IN THE ENVIRONMENT COURT AT CHRISTCHURCH

I MUA I TE KOOTI TAIAO O AOTEAROA

IN THE MATTER	of an appeal under Clause 14 of Schedule 1 of the Resource Management Act 1991
AND IN THE MATTER	of the proposed Southland Regional Water and Land Plan
BETWEEN	**Royal Forest and Bird Protection Society of New Zealand Inc** Appellant
AND	**Southland Regional Council** Respondent

STATEMENT OF EVIDENCE OF KATHRYN JANE MCARTHUR ON BEHALF OF THE ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INC

Dated 15 February 2019

Judicial officers: Judge Borthwick and Judge Hassan

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INTRODUCTION

1. My name is Kathryn (Kate) Jane McArthur.

2. I have been engaged by the Royal Forest and Bird Protection Society of New Zealand (Forest and Bird) to provide evidence on freshwater management, water quality and ecosystem health for the Southland Water and Land Plan Topic A Environment Court hearing.

3. I am the Practice Leader – Water, at The Catalyst Group, an environmental consultancy based in Palmerston North.

QUALIFICATIONS AND EXPERIENCE

4. I hold a Bachelor of Science degree with Honours in Ecology and a Master of Applied Science with Honours in Natural Resource Management, both from Massey University. My areas of post-graduate research included the influence of land use on freshwater macroinvertebrate communities and the interaction between policy and science for improved freshwater resource management, with a focus on water quality objectives and limits in regional plans. I have 18 years post-graduate experience working in the field of freshwater resource management. I joined The Catalyst Group (an environmental consultancy based in Palmerston North) as the Practice Leader - Water in 2012.

5. Before joining The Catalyst Group, I held the role of Senior Scientist – Water Quality with Horizons Regional Council (Manawatū-Whanganui Region). Over six years with Horizons I coordinated the State of the Environment (SOE), periphyton and point-source discharge monitoring programmes for water quality and aquatic biodiversity, produced expert evidence for many resource consent hearings and enforcement actions (relating mainly to takes of, and discharges to, water). During my work on the Horizons One Plan (combined Regional Policy Statement, and Coastal and Regional Plan for Manawatū-Whanganui Region) I led the identification of Sites of Significance – Aquatic work, completed the framework of water management zones for the region, reviewed and refined the river, lake and coastal water quality targets and project managed the water quality evidence for the One Plan hearings and Environment Court proceedings.

6. I have authored and co-authored a range of reports and publications, including technical reports to support the Horizons One Plan and the draft Nelson Resource Management Plan. I have also authored and co-authored papers in peer-reviewed journals on topics such as: the relationship between flow and nutrients in rivers; nutrient limitation; methods for monitoring native fish; the calculation of in-river nutrient loads and limits, and the setting of water quality objectives and limits in resource management policy. I have provided evidence in these topic areas before the Environment Court, and in Board of Inquiry and Independent Hearings Panel processes across the country.

7. I championed and reviewed two national Envirolink Tools projects; the development of methods and guidelines to assess deposited sediment in rivers (Clapcott et al. 2011), and the review of the New Zealand instream plant and nutrient guidelines (Matheson et al. 2012).

8. Most recently, I have provided ecological, water quality and freshwater policy advice to Nelson City Council, Northland Regional Council, Ngāti Kahungunu Iwi Incorporated, Hawke's Bay Regional Council, the national Iwi Leaders Group, the Department of Conservation, the Ministry for the Environment Water Directorate, the National Objective Framework Reference Group, Forest and Bird and the Biodiversity Collaborative Group tasked with preparing a draft National Policy Statement for Indigenous Biodiversity.

9. On behalf of the New Zealand Planning Institute I have co-led workshops throughout the country on best practice freshwater science and policy development with Helen Marr (Director – Perception Planning) since 2016. Participants have included: local government and industry planners, planning consultants, iwi/NGO resource managers, and the Ministry for the Environment Water Directorate staff. I was appointed as a member of the National Objectives Framework reference group for the National Policy Statement for Freshwater Management amendments by the Ministry for the Environment in 2016. I have been a guest lecturer in environmental planning and science at Massey University since 2005 and I am an accredited and experienced RMA hearings commissioner.

10. I have been a member of the New Zealand Freshwater Sciences Society since 2001 and I am currently the Society's President. I have been a member of the Resource Management Law Association of New Zealand (RMLA) for nine years and was the

RMLA scholarship recipient in 2010 for my master's thesis work on water quality policy and limits for the Manawatū River.

11. I have recently been, or am currently involved in, freshwater plan processes in Northland, Auckland, Waikato, Bay of Plenty, Hawke's Bay, Manawatū-Whanganui, Wellington, Tasman, Nelson, Canterbury and Southland regions on behalf of councils, tangata whenua, the Department of Conservation, or stakeholders; including Forest and Bird.

CODE OF CONDUCT FOR EXPERT WITNESSES

12. I confirm that I have read the code of conduct for expert witnesses contained in the Environment Court Consolidated Practice Note (2014). I have complied with the code when preparing my written statement of evidence and I agree to comply with it when presenting evidence. I confirm that the evidence and the opinions I have expressed in my evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

13. As a member of the New Zealand Freshwater Sciences Society, a constituent organisation of the Royal Society of New Zealand - Te Apārangi, I also agree to be bound by the Royal Society of New Zealand Code of Professional Standards and Ethics in Science, Technology, and the Humanities[1].

[1] https://royalsociety.org.nz/assets/Uploads/Code-of-Prof-Stds-and-Ethics-1-Jan-2019-web.pdf

SCOPE OF EVIDENCE

14. The scope of my evidence covers the following matters, to the extent relevant to Topic A issues:

    a. Summary of the state and trends in water quality and ecosystem health in Southland;

    b. Indigenous fish communities of Southland and their conservation threat status;

    c. Expert opinion on Objectives 6, 7, 9, 9A, 9B, 13, 13A, 14 and 17 of the SWLP to support maintenance and improvement of water quality and Ecosystem and Human Health values;

    d. The use of physiographic zones for management of risks to water quality from land use;

    e. Physiographic zone policies, and

    f. Management of Waituna Lagoon as a separate freshwater management unit (FMU).

15. In preparing my evidence I have read and reviewed the following documents:

    a. The evidence in chief of Dr Snelder, Mr Rodway, Dr Lloyd, Mr McCallum-Clarke, Mr Ward, Ms Robertson and Mr Hodson on behalf of Southland Regional Council (the Council);

    b. The proposed, decisions and appeals versions of the Southland Water and Land Plan (SWLP);

    c. The decision report by the hearing panel on the SWLP;

    d. The Initial Planning Statement produced by Southland Regional Council;

    e. Notices of Appeal and s274 notices by Forest and Bird and the Southland Fish and Game Council (Fish and Game);

    f. Multiple technical documents on water quality and aquatic ecology produced by Southland Regional Council: and

    g. The publications cited within this evidence.

EXECUTIVE SUMMARY

16. Many of Southland's rivers, lakes, lagoons and estuaries are in a poor state with respect to water quality and ecosystem health. Shallow groundwater is also affected in many areas. The state of water quality has been declining over the last two decades, largely attributable to expansion and intensification of land used for dairying and winter feeding of dairy stock and associated land management and drainage practices. Diffuse contamination of surface and groundwater is the primary source of contamination of Southland's aquatic ecosystems. Anthropogenic impacts are degrading freshwater values across multiple aquatic ecosystem types.

17. A number of freshwater sub-catchments within Southland have been identified as being of national priority for protection (including wetland and lagoons ecosystems) and contain nationally and regionally important communities and populations of indigenous fish, many species of which are threatened with extinction.

18. The poor state and declining trends in water quality and indicators of ecosystem health warrant an urgent and effective management response at the regional level. It is clear that water quality in Southland is degraded as a result of land use (human activities) and is 'over-allocated' with respect to the pervasive level of water quality degradation, degrading trends in water quality, and the adverse effects this is having on freshwater values such as ecosystem health, human health for recreation, human drinking water, and cultural values including mahinga kai. Southland presents a clear case of a need to improve water quality, not simply to halt decline.

19. I support changes to the pSWLP Objectives 6, 7, 9, 9A, 9B, 13, 13A, 13B, 14 and 17 to ensure water quality is maintained and improved, and that ecosystem health, indigenous species and their habitats are safeguarded as a priority and an environmental bottom line.

20. The physiographic zones and application of the overland flow and artificial drainage variants is an excellent and parsimonious[2] 'model' of water quality risk for Southland. Physiographic zones provide a useful tool to inform future FMU

[2] A parsimonious model is a model that accomplishes a desired level of explanation or prediction with as few predictor variables as possible.

processes, appropriate and effective on-farm mitigations in Farm Environmental Management Plans and can inform resource consents for land use (should these be required by the Plan). However, the current policy suite (in the proposed SWLP) will not address the effects of existing land use and therefore, will not maintain or improve water quality as required by the Objectives of the NPS-FM.

21. Southland Region has lost more than 90% of its original wetland habitat and is continuing to lose wetlands at an alarming rate over recent years. A large proportion of wetlands lost or at risk of being lost are within the catchment of the internationally recognised Awarua Wetland, adjacent to and connected with Waituna Lagoon. These wetland catchments rank highly for indigenous fish values and are priorities for protection of freshwater ecosystems. The predominant cause of wetland loss is conversion to pasture for agriculture. Consideration should be given to prohibiting further intensification of land use in Peat Wetland physiographic zones.

22. Given the international and regional importance of Waituna as a coastal lagoon wetland and the region-wide threat to wetland habitat in Southland, particularly in the vicinity of Waituna Lagoon, specific recognition of the Waituna catchment via a separate FMU is warranted in the Plan and should be included as soon as possible.

STATE AND TRENDS IN WATER QUALITY AND ECOSYSTEM HEALTH

23. Many of Southland's rivers, lakes, lagoons and estuaries are in a poor state with respect to water quality and ecosystem health. Shallow groundwater is also adversely affected in many areas[3]. The state of water quality and indicators of ecosystem health (i.e., macroinvertebrates) have been declining over the last two decades[4], largely attributable to expansion and intensification of dairying, winter feeding and associated land management and development/drainage practices. Diffuse contamination of surface and groundwater from these land uses is the primary source of contamination of Southland's aquatic ecosystems[5]. Anthropogenic impacts are degrading freshwater values across multiple ecosystem types.

24. To better understand the state of water quality in Southland and to compare this with the national picture for river water quality I have undertaken an assessment of all sites in Southland using the LAWA (Land Air Water Aotearoa[6]) data platform. The LAWA website provides some water quality information from regional council monitoring across Aotearoa New Zealand. I have assessed the LAWA data for 56 sites in Southland rivers across five FMUs to determine the general state of water quality, and the potential for adverse effects on ecosystem health and associated values (Appendix 1).

25. To assess Southland sites against the current national state for water quality, the five-year median for each water quality parameter[7] at a site was compared with the same statistic for all sites of similar elevation and land cover classification in Aotearoa New Zealand. Results are reported as to whether the median is within the worst 25%, worst 50%, best 50% or best 25% of like-sites nationally.

26. Faecal (microbial) contaminants indicated by *E. coli,* were elevated in many rivers in Southland, when compared with the national state, particularly those in the Aparima, Ōreti and Mataura FMUs. Twenty-three of the 56 monitored sites had median *E. coli* consistent with the worst 25% of like sites nationally, nineteen sites

[3] Evidence of Ewan Rodway on behalf of Southland Regional Council, paragraph 14a.
[4] Evidence of Ewan Roday, paragraph 76.
[5] Evidence of Ewan Rodway, paragraphs 97 and 103.
[6] www.lawa.org.nz
[7] *Escherichia coli* (*E. coli*), water clarity, turbidity, total nitrogen, total oxidised nitrogen, ammoniacal nitrogen, dissolved reactive phosphorus, total phosphorus and macroinvertebrate community index five-year median results and ten-year water quality trends were examined.

were in the worst 50% of sites nationally, and seven sites fell within each of the best 50% and best 25% of like-sites nationally. At nine sites, Otautau Stream, Opouriki Stream, Bog Burn, Winton Stream, Tussock Creek, Otepuni Stream, Waikawa Stream, Oteramika Stream and the Mataura River, the five-year median *E. coli* concentration was so elevated as to be of significant concern for recreational safety.

27. Dissolved phosphorus is the bioavailable form of the nutrient that can contribute to nuisance growths of algae and weeds in water. Phosphorus (measured as DRP) was elevated at some sites, predominantly in the Aparima and Mataura FMUs (overall twelve sites in the worst 25%, eleven sites in the worst 50%, thirteen sites in the best 50% and twenty in the best 25% of like-sites nationally). Sites of particular concern for DRP included: Otautau Stream, Waimatuku Stream, Bog Burn, Winton Stream, Tussock Creek, Carran Creek, Longridge Stream, Sandstone Stream, Waimea Stream, Waikaka Stream and Oteramika Stream.

28. Water clarity and turbidity were also often poor in the Aparima, Ōreti and Mataura FMUs. Twenty-six sites in Southland were in the worst 25% of like sites for clarity and fifteen sites for turbidity, with only five sites outside of the Waiau FMU being in the best 25% of like-sites for clarity or turbidity. Numerous sites were of concern for water clarity and less than the 1.6 m guideline for safe contact recreation (MfE 1994). Low water clarity also makes it difficult for fish to find prey, and for tangata whenua to collect mahinga kai, thus having an adverse effect on both ecological and cultural values.

29. Extremely elevated concentrations of nitrate-nitrogen can be directly toxic to aquatic life and at lower concentrations nitrogen degrades ecosystem health. Nitrogen (TON[8]) concentrations were consistently poor when compared with the national state and at some sites the five-year median concentrations were elevated to a concerning degree, likely to contribute to nuisance growth of periphyton (algae) and aquatic weeds (macrophytes). Nitrate was substantially elevated above concentrations likely to have adverse effects on ecosystem health and in the worst 25% of like sites at twenty-two sites, in the worst 50% at twenty sites, with eight and six sites in the best 50% and best 25% of like sites respectively.

[8] TON is total oxidised nitrogen, comprised of nitrate-nitrogen and nitrite-nitrogen and is the dissolved fraction of nitrogen that is available to plants and algae for instream growth. Ammoniacal nitrogen is also bio-available to plants and algae.

30. Elevated DRP, nitrogen, *E. coli* and low water clarity were common concerns across a particular suite of sites. Seen together these contaminant profiles usually indicate direct stock access to waterways and/or a high degree of overland flow in areas with limited riparian buffers and rapid contaminant transfer via drainage or run-off from agricultural land. Dairying land use and stock wintering on forage crops are usually implicated in this type of water quality profile in my experience of monitoring and assessing water quality in the context of surrounding land use.

