BEFORE THE INDEPENDENT COMMISSIONERS

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the Proposed Canterbury Land and Water Regional Plan

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EVIDENCE IN CHIEF OF ASSOCIATE PROFESSOR RUSSELL DEATH ON BEHAL OF NELSON/MARLBOROUGH, NORTH CANTERBURY AND CENTRAL SOUTH ISLAND FISH AND GAME COUNCILS
2 APRIL 2013

ANDERSON LLOYD
LAWYERS
DUNEDIN

Solicitor: Maree Baker-Galloway

Level 10, Otago House
Cnr Moray & Princes Street,
Private Bag 1959,
DUNEDIN 9054
Tel 03 477 3973
Fax 03 477 3184

MAB-388879-30-1165-V1:jhd

QUALIFICATIONS AND EXPERIENCE

1. My full name is Russell George Death.

2. I am an Associate Professor in Freshwater Ecology in the Institute of Agriculture and Environment – Ecology at Massey University where I have been employed since 1993. Prior to that I received a Doctor of Philosophy in Zoology from the University of Canterbury (1991) and was a Foundation for Research, Science and Technology postdoctoral fellow at Massey University (1991-93).

3. I have been a Quinney Visiting Fellow at Utah State University. I am a member of the Ecological Society of America, British Ecological Society, New Zealand Ecological Society, the New Zealand Freshwater Sciences Society and the North American Benthological Society. I have refereed scientific manuscripts for 17 scientific journals and several books. I am on the editorial board of the journal *Marine and Freshwater Research*. I have been commissioned by a number of governmental and commercial organisations to provide scientific advice on matters related to the management of freshwater resources.

4. I have had 22 years' experience in professional ecology research, teaching and management. My area of expertise is the ecology of stream invertebrates and fish. I have 80 peer-reviewed publications in international scientific journals and books, including a number of invited reviews. I have written 40 plus consultancy reports and given over 60 conference presentations. I have been the principal supervisor for 38 post-graduate research students.

5. In preparing this evidence I have reviewed:
   a. Proposed Canterbury Land and Water Regional Plan (pCLWRP);
   b. Proposed Canterbury Land and Water Regional Plan (pCLWRP) Section 42A;
   c. Managing the cumulative effects of land use on water quality in Canterbury: A contribution to the Section 32 report for the Land & Water Regional Plan;

d. Stevenson et al. 2010;

e. Regional node loads and objectives provided by Environment Canterbury on the 27 March 2013; and

f. Summary load estimates spread sheet provided by Environment Canterbury on the 27 March 2013.

6. I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

7. I have been asked by Fish and Game to prepare evidence on whether the proposed Canterbury Land and Water Regional Plan (pCLWRP) will safeguard and/or allow management of the ecological health (life supporting capacity) and Salmonid fishery in Canterbury rivers and streams.

8. This includes:

a. Whether the pCLWRP will safeguard waterbody life supporting capacity; and

b. What riparian setbacks will help safeguard waterbody life supporting capacity.

TERMS AND DEFINITIONS

9. Throughout my text I use the words 'life supporting capacity' and 'ecological health' interchangeably. Although there may be some distinction between these in a planning and/or legal arena they are the same in an ecological context. Furthermore, I also use the term 'adverse' and 'significant adverse' effect interchangeably. Again while there may be differences in these terms within the planning and/or legal arena they are identical in an ecological context.

EXECUTIVE SUMMARY

10. There is a considerable body of evidence that land use activities if not managed appropriately can and do have significant adverse effects on the ecological health of waterbodies in the Canterbury Region.

11. Ecosystem health in many of the lowland and urban waterbodies in the Canterbury region is extremely poor. Although waterbody ecosystem health is still moderate to high in some of the region's mountains, high country and hill regions scenarios of increasing agricultural intensification in these areas has the potential to result in significant adverse effects if not managed carefully. The pCLWRP does not seem to provide adequate guidance or mechanism for that management.

