



# **Department of Conservation**

## **Review of Values, Freshwater Restoration Programmes and Research Needs Within the Taieri Catchment**

October 2020



# Department of Conservation

## Review of Values, Freshwater Restoration Programmes and Research Needs Within the Taieri Catchment

*Prepared for Department of Conservation*

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Document version: October 1 2020

Cover page: The Waihola-Waipori wetland complex converging with the lower Taieri River.  
(photo credit: Greg Ryder)

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# Table of Contents

|   |           |
|---|-----------|
| <b>1. Introduction .....</b>  | <b>1</b>  |
| <b>2. Legislation &amp; Planning Context.....</b>                             | <b>3</b>  |
| <i>Kāi Tahu Otago Natural Resource Management Plan 2005 .....</i>             | <i>3</i>  |
| <i>Otago Conservation Management Strategy 2016 (CMS).....</i>                 | <i>3</i>  |
| <i>Resource Management Act (1991).....</i>                                    | <i>5</i>  |
| <i>Action for Healthy Waterways .....</i>                                     | <i>6</i>  |
| <i>National Policy Statement for Freshwater Management 2020.....</i>          | <i>6</i>  |
| <i>National Environmental Standards for Freshwater 2020.....</i>              | <i>6</i>  |
| <i>Partially Operative Otago Regional Policy Statement 2019.....</i>          | <i>7</i>  |
| <i>Regional Plan: Water for Otago 2004 .....</i>                              | <i>7</i>  |
| <i>Rural Water Quality Strategy 2011 .....</i>                                | <i>8</i>  |
| <i>Regional Plan: Land Otago .....</i>  | <i>8</i>  |
| <i>Otago Regional Council's Biodiversity Strategy 2018.....</i>               | <i>8</i>  |
| <b>3. Treaty Partners &amp; Major Stakeholders .....</b>                      | <b>9</b>  |
| <i>Aukaha .....</i>   | <i>9</i>  |
| <i>Lake Waihola Waipori Wetlands Society.....</i>                             | <i>9</i>  |
| <i>Te Nohoaka o Tukiauau/Sinclair Wetlands Trust .....</i>                    | <i>9</i>  |
| <i>Regional and District Councils .....</i>                                   | <i>10</i> |
| <i>University of Otago .....</i>  | <i>10</i> |
| <i>Upper Taieri Water Management Group .....</i>                              | <i>10</i> |
| <i>Irrigation Stakeholder Groups .....</i>                                    | <i>11</i> |
| <i>Power Generating Companies.....</i>  | <i>11</i> |
| <i>Forestry Companies.....</i>  | <i>11</i> |
| <i>Community Boards .....</i>   | <i>11</i> |
| <i>Royal Forest and Bird Protection Society.....</i>                          | <i>12</i> |
| <i>Fish and Game Council .....</i>  | <i>12</i> |
| <i>Anglers .....</i>  | <i>12</i> |
| <b>4. Catchment Overview .....</b>  | <b>14</b> |
| <i>Introduction.....</i>  | <i>14</i> |
| <i>Scroll Plain/Styx sub-catchment .....</i>                                  | <i>17</i> |
| <i>Logan Burn sub-catchment .....</i>   | <i>18</i> |
| <i>Upper Taieri Plain/Maniototo sub-catchment.....</i>                        | <i>18</i> |
| <i>Kye Burn/Swinburn sub-catchment .....</i>                                  | <i>19</i> |
| <i>Strath Taieri sub-catchment .....</i>                                      | <i>20</i> |
| <i>Mahinerangi/Lee Stream/Deep Stream sub-catchment.....</i>                  | <i>20</i> |
| <i>Silver Stream, Maungatua, Taieri Plain and Coastal sub-catchment .....</i> | <i>21</i> |
| <i>Waipori-Waihola wetland complex sub-catchment .....</i>                    | <i>22</i> |
| <i>Estuary/Mouth single channel sub-catchment.....</i>                        | <i>23</i> |
| <i>Landcover Trends .....</i>   | <i>24</i> |
| <b>5. Water and Ecosystem Health .....</b>                                    | <b>26</b> |
| <i>Flow Statistics.....</i>   | <i>26</i> |
| <i>Water Allocation .....</i>   | <i>26</i> |
| <i>Deemed Permits .....</i>   | <i>27</i> |
| <i>Water Quality &amp; Indicators of Aquatic Ecosystem Health.....</i>        | <i>28</i> |
| <i>General.....</i>   | <i>28</i> |
| <i>Periphyton (trophic state in Rivers) .....</i>                             | <i>31</i> |
| <i>Phytoplankton (trophic state in Lakes) .....</i>                           | <i>31</i> |
| <i>Macroinvertebrates .....</i>   | <i>32</i> |
| <i>Trace Elements in Lake and Estuary Sediments.....</i>                      | <i>33</i> |

|  |            |
|--|------------|
| Point-Source Discharge to Water.....   | 34         |
| Non-Point Source Discharges to Water .....   | 35         |
| <b>6. Conservation Values .....</b>  | <b>37</b>  |
| <i>Wetland Habitats</i> .....  | 37         |
| Wetland Loss.....  | 38         |
| Scroll Plain.....  | 39         |
| Waipori/Waihola Wetland Complex .....  | 40         |
| Existing Wetland Restoration Projects.....   | 41         |
| <i>River Habitats</i> .....  | 41         |
| Waipori River .....  | 41         |
| Deep Stream .....  | 42         |
| Lee Stream .....   | 42         |
| Silver Stream.....   | 42         |
| Sutton Stream .....  | 42         |
| Nenthorn Stream .....  | 43         |
| Kye Burn.....  | 43         |
| Logan Burn .....   | 43         |
| <i>Lakes</i> .....   | 43         |
| Lake Waihola & Lake Waipori .....  | 43         |
| Sutton Salt Lake .....   | 43         |
| Lake Mahinerangi .....   | 43         |
| The Lost Lakes .....   | 44         |
| <i>Fish</i> .....  | 44         |
| Non-Migratory Galaxiids .....  | 44         |
| Migratory Fish Species .....   | 51         |
| <i>Invertebrates</i> .....   | 57         |
| Marine Invertebrates - Estuary .....   | 57         |
| Lake Invertebrates .....   | 58         |
| River/Stream Invertebrates .....   | 60         |
| Terrestrial Invertebrates.....   | 61         |
| <i>Lizards</i> .....   | 62         |
| <i>Birds</i> .....   | 64         |
| <i>Plants &amp; Weeds</i> .....  | 65         |
| Terrestrial Plants.....  | 65         |
| Aquatic Plants .....   | 67         |
| Weeds .....  | 67         |
| <b>7. Summary of Threats, Information Gaps, Opportunities and Actions .....</b>                                      | <b>69</b>  |
| <b>8. References &amp; Reading List.....</b>   | <b>80</b>  |
| <b>Appendix 1 Taoka species of the Taieri catchment.....</b>   | <b>92</b>  |
| <b>Appendix 2 Public Conservation Land over the Taieri Catchment .....</b>   | <b>93</b>  |
| <b>Appendix 3 The NPS-FM 2020 Appendix 2A attribute bands for periphyton (rivers) and phytoplankton (lakes).....</b> | <b>100</b> |
| <b>Appendix 4 Scheduled Significant Natural Areas, or equivalents of the Taieri Catchment .....</b>                  | <b>101</b> |
| <b>Appendix 5 Regionally Significant Wetlands in the Taieri Catchment and Listed Conservation Values.....</b>        | <b>113</b> |
| <b>Appendix 6 Taieri Catchment RAPS associated with the Taieri River .....</b>                                       | <b>123</b> |
| <b>Appendix 7 Rare and Threatened Plants of the Taieri Catchment.....</b>  | <b>126</b> |

|                    |  |            |
|--------------------|--|------------|
| <b>Appendix 8</b>  | <b>Habitat Types at Taieri River Estuary.....</b>                              | <b>128</b> |
| <b>Appendix 9</b>  | <b>Water Quality Statistics for Taieri River collected from 2014-2019.....</b> | <b>129</b> |
| <b>Appendix 10</b> | <b>Fish of the Taieri catchment.....</b>                                       | <b>130</b> |
| <b>Appendix 11</b> | <b>Birds of the Taieri Catchment.....</b>                                      | <b>138</b> |

# 1. Introduction

The Department of Conservation (DOC), through its statement of intent (2016-2020), has set the following stretch goal to be completed within 10-years:

*“50 freshwater ecosystems are restored from mountains to the sea”*.<sup>1</sup>

There are 14 priority sites across New Zealand, that were primarily selected based on the following criteria:

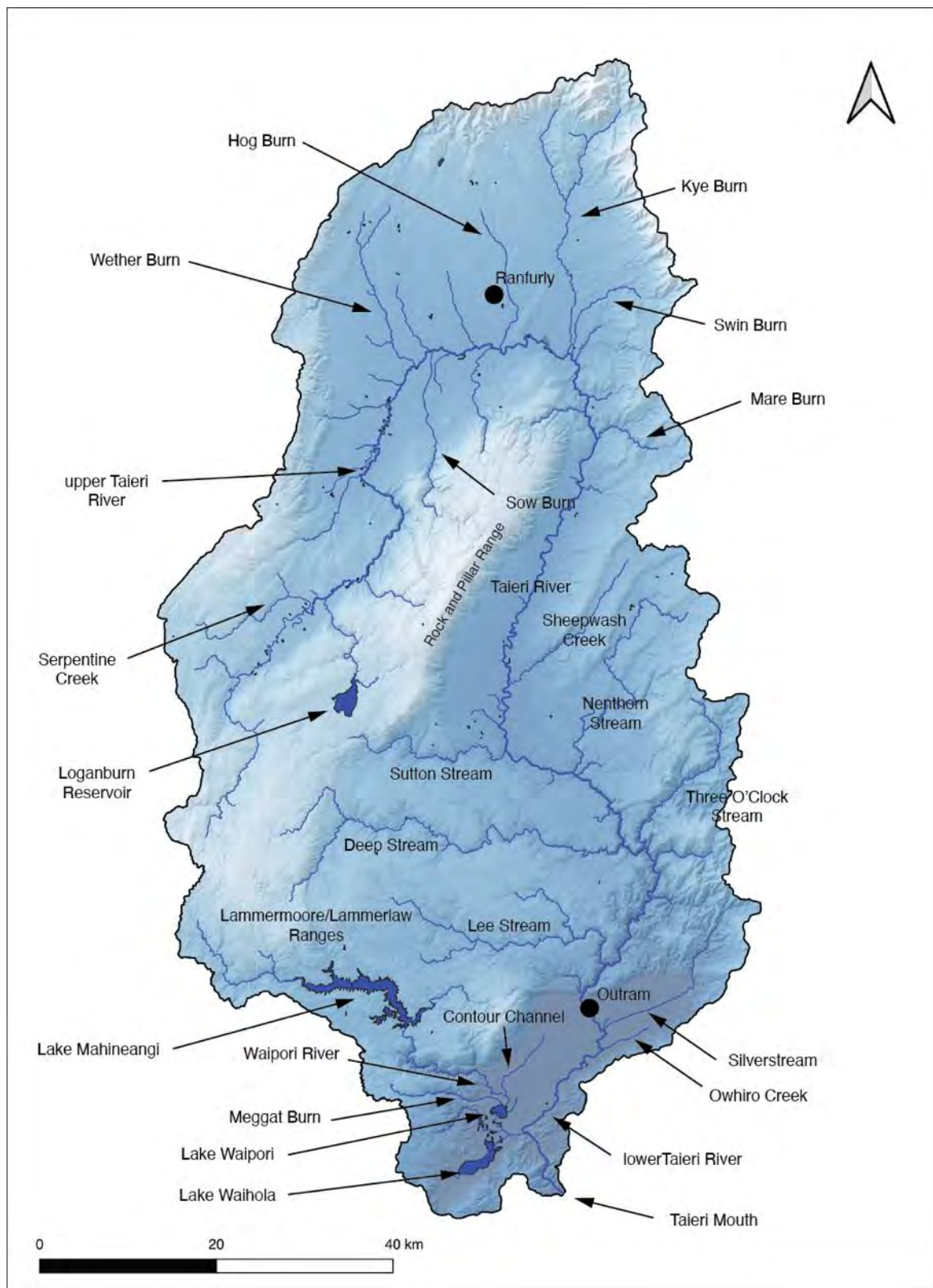
- intact headwaters (facilitating “mountains to sea” conservation);
- contain lowland reaches of residual value;
- representative of important ecosystem types;
- engaged communities and DOC staff; and
- “fixable pressures” that can be restored.

The Taieri River catchment, *Whakaahuataka O Te Riu O Taieri*, is a large (5,700 km<sup>2</sup>) and complex catchment, located in the Otago region (Figure 1). The Taieri River ecosystem has been identified as a priority site for freshwater conservation under DOC’s vision of restoring the Taieri River from mountains to sea, *te maunga ki te moana*. Kāi Tahu share DOC’s vision of *te maunga ki te moana*, and have a very long-standing relationship with the Taieri River. Kāi Tahu have identified taoka species and sites, including Lakes Waipori/Waihola, and have developed issues and policies for the Taieri catchment in their Natural Resource Management Plan (Kāi Tahu, 2005). The management plan encourages the development of the Taieri River as a “mountains to seas” corridor under Policy 9.4.3.1 ‘Mahika Kai and Biodiversity Policies in the Taieri Catchment’.

A new position within DOC Operations has been recruited to work alongside Kāi Tahu to develop a restoration plan to improve the Taieri’s conservation values, with an emphasis on biodiversity restoration. DOC intends to work with agencies, community groups and other stakeholders to develop this plan. To assist this work, this document draws on the deep knowledge base relating to the conservation values of the catchment, and reports on the most important conservation values, pressures, and restoration opportunities across the catchment.

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<sup>1</sup><https://www.doc.govt.nz/globalassets/documents/about-doc/role/publications/statement-of-intent-2016-2020.pdf>



**Figure 1** Overview map of Taieri catchment showing the origin of the Taieri River in the Lammerlaw & Lammermoor Ranges (and the origin of Deep Stream), and from there, its course down towards Ranfurly to collect waters from the Kye Burn before turning 180° back onto itself to move through the Strath Taieri Plain, through the Taieri Gorge and onto the Taieri Plain at Outram. From there (not pictured), the Taieri collects water from Lake Waipori/Waihola before heading to the Pacific Ocean via the Taieri Estuary.

## 2. Legislation & Planning Context

The RMA (1991) and the Conservation Act (1987), and its many enactments including the Wildlife Act (1953), are the primary statutes that cover the protection and management of conservation values over the Taieri River catchment. DOC has a responsibility under section 4 of the Conservation Act (1987) to interpret and administer the Act to give effect to the principles of the Treaty of Waitangi. This involves building and supporting effective conservation partnerships with tangata whenua at the local level<sup>2</sup>.

Relevant to the Taieri River catchment are the Freshwater Fisheries Regulations (1983) made under the Conservation Act 1987 and administered by the Department. These regulations can be used to ensure or control fish passage in freshwater habitats.

### **Kāi Tahu Otago Natural Resource Management Plan 2005**

As noted above, Kāi Tahu have a very long-standing relationship with the Taieri River, and have developed issues and policies for the Taieri River catchment as follows:

- To discourage any further cross mixing of water.
- To promote the re-establishment of Lake Taieri as a mahika kai.
- To require that a Cultural Impact Assessment is undertaken for any new dams or structures in the Taieri River catchments.
- To require any new or existing dam consents to provide a regular flushing flow.
- To require structures in the Taieri River catchments do not impede or obstruct flows, or fish migration.
- To oppose the allocation of any further water from the Upper Taieri and Strath Taieri.
- To require that the cumulative effects and Ki Uta Ki Tai values are addressed in water allocation in the Taieri River catchment.
- To oppose any further dairy conversions in the upper Taieri River catchment.
- To encourage the Otago Regional Council to enforce consent conditions and environmental standards for current dairying operations (Kāi Tahu, 2005).

Appendix 4 of the Kāi Tahu plan (Kāi Tahu, 2005) lists the taoka species, and the fauna taoka species of the Taieri River catchment have been collated here in this report (Appendix 1).

### **Otago Conservation Management Strategy 2016 (CMS)**

The overarching strategy document for Otago under the Conservation Act (1987) is the Otago Conservation Management Strategy 2016 (Otago CMS 2016). The Otago CMS (2016) describes the conservation values present in Otago, and provides guidance for the Department's work in the form of a vision, objectives, outcomes for Places, policies and milestones; translating the Department's strategic outcomes to Otago. Under the Otago CMS (2016), DOC works alongside its iwi partners to achieve conservation across the Taieri River catchment through a net-work of public conservation land, including marginal strips,

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<sup>2</sup> <https://www.doc.govt.nz/about-us/our-role/legislation/>