31. Ammonia contributes to nuisance algae and plant growth and at elevated concentrations can be toxic to aquatic life. When compared nationally, ammoniacal nitrogen (ammonia) was either very good, as in the Waiau FMU, or poor as in the Aparima, Ōreti and Mataura FMUs. Across Southland thirty-three sites were in the best 25% of like sites nationally. The remaining sites were either in the worst 50% (7 sites) or worst 25% (16 sites) of like-sites. Ammonia concentrations were of particular concern in Winton Stream, Makarewa Stream, Otepuni Creek, Carran Creek, Waikaka at Gore and the Mataura River 200m downstream of the bridge.

32. Degrading, ten-year water quality trends were common for Southland sites in the LAWA dataset, most often associated with *E. coli* and nitrogen, with some degrading trends in ammoniacal nitrogen, phosphorus, clarity and turbidity also apparent.

33. Macroinvertebrate health classes indicated good water quality (MCI of 100-119) at seventeen sites and excellent (MCI 120 or greater) water quality at seven sites. However degrading trends in MCI were found at nine Southland water quality monitoring sites, regardless of the current state of MCI. That is, there is a trend of decline even at some sites where current state is good or excellent. Eleven sites fall into the fair category (MCI 80-99) and six sites were poor (less than 80)[9].

34. Sites with an MCI of less than 80 or showing degrading trends are of particular concern and indicate significantly compromised ecosystem health in these waterbodies. This concern is reflected in the 2017 amendments to the NPS-FM in Policy CB3, which requires regional councils to "*establish methods to respond to a MCI score below 80, or a declining trend; and ensure that methods:*

[9] MCI was assessed only at sites with physico chemical water quality data, sites monitored only for MCI were not included in this analysis.

I. *investigate the causes of declining trends or the Macroinvertebrate Community Index score below 80;*

II. *seek to halt declining trends; and*

III. *seek to improve on a Macroinvertebrate Community Index score if it is below 80, unless this is caused by naturally occurring processes, pest or unwanted organism, or by infrastructure listed in Appendix 3* [of the NPS-FM]".

Council Evidence – Water Quality

35. The evidence of Council experts Mr Rodway, Mr Ward and Mr Hodson provides a thorough assessment of the state and trends in water quality and some aspects of ecosystem health across groundwater, lake, lagoon, estuary, and river ecosystems. This combined evidence provides a stark picture of the current state and trends of Southland's water resources. I do not intend to repeat that evidence here; instead I have drawn together and summarised the evidence across all aquatic ecosystem types at the regional level, drawing the Court's attention to specific issues pertinent to the management of freshwater resources via the SWLP.

36. There are three identified pathways by which contaminants from land reach surface water ecosystems in Southland: 1) via groundwater that feeds surface water, 2) by overland/surface flow (run-off)[10], or 3) by artificial drainage (constructed mole and tile drains) direct to surface water or shallow sub-surface flows and thence surface water. Southland's surface waters have a high degree of connectivity to groundwater and transport of contaminants from ground to surface water ecosystems is relatively rapid[11]. Overland flow and artificial drainage also contribute significantly to surface water contamination where high-risk land practices occur. Thus, land use has a rapid and pervasive effect on surface water quality and ecosystem health across much of Southland outside of Public Conservation Land.

37. The Council's monitoring data shows that a large number of aquatic ecosystems are significantly degraded by contaminants from land use, which I have summarised within each freshwater management unit (FMU) (Table 1). Waituna Lagoon has

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[10] For example, extremely elevated sediment in run-off from winter grazing, as identified in evidence by Ewan Rodway at his paragraph 106.

[11] Evidence of Ewan Rodway, paragraph 21 "*Southland has a mosaic of unconfined, shallow groundwater aquifers that exchange groundwater to surface water relatively quickly. Approximately 40-60% of all of the water in Southland streams is groundwater from these aquifers*."

been addressed separately from the Mataura FMU due to its international and national ecological significance. The requirement for targeted management of the Waituna Lagoon catchment is addressed later in this evidence.

Table 1: Summary of significantly degraded aquatic ecosystems in Southland based on SOE monitoring data and evidence presented by Council experts.[12]

FMU	Affected ecosystems	Summary of effects
Waiau	Lower river	Nuisance periphyton Benthic cyanobacteria
	Lil Burn	Nuisance periphyton
	Waiau Lagoon	Sediment and nutrient capacity exceeded At risk when closed to the sea
	Groundwater	Exceeds 1 mg/L NNN risk to surface water Some sites exceed NNN for human drinking water
Aparima	Lower river	Nuisance periphyton Benthic cyanobacteria
	Otautau Stream	Nuisance periphyton
	Lake George	Elevated nutrients
	Jacobs River Estuary	Sediment and nutrient capacity exceeded Expanding areas of gross eutrophication Nuisance macroalgae proliferation Sedimentation
	Groundwater	Exceeds 1 mg/L NNN risk to surface water Increasing N trend Some sites exceed NNN for human drinking water
Ōreti	Winton Stream	Nuisance periphyton Benthic cyanobacteria
	Makarewa Stream	Nuisance periphyton
	Dipton Stream	Nuisance periphyton
	New River Estuary	Sediment and nutrient capacity exceeded Expanding areas of gross eutrophication

[12] Evidence in chief of Ewan Rodway, Roger Hodson and Nicholas Ward.

FMU	Affected ecosystems	Summary of effects
		Nuisance macroalgae proliferation Sedimentation
	Groundwater	Exceeds 1 mg/L NNN risk to surface water Increasing N trend
Mataura	Lower river	Nuisance periphyton Benthic cyanobacteria
	Waimea River	Nuisance periphyton
	Waikaka River	Nuisance periphyton
	Longridge Stream	Nuisance periphyton
	Waikaia River	Benthic cyanobacteria
	Lake Vincent	Elevated nutrients Exceeds TN bottom line
	The Reservoir	Elevated nutrients
	ToeToes (Fortrose) Harbour	Sediment and nutrient capacity exceeded Eutrophication
	Groundwater	Exceeds 1 mg/L NNN risk to surface water Increasing N trend Some sites exceed NNN for human drinking water
Waituna sub-zone	Waituna Creek	Nuisance periphyton Elevated nutrients, *E. coli* and sediment
	Waituna Lagoon	Poor water quality TN exceeds bottom lines and chlorophyll *a* increases when closed Eutrophication Cyanobacteria/algal blooms

38. The ecosystem health of Southland's estuaries is of particular concern. Sediment and nutrients are particular issues affecting the ecosystem health of estuaries, and faecal microbes adversely affect recreational and cultural use. Estuaries and coastal lagoons are the ultimate receiving environment for all contaminants discharged to freshwater. Jacobs River and New River Estuaries are showing clear signs of significant degradation. Areas of muddy sedimentation, nuisance algal proliferation and 'dead zones' have been expanding over recent years. These

effects are directly attributable to the discharge from rivers to estuaries of high loads of diffuse contaminants sourced from agricultural land.

39. Poor water quality affects multiple aquatic ecosystems in Southland, negatively impacting on a range of values including ecosystem health, human health for recreation, safe human drinking water, and cultural use values. The locations where poor and declining water quality occurs are known, as are the sources of contamination. The contribution of land use and land use practices to contamination sources is clearly stated throughout the evidence presented by Council's experts.

Indigenous Fish Communities and their Conservation Threat Status

40. Managing freshwater to provide for ecosystem health - a compulsory national value under the NPS-FM - requires a good understanding of the components of ecosystem health, including the indigenous freshwater fauna of the Southland Region and the conservation threat status of those species. Council evidence is focussed at the ecosystem level and the water quality effects on those ecosystem types from various activities. There is little evidence provided on the indigenous fauna inhabiting Southland's aquatic ecosystems. Freshwater fish are a critical component of ecosystem health and are associated with a number of other values, including cultural values such as mahinga kai.

41. This section highlights some of the characteristics of freshwater ecosystems in Southland using national databases and models. There are a number of sub-catchments, across multiple freshwater ecosystem types, that are national priorities for protection and rank highly for indigenous fish at the national level.

42. The New Zealand Freshwater Fish Database, administered by NIWA, holds 7,448 fish survey records for the Southland Region from 1901 to 2018. Records for Southland from July 1998 to July 2018 were examined (4,513 records) to determine contemporary species presence. The species found and their conservation threat status are listed in Table 2. Southland has a very diverse indigenous fish fauna; with twenty-two species of indigenous fish and three large invertebrates found over the last twenty years. Five exotic species were also recorded in the database.

Table 2: Freshwater fish and large invertebrate taxa found in New Zealand Freshwater Fish Database records for Southland between 1998 and 2018. Conservation threat status (Dunn et al. 2018; Grainger et al. 2014) and migration strategy are noted.

Common name	Taxonomic name	Threat status	Migrate?
	Indigenous fish		
Alpine galaxias (Southland)	*Galaxias aff. paucispondylus "Southland"*	Threatened, nationally vulnerable	N
Banded kōkopu	*Galaxias fasciatus*	Not threatened	Y
Black flounder	*Rhombosolea retiaria*	Not threatened	Y
Bluegill bully	*Gobiomorphus hubbsi*	At risk, declining	Y
Common bully	*Gobiomorphus cotidianus*	Not threatened	Y
Common smelt	*Retropinna retropinna*	Not threatened	Y
Estuarine triplefin	*Grahamina sp.*	Not threatened	Marine
Southern flathead galaxias	*Galaxias "southern"*	Threatened, nationally vulnerable	N
Clutha flathead galaxias[13]	*Galaxias "species D"*	Threatened, nationally critical	N
Giant bully	*Gobiomorphus gobioides*	At risk, naturally uncommon	Y
Giant kōkopu	*Galaxias argenteus*	At risk, declining	Y
Gollum galaxias	*Galaxias gollumoides*	Threatened, nationally vulnerable	N
Īnanga	*Galaxias maculatus*	At risk, declining	Y
Kōaro	*Glaxias brevipinnis*	At risk, declining	Y
Lamprey	*Geotria australis*	Threatened, nationally vulnerable	Y
Longfin eel	*Anguilla dieffenbachii*	At risk, declining	Y
Redfin bully	*Gobiomorphus huttoni*	Not threatened	Y
Shortfin eel	*Anguilla australis*	Not threatened	Y
Shortjaw kōkopu	*Galaxias postvectis*	Threatened, nationally vulnerable	Y
Torrentfish	*Cheimarrichthys fosteri*	At risk, declining	Y

[13] These species are only found in the Clutha River catchment, however, the headwaters of some Clutha River tributaries are located within the Southland Regional Council boundary so they are included as a component of the Southland fish fauna.

Common name	Taxonomic name	Threat status	Migrate?
Upland bully	*Gobiomorphus breviceps*	Not threatened	N
Yelloweye Mullet	*Aldrichetta forsteri*	Not threatened	Marine
Indigenous invertebrates			
Freshwater shrimp	*Paratya curvirostris*	Not threatened	
Kākahi	*Echyridella menziesi*	At risk, declining	
Kōura southern	*Paranephrops zealandicus*	At risk, declining	
Exotic fish			
Atlantic salmon	*Salmo salar*	Introduced and naturalised	
Brown trout	*Salmo trutta*	Introduced and naturalised	
Goldfish	*Carassius auratus*	Introduced and naturalised	
Perch	*Perca fluviatilis*	Introduced and naturalised	
Rainbow trout	*Oncorhynchus mykiss*	Introduced and naturalised	

43. Of the twenty-two indigenous fish recorded, seven species have a conservation threat status of 'at risk' (six species are classified as declining and one is naturally uncommon), five are threatened, nationally vulnerable (alpine galaxias, Gollum galaxias, southern flathead galaxias, shortjaw kōkopu and lamprey) and one species is threatened, nationally critical (Clutha flathead galaxias), the highest class of threat ranking (Figure 1). Non-migratory galaxid fishes are an important and unique characteristic of the Southland fish fauna and contribute significantly to regional, national and global freshwater biodiversity.

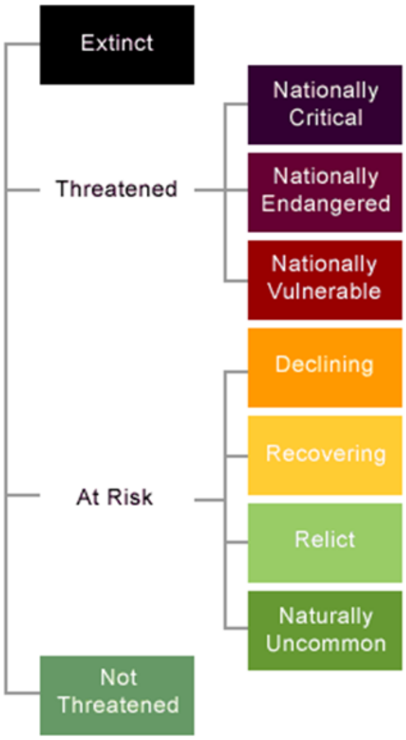

Figure 1: New Zealand Threat Classification System categories. Source: Townsend et al. (2008).

44. The New Zealand Threat Classification System uses nationally understood, consistent categories and criteria to assess the risk of extinction for all New Zealand species (Figure 1). Nationally, 74% of species in the indigenous freshwater fish fauna have an assigned threat status, this is double the global average of 37% (Joy et al. 2018). The proportion of species classified as threatened or at risk of extinction has been increasing over time in New Zealand, and negative trends in species occurrence were found in ~75% of freshwater fish species, 65% of these were significant population declines. More species were declining at survey sites within pasture than in sites within natural cover, indicating that declines are primarily associated with agricultural land use and human activities (Joy 2009; Joy et al. 2018).

45. A recent international assessment of our freshwater flora and fauna concluded that New Zealand has "*one of the most endangered freshwater habitats in the world*"[14]. The increase in the number of species listed as threatened with, or at risk of extinction over the past 25 years gives some indication of the recent decline in fish

[14] Freshwater Fish Specialist Group (2012). '2012 Annual Report.' (IUCN: Chester, UK.).

occurrence and diversity nationally. Declines are now indicated in species that were once common, like longfin eel and īnanga. Allibone et al. (2010) warned that in New Zealand:

"*More serious effort is now required to reverse the decline in native freshwater fishes and to manage the instrumental causes of their decline that are ongoing, and in some cases increasing, if the extinction of further freshwater fish is to be prevented.*"

46. Southland, Otago and Canterbury provide some of the last remaining habitats of relict populations of non-migratory galaxid fish found nowhere else in the world. Over millennia, these populations of galaxiids were isolated from other populations in New Zealand by geological events such as earthquakes and glacial movement. They evolved into distinct species, with many of the non-migratory galaxiid species having a highly fragmented population. A number of local extinctions being confirmed in recent years, predominately in Otago and Canterbury. This is largely a result of the detrimental impacts of invasive species and habitat loss. The Department of Conservation (2018)[15] identifies additional threats to the persistence of non-migratory galaxiids to include:

- macrophyte and weed invasion
- reduction in or altering of water quantity/flows
- habitat destruction and/or alteration
- reduction in water quality.