12. Fish and Game have requested information on all State of the Environment biological (e.g. MCI, periphyton[1]), water chemistry (e.g. nutrient) and hydrological[2] monitoring from Environment Canterbury (ECan). From what I have been provided with from ECan in response to those requests, there seems to be a large disjunct between technical information and documents at ECan, external research and the rules and policies in the proposed Plan.

13. There appears to be no technical data provided which supports the water quality allocation states provided in the Nutrient zone map. These allocation states do not always appear to relate well with state of the environment data (e.g. MCI) that I have reviewed.

14. Environmental thresholds presented in the proposed Fish and Game amended Table 1a provide pragmatic limits for ecological health that should safeguard the life supporting capacity and fishery values of Canterbury waterbodies.

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[1] This data was not provided
[2] This data was not provided

15. The current intensity of agriculture in Canterbury and the associated land uses practices are causing significant adverse effects on the life supporting capacity of many waterbodies within the Canterbury Region. The approaches proposed by Environment Canterbury through their pCLWRP are unlikely to prevent further degradation of ecological health or result in an improvement in ecological health.

16. Improvements (such as reducing nitrogen leaching, and excluding stock from waterways) that move conditions towards the Table 1a limits that I have proposed (the closer the better) are necessary to maintain or improve the ecosystem health of many of the region's waterways

17. Riparian buffer setbacks are an effective management tool for controlling the effect of land management activities on waterbody life supporting capacity. I believe a precautionary, but pragmatic view, with a minimum setback distance of 10 m from all lakes, wetlands and waterbodies, and a setback of 20 m in areas of high erosion and at Salmonid spawning sites should be applied.

WILL THE pCLWRP SAFEGUARD WATERBODY LIFE SUPPORTING CAPACITY?

18. As outlined in my Evidence in Chief for Hearing 1 there is a considerable body of evidence from Environment Canterbury Technical reports and external research that illustrate the ecological health and water quality of many Canterbury rivers and streams is poor and declining (Hayward, Meredith & Stevenson, 2009; Stevenson, Wilks & Hayward, 2010; Clapcott *et al.*, 2011; Clapcott *et al.*, 2012). I provided data from the Ministry of Environment league tables that some of the rivers in Canterbury are in fact amongst the worst in New Zealand.

19. This is a result of nutrient enrichment, faecal contamination, excess siltation, reduced flows and potentially nitrate toxicity. Much of the analysis in the technical reports and external research link these water

quality effects with increasing land use intensification. Again in my Hearing 1 evidence I have gone into considerable length about these linkages that I do not intend to reiterate here.

20. There are still a considerable number of streams and rivers in the region, in the more alpine and hill country regions that have high ecological values and water quality. However, as evidenced from the link between land use intensification and water quality in the plains and low hill country any inappropriately managed agricultural intensification in these regions will have the same significant adverse effects on water quality and ecological health.

21. In my Hearing 1 evidence I presented an amended version of Table 1a p 4-2 pCLWRP as my Appendix 1 that offered numerical limits for a range of environmental measures that might go some way towards arresting the decline in ecological health of Canterbury waterbodies.

22. These limits were derived from published literature, expert knowledge, state of the environment data, and technical information contained in (Hayward *et al.*, 2009).

23. Evaluating how the pCLWRP might be used to manage the health of Canterbury waterways has proved extremely difficult. There appears to be a considerable disjunct between the limited technical information and state of the environment monitoring data collected by ECan and policies and rules in the plan. There appears to be no ability to link Table 1a, and the nutrient allocation zone approach or allocation states (Ford, 2012).

24. As such there is no link between actual water quality issues in the region and management approaches. Furthermore, the zone allocation states do not appear to link with the State of the Environment data, which I have reviewed. As presented in my EIC Macroinvertebrate community health (MCI) data indicates that almost all the lowland waterbodies are degraded, whereas the nutrient allocation zone map indicates varying states of nutrient allocation. Assessments of macroinvertebrate community health are generally

held to be the best indicators of life supporting capacity in New Zealand.

