



Ahika Consulting
Rm. 2, Third Floor,
2 Dowling St, Dunedin
PO Box 1320, 9054

03 477 9242
info@ahika.co.nz
www.ahika.co.nz

for Otago Regional Council

Mapping threatened and rare freshwater-dependent flora and fauna within the Otago Region

April 2022

Report prepared for client by Dr Mike Thorsen

Date: 14 April 2022

Report number: 01088-220422FINAL

© Ahika Consulting Limited

2 Dowling Street

Dunedin 9016

New Zealand

Reliance and Disclaimer

The professional analysis and advice in this report has been prepared by Ahika Consulting Ltd for the use of the party or parties to whom it is addressed (the addressee) and for the purposes specified in it. This report is supplied in good faith and reflects the knowledge, expertise and experience of the consultants involved. Ahika Consulting Ltd accepts no responsibility whatsoever for any loss occasioned by any person acting or refraining from action as a result of reliance on the report, other than the addressee.

In preparing this report Ahika Consulting Ltd has endeavoured to use what it considers as the best information available at the date of publication, including information supplied by the addressee. Unless stated otherwise, Ahika Consulting Ltd does not guarantee the accuracy of any forecast or prediction in this report.

Ahika Consulting Ltd guarantees its work as free of political bias and as grounded in sound ecological principles based on quality knowledge.

Version	Date	Author	Change Status
220422	2 April 2022	Mike Thorsen - Author	Initial draft for ORC comment
220422b	8 April 2022	Mike Thorsen - Author	Final draft including comment from ORC
220422FINAL	14 April 2022	Mike Thorsen - Author	Final version

1 Contents

1	Contents.....	4
2	Executive summary.....	8
3	Introduction.....	9
4	Methodological approach.....	12
5	The datasets	15
5.1	Metadataset name validation	18
5.2	Site records.....	18
6	Species selection criteria, waterbody mapping, and definitions.....	19
6.1	Defining 'freshwater-dependent' species.....	19
6.2	Species selection criteria used in this exercise.....	20
6.3	Categorising Threatened species and species of conservation interest.....	22
	<i>Threatened species</i>	22
	<i>Species of other conservation interest</i>	22
6.4	Characterisation of freshwater-dependent species.....	23
	<i>Nature of dependence on freshwater</i>	23
	<i>Freshwater qualities</i>	23
	<i>Threatening processes</i>	24
6.5	Habitat.....	24
6.6	Freshwater Spatial Units.....	26
6.7	Mapping freshwater extent and extracting species.....	26
7	The freshwater-dependent species in Otago	30
7.1	Threatened freshwater-dependent species.....	30
7.2	Freshwater-dependent species of other conservation interest.....	41
7.3	Excluded and poorly known species.....	45
8	Species outside Otago region and reintroduced species.....	46
9	Knowledge gaps, identifying data poor areas and metadataset errors	50
10	Next steps.....	51
	Appendix 1. List of Threatened Freshwater-Dependent Species	52
	Appendix 2. List of freshwater-dependent species of conservation interest.....	52
	Appendix 3. Observations of freshwater-dependent species in the Otago region.....	52

Appendix 4. Descriptions of spreadsheet column headers.....	53
10.1 Description of column information in spreadsheet files: Otago_FWD_Threatened_SpeciesList_220331.xlsx & Otago_FWD_ConservationInterest_SpeciesList_220331.xlsx	53
10.1.1 Description of column information in spreadsheet and GIS file: Otago_FWD_SpeciesObservations_220331.	55
10.2 GIS files: ORC_REC_Threatened5, ORC_REC_OtherConservation5, ORC_REC_OtherConservation5_Sp2.	56
Appendix 5. Acknowledgements.....	57
Appendix 6. Database use agreements	64
Appendix 7. Species records of uncertain identity, or that could not be matched with a known entity	65
10.3 Species recorded from the Otago region, but excluded from this exercise	65
10.4 Species recorded from the Otago region, but excluded from this exercise as does not naturally occur within Otago	70
10.5 Species recorded from Otago, but of uncertain identification and not included in this exercise.....	74

List of Tables

Table 1. Sources of observations within the metadataset mapped as occurring within the Otago region.	16
Table 2. Taxonomic distribution of number of species and number of observations within the metadataset mapped as occurring within the Otago region.....	17
Table 3. Count of species and number of records for those species in each categorisation into life form, hydrosystem, freshwater reliance, flow reliance and threatening processes of Threatened freshwater-dependent species.....	32
Table 4. List of Threatened freshwater-dependent species mapped as occurring within the Otago Region	33
Table 5. Count of species and number of records in the Otago region for those species in each categorisation of each species into life form, hydrosystem, freshwater reliance, flow	

reliance, threatening processes, and conservation status of freshwater-dependent species of other conservation interest.	41
Table 6. Species observed within 10 km of the Otago region.	47
Table 7. Taxonomic bias in observations of freshwater-dependent species in the Otago region.....	50

List of Figures

Figure 1. Locations of species of conservation interest within a metadataset compiled from electronic biodiversity databases. New Zealand coast outlined in grey, and Otago region outlined in green. Note localities of Threatened species are mapped to show above records of At Risk and Data Deficient species which as a result are largely obscured in this map. ...	14
Figure 2. Locations within the Otago region (green line) of species of conservation interest held within a metadataset compiled from electronic biodiversity databases.	15
Figure 3. Freshwater spatial units of Otago. Freshwater Management Units and Rohe named. Otago Regional Council boundary outlined in green.	28
Figure 4. Mapped extent of freshwater within Otago region.	29
Figure 5. Locations of Threatened freshwater-dependent species recorded from freshwater within the Otago region (green outline).....	39
Figure 6. River Environment Classification (REC) units within the Otago region where Threatened freshwater-dependent species have been mapped.....	40
Figure 7. Locations of freshwater-dependent species of other conservation interest recorded from within the Otago region (green outline).....	43
Figure 8. River Environment Classification units within the Otago region where freshwater-dependent species of other conservation interest have been mapped.	44

2 Executive summary

The National Policy Statement for Freshwater Management 2020 (NPSFM) and National Environment Standards for Freshwater 2020 (NESF) have been formulated by the New Zealand Government to assist regulatory authorities in managing the freshwater resource. The NPSFM sets out a National Objectives Framework (NOF) to support a nationally consistent approach to setting freshwater objectives. It is an obligation of regional councils under the NOF to identify the location of freshwater habitats relied on by threatened species in each Freshwater Management Unit (FMU) and to describe the extent to which each FMU has the critical habitats and conditions necessary to support the presence, abundance, survival, and recovery of the threatened species.

An exercise was conducted to extract the records of threatened species and species of other conservation interest that occur in the Otago region from a metadataset compiled from electronic biodiversity databases of locations of species of conservation interest nationally, and to assess whether these species are likely dependent on freshwater habitats, and to map the occurrences of these species. As part of this project, it is also considered prudent to identify localities and habitats occupied by species of other conservation interest. This information can be considered a 'watch list' as continued declines in populations of species of other conservation interest will, if unchecked, lead to their being listed as a Threatened species.

62,967 records of 840 species in the metadataset are mapped as occurring in the Otago region, and 51,755 of these records are of 528 species assessed as likely dependent on freshwater habitat. This includes 11,355 records of 132 threatened species that are likely to rely on freshwater habitats. These species are primarily reliant on water quality, water quantity (flow) and water passage (for all the 18 species of Threatened fish). The Threatened species are mostly threatened by weed invasion of their habitat and by terrestrial pest animals.

Further work is required to critically examine the detail in the records of threatened species and investigation of species presence and habitat quality to determine which habitats qualify as critical habitats.

3 Introduction

New Zealand's freshwater is a scarce resource that is increasingly under pressure from surrounding land use, pests, waterway alteration, wetland drainage, water extraction, and climate change and as a result water quality and ecosystem health is declining in many places^{1,2,3}. The loss of freshwater ecosystems and the species that inhabit them can lead to increased risk of flooding, reduced carbon sequestration, less māhika kai, reduced ecosystem services, loss of social and cultural connection, and loss of water quality and quantity^{1,3}. Another consequence of declining ecosystem health is that the species that rely on an ecosystem are also put under pressure, resulting in reduced fitness of individuals and declining populations and increased demand on conservation resources. Over 1,000 native species are known to occupy freshwater habitats³ and many of the species occupying freshwater ecosystems are now categorised in the New Zealand Threat Classification System (NZTCS)⁴ as Threatened; the highest level of conservation concern^{1,3,5}.

1 Environment Aotearoa 2019. New Zealand's Environmental Reporting Series. Ministry for the Environment and Stats NZ.

2 Interim Regulatory Impact Analysis for Consultation: Essential Freshwater. Part 1: Summary and Overview.

3 Our fresh water 2017. New Zealand's Environmental Reporting Series. Ministry for the Environment and Stats NZ.

4 Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D.A. 2007: New Zealand Threat Classification System manual. Department of Conservation, Wellington. 35p. and including the October 2019 Supplement.

⁵ Gerbeaux, P; Champion, P; Dunn, N. 2016. Conservation of freshwaters. Pp. 573-594 in Jellyman, P.G; Davie, T.J.A; Pearson, C.P; Harding, J.S. Advance in New Zealand Freshwater Science. NZ Freshwater Sciences Society and NZ Hydrological Society.

The National Policy Statement for Freshwater Management 2020⁶ (NPSFM) and National Environment Standards for Freshwater 2020⁷ (NESF) have been formulated by the New Zealand Government to assist regulatory authorities in managing the freshwater resource. The fundamental concept of the NPSFM is Te Mana o Te Wai, which encompasses 6 principles relating to the roles of Tangata Whenua and other New Zealanders in the management of freshwater. The objective of the NPSFM is to ensure that natural and physical resources are managed in a way that prioritises:

- (a) first, the health and well-being of water bodies and freshwater ecosystems
- (b) second, the health needs of people (such as drinking water)
- (c) third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.

The NPSFM sets out fifteen policies to support this objective. While all of the policies are relevant, those with direct and specific relevance to freshwater ecosystems and species, and this project, are:

Policy 6: There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.

Policy 7: The loss of river extent and values is avoided to the extent practicable.

Policy 8: The significant values of outstanding water bodies are protected.

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

6 <https://environment.govt.nz/assets/Publications/Files/national-policy-statement-for-freshwater-management-2020.pdf>

7 <https://www.legislation.govt.nz/regulation/public/2020/0174/latest/LMS364099.html>

Policy 13: The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends.

Policy 14: Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.

The NPSFM sets out a National Objectives Framework (NOF) to support a nationally consistent approach to setting freshwater objectives, with flexibility for recognising regional circumstances. It is an obligation of regional councils under the NOF to identify the location of freshwater habitats relied on by threatened species in each Freshwater Management Unit (FMU) and to describe the extent to which each FMU (or part of an FMU) supporting a population of threatened species has the critical habitats and conditions necessary to support the presence, abundance, survival, and recovery of the threatened species. In practice this requires the identification of the presence of threatened species, as well as the location and condition of their habitats. As part of this project, it is also considered prudent to identify localities and habitats occupied by species of other conservation interest (species that are assessed as At Risk, Data Deficient or Non-resident Native in the NZTCS or species that are considered of conservation interest for other reasons such as rarity within a region. This information can be considered a 'watch list' as continued declines in populations of species of other conservation interest will, if unchecked, lead to their being listed as a Threatened species.

The NPSFM also requires every regional council to map every natural inland wetland in its region that are known to contain threatened species⁸.

This project works to identify the species of conservation interest inhabiting or using freshwater ecosystems and the locations at which they have been recorded within the Otago region. Species of conservation interest are those listed within the NZTCS as Threatened, At

⁸ See Section 3.23(1)(b) of the NPSFM.

Risk or Data Deficient and species considered rare within Otago for all taxonomic groups (birds, invertebrates, fish, bryophytes, plants, etc) that have both distribution data and that have had their conservation status assessed.

4 Methodological approach

In summary, this document outlines the process undertaken in identifying species of conservation interest that have been recorded from within the Otago region and summarises the results obtained. This information was sourced from a metadataset of 625,613 records of species of conservation interest (Threatened, At Risk, Data Deficient or regionally important species) compiled from 36 electronic NZ biodiversity databases containing point location information. The locations where species have been recorded in freshwater areas are used to produce initial lists of both potentially freshwater-dependent threatened species and species of other conservation interest. Further investigation of the sites can then be carried out to assess if these habitats qualify as 'critical habitats and conditions that are necessary to support' threatened species as under the NPSFM compulsory value "threatened species".

To produce the initial list of indigenous species a map of the freshwater extent within Otago was developed (Section 6.7) and any species in the metadataset recorded as occurring within this area was added to the list of candidate species. These species were then assessed to see whether they qualified as freshwater-dependent species against the selection criteria in Section 6.2. Those species that qualified were then assigned to the most recent conservation status within the NZTCS⁹, characterised on their lifeform, hydrosystem (palustrine, lacustrine, riverine, geothermal, estuarine, etc), nature of reliance on freshwater (dependence on water quantity, quality or passage), and the known threats (weed invasion, terrestrial pests, aquatic pests), based on ecological information in available data sources¹⁰, discussions with experts,

⁹ NZ Threat Classification System web database <https://nztcs.org.nz/>.

¹⁰ For flora this includes the NZ Flora series and the NZ Plant Conservation Network website www.nzpcn.org.nz. For birds this includes NZ Birds Online website www.birdsonline.org.nz.

or species-specific web searches. Records of freshwater-dependent species were electronically tagged to a catchment unit (Section 6.6) and mapped using QGIS 3.16.5 GIS software.

Further work will be required (Section 10) to assess if the locations of these species are habitats qualify as 'critical habitats and conditions' as required under the NPSFM.

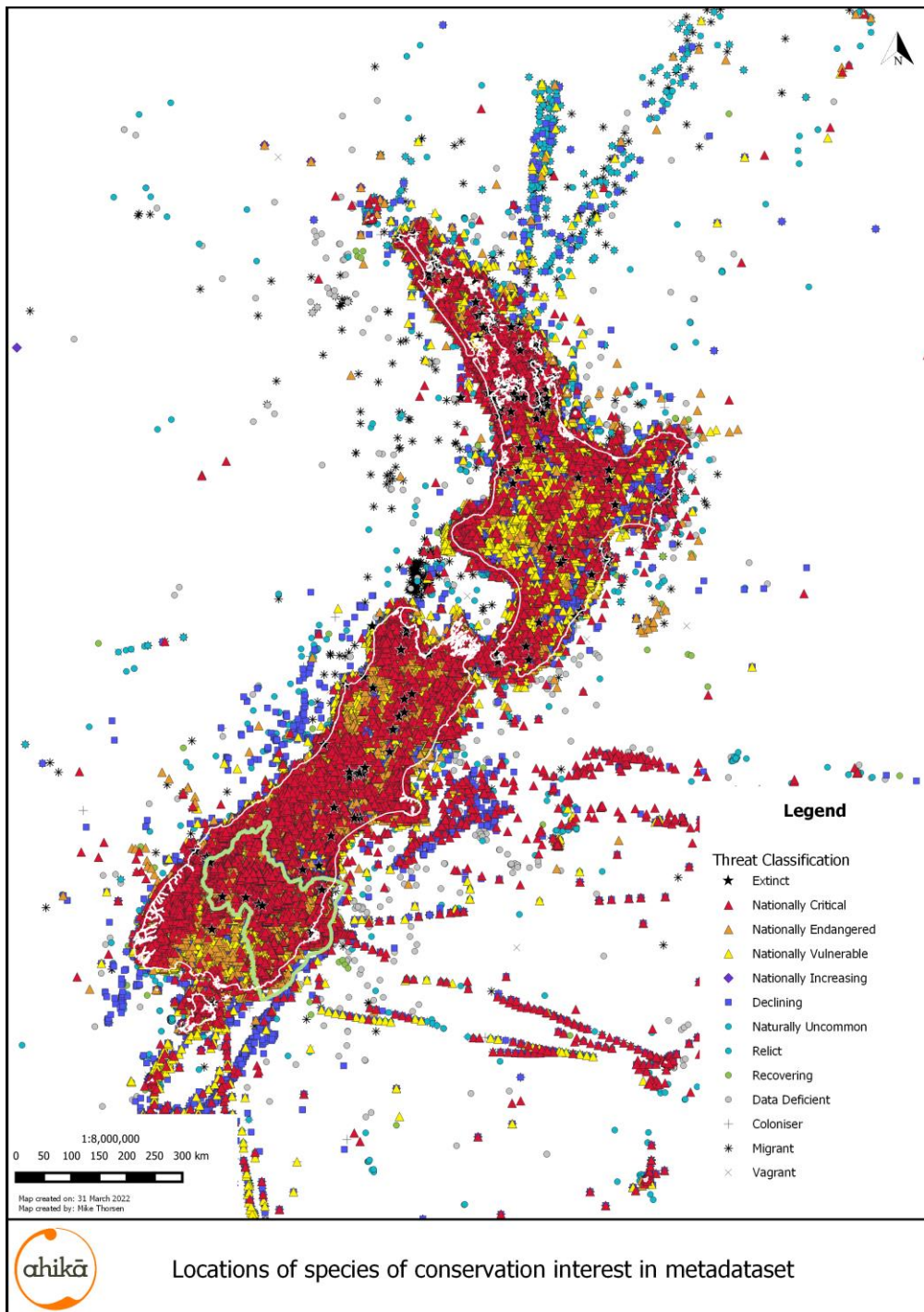


Figure 1. Locations of species of conservation interest within a metadataset compiled from electronic biodiversity databases. New Zealand coast outlined in grey, and Otago region outlined in green. Note localities of Threatened species are mapped to show above records of At Risk and Data Deficient species which as a result are largely obscured in this map.

