BEFORE THE OTAGO REGIONAL COUNCIL

AT DUNEDIN
KI ŌTEPOTI

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of the proposed Otago Regional Policy Statement 2021 (excluding those parts determined to be a Freshwater Planning Instrument)

Evidence of Dr Marine Raphaële Amélie Richarson (freshwater)
for the Director-General of Conservation *Tumuaki Ahurei*
dated 23 November 2022

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PART 1 – INTRODUCTION AND GENERAL PROVISIONS

Summary of key points

1. The Director-General of Conservation Tumuaki Ahurei (Director-General, D-G) submitted on the proposed Otago Regional Policy Statement 2021 (pORPS 2021). The submission supported some provisions, but also sought changes to many provisions.

2. The D-G also lodged a further submission, opposing specific points of some other submissions.

3. My evidence relates to the freshwater values present in the Otago region, with a focus on threatened habitats and species.

4. In my evidence, I adopt the framework of criteria for identifying areas that qualify as significant natural areas provided in the Exposure draft National Policy Statement for Indigenous Biodiversity, Appendix 1[1].

5. Freshwater fish species in Otago present a wide variety of ecological requirements and life histories. They are also highly susceptible to anthropogenic threats. Their management and conservation need to account for this complexity.

6. Non-diadromous galaxiids represent a significant and highly threatened proportion of the endemic fish fauna of New Zealand and in the Otago Region. Due to taxonomic errors in the s32 report, this is only partially recognised in the pORPS 2021. The distribution range of these species is often constrained, and populations are fragmented and vulnerable to incursions from introduced salmonids. As a result, catchment-wide provisions and the adoption of minimum flows are insufficient to adequately protect these fragile taxa and their habitats, leaving populations highly vulnerable to local extinction.

7. Conversely, diadromous fish species are highly mobile and require a catchment-wide management approach, ki uta ki tai. While some species are widely distributed nationwide, their ecological requirements and generally declining population trends highlight the importance of strong local protective measures in planning instruments.

8. The Otago Region is also host to many threatened macroinvertebrate taxa. These taxa represent significant freshwater values, that were overlooked in the s32 and s42A

[1] Notified on 9 June 2022 with public submissions closing on 21 July 2022

reports. Taking these taxa into account could expand the list of outstanding water bodies and areas of significant indigenous biodiversity in the Region.

9. I consider that the pORPS 2021 policies and methods must reconcile the need for connectivity from source to sea for diadromous species and the protection of vulnerable non-diadromous species' populations and threatened macroinvertebrates against introduced salmonids.

10. I consider that pORPS 2021 policies must provide for indigenous freshwater taxa within catchments, across domains (land, freshwater, coastal environment) to address the whole range of pressures they face, including pollution, land use, climate change, pest species and their cumulative effects.

11. I am concerned by the lack of clarity and connection between chapters in the pORPS 2021. Clear linkages across chapters must be made, including between policies, methods and anticipated environmental results to effectively provide for the protection of indigenous freshwater biodiversity.

12. I support amending objectives and policies towards indigenous biodiversity using an outcome-driven approach supported by the New Zealand Threat Classification system.

13. I support improving the consistency of the pORPS 2021 with higher order planning documents such as the exposure Draft of the National Policy Statement on Indigenous Biodiversity and the National Policy Statement for Freshwater Management 2020.

14. I support improving the policies in the pORPS 2021 by adopting outcome statements that set clear measures of the change expected and high-level results for species and ecosystems. Such measures could appropriately be based, in my view, on the indices used in the New Zealand Threat Classification System.

Introduction

15. My full name is Marine Raphaële Amélie Richarson.

16. I am appearing on behalf of the Director-General of Conservation Tumuaki Ahurei to provide expert freshwater evidence on the proposed Otago Regional Policy Statement 2021 – non-freshwater parts.

Qualifications and experience

17. I am currently employed as a Freshwater Science Advisor by the Department of Conservation Te Papa Atawhai (DOC). I have been in this position since April 2020.

18. I have worked as a freshwater ecologist since August 2007. My principal area of expertise concerns diadromous fish species, i.e., species with a life cycle featuring both marine and freshwater phases[2], and their ecological requirements. My experience relevant to the current process includes:

    (a) conducting applied and fundamental research in the ecology of aquatic organisms

    (b) providing technical and scientific advice in freshwater ecology, in matters such as environmental impact assessments, ecological surveys and monitoring in river, lake, pond and wetland systems, and fish passage provisions

    (c) managing research as well as operational programmes.

19. In my current role, I lead the Department's scientific research strategy and implementation on threatened diadromous species, currently focused on īnaka (*Galaxias maculatus*), shortjaw kōkopu (*Galaxias postvectis*), longfin eel (*Anguilla dieffenbachii*), and lamprey (*Geotria australis*). I also provide technical support and advice for DOC's work on freshwater species and ecosystems.

20. I hold a Diplome d'Ingenieur (Engineering Diploma) in Water Sciences and Technologies from Institut des Sciences de l'Ingenieur de Montpellier (Institute of

[2] Diadromous life cycles are explained in more detail in paragraph 58.

Engineering Sciences), Universite Montpellier II, which I received in 2006. I undertook an Honours programme in ecology at the Queensland University of Technology as an additional part to this curriculum. During that time, I completed a thesis on the reproduction patterns of green turtle (*Chelonia mydas*), and a thesis on the dietary ecology of sand whiting (*Sillago cilliata*).

21. I completed my Doctorate in Zoology at the University of Otago in 2020. My PhD research focused on the effects of interspecific and intraspecific interactions on ecological niches. I studied the effects of antagonistic interactions, particularly competition, predation, and their combination, on the dietary and habitat preferences of an indigenous New Zealand freshwater fish, the common bully (*Gobiomorphus cotidianus*).

22. I currently am a member of the New Zealand Fish Passage Advisory Group, a group of ecologists, engineers and environmental advisors that promote, support and develop resources for fish passage, and advocate for improved fish passage management and better guidance and policy to enhance, maintain and improve the key constraints to fish passage and connectivity of waterways.

23. I am a trustee of Te Nohoaka o Tukiauau Sinclair Wetlands Trust, which administers a 315ha portion of the Lakes Waihola-Waipori wetlands complex, south of Dunedin. In this capacity I contribute to the Trust's operational programme development and administration.

Code of Conduct

24. Although it is not strictly required at a Council hearing, I confirm that I have read the code of conduct for expert witnesses as contained in the Environment Court Practice Note 2014. I have complied with the practice note when preparing my written statement of evidence and will do so when I give oral evidence before the hearing commissioners.

25. The data, information, facts, and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in the evidence to follow.

26. Unless I state otherwise, this evidence is within my sphere of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of evidence

27. I have been asked to provide evidence in relation to the relation to the following matters:

- *freshwater values in the Otago Region in particular details of populations of the threatened indigenous fish species in the region, features that distinguish Otago's galaxiid populations from elsewhere in NZ,*
- *catchment-specific freshwater values,*
- *the proposed new provisions relating to trout habitat in the supplementary evidence for Chapter 1 'Introduction and general themes',*

to support the D-G's submissions on these points.

28. My evidence is divided into the following chapters:

- IM – Integrated Management
- CE – Coastal Environment
- LF – Land and Freshwater
- ECO – Ecosystems and indigenous biodiversity

Material Considered

29. In preparing my evidence I have read and reviewed the following key documents and information:

- The Proposed Otago Regional Policy Statement 2021 (pORPS)
- The section 42A report of the pORPS dated 31 October 2022 (and earlier versions), particularly:
    - Chapter 6 IM – Integrated Management
    - Chapter 8 CE – Coastal environment

- Chapter 9 LF – Land and freshwater
- Chapter 10 ECO – Ecosystems and indigenous biodiversity

as well as the supplementary evidence provided for these chapters

- The section 32 Evaluation Report dated May 2021, particularly appendices 12, 13 and 14 (Wildland Reports 2020a, 2020b and 2021b)
- The National Policy Statement for Freshwater Management 2020
- The exposure draft of the National Policy Statement for Indigenous Biodiversity dated June 2022, particularly Appendix 1.
- Te Mana o te Taiao Aotearoa New Zealand Biodiversity Strategy 2020
- The D-G’s submission dated 3 September 2021
- The D-G’s further submission dated 12 November 2021

30. I also used data from the New Zealand Freshwater Fish Database (NZFFD), a public repository of fish survey data for information concerning indigenous and taoka fish species, as well as invertebrate data made available to the Department of Conservation for the conservation status assessment of 2018[3].

Criteria to identify significant natural areas

31. An exposure draft of the National Policy Statement for Indigenous Biodiversity (E draft NPSIB) was released in June 2022, seeking submissions which closed on 21 July 2022.

32. I understand the E draft NPSIB has been developed based on previous extensive public consultation, and input from leading ecological practitioners. I also understand that the overall approach has largely been accepted and the Ministry for the Environment has sought feedback from practitioners, iwi/ Māori, stakeholders, and those highly familiar with the previous proposed draft NPSIB 2019, to ensure its provisions are workable.

[3] Grainger et al, *Conservation status of New Zealand freshwater invertebrates*, 2018 – refer paragraph 71.

33. I am aware that the E draft NPSIB has not been approved and gazetted and does not yet have legal force under the Resource Management Act 1991 (RMA). However, because of the process through which the E draft NPSIB has been developed and based on my review of the criteria within my area of expertise, I consider that the Hearing Panel should consider the criteria relevant to the pORPS 2021, and that pORPS 2021 APP2 should be revised to be consistent with the E draft NPSIB.

34. Of particular relevance to my evidence, the E draft NPSIB sets out a framework of criteria in Appendix 1 for identifying areas that qualify as significant natural areas. I have reviewed the E draft NPSIB Appendix 1 criteria as they relate to freshwater ecology. In my view, the criteria provide a relevant and workable framework for freshwater species. I therefore adopt these criteria in my evidence where appropriate.

SRMR – Significant resource management issues for the region

35. I am aware that issue statements in the pORPS 2021 have gone through several modifications, following consultation and changes in national direction, including amendments to current national policy statements.

36. The Significant Resource Management Issues for the Region (SRMR) section in Part 2 of the s42 report comprises a statement of the issues as well as a summary of their environmental, economic, and social impacts. The following sections are relevant to my evidence:

- SRMR-I2 – Climate change will impact our economy and environment
- SRMR–I3 – Pest species pose an ongoing threat to indigenous biodiversity, economic activities and landscapes.
- SRMR–I7 – Biodiversity loss: rich and varied biodiversity has been lost and degraded due to human activities or the presence of pests and predators.
- SRMR–I11 – Cumulative impacts and resilience – the environmental costs of our activities in Otago are adding up with tipping points potentially being reached.

37. I agree with the general philosophy of this chapter and believe that the overarching issues facing biodiversity have correctly been identified. However, I note some failures to identify certain risks related notably to climate change and pest species. I provide below an overview of the Otago Region to identify where some of these missing points lie.

Freshwater values of the Otago Region

38. The Otago Region supports a diverse freshwater fish fauna, including bullies, eels, lamprey, torrentfish and galaxiids.