47. The leading causes of decline in indigenous fish in Aotearoa New Zealand have been identified as degrading water quality, nutrient enrichment, water abstraction, invasive/exotic fish species, loss of habitat via land use, barriers to migration, loss of riparian vegetation and river modification (Allibone et al. 2010; Joy et al. 2018; Canning 2018). Globally, the drivers of decline in fish diversity and abundance are human-induced and include eutrophication (nutrient enrichment), habitat loss and population isolation through damming of rivers, flow alteration, habitat destruction, exotic species invasion, over-harvesting and climate change (Joy et al. 2018). The New Zealand fish fauna is under threat from these same global drivers.

48. Torrentfish, present in the Waiau, Aparima and Ōreti catchments, are the only member of their genus (*Cheimarrichthys*) world-wide and the only member of the

[15] https://www.doc.govt.nz/nature/native-animals/freshwater-fish/non-migratory-galaxiids/

family Pinguipedidae to inhabit freshwater globally. Thus, they have unique, intrinsic biodiversity value. There is mounting evidence in the freshwater fish database that torrentfish are declining in some large river systems, such as the Manawatū River (*Dr R. Allibone; pers. comm.*).

49. Given the national state of indigenous fish compared to global trends – declining fish diversity and increasing threat status – all remaining habitats with high species diversity, intact indigenous fish communities, or habitats for threatened and at risk taxa are of significant biodiversity value for Aotearoa New Zealand. The Southland fish fauna is diverse (species rich) and contains a number of populations of threatened species, some of which are on the brink of extinction. Protection and restoration of water quality, habitat and flows will be critical to conserving the diversity of indigenous fish in Southland and maintaining the contribution the Southland fauna makes to national and global biodiversity values.

Freshwater Ecosystems and National Priorities for Protection

50. The Department of Conservation (DOC) has recently developed a method to nationally identify priority freshwater catchments for protection and restoration across all freshwater ecosystems (rivers, lakes and wetlands) in Aotearoa New Zealand using spatial conservation prioritisation software (West et al. 2018). This research emphasises representation of the full range of ecosystems and species, while also taking account of catchment connectivity, to align with the DOC goal of restoring freshwater ecosystems at a whole-of-catchment scale.

51. Designing a prioritisation approach at a whole-of-catchment scale ('mountains to the sea') while also achieving representation of a full range of ecosystems and species is particularly challenging, largely because of complications of scale. Third order sub-catchments were found to be the most suitable scale for prioritisation, capturing the most important components within the largest river catchments (West et al. 2018).

52. Important populations of indigenous fish (migratory and non-migratory), connectivity, catchment resource pressure, habitat barriers, invasive pest occurence and the locations of major terrestrial conservation projects were considered and weighted within the catchment prioritisation method to deliver maximum benefits for protection and/or restoration.

53. Figure 2 shows the priority for protection ranks for the Southland Region. The dark blue shaded sub-catchments represent the highest priorities for protection of sub-catchments not currently within land protected for the purposes of conservation (shaded green). The sub-catchments are ranked to provide representation of a full range of river, lake and wetland ecosystems, non-migratory freshwater fish, important habitats for the maintenance of migratory indigenous fish, and intensively managed DOC Ecosystem Management Units (EMUs). The prioritisation is in essence a holistic ranking across a range of biodiversity conservation priorities. Analysis of specific priority areas for indigenous fish are included in the following section.

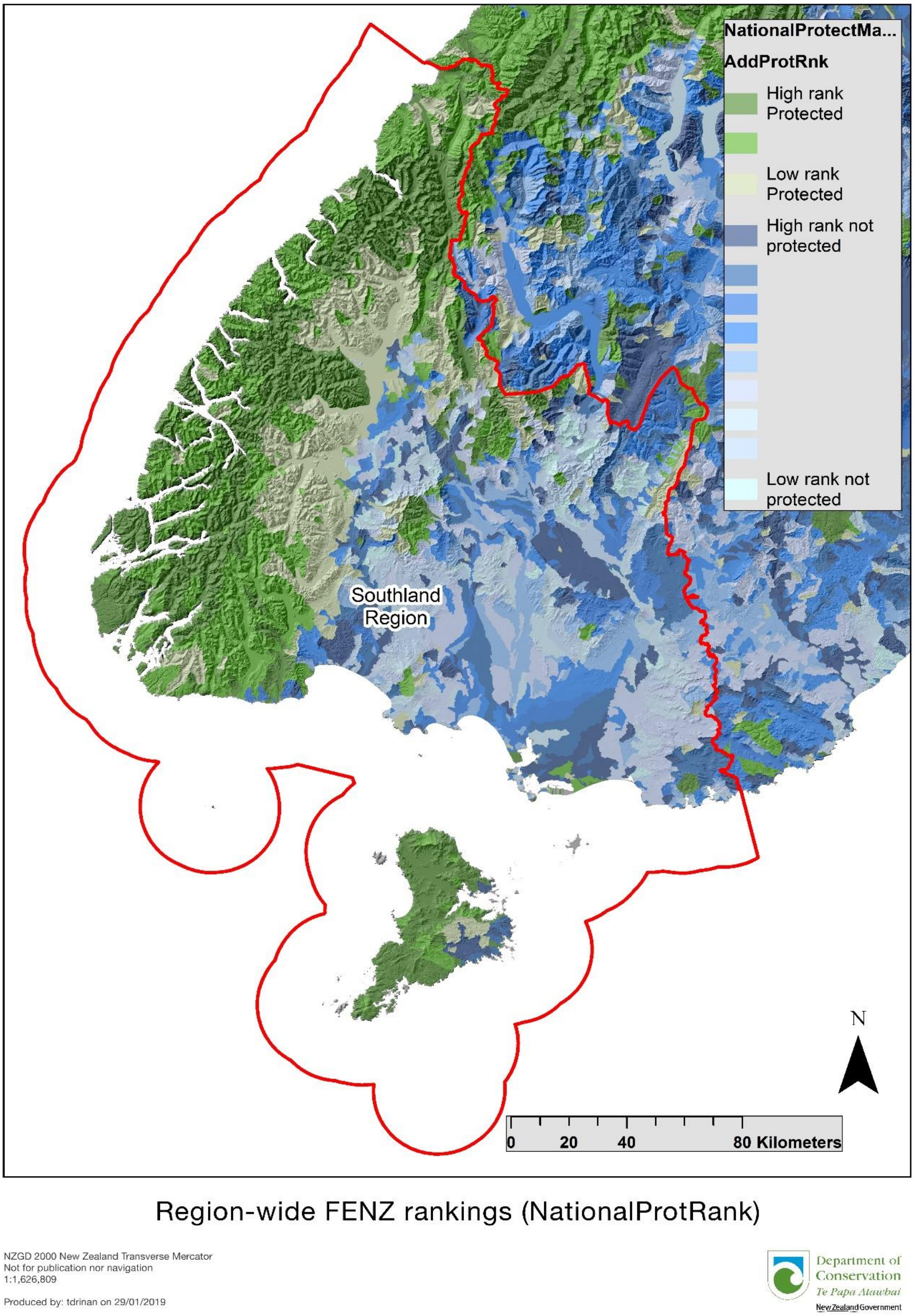

Figure 2: National priority for protection ranking of freshwater ecosystems in Southland. Data provided by the Department of Conservation following West et al. (2018).

54. The prioritisation model reflects the best available method to determine which areas within whole catchments (mountains to the sea) or FMUs should be protected and/or restored to ensure ecological values and ecosystem health are safeguarded. It is also the best available indication of where water quality objectives limits and targets may need to be more stringent for the preservation of ecosystem health and indigenous biodiversity at the sub-catchment level and can usefully inform FMU processes.

55. The national priority for protection rankings for Southland by major river catchment are provided in Appendix 2.

56. The FENZ geodatabase (Freshwater Ecosystems of New Zealand; Leathwick et al. (2012)) was used to identify priority catchments for freshwater species. The FENZ database consists of a large set of spatial data layers and supporting information on rivers, lakes and wetlands in Aotearoa New Zealand. It contains data gathered from a wide variety of sources and can be used to objectively map and quantify various aspects of New Zealand's freshwater ecosystems, providing:

    i. "*Comprehensive descriptions of the physical environment and biological character.*"
    ii. *Classifications that group together rivers and streams, lakes and wetlands having similar ecological character.*
    iii. *Estimates of human pressures and impacts on biodiversity status.*
    iv. *Rankings of biodiversity value that indicate a minimum set of sites that would provide representative protection of a full range of freshwater ecosystems while taking account of both human pressures and connectivity*" (DOC 2010).

57. Figure 3 shows the indigenous fish ranking from the FENZ geodatabase for sub-catchments in the Southland Region. Dark blue shading shows sub-catchments with the highest indigenous fish values. Appendix 3 includes maps for FENZ indigenous fish rankings by major river catchment within the Southland Region. To provide adequately for ecosystem health in Southland, the sub-catchments with the highest indigenous fish rankings should be prioritised for more protection (habitat, water quality and water quantity) through regional planning instruments and processes.

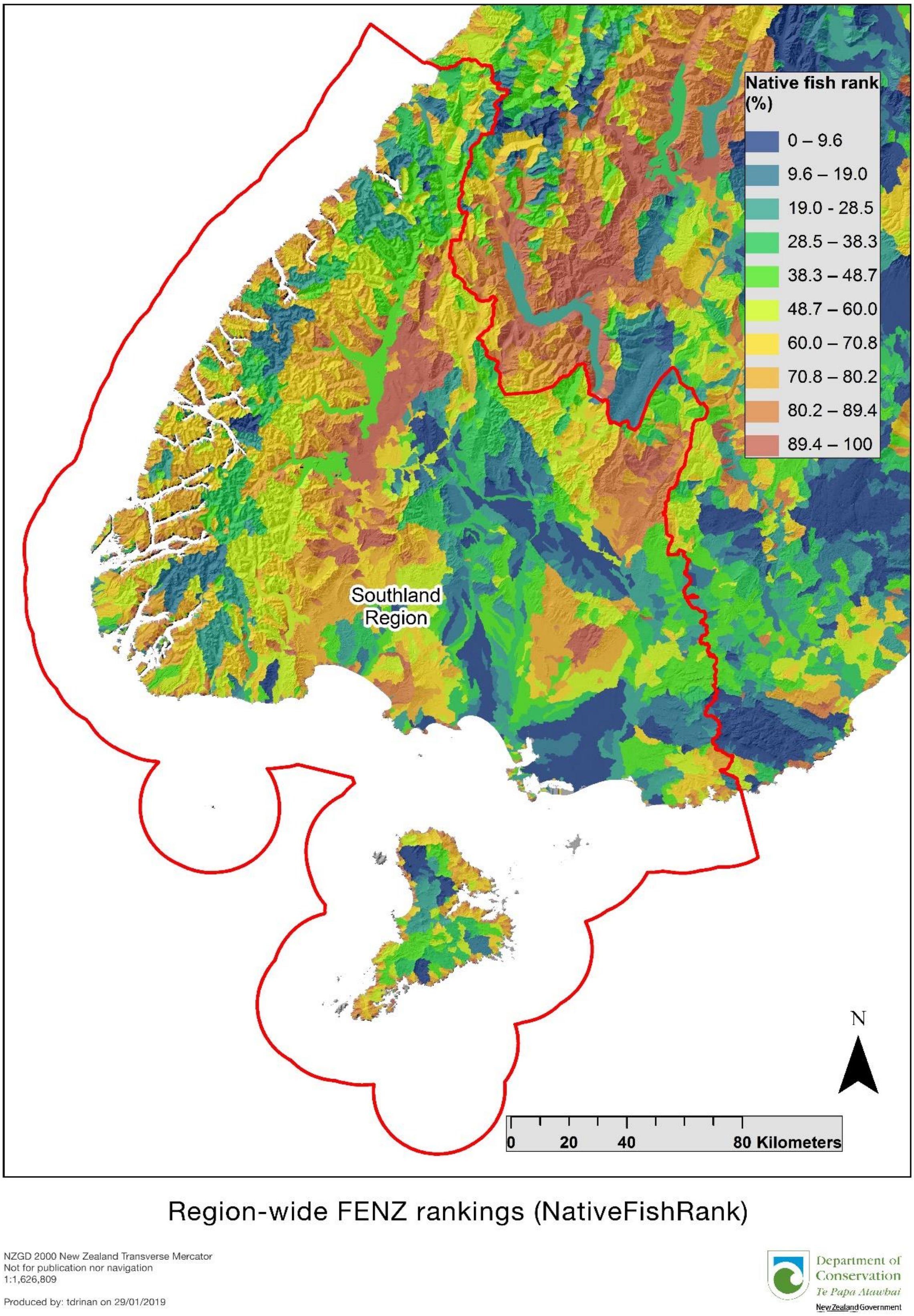

Figure 3: Southland Region indigenous fish FENZ rankings for third-order sub-catchments. Data provided by the Department of Conservation from the FENZ geodatabase following Leathwick et al. (2012).

Plan Provisions - Water

58. In the following sections I provide my opinion on the content of the Topic A provisions, where these are within my expertise as a freshwater policy and technical expert.

'Overall' water quality – SWLP Objective 6

59. 'Overall' is a meaningless term with respect to water quality. Water quality is made up of a range of physio-chemical and biological properties, indicated by various attributes such as nitrogen, phosphorus, *E. coli*, clarity or macroinvertebrate community index, that vary from site to site and river to river. The degree to which particular attributes contribute to the 'state of water quality' at a site depends on the complexity of natural factors and human impacts at a particular site. I agree with the concerns expressed by the Environment Court in the concept of 'overall' water quality;[16] "*i.e.,: who would set the average (or median) and what kinds of contaminant in one water body could be offset against others, in a different water body (what sort of beneficial effect would counterbalance an adverse effect when those effects are in different water bodies perhaps scores of kilometres apart?)*".

60. These concerns were reflected in the 2017 amendments to NPS-FM Objective A2 which shifted the focus of maintaining or improving water quality from the regional to the FMU scale (although the problems with the term 'overall' remain, just at a smaller spatial scale).

