

Response to Hearing Panel Questions on Table 3.11.1 and the Joint Witness Statement.

A minute for the hearing panel was received on 24 July 2019. This set out specific questions for experts who participated in the expert conferencing sessions on Table 3.11.1 and were signatories to the Joint Witness Statement but were not able to attend the hearing on the 18 July 2019.

The questions for Dr Robertson were as follows:

1. In relation to Table 1, on page 97 of the Joint Witness Statement, why are bottom line (i.e., bottom of the C band) annual median thresholds for riverine and peat lakes 750 (stratified) and not 800 mg/m³ (polymictic) as found in the NPS-FM?
2. In relation Table 1, what data is the 625 mg/m³ threshold for TN in Volcanic lakes based on?
3. In relation to macrophytes, at page 192 of the Joint Witness Statement, what do you mean by your comment regarding "light attenuation effects on native macrophytes"?

Responses to questions

Question 1 & 2

- These questions relate to the development of numeric targets for lake ecosystems. The Tables were prepared and presented by Dr Ngaire Phillips. Therefore, I recommend these questions are appropriately addressed by her.

Question 3

- In the Joint Witness Statement, at page 192, I provided my comments on the 'macrophyte nuisance' attribute paper (pages 78-79 of the JWS) . I stated that:

In relation to lakes, the memo on macrophytes at present does not identify the link between light attenuation (due to water quality decline) and loss of native macrophytes. The memo is focused on nuisance macrophytes only. While there may be insufficient evidence in relation to TN/TP and macrophytes, light attenuation effects on native macrophytes has not been adequately covered.

- I did not agree with the macrophyte paper because in my opinion there had been insufficient attention in the expert conferencing to consider macrophytes (i.e. macrophyte diversity, macrophyte depth, macrophyte abundance) as an attribute of lake ecosystem health. The paper was predominantly focused on 'nuisance' macrophytes, and in my view, this narrow focus meant that the assessment of macrophytes as indicators of lake ecosystem health were too quickly overlooked.
- In particular, my comments highlighted the link between water quality and the light requirements of freshwater macrophytes. I stated that '*light attenuation effects on native macrophytes has not been adequately covered.*'
- In terms of 'light attenuation effects on native macrophytes', this relates to the need for all plants (terrestrial or aquatic) to have adequate levels of light for

photosynthesis. In the absence of sufficient light levels, plants (including freshwater macrophytes) are simply not able to undertake critical functions needed for survival.

- Light attenuation relates to how quickly light levels decline in water. Light attenuation is higher (declines more rapidly) in freshwater systems with poor water clarity, for example, due to high levels of suspended sediment (Davies-Colley & Smith 2001). This means that in freshwater systems with poor water quality, light often does not penetrate as deeply.
- Consequently, in waterbodies with poor water quality where light attenuation has been compromised by anthropogenic influences such as high sediment levels, freshwater macrophytes will be negatively affected.
- There is considerable evidence from New Zealand (e.g. Schwarz et al. 2000, Vant & Davies-Colley 1984, Vant et al. 1986) that confirms the direct relationship between light penetration (i.e. the light attenuation coefficient, K_d) and the depth limits (Z_c) that macrophyte are able to occupy.
- Because the attribute paper presented in the Joint Witness Statement did not examine the links between water quality (i.e. light attenuation) and macrophytes as a measure of ecosystem health (i.e. macrophyte depth limit), I did not agree that the paper was complete.

References

- Davies-Colley RJ, Smith DG. 2001. Turbidity, suspended sediment, and water clarity: A review. *Journal of the American Water Resources Association* 37: 1085-1101
- Schwarz, A-M, Howard-Williams C, Clayton J. 2000. Analysis of relationships between maximum depth limits of aquatic plants and underwater light in 63 New Zealand lakes. *New Zealand Journal of Marine and Freshwater Research* 34: 157–174.
- Vant WN, Davies-Colley RJ. 1984. Factors affecting clarity of New Zealand lakes. *New Zealand Journal of Marine and Freshwater Research* 18: 367-377.
- Vant WN, Davies-Colley RJ, Clayton JS, Coffey BT. 1986. Macrophyte depth limits in North Island (New Zealand) lakes of differing clarity. *Hydrobiologia* 137:55 -60.



Dr Hugh Robertson, 5 August 2019