39. Genetic and morphological studies of the indigenous freshwater fish fauna in New Zealand have led to the recognition of several new freshwater fish taxa[4] in the past 40 years, mainly non-diadromous galaxiids endemic to New Zealand.

40. The Wildland Consultants Contract Report No. 5015b (Wildlands Report 2020a) identifies 27 indigenous freshwater fish species in the Otago region. However, a closer analysis of the NIWA New Zealand Freshwater Fish Database as of 18th June 2022 shows a total of 32 extant taxa within the region (see Table 1), including seven with an "indeterminate" taxonomic status, i.e., for which formal taxonomic descriptions are still underway. These indeterminate taxa are Clutha flathead galaxias (*Galaxias* "species D"), Teviot flathead galaxias (*Galaxias* "Teviot"), Pomahaka galaxias (*Galaxias* "Pomahaka"), southern flathead galaxias (*Galaxias* "Southern"), Nevis galaxias (*Galaxias* "Nevis") and two alpine galaxias species: *Galaxias* aff. *paucispondylus* "Manuherikia" (present in the Manuherekia River) and *Galaxias* aff. *paucispondylus* "Southland" (identified in Otago in tributaries of the Clutha and Mataura rivers).

41. Among the freshwater fish species identified in the region:

- Sixteen taxa, mostly of the galaxiid family, are non-diadromous. Many have limited distributions around the country, and several are limited to small parts of the Otago Region. See paragraphs 45-57 for further detail.

[4] For the purposes of this evidence, the term taxon (plural taxa) refers to both a formally described species and a biological entity as yet without a formal name (Townsend et al. 2008).

- Fourteen species belonging to six families are considered diadromous, requiring access to and from the sea to complete their lifecycles (see paragraph 58 for a more detailed definition). Some cases of landlocked populations in normally diadromous species have been documented, for example in kōaro (*Galaxias brevipinnis*)[5] and īnaka[6]. See paragraphs 58-68 for further detail.

- Two species are found in the lower reaches of some rivers and coastal areas but are not considered to undertake a significant part of their life in freshwater. These are yellow-eye mullet (*Aldrichetta forsteri*) and black flounder (*Rhombosolea retiarii*), both considered 'Not Threatened'. Note that my evidence focuses on species that are primarily found in freshwater habitats, so I do not address these two species in any further detail.

42. Indigenous freshwater fish species present in the region inhabit a wide range of water bodies, including but not limited to braided rivers, small spring-fed streams and tributaries, backwaters, wetlands and larger lakes and rivers. In the current ecological landscape, small tributaries, streams and wetlands are often the areas that support the greatest indigenous fish biodiversity, likely by providing a natural environment and refuge from introduced species and natural predators. Some species have a tolerance for brackish and saline waters at various life stages, and can be found in coastal wetlands, lagoons, estuaries and inlets.

43. Indigenous species also have varied habitat preferences. For example, some species favour still or slow-moving waters (e.g. giant kōkopu (*Galaxias argenteus*)) while others dwell in fast riffle habitats (e.g. torrentfish (*Cheimarrichthys fosteri*)). Habitat preferences can also shift at different ontogenetic (or developmental) stages within a species. This is particularly evident in diadromous species, in which life cycles are split between marine and freshwater habitats. Supplementary table S1 provides an overview of habitat

[5] E.g., McDowall, R. M. (1990). *New Zealand freshwater fishes: A natural history and guide*. Auckland: Heinemann Reed.

[6] E.g., McDowall, R. M. (2010). New Zealand freshwater fishes: an historical and ecological biogeography (Vol. 32). New York: Springer.

preferences for adults and juveniles of the indigenous fish species found in Otago.

44. Regarding the conservation status of the species identified in the Otago region, 15 are currently assessed as 'Threatened' and 10 are assessed as 'At Risk'[7] (Table 1). Threatened species are mostly represented by non-diadromous galaxiids. One diadromous species (lamprey *Geotria australis*) is 'Nationally Vulnerable' and 6 other diadromous species (e.g., īnaka, giant kōkopu and longfin eel) are considered 'At Risk – Declining'.

[7] Dunn, N.R., R.M. Allibone, G. Closs, S. Crow, B.O. David, J. Goodman, M.H. Griffiths et al. 2018. *Conservation status of New Zealand freshwater fishes, 2017*. Publishing Team, Department of Conservation.

Table 1 – Indigenous freshwater fish species present in the Otago region
The table provides information on the species' distribution relative to the Otago region. It details the estimated area occupied for threatened species at the national scale.

Conservation status	Taxon	Common name	Distribution in Otago[8]	𝒜[9]
Nationally Critical	*Galaxias cobitinis*	Lowland longjaw galaxias	Kauru and Kakanui Rivers	≤100
	Galaxias "species D"	Clutha flathead galaxias	Cardrona River, Lindis River, Clutha tributaries above Lake Dunstan, Bannock Burn, Manor Burn, Pool Burn, Benger Burn, Tributaries of Tokomairiro, lower Clutha, Catlins, Purakanui, Tahakopa and Waikawa rivers, and Karoro, and Longbeach creeks	≤100
	Galaxias "Teviot"	Teviot flathead galaxias	Teviot River tributaries and Taieri River tributary	1
	Neochanna burrowsius	Canterbury mudfish	Waitaki River south bank tributaries	≤100
Nationally Endangered	*Galaxias anomalus*	Roundhead galaxias	Taieri and Manuherikia tributaries	≤100
	Galaxias eldoni	Eldons galaxias	Taieri and Tokomairiro River tributaries	≤10
	Galaxias "Nevis"	Nevis galaxias (Nevis River)	Nevis River	≤10
	Galaxias aff. *Paucispondylus* "Manuherikia"	Alpine galaxias (Manuherikia River)	Manuherikia River above Falls Dam	≤10
	Galaxias pullus	Dusky galaxias	Lower Clutha and Taieri River tributaries	≤10
Nationally Vulnerable	*Galaxias depressiceps*	Flathead galaxias	Shag/ Waihemo, Waikouaiti, Taieri, Tokomairiro river tributaries, Akatore Creek	≤100
	Galaxias gollumoides	Gollum galaxias	Cardrona River, Lindis River, Clutha tributaries above Lake Dunstan, Bannock Burn, Manor Burn, Pool Burn, Benger Burn. Tributaries of Tokomairiro, lower Clutha, Catlins, Purakanui, Tahakopa and Waikawa rivers, and Karoro, and Longbeach creeks	≤100
	Galaxias aff. *Paucispondylus* "Southland"	Alpine galaxias (Southland)	Von and Lochy Rivers	≤1000
	Galaxia "Pomahaka"	Pomahaka galaxias	Pomahaka River	≤100
	Galaxias "southern"	Southern flathead galaxias	Von River	≤100
	Geotria australis	Lamprey	Akatore Creek tributary, Careys Creek, Catlins River and tributaries, Clutha River and tributaries, Kaikorai Stream, Kakanui River and tributaries, Kurinui Creek, Orokonui Creek, Purakaunui River and tributaries, Shag River, Takahopa River and tributaries, Taiero River and tributaries, Tautuku River and tributaries, East and West branches of the Tokomairiro, Trotters Creek, Waianakarua, Waikouaiti and Waitaki rivers	≤100
At Risk-Declining	*Anguilla dieffenbachii*	Longfin eel	Widespread across region	>10,000
	Cheimarrichthys fosteri	Torrentfish	Clutha river and tributaries, Kakanui river, Karoro Creek, Shag, Waikouaiti, Waitaki and Wainakarua rivers, Waikoura creek	>10,000
	Galaxias argenteus	Giant kokopu	Akatore Creek, Catlins and Clutha rivers and tributaries, Leith stream, Orokonui creek, Taieri river and tributaries, Fleming river, Trotters Creek, Waitati river, Wangaloa Creek	≤10,000
	Galaxias brevipinnis	Koaro	Akatore creek and tribs, Big Creek, Bull creek, Careys Ck, Catlins river, Clutha river and tributaries, Tutu and Hinahina streams, Kakanui river and tributaries, Leith Stream, Orokonui Creek, Purakanui Creek, Shag River and tributaries, Takahopa river and tributaries, Taieri river and tributaries, Tautuku river and tributaries, Tomahawk Lagoon, Trotters Creek, Waianakarua River, Waikouaiti river and tributaries, Waitangi stream, Waitati river and Sample Burn	>10,000

[8] Modified from Dunn, N.R. *Evidence of Dr Nicholas Rex Dunn on behalf of the Director-General of Conservation/Tumuaki Ahurei dated 5th February 2021*.
[9] 𝒜: Area occupied (ha). *In* Dunn et al 2018.

Conservation status	**Taxon**	**Common name**	**Distribution in Otago[8]**	$\mathcal{A}$[9]
	Galaxias maculatus	Īnanga/īnaka	Widespread in lower reaches and estuaries of rivers, streams and creeks - Akatore, Bull, Careys,Drivers, Jennings, Karoro, Orokonui, Purakanui, Shagree, Taylors, Tomahawk, Trotters, Weipers, Stewarts and Wangaloa creeks, Catlins, Clutha, Kakanui, Purakaunui, Taieri, takahopa, Waianakarua, Waikouaiti, Waitaki, Waitati rivers, Kaikorai and Leith Streams	>10,000
	Galaxias vulgaris	Canterbury galaxias	Kakanui river and tributaries, Kurinui Creek, Trotters Creek, Waianakarua River and tributaries, Waitaki River	≤1,000
	Gobiomorphus hubbsi	Bluegill bully	Lower reaches of Kakanui River, Karoro Creek, Leith Stream, Orokonui Creek, Purakanui and Trotters Creek, Purakaunui, Shag, Waianakarua, Waikouaiti, Waitati and Waitaki rivers, Waikoura creek	>10,000
At Risk-Naturally Uncommon	*Gobiomorphus gobioides*	Giant bully	Lower reaches of Careys Crrk, Clutha River and tributaries, Kakanui River and tributaries, Orokonui Creek, Watkin Creek, Purakanui Creek, Tomahawk Lagoon, Trotters Creek, Waianakarua, Waikouaiti, Waitati amd Waitaki rivers	
	Stokellia anisodon	Stokells smelt	Waitaki River	
Not Threatened	*Aldrichetta forsteri*	Yelloweye mullet	Low reaches and estuaries of the Shag River, Waianakarua River, Lake Waihola ,Taieri and Clutha rivers, Tokomairiro River, Kaikorai Lagoon streams	
	Anguilla australis	Shortfin eel	Akatore, Careys, Orokonui, Trotters and Wangaloa creeks, Catlins, Clutha, Kakanui, Pleasant, Purakaunui, Shag, Taieri, Tautuku, Tokomairiro, Waianakarua, Waikouaiti, Waitaki, and Waitati rivers and tributaries, Kaikorai and Leith streams, Lake Waihola, Lake Waipouri, Lake Tuakitoto	
	Galaxias fasciatus	Banded kokopu	Low reaches of catchments from Takahopa River to Careys Creek, Waikouaiti and Kakanui Rivers	
	Gobiomorphus breviceps	Upland bully	Clutha, Kakanui, Shag, Taieri, Tokomairiro, Waianakarua, Waikouaiti, Waitaki rivers and tributaries, Waikoura, Trotters, Oamaru, Landon, Kurinui, Kakaho and Akatore creeks	
	Gobiomorphus cotidianus	Common bully	Widespread across region	
	Gobiomorphus huttoni	Redfin bully	Low reaches of rivers and creeks across region	
	Retropinna retropinna	Common smelt	Low reaches of main water bodies except in Clutha river where recorded up to Roxburgh dam	
	Rhombosolea retiaria	Black flounder	Low reaches of Careys creek, Catlins, Clutha, Purakaunui, Shag, Takahopa, Taieri, Tautuku, Tokomairiro, Waianakarua, Waikouaiti and Waitaki rivers, Kaikorai stream	

Non-diadromous galaxiids

45. To assess the non-diadromous galaxiid species in Otago and their importance, I rely in part on the evidence of Dr Nicholas Dunn provided on behalf of the Director-General of Conservation for Otago Regional Council proposed Plan Change 7, dated 5th February 2021[10].