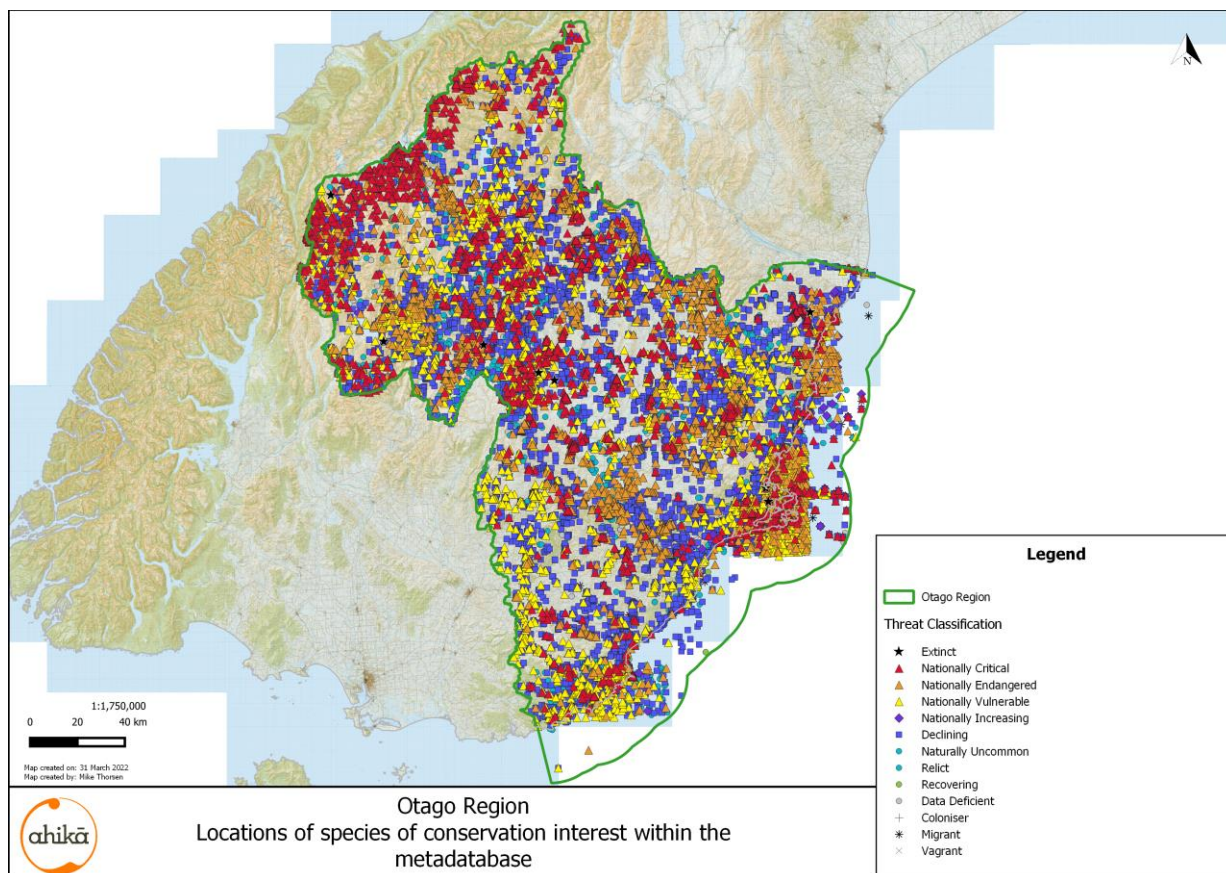


Figure 2. Locations within the Otago region (green line) of species of conservation interest held within a metadataset compiled from electronic biodiversity databases.

5 The datasets

Within the metadataset there are 625,613 records of species of conservation interest nationally (Figure 1). Of these, 62,967 records of 870 species from 18 data sources are mapped as occurring within the Otago region (Table 1) observed between 1903 and 2022. Taxonomic representation and temporal distribution of observations within the metadataset is not even, with observations of some taxonomic groups, such as birds, being over-represented, and other taxonomic groups, such as lichens, being under-represented. The majority of the records are from observations post 2010, which reflects the rise of the use of electronic data capture, hand-held GPS use and the popularity of citizen science biodiversity

recording websites such as iNaturalist and eBird. The likely extent of this unevenness and its consequences are discussed in Section 9.

Note some of these databases are constantly updated and that mātauranga-a-iwi and mātauranga-a-hapu are not yet included in this report and that mātauranga māori is an important part of understanding historical and current distributions of indigenous species, their habitats and the special connections to Tangata Whenua and the wider environment in Otago.

Table 1. Sources of observations within the metadataset mapped as occurring within the Otago region.

Data source	Number of records
Auckland Museum Herbarium	469
Auckland Museum Land Vertebrate Collection	22
Auckland Museum Marine Collection	3
Cawthron Institute freshwater invertebrate data	10
CHR Allan Herbarium	583
DOC BioWeb	8,705
DOC Marine Mammal Database	398
DOC_Bat Database	1
eBird	29,830
iNaturalist	7,354
Knox Herpetofauna Database exDOC BioWeb	3,183
MBIS Marine Fauna and Flora observations around New Zealand	5
MPI Protected species bycatch in New Zealand fisheries	9
National Vegetation Survey	1,875
NIWA FFD (updated)	9,625
NZ Arthropod Collection	91
ORC Aquatic Invertebrate Database	625
Thorsen records	179

Table 2. Taxonomic distribution of number of species and number of observations within the metadataset mapped as occurring within the Otago region.

Taxonomic Group	Number of observations	Number of species observed
Algae	47	11
Bats	2	2
Birds	33,086	124
Fish	8,240	25
Hornworts and Liverworts	28	23
Invertebrates	2,740	142
Lichens	108	56
Mosses	13	9
Plants	13,211	412
Reptiles	4,363	32
Seals and Sea lions	733	4
Whales, Dolphins and Porpoises	369	11

Permission for use of the information in the source datasets was granted under Creative Commons or was obtained from the hosting organisation. Ownership of data resides with the owner of the contributing dataset (See Appendix 6. Database use agreements for each source dataset usage provisions).

A requirement of database owners is that the actual location of each record within the metadataset is not passed onto any other party. For this reason, the outputs provided in this document are assigned to a catchment unit and grid references have been removed from publicly-available records.

5.1 Metadataset name validation

Each of the source datasets within the metadataset uses a unique name format and/or taxonomy as well as containing typographic differences. To establish relationships¹¹ between the names in the datasets a 'translation' spreadsheet was developed that converts names to the equivalent name as used in the NZTCS. Names that could not be automatically matched were examined, and if possible, converted to the correct NZTCS name. A performance standard was set of matching all names for plants, birds, reptiles, and bats. This standard was met for all records of these groups except where there was not an appropriate sub-specific assignment made in the source dataset. Corrections were not attempted for records where sub-specific assignment is not geographically based (i.e., *Mazus novaezeelandiae* which has two subspecies and two forma within one of these).

No attempt was made to check the accuracy of the identification made in the source dataset. Likewise, no attempt was made to check the accuracy of the grid reference of each record in the source dataset. However, any species that are considered erroneous records for Otago (see Section 9) were not included in mapping.

Duplicate records (arising from the same information being hosted in more than one dataset) were not removed from the metadataset to allow back-tracing of records and retrospective correction.

5.2 Site records

Some species records are recorded for a discrete area only (i.e., site plant species lists, or some site-based GIS layers). These records were not included in this mapping due to time

¹¹ Also called name harmonisation. See Grenié, M; et al. 2022. Harmonizing taxon names in biodiversity data: A review of tools, databases and best practices. *Methods in Ecology and Evolution*. DOI: 10.1111/2041-210X.13802.

constraints associated with obtaining the information, extracting data, and uncertainty about exact location of the record within the locality.

6 Species selection criteria, waterbody mapping, and definitions

6.1 Defining 'freshwater-dependent' species

The requirement within Section 3.8(3)(c) the NOF is to identify within each FMU "the location of habitats of threatened species" and in Appendix 1A - Compulsory values "(threatened species) refers to the extent to which an FMU or part of an FMU that supports a population of threatened species has the critical habitats and conditions necessary to support the presence, abundance, survival, and recovery of the threatened species. All the components of ecosystem health must be managed, as well as (if appropriate) specialised habitat or conditions needed for only part of the life cycle of the threatened species." Habitat is explained in NPSFM Appendix 1A (in compulsory value "Ecosystem Health") "as the physical form, structure, and extent of the water body, its bed, banks and margins; its riparian vegetation; and its connections to the floodplain and to groundwater."

Previous investigations^{12, 13, 14} have identified habitat characteristics and species-specific attributes as important in identifying freshwater habitat of threatened species. However,

¹² Whatley, M. 2020. Identifying the location of Freshwater Habitats of Threatened Species in New Zealand: A Summary of Current Tools and Resources. Unpub. Adaptive Environmental Consulting Report to Ministry for the Environment.

¹³ Champion, P; Elcock, S; Moss, M. 2021. Stocktake of nationally threatened freshwater dependent plants. Unpub. NIWA Report 2021186HN to Department of Conservation.

¹⁴ Storey, R; Kilroy, C; Matheson, F; Neale, M; Crow, S, Whitehead, A. 2018. Scoping indicators for impacts on freshwater biodiversity and ecosystem processes of rivers and streams. NIWA client report 20118118HN to Ministry for the Environment.

there is frequently insufficient information (including mapping and site investigations) to allow defining important habitat characteristics. Also, the habitat characteristics and species attributes listed in previous studies are often more suited for assessing the importance of the habitat, its potential ability to support a population of a threatened species, or the conservation needs of freshwater habitats, rather than with a conservation of a species perspective. Where species are listed in these previous studies, they are mainly based on expert opinion, and may cover only a portion of the biodiversity (i.e., includes plants only).

Further, under Section 3.7 of the NOF, it is a requirement to identify the 'values' present in each FMU and the locations of species of conservation interest (additional to Threatened species) is considered an FMU value.

The criteria by which a species can be considered dependent on freshwater is not considered in the NPSFM, but the interpretation for 'threatened species' (NPSFM1.4 (1)) is any indigenous species that:

- (a) "relies on water bodies for at least part of its life cycle; and
- (b) meets the criteria for nationally critical, nationally endangered, or nationally vulnerable species in the New Zealand Threat Classification System Manual" (see further below).

6.2 Species selection criteria used in this exercise

Selection criteria were used to decide if a species is likely to meet the requirements within the NOF. For the purposes of this exercise, the term 'relies on water bodies for at least part of its life cycle' is taken to mean that in the absence of freshwater individuals of that species would either 1) perish, 2) have a marked loss of vitality, or 3) have a marked reduction in their ability to reproduce. These definitions apply to the individuals of that species, not to the

population as a whole. In this report, the term ‘freshwater-dependent’¹⁵ is used to refer to species that are assessed as likely meeting the NOF specifications. An individual habitat or collection of connected habitats where water accumulates is here referred to as a waterbody.

The criteria used in this exercise to identify whether a species qualifies as ‘freshwater-dependent’ are; that it is an indigenous species, and it relies on water bodies for at least part of their life cycle, either as:

- A) Most individuals of the species are recorded as permanently inhabiting freshwater habitats, or;
- B) Most individuals of the species use freshwater habitats for a part of their lifecycle, such as for feeding or reproductive purposes, and display adaptations or lifestyles consistent with this, or;
- C) Some individuals of a species have been recorded temporarily or occasionally using freshwater habitats for activities important in maintaining health and wellbeing such as feeding, drinking, or bathing, or;
- D) The species is listed as a ‘freshwater’ species during NZ Threat Classification Assessments, in Clarkson et al. (2021) (plants only), Storey et al. (2018)¹⁶ (birds only), or has been designated elsewhere as freshwater-dependent in a similar exercise to this, or;
- E) The species is known to inhabit freshwater habitats in addition to other non-freshwater habitats¹⁷.
- F) Some individuals of the species are mapped as occurring in the mapped extent of freshwater (including the buffer, see Section 6.7), but their link to freshwater is not

¹⁵ “freshwater-dependent” is used in Champion et al. 2021 (footnote 16 below) and it is a useful ‘tag’ to identify a group of species that likely meet the NOF requirements.

¹⁶ Storey, R; Kilroy, C; Matheson, F; Neale, M; Crow, S, Whitehead, A. 2018. Scoping indicators for impacts on freshwater biodiversity and ecosystem processes of rivers and streams. NIWA client report 20118118HN to Ministry for the Environment.

¹⁷ For plants see Champion, P; Elcock, S; Moss, M. 2021. Stocktake of nationally threatened freshwater dependent plants. NIWA unpub. report 2021186HN to the Department of Conservation.

known. These species are not categorised further on their hydrosystem or other characters.

These criteria are in broad accord to the wetland indicator status ratings of vascular plant taxa in Clarkson et al. (2021)¹⁸, but redefines the Facultative definition to include motile species, and also includes species where this designation cannot be made on the basis of currently available information.

6.3 Categorising Threatened species and species of conservation interest.

Threatened species

A species is categorised as Threatened if it is listed as such in the NZTCS¹⁹. The Threatened category includes species listed as Nationally Critical, Nationally Endangered, Nationally Vulnerable or Nationally Increasing.

Species of other conservation interest

Species of other conservation interest are those listed within the NZTCS as At Risk or Data Deficient and species listed as Not Threatened in the NZTCS, but which are considered rare within Otago.

¹⁸ Clarkson, B.R., Fitzgerald, N.B., Champion, P.D., Forester, L., Rance, B.D. (2021) New Zealand plant list 2021. Landcare Research Envirolink Report 2123-HBRC259, Hamilton. 58 pp.

¹⁹ Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D.A. 2007: New Zealand Threat Classification System manual. Department of Conservation, Wellington. 35p. and including the October 2019 Supplement and 2021 Amendment.

Each species in the metadata base is categorised on the basis of its current classification within the NZTCS.²⁰

6.4 Characterisation of freshwater-dependent species

Nature of dependence on freshwater

The nature of the dependence on freshwater of each species was categorised into dependence classes: obligate, facultative, and unknown. Obligate species are those who spend their entire life cycle within a freshwater habitat. Facultative species are those who either: require a freshwater habitat for part of their lifecycle (i.e., black-billed gull that breed only on riverbeds but can forage in other habitats); some individuals of the species use the freshwater habitat as part of a range of habitats for a part of their lifecycle (i.e., long-tailed bats that forage along habitat margins, including wetland and river margins); or, part of the population occurs in wetland habitat (i.e., heart-leaved kohuhu plant *Pittosporum obcordatum* that occurs in riparian habitats, wetland margins but also on hillslope shrublands). Species categorised as 'Unknown' are species that are mapped as occurring in a freshwater area, but the nature of their relationship to freshwater habitats is not known.

Freshwater qualities

Species vary in their dependence on intrinsic values of the water body they inhabit, and this is influenced by the form that water takes in their habitat (i.e., ponded, flowing, still water): the flow regime (including ephemeral waterbodies and flooding of adjoining flood plain);

²⁰ Up to and including the 2021 reassessment of birds: Robertson, H.A.; Baird, K.A.; Elliott, G.P.; Hitchmough, R.A.; McArthur, N.J.; Makan, T.D.; Miskelly, C.M.; O'Donnell, C.F.J.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A.; Michel, P. 2021: Conservation status of birds in Aotearoa New Zealand, 2021. New Zealand Threat Classification Series 36. Department of Conservation, Wellington. 43 p

the mineral turbidity, and the chemical quality of the water; or are dependent on a continuous connection to the sea to complete their lifecycle (fish passage).

Threatening processes

The persistence of a species within a freshwater habitat can be threatened by changed ecological process arising from weed invasion and proliferation of pests (both terrestrial and aquatic animal pests and weeds), changes to water qualities (described above) as well as extrinsic factors such as climate change, and probably a number of other factors (such as disease)^{21,22}. The freshwater-dependent species in the Otago region have been categorised on the basis the processes which are known to frequently threaten their continued persistence at sites. Species have not been categorised on the basis of extrinsic factors (such as climate change) in this project because of a shortage of information on the identification and prevalence of these factors.

6.5 Habitat

In this exercise, the freshwater habitats used are broadly those described as the Wetland Classes and Wetland Forms in Johnson and Gerbeaux (2004)²³ within their Palustrine, Riverine, Lacustrine, Estuarine, Nival, Plutonic, and Geothermal Hydrosystems²⁴. This includes seasonal freshwater habitats such as floodplains and ephemeral wetlands, and habitats

²¹ Diaz, S; et al. 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. Science 366. DOI: [10.1126/science.aax3100](https://doi.org/10.1126/science.aax3100).

²² See Page 19 of Te Mana of te Taiao – Aotearoa NZ Biodiversity Strategy
<https://www.doc.govt.nz/globalassets/documents/conservation/biodiversity/anzbs-2020.pdf>

²³ Johnson, P; Gerbeaux, P. 2004. Wetland types in New Zealand. Department of Conservation and Ministry for Environment, Wellington.

²⁴ Habitats associated with aquifers are not included as no information is available for this habitat within Otago.

directly created by the actions of freshwater (i.e., bare flood zones, lake beaches). Another hydrosystem, not included in Johnson and Gerbeaux (2004), is pluvial (frequent rainfall-derived) and ombral (constant mist-derived) (in this document combined into a single Pluvial hydrosystem) - in which the waterbody is created by moisture accumulation on trees creating 'cloud forest'²⁵ or 'goblin forest' or high-temperate rainforest trees with high epiphyte loadings^{26,27,28}. Hydrosystems can also transition between two types (such as a transition between palustrine and riverine hydrosystems in gully heads). In this exercise, the hydrosystem assignment is based primarily by the nature of their input water and by the substrate as described in Johnson and Gerbeaux (2004).

Each 'freshwater-dependent' species is categorised to the hydrosystem in which it occurs (a species can occur in one or multiple hydrosystems), and the boundaries of these hydrosystems are interpreted as that which the waterbody is primarily influenced by (i.e., the Lacustrine hydrosystem includes beach gravels, shallow water wetlands on the lake margin, and wetlands impounded by wave-formed levees). If there was doubt over the hydrosystems inhabited by a species, it was assigned to all candidate hydrosystems.

Further work will be required to describe and characterise the freshwater habitats occupied by freshwater-dependent species.

²⁵ Cloud forest is also a Nationally Uncommon ecosystem.

²⁶ <https://www.nzgeo.com/stories/islands-in-the-sky/>

²⁷ Dawson, J.W; Sneddon, B.V. 1969. The New Zealand rainforest: a comparison with Tropical Rain Forest. *Pacific Science* 23: 131-147.

²⁸ Dickinson, K.J.M; Mark, A.F; Dawkins, B. 1993. Ecology of lianoid/epiphytic communities in coastal podocarp rain forest, Haast Ecological District, New Zealand. *Journal of Biogeography* 20: 687-705.