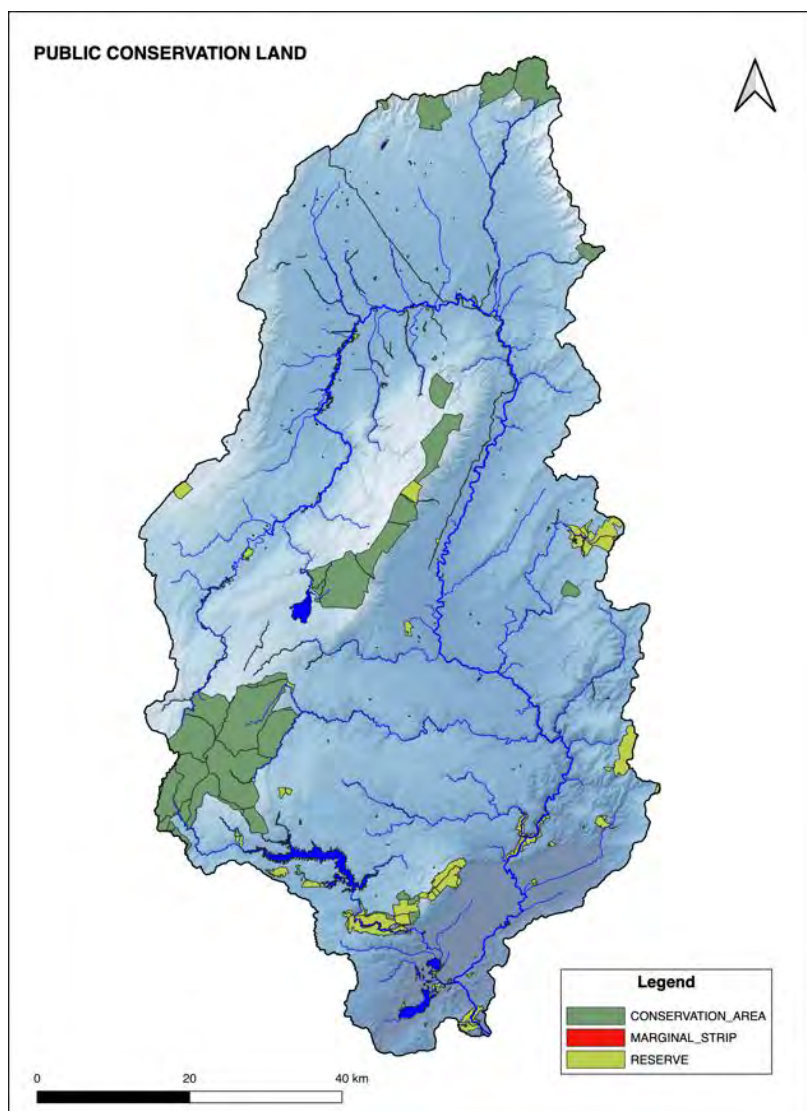
that covers c. 122,000 ha (see Figure 2; Appendix 2), and through advocacy functions across all land tenures.

Values of the Taieri River catchment are recognised in policies within Sections 2.6 Central Otago Drylands/Manuherikia Place and 2.10 Freshwater/Wai Māori Place, and in the case of the Taieri Scroll Plain, Appendix 9. Section 13.3 cites Nohoanga entitlements<sup>3</sup> on public conservation lands and waters, including Paerau Reservoir and Taieri River (Logan Burn) and Taieri River off Murray Road and Section 13.4 lists taoka plants and animals of the catchment (see Appendix 1 for taoka fauna species). Appendix 4 of the Otago CMS (2016) identifies multiple “priority ecosystem units on public conservation lands and waters within the Taieri River catchment”, including, as examples, a 143.4 ha part of Serpentine Scenic Reserve; Nenthorn wetland; Sutton Salt Lake Scenic Reserve.<sup>4</sup> These are priority sites for conservation activity, the nature of which differs for each of the units depending on threats and pressures present.

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<sup>3</sup> Entitlements to occupy temporarily and exclusively an area of land bordering lakes or rivers for the purpose of lawful fishing and the gathering of other natural resources.

<sup>4</sup><https://www.doc.govt.nz/about-us/our-policies-and-plans/statutory-plans/statutory-plan-publications/conservation-management-strategies/otago/appendix-4/>



**Figure 2** *Public Conservation Land.*

## Resource Management Act (1991)

On private land, the Resource Management Act (RMA) and its planning tools regulate land and water use, and water allocation within the catchment. The RMA has national-level policy statements and environmental standards that are given effect to through the Otago Regional Council Policy Statement (Otago RPS) and the Regional Plan: Water for Otago; and through Clutha, Dunedin City, Waitaki and Central Otago District Plans, all of which have jurisdictions over part of the Taieri River catchment.

On 23 September 2019, the Government introduced the Resource Management Act Amendment Bill. This Bill provides for a chief freshwater commissioner who will convene freshwater hearings panels to conduct public hearings of submissions on freshwater policies and plans prepared to give effect to the new National Policy Statement for Freshwater Management (NPSFM; see next Section). Water management within the catchment, therefore, is in a state a transition.

## Action for Healthy Waterways

The government has recently (May 2020) announced a series of new provisions designed to restore and protect the health of New Zealand's waterways. The provisions—including rules, objectives and policies—are collected under the title “Action for Healthy Waterways”, part of the Ministry for the Environment’s Essential Freshwater work programme. The provisions include the new National Policy Statement for Freshwater Management (NPS-FM) and new National Environmental Standards introduced below, and various section 360 RMA (1991) regulations.

### National Policy Statement for Freshwater Management 2020

The NPS-FM 2020 came into force on September 3 2020. It is one of several pieces of national direction for managing New Zealand’s freshwater. National Environmental Standards for Freshwater (NES), and RMA Section 360 regulations for stock exclusion, have also been introduced. Guidance to support the implementation of these new rules and regulations will be released on the Ministry for the Environment website as they come into force<sup>5</sup>.

Under the NPS-FM 2020, regional water plans are required, by 2025, to show mapped areas called freshwater management units (FMUs) and for each, to define their important values and set clear objectives and limits for water quality and quantity. These must comply with the detailed requirements of the NPSFM, and councils must report annually on their progress towards finalising FMUs. The Taieri River has recently been identified as a ‘mountains to seas’ FMU by ORC, but finer-scale divisions (sub-FMUs) are yet to be allocated; sub-FMUs need assigned jointly with Kāi Tahu. There may be some rules set for the Taieri FMU that differ from other areas and this will be done in consultation with the local community to ensure that waterway management reflects local values and objectives<sup>6</sup>.

The NPS-FW provides for maintaining and improving water quality through establishment of “bottom lines” and “bands” for the management of water quality and ecosystem health attributes, as well as allocation objectives for both water quality and quantity. The bands for periphyton (rivers) and phytoplankton (Lakes) are provided in Appendix 3 as they relate to our commentary on water quality in Section 5.

### National Environmental Standards for Freshwater 2020

The NES will regulate activities that pose risks to the health of freshwater and freshwater ecosystems. The NES will come into force later this year<sup>7</sup>. The standards are designed to:

- protect existing inland and coastal wetlands;
- protect urban and rural streams from in-filling;
- ensure connectivity of fish habitat (fish passage);

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<sup>5</sup> <https://www.mfe.govt.nz/fresh-water/national-policy-statement/about-nps>

<sup>6</sup> <https://goodwaterinotago.orc.govt.nz/rohe/taieri>

<sup>7</sup> <https://www.mfe.govt.nz/fresh-water/freshwater-acts-and-regulations/national-environmental-standards-freshwater>

- set minimum requirements for feedlots and other stockholding areas (to take effect in winter of 2021);
- improve poor practice intensive winter grazing of forage crops (to take effect in winter of 2021);
- restrict further agricultural intensification until the end of 2024; and
- limit the discharge of synthetic nitrogen fertiliser to land, and require reporting of fertiliser use (to take effect in winter of 2021).

For the Taieri River catchment, key provisions relate to *Te Mana o te Wai*, stock exclusion and wetland protection. The new policies include a clearer definition of the concept and framework of *Te Mana o te Wai*, a new compulsory value for mahika kai to provide greater recognition of Māori values.

The new rules will exclude stock from waterways wider than one metre. For existing pastoral systems, this will include exclusion of dairy cattle and pigs by 1 July 2023, and apply to beef cattle and deer on low slope land by 1 July 2025, and of importance to the Taieri catchment, will require exclusion of stock from Regionally Significant Wetlands 1 July 2025. Maintaining existing structures within wetlands will be provided for, but other activities with more than minor effect will not be allowed on wetlands or will require consent. A three-metre grazing setback from waterways within five years will also be imposed.

## **Partially Operative Otago Regional Policy Statement 2019**

The Partially Operative Otago Regional Policy Statement 2019 (Otago RPS) details Otago-wide issues, objectives and policies relating to resource management over the entire region; District plans must give effect to Otago RPS policies in their plans. In a recent report commissioned by the Ministry for the Environment, Professor Peter Skelton concluded that a *de novo* planning framework is required to guide the ORC through the administration of the expiry of Otago mining privileges (deemed permits); these are due to expire on 1 October 2021 (see Section 5), meaning substantial changes are likely to be required to the Otago RPS in the near future. Until such changes are in place, Plan Change 6AA, “the Omnibus Plan Change” will provide short-term measures for managing freshwater, as well as a new robust resource consenting regime which will avoid the granting of long-term consents during this interim period. All water consent applications need to be considered under the interim regime, including those that are made to replace any deemed permits. Public submissions are now open on the Plan Change 6AA.

## **Regional Plan: Water for Otago 2004**

The Regional Plan: Water for Otago (Water Plan) provides a framework for the management of water in the region and was made operative on 1 January 2004. It applies to lakes, rivers, groundwater, and wetlands. The plan includes some provisions for assessing applications for replacement water consents once the deemed permits expire, and it takes an effects-based approach to managing water quality. The Water Plan focuses on controlling contaminant and sediment discharges, rather than regulating or managing land use activities themselves. Since becoming operative in 2004, the Water Plan has already undergone 15 plan changes. Four of these plan changes set minimum flow and allocation limits for the Taieri River (Skelton, 2019). As noted above, the Water Plan is no longer considered ‘fit for purpose’ for

administering deemed permits, and a new Otago Land and Water Regional Plan will be notified by 2023.