46. Endemic non-diadromous galaxiids are highly significant within the New Zealand freshwater fish fauna. There are 22 taxa considered to be 'Threatened' in the 2018 conservation status assessment (Dunn et al 2018). Twenty of these (or 91%) are non-diadromous galaxiids, and fourteen of these occur in the Otago region.

47. Some of the non-diadromous galaxiid taxa present in the Otago region are endemic to, or predominantly occur in Otago. Other taxa predominantly occur in the Canterbury or Southland regions, but have subpopulations[11] in the Otago region (Figure 1).

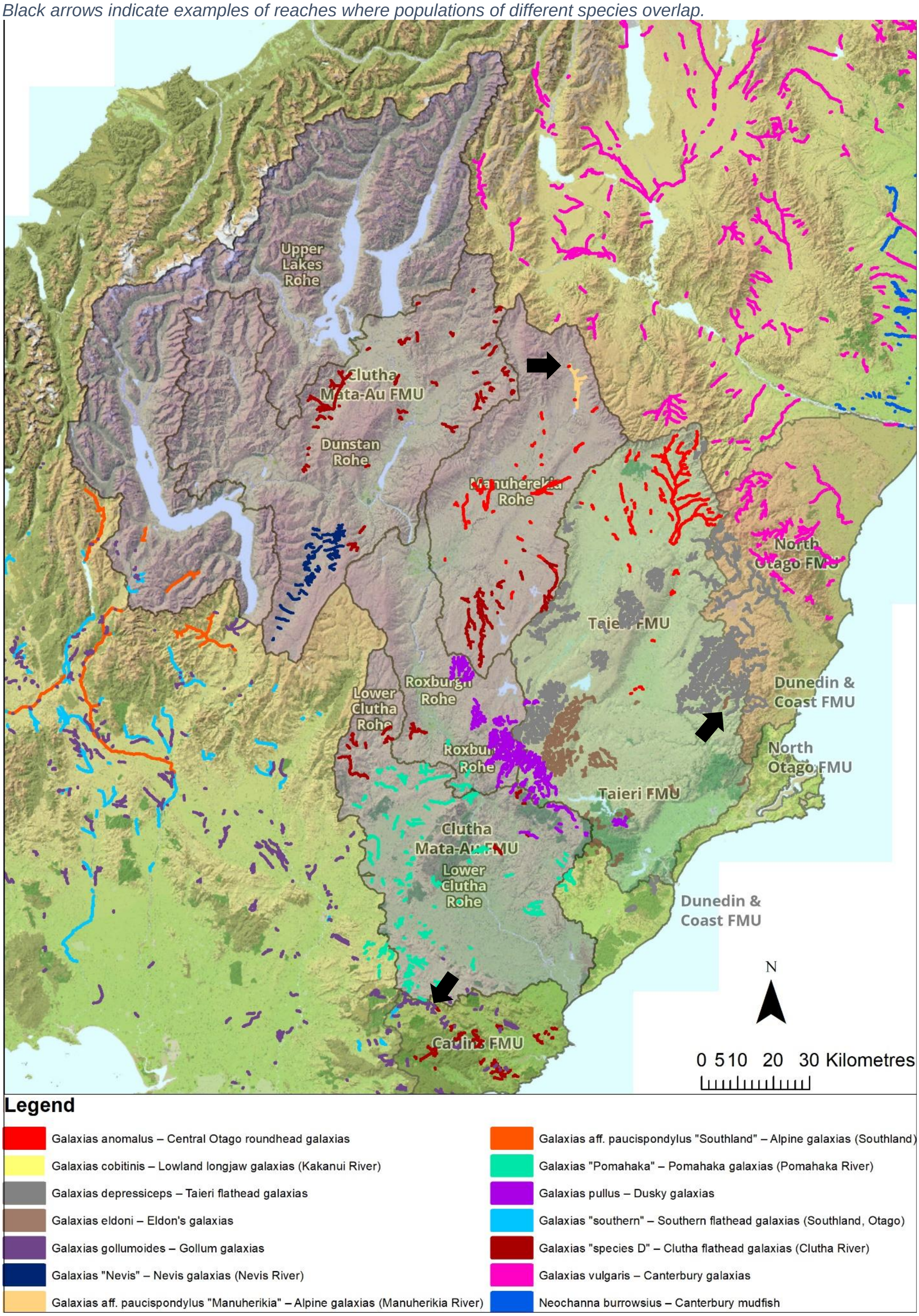
48. The Canterbury mudfish (*Neochanna burrowsius*) excepted[12], non-diadromous galaxiids in Otago are all stream dwellers and many have very flexible habitat usage. However, different species occupy streams with different typologies. Central Otago roundhead galaxias and southern flathead galaxias are known to primarily occupy low-gradient streams with dominantly gravel and cobble substrates; Eldon's galaxias and dusky galaxias occupy a broad range of low- to high-gradient streams with stable beds often dominated by boulder and bedrock substrates; while lowland longjaw galaxias are thought to prefer braided riverbeds and reside amongst cobbles and gravel in shallow riffle areas.

[10] https://environmentcourt.govt.nz/assets/Documents/Publications/2021-02-05-D-G-Conservation-evidence-Nicholas-Dunn-freshwater-ecology.pdf

[11] Hitchmough et al (2007) define subpopulation as: "geographically or otherwise distinct groups in the population between which there is little exchange (typically one successful migrant individual of gamete per year or less)". For non-migratory freshwater fish, a subpopulation is considered to be contained within a single catchment, e.g., the Clutha River/ Mata Au catchment or Taieri River catchment. A sub-population consists of one or more local populations.

[12] In Otago, the species has been found in tributaries and ponds in the lower reaches of the Waitaki River.

Figure 1 – Distribution of non-diadromous galaxiids present in the Otago Region
Black arrows indicate examples of reaches where populations of different species overlap.



49. Non-diadromous galaxiids face a range of anthropogenic threats stemming from changes in land use, agricultural intensification, water abstraction, and the introduction of sports fish.

50. Habitat alteration is one of the major threats to non-diadromous galaxiids. Human modifications have significantly altered the hydrological environment, leading to increased sedimentation, changes in natural flows, and reduction in the amount and quality of spawning habitat. Other habitat disturbances include stock access to streams, reduction of native vegetation, land development and forest harvesting.

51. Negative biological interactions (i.e., competition and predation) with introduced species also pose significant conservation issues in catchments containing non-diadromous galaxiids. Where they occur, interactions between non-diadromous galaxiids and introduced salmonids are significant threats to the persistence of non-diadromous galaxiids and lead to range reduction and population fragmentation. However, the magnitude of this threat is unknown.

52. Many non-diadromous galaxiid populations exist today in areas inaccessible to salmonids due to the presence of natural or built barriers. Occasional failure of these barriers can allow salmonid incursions that are followed by corresponding declines in galaxiid distributions.

53. The constriction of habitat use of non-diadromous galaxiids is most commonly caused by brown trout, and to a lesser extent by brook char and occasionally rainbow trout. Furthermore, comparison of habitat use by several non-diadromous galaxiid species in areas with and without brown trout suggests that these species might be able to utilise a greater range of habitat in the absence of trout. This has been suggested for Taieri flathead galaxias *G. depressiceps*[13] and has recently been demonstrated for Canterbury galaxias *G. vulgaris* and alpine galaxias *G. pauscipondylus*[14].

[13] Baker CF, Jowett IG, Allibone RM 2003. Habitat use by nonmigratory Otago galaxiids and implications for water management. Science for Conservation 221. Wellington, Department of Conservation. 34 p.
[14] Short communication, Department of Conservation, September 2022. Available at https://www.doc.govt.nz/globalassets/documents/conservation/land-and-freshwater/freshwater/trout-influences-on-non-migratory-galaxiids-report.pdf

54. Anthropogenic impacts do not occur in isolation, and responses of non-diadromous populations result from the interaction of different pressures. For example, the research cited above also examined the effects of reduced river flows and trout density on Canterbury galaxias *G. vulgaris* and alpine galaxias *G. pauscipondylus*, and shows that while these species can survive in areas with low flows (i.e. less accessible to predatory trout), they thrive in habitats with consistent flow where trout is absent[15].

55. Protecting a wide range of habitats is critical for ensuring the security of fragile species. The significance of threatened non-diadromous galaxiids in the Otago Region highlights the importance of planning instruments such as the pORPS 2021 relating to them or their habitats, in order to ensure their continued persistence and ongoing management.

56. Braided rivers, headwaters, spring-fed streams, small tributaries and backwaters are important habitats for the protection and persistence of non-diadromous galaxiids, but these habitats tend to have a small footprint at the catchment scale and are often fragmented. Catchment-wide provisions and minimum flows will not adequately protect these types of habitats, leaving populations of non-diadromous galaxiids highly vulnerable to local extinction, particularly in the case of small and highly fragmented populations, such as *Galaxias* “species D", which has populations typically found in small tributary streams of larger rivers such as the Clutha Mata-Au, Lindis and Cardrona that are separated by river reaches containing predatory salmonids.

57. Fish passage provisions in the pORPS 2021 seek to restore connectivity and provide for highly mobile species. However, careful consideration of maintaining existing instream barriers to trout or, in some cases, constructing and modifying instream barriers to prevent trout access, is critical for protecting non-diadromous galaxiids given the risk of salmonid incursions into their habitats. Built barriers and salmonid removal are commonly used methods to protect non-

[15] McIntosh A. In prep. *Trout influences on non-migratory galaxiids under natural and reduced flow conditions*. University of Canterbury.

diadromous galaxiids and should be provided for in pORPS policies (e.g. LF-FW-P14).