6.6 Freshwater Spatial Units

Each location of a freshwater-dependent species is assigned to the underlying spatial units: Otago Regional Council Freshwater Management Unit (FMU)²⁹, of which the Clutha Mata-au FMU is further subdivided into Rohe³⁰, Water of National Importance (WONI) Unit, 5th and 4th Order Freshwater Environment of NZ (FWENZ) River Catchment, Unit and River Environment Classification (REC) Hydro Unit (Figure 3). There are 72,005 REC hydro units within the Otago Regional Council boundary. The REC hydro unit are used as the basis for aggregated mapping as they offer fine-scale detail throughout the region.

6.7 Mapping freshwater extent and extracting species.

The mapped extent of freshwater bodies within the Otago Regional Council boundary (Figure 4) used mapped extent of wetlands provided by ORC together with 100 m either side of river centre lines from the FWENZ database, 5 m either side of water race centrelines, lake, pond, and reservoir outlines, available through Land Information NZ³¹ and freshwater vegetation communities as mapped in the Land Cover Database³². Each water body was buffered by 100 m to account for uncertainties in boundary of waterbody and errors in mapped locations of species and to give a conservative picture. The buffer areas are included in the mapped extent of freshwater (Figure 4).

Any species mapped as occurring within the freshwater extent, including the buffer, and not already classified as a freshwater-dependent species, was considered for inclusion as a 'freshwater-dependent' species under Criteria F.

²⁹ <https://www.orc.govt.nz/plans-policies-reports/regional-plans-and-policies/water/freshwater-management-units>

³⁰ An area where an Iwi or hapu have mana whenua (occupation and decision-making rights).

³¹ <https://data.linz.govt.nz/data/>.

³² Version 5. <https://iris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/>.

All mapping was undertaken in the QGIS 3.16.5 GIS software.

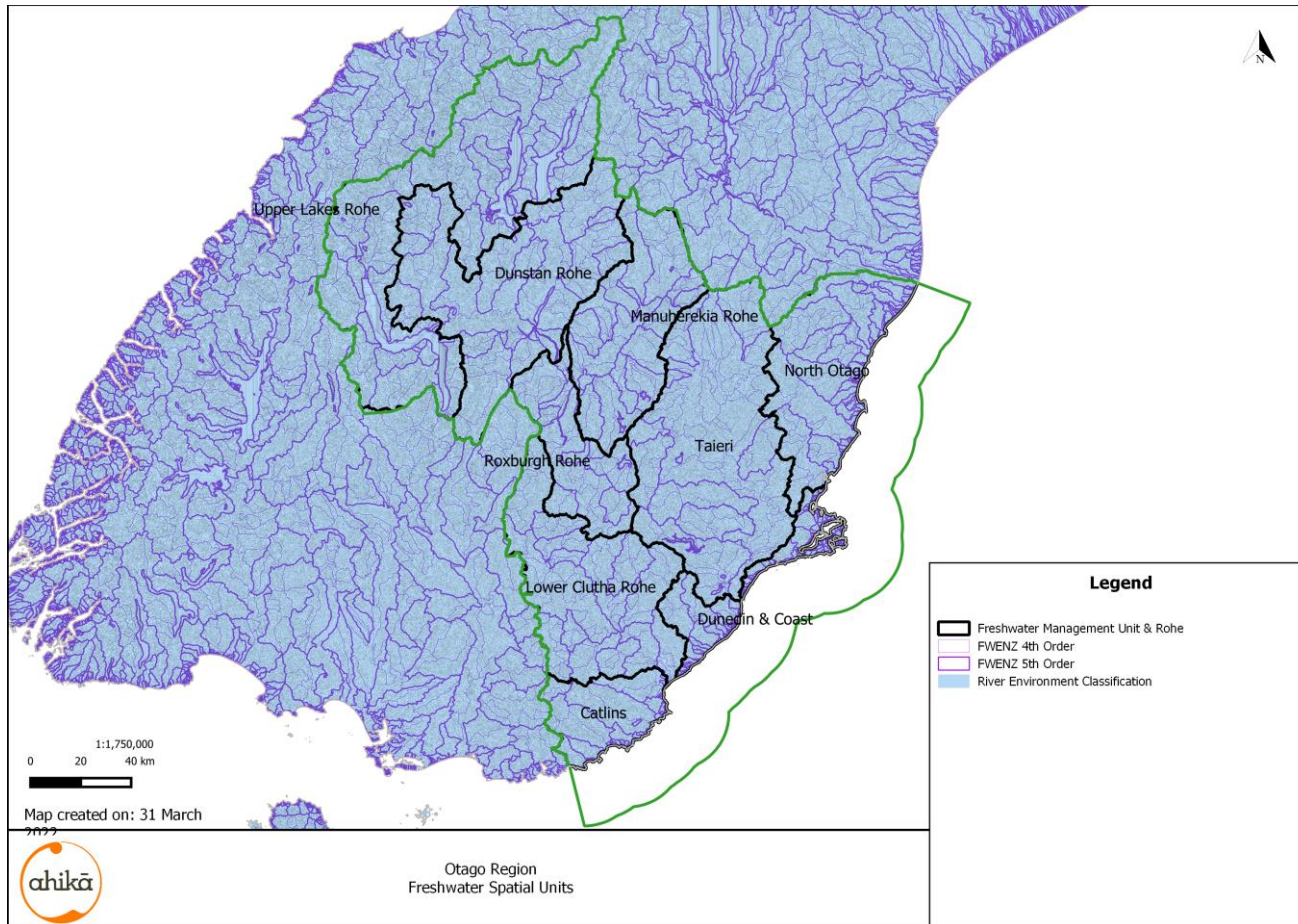


Figure 3. Freshwater spatial units of Otago. Freshwater Management Units and Rohe named. Otago Regional Council boundary outlined in green.

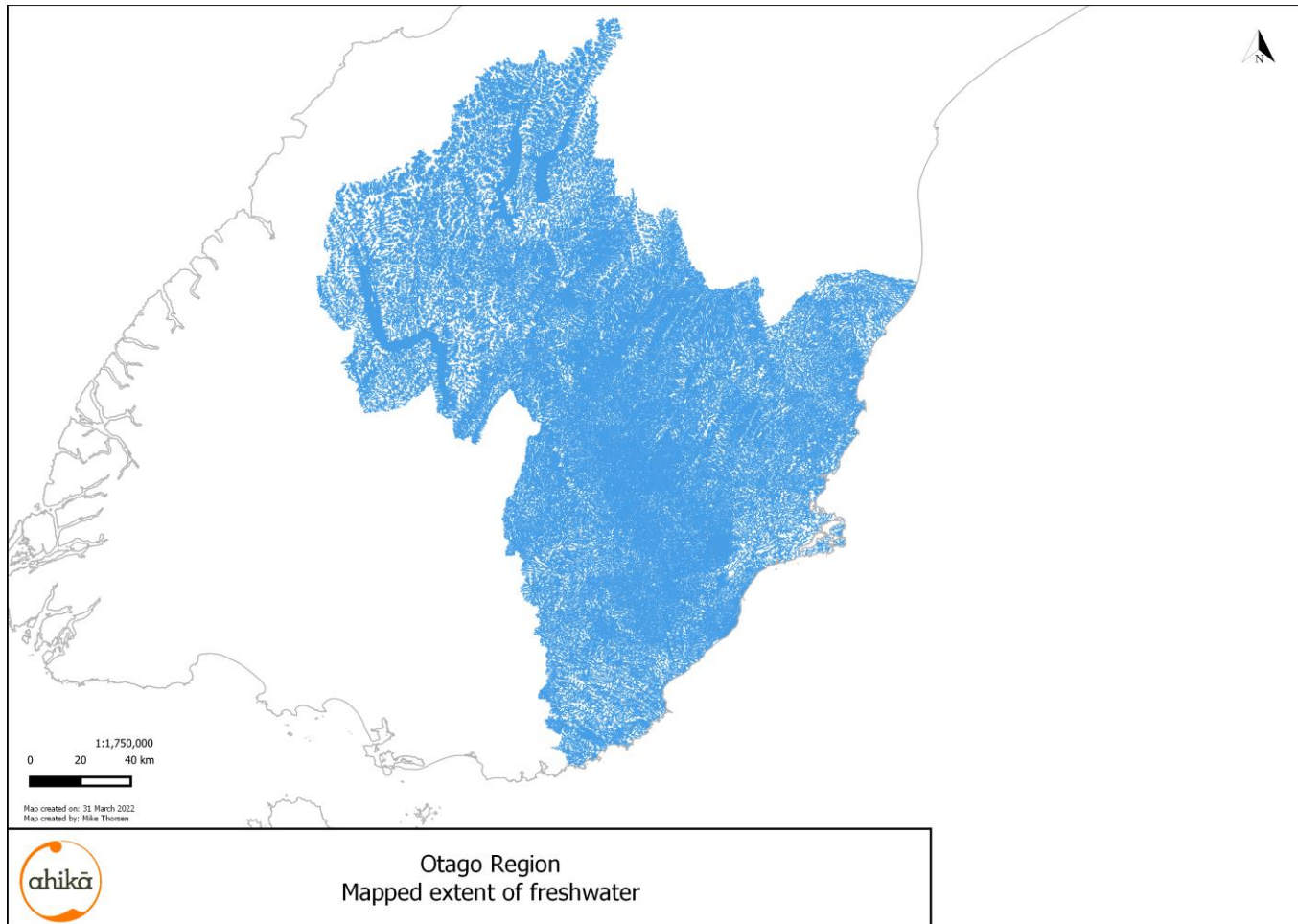


Figure 4. Mapped extent of freshwater within Otago region.

7 The freshwater-dependent species in Otago

528 of the 870 Threatened species or species of other conservation interest mapped in the metadataset as occurring within the boundaries of the Otago region are identified as freshwater-dependent species using the criteria in Section 6.2. There are 51,755 records of these 528 species (Appendix 3. Observations of freshwater-dependent species in the Otago region.).

7.1 Threatened freshwater-dependent species

One hundred and thirty-five species are identified as Threatened freshwater-dependent species within the Otago region (Table 4, Appendix 1. List of Threatened Freshwater-Dependent Species). 41 species are assigned as potentially freshwater-dependent based solely on their being located within the mapped extent of freshwater in Otago (Criteria F). Most of the Threatened species are located in lacustrine, palustrine or riverine hydrosystems (Table 3). Forty are currently³³ categorised as Nationally Critical, 29 as Nationally Endangered, 62 as Nationally Vulnerable and two as Nationally Increasing. Nearly all Threatened species are dependent on flow quantity, and most are also dependent on flow quality (Table 3). All Threatened fish species are dependent also on fish passage, and the number of fish records in Otago strongly influences the high number of records of species dependent on freshwater passage³⁴. The majority of species are threatened by weeds and aquatic pest weeds and animals (Table 3).

There are 11,355 records of Threatened species (Table 3) within the Otago region (Figure 5) located within 3,377 REC Units (Figure 6). 2,502 records are of a Nationally Critical species, 4,182 records are of a Nationally Endangered species, 4,641 records are of a Nationally

³³ Threat status is reassessed on a roughly 5-yearly interval.

³⁴ Though most of these species are non-migratory, passage is also required to maintain connectivity between populations.

Vulnerable species, and 30 records of a Nationally Increasing species. 1,353 records of Threatened freshwater-dependent species are mapped outside the mapped extent of freshwater in Otago.

Table 3. Count of species and number of records for those species in each categorisation into life form, hydrosystem, freshwater reliance, flow reliance and threatening processes of Threatened freshwater-dependent species.

Feature	Number of Species	Number of Records
Life Form		
Bats	1	1
Birds	17	2,582
Fish	15	4,436
Invertebrates	26	135
Lichens	1	1
Plants	68	3,278
Reptiles	8	922
Hydrosystem		
Lacustrine	42	3,498
Palustrine	32	1,172
Riverine	66	7,712
Geothermal	-	-
Estuarine	16	1,683
Nival	3	350
Saline	4	199
Plutonic	-	-
Pluvial	-	-
Reliance		
Obligate	51	5,476
Facultative - Lifecycle	3	818
Facultative - Occasional	30	2,584
Facultative - Distribution	5	43
Flow		
Quantity	91	9,186
Quality	73	8,671
Passage	15	4,436
Threatened by		
Weeds	49	3,200
Pests - terrestrial	32	3,237
Pests - aquatic	27	4,508
TOTAL in metadatabase	135	11,355

Table 4. List of Threatened freshwater-dependent species mapped as occurring within the Otago Region

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
<i>Edpercivalia tahatika</i>	caddisfly	Fauna	Invertebrates	Nationally Vulnerable	
<i>Eulimnadia marplei</i>	clam shrimp	Fauna	Invertebrates	Nationally Critical	A(3)
<i>Kiwisaldula laelaps</i>	shore bug	Fauna	Invertebrates	Nationally Endangered	B(3)
<i>Nesoperla patricki</i>	stonefly	Fauna	Invertebrates	Nationally Critical	
<i>Oeconesus angustus</i>	caddisfly	Fauna	Invertebrates	Nationally Critical	A(3)
<i>Olinga fumosa</i>	caddis	Fauna	Invertebrates	Nationally Endangered	
<i>Pseudoeconesus n. sp. T</i>	caddisfly	Fauna	Invertebrates	Nationally Vulnerable	
<i>Pseudoeconesus paludis</i>	caddisfly	Fauna	Invertebrates	Nationally Endangered	
<i>Taraperla johnsi</i>	stonefly	Fauna	Invertebrates	Nationally Critical	
<i>Vesicaperla trilinea</i>	stonefly	Fauna	Invertebrates	Nationally Critical	
<i>Zelandobius crawfordi</i>	stonefly	Fauna	Invertebrates	Nationally Critical	
<i>Zelandobius edwardsi</i>	stonefly	Fauna	Invertebrates	Nationally Critical	
<i>Zelandobius mariae</i>	stonefly	Fauna	Invertebrates	Nationally Critical	
<i>Chalinolobus tuberculatus</i>	Long-tailed bat	Fauna	Bats	Nationally Critical	C
<i>Bembidion chalmeri</i>	Carabidae	Fauna	Invertebrates	Nationally Critical	A(1)
<i>Anarhynchus frontalis</i>	wrybill, ngutu-pare	Fauna	Birds	Nationally Increasing	
<i>Anas chlorotis</i>	brown teal, pāteke	Fauna	Birds	Nationally Increasing	
<i>Anas superciliosa</i>	grey duck, pāpera	Fauna	Birds	Nationally Vulnerable	C(1)
<i>Ardea modesta</i>	white heron, kōtuku	Fauna	Birds	Nationally Critical	A(1)
<i>Botaurus poiciloptilus</i>	Australasian bittern, matuku hūrepo	Fauna	Birds	Nationally Critical	B(1)
<i>Chlidonias albobristatus</i>	black-fronted tern, tarapirohe, tarapiroe	Fauna	Birds	Nationally Endangered	C(1)
<i>Egretta sacra sacra</i>	reef heron, matuku moana	Fauna	Birds	Nationally Endangered	A(1)

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
<i>Eudynamys taitensis</i>	long-tailed cuckoo, koekoeā, koekoea, kohoperoa, long-tailed koel	Fauna	Birds	Nationally Vulnerable	D(1)
<i>Falco novaeseelandiae novaeseelandiae</i>	eastern falcon, kārearea,	Fauna	Birds	Nationally Vulnerable	B(1)
<i>Himantopus novaezelandiae</i>	black stilt, kakī	Fauna	Birds	Nationally Critical	A(1)
<i>Hydroprogne caspia</i>	Caspian tern, taranui	Fauna	Birds	Nationally Vulnerable	B(1)
<i>Hymenolaimus malacorhynchos</i>	whio, blue duck, whio, kōwhiowhio (Ngāi Tahu), kowhiowhio, blue duck, mountain duck, blue mountain duck	Fauna	Birds	Nationally Vulnerable	C(1)
<i>Leucocarbo carunculatus</i>	king shag, kawau	Fauna	Birds	Nationally Endangered	B(1)
<i>Nestor meridionalis meridionalis</i>	South Island kākā, kākā, bush parrot, brown parrot, kawkaw, South Island kaka	Fauna	Birds	Nationally Vulnerable	B(1)
<i>Nestor notabilis</i>	kea	Fauna	Birds	Nationally Endangered	
<i>Podiceps cristatus australis</i>	Australasian crested grebe, southern crested grebe, great crested grebe, pūteketeke, puteketeke, kamana, kāmana	Fauna	Birds	Nationally Vulnerable	A(1)
<i>Porphyrio hochstetteri</i>	South Island takahē, takahē, South Island takahe	Fauna	Birds	Nationally Vulnerable	A(1)
<i>Pimeleocoris roseus</i>		Fauna	Invertebrates	Nationally Critical	A(3)
Galaxias "Nevis"	Nevis galaxias (Nevis River)	Fauna	Fish	Nationally Endangered	A(3)
Galaxias "Pomahaka"	Pomahaka galaxias (Pomahaka River)	Fauna	Fish	Nationally Vulnerable	C(3)
Galaxias "southern"	Southern flathead galaxias (Southland, Otago)	Fauna	Fish	Nationally Vulnerable	C(3)
Galaxias "species D"	Clutha flathead galaxias (Clutha River)	Fauna	Fish	Nationally Critical	C
Galaxias "Teviot"	Teviot flathead galaxias (Teviot River)	Fauna	Fish	Nationally Critical	A(3)
Galaxias aff. paucispondylus "Manuherikia"	Alpine galaxias (Manuherikia River)	Fauna	Fish	Nationally Endangered	A(3)