The Water Plan has 17 Schedules, many of which are relevant to the Taieri catchment; in particular, Schedule 1A lists the natural values of surface water bodies (summarised in Appendix 4); and Schedule 1AA lists the Otago resident Native freshwater fish. Schedule 1D provides a very comprehensive list of Kāi Tahu values of Otago surface waterbodies, including many creeks, streams and rivers of the Taieri River catchment. Data are provided for the Kaitiakitanga, Mauri, Waahi tapu and/or Waiwhakaheke, Waahi taoka, Mahika kai, Kohanga, Trails, Cultural materials, and Waipuna values attributed to each waterbody.

Schedule 15 of the Water Plan sets out the numerical limits for acceptable water quality for all catchments in the Otago region. The receiving water limits are applied as five-year, 80<sup>th</sup> percentiles, when flows are at or below median flow. The ORC prepare an annual report card which documents the results of ORC water-quality monitoring undertaken over the previous five years (the most recent being July 2015 and June 2020), and assesses the results against the Schedule 15 limits. Thirteen monitoring sites are located in the Taieri catchment.

## **Rural Water Quality Strategy 2011**

Under the Water Plan, ORC have developed two non-statutory strategies: an urban water quality strategy, and a rural water quality strategy, the latter strategy relevant to the Taieri River catchment. The stated goal of the rural water strategy is to ensure that Otago's waterways remain 'healthy'<sup>8</sup>. The plan sets out the planning context for rural water quality management and details the methods and actions required to meet objectives and policies of the Water Plan.

## **Regional Plan: Land Otago**

There is currently no "Land Plan" for the Otago region, but ORC has recently agreed with the Minister for the Environment to a work programme that includes notification of a new Land and Water Regional Plan by 2023.

## **Otago Regional Council's Biodiversity Strategy 2018**

The ORC's Biodiversity Strategy<sup>9</sup> is a high-level plan that identifies how it will add value and strategic leadership to the biodiversity initiatives of communities and other organisations in Otago. In implementing the Biodiversity Strategy, ORC will work with Kāi Tahu on regional initiatives and incorporate tikaka (traditional Māori practices) and enhancement of mahika kai and taoka species into biodiversity management. Other key ORC actions over the region include: developing a spatial plan showing biodiversity outcomes sought, values, protected areas, and planned initiatives; partner with city and district councils, Kāi Tahu, DOC, Fish and Game, and other organisations on key projects; administer an eco-fund; employ a biodiversity coordinator to act as a central point of contact, and drive

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<sup>8</sup> <https://www.orc.govt.nz/media/3733/rural-water-quality-strategy.pdf>

<sup>9</sup> [https://www.orc.govt.nz/media/5798/orc\\_biodiversitystrategy\\_document-final-web.pdf](https://www.orc.govt.nz/media/5798/orc_biodiversitystrategy_document-final-web.pdf)

strategy implementation. The Biodiversity Strategy also lists identified threats to ecosystems, region-wide, including ecosystems of the Taieri River catchment discussed in this report (see Table 1).

**Table 1** *Ecosystems found over the Taieri River catchment and identified threats in the Otago Regional Council's Biodiversity Strategy 2018.*

| Ecosystem                                       | Key Species  | Threats  |
|---|--|--|
| Inland saline habitats (salt pans, Lake Sutton) | Indigenous halophytic plant species (inc. salt pan cress), indigenous turf vegetation (Lake Sutton), moths (inc. <i>Paranotoreas fulva</i> ) | Agricultural intensification, exotic weeds   |
| Tussock grassland and shrubland                 | Plants, lizards, birds, invertebrates  | Agricultural intensification, mining, predators, burning, wilding conifers   |
| Wetlands  | Plant species, wetland birds (inc. bittern, fernbird), fish (inc. galaxiids, long-finned eel, bullies)                                       | Drainage, exotic weeds, predators, nutrient and sediment runoff  |
| Rivers and lakes                                | Aquatic plant species, waterfowl, fish (inc. galaxiids, longfin eel, bullies), invertebrates   | Predators (particularly trout), fish passage issues, exotic weeds, habitat loss due to abstraction, nutrient and sediment run-off, wastewater discharges and urban contaminants (heavy metals, petroleum)        |
| Estuaries                                       | Fish (flatfish, galaxiids, flounder), wading birds (godwits, herons), sea birds, diadromous fish   | Infill and drainage, exotic plants, upstream land uses   |
| River mouths and receiving coastal water        | Sea birds (inc. Otago shag, southern blue penguin), Hector's dolphin, squat lobster, fish, waterfowl   | General Threats: Sedimentation, Excessive nutrients, Wastewater discharges, dumping of dredge spoil, rising sea temperatures, Invasive species, Harvesting of kelp, Fishing (particularly trawling and dredging) |

### 3. Treaty Partners & Major Stakeholders

#### Aukaha

The Kāi Tahu ki Otago Natural Resource Management Plan (2005) is chiefly administered by Aukaha, formerly known as Kāi Tahu ki Otago Ltd (KTKO Ltd). Aukaha was established in 1997 to represent Kāi Tahu in RMA (1991) consent matters. It is wholly owned by the four Papatipu Rūnanga of Otago - Te Rūnanga o Moeraki, Kāti Huirapa Rūnaka ki Puketeraki, Te Rūnanga o Ōtākou, and Hokonui Rūnanga (ngā Rūnanga/Rūnaka).

#### Lake Waihola Waipori Wetlands Society

The Lake Waihola Waipori Wetland Society was established with a mission statement to sustainably manage the Lake Waihola Waipori wetlands and enhance the area for the benefit of all communities of interest. The Society has led a major willow and weed control programme help to restore habitat values (Raal 2009).

#### Te Nohoaka o Tukiauau/Sinclair Wetlands Trust

The Sinclair wetlands are part of a nationally important and regionally significant wetland complex in the Taieri Plains. The area is now owned by Te Rūnanga o Ngāi Tahu, and is

valued as a wāhi taoka (culturally significant site), for mahika kai (traditional food and resources), conservation, recreation, and education<sup>10</sup>.

There is a mixture of river channels, pools, swamps, and forested islands. Water birds are abundant, and are a focus for visitors, who are welcome to walk or kayak, to stay overnight, to help as volunteers, and to connect to the wetland environment, via education and hands-on participation. Management includes enhancing wetland habitats, control of weeds and pests, and replanting native forest on the 'islands' within the wetlands. These activities are looked after by an on-site coordinator, on behalf of Te Nohoaka o Tukiauau/Sinclair Wetlands Trust.

## Regional and District Councils

As noted elsewhere, the Otago Regional Council along with Clutha, Waitaki, Central Otago and Dunedin City Councils all have jurisdiction over the Taieri River catchment. Many important sites on private land, with high conservation values, are protected by Rules under these plans. Over the Taieri River catchment, there are c. 130 sites and streams deemed significant under the RMA (1991) across all 5 plans, and in a few cases, of conservation interest; these sites along with their listed values have been collated in Appendix 4<sup>11</sup>.

## University of Otago

Students and academic staff have carried out much work over the Taieri catchment including work on mysid shrimps and ichthyoplankton in the Estuary (e.g. Sutherland and Gloss, 2001); hydrology, plankton and macrophytes of the Lake Waipori/Waihola wetland complex (e.g. Schallenberg *et al.* 2003, and Schallenberg *et al.* 2003b); bullies, e.g. Kattel and Closs, 2007; Perch, e.g. Ludgate and Gerard, 2007; and much work on the native galaxiids (e.g. McDowell and Allibone, 1994).

## Upper Taieri Water Management Group

The Upper Taieri Water Management Group is a broad affiliation of agencies and individuals with a strong interest in the Taieri River and its tributaries. The group was initiated in 2007 at the conclusion of the Taieri Trust programme. The group is focused in the Upper catchment with emphasis on resolving issues related to the pending expiry of Deemed Permits. Key actions of this group include the development of a Wetlands Management Plan for the upper catchment from Paerau to Waipiata. This is being led by members of the group including representation from Fish and Game Otago, local farmers and residents of the Maniototo. Other actions include facilitation of a proposal from a Strath Taieri group seeking to increase the catchment and storage capacity of the Loganburn Dam to enhance supply for irrigation; and ongoing monitoring and reporting of water quality and flow volumes throughout the upper catchment<sup>12</sup>.

<sup>10</sup> <https://www.tenohoaka.org.nz/>

<sup>11</sup> Not all sites scheduled and list in regional and district plans are available as mapped GIS-type layers, but all are likely to be mapped as District/Regional Plans complete their respective reviews. The DCC 2GP has excellent maps of ASBVs found here: <https://www.dunedin.govt.nz/council/district-plan/2nd-generation-district-plan/view-the-2gp-maps>

<sup>12</sup> <https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/2412%20Upper%20Taieri%20Water%20Management%20Group.pdf>

## **Irrigation Stakeholder Groups**

Some communities in the Taieri River catchment rely on irrigation, such as the Maniototo farming community. As of 2012, there were three major irrigation schemes reported for the Taieri River catchment: the Maniototo Irrigation Company, the Hawkdun-Idaburn Irrigation Company and the Ida Valley Irrigation Company. To this list can now be added the Strath Taieri Irrigation Company, which is the subject of a recent proposal to raise the Loganburn Reservoir (see Section 6).