Diadromous species

58. Diadromous species are all characterised by complex life histories in which movement between sea and freshwater is pivotal. In the Otago region, three types of diadromous life cycles are found among indigenous freshwater fish species (Supplementary table S1):

- Amphidromy: whitebait species (e.g., īnaka, giant kōkopu), bullies, smelt and torrentfish are amphidromous. Adults mature and spawn in freshwater, while larval growth occurs at sea. Important research gaps on various aspects of reproduction exist for most amphidromous species, including about spawning behaviour, timing and spatiotemporal variability of spawning events across catchments, ecological triggers and factors affecting spawning success.
- Catadromy: indigenous eels *Anguilla spp.* have this life cycle. Mature adults undertake a once-in-a-lifetime migration to oceanic spawning grounds. Larvae hatch at sea and spend a few months migrating back to freshwater where they recruit as glass eels. Juvenile eels (elvers) move upstream to their foraging grounds, where they will spend up to several decades to reach maturity and metamorphose into silver eels (migrant adults).
- Anadromy is found in lamprey *G. australis*. Lamprey spend several years at sea feeding parasitically on other fish. They enter freshwater as immature adults and spend months reaching sexual maturity and migrating upstream to small hard-bottomed streams where they spawn and die. Larvae spend around 4 years as filter feeders in freshwater buried in fine sediments before metamorphosing into miniature adults which travel downstream to their oceanic life.

59. Some diadromous species, including the five migratory galaxiid species[16], can form non-diadromous populations, where larvae are entrained and rear in slow-moving freshwater environments instead of at sea. Landlocked populations may develop where physical connections to the sea are lost over time. However, non-diadromous and diadromous populations of the same species can also cooccur, for example in the Waihola-Waipori wetland complex where both diadromous and non-diadromous common bully *Gobiomorphus cotidianu*s populations are present[17].

60. There are several threatened diadromous species present in Otago, including one Threatened – Nationally Vulnerable, six At Risk – Declining, and two At Risk – Naturally Uncommon (Table 1 above).

61. While diadromous life cycles are broadly understood, there are many unknowns in species-specific ecological requirements, even for species such as eels and whitebait that have good representation at the national scale. Knowledge gaps vary from species to species, but the most common gaps relate to spawning and larval rearing habitats, stream selection processes, ecological requirements, and timing, triggers, and success of critical life events (e.g., spawning of whitebait species, downstream migration of reproductive eels, upstream migration of lamprey).

62. Diadromous species are vulnerable to many human-driven pressures, including habitat degradation and loss, reduced connectivity and impediment of free movement within catchments through man-made instream structures, changes in water quantity and quality, introduced species and harvest. Climate change and disease are emerging threats.

63. These pressures and the interaction between them have broad direct and indirect impacts on diadromous species and their habitats, although the extent of those impacts is largely unknown. For example, alteration of hydrological regimes and sea level rise might affect ecological outcomes by altering the

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[16] Īnaka, kōaro, banded kōkopu, giant kōkopu and shortjaw kōkopu

[17] Closs G.P, M. Smith M, B. Barry & A. Markwitz (2003) *Non-diadromous recruitment in coastal populations of common bully (Gobiomorphus cotidianus)*, New Zealand Journal of Marine and Freshwater Research, 37:2, 301-313, DOI: 10.1080/00288330.2003.9517168

quality and distribution of coastal habitats, thereby affecting the life cycles and behaviours of indigenous freshwater species that use these habitats at critical life stages (e.g. larval rearing of whitebait species) or life cycle events (e.g. īnaka spawning).

64. Approaches to species management, habitat restoration, connectivity improvement and, more generally, threat mitigation, usually focus on freshwater life stages, as oceanic life stages are often difficult to investigate and manage. However, these approaches often rely on incomplete information and guidance.

65. It is important for the pORPS 2021 to circumvent the knowledge gaps that exist, e.g., around the current distribution of critical habitats (spawning grounds of most amphidromous species, spawning and larval rearing habitats for lamprey, etc.), to ensure the persistence of indigenous diadromous species. This means that the pORPS 2021 should protect these freshwater habitats and species in their own right (e.g., policies LF-FW-P13, LF-FW-P14, ECO-P3, ECO-P6, ECO-P8, and the APP2 significance criteria), and not be dependent on them being mapped or otherwise already identified in the pORPS 2021 or regional plans.

66. Several species distribution models that rely on survey data and macro-habitat distribution have been developed[18]. While this approach can be useful at the national and regional scales, local implementation requires knowledge of the extent, integrity, and rate of change of mesohabitats[19], in relation with associated life stages.

67. For all indigenous freshwater species, effective management strategies rely on targeting critical habitats, critical life stages, or both, at an appropriate scale. For diadromous species, an important aspect of management also requires having

[18] See for instance:
Canning AD. 2018. *Predicting New Zealand riverine fish reference assemblages*. PeerJ, 6, p.e4890
Leathwick, J.R., Rowe, D., Richardson, J., Elith, J. and Hastie, T. 2005. *Using multivariate adaptive regression splines to predict the distributions of New Zealand's freshwater diadromous fish*. Freshwater Biology, 50(12), pp.2034-2052.
White R., R. Stoffles and A. Whitehead. 2022. *State and trends of New Zealand's freshwater fishes to support the 2022 Threat Classification*. NIWA Client Report No 2022105CH, May 2022. 90 p.
[19] Mesohabitats are visually distinct units of habitat within a stream. Riffles, pools, rapids and runs are examples of mesohabitats.

functional catchment connectivity to ensure they can undertake their upstream and downstream migrations.

68. This means that the ki uta ki tai mountains to sea approach to the pORPS 2021 is necessary to ensure the persistence of these species in the Region. However, in some cases, this approach might conflict with the management of non-diadromous populations, in particular, fragile non-diadromous galaxiids.

Other freshwater values

69. An important gap, in my view, in the Wildland Consultants Contract Report No. 5015b is the failure to identify freshwater values related to aquatic macroinvertebrates.

70. Benthic macroinvertebrates are organisms without backbones that live on or within the streambed substrata. Aquatic invertebrates found in rivers include insect nymphs/larvae (e.g., mayflies, stoneflies, caddisflies, etc.), aquatic oligochaetes (worms), crustaceans (e.g., shrimps and crayfish), and molluscs (e.g., snails).

71. There are 14 threatened freshwater invertebrates present in Otago (Table 2, Figure 2), with eight species listed as Nationally Critical, two Nationally Endangered, two Nationally Vulnerable and two Declining[20]. This overall represents 8% of the threatened freshwater invertebrate fauna of New Zealand (177 threatened taxa).

[20] Grainger N, Harding J, Drinan T, Collier K, Smith B, Death R, Makan T, J Rolfe. 2018. *Conservation status of New Zealand freshwater invertebrates*. New Zealand Threat Classification Series 28. Wellington: Department of Conservation; 25p.

Table 2 – List of threatened macroinvertebrate taxa in the Otago Region

Conservation status (Grainger et al 2018)	**Common name**	**Scientific Name**
Threatened - Nationally Critical	**Caddisfly**	*Oeconesus angustus* (Ward, 1997)
	Clam shrimp	*Eulimnadia marplesi* (Timms & McLay, 2006)
	Stonefly	*Nesoperla patricki* (McLellan, 2003)
		Taraperla johnsi (McLellan, 2003)
		Vesicaperla trilinea (McLellan, 2003)
		Zelandobius crawfordi (McLellan, 2008)
		Zelandobius edwardsi (McLellan, 2008)
		Zelandobius mariae (McLellan, 1993)
Threatened – Nationally Endangered	**Caddisfly**	*Olinga fumosa* (Wise, 1958)
		Pseudoeconesus 22aludism (Ward, 1997)
Threatened - Nationally Vulnerable	**Caddisfly**	*Edpercivalia tahatika* (Ward, 2005)
		Pseudoeconesus n. sp. T
At Risk - Declining	**Crayfish/kōura**	*Paranephrops zealandicus* (White, 1847)
	Mussel	*Echyridella menziesii* (Dieffenbach, 1843)

72. Drinan et al (2021) remark that most freshwater invertebrate taxa are listed as either Not Threatened or Data Deficient. This is due in part to insufficient data on taxa distributions and on the status and trend of populations, in addition to a lack of ecological and taxonomic information, as a large number of species remain undiscovered and undescribed[21].

73. Macroinvertebrates occupy a niche as primary consumers, feeding mostly on periphyton, detritus (i.e., leaf litter, dead wood, decomposing macrophytes, etc.), or other invertebrates. In turn, they are predated upon by fish and other vertebrates, such as waterfowl. In addition to their intrinsic value, macroinvertebrates are important for processing organic matter and primary productivity and passing it on to higher trophic levels (i.e., predatory organisms).

[21] Drinan TJ, NPJ Grainger, JS Harding, KJ Collier, BJ Smith, RG Death, T Makan, JR Rolfe. 2021. *Analysis of the conservation status of New Zealand freshwater invertebrates: temporal changes, knowledge gaps, impediments, and management implications*, New Zealand Journal of Zoology, 48:1, 81-96, DOI: 10.1080/03014223.2020.1778044

Some macroinvertebrates also have important cultural and recreational values. Freshwater mussels kākahi (*Echyridella menziesi*) and freshwater crayfish kōura (*Paranephrops zealandicus*) are valuable mahika kai and taoka species.

74. Kākahi (freshwater mussels) form beds in lakes and rivers, living shallowly buried in soft substrates. They are relatively common and widespread throughout New Zealand, in habitats ranging from small, fast-flowing streams to lakes. However, few records exist in Otago, most originating from the Auckland Museum Freshwater Invertebrate Data database. Kākahi larvae are parasitic, latching on to fish around the gills, head or fins. At the end of their parasitic phase, individuals burrow around 10cm in the streambed substrate, living hidden for around five years before they slowly make their way upwards. Freshwater mussels are declining, both in New Zealand and worldwide. Key threats include loss of habitat associated with altered flow regimes, eutrophication and other types of pollution, and possibly loss of the host fish on which their life cycle depends.

75. There are two kōura (freshwater crayfish) species found in New Zealand, one (*Paranephrops zealandicus*) in Otago. Kōura are common in bush-covered and farmland streams of moderate to good water quality, usually found amongst the shelter of stones, woody debris or weed beds in pools and areas of slow or no flow in streams and lakes. They are omnivores, eating mostly plant matter, but also occasionally preying on other invertebrates. Kōura are vulnerable to predation from introduced species, such as trout, catfish, and perch. Nisikawa and Townsend (2000)[22] found that brown trout were the main factor affecting kōura abundance, particularly of small individuals.