61. In my opinion, the addition of 'overall' to Objective 6 is not useful and changes the direction of water quality action at the regional level. The Objective should be retained in the proposed form, without reference to 'overall'. The state of water quality at many sites in Southland is so consistently poor across a range of attributes that improvement in water quality should occur at all sites currently showing degradation and there should be no further decline allowed by the SWLP. The more stringent direction in the proposed plan of "*no reduction in the quality of freshwater*" is warranted and should be reinstated.

62. Additionally, trends in water quality show significant ongoing degradation with respect to nitrogen, *E. coli,* clarity and MCI at a number of sites across the region outside of Public Conservation Land. These trends clearly show the goal of

[16] *Ngāti Kahungunu v Hawkes Bay Regional Council* [2015] NZEnvC 50 At [62].

Objective 3.1(5) of the operative Regional Water Plan (2010) to improve water quality by 10% for selected states (parameters) across the life of the Plan is not being achieved, in fact the opposite has occurred. This reinforces the need for more stringent wording of Objective 6.

Maintenance, improvement and over-allocation – SWLP Objective 7

63. The SWLP broadly focusses on arresting future land intensification to manage further effects on water quality, as such it can be seen (at least at the objective level) as a 'hold the line' approach. Such an approach is consistent with a goal of 'maintaining' water quality and preventing further deterioration, however it does not fundamentally address the considerable need for improvement in Southland's water quality. This is worded in Objective 7 as "*further over-allocation is avoided and any existing over-allocation is phased out in accordance with… Freshwater Management Unit processes*."

64. The NPS-FM Objective A2(c) requires improvement where water quality is degraded by human activities to the point of being over-allocated. However, the approach in the SWLP is to defer any improvement until an FMU process is completed, at the earliest by 2025. The outcome of FMU processes is currently unknown.

65. Freshwater in Southland is a clear case of degraded water quality as a result of agricultural land use and is 'over-allocated' with respect to the pervasive level of water quality degradation, highly elevated contaminant concentrations, degrading trends in water quality, and the adverse effects this is having on freshwater values such as ecosystem health, human health for recreation, human drinking water, and according to evidence from Ngāi Tahu, cultural values including mahinga kai[17].

66. While the definition of over-allocation in the NPS-FM is by reference to a limit or freshwater objective (set through yet to come FMU processes), in my opinion, for most freshwater bodies in Southland it is inappropriate that limits and freshwater objectives will be set at a point that allows further water quality degradation to occur. If this were to happen, such objectives and limits would not give effect to NPS-FM objective A1 to safeguard the life-supporting capacity of ecosystems and

[17] Evidence of Dr Kitson and cultural experts for Ngāi Tahu.

the health of people and communities, both of which are compulsory national values. To meet this objective significant improvement in water quality is needed.

67. While specific freshwater objectives and limits for Southland are yet to be set through the FMU process, in my opinion it is very clear now that Southland's freshwater bodies are over-allocated. Over-allocation generally refers to situations where resources are allocated at excessive levels. This is certainly the case in Southland (Table 1 and Appendix 1). Given the large number of degrading water quality trends within the Region, addressing over-allocation at the regional scale should not be delayed. Waiting until 2025 before setting an 'improvement' course would be devastating, particularly for the region's unique and threatened freshwater ecology. Water quality in Southland in many places (excluding those that fall within Public Conservation Land) meets the NPS-FM Objective A2 criteria that triggers the requirement for improvement. This is particularly so for the Aparima, Ōreti, Mataura and Waituna FMUs, and improving water quality at these places should not be further delayed via a process which is at best in initial stages.

68. Comparing the state of water quality attributes against guidelines, standards or NOF bottom lines for water quality is also useful to demonstrate areas of over-allocation. The evidence of Ewan Rodway, Roger Hodson and Nicholas Ward identify a number of instances where standards or bottom-lines for water quality are being exceeded at many sites across multiple ecosystem types within the four FMUs affected by land use impacts. This is consistent with the evidence of Professor Death who also illustrates exceedances when comparing the current state of water quality in Southland with proposed numeric water quality limits. Comparison of water quality attributes in Southland with other like-sites nationally, shows water quality is significantly poorer at a large number of sites, compared to the national 'state' for similar land uses. This exemplifies the need for improvement in many Southland rivers, (Appendix 1).

69. Fish and Game seeks to amend Objective 7 so that phasing out over-allocation happens through resource consent processes (prior to FMU processes occurring). I support that amendment. There is sufficient existing information about the state of Southland's waterbodies to enable over-allocation to be addressed in part through a less permissive activity status for intensive land uses and via resource consent decisions. For example, declining intensification consents, or setting short consent durations with stringent mitigation conditions. The detailed physiographic

zones and variants complement such an approach, identifying areas and land use practices of significant risk.

Objectives 9, 9A and 9B of the SWLP

70. Objective 9 relates to the management of the quantity of surface water to safeguard aquatic ecosystem health, life-supporting capacity, outstanding natural features and landscapes, and natural character. Proposed references to recreational and historic heritage values were removed from the decision version of the Plan, along with reference to the margins of waterbodies. Removal of references to recreational and historic heritage values fails to acknowledge that people's recreational and cultural wellbeing associated with water is dependent on the physical connection with that water. Therefore, the management of the quantity of surface water is paramount for maintaining the provision of benefits and associated values people get from water. Recreational, historic and traditional uses of rivers often rely on adequate availability of water and suitable flow regimes.

71. Without safeguarding the management of surface water quantity to provide for these values they may be lost or degraded. I agree with Mr McCallum-Clark[18] that the 2017 amendments to the NPS-FM Objective A3 encourages the inclusion of recreational values at the national level. These amendments to the NPS-FM, alongside the setting of national targets to improve 'swimmability' were developed in response to significant public concern over degradation of safe recreational water quality. National direction to improve 'swimmability' more of the time must be translated into Regional Plans for effective implementation.

72. The reference to waterbody margins should also be reinstated within Objective 9 as waterbodies and their margins function ecologically as one system. When the functionality of margins is compromised, values such as ecosystem health are eroded or lost. This is equally applicable for human use values such as recreation and mahinga kai, which require the land-water interface at the margins of waterbodies to be functional and safeguarded to ensure the quality of water and aquatic habitats is maintained to the level required to provide for those values.

[18] Evidence of Matthew McCallum-Clark paragraph 82.

73. An example of the importance of considering waterbody margins in management of water quantity for a range of freshwater values is the spawning habitat of the threatened shortjaw kōkopu (*Galaxias fasciatus*) and the other migratory Galaxid fishes[19] which spawn in riparian margins. Shortjaw kōkopu spawn in riparian margins of streams, among leaf-litter, vegetation and gravels during autumnal freshes, when river levels are elevated and inundate the margins. Eggs develop in humid conditions within riparian vegetation and larvae are washed downstream and into the coastal environment on subsequent fresh events, returning to freshwater as whitebait.

74. Reliance on the quality of the vegetation in the margin of the waterbody and a relatively natural flow regime resulting in inundation at critical times, supports not only successful reproduction of this threatened species and other fish, but also supports a range of freshwater values associated with ecosystem health, Te mana o te Wai, cultural and recreational values (e.g., mahinga kai and whitebaiting). Accordingly, I do not agree with Mr McCallum-Clark[20] that the effects of water quantity/abstraction on the margins of waterbodies is "secondary". Mr McCallum-Clark goes on to suggest margins are adequately covered by Objective 17 of the SWLP. However, Objective 17 relates only to natural character and does not specifically provide for critical ecological functions such as riparian spawning.

75. Objective A1 of the NPS-FM clearly prioritises safeguarding ecological health and the health of people and communities. SWLP Objectives 9A and 9B have the potential to conflict with the achievement of the safeguarding requirement of NPS-FM Objective A1. Within the decision version of the SWLP, Objectives 9A and 9B give an inappropriate and similar level of emphasis to out of stream uses as the safeguarding provisions of Objective 9.

76. With respect to Objective 9B, if the objective is to halt further degradation and improve the health of degraded freshwater bodies, then provisions for significant infrastructure should be dealt with in the same way as activities subject to 9A. Safeguarding ecosystem and human health (and other) values can operate as an environmental bottom line with respect to adverse effects from significant infrastructure.

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[19] Giant kōkopu, banded kōkopu, kōaro and īnanga also spawn in riparian margins.
[20] At his paragraph 85.

SWLP Objectives 13, 13A and 13B

77. I agree with Mr McCallum-Clark[21] that the intent of Objective 13 is lost through the splitting of the objectives in the decision version of the Plan, particularly with respect to the requirements of Objective A1(b) of the NPS-FM to safeguard the health of people and communities and Policy A4 in relation to ecosystem and human health. The prioritising intent of Objective 13 (analogous to that in proposed Objective 9) should be retained in the wording of these objectives.

78. There are a number of instances in Southland where the use of land and discharges to land and water (individually and cumulatively) are adversely affecting human and ecosystem health. The term "significant" in the objective is not useful with respect to the effects on freshwater values. Effects on human health and recreation mean water is either safe for immersion or drinking relative to the appropriate standards, or it is not. There is no environmental standard which delineates a 'significant' adverse effect on these values. The term significant should be deleted.

SWLP Objective 14

79. I do not address whether this objective should refer to dryland environments, as this is not within my expertise.

80. Forest & Bird's appeal seeks a reference to "species" in addition to "indigenous ecosystem types" in Objective 14. In my opinion the reference to species is needed for two key reasons. Firstly, it is consistent with the definition of ecosystem health in the NPS-FM which directly references indigenous species. Secondly, there are a number of indigenous freshwater species that are threatened with or at-risk of extinction (Table 2) that may not be adequately captured by 'ecosystem type'. Provision for these species in Objective 14 allows for the specific needs of threatened species to be considered.

SWLP Objective 17

81. With respect to Objective 17, which refers to the natural character values of wetlands, rivers and lakes and their margins, there are biotic components of natural character[22] which require both protection and preservation, e.g.,

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[21] At his paragraph 153.

[22] Appendix 1 of the NPS-FM definition of natural form and character includes specific reference to ecological components and indigenous flora and fauna.

threatened indigenous fish and riparian spawning habitat. With respect to wetlands there is documented significant, rapid and continued loss of wetland habitats (and by inference their values) across Southland, particularly in the internationally important Awarua-Waituna wetland complex (Robertson et al. 2018). Robertson et al. (2018) state that previous attempts at protecting wetland habitats in Southland via policy and planning instruments have failed in the face of rapid wetland loss to agricultural land development. This evidence suggests that wetland systems require strong protection <u>and</u> preservation if their loss is to be halted in Southland.

Physiographic Zones and a Regional Approach to Water Quality now

82. Physiographic zones are a landscape scale classification of the Southland region based on land use risks to water quality (Snelder et al. 2016). There are nine zones and additional overlaid 'variants' of contaminant transport, dilution and attenuation of nitrogen, phosphorus, sediment and faecal microbes. Each zone represents areas of the landscape with common attributes that influence water quality, such as climate, topography, geology and soil type. A collation of scientific knowledge and research has enabled experts to identify the main water quality risks and mitigation objectives associated with each zone and variant. There are two types of variants:
    - Overland flow (o) – in areas that tend to have steeper slopes (also known as run-off)
    - Artificial drainage (a) – in areas that have artificial drainage

83. The physiographic zones with variants are:
    a. Bedrock/Hill Country – (o) and (a) variants;
    b. Gleyed – (o) variant;
    c. Lignite/Marine Terraces – (o) and (a) variants;
    d. Oxidising – (o) and (a) variants;
    e. Riverine – (o) variant.

84. In my view, there is clear evidence the physiographic zones and application of the variants is an excellent and parsimonious 'model' of water quality risk for Southland and that they are a useful tool to inform freshwater management at the FMU process, through effective Farm Environmental Management Plans or at the resource consent level. Research is underway that uses the physiographic zones to

model land use scenarios and water quality outcomes, which will usefully inform FMU processes.

85. However, with a large number of waterbodies already significantly degraded and at high risk of further degradation, some critical changes to land use and land management practices should be introduced now, not several years later whenever the FMU processes are completed. Furthermore, many of the water quality issues are common across FMUs, differing largely by the presence of variants and to a lesser degree by physiographic zone characteristics, rather than broad river catchment or FMU[23].

86. I note Dr Snelder's reservations with respect to the limitations of the model at the property scale and the transitional nature of the boundary areas between zones. However, in my opinion these uncertainties are manageable in policy and are no greater than the uncertainties inherent in many policy approaches around the country aimed at managing cumulative land use effects on water quality - the science will never be perfect.

87. For example, at physiographic zone boundaries an appropriately precautionary policy response could require mitigations to address all high-risk contaminant sources and pathways for all potential zone types at the boundary interface, particularly for properties where variants which elevate risks of rapid contaminant transport to surface water are present. Using this approach, the 'benefit of the doubt' (or uncertainty) is given to the environment, an appropriate response where water quality degradation is severe and worsening, as it is in Southland. Properties could be assumed to be 'in' the zone requiring the most stringent management unless it can be proven that the property is not subject to the zone characteristics or variants and is 'out'.

88. Uncertainty around boundaries and scale should not prevent the use of this tool in resource management, particularly when that uncertainty is weighed against the significant known risks associated with doing nothing about the effects of further intensification of land use and the resulting degradation of water quality in Southland.

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[23] Although catchments require consideration for the management of estuarine and lagoon water quality degradation.

89. This approach does not however deal with existing 'over-allocation' or lead to the maintenance or improvement of water quality that is needed to safeguard ecosystem health and other freshwater values.

Physiographic Zone Policies and Water Quality

90. The physiographic zones are a useful tool to assist in mitigating future water quality risks associated with land use and land development practices. In my opinion, the uncertainties with respect to the zone boundaries and use of the zones at the property scale can be overcome and the physiographic zones and the associated policy framework should be retained in the SWLP, with some improvements, to guide future FMU processes, inform resource consents for land use (should these be required) and assist in the development of evidence-based and effective FEMPs to manage water quality risk. For example, consideration should be given in the SWLP to prohibiting further intensification in the Peat Wetlands zones, given the rapid and recent loss of wetland habitat to agricultural land use in Southland (Robertson et al. 2018), if these ecosystems are to be preserved over the long term. However, the current physiographic zone approach will not manage all key issues for water quality in Southland.

91. A two-tiered approach is needed in the SWLP to address the two fundamental water quality issues in Southland. Below I refer to these as issue 1: halting further degradation, and issue 2: improving existing degraded water quality.