## **Power Generating Companies**

Trustpower Ltd is the only power generating company within the catchment, running the large Waipori Scheme centred in the upper Waipori River, and the smaller Paerau and Patearoa Power Stations in the upper Taieri River catchment. As mentioned in Section 6 and above, there is interest by the Strath Taieri Irrigation Group to raise the height of the Loganburn Reservoir to provide for irrigation and should this scheme eventuate, the scheme will also increase electricity generation through the Paerau and Patearoa Power Stations.

## **Forestry Companies**

There are three Forestry companies with operational plantation forestry blocks over the Taieri River catchment: Wenita, Rayonier NZ Ltd and City Forests. Activities within forestry blocks are regulated by the National Environmental Standards for Plantation Forestry (NES-PF) which regulates, amongst other things, setbacks from waterbodies and significant natural areas. Plantation forestry activities must be managed to avoid disturbance of river and lake beds, or wetlands, when fish (salmonids and native fish) are spawning. The NES-PF has a tool to assist managers determine when it is safe to carry out activities when fish maybe spawning.

All three forestry companies are managed to a high environmental standard and this is verified by Forest Stewardship Council (FSC) certification. Under FSC certification, areas with high conservation values within the plantations are set-aside and managed to retain and enhance such values; management can include weed control; pest-management and additional setbacks. To assist with management, such areas are georeferenced and values, threats and management are recorded in a database.

## **Community Boards**

The DCC has two community boards within the Taieri River catchment: Strath Taieri Community Board and the Mosgiel-Taieri Community Board. The role of the boards is to provide advice to the Council on matters affecting their communities and to advocate for the interests of their communities. Community Boards may make submissions to the Council and other organisations on matters affecting the Community Board. The Clutha and Waitaki Districts do not have an active community board that covers the Taieri River catchment.

Only two Community boards have accessible information on the community's aspirations for conservation within the Taieri River catchment: The Maniototo and Mosgiel-Taieri boards. A third community group, however, seems the most engaged with conservation values of the Taieri River catchment: the Patearoa community. The Patearoa community



(not an official community board) has produced the “Patearoa and Upper Taieri Community-led Plan” (dated 2019)<sup>13</sup>. This plan identifies ecological areas of significance, namely the Upper Taieri Scroll Plain and its associated wetlands and saline habitats. The plan also notes that in a community survey, when asked to rank activities that relate to the natural environment, 61 % of respondents indicated that exploring further access to natural features was important or very important to them. The plan lists an action to “Arrange a meeting with DOC to discuss access opportunities to unique features and Landscapes”. Concerns were raised in a community workshop and in the survey about the water quality of the Sow Burn and its low water levels in summer, including the impact this has on fish and wildlife populations.

The Central Otago District Maniototo Community Board has also produced a plan (dated February 2007) that includes a community desire to maintain distinct ecological areas and flora and fauna associated with the upland areas and around the head of the Taieri for future generations; water quality in the Taieri River is also identified as a community interest. The Mosgiel-Taieri Community Board has a list of projects in its long-term plan (2020-2028), including to facilitate a planting project at Silver Stream Valley carpark, collaborating with Silver Stream School and Rotary Club of Mosgiel; and to identify an area that would benefit from native plantings.

## **Royal Forest and Bird Protection Society**

The Forest and Bird, Dunedin and Central Otago Lakes Branch have had extensive involvement over the Taieri River catchment carrying out wilding conifer control. Major operations were carried out on Maungatua and Post Office Creek. The Dunedin Branch was also involved in predator control to protect the South Island Robin at Whare Flat.

## **Fish and Game Council**

Fish and Game is the statutory manager of sports fish and game bird resources within Otago.

It holds functions and responsibilities set out in the Conservation Act (1987). Part of the organisation’s function is to represent the interests and aspirations of anglers and hunters in the statutory planning process and to advocate the interests of the Council, including its interests in habitats. Fish and Game has prepared a sports Fish and Game Management Plan for Otago<sup>14</sup> that describes the sports fish and game bird resources in the region and outlines issues, objectives and policies for management over the period. Fish and Game actively monitor sport fisheries over the Taieri River catchment.

## **Anglers**

Angling clubs that regularly fish over the Taieri River catchment include the Otago Anglers Association, the New Zealand Salmon Anglers (Otago Branch), and the Taieri Anglers Club. Popular fishing areas, with details of access and which species of fish are present, can be

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<sup>13</sup><https://www.codc.govt.nz/SiteCollectionDocuments/Plans/Community%20Plans/Patearoa%20Community%20Plan%202019.pdf>

<sup>14</sup> This was not able to be located.

found on the Fish and Game website<sup>15</sup>. The New Zealand Salmon Anglers (Otago Branch) have attempted to establish self-sustaining salmon populations in the Taieri River. Salmon ova have been planted into artificial redds in the upper Taieri River (Hores Bridge (Stonehenge) at the Patearoa power station), in the Sow Burn, a tributary that joins the Taieri River approximately 8 km upstream of Waipiata. Hatchery reared smolts have also been released at the Hores Bridge site (Ryder Consulting, August 2006).

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<sup>15</sup> <https://fishandgame.org.nz/otago/freshwater-fishing-in-new-zealand/fishing-locations-and-access/>

## 4. Catchment Overview

### Introduction

The Taieri River begins in the Lammermoor and Lammerlaw Ranges where it flows north over the Maniototo Plain towards Ranfurly before turning south at Waipiata and flowing through the high plateau of the Strath Taieri, located on the eastern side of the Rock and Pillar Range. It then enters a deep rocky gorge before exiting onto the low-lying coastal Taieri Plains, before finally discharging to sea via the Waipori/Waihola wetland complex south of Dunedin, just c. 60 km from where it begins (Figure 1).

The catchment has varied topography including three plains (Taieri, Strath Taieri and Maniototo), low altitude mountain ranges, and a mix of steep and gently rolling hill country. At 288 km, the Taieri River is the 4<sup>th</sup> longest River in New Zealand. The catchment has c. 105 waterbodies (including dams and reservoirs) greater than 1 ha in size, of which 28 are classed as lakes (Skelton, 2019).

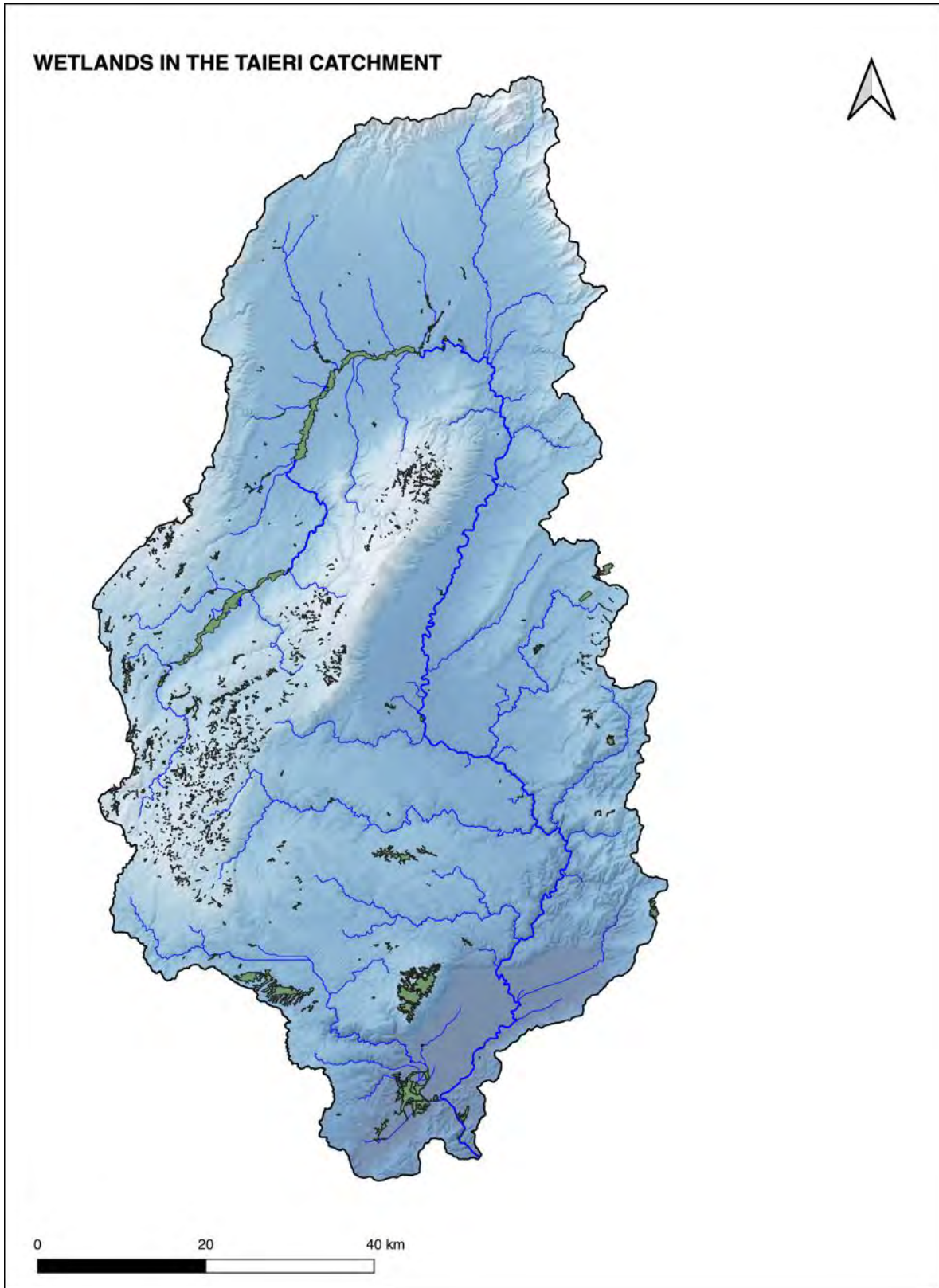
In terms of biodiversity, the Taieri River catchment is well known for its diverse fishery including many species of non-migratory galaxias, some with extremely restricted distributions. For example, Eldon's galaxias (*Galaxias eldoni*) consists of more than 18 populations spread over 5.4 ha (see Section 6).

