high biomass causes a range of effects including dissolved oxygen and pH fluctuations, a reduction in the diversity and productivity of invertebrates and fish, as well as affecting recreational values (Snelder et al. 2013). Periphyton abundance is influenced by a range of factors that can be managed, such as nutrient concentrations, flow regimes, and light, and therefore can be used to define limits on resource use relating to nutrient discharges, water use, and land uses impacting on riparian vegetation. Chlorophyll *a* was chosen as a measurement method as it is the most commonly recognised standard method internationally and nationally, and had stronger performance in models relating periphyton to water chemistry, flow and ecosystem health measures (Snelder et al. 2013).

In 2017 the NPS-FM was updated to incorporate a detailed note requiring Councils to set instream concentrations for DIN and DRP to achieve periphyton objectives or sensitive downstream receiving environments, or where the FMU does not support conspicuous periphyton, set criteria to achieve any other relevant freshwater objectives.

Technical guidance was published in August 2018 to help councils set appropriate instream concentrations and exceedance criteria for nitrogen and phosphorus to achieve periphyton objectives, while ensuring the outcomes sought for sensitive downstream environments are also achieved (MfE 2018).

Timeline

2009	Government sets strategic direction for freshwater reform.
2011	NPS-FM released: a first step towards improving freshwater management in New Zealand.
2013	Publication of "Freshwater reform 2013 and beyond", which set out the Government's approach to reforming New Zealand's freshwater management system. Publication of "Proposed amendments to the National Policy Statement for Freshwater Management 2011: A discussion document", proposing addition of compulsory values, the NOF including attributes and attribute states, national bottom lines, among others.
2014	NPS-FM amended to include NOF attributes.
2017	NPS-FM updated to incorporate a detailed note requiring Councils to set instream concentrations for DIN and DRP to achieve periphyton objectives or sensitive downstream receiving environments, or where the FMU does not support conspicuous periphyton, set criteria to achieve any other freshwater objectives. Publication of "A Guide to the National Policy Statement for Freshwater Management 2017", providing detailed information about the policy intent and requirements for each objective and policy.
2018	Publication of "Draft Guide to Attributes in Appendix 2 of the National Policy Statement for Freshwater Management (as amended 2017)", which covers the definition of the periphyton attribute, defines management actions and provides sampling considerations. Publication of "A draft technical guide to the Periphyton Attribute Note".

Why was this approach taken?

The following excerpt from the NOF Reference Group Report (October 2012) summarises the reasoning behind including the periphyton attribute. The percentage figures refer to measures of periphyton abundance by cover. As mentioned above, the final NOF used chlorophyll *a*, but the reasoning remains the same.

> *"Thresholds have been developed arising out of science currently in progress to revise the previous (MfE, 2000) periphyton guideline, which were highly conservative for many NZ streams. A bottom line of 55% cover has been developed to maintain 'fair' ecological condition in streams, mainly based on correlations with invertebrate measures of enrichment such as MCI. The 40% threshold uses similar parameters to derive a 'good' condition, although the 40% value is also close to desirable periphyton cover thresholds for contact recreational use (ie swimming)[14].*
>
> *As indicated by the band descriptors, nutrients, flow and habitat are drivers of periphyton growth. However it is not recommended that these be included in the national objectives framework as bottom-lines derived from the bottom-lines for periphyton growth. This is because periphyton response to nutrients and other drivers is highly variable by river type throughout the country and robust in-stream thresholds can only be generated through detailed site-specific science studies for each local river or river reach. National methodologies and tools could be developed to support regions to develop their own in-stream thresholds at an appropriate scale to achieve the periphyton cover thresholds outlined above."*

[14] Periphyton thresholds are typically 30-40% in existing regional plans

References

Hickey, C. 2013. Updating nitrate toxicity effects on freshwater aquatic species. NIWA Client Report No. HAM2013-009. Prepared for the Ministry for the Environment by NIWA. Hamilton: NIWA.

Hickey, C. 2014. Derivation of indicative ammoniacal nitrogen guidelines for the National Objectives Framework. Memo to Ms Vera Power of MfE, from Chris Hickey of NIWA. Wellington: Ministry for the Environment.

Ministry for the Environment. 2013a. Proposed amendments to the National Policy Statement for Freshwater Management 2011: A discussion document. Wellington: Ministry for the Environment.