25. Even the criteria for placing catchments in nutrient allocation zones (Section 32 report Ford 2012 P 88) are difficult to follow with an unclear combination of expert opinion and "quantitative assessment". There appears to have been no consideration of the values to be managed for. Furthermore, management units defined here do not seem to be the same as those in the pCLWRP. While I requested information (Appendix 1) to enable me to assess the merits of the approach taken, the limited information provided (26 March 2013) still did not provide technical information to support this approach and the allocation states. It appears that both my assessment of data (EIC) and the preliminary work of ECan based on an analysis of current state against desired state, indicates that many of Canterbury's lowland surface waterbodies are degraded.

26. In my opinion the approach that should have been taken to provide a clear link between the values, limits, and management is:
    a. For each river reach identify the appropriate values.
    b. Establish numerical water quality and quantity limits to provide for those values. Water quality limits should include those parameters I proposed in my evidence in chief for Hearing 1.
    c. Undertake an assessment of current state against those limits and use that to determine allocation state for the waterbody.
    d. Establish management approach to address any over allocation issues and to enhance or provide for the life supporting capacity of the waterbodies concerned.

27. To illustrate my concerns, Table 1 provides the minimum, maximum and average dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) concentrations from data supplied by ECan (collected between 1993 and 2012) on water quality monitoring at their State of the Environment (SOE) sites. However, data from the SOE monitoring sites are linked with their corresponding catchments not the management units presented in Table 1a of the pCLWRP.

Table 1 Maximum (Max.), minimum (Min.), and average (Ave.) dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) concentrations from data supplied by Environment Canterbury (collected between 1993 and 2012) on water quality monitoring at their State of the Environment sites.

WMCR zone	Nutrient status	Max. DIN	Ave. DIN	Min. DIN	Max. DRP	Ave. DRP	Min. DRP
		g/m3	g/m3	g/m3	g/m3	g/m3	g/m3
Ashburton	At risk	8.99	3.83	0.21	0.107	0.023	0.004
Banks Peninsula	Unclassified	0.78	0.43	0.27	0.042	0.030	0.019
Christchurch - West Melton	Special purpose area	0.72	0.57	0.28	0.081	0.040	0.011
Hurunui - Waiau	Sub-regional chapter	1.07	0.37	0.16	0.015	0.007	0.003
Kaikoura	Water quality outcomes not met	1.95	0.96	0.19	0.031	0.015	0.004
Lower Waitaki - South Coastal Canterbury	Meets water quality outcomes	2.87	1.14	0.15	0.265	0.050	0.003
Orari-Opihi-Pareora	At risk	9.40	1.91	0.18	0.659	0.038	0.003
Selwyn - Waihora	Water quality outcomes not met	5.99	2.34	0.12	0.055	0.021	0.003
Upper Waitaki	Water quality outcomes not met/at risk	0.57	0.28	0.15	0.013	0.004	0.002
Waimakariri	Meets water quality outcomes	4.84	1.51	0.20	0.100	0.026	0.004

28. There seems to be no supporting technical document or material in the pCLWRP that allows a plan reader to relate this catchment data to the management units in Table 1a or subsequently to the nutrient zone allocation states.

29. In summary, as a scientist asked to assess the ability of the plan to safeguard the fishery and life supporting capacity of Canterbury rivers based on their current condition I was frustrated to have to admit that it was next to impossible with the supplied information, supporting (or paucity of) technical documents, and the current version of the Plan.

30. Clearly ecological health in many of Canterbury's waterbodies is poor and degrading. Limits in Table 1a should in theory provide some safeguards against this decline, but information on which rivers fit in which management units is required in the pCLWRP.

31. To provide a clear link between the stated management objectives and management approaches, the Table 1a limits should be used to assess the current state of water quality for surface waterbodies in the region, and determine allocation state. Management approaches can then be developed to ensure that ecosystem health within the region is either improved where degraded, or maintained where the limits are currently met.