Inland saline soils and related aquatic habitats, and ephemeral wetlands, both with associated rare plants, are also important ecological features of the catchment. Sutton Salt Lake in the Strath Taieri sub-catchment is the only inland saline lake in New Zealand. It is scheduled as a "Outstanding Natural Feature or Landscape" in Schedule 1A of Regional Plan: Water for Otago.

The Taieri River catchment is characterised by many world-class wetlands (Figure 3), the most impressive of which is the extensive naturally occurring scroll plain in the upper reaches, highly significant for both landscape and biodiversity values. The Waipori/Waihola wetland complex, situated at the southern end of the Taieri plains, is also highly significant and provides habitat for a diverse range of wildlife species over a very concentrated area.

The most populated part of the catchment is the Taieri Plains, a low-lying plain where populations are clustered around Mosgiel, Outram, Allanton and East Taieri. The lower third of the Taieri Plain is below sea level, but all four population centres are largely located beyond the flood extents observed in the late 19th century (ORC, March 2013). This awareness of flood history apparently led to an early desire for engineered modifications of the Taieri River, Silver Stream and many other parts of the plains, including land-drainage works (ORC, March 2013). Flooding remains an issue in the lower catchment and the ORC operates several pumping stations in the catchment, including the Main Drain Pump Station, which pumps water from the West Taieri Plain into Lake Waipori.

The lower part of the Taieri Plain is protected by flood banks from inundations, including those anticipated to occur more frequently with climate change, and with it, sea level rise (ORC, June 2014). The lower third of the Taieri Plain aquifer is weakly saline (see Schallenberg *et al.* 2003b and references therein).



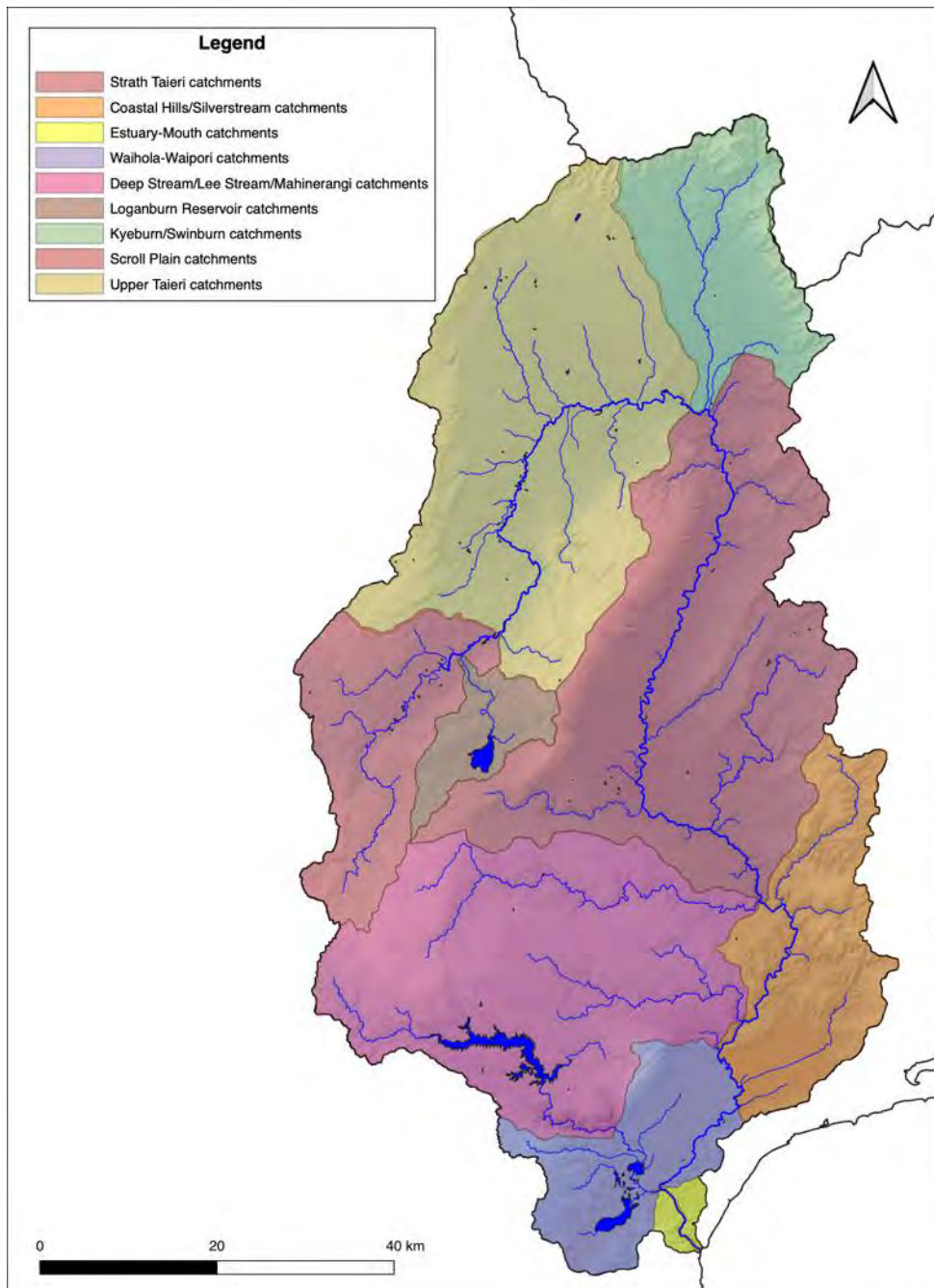
**Figure 3** Wetlands of the Taieri Catchment.

Large areas of the Taieri River catchment (c. 122,00 ha), including wetland habitat, is a mix of public conservation land and conservation covenanted land (Figure 2), but farming and plantation forestry are the major land-uses of the catchment, including sheep and beef on hill country, and dairying on the plains (Ryder Consulting, 1995). The Taieri River has experienced a decline in water quality since approximately 2012; reported declines extend from the upper to the lower catchment. This decline is coupled, at the catchment scale, with an increase in dairying and plantation forestry land uses. Dairying is especially prevalent over the Taieri Plains where the cumulative impacts of a long-history of farming and human settlement on water quality is exacerbated by the naturally sluggish flow of the river in this part of the catchment (ORC, 2004). Dairying is also present in the upper reaches of the Taieri River catchment, on the Maniototo, a land use that is heavily dependent on irrigation over this naturally arid upland plain.

The Taieri River catchment is a popular fishing spot, with brown trout abundant throughout, and both migratory and resident trout present in the upper reaches. Migratory trout have been recorded up to Kye Burn river and in the Taieri River up to the Paerau Dam. Significant trout spawning areas have been recorded at Styx Creek, Serpentine Creek and the Logan Burn. Other recreation activities and community values include swimming, fishing, and picnicking, collecting mahika kai, and use of the river for gold mining (ORC, April 2016).

The Taieri River receives water from 8 major tributaries: Waipori River, Deep Stream, Lee Stream, Silver Stream, Sutton Stream, Nenthorn Stream, Kye Burn, and the Loganburn (which drains the Loganburn Reservoir). For the purposes of this review, we have divided discussion on conservation values, where information allows, into 9 sub-catchment areas that are introduced in turn below. These sub-catchment areas broadly correspond with Otago Regional Council water monitoring sub-regions as follows (Figure 4):

1. Mahinerangi/Lee Stream/Deep Stream sub-catchment (dominated by hydro schemes and farming).
2. Scroll Plain/Styx sub-catchment (elevated, unique and with similar land use).
3. Logan Burn sub-catchment (drain the artificial lake and then down to power stations, so modified flow regimes, but similar land uses (low intensity high country farming)).
4. Upper Taieri Plain/Maniototo sub-catchment (dry catchment with similar land uses and more intensified than upstream).
5. Kye Burn/Swinburn sub-catchment (geographically the most northern part of the catchment and with similar land uses, elevated in headwaters, unique fisheries)
6. Strath Taieri sub-catchment (uniform catchments and land use).
7. Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment (super forested catchment and urban/rural flat lower section).
8. Waipori-Waihola wetland complex sub-catchment (Waipori/Waihola wetland complex is inter-connected, low-lying and tidal).
9. Estuary/Mouth single channel sub-catchment (unique part of river).