Ministry for the Environment. 2013b. Freshwater reform 2013 and beyond. Wellington: Ministry for the Environment.

Ministry for the Environment. 2018. A draft technical guide to the Periphyton Attribute Note Under the National Policy Statement for Freshwater Management 2014 (as amended 2017). Wellington: Ministry for the Environment.

Snelder, T., Biggs, B., Kilroy, C., Booker, D. 2013. National Objective Framework for periphyton. Prepared by NIWA for Ministry for the Environment. NIWA Client Report no. CHC2013-122. Chirstchurch: NIWA.

Appendix I: NPS Attribute Tables

Periphyton

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	Periphyton (Trophic state)		
Attribute Unit	mg chl-a/m² (milligrams chlorophyll-a per square metre)		
Attribute State	Numeric Attribute State (Default Class)	Numeric Attribute State (Productive Class)[1]	Narrative Attribute State
	Exceeded no more than 8% of samples[2]	Exceeded no more than 17% of samples[2]	
A	≤50	≤50	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.
B	>50 and ≤120	>50 and ≤120	Occasional blooms reflecting low nutrient enrichment and/ or alteration of the natural flow regime or habitat.
C	>120 and ≤200	>120 and ≤200	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat.
National Bottom Line	200	200	

D	>200	>200	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.

1. Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC "Dry" Climate categories (i.e. Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (i.e. Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class.

2. Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chl-a) is 3 years.

Note: To achieve a freshwater objective for periphyton within a freshwater management unit, regional councils must at least set appropriate instream concentrations and exceedance criteria for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP). Where there are nutrient sensitive downstream receiving environments, criteria for nitrogen and phosphorus will also need to be set to achieve the outcomes sought for those environments.

Regional councils must use the following process, in the following order, to determine instream nitrogen and phosphorus criteria in a freshwater management unit:

a) either –

   i) if the freshwater management unit supports, or could support, conspicuous periphyton, derive instream concentrations and exceedance criteria for DIN and DRP to achieve a periphyton objective for the freshwater management unit; or

   ii) if the freshwater management unit does not support, and could not support, conspicuous periphyton, consider the nitrogen and phosphorus criteria (instream concentrations or instream loads) needed to achieve any other freshwater objectives:

b) if there are nutrient sensitive downstream environments, for example, a lake and/or estuary, derive relevant nitrogen and phosphorus criteria (instream concentrations or instream loads) needed to achieve the outcomes sought for those sensitive downstream environments:

c) compare all nitrogen and phosphorus criteria derived in steps (a) – (b) and adopt those necessary to achieve the freshwater objectives for the freshwater management unit and outcomes sought for the nutrient sensitive downstream environments.

Nitrate

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	Nitrate (Toxicity)		
Attribute Unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual 95th Percentile	
A	≤1.0	≤1.5	High conservation value system. Unlikely to be effects even on sensitive species.
B	>1.0 and ≤2.4	>1.5 and ≤3.5	Some growth effect on up to 5% of species.
C	>2.4 and ≤6.9	>3.5 and ≤9.8	Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.
National Bottom Line	6.9	9.8	
D	>6.9	>9.8	Impacts on growth of multiple species, and starts approaching acute impact level (ie risk of death) for sensitive species at higher concentrations (>20 mg/L).

Note: This attribute measures the toxic effects of nitrate, not the trophic state. Where other attributes measure trophic state, for example periphyton, freshwater objectives, limits and/or methods for those attributes will be more stringent.

Ammonia

Value	Ecosystem health		
Freshwater Body Type	Lakes and rivers		
Attribute	**Ammonia (Toxicity)**		
Attribute Unit	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)		
Attribute State	**Numeric Attribute State**		**Narrative Attribute State**
	Annual Median*	**Annual Maximum***	
A	≤0.03	≤0.05	99% species protection level: No observed effect on any species tested
B	>0.03 and ≤0.24	>0.05 and ≤0.40	95% species protection level: Starts impacting occasionally on the 5% most sensitive species
C	>0.24 and ≤1.30	>0.40 and ≤2.20	80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species)
National Bottom Line	**1.30**	**2.20**	
D	>1.30	>2.20	Starts approaching acute impact level (ie risk of death) for sensitive species

* Based on pH 8 and temperature of 20°C.

Compliance with the numeric attribute states should be undertaken after pH adjustment.