76. The ecological quality of a stream can be assessed using indices based on macroinvertebrate communities. The macroinvertebrate community index (MCI) and similar biotic indices are commonly used as indicators of water quality and overall stream health in New Zealand. Biotic indices incorporate the sensitivity to pollution and habitat disturbance for various types of organisms, and the

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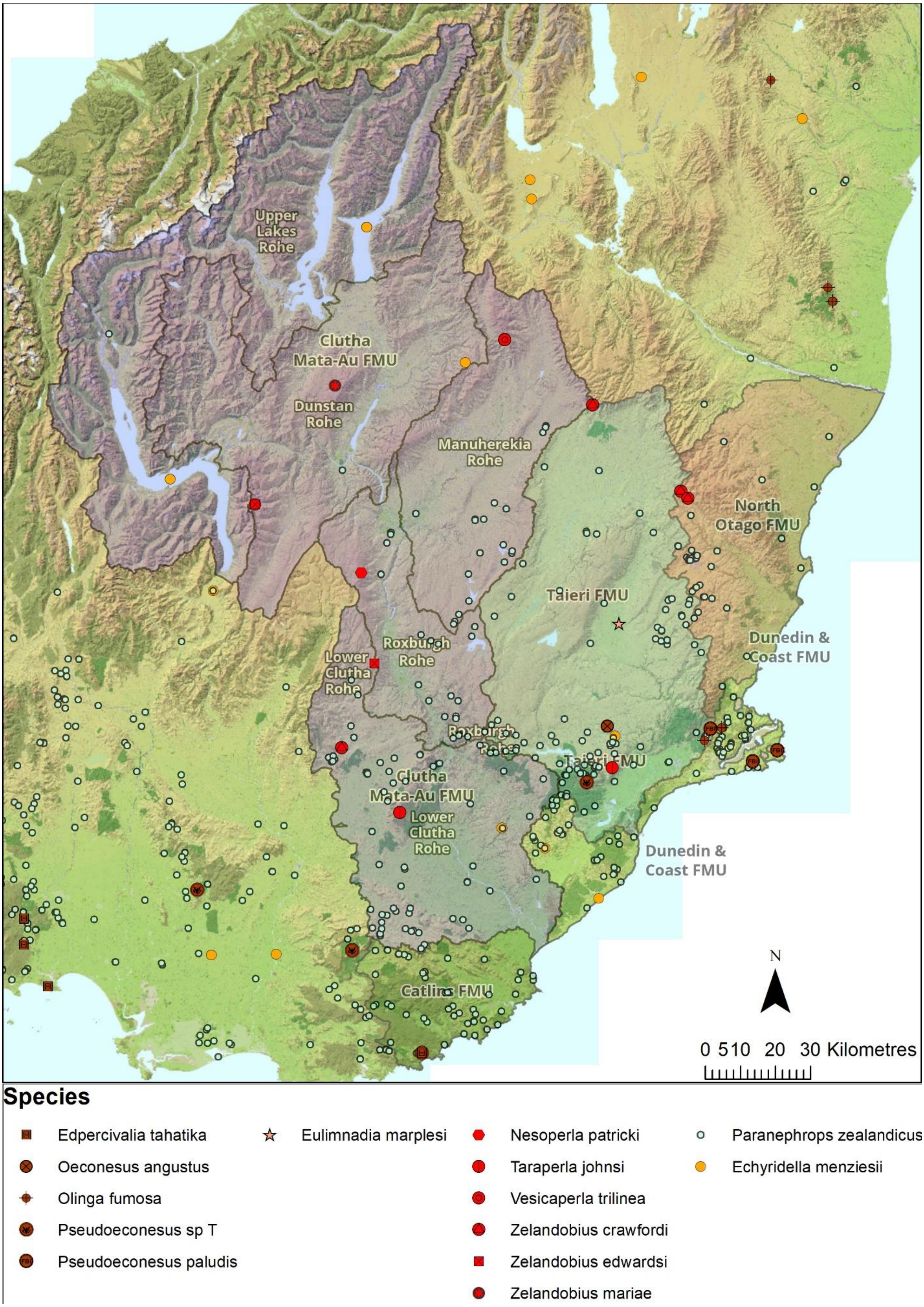
[22] Nisikawa, U., Townsend, C. R. 2000. *Distribution of the New Zealand crayfish Paranephrops zealandicus in relation to stream physico-chemistry, predatory fish, and invertebrate prey*. New Zealand Journal of Marine and Freshwater Research 34: 557-567.

distribution of taxa according to the degree of human impact[23], therefore they are regionally specific.

77. I believe that significant kākahi and kōura populations, as well as MCI scores and trends can successfully be used in the pORPS 2021 to identify other significant natural areas in freshwater based on macroinvertebrate communities. Examples would include them triggering criteria under APP1 (outstanding water bodies) or APP2 (significant indigenous biodiversity), or their use in Regional Council monitoring under LF-FW-M9.

[23] Stark JD, Maxted JR 2007. *A user guide for the Macroinvertebrate Community Index.* Prepared for the Ministry for the Environment. Cawthron Report No.1166. 58 p.

Figure 2 – Distribution of Threatened and At Risk macroinvertebrates taxa in the Otago Region



Introduced fish

78. Introduced species, including sports fish, have complex effects on freshwater ecosystems and species. They can prey on indigenous fish and invertebrates and displace other fauna through competition for resources, altering food web form and function. For instance, trout compete for habitat and food not only with indigenous fish such as giant kōkopu and eels, but also with other consumers of macroinvertebrates such as whio/blue duck – although small trout might also be a source of food for these species.

79. The extent of the impact of introduced fish on indigenous biodiversity is unknown but is likely significant. For example, brown trout is considered one of the most invasive species on the planet by the Invasive Species Specialist Group of the International Union for Conservation of Nature[24].

80. Although sports fish are "desirable" species for recreation, it is important that their protection through the pORPS 2021 provisions is not to the detriment of indigenous species. For example, brown trout and other salmonids benefit from the maintenance of good connectivity between their oceanic and freshwater habitats. Good connectivity increases their chances to colonise areas beyond their original introduction range. As outlined in paragraph 57, fish passage provisions in the pORPS 2021 must take into consideration potential gains for highly mobile species against the protection of fragile non-diadromous galaxiid populations.

81. I discuss some aspects of introduced salmonids management in paragraphs 132 to 140.

Significant freshwater ecosystems in the Otago Region

82. In preparing this section, I reviewed the reports issued by Wildland Consultants (Wildland Reports 2020a and 2021b).

83. It is my view that the Wildlands Report 2020a provides a clear and useful overview of the biodiversity values present in the Otago Region. The Wildlands

[24] Lowe, S., Browne, M., Boudjelas, S. and De Poorter, M., 2000. *100 of the world's worst invasive alien species: a selection from the global invasive species database (Vol. 12)*. Auckland: Invasive Species Specialist Group.

Report 2021b provides an appropriate overview of the freshwater systems of the Otago Region and their value at the national level.

84. I consider that Wildlands Consultants used appropriate methods to identify outstanding water bodies and areas of significant indigenous biodiversity. They used publicly available databases (New Zealand Freshwater Fish Database and Freshwater Ecosystems of New Zealand (FENZ) (Department of Conservation) to identify stream reaches and lake habitats that contain nationally Threatened fish species and high-ranking catchments in Otago, both on a national scale and regional scale. I also support the inclusion of known īnaka spawning habitats in the list of significant natural areas.

85. Wildlands Consultants correctly acknowledge, in my view, that the identified significant habitats are a starting point in evaluating sites in terms of RMA section 6(c), and that bridging information gaps through further fauna surveys will improve the quality of the information used in those processes.

86. I support Wildland Consultants' assessment that many of the region's freshwater ecosystems, lakes, rivers, streams, from source to estuary, wetlands, including ephemeral wetlands are of national or regional significance, based on records of Threatened indigenous fish, and FENZ catchments that are ranked in the top 10% regionally or nationally.

87. While I noted some errors regarding identification of freshwater fish values present in the region – which are corrected in this evidence (see paragraphs 40-44) – I consider that most of Wildlands Consultants' general methodology and results in identifying significant habitats for indigenous fish fauna in freshwater ecosystems stand, since those errors lie in misidentification of taxa which belong to the same taxonomic group of Threatened taxa (i.e., non-migratory galaxiids[25]).

88. I note, however, that some significant habitats might currently be overlooked in the pORPS, based on 1) these misidentified non-diadromous galaxiid, particularly in areas where populations of different species overlap, and 2) disregarded macroinvertebrate taxa. For example, populations of roundhead

[25] The only non-diadromous species in Otago that does not have a Threatened status is Canterbury galaxias which is At Risk – Declining.

galaxias and alpine galaxias “Manuherikia” overlap at the confluence of the East and West branches of the Manuherikia River, which has not been captured using the methodology in Wildlands Report 2020a (see Figure 1). Similarly, it appears that only one of the reaches where populations of Eldon’s galaxias and Taieri flathead galaxias overlap has been identified in that report, missing a tributary of Three O’Clock Stream. The Nationally Critical stonefly *Zelandobius mariae* is only known from three locations close together in the Kirtle Burn in the Pisa Range (Figure 2), which does not seem identified in Wildlands Report 2020a.

Climate change

89. The s42A report identifies potential environmental impacts of climate change on indigenous biodiversity but fails to sufficiently link it to aquatic species.

90. Many of the risks outlined for marine and coastal ecosystems are the same for freshwater species. For freshwater and estuarine biodiversity, climate change-related risks also include increasing risks of incidence, transmission and impacts of parasites and pathogens, higher amplitude in temperature fluctuations, and higher oxygen demand that particularly impact aquatic communities in freshwater and coastal systems, particularly in shallow waters. Hydrological regime changes might affect life cycles and behaviours of aquatic species, e.g., by displacing or altering spawning habitat quality.

91. Climate change impacts are complex and far reaching. It is likely that changes in temperature and flow regimes will have cumulative effects, making it difficult to predict the response of populations and communities more generally.

92. The pORPS 2021 acknowledges the need to integrate climate change in its strategy and details objectives and policies to address impacts in the IM – Integrated management chapter. I provide one example in support of this approach in paragraph 102.

Pest species and the threat to indigenous biodiversity, economic activities and landscapes.

93. I agree with the statement, context and impact snapshot of the threats posed by pest species provided in section SRMR-I3 of the pORPS.

94. I illustrate the notion that some pest species and parasites might affect ecosystems from mountains to sea by analysing the issue of environmental transmission of toxoplasmosis in regard to wildlife, see paragraphs 106 to 113.

IM – Integrated management

95. In this section I discuss the reasons why I support the principles and general policies of integrated management highlighted in the pORPS 2021. I also highlight the weaknesses that stem from the pORPS 2021 subsequent structure, which addresses the Coastal Environment, Land and Freshwater, and Ecosystems and indigenous biodiversity separately.

96. I understand that following a High Court decision, the Otago Regional Council cannot process the whole of the pORPS 2021 as a single freshwater planning instrument and that policies that directly relate to the maintenance or enhancement of freshwater quality or quantity are not included in the current parts of the pORPS 2021 that I am giving evidence on.

97. I support the general objectives outlined in the pORPS 2021 regarding the adoption of an integrated approach to resource management. I understand the IM chapter to be based on the notion that land, water and sea are interconnected and interdependent, and note that the proposed policies endeavour to give effect to a ki uta ki tai, “mountains to sea” management strategy (as stated in IM-O2 – ki uta ki tai).

98. Developing domain-specific policies without accounting for this interconnectedness would lead to poor environmental outcomes, in direct contradiction with the central tenet of the pORPS 2021, *“seeing the environment as a single connected system, ki uta ki tai”*. A ki uta ki tai management approach therefore cannot forgo the integration of freshwater ecosystems in decision making if it is to ensure the persistence of many indigenous freshwater species, particularly diadromous taxa.

Management of īnaka spawning habitats

99. Īnaka spawning habitat management provides an example of the need to manage terrestrial, freshwater and coastal systems in an integrated way.

100. Īnaka spawning grounds occur in very specific locations in the aquatic landscape, most of which are out-of-water most of the time. Nearly all known spawning sites are located close to the high-water mark on riparian margins that are periodically inundated due to water level fluctuations, most often generated by spring high tides. Spawning sites may occupy slightly different positions within the same general location of a waterway as a result of varying water levels and vegetation conditions during different spawning events.