Issue 1: Halting further degradation

92. Dairy farming and intensive winter grazing are currently causing known and disproportionately greater effects on water quality than other activities. The proposed SWLP provisions do not provide an effective framework to address this ongoing degradation. For waterbodies where there is clear evidence that these activities are already adversely affecting ecosystem health and life-supporting capacity (i.e., by comparing current water quality with numeric attribute states as discussed in the evidence of Professor Death) prohibiting activities that generate further effects is the most certain way of halting continued water quality degradation. Controls are needed for all land affected by overland flow (o) and artificial drainage (a) variants, and all land contributing to degrading water quality in estuaries and lagoons as a minimum. A Physiographic zone approach does not address the over-riding influence of the variants on water quality risk, nor does it

address the issue of estuaries and lagoons which show a degrading water quality trajectory. A broader approach is needed in the SWLP.

Issue 2: Improving existing degraded water quality

93. There is no specific approach in the SWLP to managing the adverse effects of existing dairying or intensive winter grazing. Even with a prohibited activity status for further intensification, discussed as issue 1 above, existing land use practices will continue to cause degraded water quality, and degradation of ecosystem health and other freshwater values in Southland. A policy framework is needed which explicitly requires maintenance of water quality where it is good and improvement of water quality where it is degraded via control of contributing land uses. The physiographic zone policies do not currently support such a framework.

94. For all areas with the (o) overland flow or (a) artificial drainage variants there is a significantly elevated likelihood of adverse effects on water quality across the region, regardless of the physiographic zone or catchment. Not only do degrading trends in water quality need to be managed through ceasing further intensification (issue 1), but the effects of existing land use need to be addressed at the regional level, particularly on land with (o) or (a) variants, and including all land contributing to degraded estuaries or lagoons (issue 2). For example, the Bedrock/Hill Country zone comprises the largest land area of all of the physiographic zones in Southland, although it is not identified for control of intensification through the current physiographic zone policies in the same way as more sensitive zones. This zone has the greatest area of land susceptible to overland flow, with some areas also affected by artificial drainage and contributes significantly to degraded water quality at many sites.

95. In order to deal with the current water quality problem a region-wide response is needed which addresses the effects from existing land use and does not permit activities to continue where water quality is poor without effective and evidence-based mitigations in place. If land uses and practices such as winter grazing and artificial drainage continue unchecked there will be no water quality improvement, freshwater values will continue to be degraded and the ecosystem health of the region's rivers, estuaries and lagoons will remain poor.

96. I would support an approach like that proposed under Policy 12A, allowing for the collection of more detailed information physiographic zones and contaminant

transport pathways, as this will assist with reducing uncertainty and will help apply the most appropriate mitigations through Farm Environmental Management Plans and future resource consenting processes (notwithstanding this, I maintain the view as stated at paragraph 86 that the current level of physiographic zone knowledge can be worked with in the interim).

Policy 46 - Waituna Lagoon FMU

97. The Waituna catchment forms part of the Awarua-Waituna wetland complex and has been recognised under the Ramsar Convention as a wetland of international importance since 1976. Awarua-Waituna Wetlands is one of the largest (3,556 ha) remaining wetland complexes in New Zealand and it is important for its biodiversity and cultural values. The Waituna catchment drains into the Waituna Lagoon, a brackish intermittently closed and open lagoon or lake (ICOLL). Waituna Lagoon is fed by Waituna, Moffat, and Carran Creeks.

98. Whakamana te Waituna is a multi-agency catchment co-management programme for Waituna Lagoon. There is dedicated funding, and an extensive body of scientific and socio-economic research specific to the lagoon and its catchment has been completed to date, including specific physiographic risk and mitigation assessments[24].

99. Southland Region has lost more than 90% of its original wetland habitat and is continuing to lose wetlands at an alarming rate over recent years (1% per year since 1990; Robertson et al. 2018). A large proportion of the wetlands lost or at risk are within the catchment of the Awarua Wetland, adjacent to and connected to the Waituna Lagoon (Robertson et al. 2018). The predominant cause of wetland loss is conversion to other land use, typically to pasture used for agriculture. Given the international and regional importance of Waituna as a coastal lagoon wetland and the region-wide threat to wetland habitat in Southland and particularly in the vacinity of Waituna, specific recognition of Waituna via bespoke policy development aimed at preserving and protecting the lagoon and its significant values is warranted in the Plan and should be included as soon as possible.

[24] http://www.waituna.org.nz/resources/catchment-management

100. Priority protection of aquatic ecosystems in the wider catchment of the Awarua-Waituna complex is needed to ensure the high indigenous fish values (ranked in the top 10% as shown in Figure 3) are sustained over the long term, particularly outside of the conservation protected areas.

101. The decision not to have Waituna Lagoon as a separate FMU is contrary to all of the current ecological and socio-economic investment in the lagoon catchment to date. There is a clearly defined community of interest who have been working together for some time to understand the issues and find solutions for Waituna. Waituna Lagoon is further advanced down the FMU process than other parts of the Southland Region. To include it within the Mataura FMU process would be counter to the level of effort already spent and would potentially allow outside interests to be involved in catchment decision-making for Waituna[25], contrary to the intent of a community collaborative process under the NPS-FM. Having Waituna as part of the Mataura FMU process carried a risk that the priority needs of this internationally significant and at risk wetland system and contributing catchment may be lost within a wider process.

Kate McArthur
15 February 2019

[25] Whether intentional or not.

REFERENCES

Allibone R, David B, Hitchmough R, Jellyman D, Ling N, Ravenscroft P, Waters J 2010. Conservation status of New Zealand freshwater fish, 2009. *New Zealand Journal of Marine and Freshwater Research 44*: 271 287.

Canning AD. 2018. Predicting New Zealand riverine fish reference assemblages. PeerJ 6:e4890 https://doi.org/10.7717/peerj.4890

Clapcott JE, Young RG, Harding JS, Matthaei CD, Quinn JM, Death RG 2011. Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.

Department of Conservation 2010. Freshwater Ecosystems of New Zealand. Department of Conservation, Wellington. http://www.doc.govt.nz/our-work/freshwater-ecosystems-of-new-zealand/

Dunn NR, Allibone RM, Closs GP, Crow SK, David BO, Goodman JM, Griffiths M, Jack DC, Ling N, Waters JM, Rolfe JR 2018. Conservation status of New Zealand freshwater fishes, 2017. *New Zealand Threat Classification Series 24*. Department of Conservation, Wellington. 11 p.

Grainger N, Collier K, Hitchmough R, Harding J, Smith B, Sutherland D 2014. Conservation status of New Zealand freshwater invertebrates, 2013. New Zealand Threat Classification Series 8. Department of Conservation, Wellington. 28 p.

Joy, MK 2009. Temporal and land-cover trends in freshwater fish communities in New Zealand's rivers: an analysis of data from the New Zealand Freshwater Fish Database – 1970 – 2007. Prepared for the Ministry for the Environment, Wellington, 17 p.

Joy MK, Foote KJ, McNie P, Piria M 2018. Decline in New Zealand's freshwater fish fauna: effect of land use. Marine and Freshwater Research https://doi.org/10.1071/MF18028. CSIRO Publishing.

Leathwick JR, West DW, Moilanen A, Chadderton WL 2012. Development of a Systematic, Information-Based Approach to the Identification of High Value Sites for River Conservation in New Zealand. River Conservation and Management, John Wiley & Sons, Ltd: 183-191.

Matheson F, Quinn J, Hickey C 2012. Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision-making framework: Phases

1 and 2 final report. Prepared for the Ministry of Science & Innovation Envirolink Fund. NIWA Client Report No: HAM2012-081.

MfE 1994. Water quality guidelines No. 2: Guidelines for the colour and clarity. Ministry for the Environment. Wellington.

Robertson HA, Ausseil A-G, Rance B, Betts H, Pomeroy E 2018. Loss of wetlands since 1990 in Southland, New Zealand. New Zealand Journal of Ecology 43(1): 3355 https://newzealandecology.org/nzje/3355.pdf

Snelder T, Hughes B, Wilson K, Dey K 2016. Physiographic Zones for the Southland Region: Classification System Validation and Testing Report. LWP Client Report, LWP Ltd, Christchurch, New Zealand.

Townsend AJ, de Lange PJ, Duffy CAJ, Miskelly CM, Molloy J, Norton DA 2008. New Zealand Threat Classification System Manual. Science and Technical Publishing, Wellington, Department of Conservation.

West DW, Leathwick JR, Dean-Speirs TL 2018. Approaches to the Selection of a Network of Freshwater Ecosystems within NZ for Conservation. Aquatic Conservation: Marine and Freshwater Ecosystems, in press.

WWF 2018. Living Planet Report - 2018: Aiming Higher. Grooten M. Almond REA (Eds). WWF, Gland, Switzerland. 148 p.

APPENDIX 1

Table 1: Summary of river water quality at SOE sites for four Freshwater Management Units (FMU) and the Waituna Lagoon catchment in Southland, downloaded from the LAWA website[26] in December 2018 and January 2019. Five-year median values are shown for each attribute available on LAWA. LF=Lowland Forest, UF=Upland Forest, LR=Lowland Rural, UR=Upland Rural, LU=Lowland Urban denote catchment position and broad land cover classes. Water quality attributes within the worst 25% of like sites nationally and MCI<80 or with degrading trends are shaded red. Grey-shaded cells indicate areas of water quality concern for key water quality attributes. Water quality trends showing "-" were indeterminant (neither improving or degrading), blank cells indicate no trend data was available and trend summaries amalgamated 'likely' (90-100% certainty) and 'very likely' (67-90% certainty) degrading or improving trends.

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m^3	TON g/m^3	Ammonia g/m^3	DRP g/m^3	TP g/m^3	MCI class
Mararoa at South Mavora Lake	Waiau	UF	5	5.65	0.44	0.055	0.005	0.005	0.002	0.002	No data
		Like sites	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	
		10-y trend	Degrading			-				-	
Upukerora at Te Anau – Milford Rd		UF	30	3.21	1.195	0.24	0.143	0.005	0.002	0.006	108
		Like sites	Worst 50%	Best 50%	Best 50%	Worst 50%	Worst 50%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	-	Degrading		Degrading	Improving	Improving		Degrading	-
Whitestone d/s Manapouri		UR	20	3.9	0.67	0.65	0.49	0.005	0.002	0.005	No data
		Like sites	Best 25%	Best 25%	Best 25%	Worst 50%	Worst 50%	Best 25%	Best 25%	Best 25%	
		10-y trend	Improving	-		Degrading	Degrading	Improving	Degrading	Degrading	
Mararoa at The Key		UR	35	3.4	0.755	0.255	0.119	0.005	0.002	0.002	No data
		Like sites	Best 50%	Best 25%	Best 25%	Best 50%	Best 50%	Best 25%	Best 25%	Best 25%	
		10-y trend	-	-		-	Improving	-		Improving	

[26] www.lawa.org.nz

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m³	TON g/m³	Ammonia g/m³	DRP g/m³	TP g/m³	MCI class
Mararoa at Weir Rd		UR	30	3.74	0.86	0.52	0.395	0.005	0.002	0.004	106
		Like sites	Best 50%	Best 25%	Best 25%	Worst 50%	Worst 50%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	Improving	Improving		-	-	Degrading		Improving	-
Waiau at Sunnyside		LF	30	2.93	0.795	0.27	0.1665	0.005	0.002	0.002	No data
		Like sites	Best 50%	Best 50%	Best 25%	Worst 50%	Worst 50%	Best 25%	Best 25%	Best 25%	
		10-y trend	Degrading	Improving		Degrading	Degrading			Improving	
Lill Burn at Lill Burn - Monowai Rd		LF	90	1.06	5.1	0.265	0.0575	0.005	0.004	0.016	102
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Best 50%	Best 25%	Best 25%	Best 50%	Good
		10-y trend									Degrading
Orauea at Orawia PukeMāori		LR	315	1.13	4.3	0.73	0.415	0.005	0.011	0.0275	93
		Like sites	Worst 50%	Worst 50%	Worst 50%	Worst 50%	Worst 50%	Best 25%	Best 50%	Worst 50%	Fair
		10-y trend	Improving			-	Improving		-	Improving	
Waiau at Tuatapere	Toxic algae warning	LR	53.7	1.77	1.46	0.363	0.2485	0.003	0.001	0.006	103
		Like sites	Best 25%	Best 50%	Best 25%	Best 50%	Best 50%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	Improving	Improving	Degrading	Degrading	-			-	-
Aparima at Dunrobin	Aparima	UF	62.5	5.1	0.8	0.11	0.025	0.005	0.002	0.004	118
		Like sites	Worst 25%	Best 25%	Best 50%	Best 50%	Best 50%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	Improving	Improving			-		-	Improving	

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m³	TON g/m³	Ammonia g/m³	DRP g/m³	TP g/m³	MCI class
Hamilton Burn at Affleck Rd		UR	120	2.715	1.33	0.64	0.425	0.005	0.0045	0.014	104
		Like sites	Worst 50%	Best 50%	Best 50%	Worst 50%	Worst 50%	Best 25%	Best 50%	Best 50%	Good
		10-y trend									
Otautau Stream at Waikouro		LR	1300	0.71	8.35	1.215	0.79	0.0225	0.021	0.0535	100
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Good
		10-y trend	Improving			Improving	Improving	Improving	Improving	Improving	
Otautau Stream at O-T Road		LR	850	0.77	6.95	1.23	0.705	0.026	0.0235	0.051	No data
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	
		10-y trend	Improving			Improving	Improving	-	Degrading	Improving	
Aparima at Thornbury		LR	130	2.305	1.53	0.91	0.665	0.005	0.006	0.041	100
		Like sites	Best 50%	Best 50%	Best 50%	Worst 50%	Worst 50%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	Improving	Improving	Improving	Improving	Improving		Improving	Improving	-
Cascade Stream at Pourakino V		LF	130	1.72	2.1	0.17	0.016	0.005	0.002	0.007	120
		Like sites	Worst 25%	Worst 50%	Worst 50%	Best 50%	Best 25%	Best 25%	Best 25%	Best 25%	Excellent
		10-y trend	Degrading			Degrading				Improving	
Opouriki Stream at Tweedie Rd		LR	600	0.95	5.95	2.2	1.805	0.021	0.01	0.034	No data
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Best 50%	Worst 50%	