Total nitrogen

Value	Ecosystem health		
Freshwater Body Type	Lakes		
Attribute	Total Nitrogen (Trophic state)		
Attribute Unit	mg/m³ (milligrams per cubic metre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual Median	
	Seasonally Stratified and Brackish	Polymictic	
A	≤160	≤300	Lake ecological communities are healthy and resilient, similar to natural reference conditions.
B	>160 and ≤350	>300 and ≤500	Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.

C	>350 and ≤750	>500 and ≤800	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions.
National Bottom Line	**750**	**800**	
D	>750	>800	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, (without native macrophyte/seagrass cover) due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.

Note: For lakes and lagoons that are intermittently open to the sea, monitoring data should be analysed separately for closed periods and open periods.

Freshwater Science and Technical Advisory Group:

Update on package to address copper and zinc

Paper Author	Nik Andic	Classification	**Confidential**

Meeting date	29 November 2018	Agenda item (number)	6

Paper summary:
This paper provides STAG members with an update on work to address copper and zinc as part of the *Essential Freshwater* work programme, and seeks their input on a number of issues.

Update on package to address copper and zinc

This paper provides STAG members with an update on work to address copper and zinc as part of the *Essential Freshwater* work programme, and seeks their input on a number of issues.

Please note that Ministers have not received detailed advice on options being developed, and are yet to make any decisions. Please treat this paper in confidence.

Introduction

At elevated concentrations, both copper and zinc have toxic effects on aquatic biodiversity, and managing them is a relatively high priority because of the risk of irreversible harm.

Concentrations are higher in catchments with greater urban land cover, and at some monitored sites, are already high enough to be impacting on more sensitive species.[15]

Defining attributes for copper and zinc in the Freshwater NPS can direct regional planning to set objectives and limit resource use activities to achieve these (e.g. by constraining stormwater discharges and the range of activities that generate the metals further up the pipe).[16]

However, legislative settings mean that local government can't control vehicle sources and (potentially) building materials – both are significant sources of copper and zinc. This is an issue because local government will have limited option to achieve copper and zinc objectives – such as treatment and infrastructure upgrades – which are likely to be less efficient than source control (if at all possible).

To address this, we are developing a wider package of options to both direct regional planning to manage copper and zinc *and* ensure local government is able to do so in an efficient way:

- **Option A.** direct regional planning to manage copper and zinc, and in particular, the cumulative impact of multiple activities;
- **Option B.** clarify that regional councils are able to control building materials to manage water quality;
- **Option C.** address vehicle sources at the national level; and
- **Option D.** promote water sensitive urban design.

[15] Current state of monitored sites is available here: http://archive.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/environmental-indicators/Home/Fresh%20water/urban-stream-water-quality.aspx
More detailed state and trends analysis by NIWA is available here: http://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/urban-streams-water-quality-state-and-trends-report.pdf

[16] A desktop review of regional plans indicates most do not describe freshwater objectives for copper and zinc in receiving environments (with some exceptions in Northland, Horizons, Canterbury and Southland). This means the councils will not be able to rely on their plans to constrain activities generating copper and zinc based on their cumulative effect on the receiving environment – for example, these councils are unlikely to be able to prevent further releases of copper and zinc into the environment if concentrations approach toxic thresholds because the cumulative effect of multiple activities.

Possible topics for discussion (if time)

a) Are ANZECC guidelines for chronic toxicity are an appropriate starting point for Cu and Zn attributes in NZ? We intend to invite Jennifer Gadd and Chris Hickey to the next meeting when we have time for a substantive discussion about this.

b) We are dependent on NIWA to develop acute thresholds, and this work is yet to be done (may need to be procured). It may be worth discussing how much of a risk this is and ways to mitigate it (e.g. if, for example, acute thresholds have to be inserted in future amendments and are more constraining)?

c) Monitoring copper and zinc may have a significant impact on regional council resources outside of urban centres that do it already, and may be unnecessary where the metals are unlikely to be an issue. Are there ways we can minimise this burden? Previous suggestions include limiting the application of the attribute via a classification system, or more broadly, enabling councils to take a risk based approach to monitoring.

d) Options C (and to a lesser extent D) may be longer term commitments. There is a tension here between directing planning to manage the metals (and do so in time for the next generation of plans) vs tasking regional councils with a problem they can't solve in an efficient way (if at all) until central government helps address vehicle sources.

e) Next steps (the chunky bits of work still needed):
    i. Procuring/finalising attributes, and impact testing (i.e. working with a wider set of councils to agree on what mitigation will be required).
    ii. Significant information gathering and impact testing needed to support Option C.

f) Note that Option D is being led out of the dedicated urban water team, and is a broader piece of work in itself.