101. Spawning grounds have been located in the downstream reaches of both tidal and non-tidal rivers. There is additional evidence of spawning grounds associated with the margins of tidally influenced and intermittently open coastal lakes and lagoons. For example, spawning has been recorded near the outlets of Lakes Waipori and Waihola, which are tidally influenced. While there is no confirmed record of spawning grounds in landlocked lakes, the existence of landlocked īnaka populations means it is reasonable to expect that periodically inundated riparian zones or perhaps emergent lakeshore vegetation would support īnaka spawning in landlocked lakes, given that these places provide spawning habitat in intermittently open lakes[26].

102. These characteristics illustrate the inadequacy of partitioning management of īnaka spawning grounds between terrestrial, freshwater and coastal domains. Īnaka spawning locations are vulnerable to a wide range of human activities both land- and freshwater-based, such as weed control, stock grazing, channel vegetation clearance, flood control works, and altered flow regimes. In the foreseeable future, sea level rise and other climate change effects might further alter the quality and quantity of available spawning grounds.

103. As it currently stands, management of īnaka spawning grounds would rely on methods scattered across chapters in the pORPS 2021 with no clear linkage

[26] Orchard S. 2022. *A history of surveying īnaka(whitebait) spawning grounds in Aotearoa New Zealand*. Department of Conservation. 40 p. and references within.

between them, such as CE-M2 (identification of areas and values of high and outstanding natural character, natural features and indigenous biodiversity), CE-M5 (use of mechanisms and incentives to help achieve policy in the coastal environment), LF-FW-M5 (outstanding water bodies), and LF-LS-M13 (management of bed and riparian margins).

104. For the protection of īnaka spawning habitats in statutory plans, Orchard & Hickford[27] (2021) recommend a tailored approach using a schedule of named sites and GIS-based planning maps to identify īnaka spawning reaches, associated with text definitions that accurately identifies the location of spawning sites at the riverbank scale. The combination of the mapped reaches and text description then acts to define the areas for protection through provisions in statutory planning instruments. The Wildlands Report (2020a) only partially fulfils this recommendation and uses polygons drawn around known spawning locations to encompass areas of suitable habitat, particularly tall rank vegetation.

105. I recommend a more thorough approach to identifying īnaka spawning sites is used during the Freshwater Planning Instrument process, and in the subsequent Land and Water Regional Plan process.

Management of toxoplasmosis transmission in wildlife

106. This section summarises the key issues with toxoplasmosis and implications for management, as outlined in Roberts et al. (2020) [28].

107. *Toxoplasma gondii* is a globally widespread protozoan parasite that can cause the potentially fatal disease toxoplasmosis. Toxoplasmosis can affect humans, domestic animals, livestock and wildlife, including threatened terrestrial and aquatic fauna. In Otago, *toxoplasma* infection has also recently been identified as a casual factor in the death of a New Zealand sea lion (*Phocarctos hookeri*). It

[27] Orchard, S., & Hickford, M. J. H. (2021). *Protected areas for īnaka(whitebait) spawning in statutory plans: A national review*. Envirolink 2143-WCRC199. Report prepared for West Coast Regional Council. 54pp.
[28] Roberts JO, HFE Jones and WD Roe. 2020. *The effects of Toxoplasma gondii on New Zealand wildlife: implications for conservation and management*. Pacific Conservation Biology 27, 208-220

is unknown how many indigenous species might be susceptible to toxoplasmosis, or the overall effect of this disease on indigenous biodiversity[29].

108. *Toxoplasma* oocysts are released into the environment in the faeces of cats (the only known definitive hosts). These oocysts remain infective in soil and freshwater for at least one year, and in seawater for at least six months. Birds and mammals can become infected with *T. gondii* by ingesting contaminated soil, water, plant material or infected prey species. These multiple pathways for infection appear to be facilitated in developed coastal areas, which tend to have high densities of cats, and areas of high freshwater runoff which can transport the parasite from land to sea. Evidence suggests that the parasite could be widespread in the New Zealand environment and is potentially an ecologically significant contaminant that crosses the land-sea boundary.

109. There are two main strategies to reduce *T. gondii* entering the marine environment: reducing the transfer of oocysts from cats to the environment (a complex management issue that I will not develop here) and limiting the transfer into the sea of oocysts already in the environment through interventions focused on hydrological networks. I focus my evidence on the latter.

110. Management strategies aiming at limiting the transport of *T. gondii* oocysts through hydrological networks and into the marine environment rely on wetland restoration, riparian planting and storm/wastewater treatment.

111. Wetlands can reduce the transmission of toxoplasma oocysts into estuarine and coastal environments by slowing water flow and trapping oocysts in sediment, wetland vegetation and associated biofilms. However, the efficacy of wetlands at processing any type of contaminant is dependent on multiple factors, including hydrology, wetland size, location, type of vegetation, and contaminant loading.

112. Current treatment options for stormwater and wastewater appear to have limited efficacy in removing *T. gondii*, but green infrastructure, such as vegetated areas

[29] In addition to negative effects on indigenous biodiversity, there are significant societal and economic costs associated with the impact of toxoplasmosis on agriculture and human health, which I will not develop here as they are not my area of expertise. However, I note that these impacts warrant an integrated approach beyond purely environmental considerations.

or constructed wetlands in stormwater and wastewater treatment plants, may be able to reduce oocyst transmission into waterways.

113. The strategies to contain and manage *T. gondii* transmission throughout the New Zealand environment highlights the need for a concerted and coordinated approach across the terrestrial, freshwater, and coastal domains[30] and across sectors including environment, public health and urban development.

Conclusion on integrated management

114. I concur with Bruce McKinlay's statement in his evidence: *"The more an ecological system is partitioned the less resilient is becomes and the more at risk the constituent parts of the system are at of a perturbation causing irretrievable damage or not returning to a normal state"*.[31] This is particularly important as the remainder of the pORPS 2021 provides separate chapters for Coastal Environment, Land and Freshwater and Ecosystems and biodiversity. Clear linkages in these chapters must be made between objectives, policies, methods and anticipated environmental results to effectively provide protection for indigenous freshwater biodiversity.

CE – Coastal environment

115. The coastal environment is incredibly significant as the interface between oceanic and freshwater life phases for diadromous species. The coastal aquatic environment is used by many freshwater species, at critical life stages and processes. Larval grounds of amphidromous species are located in the coastal area, and spawning grounds of some whitebait species are found in estuaries, coastal lagoons and coastal wetlands.

116. Fish communities in coastal wetlands and lakes are often diverse, due to the presence of indigenous non-diadromous and diadromous species, and a number of introduced species.

[30] It also highlights the intrinsic value of wetlands as a useful management tool that reaches beyond issues related to water quality and quantity and indigenous biodiversity.
[31] Evidence of Bruce McKinlay for Director-General of Conservation dated 23 November 2022, para 133.

117. Shallow coastal lakes and wetlands hold high diversity but can be highly dynamic environments. Absolute and relative abundance of taxa can vary, leading to shifts in the composition of fish communities. This has been attributed to life history and ontogenetic shifts[32] in habitat use, and changes in habitat structure related to the dynamics of submerged macrophyte beds.

118. The pORPS 2021 policies for the coastal environment (CE-P2 to P5) must therefore provide for indigenous freshwater taxa that may transit through and/or temporarily inhabit coastal areas.

119. As highlighted in paragraph 102, the linkages between coastal and freshwater policies and methods could be made more clearly in the pORPS 2021. At the very least, they need to be clearly established between relevant planning instruments (Land and Water Plan and Coastal Plan).

LF – Land and Freshwater

120. This section furthers the arguments made in the IM – Integrated management section (paragraphs 95-98 and 114). As previously stated, the separation of Coastal environment, Land and Freshwater, and Land and Soil from Ecosystems and indigenous biodiversity constitutes a fundamental structural issue for species that rely on all these domains to fulfil their life cycles. This is typically the case for indigenous diadromous species.

121. While some sections in the Land and Freshwater chapter highlight the connectedness between land and water (e.g. LF-LS-M13 – Management of beds and riparian margins), a full integration of the Land and Freshwater chapter into Ecosystems and Indigenous Biodiversity would better promote integrated management of the natural resources of Otago.

Outstanding water bodies

122. Outstanding water bodies for the Otago Region are listed in policy LF-FW-P11 of the pORPS, which reads:

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[32] Ecological phenomenon in which an organism changes its diet or habitat during its development. For example, as explained in paragraph 74, kākahi undergo an ontogenetic shift from a parasitic larval phase to a filter-feeding phase buried in sediment.

"*Otago's outstanding water bodies are:*

(1) the Kawarau River and tributaries described in the Water Conservation (Kawarau) Order 1997,

(2) Lake Wanaka and the outflow and tributaries described in the Lake Wanaka Preservation Act 1973,

(3) any water bodies body or part of a water body identified as being wholly or partly within an outstanding natural feature or landscape in accordance with NFL-P1, and

(4) any other water bodies identified in accordance with APP1."

123. TrustPower suggested amending the proposed criteria for identifying outstanding water bodies in APP1 of the pORPS 2021. This list of criteria was prepared for the Hawke's Bay Regional Council, where freshwater issues might significantly differ from the ones in the Otago Region. In particular, non-diadromous galaxiids do not represent a significant proportion of the indigenous freshwater diversity of the Hawke's Bay region. In my view, the table in the notified pORPS 2021 provided space for expert evaluation and interpretation. By contrast, I find the TrustPower proposed amended table unsatisfactory.

124. The ecology criteria for indigenous fish habitat in the alternative table are stated as follows:

"*Water body provides an outstanding habitat for native fish where it meets:*

- *at least one matter in List A; and*
- *all matters in List B.*

List A

a. *A unique species or distinctive assemblage of native fish not found elsewhere in the region.*
b. *Native fish that are landlocked and not affected by presence of introduced species.*
c. *One of the highest diversities of native fish species in the region, which includes a threatened, endangered, or distinctive species.*

d. An outstanding customary fishery.

List B

a. Evidence is provided in support of outstanding native fish habitat value."

125. I find these criteria too restrictive, as they leave out some critical habitats such as spawning grounds. Furthermore, I find criterion b problematic, as non-diadromous galaxiids are landlocked but in most areas are affected by salmonids.

126. In comparison, habitat criteria for salmonids in the alternative table include population-centric arguments, namely habitat "*critical to maintaining an outstanding angling amenity elsewhere in the catchment*" (i.e. a significant source population), and "*Supports a self-sustaining population of wild trout or salmon*".

127. If this alternative is to be used in the pORPS 2021 I recommend adding to List A the following criterion: *"is critical to the persistence of a threatened species or to the maintenance of a population with threatened status"*.

128. I also note in the alternative table criterion A. c for recreational criteria for angling amenity (trout and salmon) reads:

"*high number of trout (water body support the highest trout numbers in the region or the highest trout biomass in the region*".