MODELLING OF PROPOSED LAND USE

32. Alternative farming management scenarios are presented in the expert evidence of Dr Jim Cooke (2013). The scenarios show that imposing nitrogen leaching caps below 35kg N/ha/yr will halt the increase in instream nitrogen loads, and result in an improvement of water quality. Setting the nitrogen cap at 20kg N/ha/yr is predicted to reduce total nitrogen concentrations by nearly 20% for the Ashburton catchment and approximately 25% for the Selwyn catchment.

33. Translating the alternative farming management scenarios discussed by Dr Cooke into outcomes with respect to improvements or declines in ecological health of the receiving waterbodies is extremely difficult. These management scenarios evaluate the outcomes for nitrogen loads alone. As I have discussed in my Evidence in Chief for Hearing 1, instream ecological health is a result of a combination of nutrient levels (both nitrogen and phosphorous), deposited sediment, water quantity and flow pattern (particularly flushing flows, i.e. those that remove periphyton) and habitat quality (Death, Dewson & James, 2009; Death & Collier, 2010; Clapcott *et al.*, 2012).

34. There is, however a considerable body of evidence that changes in these environmental drivers result in corresponding changes in ecological health, and that any reductions in the factors stressing these systems (e.g. nitrogen, phosphorous, sediment) is likely to result

in an ecological improvement when compared with the status quo. As I detailed above, the state of many of these waterways is currently poor as a result of bad agricultural land use management. Maintaining current farming practise will not create any improvement, and increasing intensification will result in further significant declines in ecological condition and life-supporting capacity.

35. The current land and water management practises are therefore compromising life-supporting capacity of these waterways, and further degradation will result in further significant adverse effects on ecological health. Any improvements (such as reducing nitrogen leaching, and excluding stock from waterways) that move conditions towards the Table 1a limits that I have proposed (the closer the better) are necessary to maintain or improve the ecosystem health of the region's waterways.

RIPARIAN SETBACKS

36. I have discussed in my Evidence in Chief presented as part of Hearing 1, the impact of sediment and nutrient losses from land use activities on freshwater ecosystem health, requirements to exclude stock from surface waterbodies, and the need to include management approaches which provide for the protection for small and ephemeral streams. I will not repeat that evidence here. The following evidence simply addresses the appropriateness of riparian set back widths.

37. One of the best ways to manage the impacts of land activities on waterbodies is to use a riparian (alongside the waterbody) buffer strip to limit inputs of nutrients and/or sediment (Osborne & Kovacic, 1993; Quinn, Cooper & Williamson, 1993; Davies & Nelson, 1994; Weigel *et al.*, 2000; Kiffney, Richardson & Bull, 2003; Parkyn *et al.*, 2003; Yuan, Bingner & Locke, 2009; Weller, Baker & Jordan, 2011). This can range from a simple strip of vegetation from which livestock or other agricultural activities are excluded to a completely vegetated native forest riparian strip.

38. The principal effect of the riparian buffer is to act as a barrier to nutrients, sediment, pathogens and other potential contaminants running off the land and to prevent it entering the waterway. It will also stabilise stream banks and limit erosion and undercutting. The vegetation can also take up some of the nutrients. If a forested riparian zone exists this can also serve to limit light reaching the stream bed (which can also exacerbate periphyton growth) and water temperature (most aquatic animals have an upper threshold for survival which can be comparatively low, e.g. 19°C for stoneflies).

39. The riparian buffer zone can also provide suitable habitat for the adult stages of many aquatic invertebrates (the in water life stage of many aquatic animals is the juvenile form with winged adults emerging from the water to mate and reproduce) (Collier & Scarsbrook, 2000; Collier & Winterbourn, 2000; Smith, Collier & Halliday, 2002; Smith & Collier, 2005). Terrestrial insects and mammals from riparian zones often form a major component of the diet for many native and sport fish at certain times of the year (Main, 1988; McDowall, 1990). Thus riparian buffer zones also serve to maintain the proper ecological functioning of instream ecosystems.