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
Galaxias aff. paucispondylus "Southland"	Alpine galaxias (Southland)	Fauna	Fish	Nationally Vulnerable	D(3)
Galaxias anomalus	Central Otago roundhead galaxias	Fauna	Fish	Nationally Endangered	
Galaxias cobitinis	Lowland longjaw galaxias (Kakanui River)	Fauna	Fish	Nationally Critical	
Galaxias depressiceps	Taieri flathead galaxias	Fauna	Fish	Nationally Vulnerable	C(3)
Galaxias eldoni	Eldon's galaxias	Fauna	Fish	Nationally Endangered	
Galaxias gollumoides	Gollum galaxias	Fauna	Fish	Nationally Vulnerable	C(2)
Galaxias pullus	Dusky galaxias	Fauna	Fish	Nationally Endangered	
Geotria australis	Lamprey	Fauna	Fish	Nationally Vulnerable	C(3)
Neochanna burrowsius	Canterbury mudfish	Fauna	Fish	Nationally Critical	C
Woodworthia "Raggedy"	Raggedy Range gecko	Fauna	Reptiles	Nationally Vulnerable	C(3)
Asaphodes frivola	Remuremu looper moth	Fauna	Invertebrates	Nationally Critical	A(3)
Asaphodes stinaria	Moth	Fauna	Invertebrates	Nationally Vulnerable	B(2)
Cephalissa siria	Moth	Fauna	Invertebrates	Nationally Vulnerable	
Declana toreuta		Fauna	Invertebrates	Nationally Vulnerable	
Gingidiobora nebulosa	Moth	Fauna	Invertebrates	Nationally Vulnerable	B(2)
Maoricrambus oncobolus	Moth	Fauna	Invertebrates	Nationally Endangered	B(2)
Orocrambus sophistes	Moth	Fauna	Invertebrates	Nationally Vulnerable	B(3)
Sporophyla oenospora	Snout moth	Fauna	Invertebrates	Nationally Critical	C
Theoxena scissaria	Moth	Fauna	Invertebrates	Nationally Vulnerable	C(2)
Xanthorhoe frigida	Looper moth	Fauna	Invertebrates	Nationally Vulnerable	C(3)
Oligosoma aff. chloronoton "West Otago"	Lakes skink, west Otago green skink	Fauna	Reptiles	Nationally Vulnerable	C(2)
Oligosoma aff. inconspicuum "North Otago"	North Otago skink, Oteake skink	Fauna	Reptiles	Nationally Vulnerable	C(3)
Oligosoma aff. waimatense "alpine rock"	alpine rock skink	Fauna	Reptiles	Nationally Vulnerable	D(3)
Oligosoma burganae	Burgan skink	Fauna	Reptiles	Nationally Endangered	C(1)
Oligosoma grande	grand skink	Fauna	Reptiles	Nationally Endangered	B(1)

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
<i>Oligosoma ottagense</i>	Otago skink	Fauna	Reptiles	Nationally Endangered	B(1)
<i>Oligosoma waimatense</i>	scree skink	Fauna	Reptiles	Nationally Vulnerable	D(1)
<i>Alsolemia cresswelli</i>	land snail	Fauna	Invertebrates	Nationally Critical	B(3/1)
<i>Ramalina pollinaria</i>		Flora	Lichens	Nationally Critical	
<i>Amphibromus fluitans</i>	Water brome	Flora	Plants	Nationally Vulnerable	C(3)
<i>Atriplex buchananii</i>	Buchanan's orache	Flora	Plants	Nationally Vulnerable	C(3)
<i>Brachyscome linearis</i>		Flora	Plants	Nationally Critical	A(3)
<i>Cardamine mutabilis</i>		Flora	Plants	Nationally Critical	A(3)
<i>Carex albula</i>	White Sedge	Flora	Plants	Nationally Vulnerable	D(3)
<i>Carex capillacea</i>	Sedge	Flora	Plants	Nationally Vulnerable	C(3)
<i>Carex cirrhosa</i>	Curly Sedge	Flora	Plants	Nationally Endangered	A(3)
<i>Carex inopinata</i>	grassy mat sedge	Flora	Plants	Nationally Vulnerable	B(3)
<i>Carex rubicunda</i>	Sedge	Flora	Plants	Nationally Vulnerable	C(3)
<i>Carex strictissima</i>	Bastard grass, hook sedge	Flora	Plants	Nationally Endangered	A(1)
<i>Carex uncifolia</i>	Sedge	Flora	Plants	Nationally Vulnerable	B(3)
<i>Carmichaelia corrugata</i>	common dwarf broom	Flora	Plants	Nationally Vulnerable	D(3)
<i>Carmichaelia crassicaulis</i> subsp. <i>racemosa</i>	slender coral broom	Flora	Plants	Nationally Vulnerable	C(1)
<i>Carmichaelia curta</i>	Waitaki Broom, Whip Broom	Flora	Plants	Nationally Critical	C
<i>Carmichaelia juncea</i>		Flora	Plants	Nationally Vulnerable	C(1)
<i>Carmichaelia kirkii</i>	climbing broom, Kirk's broom	Flora	Plants	Nationally Vulnerable	C(1)
<i>Carmichaelia nana</i>	dwarf Broom	Flora	Plants	Nationally Vulnerable	E(1)
<i>Ceratocephala pungens</i>		Flora	Plants	Nationally Critical	A(3)
<i>Chaerophyllum colensoi</i> var. <i>delicatulum</i> (CHR 73872; Hauhungaroa Range)	mountain myrrh	Flora	Plants	Nationally Endangered	B(3)
<i>Chenopodium detestans</i>	New Zealand fish-guts plant	Flora	Plants	Nationally Critical	A(3)
<i>Convolvulus verecundus</i>	Trailing bindweed, tussock bindweed	Flora	Plants	Nationally Vulnerable	D(1)

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
Coprosma obconica		Flora	Plants	Nationally Vulnerable	C(1)
Craspedia incana	Woollyhead	Flora	Plants	Nationally Critical	A(1)
Crassula multicaulis		Flora	Plants	Nationally Endangered	A(3)
Crassula peduncularis		Flora	Plants	Nationally Critical	A(3)
Epilobium pictum	grassland willow herb	Flora	Plants	Nationally Critical	C
Eryngium vesiculosum	Sea holly, coastal eryngo	Flora	Plants	Nationally Vulnerable	C(3)
Euchiton ensifer	Creeping Cudweed	Flora	Plants	Nationally Endangered	A(1)
Geranium retrorsum	turnip-rooted geranium	Flora	Plants	Nationally Vulnerable	C(1)
Gratiola concinna		Flora	Plants	Nationally Endangered	B(3)
Hypericum rubicundulum		Flora	Plants	Nationally Endangered	A(3)
Korthalsella salicornioides	Mistletoe, dwarf mistletoe, leafless mistletoe	Flora	Plants	Nationally Critical	C
Lachnagrostis tenuis	wind grass	Flora	Plants	Nationally Vulnerable	C(3)
Lagenophora montana	papataniwha	Flora	Plants	Nationally Critical	A(3)
Lepidium kirkii	Kirk's scurvy grass, salt pan cress	Flora	Plants	Nationally Critical	C
Leptinella conjuncta		Flora	Plants	Nationally Critical	A(3)
Leptospermum scoparium var. scoparium	manuka, tea tree, kahikatoa	Flora	Plants	Nationally Vulnerable	
Libertia peregrinans	New Zealand iris, mikoikoi	Flora	Plants	Nationally Vulnerable	D(3)
Lophomyrtus obcordata	Rohutu, New Zealand myrtle	Flora	Plants	Nationally Critical	C
Mazus novaezeelandiae subsp. impolitus f. impolitus	dwarf musk/matt leaved mazus	Flora	Plants	Nationally Endangered	A(3)
Melicytus flexuosus		Flora	Plants	Nationally Vulnerable	D(1)
Metrosideros diffusa	white rata	Flora	Plants	Nationally Vulnerable	
Metrosideros umbellata	Southern rata	Flora	Plants	Nationally Vulnerable	
Myosotis brevis		Flora	Plants	Nationally Vulnerable	C(3)
Myosotis elderi		Flora	Plants	Nationally Vulnerable	C(3)
Myosotis glauca		Flora	Plants	Nationally Vulnerable	B(3)

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
<i>Myosotis umbrosa</i>		Flora	Plants	Nationally Critical	A(1)
<i>Myosurus minimus</i> subsp. <i>novae-zelandiae</i>	New Zealand mousetail, bearded mousetail	Flora	Plants	Nationally Vulnerable	C(3)
<i>Neomyrtus pedunculata</i>	Rohutu, myrtle	Flora	Plants	Nationally Critical	C
<i>Olearia fimbriata</i>		Flora	Plants	Nationally Vulnerable	D(1)
<i>Olearia hectorii</i>	Deciduous tree daisy, Hectors tree daisy	Flora	Plants	Nationally Endangered	C(1)
<i>Ourisia modesta</i>	Creeping Foxglove	Flora	Plants	Nationally Critical	A(3)
<i>Pimelea sericeovillosa</i> subsp. <i>pulvinaris</i>	Cushion Pimelea	Flora	Plants	Nationally Vulnerable	D(1)
<i>Pittosporum obcordatum</i>	Heart-leaved kohuhu	Flora	Plants	Nationally Vulnerable	B(1)
<i>Pittosporum patulum</i>	Pitpat	Flora	Plants	Nationally Vulnerable	C(1)
<i>Puccinellia rariflorens</i>	Saltgrass	Flora	Plants	Nationally Critical	A(3)
<i>Ranunculus acraeus</i>		Flora	Plants	Nationally Endangered	A(1)
<i>Ranunculus brevis</i>		Flora	Plants	Nationally Endangered	A(3)
<i>Ranunculus recens</i>		Flora	Plants	Nationally Vulnerable	B(3)
<i>Ranunculus ternatifolius</i>		Flora	Plants	Nationally Vulnerable	C(3)
<i>Raoulia monroi</i>	fan-leaved mat daisy	Flora	Plants	Nationally Vulnerable	D(3)
<i>Senecio dunedinensis</i>	Fireweed	Flora	Plants	Nationally Endangered	A(3)
<i>Simplicia laxa</i>	Simplicia	Flora	Plants	Nationally Critical	A(3)
<i>Sonchus novae-zelandiae</i>	Dryland sow thistle	Flora	Plants	Nationally Vulnerable	D(3)
<i>Tetrachondra hamiltonii</i>		Flora	Plants	Nationally Vulnerable	C(3)
<i>Triglochin palustris</i>	marsh arrow grass	Flora	Plants	Nationally Critical	A(3)
<i>Veronica cupressoides</i>	cypress hebe	Flora	Plants	Nationally Endangered	C(1)
<i>Wurmbea novae-zelandiae</i>		Flora	Plants	Nationally Endangered	A(3)

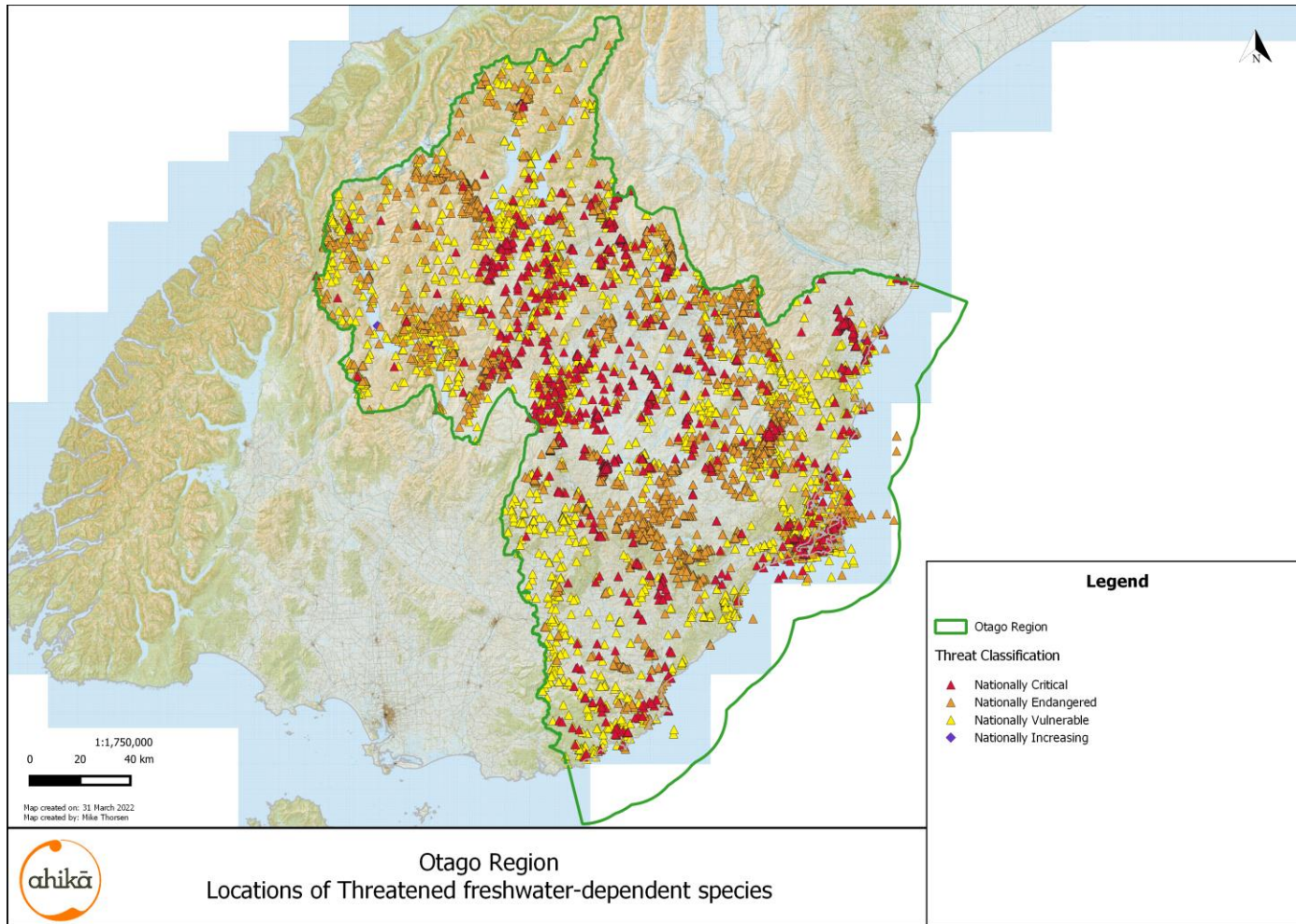


Figure 5. Locations of Threatened freshwater-dependent species recorded from freshwater within the Otago region (green outline).

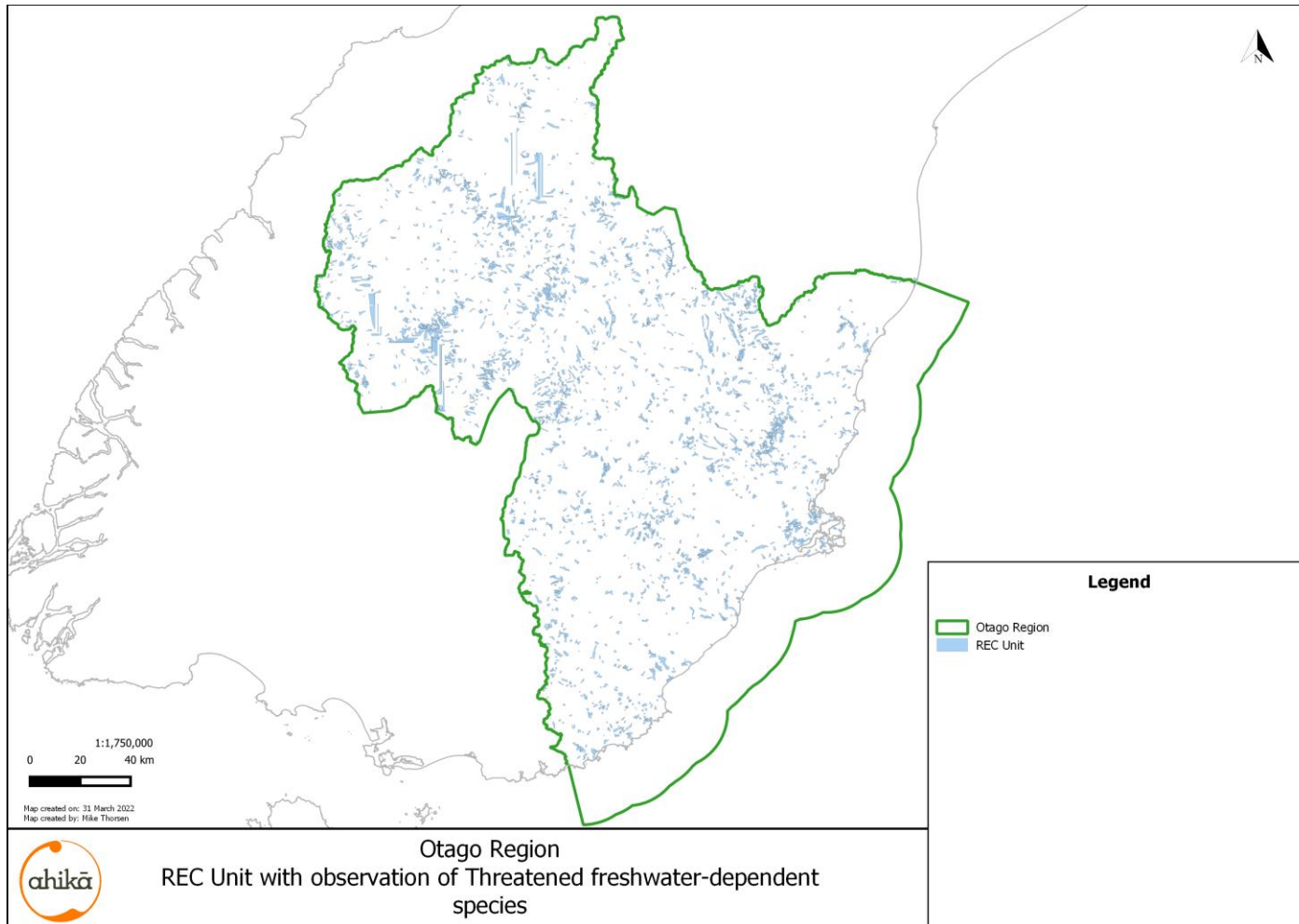


Figure 6. River Environment Classification (REC) units within the Otago region where Threatened freshwater-dependent species have been mapped.

7.2 Freshwater-dependent species of other conservation interest

Three hundred and ninety-three species are identified as freshwater-dependent species of other conservation interest within the Otago region (Appendix 2. List of freshwater-dependent species of conservation interest. 180 species are assigned as potentially freshwater-dependent based solely on their being located within the mapped extent of freshwater in Otago (Criteria F). Most of the species of other conservation interest are located in either lacustrine, riverine or estuarine hydrosystems, and are mostly of Naturally Uncommon or Declining conservation status (Table 5). Nearly all species of conservation interest are dependent on flow quantity, and most are also dependent on flow quality (Table 5). The majority of the species are potentially threatened by terrestrial pest animals (Table 5).