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m^3	TON g/m^3	Ammonia g/m^3	DRP g/m^3	TP g/m^3	MCI class
		10-y trend	Improving			Degrading	Degrading		-	Improving	
Pourakino at Traill Road		LF	355	0.83	3.75	0.37	0.17	0.012	0.002	0.013	No data
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 50%	Worst 25%	Best 25%	Best 50%	
		10-y trend	Degrading			-	Degrading	-	Improving	Improving	
Waimatuku Stream at Lorneville R		LR	450	1.22	3.25	3.65	3.0	0.01	0.0425	0.06	No data
		Like sites	Worst 25%	Worst 50%	Worst 50%	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	
		10-y trend	Improving	Improving	Improving	Improving	Improving	Improving	Degrading	Improving	
Mokotua Stream at Awarua	Ōreti	LR	10	0.37	1.335	0.7	0.02	0.005	0.002	0.014	No data
		Like sites	Best 25%	Worst 25%	Best 25%	Worst 50%	Best 25%	Best 25%	Best 25%	Best 25%	
		10-y trend	Improving			Improving		Improving	Improving	Improving	
Ōreti River at Three Kings		UR	10	4.802	0.57	0.055	0.03	0.005	0.002	0.002	117
		Like sites	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	-				Improving		Improving	-	
Cromel at Selbie Road		UF	20	4.165	0.995	0.055	0.008	0.005	0.002	0.005	119
		Like sites	Worst 50%	Best 50%	Best 50%	Best 25%	Best 25%	Best 25%	Best 25%	Best 25%	Good
		10-y trend		Degrading		Degrading	Degrading	Degrading		Degrading	
Irthing Stream at Ellis Road		UR	90	2.9795	1.1	1.645	1.465	0.005	0.002	0.0075	120
		Like sites	Worst 50%	Best 50%	Best 50%	Worst 25%	Worst 25%	Best 25%	Best 25%	Best 25%	Excellent

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m^3	TON g/m^3	Ammonia g/m^3	DRP g/m^3	TP g/m^3	MCI class
		10-y trend	-	-		-	Degrading	-		-	-
Ōreti at Lumsden Bridge		UR	52.1	2.99	1.04	0.72	0.589	0.005	0.002	0.005	114
		Like sites	Best 50%	Best 50%	Best 25%	Worst 50%	Worst 25%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	Degrading	Degrading	-	Improving	Improving			-	Degrading
Otapiri Stream at Gorge		LR	415	0.8	5.45	0.83	0.485	0.005	0.0175	0.083	110
		Like sites	Worst 25%	Worst 25%	Worst 50%	Worst 50%	Worst 50%	Best 25%	Worst 50%	Worst 50%	Good
		10-y trend	Improving	-		-	-	Degrading	Degrading	-	
Bog Burn d/s H-L Road		LR	800	0.87	5.4	1.38	0.91	0.015	0.0275	0.0515	97
		Like sites	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	Fair
		10-y trend	-			Improving	Improving		Degrading	Degrading	
Makarewa at Lora Gorge Road		LR	460	0.85	4.7	0.935	0.535	0.005	0.014	0.0325	101
		Like sites	Worst 25%	Worst 25%	Worst 50%	Worst 50%	Worst 50%	Best 25%	Worst 50%	Worst 50%	Good
		10-y trend	-			Degrading	-	Degrading	Degrading	-	
Dunsdale Stream at Reserve		LF	140	1.3	2.4	0.295	0.173	0.005	0.01	0.0195	121
		Like sites	Worst 50%	Worst 25%	Worst 50%	Worst 50%	Worst 50%	Best 25%	Worst 50%	Worst 50%	Excellent
		10-y trend	Degrading	Degrading		Degrading	Degrading		Degrading	Degrading	-
		LR	1250	0.745	6.65	2.4	1.52	0.107	0.0595	0.131	81

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m³	TON g/m³	Ammonia g/m³	DRP g/m³	TP g/m³	MCI class
Winton Stream at Lochiel		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Fair
		10-y trend	Improving			Improving	Improving	Degrading	Improving	Improving	Improving
Ōreti at Wallacetown		LR	130	1.815	1.61	1.13	0.94	0.005	0.006	0.012	95
		Like sites	Best 50%	Best 50%	Best 50%	Worst 50%	Worst 25%	Best 25%	Best 25%	Best 25%	Fair
		10-y trend	Improving	-							Degrading
Tussock Creek at Cooper Road		LR	1100	1.0	3.5	2.0	1.27	0.0245	0.029	0.052	No data
		Like sites	Worst 25%	Worst 50%	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	
		10-y trend	-			Improving	Improving	Improving	-	Improving	
Makarewa at Wallacetown		LR	335	0.84	6.15	1.385	0.895	0.0495	0.019	0.0435	87
		Like sites	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 50%	Fair
		10-y trend	-			Improving	Improving	Improving	-	Improving	Improving
Waiokiwi at North Road		LR	495	1.085	4.45	3.3	2.65	0.019	0.011	0.0295	76
		Like sites	Worst 25%	Worst 50%	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Best 50%	Worst 50%	Poor
		10-y trend	Improving			Improving	Improving		-	Improving	Improving
Otepuni Creek at Ninth Street		LU	1700	0.777	5.85	1.95	1.165	0.0535	0.014	0.038	64.5
		Like sites	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 50%	Worst 50%	Best 50%	Worst 50%	Poor
		10-y trend	-	-		Improving	Improving	Degrading	Degrading	Improving	

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m^3	TON g/m^3	Ammonia g/m^3	DRP g/m^3	TP g/m^3	MCI class
Waihopai u/s Queens Drive		LR	330	1.28	3.4	2.8	1.995	0.0165	0.009	0.028	75
		Like sites	Worst 50%	Worst 50%	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Best 50%	Worst 50%	Poor
		10-y trend	Improving	Improving		Improving	Improving	Improving	Improving	Improving	Improving
Waituna Creek at Marshall Rd	Waituna	LR	310	0.89	6.15	1.78	1.045	0.0185	0.014	0.039	72.5
		Like sites	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 50%	Poor
		10-y trend	-			Improving	Improving	Improving	Improving	Improving	-
Carran Creek at Waituna Lagoon Rd		LR	220	0.424	11.9	1.11	0.305	0.045	0.0465	0.1185	No data
		Like sites	Worst 50%	Worst 25%	Worst 25%	Worst 50%	Best 50%	Worst 25%	Worst 25%	Worst 25%	
		10-y trend	-			Improving	Improving	Improving	Degrading	Improving	
Tokonui at Fortrose Otara Rd	Mataura	LR	305	0.56	10.3	1.44	1.045	0.021	0.019	0.056	79
		Like sites	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Poor
		10-y trend	-			Improving	Improving		-	Improving	
Waikawa at Progress Valley		LR	600	0.73	6.65	0.95	0.585	0.012	0.013	0.0345	106
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 50%	Worst 50%	Worst 50%	Worst 50%	Good
		10-y trend	-		Improving	Improving	Improving		-	Improving	Degrading
Waikopiko-piko at H. Curio Bay		LF	145	0.935	3.4	0.33	0.147	0.005	0.009	0.019	124
		Like sites	Worst 25%	Worst 25%	Worst 50%	Worst 50%	Worst 50%	Best 25%	Worst 50%	Worst 50%	Excellent

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m³	TON g/m³	Ammonia g/m³	DRP g/m³	TP g/m³	MCI class
		10-y trend	-			Improving	Improving	Degrading	Degrading	Improving	
Mataura at Parawa		UR	114.5	2.26	1.77	0.413	0.335	0.005	0.005	0.009	115
		Like sites	Worst 50%	Best 50%	Best 50%	Worst 50%	Worst 50%	Best 25%	Best 50%	Best 50%	Good
		10-y trend	Degrading	-	Degrading	Degrading	Degrading		Improving	Improving	-
Waikaia u/s Piano Flat		UR	20	3.2	0.87	0.1	0.01	0.005	0.004	0.008	127
		Like sites	Best 25%	Best 50%	Best 25%	Best 25%	Best 25%	Best 25%	Best 50%	Best 25%	Excellent
		10-y trend	Improving	-		Degrading	Degrading		Degrading	Improving	-
Waikaia at Waikaia	Toxic algae warning	UR	200	1.8	1.61	0.285	0.1295	0.005	0.006	0.012	120
		Like sites	Worst 25%	Worst 50%	Best 50%	Best 50%	Best 50%	Best 25%	Best 50%	Best 50%	Excellent
		10-y trend	-	Degrading		Degrading	-	Improving	Degrading	Improving	
Waikaia at Waipounamu		LR	150	1.9	2.55	0.665	0.51	0.005	0.006	0.012	115
		Like sites	Best 50%	Best 50%	Best 50%	Worst 50%	Worst 50%	Best 25%	Best 25%	Best 25%	Good
		10-y trend	Degrading	Degrading		Degrading	Degrading	-	-	Improving	Degrading
Longridge at Sandstone		UR	305	1.055	3.6	4.25	3.6	0.0125	0.033	0.056	87
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Fair
		10-y trend	Degrading			Degrading	Degrading	Degrading	-	Improving	
North Peak at Waimea Valley		LR	170	0.73	5.55	0.815	0.285	0.01	0.016	0.0345	No data
		Like sites	Worst 50%	Worst 25%	Worst 50%	Worst 50%	Best 50%	Worst 50%	Worst 50%	Worst 50%	

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m^3	TON g/m^3	Ammonia g/m^3	DRP g/m^3	TP g/m^3	MCI class
		10-y trend	Improving	Improving		Improving	Improving	Improving	Degrading	Improving	
Sandstone at Kingston Crossing Rd		LR	420	0.9	4.4	2.095	1.195	0.0115	0.042	0.0735	79
		Like sites	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	Poor
		10-y trend	Degrading			Improving	-		Degrading	-	
Waimea at Mandeville		LR	280	1.16	3.55	3.75	3.05	0.005	0.0215	0.044	91.5
		Like sites	Worst 50%	Worst 50%	Worst 50%	Worst 25%	Worst 25%	Best 25%	Worst 25%	Worst 50%	Fair
		10-y trend	-	Improving		Degrading	Degrading	-	-	Improving	Improving
Otamita at Mandeville		LR	300	1.03	3.9	0.99	0.72	0.005	0.01	0.028	104
		Like sites	Worst 50%	Worst 50%	Worst 50%	Worst 50%	Worst 50%	Best 25%	Best 50%	Worst 50%	Good
		10-y trend	-	Degrading		Improving	Improving	Improving	-	-	
Mataura at Gore		LU	375	1.115	2.1	1.1	0.89	0.005	0.006	0.0155	94
		Like sites	Worst 50%	Worst 25%	Worst 50%	Worst 50%	Worst 50%	Best 25%	Best 25%	Best 25%	Fair
		10-y trend	Degrading	-		Degrading	-	-	-	-	-
Waikaka at Gore		LR	315	0.9	6.55	1.33	0.745	0.042	0.024	0.0535	88
		Like sites	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	Worst 25%	Fair
		10-y trend	Improving			-	Improving	Improving	Improving	Improving	Degrading
		LR	1300	1.11	3.1	1.15	0.89	0.04	0.01	0.02	103

Site	FMU	Classification	E.coli / 100ml	Clarity (m)	Turbidity (NTU)	TN g/m³	TON g/m³	Ammonia g/m³	DRP g/m³	TP g/m³	MCI class
Mataura 200m d/s Bridge		Like sites	Worst 25%	Worst 50%	Best 50%	Worst 50%	Worst 25%	Worst 25%	Best 50%	Best 50%	Good
		10-y trend	-	-		-	Improving	-	Improving	Improving	Improving
Mimihau trib at Venlaw		UR	20	1.49	1.62	0.27	0.146	0.005	0.012	0.016	122
		Like sites	Best 25%	Worst 50%	Best 50%	Best 50%	Best 50%	Best 25%	Worst 50%	Best 50%	Excellent
		10-y trend		Degrading							Degrading
Mimihau at Wyndham		LR	385	0.7	6.62	1.16	0.86	0.005	0.012	0.036	97
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 50%	Worst 25%	Best 25%	Worst 50%	Worst 50%	Fair
		10-y trend	-			-	-	Degrading	Improving	Improving	
Mokoreta at Wyndham		LR	320	0.875	4.4	1.36	1.04	0.005	0.008	0.026	103
		Like sites	Worst 50%	Worst 25%	Worst 50%	Worst 25%	Worst 25%	Best 25%	Best 50%	Best 50%	Good
		10-y trend	Improving	-		Improving	Improving		Improving	Improving	-
Oteramika at Seaward Downs		LR	700	0.54	10.7	2.75	1.74	0.0455	0.035	0.097	88
		Like sites	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Worst 25%	Fair
		10-y trend	Degrading	Degrading		Degrading	Degrading	Degrading	Degrading	Degrading	Degrading
Mataura at Mataura Island Bridge		LR	300	1.145	3.35	1.17	0.89	0.013	0.009	0.021	92.5
		Like sites	Worst 50%	Worst 50%	Worst 50%	Worst 50%	Worst 25%	Worst 50%	Best 50%	Best 50%	Fair
		10-y trend	Degrading	Improving	Degrading	-	Improving		Improving	Improving	Degrading

APPENDIX 2:

Maps of third-order sub-catchment national priority for protection rankings for major river catchments in Southland. Data provided by DOC.

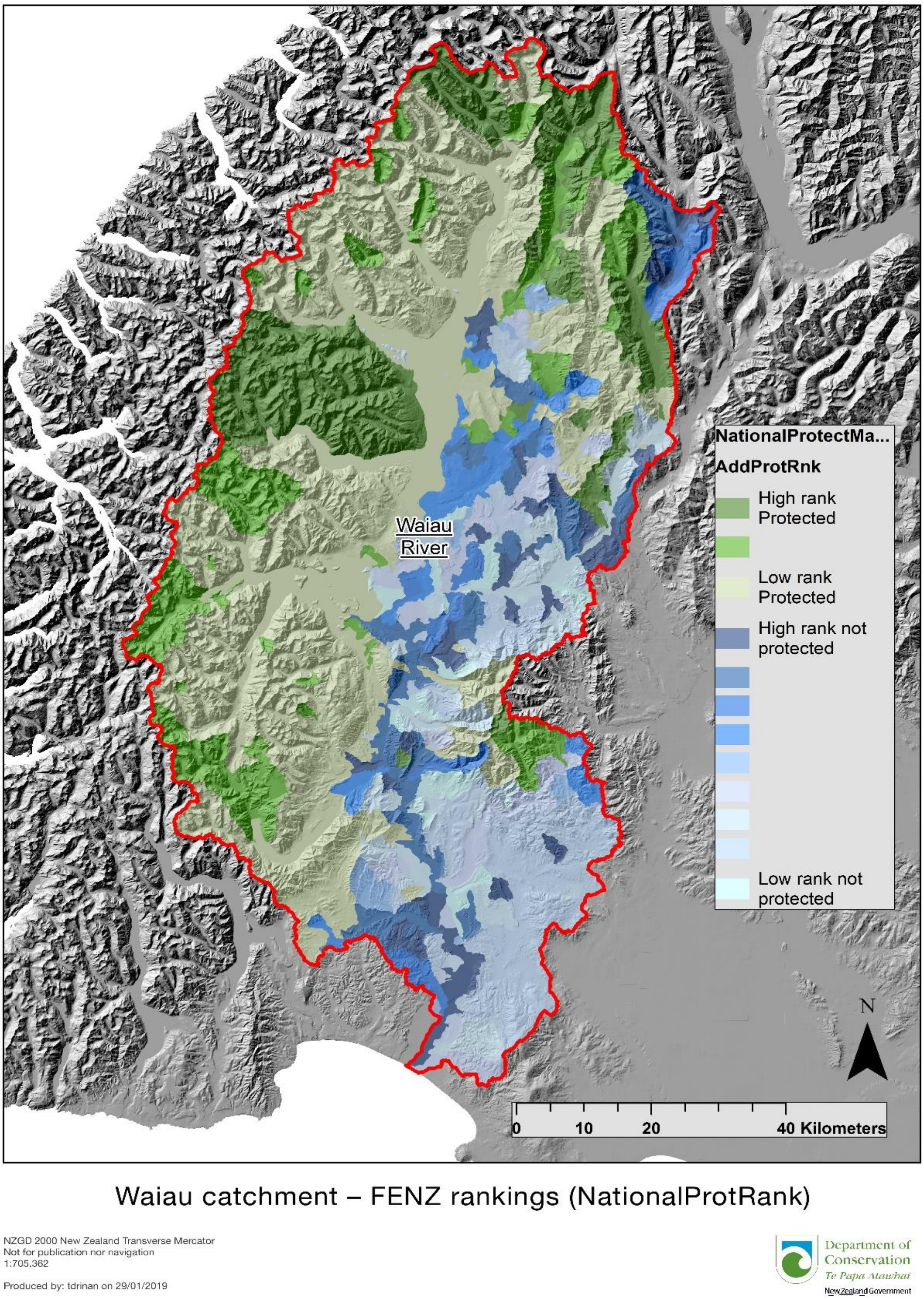

Figure 1: National priority for protection ranking of third-order sub-catchments in the Waiau River catchment, Southland.