40. Riparian buffer zones, particularly those with forested vegetation, are also important for providing instream habitat for native fish and trout by enhancing habitat diversity (e.g. overhanging branches, bank under cutting), creating pools and areas of day time and flood refuge. Grassy or forested river banks also provide spawning habitat for Inanga and other *Galaxias* species, respectively. Thus riparian buffer zones also serve to maintain the proper ecological functioning of instream ecosystems.

41. Although there has been considerable research over the nature and width of riparian buffer strips necessary to maintain ecological health and/or limit the effects of land use activities in the surrounding land the actual width depends on a variety of factors such as adjoining land use practises, soil type, slope and the values that require protection (Osborne & Kovacic, 1993; Quinn *et al.*, 1993; Davies & Nelson, 1994;

Weigel *et al.*, 2000; Kiffney *et al.*, 2003; Parkyn *et al.*, 2003; Yuan *et al.*, 2009; Weller *et al.*, 2011).

42. Several international reviews of buffer width requirements to protect a cross section of instream values found widths ranged between 5 and more than 100 m (Barling & Moore, 1994; Wenger, 1999; Hickey & Doran, 2004; Lee, Smyth & Boutin, 2004; Yuan *et al.*, 2009). Ecological health may require at least a minimum of 10 – 20 m buffer zones and often much greater (Parkyn, Shaw & Eades, 2000). Parkyn et al. (2000) recommended buffer widths of 10 – 20 m to manage vegetation in Auckland streams.

43. In agricultural land to protect water quality, Parkyn (2004) has reviewed buffer zone effectiveness and found phosphorus removal rates increase from 53 to 98% as buffers increase from 4.6 to 27 m, and nitrogen removal of 70% is possible with 10 m wide strips but may need to be 20 – 30 m wide for 100% retention. The Natural Resources Conservation Service (NRCS) an agency of the United States Department of Agriculture that provides technical assistance to US farmers recommend minimum grass buffer widths of 8 – 10 m to protect water quality (Yuan et al 2009).

44. In regards to sediment trapping efficiency, Collier et al. (1995) presented a table to relate land slope, drainage and proportion of soil as clay to the efficiency of buffer strip widths expressed as percentage hill slope length, while Yuan et al. (2009) fitted a log-linear model to compiled data from a multitude of sediment retention buffer width studies and concluded sediment trapping efficiency increases with buffer width.

45. Integrating the information from the above reviews, an approach to setting a riparian buffer zone width that involves consideration of at least land use, soil type and catchment slope, and the goals of the set back (e.g. ecological health versus limiting contaminant runoff) would seem the most sensible.

46. Although there has been considerable research on buffer widths there is still a large level of uncertainty (because of the interacting effects of factors such as those listed above in paragraphs 41 and 45) around the widths necessary to achieve particular outcomes. Yuan et al. (2009) fitted a log-linear model to compiled data from a multitude of sediment retention buffer width studies and concluded sediment trapping efficiency increases with buffer width. The Natural Resources Conservation Service (NRCS) an agency of the United States Department of Agriculture that provides technical assistance to US farmers recommend minimum grass buffer widths of 8 – 10 m to protect water quality (Yuan et al 2009). Phosphorus removal rates increase from 53 to 98% as buffers increase from 4.6 to 27 m (Parkyn, 2004). Nitrogen removal of 70% is possible with 10 m wide strips but may need to be 20-30 m wide for 100% retention. Ecological health may require at least 10 -20 m buffers often much greater (Parkyn *et al.*, 2000).

47. To limit sediment and nutrient runoff and to factor in slope (Wenger, 1999) in the USA and (Barling & Moore, 1994) in Australia based on their reviews recommended a base width and an addition factor based on slope.

Buffer width = 15.2 + 0.61 per 1% of slope (m) (Wenger, 1999)

Buffer width = 8 + 0.65 x slope (m) (Barling & Moore, 1994).

Collier et al. (1995) present a table to relate land slope, drainage and proportion of soil as clay to the efficiency of buffer strip widths expressed as percentage hill slope length. However this may be difficult to implement in a planning framework.