There are 40,400 records of these species within the Otago region (Figure 7) located within 6,691 REC Units (Figure 8). 12,893 records are situated outside of the mapped extent of freshwater in Otago.

Table 5. Count of species and number of records in the Otago region for those species in each categorisation of each species into life form, hydrosystem, freshwater reliance, flow reliance, threatening processes, and conservation status of freshwater-dependent species of other conservation interest.

Feature	Number of Species	Number of Records
Life Form		
Birds	46	23,185
Fish	10	3,804
Hornworts and Liverworts	10	14
Invertebrates	80	2,546
Lichens	34	81
Mosses	9	13
Plants	189	7,406
Reptiles	15	3,351
Hydrosystem		
Lacustrine	73	22,606
Palustrine	79	8,425
Riverine	113	24,992
Geothermal	1	1
Estuarine	42	19,688
Nival	8	103
Saline	3	87

Feature	Number of Species	Number of Records
<i>Plutonic</i>	-	-
<i>Pluvial</i>	-	-
Reliance		
<i>Obligate</i>	98	10,421
<i>Facultative - Lifecycle</i>	5	3,095
<i>Facultative - Occasional</i>	82	17,879
<i>Facultative - Distribution</i>	13	5,633
Flow		
<i>Quantity</i>	212	32,026
<i>Quality</i>	173	27,719
<i>Passage</i>	10	3,804
Threatened by		
<i>Weeds</i>	112	8,794
<i>Pests - terrestrial</i>	95	24,998
<i>Pests - aquatic</i>	39	5,982
Conservation Status		
<i>Coloniser</i>	2	4
<i>Data Deficient</i>	69	455
<i>Declining</i>	124	29,416
<i>Extinct</i>	2	2
<i>Migrant</i>	5	39
<i>Naturally Uncommon</i>	163	4,119
<i>Recovering</i>	4	3,482
<i>Relict</i>	12	2,827
<i>Vagrant</i>	11	56
TOTAL in metadatabase	393	40,400

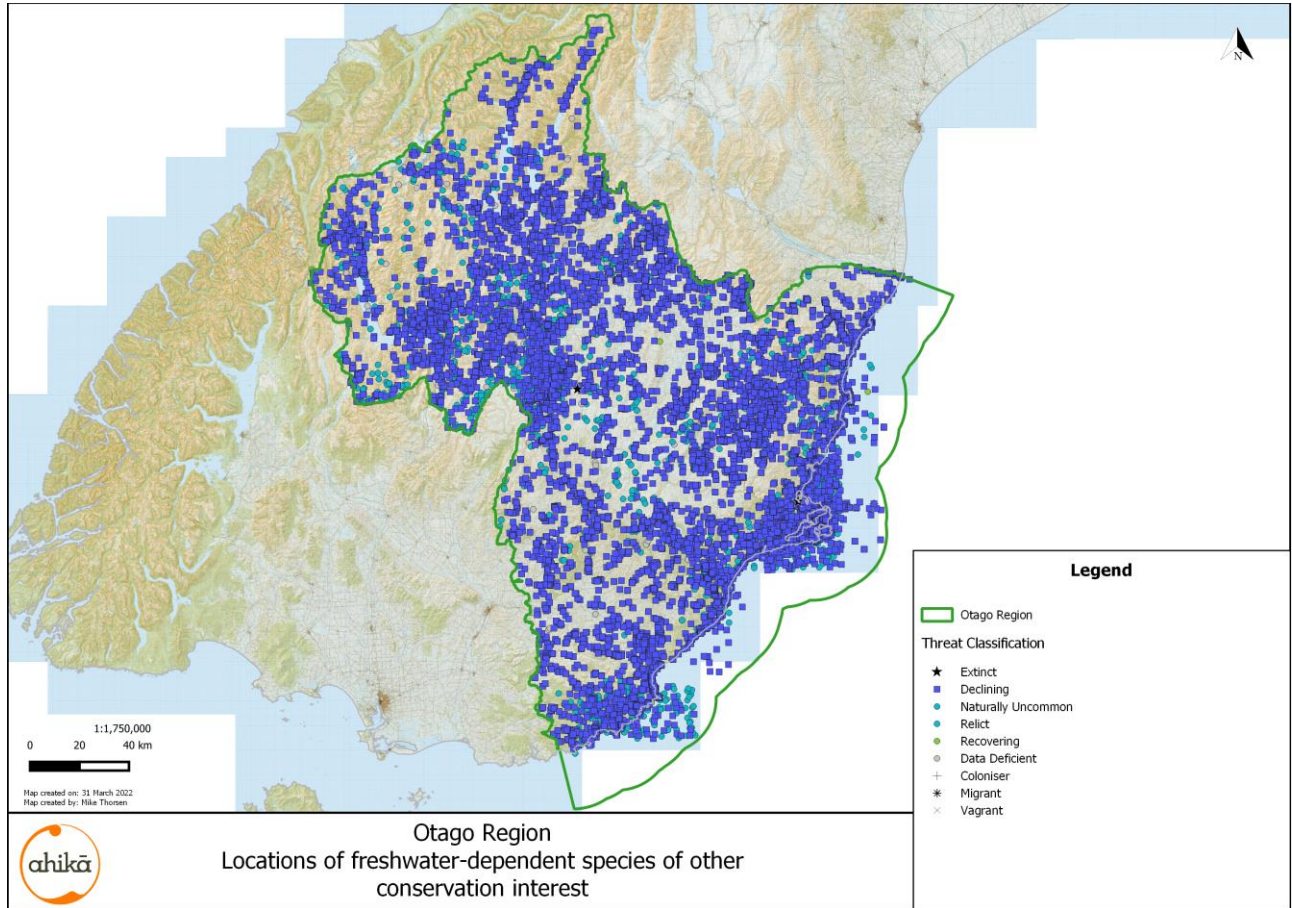


Figure 7. Locations of freshwater-dependent species of other conservation interest recorded from within the Otago region (green outline).

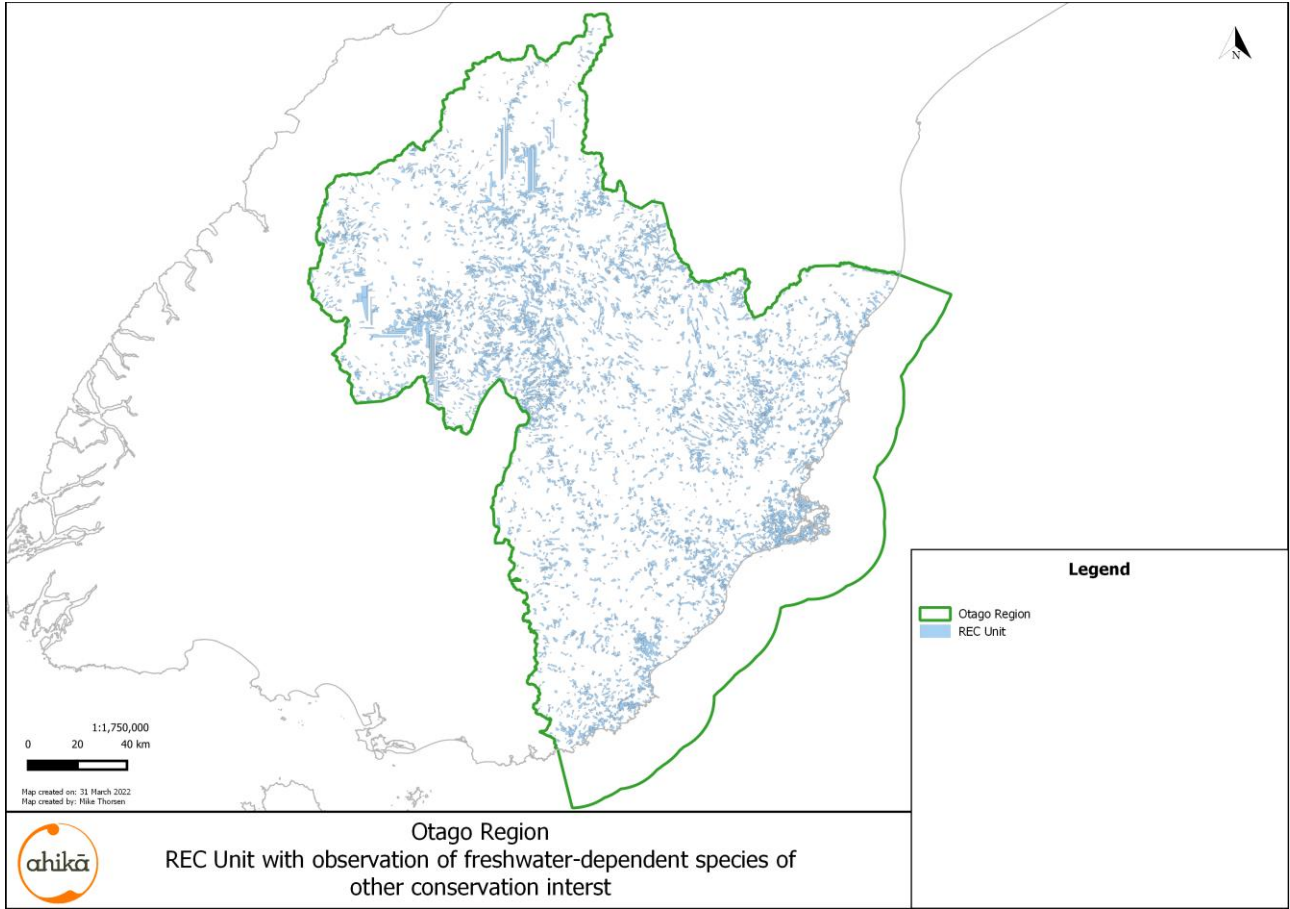


Figure 8. River Environment Classification units within the Otago region where freshwater-dependent species of other conservation interest have been mapped.

7.3 Excluded and poorly known species

Where possible, errors in the metadatabase are corrected as they are discovered during several cross-validation exercises. However, the observations of 85 species mapped as occurring within the Otago region but that do not occur naturally within the region could not be corrected and therefore were excluded from this exercise. These observations appear mainly a result of observations of species in cultivation or captivity, where the coordinates have been recorded incorrectly, or where there has been an error in identification. Records of a further 20 species are of uncertain identity in Otago and are not included in this current exercise. It is possible that corrections can be made to these observations by querying the original database or observer. Seventeen species that are mapped as occurring within the Otago region, but there is insufficient information to assess their dependence on freshwater habitats. These species are listed in Appendix 7. Species records of uncertain identity, or that could not be matched with a known entity.

8 Species outside Otago region and reintroduced species

Some species have been reintroduced back into Otago, such as South Island saddleback and tuatara to Orokonui Ecosanctuary³⁵. Observations of species such as these are included in the metadataset (if recorded in one of the source datasets).

The biodiversity of Otago is not fully inventoried and species not previously recorded are regularly discovered, as are species new to science. There are 46 species of conservation interest that have been observed within 10 km of the Otago region (Table 6). It is possible that some of these also use freshwater habitats within Otago.

³⁵ <https://orokonui.nz/>

Table 6. Species observed within 10 km of the Otago region³⁶.

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
<i>Apteryx owenii</i>	little spotted kiwi, kiwi pukupuku,	Fauna	Birds	Nationally Increasing	
<i>Megalapteryx didinus</i>	upland moa	Fauna	Birds	Extinct	
<i>Sterna hirundo longipennis</i>	common tern	Fauna	Birds	Vagrant	
<i>Strigops habroptilus</i>	kākāpō, kākāpō, tarapo, tarepo, kakapo, night parrot, owl-parrot	Fauna	Birds	Nationally Critical	
<i>Galaxias macronasus</i>	Bignose galaxias	Fauna	Fish	Nationally Vulnerable	C(3)
<i>Galaxias prognathus</i>	Upland longjaw galaxias (Canterbury, West Coast)	Fauna	Fish	Nationally Vulnerable	
<i>Cycloclamys pileolus</i>	Scallop	Fauna	Invertebrates	Naturally Uncommon	
<i>Hoplochaetina rossii</i>	Earthworm	Fauna	Invertebrates	Data Deficient	
<i>Maotoweta virescens</i>	Weta	Fauna	Invertebrates	Data Deficient	
<i>Myerslophia whakatipuensis</i>		Fauna	Invertebrates	Data Deficient	
<i>Nysius liliputanus</i>	Lygaeidae	Fauna	Invertebrates	Naturally Uncommon	
<i>Orchymontia calcarata</i>	beetle	Fauna	Invertebrates	Data Deficient	
<i>Otoconcha fiordlandica</i>	land snail	Fauna	Invertebrates	Naturally Uncommon	
<i>Pianoa isolata</i>	large-clawed spider	Fauna	Invertebrates	Relict	
<i>Pyrausta comastis</i>	Crambid snout moth	Fauna	Invertebrates	Nationally Vulnerable	C(3)
<i>Sigaus homerensis</i>	Homer grasshopper	Fauna	Invertebrates	Nationally Critical	
<i>Oligosoma judgei</i>	Barrier skink	Fauna	Reptiles	Nationally Endangered	A(2)
<i>Lissodelphis peronii</i>	southern right whale dolphin	Fauna	Whales, Dolphins and Porpoises	Data Deficient	

³⁶ Some records may be historic and no longer present.

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
Balantiopsis verrucosa	liverwort	Flora	Hornworts and Liverworts	Naturally Uncommon	
Chiloscyphus herzogii	liverwort	Flora	Hornworts and Liverworts	Data Deficient	
Heteroscyphus assurgentifolius	liverwort	Flora	Hornworts and Liverworts	Data Deficient	
Isophyllaria attenuata	liverwort	Flora	Hornworts and Liverworts	Naturally Uncommon	
Lepidozia bragginsiana	liverwort	Flora	Hornworts and Liverworts	Not Threatened	
Neohodgsonia mirabilis	liverwort	Flora	Hornworts and Liverworts	Naturally Uncommon	
Hypotrachyna rockii	lichen	Flora	Lichens	Naturally Uncommon	
Umbilicaria murihikuana		Flora	Lichens	Naturally Uncommon	
Azorella schizeilema		Flora	Plants	Naturally Uncommon	
Celmisia holosericea	mountain daisy	Flora	Plants	Declining	B(2)
Celmisia markii	Marks Celmisia	Flora	Plants	Naturally Uncommon	
Celmisia rigida		Flora	Plants	Naturally Uncommon	
Dracophyllum fiordense		Flora	Plants	Declining	C(2)
Dracophyllum pearsonii		Flora	Plants	Naturally Uncommon	
Gentianella calcis subsp. calcis	Awahokomo Gentian	Flora	Plants	Nationally Critical	A(3)
Gingidia flabellata	Stewart Island aniseed	Flora	Plants	Naturally Uncommon	
Helichrysum dimorphum	Climbing everlasting daisy	Flora	Plants	Nationally Endangered	A(1)
Helichrysum plumeum		Flora	Plants	Naturally Uncommon	
Lindsaea viridis		Flora	Plants	Naturally Uncommon	
Myosotis antarctica		Flora	Plants	Naturally Uncommon	
Oxalis aff. rubens (AK 234308; "scree")		Flora	Plants	Naturally Uncommon	
Pimelea microphylla	Pimelea	Flora	Plants	Naturally Uncommon	
Ranunculus aff. reflexus (CHR 394270; Mt Peel)		Flora	Plants	Data Deficient	
Ranunculus grahamii	Grahams buttercup	Flora	Plants	Naturally Uncommon	

Scientific Name	Common Name	Taxonomic Group	Life Form	Threat Status	Threat Criteria
<i>Rytidosperma horrens</i>	bristle grass	Flora	Plants	Nationally Critical	A(3)
<i>Spiranthes novae-zelandiae</i>	Ladys tresses, <i>Spiranthes</i>	Flora	Plants	Declining	A(2)
<i>Trithuria inconspicua</i>	Hydatella	Flora	Plants	Nationally Critical	B(3)
<i>Veronica ciliolata</i> subsp. <i>fiordensis</i>		Flora	Plants	Naturally Uncommon	

9 Knowledge gaps, identifying data poor areas and metadata errors

The list and map of candidate freshwater-dependent species in the Otago region contains bias. There is considerable taxonomic bias in which species are recorded (Table 7), an effect partly compounded by the lack of people with sufficient experience to accurately identify less-represented taxonomic groups, or difficult to identify life forms (such as grasses). A temporal bias towards more recent observations is also present due to an increase in the ease of recording biodiversity observations resulting from the development of electronic databasing and data capture tools and the rise in usage of citizen science biodiversity recording systems such as eBird and iNaturalist.

Table 7. Taxonomic bias in observations of freshwater-dependent species in the Otago region.

Taxonomic Group	Number of Species	Number of Observations
<i>Bats</i>	1	1
<i>Birds</i>	62	25,767
<i>Fish</i>	25	8,240
<i>Hornworts and Liverworts</i>	10	14
<i>Invertebrates</i>	106	2,681
<i>Lichens</i>	35	82
<i>Mosses</i>	9	13
<i>Plants</i>	257	10,684
<i>Reptiles</i>	24	4,274

There are several potential other sources of error in the metadata set that this analysis uses. The analysis is dependent on accurate identification of species identity and correctly recorded locations in the source datasets. Obvious errors in identity were removed from analysis, but it is not possible to confirm the identity of each species record without querying the original data record and probably the original observer.

The metadata set is based on datasets that mainly contain 'incidental' records in that someone observed something that they thought was worthy of recording. For this reason, the datasets contain inherent bias towards recording 'notable' species and the composition of records in the dataset indicate that birds over-recorded and invertebrates under-recorded. There is also probable spatial

bias in that remote areas are under-sampled and 'popular' biodiversity areas, particularly those near towns and cities, are over-sampled.

Blank areas in the map may mean that the area has not been examined.

Matauranga māori which could provide valuable observations over extended period of time, are not generally included in these records. This can be considered as a gap in the accessible data.