Freshwater Science and Technical Advisory Group:

Summary of attribute development: Dissolved Oxygen

Paper Author	Jen Price	Classification	**Confidential**

Meeting date	29 November	Agenda item (number)	6

Paper summary:
This paper summarises previous work towards development of an attribute for dissolved oxygen. The purpose of this paper is to provide background information to inform discussions on potential changes to dissolved oxygen in the National Policy Statement for Freshwater Management.

A summary of attribute development to date: dissolved oxygen

Dissolved oxygen in the National Policy Statement for Freshwater Management

Oxygen is essential for almost all forms of life for respiration. Reduced dissolved oxygen levels (hypoxia) can impair the growth and/or reproduction of aquatic organisms and very low or zero dissolved oxygen levels (anoxia) will kill organisms (Davies-Colley et al. 2013). Consequently, the dissolved oxygen concentration of water is critical to stream ecosystem health (Davies-Colley et al. 2013).

There are three key processes affecting dissolved oxygen concentrations: 1) oxygen production associated with photosynthesis of algae and other plants; 2) oxygen uptake associated with respiration of all river life including plants, algae, fish, invertebrates and microbes; and 3)oxygen diffusion through the water surface.

The measurement of dissolved oxygen is complicated by the fact that concentrations vary widely on a 24-hour cycle, often peaking in the late afternoon due to photosynthesis, and reaching a minimum in the early hours of the morning due to respiration. Dissolved oxygen is therefore best characterised by continuous measurements, using loggers that are deployed in the waterbody of interest for a period of several days or weeks. Loggers are expensive and require specialist training to deploy and maintain, generally limiting their use to sites of particular interest or need, for example, for assessing effects of water takes or discharges. State of the Environment monitoring more often uses spot measurements of dissolved oxygen. Because different sites are measured at different times of the day, it is not straightforward to use spot measurements to gain an overall picture, measure trends over time, or compare between sites (but see description of study by Depree et al. (2016) below, for potential methods to address this).

In early June 2013 during the development phase of the NOF, NIWA prepared a report (Davies-Colley et al. 2013) to inform the inclusion of attributes in the NOF (including dissolved oxygen). The report specifically presented discussion on:

a) The drivers of dissolved oxygen in water
b) Where low dissolved oxygen most commonly occurs
c) Dissolved oxygen tolerances by organisms
d) Approaches to defining dissolved oxygen thresholds and bottom lines
e) Dissolved oxygen criteria and NOF limits for temperature, including narrative band descriptions and tentative numeric band boundaries

The information presented in Davies-Colley et al. 2013 only provided sufficient information to justify inclusion of a dissolved oxygen attribute in the NOF below point source discharges (Table 1). The difficulties associated with defining an attribute for dissolved oxygen for diffuse sources were not satisfactorily resolved when the 2014 NPS-FM was released. It was envisaged that the remaining information gaps would be addressed at a later date (see details under “Details of the proposed research” below.

Table 4. Dissolved oxygen attribute for rivers below point sources.

Attribute State	Numeric Attribute State	
	7-day mean minimum (1 Nov-30 April)	**1-day minimum (1 Nov-30 April)**
A	≥8.0	≥7.5
B	≥7.0 and <8.0	≥5.0 and <7.5
C	≥5.0 and <7.0	≥4.0 and <5.0
National Bottom Line	5.0	4.0

The following statement from the NOF Reference Group minutes (19/3/2014) sums up the decision to include a dissolved oxygen attribute in the NOF below point source discharges:

> *"The group recognised that the inclusion of a point source dissolved oxygen attribute was more about making a start, and there was a desire to keep it.*
>
> *Guidance should recognise that the attribute is not quite there for all sources yet, and there was a desire to eventually include a diffuse source attribute.*
>
> *The group noted that in any case the inclusion of the point source attribute now, means councils will do something about continuous monitoring, and that this would inform management interventions."*

What is the current state of dissolved oxygen?