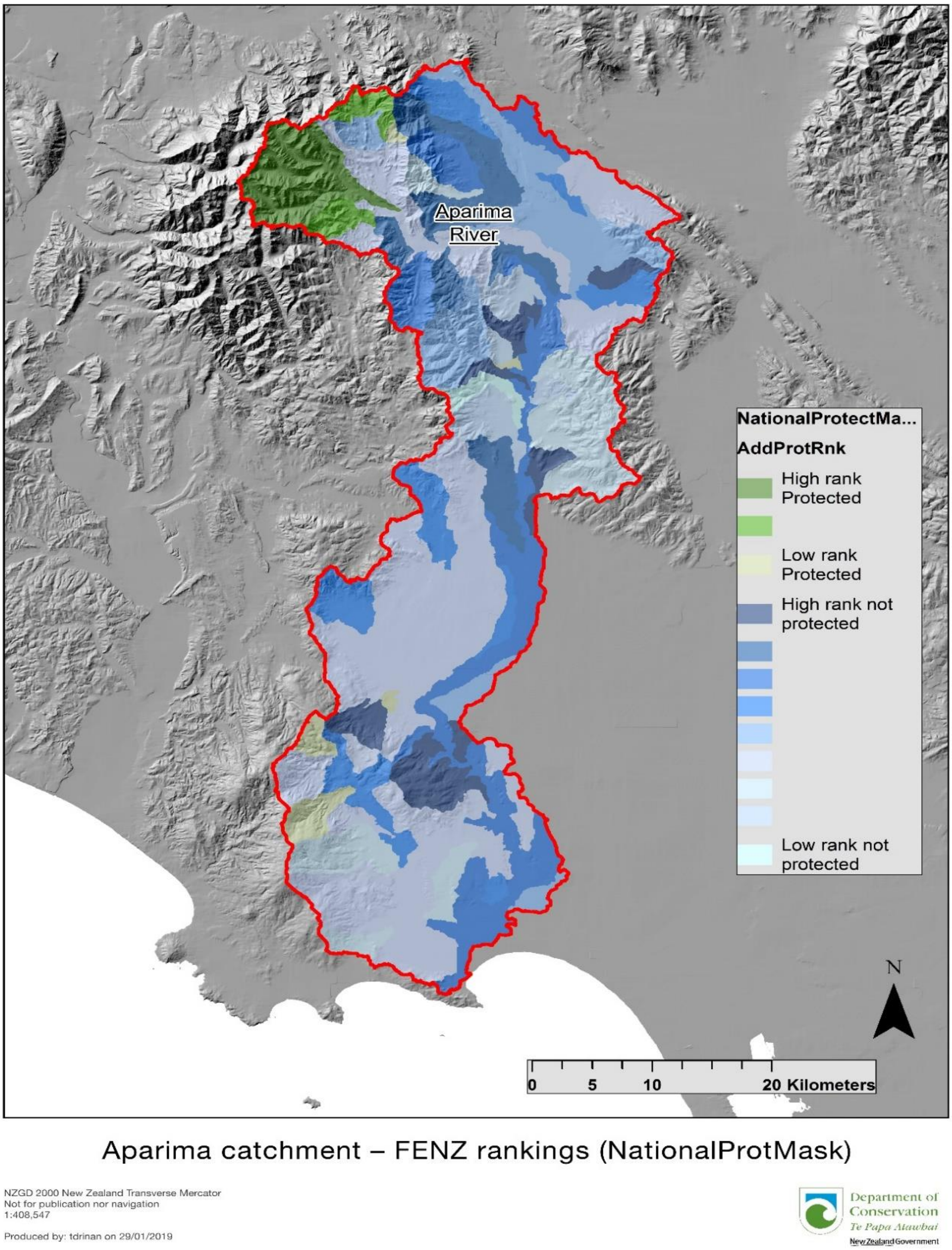

Figure 2: National priority for protection ranking of third-order sub-catchments in the Aparima River catchment, Southland.

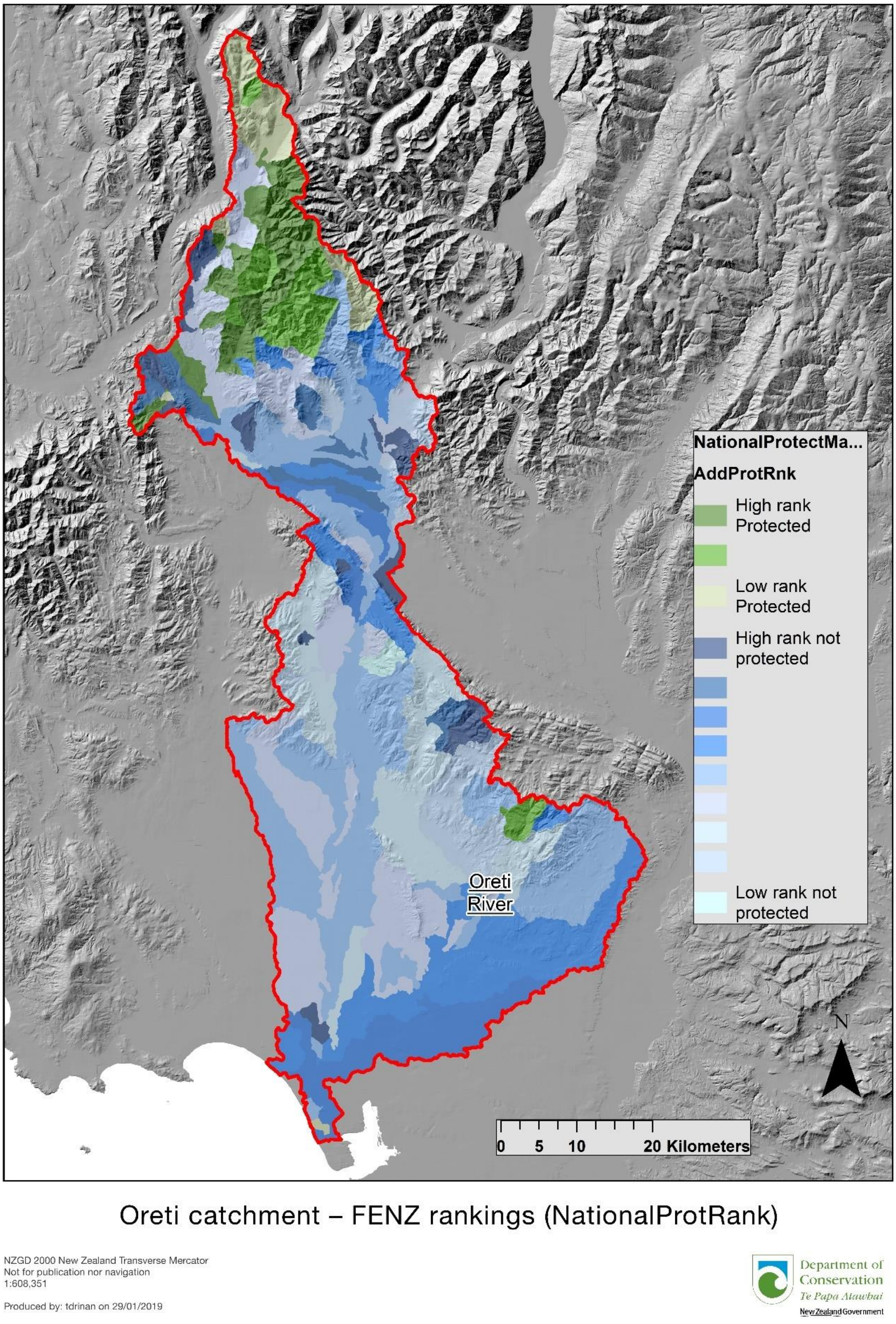

Figure 3: National priority for protection ranking of third-order sub-catchments in the Ōreti River catchment, Southland.

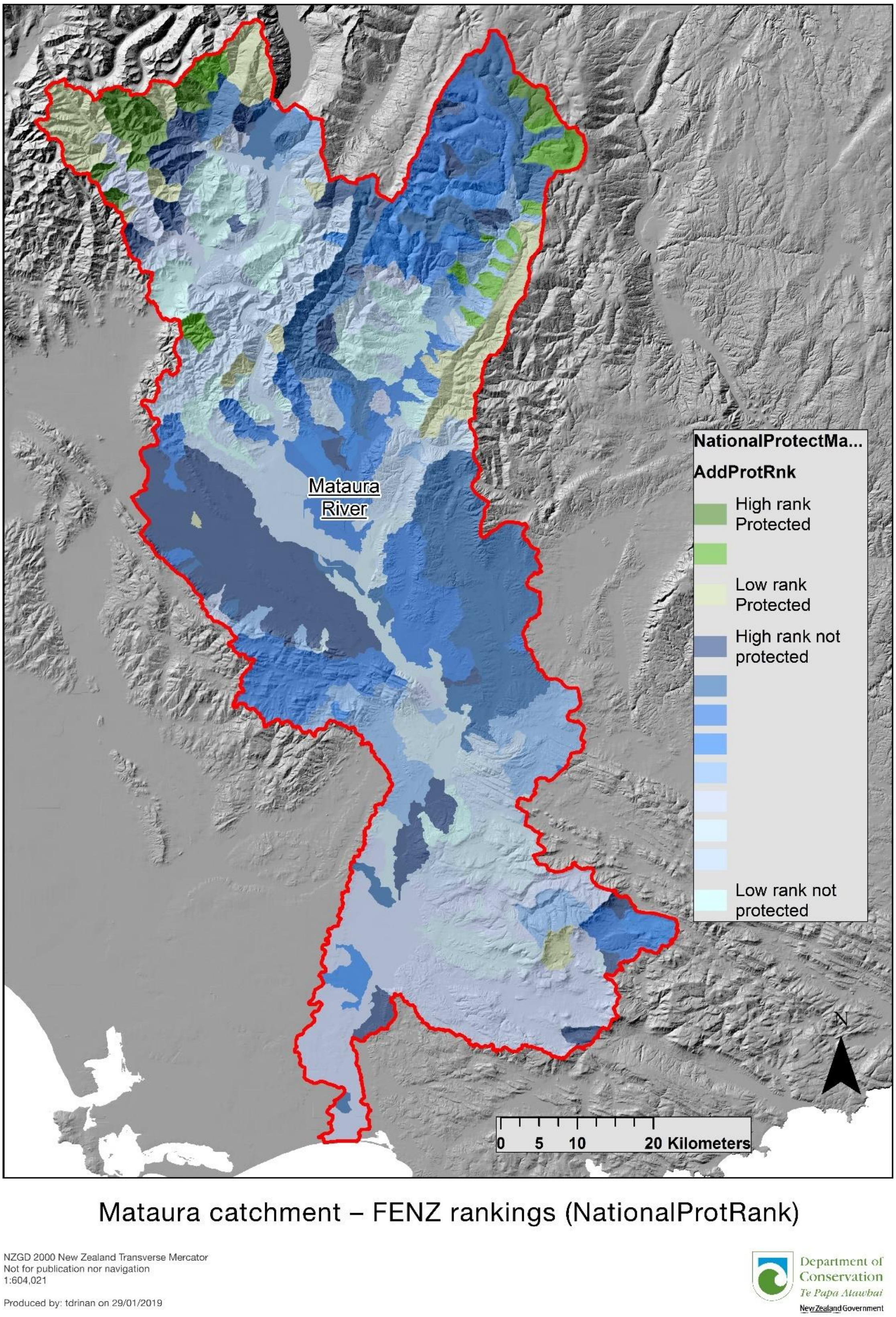

Figure 4: National priority for protection ranking of third-order sub-catchments in the Mataru River catchment, Southland.

APPENDIX 3: Maps of Freshwater Ecosystems of New Zealand (FENZ) indigenous fish rankings for major river catchments in Southland. Data provided by DOC.