10 Next steps

The recommended next steps in the process of fulfilling the requirements in the NOF is to critically evaluate the detail (possibly involving examining the original record or querying the original recorder) in the dataset generated in this exercise to select locality records of Threatened species where there is higher probability of persistence of the population at the site. A field examination will then be required to both assess the status (including trend) of the threatened species at the site and to assess the quality of its habitat and the processes that are threatening that habitat. An assessment on whether the habitat qualifies as 'critical habitat' can be undertaken based on the field examinations (ideally performed throughout New Zealand). An Action Plan will be required that covers each species or site identified as containing critical habitat within the boundaries of a regional council. The Action Plan may take the form of a site management plan, species management plan or habitat management plan (or other plan). This plan will require full description of the management actions (including cross-boundary issues) and resources required to safeguard (and ideally improve) the critical habitat.

Appendix 1. List of Threatened Freshwater-Dependent Species

See file: [Otago_FWD_Threatened_SpeciesList_220331.xlsx](#)

Appendix 2. List of freshwater-dependent species of conservation interest

See file: [Otago_FWD_ConservationInterest_SpeciesList_220331.xlsx](#)

Appendix 3. Observations of freshwater-dependent species in the Otago region.

See spreadsheet and GIS files: [Otago_FWD_SpeciesObservations_220331](#).

Appendix 4. Descriptions of spreadsheet column headers

10.1 Description of column information in spreadsheet files:

Otago_FWD_Threatened_SpeciesList_220331.xlsx &

Otago_FWD_ConservationInterest_SpeciesList_220331.xlsx

Column Header	Description of column information
NameCurren	The current taxonomic name and naming authority as used in the NZTCS.
NameSimple	The current taxonomic name excluding naming authority as used in the NZTCS.
NameCommon	Common name(s) of the species (if any)
Environment	The predominant environment inhabited by the species (Marine, Terrestrial or Freshwater)
Taxonomic_	The higher-order taxonomic grouping of the species (Flora, Fauna)
Taxonomi_1	The main taxonomic grouping based on life form of the species (Bats, Birds, Fish, Invertebrates, Plants)
Taxonomi_2	A finer-scale taxonomic grouping of the species for large groups (such as invertebrates) in Taxonomic_1 if needed (otherwise inherits value of Taxonomic_1).
BioStatus_	Whether the species is Indigenous (also found outside of NZ, or Endemic), if known.
ThreatCate	The NZTCS Threat Category (Threatened, At Risk, Data Deficient, Non-resident Native, Not Threatened) of the species.
ThreatStat	The NZTCS Threat Status of the species.
ThreatCrit	The Criteria for which the species qualifies for Threat Status in the NZTCS (refer to NZTCS manual and updates for descriptors of these criteria).
ObligateFW	If this species is considered to qualify as an obligate freshwater inhabitant in Criteria A of Section 6.2.
FAC_LifeCycle	If this species is considered to inhabit freshwater habitats for part of its life cycle in Criteria B of Section 6.2.
FAC_Occ	Some individuals of this species have been recorded temporarily or occasionally using freshwater habitats for activities important in maintaining health and wellbeing such as feeding, drinking, or bathing in Criteria C of Section 6.2.
OtherRC	The species has previously been assessed as freshwater-dependent within other regions using this process as in Criteria D of Section 6.2.
NZTCS_FW	The species is listed as a 'freshwater' species during NZ Threat Classification Assessments as in Criteria D of Section 6.2.
FAC_Distribution	The species is known to inhabit freshwater habitats in addition to other non-freshwater habitats in Criteria E of Section 6.2.
FAC_Map	Some individuals of this species have mapped as occurring within the mapped extent of freshwater as in Criteria F of Section 6.2. and this is the only Criteria that is met
MappedFW	Some individuals of this species are mapped as occurring within the mapped extent of freshwater, but their link to freshwater is not known as in Criteria F of Section 6.2.
FWBuffer	Observations of this species only occur in the buffer around the predicted freshwater extent (and not in the mapped extent of freshwater).
Clarkson et al.	The Wetland Indicator Status of the species as listed in Clarkson et al. (2021), New Zealand Plant List 2021 (Plants only). see: https://datastore.landcareresearch.co.nz/dataset/nz-wetland-plant-indicator-status-ratings-2021
Storey et al.	The species is considered freshwater-dependent in Storey, R; Kilroy, C; Matheson, F; Neale, M; Crow, S, Whitehead, A. 2018. Scoping indicators for impacts on freshwater biodiversity and ecosystem processes of rivers and streams. NIWA client report 20118118HN to Ministry for the Environment.
FWSp	Whether the species qualifies as a freshwater-dependent species by meeting one or more of Criteria A-F of Section 6.2.

Lacustrine	Whether the species occupies wetland habitats within the Lacustrine hydrosystem.
Palustrine	Whether the species occupies wetland habitats within the Palustrine hydrosystem.
Riverine	Whether the species occupies wetland habitats within the Riverine hydrosystem.
Geothermal	Whether the species occupies wetland habitats within the Geothermal hydrosystem.
Estuarine	Whether the species occupies wetland habitats within the Estuarine hydrosystem.
Nival	Whether the species occupies wetland habitats within the Nival hydrosystem.
Saline	Whether the species occupies wetland habitats within the inland Saline hydrosystem. Coastal Saline hydrosystems are outside the scope of this exercise.
Plutonic	Whether the species occupies wetland habitats within the Plutonic (cave) hydrosystem.
Pluvial	Whether the species occupies wetland habitats within the Pluvial (rain/cloud forest) hydrosystem.
Notes	Notes and links to information supporting categorisation(s) of the species.
Excluded	Whether the species has been excluded from the list of freshwater-dependent species.
ExclNote	The reason why the species has been excluded from the list of freshwater-dependent species.
WaterQuantity	Whether the species, or the habitat it occupies, is reliant on the quantity of water (including dependence on seasonal variation in water quantity) at the sites it inhabits.
WaterUpQuality	Whether the species, or the habitat it occupies, is reliant on the quality of water arriving from upstream at the sites it inhabits.
WaterPassage	Whether the species, or the habitat it occupies, is reliant on a continuous water passage to the sites it inhabits.
WeedsLand	Whether the continued presence of a species at sites is often threatened by terrestrial weeds.
PestsLand	Whether the continued presence of a species at sites is often threatened by terrestrial pest animals such as possums, rodents, rabbits, etc.
PestAquatic	Whether the continued presence of a species at sites is often threatened by aquatic weeds or aquatic pest animals.
NumRecords	The number of observations within Otago of this species in the metadataset.

10.1.1 Description of column information in spreadsheet and GIS file: Otago_FWD_SpeciesObservations_220331.

Column Header	Description of column information
DatabaseNu	A unique identifier code within the metadataset.
DatabaseSc	The scale of the source dataset (region or national).
Source	The source dataset of the observation.
Accessed	Date observation obtained from the source dataset
NZTM E	Coordinate of observation (obscured for species and landowner security reasons).
NZTM S	Coordinate of observation (obscured for species and landowner security reasons).
ID	The ID number used in the source dataset of observation.
NameOrigin	The name of the species as used in the source dataset.
NameCurren	The current taxonomic name and naming authority as used in the NZTCS.
NameSimple	The current taxonomic name excluding naming authority as used in the NZTCS.
NameCommon	Common name(s) of the species (if any)
Date	The date on which the observation was made.
Year	The year on which the observation was made.
Locality	The locality where the observation was made (if given).
Observer	The name of user code of the person(s) who made the observation.
Notes	Notes provided as part of the observation.
Count	A count of the number of individuals observed (if given).
Environmen	The predominant environment inhabited by the species (Marine, Terrestrial or Freshwater)
Taxonomic_	The higher-order taxonomic grouping of the species (Flora, Fauna)
Taxonomi_1	The main life form grouping of the species (Bats, Birds, Fish, Invertebrates, Plants)
Taxonomi_2	A finer-scale taxonomic grouping of the species for large groups (such as invertebrates) in Taxonomic_1 if needed (otherwise inherits value of Taxonomic_1).
BioStatus_	Whether species is Indigenous (also found outside of NZ, or Endemic), if known.
ThreatCate	The NZTCS Threat Category (Threatened, At Risk, Data Deficient, Non-resident Native, Not Threatened) of the species.
ThreatStat	The NZTCS Threat Status of the species.
ThreatCrit	The Criteria for which the species qualifies for Threat Status in the NZTCS (refer to NZTCS manual and updates for descriptors of these criteria).
FWSp	Whether the species qualifies as a freshwater-dependent species by meeting one or more of Criteria A-F of Section 6.2.
MapFW	Whether the observation is located within the mapped extent of freshwater.
MapFWB	Whether the observation is located within the buffer to the mapped extent of freshwater.
MapFWFWB	Whether the observation is located within the buffer or the mapped extent of freshwater.
WONlunitID	The Waters of National Importance database Unit number in which the observation occurs.
CatchID	The Waters of National Importance Catchment number in which the observation occurs.
FWENZ5thID	The Freshwater Environments of NZ 5 th order unit ID number in which the observation occurs.
FWENZ4thID	The Freshwater Environments of NZ 4 th order unit ID number in which the observation occurs.
RECHydroID	River Environment Classification Hydro Unit ID number in which the observation occurs.

FMU	The name of the Freshwater Management Unit in which the observation occurs.
Rohe	The name of the Rohe in which the observation occurs.

10.2 GIS files: ORC_REC_Threatened5, ORC_REC_OtherConservation5, ORC_REC_OtherConservation5_Sp2.

ORC_REC_Threatened5 are GIS files (QGIS format) of the REC Units in within the Otago region where Threatened freshwater-dependent species have been mapped that were used in the preparation of Figure 6. ORC_REC_OtherConservation5_Sp2 is an expanded version of ORC_REC_Threatened5 which shows the REC Unit for each record of a threatened species. This allows a map to be generated of REC Units where any of the threatened species have been observed within the Otago region.

ORC_REC_OtherConservation5 are GIS files (QGIS format) of the REC Units in within the Otago region where freshwater-dependent species of other conservation interest have been mapped that were used in the preparation of Figure 8.

Appendix 5. Acknowledgements

Acknowledgement is made to the Department of Conservation (DOC), Cornell Lab of Ornithology, Landcare Research Manaaki Whenua, Auckland War Memorial Museum, National Institute of Water and Atmospheric Research (NIWA), Cawthron Institute, iNaturalist (<https://inaturalist.nz/>) and National Vegetation Survey for access to this very important information. Thanks also to Shay Dean, Scott Jarvie, and the biodiversity teams at the Bay of Plenty and Otago Regional Councils for comments that have improved this process.

Thanks are made to the following people and users who have contributed records into the source databases:

A E Esler 918, A E Wade, A E Wright, A E Wright 337, A Hamilton, A Lee 48/06, A Lee 49/06, A M Brandon, R J Stanley, M J Thorsen, A P Druce, A. Cunningham, G. Walls, A. Hamilton, A. Hamilton and W. Colenso, A. Hamilton. W. Colenso, A. Lee, A. P. Druce, A. P. Druce, W.B. Shaw, S.M. Beadel, A. T. Pycroft (Auckland), A. T. Pycroft (Auckland), G Archey, A. T. Pycroft (Auckland), Sir Frank Mappin (Auckland), A. Townsend, A. Townsend & M. Thorsen, A. Ure, A. Ure. P.B. Heenan, A.Hamilton, T.Kirk, H.Hill, A.M. Buchanan, A.P. Druce, A.P.Druce, A.P.Druce, B.D.Clarkson, P.J. Garnock-Jones, A.P.Druce, B.D.Clarkson,P.J. Garnock-Jones,, A.P.Druce, H.H.Allan, A.P.Druce, W.B.Shaw,S.M.Beadel, A.P.Druce,W.B.Shaw,S.M.Beadel, ael, aelyshumphreys, agoranomos, AH, Whitaker, ajackson, ajw, al45, Alan & Donna McKenzie, Alan Lee, Alan Lee & M. Thorsen (revisited), albeer23, alexjesk, alice_shanks, Allan Lee, amca, Andrew Wilson, andrewlowe, andyb, Ann Crawford, Anthony Caprio, aramata, Armitage, Ian, Armstrong, JS;, arnim, arthur, Aston per Petrie, BCD;, Aston, Bernard Cracroft, Auld, H;, B Bensemen, B C Aston, B Williams, B, Christensen, B, Slade, B, Teague, B, Turner, B. Rogan & J. Valentine, B. Rogan J. Valentine, B. W. Hayward, B.D. Clarkson, B.H.Macmillan 81/49, FRI herbarium: 17425, B.R. Burns, W. Shaw, Barry Ovenden, Bartlett, JK;, Bayly, Michael; Wotton, Debra, Baynes, Hugo, BC Jerebine, Beadel S.M.; Shaw, W.B., Beadel, S.M., Ben Keen, benackerley, benknight, benmannell, Bernie Kelly, Beveridge, P; Beveridge, P;, Beveridge, Peter, Birds NZ Wellington Region Data, Bisley, L;, BJ Sanders, booboo, Braggins, JE;, Braggins, John, Brandon, Andrea, brettpayne, briartaylorSmith, Bruce McKinlay, Bruce

Wedderburn, BSMI team, Buchanan AM, Buchanan, John, bugman-nz, Burke, Warren, Burns, B.; Shaw, W.B., Burns, W. Shaw, Butcher, CF;; butterfly4, Buzz Crowston, bwessling, C E Ecroyd, C, Berry, C. Ogle, C.C. Ogle, C.E. Ecroyd, C.Ogle, caleb187, Cameron Poole Smith, candler, Canterbury Conservancy Database, caqalai, Carsten Fog, Cashmore, P, Cashmore, P., Cashmore, P.B., ccrummack, Charmaine Jones, Cheeseman. Elder (1950), Cheesman and Elder, Che'ree Grimsley, Cheryl Walton, cheryldawson19, chhf, Chinnock, Robert (Bob), chrismorse, Christine Cullen, christinealawrence, ci, Colenso, Colenso 1149, Colenso, B.C. Aston, Colenso, William, Colin T. Richardson, Colin Taylor, connie cloud, conservation_company, Conway, T;; corokid, Cottier, W;; courtney_92, CR, Pickard, Craig Doolan, curtisnz, D M Tara, D M Tiffen, D myhr, D Petrie, D, King, D. King, D. King?, D. McLean, D. Petrie, D. Rudd, D.E. Hofstra, P.D. Champion, and J.S. Clayton, D.E. Hofstra, P.D. Champion, J.S. Clayton, D.King, D.R. Given, A.W. Purdie, Dan Burgin, Dan Burgin and Tansy Bliss, Daniele Mitchell, danilo_hegg, Darren Lees, darrylh, dave228, Davey, IW;; David Anderson, David Holyoak, David King, David Lawrie, Davies, TH; Davies, JM;; davo, debbie81, delautourt, Dept Agric.;; dgroberts, dhobonnel, dianevallienne, docb, doce, doch, docn, docw, dominic auld, Don McLean, dougbridge, Douglas Long, Dr Fred Brook (Tasman), dragonermine, Druce, Druce AP, Druce, A.P., Druce, A.P. (DSIR), list based on visits from 1957 to 1984, Druce, AP;; Druce, record sheet (CHR), Druce, record sheet; (CHR), Duncan Watson, Duncan Wright, E A Brown, E A Brown 86/19, E A Brown 86/2, E A Brown 86/7, E A Hodgson, E A Hodgson 101, E A Hodgson 142, E A Hodgson 18, E K Cameron, E K Cameron 14461, E K Cameron 14462, E Phillips Turner, E Phillips Turner ?, E. Williams, E.J. Remson, E.P.Turner, S.M.Beadel, H.H.Allan, eafg, eam, earnst, Ecroyd CE, Ed Lowe, Elder NL, Elder NL 195/3, Elder NL 31/162, Elder NL; Wardle P, Elder, N.L., Elder, NL, Elder, NL;; emma-and-tom, enzedfred, Eric de Leeuw, ewanbennett, Eyles, AC;; F. J. Shirley, fergus, Fishermen in Waiau, flackfamily, flyingkiwigirl, fordk, Frank Hall, fredderks, frufan, G Archey, G Archey, A. T. Pycroft (Auckland), G C Platt, G O K Sainsbury, G O K Sainsbury No.2, G Sturgeon, G T Jane, G Y Walls, G. Jane, G. Rogers, G. Walls, G.O.K. Sainsbury, G.O.K. Sanbury, G.O.K.Sainsbury, G.O.K.Sanbury, G.Walls, Gary Stone, gary14, Gasson P; Dahm R; Whiting R; Jonas H, gem2016, Geoff de Lisle, Geoff Rogers;; Geoff Walls, Geraldine King, gerry_kessels, Given DR 10676; Purdie A, Given DR; Purdie AW, gizz, Grahame Brind, Grant A, Grant, D;; greenfalcon, Greg Hottman, greghart, Guthrie-Smith, gwyn_ashcroft, H H T Kirk, H Hill, H Rendle, H. Grubner, H. Hill, H. Hill, T.F. Cheeseman, H. Jonas, H. R. Grenfell, B. W.