In mid-2015 the Ministry for the Environment commissioned NIWA to determine whether there was dissolved oxygen data of sufficient quality, quantity and representativeness to assess the current state of the attribute on a national scale (Depree et al. 2016). The report assessed continuous dissolved oxygen data recorded at 368 sites (Figure 1), and also compared spot dissolved oxygen data from 799 sites with the 7-day average minimum dissolved oxygen attribute bands proposed in Davies-Colley et al. (2013). The report indicates that potentially 15% of streams may be below the national bottom line.

Depree et al. (2016) concluded that:

- Spot data had good spatial and temporal coverage.
- Continuously logged data was collected for general monitoring purposes as well as for specific projects, which means that it may not be representative on a regional or national scale.
- a reasonable picture of current state at the national scale may be attained when using rule-of-thumb techniques to align continuous data with the more widespread spot data.
- The quality and quantity of dissolved oxygen data may therefore be sufficient to allow the current state to be assessed at the national scale (data were requested from regional councils and research institutions in 2015).

The continuous and spot measurements were compared to the NOF bands in different ways. Spot data were evaluated against the NOF 1-day and 7-day average minimum dissolved oxygen attributes. For spot measurements, the C and D bands were combined into one “at risk” classification due to the tendency of spot data to be above the daily minimum. The continuous data were evaluated against the NOF 1-day and 7-day bands.