129. I consider such a criterion incompatible with the preservation of indigenous freshwater communities, fish and macroinvertebrate, as high trout biomass means high degree of competition and predation on indigenous fauna. In my view it is also incompatible with good quality recreational fisheries, as high trout densities might lead to stunted growth and absence of large fish as a result. This criterion is in my view incompatible overall with the LF-FW chapter of the pORPS.

Preserving and restoring freshwater values

130. I support policies LF-FW-P13 – Preserving natural character and instream values and LF-FW-P14 – Restoring natural character and instream values of the pORPS. I stress the importance of including a fish passage provision which, combined with adequate aquatic habitat protection and restoration measures, would not only help increase the presence and resilience of highly mobile species within river systems but also would help restore the natural behaviours of these water bodies.

131. However, I recommend amending the policy wording that mentions *“creating fish barriers to prevent predation where necessary”* to *“creating fish barriers to prevent incursions from undesirable species where necessary and appropriate”*. This would ensure that creating barriers to fish passage is not seen as a standard approach to management of fragile aquatic communities. As stated in paragraph 57, built barriers can be useful to protect fragile communities from the incursion of non-desirable species. However, they are not a silver bullet, as instream barriers not only affect the movement of aquatic species but also alter habitat-shaping and hydrological processes (e.g., sediment transport).

Proposed new provisions relating to trout habitat in the supplementary evidence for Chapter 1 ‘Introduction and general themes’.

132. I have been asked to comment on proposed new provisions relating to the protection of trout and salmon in the supplementary evidence [33]for Chapter 1 ‘Introduction and general themes’, prepared by Mrs Felicity Boyd (paragraphs 26 to 37 of the document).

133. For the reasons stated in paragraph 96, many of the LF-FW sections have been removed from the parts of the pORPS 2021 being considered in this process and are provided in the pORPS for information only. However, based on the supplementary evidence I understand that this matter is addressed in the ‘non-freshwater’ process so is relevant to this hearing.

[33] Brief of supplementary evidence of Felicity Ann Boyd, introduction and general themes, dated 11 October 2022

134. Mrs. Boyd recommends the addition of the following new method to the LF-FW section:

LF-FW-M8A – Identifying and managing species interactions between trout and salmon and indigenous species

(1) When making decisions that might affect the interactions between trout and salmon and indigenous species, local authorities will have particular regard to the recommendations of the Department of Conservation, the Fish and Game Council relevant to the area, Kāi Tahu, and the matters set out in LF-FW-M8A(2)(a) to (c), and

(2) Otago Regional Council will work with the Department of Conservation, the relevant Fish and Game Council and Kāi Tahu, to:

(a) identify areas where the protection of the habitat of trout and salmon, including fish passage, will be consistent with the protection of the habitat of indigenous species,

(b) identify areas where the protection of the habitat of trout and salmon will not be consistent with the protection of habitat of indigenous species, and

(c) for areas identified in (b), develop provisions for any relevant action plans(s) prepared under the NPSFM, including for fish passage, that will at minimum:

(i) determine information needs to manage the species,

(ii) set short-, medium- and long-term objectives,

(iii) identify appropriate management actions that will achieve objectives determined in (ii) and account for habitat needs, and

(iv) use tools available within the Conservation Act 1987 and the Freshwater Fisheries Regulations 1983, where appropriate.

135. Diverse perspectives exist on whether trout presence is consistent with a ‘healthy ecosystem’, depending on one’s definition for this concept. In my view, a ‘healthy ecosystem’ sustains valued species and ecological processes and retains a high degree of indigenous biodiversity despite potentially presenting species assemblages and ecological processes that differ from those existing before human arrival.

136. I agree with the general view stated by Koolen-Bourke and Peart (2021)[34] that trout receive greater statutory protection than indigenous fish species by virtue of the statutory recognition under the Conservation Act of the need to 'manage, enhance, maintain and protect' sports fish, and that this protection relies on the notion that the socio-economic benefits of freshwater trout fisheries outweigh their ecological impact. I acknowledge that trout protection has provided an avenue for strong habitat conservation advocacy, however I also consider that conservation of indigenous freshwater species requires the consideration and integrated management of salmonids as an invasive freshwater species.

137. Tadaki et al (2021)[35] propose three foundational principles for trout management that allow a balance between conservation, recreational and cultural values:

(1) shared decision making within a Treaty framework,

(2) management of the negative impacts of trout by fishery managers, and

(3) coordination of government agencies to achieve management objectives for multiple species and values.

138. This approach reconciles potentially divergent perspectives on trout, although in the context of the pORPS 2021 a clear statement of intent and clearly defined objectives are required. This is resolved in my view by adopting the hierarchy of values as stated in the NPSFM 2020 policies, namely:

Policy 9: The habitats of indigenous freshwater species are protected.

Policy 10: The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.

139. Following these principles, I believe the proposed addition can be substantially improved by:

[34] Koolen-Bourke D. and R. Peart. 2021. *Conserving Nature: Conservation Reform Issues Paper*. August 2021, 168 p.
[35] Tadaki M., R. Holmes, J. Kitson and K. McFarlane. 2021. *Understanding divergent perspectives on introduced trout in Aotearoa: a relational values approach*. Kōtuitui: New Zealand Journal of Social Sciences Online, 17:4, 461-478, DOI: 10.1080/1177083X.2021.2023198

- adding provisions towards managing the negative impacts of trout on indigenous biodiversity in section (2)(a),
- removing provision (2)(c)(iv) as the current regulatory framework might change within the term of the RPS,
- ensuring the coordination of relevant agencies and stakeholders at all levels.

140. These amendments would need to be consistent with the objectives explicitly stated in the future FPI parts of the pORPS.

ECO – Ecosystems and indigenous biodiversity

141. As stated in the Wildlands Report 2021b: *"Otago has a range of nationally significant biodiversity features and values, and a significant responsibility for maintaining biodiversity nationally"*. This responsibility extends to the extensive network of freshwater lakes, wetlands, rivers and streams of the region, and to the Nationally significant populations of Threatened and At Risk freshwater fish, including non-diadromous galaxiids with a range restricted to the Region.

142. Policies and methods of the pORPS 2021 should demonstrably ensure the fulfilment of clearly stated and meaningful objectives. In the ECO chapter, the pORPS 2021 should provide clear objectives with comprehensive bottom lines by clearly outlining the biodiversity outcomes that it seeks for the resources described in the Section 32 Reporting and in the case of threatened freshwater species included in this evidence.

143. To achieve this, I consider that outcome statements that set clear measures of the change expected and high-level results for species and ecosystems are an effective method to measure the effectiveness and the performance of the pORPS 2021. It is my view that such outcome statements are required to promote sustainable management of the Region's resources and integrated management. In addition to clearly defined objectives, strong policies in the pORPS 2021 will be fundamental to managing the adverse effects of activities and lead to measurable outcomes for species that are only found in Otago.

144. The language currently used in the objectives of the ECO chapter lack, in my view, the necessary qualities outlined above, as they utilise vague language or concepts that have no biological meaning.

145. Objectives in the RPS should be consistent with the Fundamental Concepts (Section 1.7, sections (2) and (3) p.8-9) of the E draft NPSIB. In my opinion accepting its language and standard of commitment to indigenous biodiversity in the RPS is necessary to achieve the objectives of the Resource Management Act 1991 and to ensure that indigenous biodiversity is protected from the effects of adverse activities in Otago.

146. The relevant Fundamental Concept in the E draft NPSIB is:

> *(3) Maintenance of indigenous biodiversity*
>
> *The maintenance of indigenous biodiversity requires at least no reduction, as from the commencement date, in the following:*
>
> *(a) the size of populations of indigenous species:*
> *(b) indigenous species occupancy across their natural range:*
> *(c) the properties and function of ecosystems and habitats:*
> *(d) the full range and extent of ecosystems and habitats:*
> *(e) connectivity between, and buffering around, ecosystems:*
> *(f) the resilience and adaptability of ecosystems.*

147. A framework such as the one used in the New Zealand threat classification system[36] (NZTCS) is in my view appropriate to set outcome-driven objectives and policies in the RPS. I endorse Mr McKinlay's statements on the NZTCS in his evidence.[37] I subscribe to the idea that linking the policies in the pORPS 2021 to the conservation status of species and taxa as described by the NZTCS, would allow the Council to set objectives and outcomes for the pORPS 2021 which are specific, measurable, time bound, and set at appropriate spatial scales.

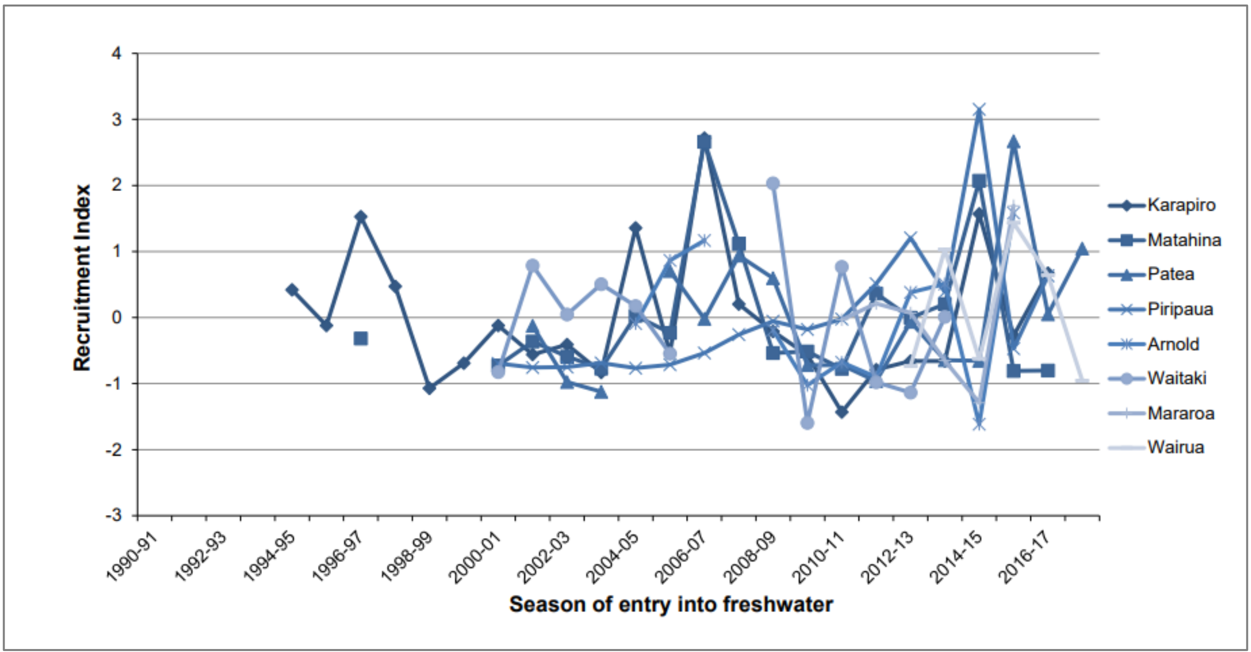
[36] Townsend AJ, PJ de Lange, CAL Duffy, CM Miskelly, J Molloy and DA Norton. 2008. New Zealand threat Classification System manual. Department of Conservation. 36 p.
[37] Evidence of Bruce McKinlay for Director-General of Conservation dated 23 November 2022 at paras 93-102

148. As currently worded in "ECO-O1 – Indigenous biodiversity", it is unclear to me what is meant by the terms *"decline in condition, quantity and diversity"* and whether condition, quantity and diversity refer to biodiversity or to something else. To illustrate this point, I will briefly focus on the notion of "net decline" in ECO-O1, which is essentially meaningless without a temporal, spatial and community context.