**Figure 4** General sub-catchments of the Taieri Catchment.

### ***Scroll Plain/Styx sub-catchment***

The upper Taieri scroll plains sub-catchment, the very upper reaches of which extend to Te Papanui Conservation Park in the Lammerlaws, captures the headwaters of the Taieri River and the area of scroll plain to Paerau (Figure 4). The Taieri scroll plain (part of which is on the Maniototo; see next Section) is said to be New Zealand's best example of a meandering river with old braids, backwaters and cut-offs (oxbows), with other areas (further down onto the Maniototo) being modified by channelling and various irrigation infrastructure changes (Grove, 1994). This large, naturally occurring wetland has regionally and nationally significant landscape and conservation values. It is situated in the centre of the Styx Basins

and takes in Canadian and Serpentine Flats (Figure 4). DOC administers reserves and covenants on the upper scroll plain and surrounding areas; the largest of which is the Serpentine Wildlife Management Reserve (138 ha) and the Canadian Flats Wildlife Management Area (103 ha) (see Section 6, Wetland Habitats, for conservation values of the scroll plain).

Some important conservation values of the sub-catchment are captured within the Maniototo Ecological District PNAP report (Grove, 1994). This report identified ten “Recommended Areas for Protection” (RAPs) including habitats associated with the Taieri River (see Appendix 6). This sub-catchment is within the Central Otago District, and Schedule 19.6.1. of the Central Otago District Plan lists areas of significant indigenous vegetation, and habitats of indigenous fauna and wetlands relevant to the Scroll Plain/Styx sub-catchment. These sites are protected by plan rules, and sites listed include the Serpentine Reserve and are provided here in Appendix 4. The Scroll Plain/Styx sub-catchment also has 2 regionally significant wetlands: the 10.9 ha Styx Ephemeral Wetland Management Area, and part of the Upper Taieri Wetland Complex named “the Styx (Paerau Basin Wetlands)” (Appendix 5).

### ***Logan Burn sub-catchment***

This small sub-catchment has the Loganburn Reservoir as its focal point, on top of the southern end of the Rock and Pillar Range. The Loganburn Reservoir was once known as the “Great Moss Swamp” and a regionally significant wetland remains, in part, around the reservoir (Johnson, 1987; Appendix 5). The reservoir butts against the Rock and Pillar Scenic Reserve and is almost entirely surrounded by a DCC ABSV (“Great Moss Swamp”, CO99). The swamp, and now the reservoir, drains into the Logan Burn that then flows down towards the Maniototo Plain, and enters the Taieri River at Paerau after flowing through two Trustpower-owned hydro-electric stations. The Logan Burn was first dammed in 1983 to store water for irrigation and hydroelectricity. This action has turned the 'swamp' into a lake. Although controversial, the dam height was increased in 2014 and there is continued interest in storing more water in the reservoir to provide irrigation for an additional c. 60 Maniototo farmers (Maniototo Irrigation Company Ltd). In addition to irrigation, some power is generated by Trustpower when water is released for irrigation.

The sub-catchment is situated on the boundary of the Central Otago and Dunedin City District Council boundaries. Stony Creek, near the southern boundary of this sub-catchment, is a mapped esplanade reserve in the DCC 2GP (see Appendix 4 for listed conservation values).

### ***Upper Taieri Plain/Maniototo sub-catchment***

The Taieri River leaves the scroll plain/Styx sub-catchment, and flows down through a gorge onto the lower Maniototo Plain towards Ranfurly. Ranfurly, the main population centre of the Maniototo, was once known as *O Tu Rehua*. The river moves through two small hydro-electric power stations run by Trustpower before Patearoa (Patearoa and Paerau stations). At Waipiata, the Taieri River turns back onto itself, to round the Rock and Pillar Range; but not before collecting water from the Kye Burn/Swinburn sub-catchments (Figure 4). It was between Waipiata and Kokonga that the Taieri Lake was once situated, near Camp Hill. This Lake, known as *tuna-heke-taha* (“dangling the eels”) was drained in the 1940’s and is now primarily used as farmland and recreation. Public conservation land at this site includes the

53 ha Taieri Lake Conservation Area (Grove, 1994); that is continuous with the 128 ha Kye Burn marginal strip (Figure 2). Taieri Lake was an important mahika kai site for rūnaka o Kāi Tahu, who now have an active interest in promoting the re-establishment of the Lake Taieri as mahika kai (Kāi Tahu, 2005; see Section 8).

Compared to the Scroll plain/Styx sub-catchment, the lower scroll plain has been heavily impacted on by fires and agricultural intensification that has seen the coming and going of many small-scale irrigation schemes, the construction of water races and, at one time, the proliferation of inefficient “flood irrigation” (Kitto, 2012). Channelisation of the Taieri River and its main tributaries and the draining of wetlands has occurred, for the purpose of hastening draining as flood risk management. The area still retains water races first used when gold was discovered in the Kye Burn and in its gravels that line the Maniototo Plain.

The elevated Maniototo Plain (c. 400 m a.s.l.) is famous for its harsh, dry climate with temperature extremes recorded in both summer and winter. Given the climate, and its fertile primarily alluvial soils, irrigation has had a major impact on farming practices in this part of the catchment, and although sheep farming is still the major source of income, an expansion in the dairy industry has been noted (Rance, 2019). Much of the water used for irrigation over the Maniototo was abstracted under deemed permits, many of which have undergone consenting with still more to transition over the next few years (see Section 5).

The Maniototo Ecological District was subject to a PNAP report (Grove, 1994) that identified six Recommended Areas for Protection (RAPs) over this sub-catchment (see Appendix 6 for the conservation values for each). Evidence of the conservation importance of this sub-catchment is provided by the large number of conservation reserves and protected areas that include the salt pans and other small saline areas that naturally occur. The botanical and fauna values of these unique ecosystems are well documented (Allen and McIntosh 1997; Grove, 1994). The largest of these is the 4.5 ha Patearoa Inland Saline wetland that has rare salt-tolerating plants (see Appendix 7). In addition, there are multiple DOC conservation areas over this sub-catchment (Figure 2 and Appendix 2).

Schedule 19.6.1. of the Central Otago District Plan list areas of significant indigenous vegetation, habitats of indigenous fauna and wetlands relevant to the Maniototo area that are protected by plan rules; sites are provided here in Appendix 4. The sub-catchment also has 6 Regionally significant wetlands: Clachanburn Marsh, Cross Eden Creek Marsh Complex, Laws Road Swamp, Upper Taieri Wetlands Complex, Totara Creek Inland Saline Wetland Management Area and Patearoa Inland Saline Wetland (Appendix 5).

### ***Kye Burn/Swinburn sub-catchment***

The Kye Burn is a naturally turbid stream that collects waters from mountains northeast of the Maniototo Plain, before joining the Taieri River south of east of Waipiata. The Kye Burn (and Swinburn) bring gravels down into the Maniototo from the greywacke Kakanui and Hawkdun Ranges, and has an ancestral course into the Clutha catchment. The area around Kye Burn was a busy mining location during the latter part of the Otago Gold Rush.

A large part of the upper Kye Burn sub-catchment is covered by the Oteake Conservation Park and Timber Creek Conservation Area, the former a site of recent important lizard discoveries, including at least one new species (see Section 6). This sub-catchment has no



regionally significant wetlands (Appendix 5), or significant areas in Central Otago District Plan, but is well known as supporting strong-hold populations of native galaxias (see Section 6; Olsen, 2003).

### ***Strath Taieri sub-catchment***

The Taieri River rounds the Rock and Pillar Range leaving the Maniototo behind, before entering the Strath Taieri Plain. The population centre of this sub-catchment is Middlemarch, with a population of c. 160. The Strath Taieri sub-catchment is bordered to the west by the Rock and Pillar Range and to the east, by the Taieri Ridge beyond which is the Moonlight Valley. Eastward of the Moonlight are the hills drained by a major tributary of the Taieri River, Nenthorn Stream, renowned for its herpetological and botanical conservation values (Bibby, 1997). Sutton Stream, another major tributary joins the Taieri River c. 6 km north west of Pukerangi, draining the Lammerlaw Range, before the river moves through the Taieri gorge and onto the plains at Outram.

The Strath Taieri Plain is heavily pasteurised, with much of the remaining conservation values occurring away from the main river itself amongst the surrounding hill country and tributaries of the Taieri River, e.g. Nenthorn Stream. Sutton Salt Lake occurs at the southern end of the plain, New Zealand's only inland Salt Lake. The Strath Taieri sub-catchment also has many ephemeral wetlands with associated specialised rare and threatened plant species (see Appendix 7 for a list of rare and threatened plants of the Taieri River catchment). The Strath reach of the Taieri River also supports a regionally important brown trout fishery, estimated at c. 2730 angler days in 2007/2008 (ORC, May 2016).