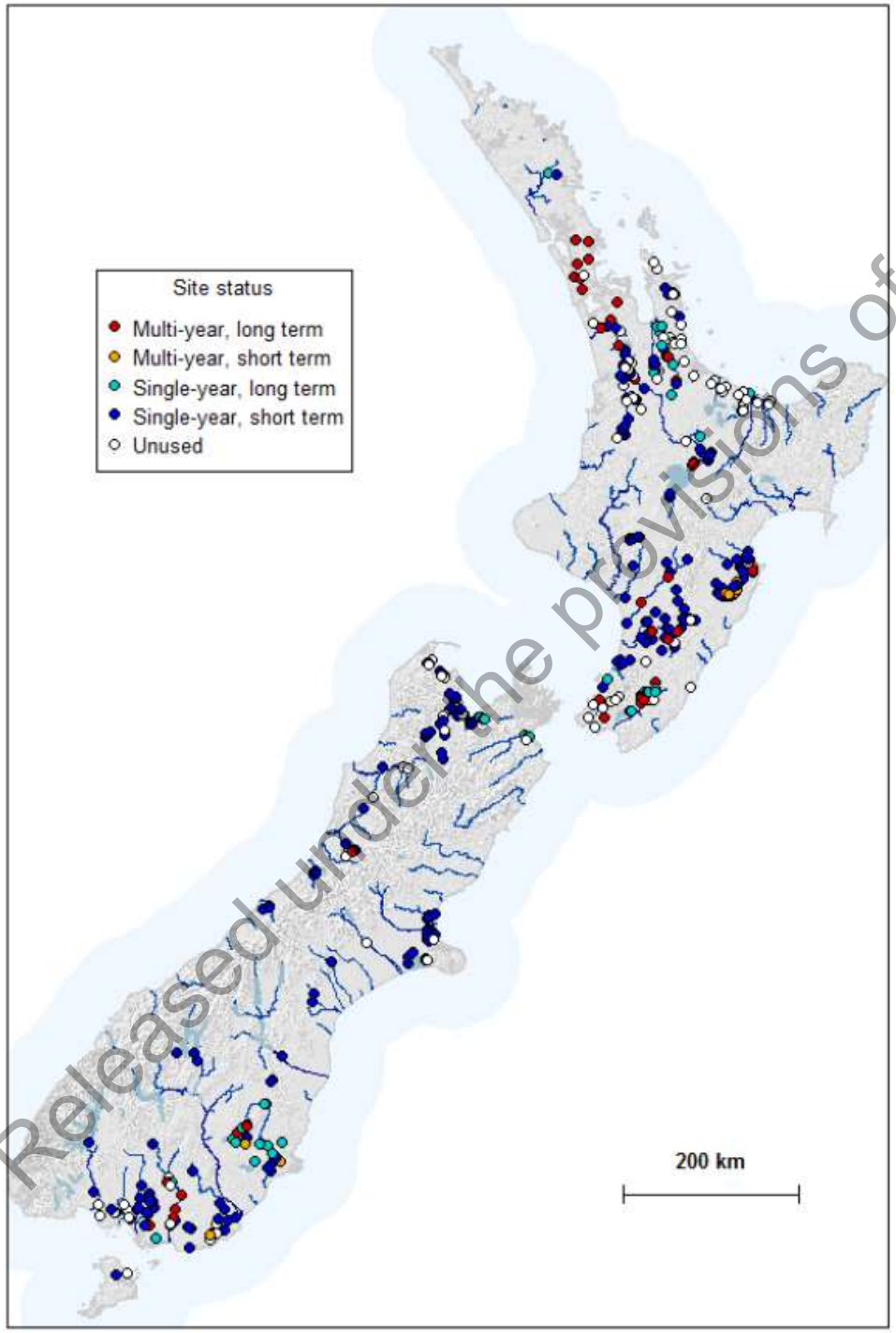


Figure 3. Geographical distribution of continuous dissolved oxygen monitoring data sets (sites) collated in the dissolved oxygen database. (Depree et al. 2016)

Based on the analysis of Depree et al. (2016), approximately 15% of streams may be below the NOF 1-day minimum bottom line that currently applies below point source discharges. Dissolved oxygen showed a similar pattern to other water quality indicators; spot and continuous measurements of dissolved oxygen were highest in streams and rivers with natural land cover, followed by exotic forest, pasture, and urban, in order of declining water quality. Temporal trends were not assessed.

The report recommended that "guidance be provided for characterising the dissolved oxygen state of streams for a given season, and also longer-term for multi-year/seasonal dissolved oxygen records. In addition, some consideration may need to be given for having different dissolved oxygen criteria for different stream types."

Following the study of Depree et al. (2016), a request for proposal was put out for further data collation and analysis to inform the inclusion of an instream temperature attribute in the NOF.

Details of the proposed research

The objectives of this proposed project were to develop a dissolved oxygen attribute as detailed in stages 1 and 2 below. The work was planned to collate sufficient technical detail to support inclusion of a dissolved oxygen attribute for diffuse and point sources in a future iteration of the NOF.

Stage 1 - Quantify the influence of critical drivers

The objective of Stage 1 was to assess the relative importance of the critical drivers influencing the dissolved oxygen regime. Whilst there are numerous drivers, emphasis should be placed on those that are deemed critical.

Information on the critical drivers of depleted dissolved oxygen should be collated and a conceptual model of the relationship between drivers presented. The relative importance of these critical drivers should then be examined and presented. This could be in the form of a Bayesian network type approach or similar.

Stage 2 – Identify potential management actions available to meet dissolved oxygen objectives

The objective of Stage 2 was to identify management actions which could be implemented to meet dissolved oxygen objectives. It was planned that information on management actions should be collated and a conceptual model of the relationship between management actions and critical drivers should be presented.

The ability of management actions to meet dissolved oxygen objectives should be explored in some detail. Exploration should include analysis of how management actions could be implemented to enhance waterways from degraded to less degraded dissolved oxygen attribute band states, with consideration given to different settings across New Zealand.

What other monitoring data are available?

In addition to the regional council monitoring data collated by Depree et al. (2016), several studies have been carried out monitoring the effects of mechanical desilting, aquatic vegetation removal on dissolved oxygen, using continuous monitoring.

Summary

The attribute for dissolved oxygen currently only applies below point sources. The attribute was not applied to all waterbodies due to information gaps in 1) the national state of dissolved oxygen, 2) the relative importance of the critical drivers influencing the dissolved oxygen regime, and 3)

management actions which could be implemented to meet dissolved oxygen objectives. The gap in knowledge in point 1) above has been addressed, but the second two points have not.

Questions:

1. Do we have enough information to progress the dissolved oxygen attribute?
    a. If so, what form would this take?
    b. If not, can dissolved oxygen be incorporated in another way? Could dissolved oxygen be included as a monitoring requirement, for example?

References

Davies-Colley, R., Franklin, P., Wilcock, R., Clearwater, S., Hickey, C. (2013) National Objectives Framework – Temperature, Dissolved Oxygen & pH, proposed thresholds for discussion. *NIWA Client Report HAM2013-056.*

Depree, C., Unwin, M., Young, R. (2016) Dissolved Oxygen data collation and preliminary analysis. *NIWA Client Report HAM2016-008.*