149. One methodological aspect of the NZTCS is the assessment of decline over a set time scale. The NZTCS sets the timeframe for population trends as 10 years or 3 generations, whichever is longer. This is important to provide some degree of consistency in freshwater communities, in which some taxa are short lived and others are not (for instance, īnaka live up to 3 years, while eels and kākahi can reach several decades).

150. Significant population fluctuations can naturally occur at a site, depending on the location and time of year. For instance, populations sizes can increase dramatically for a short period of time due to whitebait runs, and rapidly return to a more modest baseline once the recruitment period is passed. There can also be very wide fluctuations in the population size and structure of diadromous species from year to year, as they depend highly on juvenile recruitment and adult movement within a waterway (see Figure 33 as an example).

Figure 3 - Recruitment Indices (i.e., Catch Indices offset by median age) for longfin elvers at monitored elver catch and transfer sites. A value of 0 indicates the mean catch for each site. In Crow et al (2020)[38].



151. Decline must also be understood within a geographic context and be linked to such notions as genetic diversity (or more generally intraspecific diversity), and metapopulation structure, which are also components of biodiversity[39]. In the case of a species with a wide distribution, for instance, a net decline in absolute numbers might not be observed at a broad scale as population numbers rise in some places and mask local extinction events. Localised population decline can have significant consequences for a species' genetic structure and diversity. Landlocked species can display strong genetic differences between populations, and even among diadromous species some degree of population structuring is either suspected (for instance in giant kōkopu) or has been demonstrated (for instance in lamprey[40]).

152. The NZTCS adopts criteria based on the population size of mature individuals, population trend, number of subpopulations, and species' area of occupancy. It

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[38] Crow SK, PJ Jellyman, ML Martin and E Bowman. 2020. Recruitment of freshwater eels, 1995–2018 New Zealand Fisheries Assessment Report 2020/36, November 2020. Fisheries New Zealand, 124 p.
[39] The definition of biological diversity p. 20 of the pOPRS supports these notions, as it reads: "the variability among organisms, and the ecological complexes of which they are a part, including diversity within species, among species, and of ecosystems".
[40] Miller AK, Timoshevskaya N, Smith JJ, Gillum J, Sharif S, Clarke S, Baker C, Kitson J, Gemmell NJ, Alexander A. *Population Genomics of New Zealand Pouched Lamprey (kanakana; piharau; Geotria australis)*. J Hered. 2022 Jul 23;113(4):380-397. doi: 10.1093/jhered/esac014.

also incorporates additional qualifiers which provide important additional information about a taxon's listing, status and management.

153. I recommend a revision of ECO-O1 that would include more rigorous language and adopt the standards of the E draft NPSIB. I also recommend using the indices and qualifiers used in the New Zealand Threat Classification system so that the subsequent policies and methods of the ECO chapter ensure that the threat classification of threatened indigenous species in Otago will not worsen (both at a regional and local scale) and that it will be improved at the term of the pORPS 2021.

154. The D-G submitted on this and her submission was rejected in the s42A analysis for the following reason: *"threat classification is a nationwide assessment, therefore the threat classification of a species found in Otago might not always be dependent on what occurs within the Otago Region"*.

155. I dispute this analysis on the basis that it does not apply to species that have highly restricted ranges, such as many non-diadromous galaxiids that are endemic to Otago. There cannot be any relevant objectives or policies for these species from territorial authorities outside the Region. Furthermore, the threat classification system uses qualifiers of distribution range, population size and population trends, that can be used to assess the relative status of a given species within the Region and outside of it.

156. The same issue of using vague terminology is present in "ECO-O2 Restoring and enhancing", with the use of the term *"enhancement activities"*. This can be understood very differently by different parties. For example, larvae of lamprey are filter feeders that live buried in soft, silty, depositional areas, often along exposed river margins. Such areas tend to not provide particularly good habitat for other freshwater species and might be targeted for habitat improvement through riparian planting, which might turn out to be detrimental to lamprey.

157. Policies P2-P4 seek to use the Significant Natural Areas assessment process to identify places of significance. While I support this approach, I also believe that it requires clearly defined outcomes for the region as a whole. Failing this, the SNA mapping process will lack direction and clarity as to purpose and intention.

Marine Richarson

DATED 23 November 2022

Appendix

Supplementary table S1 - Habitat preferences and life cycles of the indigenous fish fauna of the Otago Region

Taxon	Common name	Life cycle	Habitats commonly occupied	
			Adults	**Larvae/juveniles**
Galaxias cobitinis	Lowland longjaw galaxias	Freshwater	Small braided rivers, streams and spring-fed streams and wetlands. Generally riffle and run dwellers.	Stationary and slow flowing habitats e.g. backwaters.
***Galaxias* "species D"**	Clutha flathead galaxias	Freshwater	Small headwater streams and seepages surrounded by grasses and tussock.	Slow-moving habitats.
***Galaxias* "Teviot"**	Teviot flathead galaxias	Freshwater	Few of the small headwater streams in the Teviot River, surrounding Lake Onslow with small substrates (silt/mud to fine gravel).	
Neochanna burrowsius	Canterbury mudfish	Freshwater	Springs, creeks, drains and around the margins of wetlands. Only movement within catchments would be from flood flows.	Open water habitats.
Galaxias anomalus	Roundhead galaxias	Freshwater	Runs in low-gradient streams with dominantly gravel and cobble substrates	Slow moving habitats in pools and margins of runs
Galaxias eldoni	Eldons galaxias	Freshwater	broad range of low- to high-gradient streams with stable beds with boulder and bedrock substrates	
***Galaxias* "Nevis"**	Nevis galaxias (Nevis River)	Freshwater	Runs with large gravel and cobbles. Medium depths (30-60 cm-)	
***Galaxias* aff. *paucispondylus* "Manuherikia"**	Alpine galaxias (Manuherikia River)	Freshwater	Rivers at high elevations amongst foothills in swiftly flowing habitat, especially riffles and runs.	Slow-moving habitats.
Galaxias pullus	Dusky galaxias	Freshwater	broad range of low- to high-gradient streams with stable beds with boulder and bedrock substrates	
Galaxias depressiceps	Flathead galaxias	Freshwater	Pool, run and riffle habitats with hard bottoms	Slow moving habitats in pools and margins of runs
Galaxias gollumoides	Gollum galaxias	Freshwater	Lowland wetlands near sea level to small headwater streams in high country tussocklands up to 1100 m above sea level. Often seen in lower margins of waterways, in ponds or ditches amongst aquatic plants or debris.	
***Galaxias* aff. *paucispondylus* "Southland"**	Alpine galaxias (Southland)	Freshwater	Rivers at high elevations amongst foothills in swiftly flowing habitat, especially riffles and runs.	Slow-moving habitats.

Taxon	Common name	Life cycle	Habitats commonly occupied	
			Adults	**Larvae/juveniles**
***Galaxias* "Pomahaka"**	Pomahaka galaxias	Freshwater	From streams with strong flows to seepages and small ditches on farmland and road-sides	
***Galaxias* "southern"**	Southern flathead galaxias	Freshwater	large gravel and cobbles	
Geotria australis	Lamprey	Anadromous	Variety of habitats including streams, rivers, braided rivers and lagoons during upstream breeding migration	Sandy/silty areas along stream margins
Anguilla dieffenbachii	Longfin eel	Catadromous	Variety of habitats from lowlands to long distances inland- including lakes, pools in small streams, rivers and wetlands.	When <300 mm found mostly in boulder/cobble riffles in rivers.
Cheimarrichthys fosteri	Torrentfish	Amphidromous	Rivers, often braided, generally in swift riffle habitats. It is thought that the females occupy upper reaches of rivers and males the lower.	Larvae go to sea. Juveniles migrate into rivers, moving along the bottom, some months later
Galaxias argenteus	Giant kokopu	Amphidromous	Favours small to medium, deep gentlyflowing streams, wetlands and lagoons.	Goes to sea after hatching then returns to river mouths, as whitebait, months later and migrates upstream along the river margins to find adult habitat
Galaxias brevipinnis	Koaro	Amphidromous	Boulder/cobble streams and landlocked high country lakes.	Boulder/cobble streams and landlocked high country lakes.
Galaxias maculatus	Inanga	Amphidromous	Gently flowing to still estuaries, rivers, streams and wetlands.	Goes to sea after hatching then returns to river mouths, as whitebait, months later and migrates upstream along the river margins to find adult habitat.
Galaxias vulgaris	Canterbury galaxias	Freshwater	Flowing rivers and tributaries. Prefer cobble substrate.	Gently flowing margins
Gobiomorphus hubbsi	Bluegill bully	Amphidromous	Swift flowing riffles, often in the larger braided rivers. Prefer coarser substrates.	Larvae go to sea and return to rivers in spring as juveniles.
Gobiomorphus gobioides	Giant bully	Amphidromous	Streams	Larvae go to sea and return to rivers in spring as juveniles.
Stokellia anisodon	Stokells smelt	Amphidromous	Low elevation estuaries and streams.	Sea

Taxon	Common name	Life cycle	Habitats commonly occupied	
			Adults	**Larvae/juveniles**
Aldrichetta forsteri	Yelloweye mullet	Marine	Marine wanderer - primarily marine species that can venture inland along rivers	
Anguilla australis	Shortfin eel	Catadromous	Variety of habitats, generally low elevation rivers, streams, wetlands and lakes.	When 300 mm found mostly in boulder/cobble riffles in rivers.
Galaxias fasciatus	Banded kokopu	Amphidromous	Penetrates inland; commonly found in small forested streams and rivers. Often pool dwellers.	Goes to sea after hatching then returns to river mouths, as whitebait, months later and migrates upstream along the river margins to find adult habitat.
Gobiomorphus breviceps	Upland bully	Freshwater	Varied habitats including wetlands, lakes, ponds, drains, streams and rivers, usually where flow is gentle. Prefer coarser substrates.	Stream margins and lake shallows.
Gobiomorphus cotidianus	Common bully	Amphidromous	Varied habitats including lakes, wetland margins, streams and rivers in gentle flowing areas. Prefer finer substrate.	Gentle-flowing habitats.
Gobiomorphus huttoni	Redfin bully	Amphidromous	Cobble/boulder streams usually in swift flows.	Larvae go to sea and return to rivers in spring as juveniles.
Retropinna retropinna	Common smelt	Amphidromous	Estuaries and lowland rivers, usually still or gently-flowing waters.	Go to sea after hatching, returning to river months later as juveniles or adults.
Rhombosolea retiaria	Black flounder	Freshwater	Primarily a coastal species, common in estuaries, lowland lakes and in rivers in both gentle and swift-flowing habitats. Can penetrate well inland in low gradient rivers.	Spawn at sea, migrate into freshwater in spring.