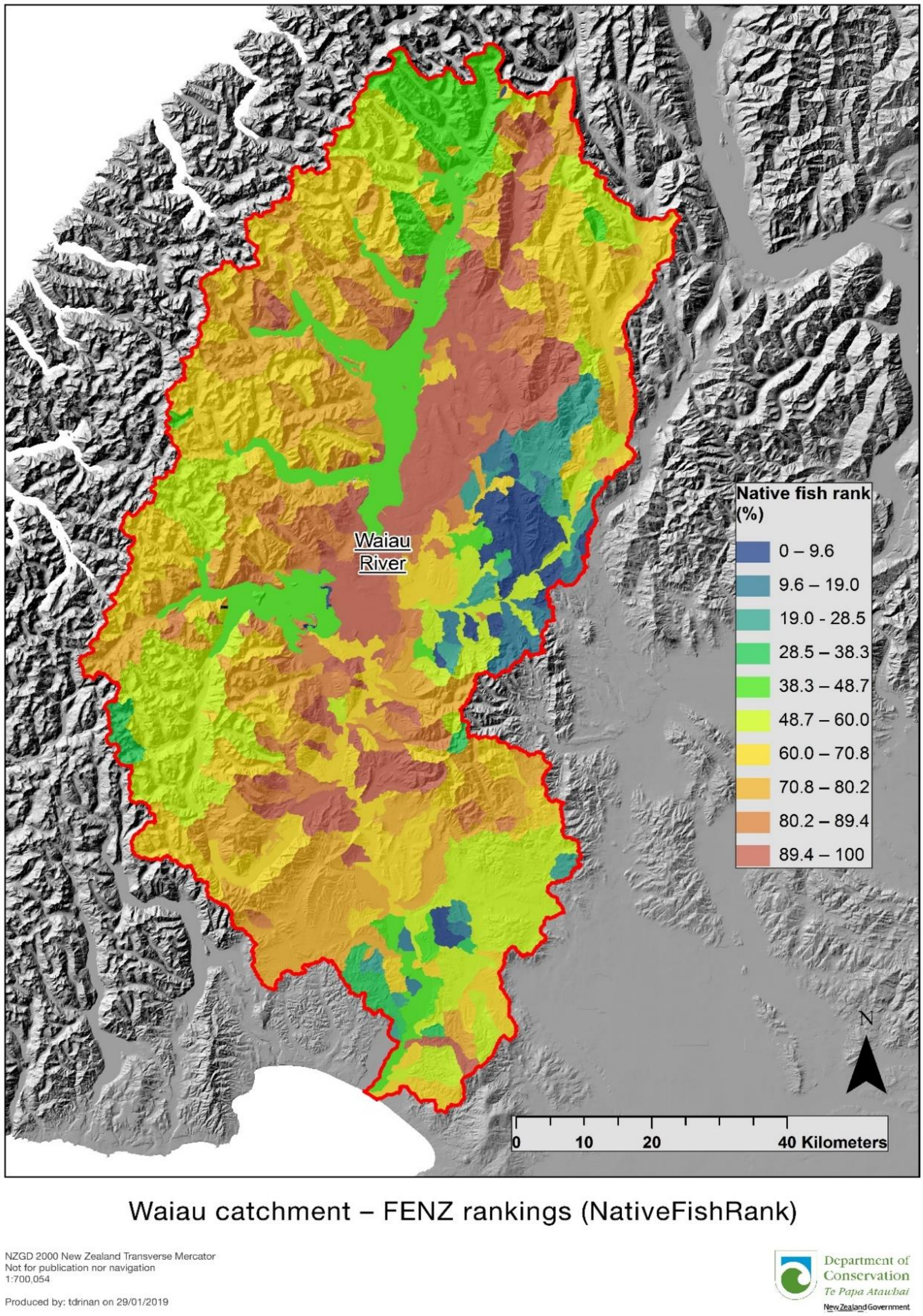

Figure 1: FENZ indigenous fish ranking for third-order catchments in the Waiau River catchment, Southland.

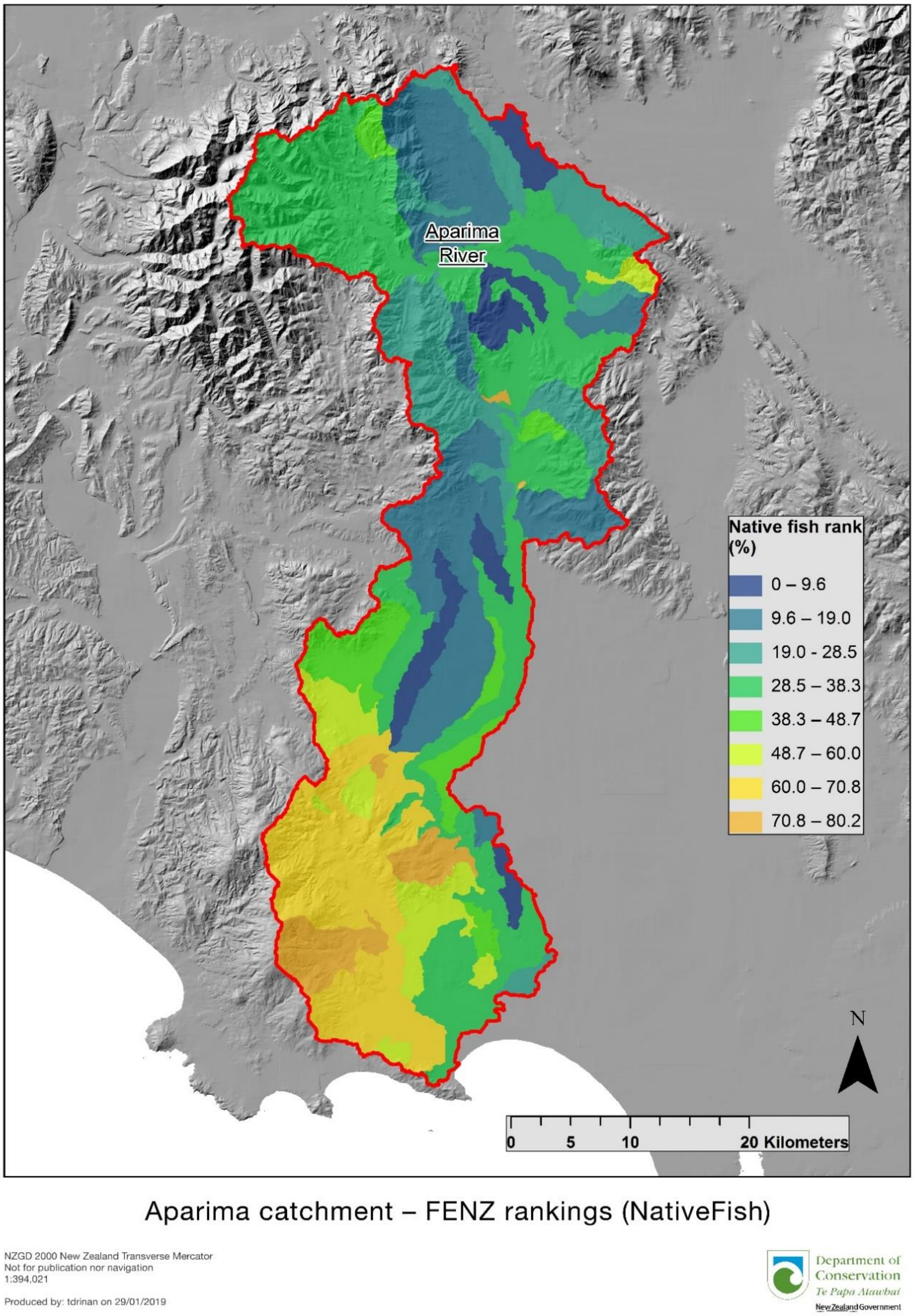

Figure 2: FENZ indigenous fish ranking for third-order catchments in the Aparima River catchment, Southland.

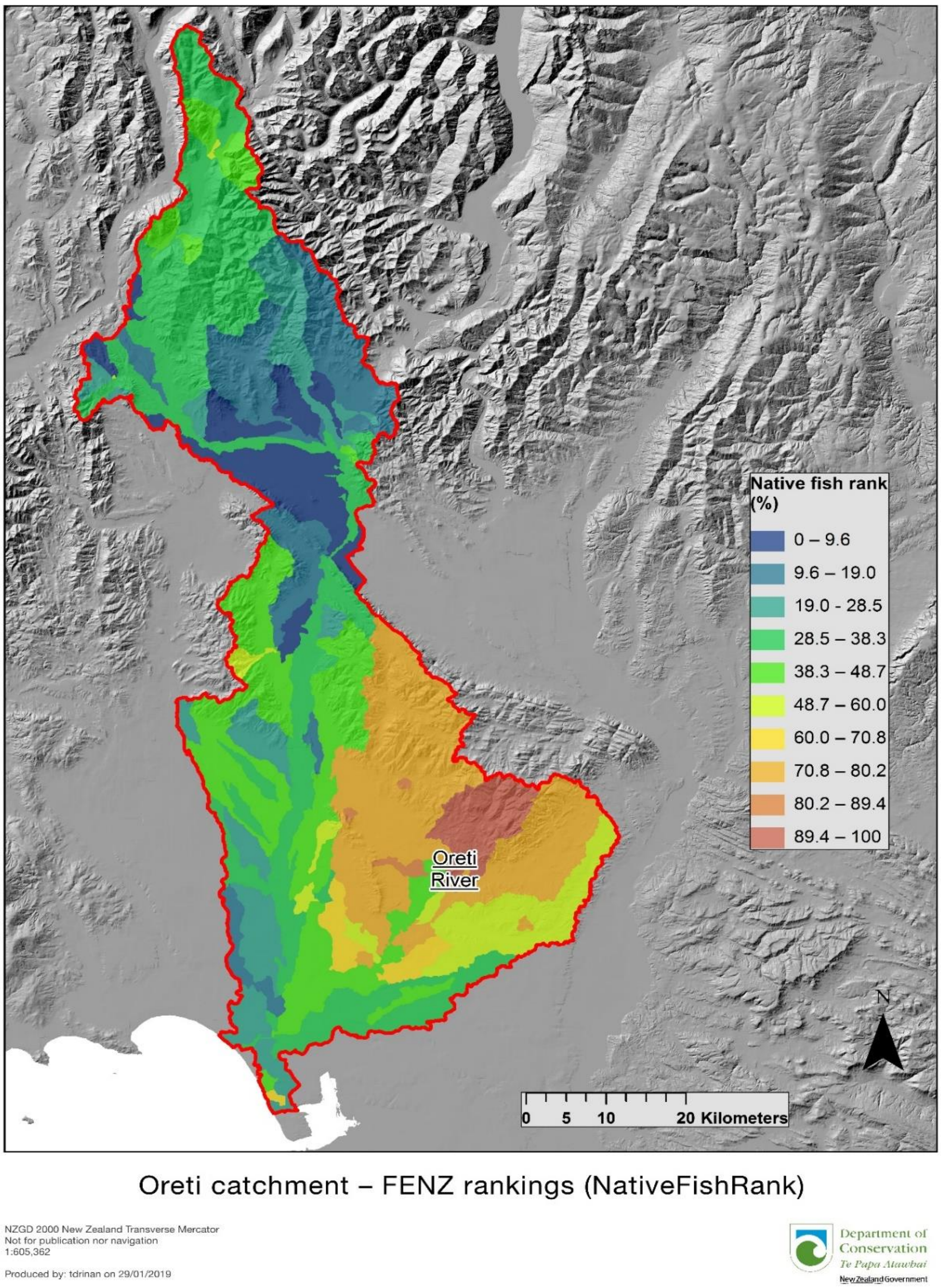

Figure 3: FENZ indigenous fish ranking for third-order catchments in the Ōreti River catchment, Southland.

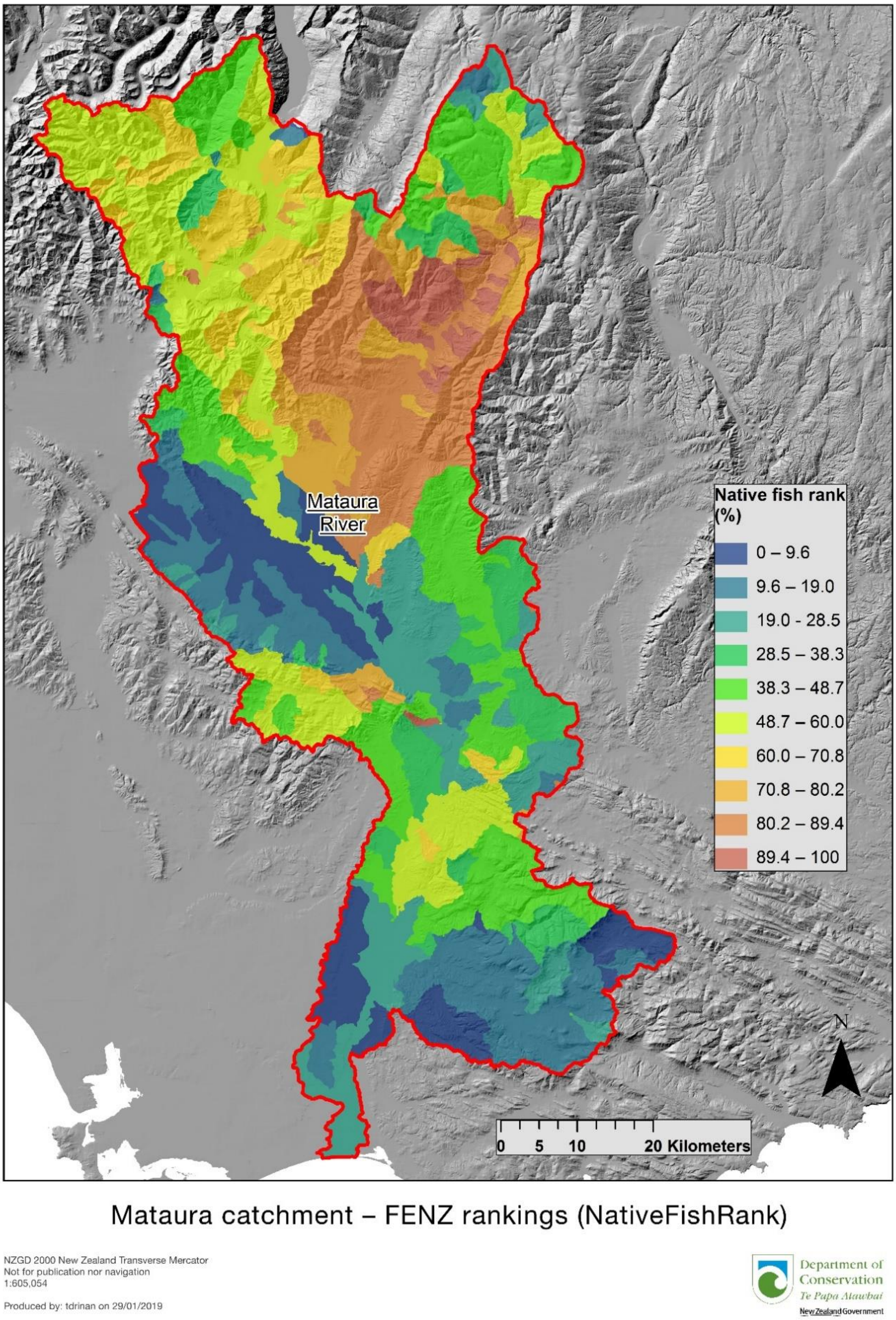

Figure 4: FENZ indigenous fish ranking for third-order catchments in the Mataura River catchment, Southland.