Hayward, M. S. Morley, H. Tryon and Colenso, H. Tryon. Colenso., H.Hill, H.Hill, T.F.Cheeseman, H.Jonas, H.M.Hodgson, B.D.Clarkson, P.J.Garnock-Jones, Hamilton, Augustus, hamish_carson, hamishmcw, Hamlin, BG;, Hamlin, Bruce, Hans Rook, Harry Boorman, harrylurling, hawkdoc, hbf, hbrc, Healy, AJ;, Heenan P 9/97, Heenan, P.B., heeni, heidimeudt, Helen Jonas, Helen Jonas, Roger Dahm, Henry Hill (Napier), HG, Calvert, hilary5, Hill, Henry Thomas, Hodgson, Hodgson EA, Hodgson Mrs, houi, hovmoller, Howard-Williams, C; John Davies;, hudsonianjoe, Hughes, P, Hughes, PM, Hume 1990, Hunterpark Kindergarden, Hutchinson, Iain Johnson, Ian Armitage, Ian Smith, iansfinds, ind, indeynz, inds, irene_r, isaac162, izogi, J E Beever, J E Braggins, J E Morton, J G Bilkey, J Harding, J K Bartlett, J K Bartlett 26102b, J K Bartlett 26671, J K Bartlett 26678, J M McEwan 697, J R Rolfe, J R Rolfe 15019, J Ronaldson, J Salter, J. Buchanan, J. Fuller 17, J. Quirke, J. Ronaldson, J. Yaldnif, J. Yaldwin, J.A. Langbein, J.Buchanan, Jack Levene (from Wildlife Recorder), Jake Holland, James Boccia, Jamie Ross, Jane John, Jason Wilder, Jeff Yunke, Jenkins, F;, Jenny Stiles, jeremyc-nz, jessielee, JM, Winn, jnleastcoast, Joanna McVeagh, Joanna Roberts, joduncan, John & Abby Dux, John Groves, John Lewis, John McLean, John McLennan, John Phelps, john_barkla, johnb-nz, johnhb, johnvandenhoeven, jon_sullivan, Jonathan Boucher, Judy Rash, juliekaahu, June, SR;, K A Riddell, K Broster, K Hewitt, K Hewitt, J Adams, B Kappers, K Hewitt, T Billing, J Adams, K M Wood, K P Tupper, K, Hawkins, K. Hewitt, K. Lloyd, K. Riddell, K.J.Whaley, Clarkson, B.D., Emmett, D.K., Innes, J.G., Leathwick, J.R., Smale, M.C., Whaley, P.T, K.J.Whaley, ., Clarkson, B.D., Emmett, D.K., Innes, J.G., Leathwick, J.R., Smale, M.C., Whaley, P.T., K.J.Whaley, B.D.Clarkson,D.K.Emmett, J.G.Innes, J.R.Leathwick, M.C.Smale, K.J.Whaley, Clarkson, B.D., Emmett, D.K., Innes, J.G., Leathwick, J.R., Smale, M.C., W, K.J.Whaley, Clarkson, B.D., Emmett, D.K., Innes, J.G., Leathwick, J.R., Smale, M.C., Whaley, P.T, K.J.Whaley, Clarkson, B.D., Emmett, D.K., Innes, J.G., Leathwick, J.R., Smale, M.C., Whaley, P.T., K.J.Whaley,B.D. Clarkson, D.K.Emmett, J.G. Innes,J.R. Leathwick,M.C. Smale,P.T. Whaley, K.J.Whaley,Clarkson, B.D., Emmett, D.K., Innes, J.G., Leathwick, J.R., Smale, M.C., Whaley, P.T., kal, Karen Riddell, Kath Shurcliff, Keith Hawkins, Keith Taylor, Kellow, Alison with Lee, Julia, kellyeaton, Ken George, Ken Janes, Ken Mills, Ken Noble, Kerry Hewitt, Kevin Campbell, Pete Shaw, kevin_frank, kirsty-b, kiwifergus, k-ko, Kuschel, G;, kyleb, L J Gordon, L, Coham, Lance Dew, Landcare Research Herbarium, Langbein JA A/14, Langbein, JA;, leonperrie, Leslie Feasey, linda_johnson, Lisa Jones, lisa_bennett, lizid, M A M Renner, M A M Renner 01/39, M A M Renner 01/41, M A M Renner 01/51, M A M Renner

4452, M A M Renner 4453, M D Hampton, M E Sexton, M F Hynes, M J Bayly MJB 865, B Maich, M J Bayly|B Maich, M J Thorsen, M Lusk, M Merrett, M R Woodhead, M Thorsen, M. F. Weeks, M. Merrett, M. Renner, M. S. Morley, B. W. Hayward, H. R. Grenfell, M. Smith, M. Thorsen, M. Thorsen & A. Townsend, M. Thorsen & D. King, M. Thorsen, K. Griffiths, C. Howell, M.D. Hampton, M.J.A.Bolfin, R.B.Allen, M.Thorsen, M.Thorsen, D.King, Macmillan, B;, Malcolm Smith, mandln, Marcia Balestri, Margaret Twydle, Marie Taylor, Marie Taylor;, Marilynne Keyser, Mark Lewis, mark_smale, mark-mitchell, marshy, Mason, Mason R, Mason R 8414, Mason, R;, mattbrady, Matthew Pierce, matthieu_gauvain, mattward, mcarthurn, mcleary, Meinrat O. Andreae, melissa_hutchison, Merrett M, Meudt, Heidi with Prebble, Jessica, meurkc, Michael Moshier, michael reavey, Mike Leslie, Mike Thorsen, Mike Thorsen 079/07, Mike Thorsen, Fran Muckle, Mike Thorsen, Murray King, Rebecca Stanley, Andrea Brandon, Mike Thorsen;, mike68lusk, mikefake, mikepirie, MMD, mmiller1, Moar, NT;, Moniqua Nelson-Tunley, Mr O M Weaver (Hastings), Mr Ronald J Scarlett, C Wiffen, Mr Ronald J Scarlett, R. A. Whittle, Mr Skudder, Mr W H Hartree, Mr W H Hartree, Mr Ronald J Scarlett, Mr William Gregory, Mrs Alford, Mrs Hodgson, Mrs Hodgson;, Mrs Lois Wagener, mrutherford, Murray Heays, mwh, N Cartwright, N. Singers, N.L. Elder, N.L. Elder, A.P. Druce, N.Singers, N.T. Moar, n/a, Nathan Cross, National Park Ranger, naturewatchwidow, neil_fitzgerald, New Zealand, Nic Goodman, Nichola Nelson, Nicholas Allen, Nicholas Singers, nickg-nz, nigel kendall, Nikki McArthur, Nikki McArthur & Hayley Ricardo, Nikki McArthur and Hayley Ricardo, Nikki McArthur and Keiko Hashiba, Nikki McArthur and Tansy Bliss, Nikki McArthur, Hayley Ricardo, Keiko Hashiba, Nikki McArthur, Samantha Ray and Darren Lees, Nikki McArthur, Samantha Ray and Keiko Hashiba, Nikki McArthur, Samantha Ray, Darren Lees, NIWA, NMNZ, Noam Markus, nsingers, nzgardenbirdsurvey, oaag1993, obscurus, obsr1000633, obsr1014519, obsr101835, obsr1020468, obsr1024645, obsr1034746, obsr103682, obsr1058520, obsr1072242, obsr107304, obsr1078701, obsr1088879, obsr1115038, obsr1120934, obsr1121224, obsr1138577, obsr1142496, obsr1176319, obsr1224986, obsr1226951, obsr1230406, obsr123276, obsr1256802, obsr1263287, obsr1278080, obsr1294975, obsr1309687, obsr133255, obsr1347812, obsr1364040, obsr1369101, obsr1369296, obsr1380189, obsr1381981, obsr1382495, obsr1384437, obsr1386827, obsr1388074, obsr1388385, obsr1388411, obsr1390789, obsr1397773, obsr1398322, obsr1399994, obsr1403133, obsr141265, obsr1413197, obsr1427575, obsr1427822, obsr1429892, obsr1432039, obsr1437316, obsr1437516,

obsr1437751, obsr1439924, obsr1439925, obsr1440356, obsr1440374, obsr1440778, obsr1445244, obsr1455657, obsr1481356, obsr1506580, obsr1517522, obsr153472, obsr1536484, obsr1538086, obsr154724, obsr154907, obsr155721, obsr157963, obsr1602235, obsr160792, obsr1619115, obsr1642984, obsr167943, obsr171928, obsr181946, obsr189143, obsr192698, obsr194930, obsr204031, obsr211340, obsr211537, obsr240018, obsr248569, obsr274477, obsr276721, obsr280848, obsr282729, obsr28733, obsr293526, obsr303341, obsr309402, obsr329679, obsr332007, obsr337803, obsr339135, obsr339900, obsr341625, obsr346382, obsr397019, obsr411589, obsr414154, obsr414650, obsr419820, obsr420036, obsr420781, obsr426063, obsr442312, obsr443677, obsr446448, obsr447864, obsr450350, obsr450566, obsr459322, obsr478877, obsr495297, obsr497821, obsr524767, obsr526423, obsr527767, obsr531804, obsr532139, obsr533022, obsr539909, obsr540062, obsr542691, obsr549964, obsr554219, obsr578535, obsr614601, obsr616840, obsr619713, obsr620829, obsr621803, obsr626605, obsr632799, obsr633792, obsr649505, obsr651829, obsr664076, obsr675260, obsr676872, obsr677708, obsr678136, obsr684259, obsr686788, obsr711366, obsr733046, obsr744169, obsr7509, obsr753189, obsr761869, obsr777918, obsr795765, obsr798393, obsr800441, obsr805669, obsr809267, obsr817235, obsr826510, obsr837645, obsr837867, obsr888581, obsr910184, obsr921115, obsr941871, obsr944808, obsr952709, obsr955058, obsr955314, obsr95766, obsr980301, obsr98133, obsr984050, obsr994784, odonata, OFC team, offtrackecology, Ogle CC 1721, Ogle CC 1826, Ogle CC 2030, Ogle CC 556, Ogle, CC;, Ogle, Colin, Oliver, Oliver, W. Reginald B., Oliver, WRB, one of several populations on stable gravel terraces of this section of Taruarau River braids., oscarokoko, P Cashmore, P Cashmore and Rotorua Botanical Society, P Cashmore, G Boyt, P D Champion, P Hynes, P J de Lange, P J de Lange 10906, P J de Lange 11063, P J de Lange 11263, P J de Lange 11267, P J de Lange 11299, G M Crowcroft, P J de Lange 11305, G M Crowcroft, P J de Lange 11306, G M Crowcroft, P J de Lange 11317, G M Crowcroft, P J de Lange 11346, P J de Lange 11356, P J de Lange 11360, G M Crowcroft, P J de Lange 11476, P J de Lange 11517, P J de Lange 13027, T J de Lange, P J de Lange 13028, T J de Lange, P J de Lange 13029, G M Crowcroft, P J de Lange 4383, P J de Lange 4633, P J de Lange 4655, P J de Lange 4663, P J de Lange 4669, P J de Lange 4685, P J de Lange 4711, D A Norton, P J de Lange 5297, P J de Lange 5650, P J de Lange 5994, P J de Lange 6413, P J de Lange 6414, P J de Lange 6417, P J de Lange 7425, P J de Lange 7557, P B Cashmore, P J de Lange 7558, P B Cashmore, P J de Lange 7766, P J de Lange|D A

Norton, P J de Lange|G M Crowcroft, P J de Lange|P B Cashmore, P J de Lange|T J de Lange, P Shaw, M Merrett, P Shaw|M Merrett, P T Corson, P. Cashmore, P. Gasson, R. Dahm, R. Whiting, H. Jonas, P. Shaw & M. Merrett, P. Shaw, M. Merrett, P.B. Heenan, P.J. de Lange, P.J.de Lange, D.A. Norton, G.M. Crowcroft, paddy18, Park, Geoffrey (Geoff), parkecology, Partride, Partridge, Paterson B, Patricia Schleiffer, Patrick Crowe, Patrick Crowe and Dan Burgin, Patrick Crowe and Hayley Ricardo, Patrick Crowe and Tansy Bliss, Patrick Crowe, Dan Burgin and Hayley Ricardo, Paul Coddington, Paul Gasson, Paviour-Smith, K;, PD, Dilks, Perrie, Leon, Pete Corson, Pete Shaw, Peter Allison, Peter Hein;, Peter MacIntyre, Peter Williams, Petrie, D, Petrie, Donald, PFC team and Forest&Bird volunteers, pfolen15, pfolenstaff, Phil Barnes, Phil Rhodes, pjd1, Polly, Barbara, Poole AL, Pouwer, M;, questagame, R M Bellingham, A Davis, R M Bellingham|A Davis, R Mason, R Mason 8342, R O Gardner, R O Gardner 7504, R O Gardner 7505, R O Gardner 7507, R Willet, R, Cooper, R, Parrish, R, Willet, R, Woods, R. A. Whittle, R. Mason, R. Platt, R.Cotter, J.Cotter, RA, Fordham, Ramsay, G.W.;; regan22, Rex Platt, Rex Platt (06 8391863), Richard Hawkins, Richard Moore, Rob Fraser and Jenny Hurst, Grant Craill, Colin Taylor, Rob Fraser, Jenny Hurst, Grant Craill and Colin Taylor, robert coffman, Rod Lowther, Rogan B; Valentine J, Roger Hunt, Roger McGlashan, Ron Morris, Ronald J Scarlett, Ros Batcheler, Rose Swift, Ross Silcock, Roy Lappalainen, rubecula, Rudge, M;; Russell Cannings, russellsmith, ryan_nz, S Beadel, S Bennie, S Berggren, S Berggren 193, S Phillips, S. Hampton, S.M.Beadel, Sacha Heath, sacredheart, Sainsbury GOK, Samantha Ray and Darren Lees, Samantha Ray, Darren Lees and Bernie Kelly, Samantha Ray, Darren Lees, Bernie Kelly, Keiko Hashiba and Nikki McArthur, samcarruthers, Sandra Elia, Sandy Hampton, santiago Imberti, Sarah King, sarah_richardson, savvy, scott_phares, sea-kangaroo, seastar, seaview, Shane McPherson, shane_orchard, shaun-lee, Shaw and Beadel, Shaw P; Merrett M, Shaw, et al., Shellie Evans, Shepherd, Lara, silversea_starson, Simon Turner, simon-waugh, Simpson MJA; Allen RB, Simpson NC; Druce AP, Simpson, MJA; Allen, RB;; Singers N.; Thorsen, M., Sir Frank Mappin (Auckland), Sir Frank Mappin (Auckland), A. T. Pycroft (Auckland), Sir Frank Mappin (Auckland), G Archey, Sir Frank Mappin (Auckland), Sir Carrick Robertson (Auckland), Smith M, Sneddon, Barry, Stephan Lorenz, stephen_thorpe, Steve Deverell and Marie Tonnberg, strewick, surfap, Susanne Govella, T C Chambers, T F Cheeseman, T K James, T, Grant-Taylor, tamsinwardsmith, tamswardsmith, Tansy Bliss, Tansy Bliss and Dan Burgin, Tansy Bliss and Hayley Ricardo, Tansy Bliss, Darren Lees and Hayley Ricardo, Tansy Bliss, Darren Lees, Keiko

Hashiba and Samantha Ray, Taylor, M.; Thorsen, M.; Walls, G.Y., TH Worthy, TH Worthy, RN Holdaway, Thomas Boni, Thomas GouÃ«llo, Thorsen, M., Thorsen, M.; Townsend, A.J., Tier 1-Brian Lloyd, Tim Barnard, Tim Senington, tim_hopley, timquinnell, Tina Greenawalt, todd nachowitz, Tom Laeser, tom_saunders, Tony Druce, Townsend, JI;, Travis Cullen, Travis Cullen and Bevan Eagle, Travis Cullen, Bevan Eagle and Ken Mills, Trevarthen and Mason, Trewick, SA; Morgan-Richards, M;, Tryon, Tryon, H, Tryon, Henry, tuilover, two plants covered 1 m x 30 cm. Short tussock of Festuca novae zelandiae & Dracophyllum subulatum., Type of var. lobulatus. Allan, unknown, Unknown (Biodiversity inventory compiled by Bec Stanely), Unknown (Biodiversity inventory compiled by Bryce Jerebine), Unknown (Biodiversity inventory), Unknown (landowner), Unknown, per Canterbury Museum, Ure A, Vince Griesemer, vitex_lucens, W B Shaw, W Colenso, W Colenso 1711, W H & T Hartree, W H Guthrie-Smith, W. B. Shaw, S.M. Beadel, W. Colenso, W. Shaw, B.D. Clarkson, S. Beadel, W.B. Shaw & S.M. Beadel, W.B. Shaw and S.M. Beadel, W.B. Shaw, S.M.Beadel, M. Thorsen, W.B. Shaw, S.M. Beadel, W.B. Shaw, S.M.Beadel, D. King, W.B.Shaw, W.B.Shaw and S.M.Beadel, W.B.Shaw, B.D.Clarkson, S.Beadel, W.B.Shaw, B.D.Clarkson, S.M.Beadel, M.Thorsen, W.B.Shaw, S.M. Beadel, W.B.Shaw, S.M.Beadel, W.B.Shaw,S.Beadel, W.B.Shaw,S.M.Beadel, W.Colenso, T.F.Cheeseman, H.H.Allan, W.L. Williams, W.L.Williams, T.Kirk, W.R.B.Oliver, Walker, JTS;, Walls, Walls G, Wesley Hochachka, West, E, Westerman, WH Hartree, Whaley, K.J., Clarkson, B.D., Emmett, D.K., Innes, J.G., Leathwick, J.R., Smale, M.C., Whaley, P.T., whio, wilfredlandon, William Colenso, Williams E, Worthy, Trevor, Worthy, Trevor with Cross, T, Worthy, Trevor with Jones, Jenny, Yaldnif J, Zotov, Zotov, VD.

Appendix 6. Database use agreements

DOC bioweb plant & reptile, bat & marine mammal databases: provided via email.

eBird database: provided under terms of use 2 May 2016.

Landcare Research Manaaki Whenua Allan Herbarium (CHR):

<http://creativecommons.org/licenses/by/3./nz/> via GBIF.

Landcare Research Manaaki Whenua Arthropod Collection:

<http://creativecommons.org/licenses/by/3./nz/> and via email.

Auckland War Memorial Museum: <http://creativecommons.org/licenses/by/4./legalcode> via GBIF and via email.

NIWA NZ Freshwater Fish database (NZFFD): "Access to NZFFD data is freely available and users can search the NZFFD to return all records, or to return records for specific river catchments, areas, years, species and fishing methods" (from website).

NIWA Invertebrate Type Collection: [CC BY 4.](#) via GBIF.

NIWA Marine Biological Observations & OBIS catch data: [CC BY 4.](#) via GBIF.

NIWA Lake Macrophyte data: [CC BY 4.](#) via GBIF.

Cawthron Institute Freshwater Invertebrate database: [CC BY-NC 4.](#) via GBIF.

National Vegetation Survey (NVS) under terms of use 8 November 2019.

iNaturalist database provided under email and implied terms of use.