48. All of the reviews, recommendations and guidelines opt for a base or minimum buffer width, excluding any effect of slope at 8 – 10 m. Given the high level of uncertainty, a precautionary base width of 10 m would be the most sensible pragmatic option to achieve good water quality outcomes from land management. I support riparian buffer zones of “10 m from the bed of a river, lake, or wetland, and 5 m from artificial waterbodies”.

49. All of the research highlights that as slope increases the ability of a buffer zone of a given width to offer protection to water quality declines. Identifying a particular slope threshold at which to increase buffer width or even assessing the highly variable slope of a hill has some practical limitations. Riparian guidelines produced by NIWA (Collier *et al.*, 1995) provide a mechanism for accounting for slope in establishing buffer widths. I would support this approach but think it may be difficult to follow in translating percentage of hillslope into a buffer width for individual landowners. (Collier *et al.*, 1995) do not provide a practical solution to the issue but relating the slope class back to the LRI (Land Resource Inventory) class of the land may be a suitable alternative.

50. There is also a need to offer greater protection, with respect to wider buffer widths, in receiving waterbodies that may have more sensitive organisms such as trout spawning rivers, and regionally significant waterbodies. Given the sensitivity of trout and native fish to sediment and other contaminants as well as the need to retain an intact vegetated buffer zone, I feel that a more precautionary approach of 20 m in regards to the appropriate width of buffer zones is appropriate while still being pragmatic.

51. To summarise there is considerable research on buffer widths to minimise the effects of land management on water quality. Clearly buffers are effective in minimising the effects of land use activities on waterways. However, despite all the research there is still considerable uncertainty around the exact width necessary to account for land use, soil type, catchment slope, and the goals of the setback in providing that protection. I believe a precautionary, but pragmatic view, similar to that adopted by a number of other land use management agencies around the world is sensible with a minimum setback distance of 10 m from all lakes, wetlands and waterbodies. This distance should be increased in areas of erosion management to 20 m. The distance should also be increased to 20 m in Salmonid spawning sites

CONCLUSION

52. There is a considerable body of evidence that land use activities if not managed appropriately can and do have significant adverse effects on the ecological health of waterbodies in the Canterbury Region.

53. Ecosystem health in many of the lowland and urban waterbodies in the Canterbury region is extremely poor. Although waterbody ecosystem health is still moderate to high in some of the region's mountains, high country and hill regions, scenarios of increasing agricultural intensification in these areas has the potential to result in significant adverse effects if not managed carefully. The pCLWRP does not seem to provide adequate guidance or mechanism for that management.

54. There seems to be a large disjunct between technical information and documents at ECan, external research and the rules and policies in the proposed Plan.

55. Environmental thresholds presented in the proposed Fish and Game amended Table 1a provide pragmatic limits for ecological health that should safeguard the life supporting capacity and fishery values of Canterbury waterbodies.

56. Riparian buffer setbacks are an effective management tool for controlling the effect of land management activities on waterbody life supporting capacity. I believe a precautionary, but pragmatic view, with a minimum setback distance of 10 m from all lakes, wetlands and waterbodies, 20 m in areas of high erosion and at Salmonid spawning sites.

Associate Professor Russell George Death

DATED this 2nd day of April 2013

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Appendix 1

From: Death, Russell
To: Adrian.meredith@ecan.govt.nz
Subject: Quick question
Date: Monday, 18 March 2013 10:30:00 a.m.
Attachments: image001.png

Adrian
Sorry to bother you. But in appendix 6 of the section 32 report for the CLWRP by Raymond Ford did you have specific criteria for assigning catchments to below, at or above nutrient limits? You talk about a nutrient model but there is no reference to which one you used. Or was it more just your expert opinion based on your knowledge of the catchments?

Thanks Russell

Russell Death
Associate Professor
Institute of Agriculture and Environment - Ecology (PN624)
Te Kura Matauranga o nga Taonga a Papatuanuku
Private Bag 11-222 Palmerston North
New Zealand.
website: http://femm.massey.ac.nz/index.html