Appendix 7. Species records of uncertain identity, or that could not be matched with a known entity

10.3 Species recorded from the Otago region, but excluded from this exercise

Scientific Name	Common Name	Life Form	Threat Status	Reason for Exclusion
<i>Amaurobioides maritima</i>	splash zone spider	Invertebrates	Naturally Uncommon	Marine
<i>Anomalopteryx didiformis</i>	little bush moa	Birds	Extinct	Extinct
<i>Balaenoptera physalus</i>	fin whale	Whales, Dolphins and Porpoises	Data Deficient	Marine
<i>Berardius arnuxii</i>	Arnoux's beaked whale	Whales, Dolphins and Porpoises	Data Deficient	Marine
<i>Calidris ferruginea</i>	Curlew Sandpiper	Birds	Vagrant	Marine
<i>Catharacta antarctica lonnbergi</i>	subantarctic skua, hākoakoa, brown skua, southern skua, southern great skua, hakoakoa	Birds	Nationally Vulnerable	Marine
<i>Cephalorhynchus hectori hectori</i>	Hector's dolphin	Whales, Dolphins and Porpoises	Nationally Vulnerable	Marine
<i>Coprotheres pomarinus</i>	pomarine skua	Birds	Migrant	Marine
<i>Daption capense australe</i>	Snares Cape petrel	Birds	Naturally Uncommon	Marine
<i>Dermochelys coriacea</i>	Leatherback, Coffin-back, Leatherback Sea Turtle, Leathery Turtle, Luth, Trunkback Turtle, Trunk Turtle	Reptiles	Migrant	Marine
<i>Dinornis novaezealandiae</i>	North Island giant moa	Birds	Extinct	Extinct
<i>Dinornis robustus</i>	South Island giant moa	Birds	Extinct	Extinct

<i>Diomedea antipodensis gibsoni</i>	Gibson's wandering albatross, toroa,	Birds	Nationally Critical	Marine
<i>Diomedea epomophora epomophora</i>	southern royal albatross, toroa,	Birds	Nationally Vulnerable	Marine
<i>Diomedea exulans</i>	wandering albatross, toroa,	Birds	Migrant	Marine
<i>Diomedea sanfordi</i>	northern royal albatross, toroa,	Birds	Nationally Vulnerable	Marine
<i>Durvillaea antarctica</i>	New Zealand bull kelp, rimurapa, brown seaweed	Algae	Declining	Marine
<i>Durvillaea willana</i>	bull kelpbrown seaweed	Algae	Naturally Uncommon	Marine
<i>Emeus crassus</i>	eastern moa	Birds	Extinct	Extinct
<i>Eubalaena australis</i>	southern right whale	Whales, Dolphins and Porpoises	Recovering	Marine
<i>Eudyptes sclateri</i>	erect-crested penguin	Birds	Declining	Marine
<i>Eudyptula minor albosignata</i>	white-flipped blue penguin, kororā,	Birds	Declining	Marine
<i>Euryapteryx curtus curtus</i>	coastal moa	Birds	Extinct	Extinct
<i>Euryapteryx curtus gravis</i>	stout-legged moa	Birds	Extinct	Extinct
<i>Fulmarus glacialisoides</i>	Antarctic fulmar	Birds	Migrant	Marine
<i>Hoplodactylus duvaucelii</i> "southern"	southern Duvaucel's gecko	Reptiles	Nationally Increasing	Extinct
<i>Garrodia nereis</i>	grey-backed storm petrel	Birds	Relict	Marine
<i>Heterosquilla tricarinata</i>	Mantis shrimp	Invertebrates	Naturally Uncommon	Marine
<i>Hydrurga leptonyx</i>	leopard seal	Seals and Sea lions	Naturally Uncommon	Marine
<i>Lepidochelys olivacea</i>	olive ridley turtle	Reptiles	Vagrant	Marine
<i>Leucocarbo chalconotus</i>	Otago shag	Birds	Nationally Increasing	Marine
<i>Limosa lapponica baueri</i>	eastern bar-tailed godwit, kūaka,	Birds	Declining	Marine
<i>Lobodon carcinophaga</i>	crabeater seal	Seals and Sea lions	Vagrant	Marine

Macrocystis pyrifera	giant kelpbrown seaweed, brown seaweed	Algae	Declining	Marine
Macronectes giganteus	southern giant petrel, pangurunguru,	Birds	Migrant	Marine
Macronectes halli	northern giant petrel, pāngurunguru, pangurunguru	Birds	Recovering	Marine
Marpissa marina	jumping spider	Invertebrates	Naturally Uncommon	Coastal
Megadyptes antipodes	hoiho, hoiho, yellow-eyed penguin	Birds	Nationally Endangered	Marine
Megaptera novaeangliae	humpback whale	Whales, Dolphins and Porpoises	Migrant	Marine
Microzonia velutina	brown seaweed	Algae	Data Deficient	Marine
Mirounga leonina	southern elephant seal	Seals and Sea lions	Nationally Critical	Marine
Myro marinus	intertidal spider	Invertebrates	Naturally Uncommon	Coastal
Notheia anomala	brown seaweed	Algae	Naturally Uncommon	Marine
Nothogenia neilliae	red seaweed	Algae	Naturally Uncommon	Marine
Oramia littoralis	funnel weaver spider	Invertebrates	Naturally Uncommon	Coastal
Orcinus orca	orca	Whales, Dolphins and Porpoises	Nationally Critical	Marine
Otagoa wiltoni	hunting spider	Invertebrates	Data Deficient	Coastal
Pachymenia dichotoma	red seaweed	Algae	Naturally Uncommon	Marine
Pachyornis elephantopus	heavy-footed moa	Birds	Extinct	Extinct
Pachyptila turtur	fairy prion, tītī wainui,	Birds	Relict	Marine
Pachyptila vittata	broad-billed prion, tītī, titi, pararā, parara, whalebird, blue billy	Birds	Relict	Marine
Papenfussiella lutea	brown seaweed	Algae	Naturally Uncommon	Marine
Pelagodroma marina maoriana	New Zealand white-faced storm petrel, tītī, titi, takahikare-moana, takahikare, frigate petrel, Jesus Christ bird	Birds	Relict	Marine

<i>Pelecanoides urinatrix</i> <i>urinatrix</i>	northern diving petrel, tītī,	Birds	Relict	Marine
<i>Phocarcctos hookeri</i>	New Zealand sea lion ³⁷	Seals and Sea lions	Nationally Vulnerable	Marine
<i>Phocoena dioptrica</i>	spectacled porpoise	Whales, Dolphins and Porpoises	Data Deficient	Marine
<i>Phoebetria palpebrata</i>	light-mantled sooty albatross, toroa pango,	Birds	Nationally Vulnerable	Marine
<i>Physeter macrocephalus</i>	sperm whale	Whales, Dolphins and Porpoises	Data Deficient	Marine
<i>Plocamium angustum</i>	red seaweed	Algae	Data Deficient	Marine
<i>Plocamium cirrhosum</i>	red seaweed	Algae	Data Deficient	Marine
<i>Procellaria cinerea</i>	grey petrel, kuia, black-tailed shearwater, black-tailed petrel	Birds	Relict	Marine
<i>Procellaria westlandica</i>	Westland petrel, tītī, titi, tāiko, taiko, Westland black petrel	Birds	Naturally Uncommon	Marine
<i>Pterodroma cookii</i>	Cook's petrel, tītī,	Birds	Relict	Marine
<i>Pterodroma inexpectata</i>	mottled petrel, tītī, titi, korure, Dawson's petrel	Birds	Relict	Marine
<i>Pterodroma mollis</i>	soft-plumaged petrel	Birds	Naturally Uncommon	Marine
<i>Puffinus assimilis</i> <i>haurakiensis</i>	North Island little shearwater	Birds	Recovering	Marine
<i>Puffinus bulleri</i>	Buller's shearwater	Birds	Declining	Marine
<i>Puffinus carneipes</i>	flesh-footed shearwater, toanui, tuanui	Birds	Relict	Marine
<i>Puffinus gavia</i>	fluttering shearwater, pakaha,	Birds	Relict	Marine
<i>Puffinus gravis</i>	great shearwater	Birds	Vagrant	Marine
<i>Puffinus griseus</i>	sooty shearwater, tītī, titi, hakaoakoa, muttonbird	Birds	Declining	Marine

³⁷ This species does use freshwater habitats on occasions and may be better reclassified as freshwater-dependent on the basis of this occasional use.

<i>Puffinus huttoni</i>	Hutton's shearwater	Birds	Nationally Vulnerable	Marine
<i>Puffinus tenuirostris</i>	short-tailed shearwater	Birds	Migrant	Marine
<i>Pygoscelis antarcticus</i>	chinstrap penguin	Birds	Vagrant	Marine
<i>Pygoscelis papua</i>	gentoo penguin	Birds	Vagrant	Marine
<i>Rhizopogonia asperata</i>	red seaweed	Algae	Naturally Uncommon	Marine
<i>Stercorarius parasiticus</i>	Arctic skua	Birds	Migrant	Marine
<i>Sterna paradisaea</i>	Arctic tern	Birds	Migrant	Marine
<i>Sterna vittata bethunei</i>	Antarctic tern	Birds	Nationally Increasing	Marine
<i>Sternula albifrons sinensis</i>	little tern	Birds	Migrant	Marine
<i>Stictocarbo punctatus</i>	spotted shag, kawau pāteketeke, kawau pateketeke, kawau tikitiki, parekareka	Birds	Nationally Vulnerable	Marine
<i>Tasmacetus shepherdi</i>	Shepherd's beaked whale	Whales, Dolphins and Porpoises	Data Deficient	Marine
<i>Thalassarche bulleri bulleri</i>	southern Buller's mollymawk, toroa, southern Buller's albatross	Birds	Declining	Marine
<i>Thalassarche cauta cauta</i>	Tasmanian albatross	Birds	Vagrant	Marine
<i>Thalassarche cauta steadi</i>	New Zealand white-capped mollymawk, toroa, New Zealand white-capped albatross	Birds	Declining	Marine
<i>Thalassarche chrysostoma</i>	grey-headed mollymawk, grey-headed albatross	Birds	Nationally Vulnerable	Marine
<i>Thalassarche eremita</i>	Chatham Island mollymawk, toroa, Chatham Island albatross	Birds	Naturally Uncommon	Marine
<i>Thalassarche melanophris</i>	Black-browed Albatross	Birds	Coloniser	Marine
<i>Thalassarche salvini</i>	Salvin's mollymawk, toroa, Salvin's albatross	Birds	Nationally Critical	Marine
<i>Tursiops truncatus</i>	bottlenose dolphin	Whales, Dolphins and Porpoises	Nationally Endangered	Marine
<i>Ziphius cavirostris</i>	goose-beaked whale	Whales, Dolphins and Porpoises	Data Deficient	Marine

10.4 Species recorded from the Otago region, but excluded from this exercise as does not naturally occur within Otago

Scientific Name	Common Name	Life Form	Remedial Action ³⁸
Aciphylla traversii	Chatham Island speargrass, taramea	Plants	
Agrostis subulata		Plants	
Anisotome antipoda		Plants	
Anthosachne sacandros		Plants	
Argyrotegium nitidulum		Plants	
Astelia chathamica	Chatham Island astelia or kakaha, Moriori flax	Plants	
Azorella lyallii		Plants	
Brachyglottis arborescens	Three Kings Rangiora	Plants	
Brachyglottis compacta	Castlepoint daisy, Castlepoint groundsel	Plants	
Brachyglottis greyi		Plants	
Brachyglottis huntii	Rautini, Chatham Island Christmas tree	Plants	
Brachyglottis kirkii var. kirkii	Kohurangi, Kirk's daisy	Plants	
Brachyglottis pentacopa		Plants	
Brachyglottis perdicioides	Raukumara	Plants	

³⁸ Records of species excluded from exercise except those for which remedial action was identified

<i>Caladenia minor</i>	Caladenia	Plants
<i>Cardamine subcarnosa</i>	Campbell Island bitter cress	Plants
<i>Carmichaelia torulosa</i>	Canterbury Pink Broom	Plants
<i>Carmichaelia williamsii</i>	William's Broom, Giant-flowered broom	Plants
<i>Celmisia adamsii</i> var. <i>adamsii</i>	Adams Daisy	Plants
<i>Celmisia graminifolia</i>	Whangarei Heads Daisy	Plants
<i>Celmisia insignis</i>		Plants
<i>Charadrius obscurus aquilonius</i>	northern New Zealand dotterel	Birds
<i>Clianthus maximus</i>	kakabeak, kowhai ngutu-kaka, kaka beak	Plants
<i>Clianthus puniceus</i>	Kakabeak, kowhai ngutu kaka, kaka beak	Plants
<i>Coprosma chathamica</i>	Chatham Island karamu, karamu	Plants
<i>Corokia macrocarpa</i>	Hokataka, whakataka	Plants
<i>Ewartiothamnus sinclairii</i>	Ewartia	Plants
<i>Fuchsia procumbens</i>	creeping fuchsia, climbing or trailing fuchsia	Plants
<i>Geranium microphyllum</i>		Plants
<i>Hibiscus richardsonii</i>	native Hibiscus, puarangi	Plants
<i>Hypericum gramineum</i>		Plants
<i>Kunzea ericoides</i>	Manuoa, Titira, Atitira, Kanuka	Plants
<i>Lepidium flexicaule</i>	Coastal cress	Plants
<i>Leptinella intermedia</i>		Plants
<i>Leptinella rotundata</i>		Plants
<i>Lobelia physaloides</i>	Colensoa, koru	Plants
<i>Mazus pumilio</i>	Mazus	Plants
<i>Megadromus bucolicus</i>	Ground beetle	Invertebrates
<i>Melicytus</i> (a) (CHR 355077; Matiri Range)		Plants
<i>Melicytus chathamicus</i>	Chatham Island mahoe	Plants
<i>Melicytus crassifolius</i>	Thick-leaved mahoe	Plants

Melicytus orarius		Plants
Muehlenbeckia astonii	Shrubby tororaro, wiggywig, mingimingi	Plants
Myosotidium hortensia	Chatham Island Forget-me-not, Kopakopa, Kopukapuka	Plants
Olearia chathamica	keketerehe	Plants
Olearia semidentata	Chatham Island aster, swamp aster, hanga-tare	Plants
Olearia traversiorum	Chatham Island akeake, Chatham Island tree daisy	Plants
Pennantia baylisiana	Three Kings Kaikomako	Plants
Pimelea longifolia	Long-leaved pimelea	Plants
Pimelea mesoa subsp. mesoa	Pimelea	Plants
Pimelea orthia subsp. protea	C.J.Burrows & Thorsen	Plants
Pimelea tomentosa		Plants
Pimelea villosa	sand daphne, autetaranga, toroheke, sand pimelea	Plants
Poa sudicola		Plants
Pomaderris apetala subsp. maritima	Tainui, New Zealand hazel	Plants
Pseudopanax laetus		Plants
Pseudopanax macintyreii	MacIntyres panax	Plants
Ptisana salicina	King fern, Para, Tawhiti para, Horseshoe fern	Plants
Ranunculus subscaposus		Plants
Scutellaria novae-zelandiae	New Zealand skullcap, shovel mint	Plants
Senecio matatini subsp. matatini		Plants
Sonchus grandifolius	Chatham Island sow thistle, Embergeria	Plants
Sophora fulvida	kowhai	Plants
Sophora longicarinata	Limestone Kowhai	Plants
Sophora molloyi	Cook Strait Kowhai, Molloy's Kowhai	Plants
Stellaria decipiens var. decipiens		Plants
Streblus smithii	Three Kings milk tree	Plants
Syzygium maire	swamp maire, maire tawake, waiwaka	Plants

<i>Todea barbara</i>	Royal Fern, Hard todea, King fern	Plants	
<i>Trisetum antarcticum</i>		Plants	
<i>Veronica aff. treadwellii</i> (a) (CHR 394533; Bald Knob Ridge)		Plants	
<i>Veronica barkeri</i>	Barker's koromiko, Chatham Island tree hebe	Plants	
<i>Veronica chathamica</i>	Chatham Island koromiko	Plants	
<i>Veronica dieffenbachii</i>	Dieffenbach's koromiko	Plants	
<i>Veronica rigidula</i> var. <i>rigidula</i>	Hebe	Plants	
<i>Veronica rivalis</i>	Northland River Koromiko	Plants	
<i>Veronica salicornioides</i>	whipcord hebe	Plants	
<i>Veronica speciosa</i>	Napuka, Titirangi	Plants	
<i>Anthus novaeseelandiae aucklandicus</i>	Auckland Island pipit , pīhoihoi,	Birds	All records reassigned to NZ pipit
<i>Bowdleria punctata vealeae</i>	North Island fernbird, mātātā, koroatito, karoti, matata	Birds	All records reassigned to South Island fernbird
<i>Gallirallus australis greyi</i>	North Island weka, weka,	Birds	All records reassigned to Buff weka (western weka may be present in the Southern Alps area of the Otago region)
<i>Nestor meridionalis septentrionalis</i>	North Island kākā, kākā, bush parrot, brown parrot, kawkaw, North Island kaka	Birds	All records reassigned to South Island kaka
<i>Petroica macrocephala dannefaerdi</i>	Snares Island tomtit	Birds	All records reassigned to South Island tomtit
<i>Olearia gardneri</i>	Gardner's tree daisy	Plants	All records reassigned to <i>Olearia hectorii</i>
<i>Senecio aff. dunedinensis</i> (CHR 550250; Leatham)		Plants	All records reassigned to <i>Senecio dunedinensis</i>

10.5 Species recorded from Otago, but of uncertain identification and not included in this exercise.

Scientific Name	Common Name	Life Form	Remedial Action ³⁹
Aciphylla dieffenbachii	Dieffenbach's speargrass, soft speargrass, coxella	Plants	
Calliphora hilli		Invertebrates	
Cardamine pachyphylla		Plants	
Corybas hypogaeus	Spider Orchid	Plants	
Corybas sulcatus	spider orchid	Plants	
Dichelachne inaequiglumis	short-hair plume grass	Plants	
Echyridella onekaka	mussel	Invertebrates	
Epilobium brevipes	Willowherb	Plants	
Fissurina insidiosa		Lichens	
Gastrodia cooperae	Cooper's black potato orchid	Plants	
Gunnera hamiltonii		Plants	
Leucopogon nanum		Plants	
Notogrammitis rigida	Southern strap-fern	Plants	
Olearia angustifolia	Teteaweke	Plants	

³⁹ Records of species excluded from exercise except those for which remedial action was identified

Oligosoma chloronoton	green skink, southland green skink	Reptiles	
Oligosoma lineocellatum	Canterbury spotted skink, central Canterbury spotted skink	Reptiles	
Ramalina geniculata		Lichens	
Xenicus gilviventris	northern rock wren	Birds	
Phalacrocorax melanoleucos melanoleucos	little pied shag	Birds	All records provisionally reassigned to subsp. <i>brevirostris</i>
Galaxias paucispondylus	Alpine galaxias (Canterbury, Marlborough, West Coast)	Fish	