To secure arable land and mitigate bank erosion/scouring and excessive gravel accumulation, gravel extraction from the river has occurred; records provided by gravel extractors to the ORC show that approximately 27,239 m<sup>3</sup> of gravel was extracted from the Strath reach of the Taieri River between 1998 and 2016. ORC have promoted riparian plantings to lessen the need to conduct gravel extraction, which has been shown to have an overall negative effect on instream ecology (ORC, May 2016). It is not known how much gravel extraction is still carried out over the Strath reach of the Taieri River.

The Strath-Taieri sub-catchment includes the Macraes Ecological District, that was subject to a PNAP report (Bibby, 1997). Six RAPs were identified, that were heavily weighted towards ephemeral wetlands habitats (Bibby, 1997). The sub-catchment lies within both the Waitaki District Council (over north eastern parts) and the Dunedin City Council jurisdiction and has 8 Regionally significant wetlands: Black Rock Marshes; Fernhill Marsh; Glyn Wye Wetland Management Area; Lamb Hill Fen Complex; Murrays Road Inland Saline Wetland Management Area; Peat Moss Hills Fen Complex; Old Dunstan Road Swamp and Sutton Salt Lake Wetland Management Area (see conservation values for each in Appendix 5). A few Dunedin City Council ASBVs (Area of Significant Biodiversity Value) are also present, along with the Upper Taieri River, Lug Creek, Nenthorn Stream and Sutton Stream mapped esplanade reserves/strips in the DCC 2GP (see Appendix 4 for listed values).

### ***Mahinerangi/Lee Stream/Deep Stream sub-catchment***

This sub-catchment includes the head waters of the Taieri River in the Lammerlaw Range, and the upper Waipori River catchment above Lake Mahinerangi. The sub-catchment lies within the Waipori Ecological District, a district known for its extensive wetland habitats,

especially on top of the Lammerlaws (Johnson, 1986). The upper reaches of the Waipori River flow through farmland, and eventually, through Berwick Forest, a plantation forest managed by Wenita. An artificial lake, Lake Mahinerangi, is formed on the river behind a dam and associated hydroelectric station at Waipori Falls, which was built in 1880 to provide power for the city of Dunedin. The Waipori Hydro-Electric Power Scheme includes a network of four dams and power stations and much of this infrastructure is within the Waipori Falls Scenic Reserve, a DOC managed reserve. Major streams flowing into Lake Mahinerangi then the Waipori River include Lammerlaw Stream, Blackrock Stream, Broad Stream, and Verterburn, with Lee Stream, Fortification Stream and Deep Stream, entering the Taieri River before it reaches the Taieri Plain at Outram. Land use over the Mahinerangi sub-catchment is dominated by farming and plantation forestry (Trustpower, 2004).

Deep Creek, Deep Stream, Flat Stream, Lee Stream, Post Office Creek (Waipori), Smugglers Creek, Traquair Burn, Verter Burn and the Waipori River are mapped Esplanade reserves in the DCC 2GP (see Appendix 4 for listed conservation values for each stream from Schedule 10C of the DCC 2GP). Much of Maungatua tops is public conservation land, and/or ASBV of national significance named “Maungatua Summit Wetland Management Area and Maungatua Scenic Reserve” in the DCC 2GP. Office Creek Seepage, another ASBV in this sub-catchment, is known for providing habitat for nationally and internationally rare or threatened species or communities, which includes Eldon's galaxias (*Galaxias eldoni*).

The sub-catchment has 5 regionally significant wetlands: Loch Loudon Fen Complex; Braeside Swamp; Fortification Stream Headwaters Swamp; Reefs Pond Margins and Office Creek Seepage (Appendix 5). Fortification Creek Wetland is also scheduled in the Central Otago District Plan and in the DCC 2GP (Fortification Stream Headwaters Swamp). Other DCC ABSVs include Mt McKay Covenant; Reefs Pond Margins; Tappers Conservation Covenant; Fortification Stream Headwaters Swamp; Andersons Pond Margins and Black Rock (see Appendix 4 for conservation values of each).

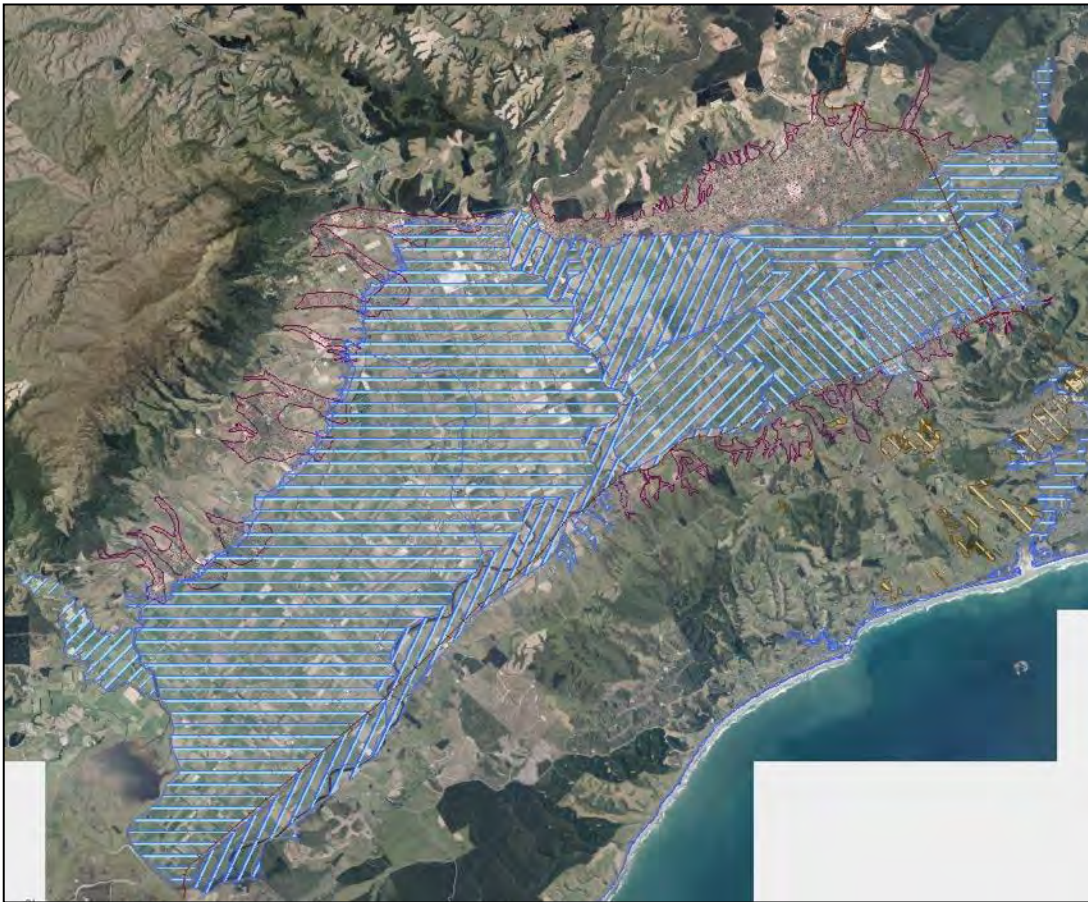
### ***Silver Stream, Maungatua, Taieri Plain and Coastal sub-catchment***

The sub-catchment spans both the Waikouaiti and Tokomairiro Ecological Districts, neither of which were subject to a PNAP survey. This sub-catchment includes the top part of the Taieri Plains to Allanton Road, and streams that flow onto and through the most heavily populated and most intensively farmed area of the catchment, before joining the Taieri River near Henley. Arising in the Silverpeaks north of Dunedin, several streams flow into the Taieri River including Three O’Clock Stream, Christmas Creek, Big Stream, and further down, Silver Stream, a major tributary of the Taieri River that dominates the Taieri Plain. Rising 900 m out of the Taieri Plains, is Maungatua that forms a prominent ridge on the skyline that itself drains into the plains via the Lee Creek. The sub-catchment is bounded to the east by low coastal hills through which the Taieri River eventually flows out to sea via the estuary.

The land use over the Taieri Plain is mainly farming, dominated by dairy and sheep with some deer farming and agriculture. Treated wastewater from the Mosgiel treatment plant no longer discharges to the Taieri River, and effluent from dairy sheds is no longer pumped into drains, but bacteria (*E. coli*) levels in the drains and waterways of the Taieri Plain still often exceed ORC Water Plan limits (ORC, Water Quality Report Card for Taieri Plains July 2014 to June 2019). Water quality over this sub-catchment and the neighbouring

Waipori/Waihola wetland complex sub-catchment is the worst of any place, Otago-wide (see Appendix 9).

The entire sub-catchment falls within the Dunedin City boundaries, and almost all the plain is mapped as natural hazard areas in the Dunedin City 2GP (Figure 5), due to its flood-prone nature. The sub-catchment also has a variety of mapped ASCVs under the DCC 2GP, and esplanade reserves/strips and 2 Regionally significant wetlands: Maungatua Summit Wetland Management Area and McKay's Triangle Wetland (Appendices 4 & 5 for conservation values of each).



**Figure 5** Areas of the Taieri Plain mapped as natural hazards zones in the DCC 2GP (purple and blue hatching and stippling).

### ***Waipori-Waihola wetland complex sub-catchment***

This relatively small sub-catchment lies over the southern stretches of Taieri Plain from Allanton Road, and is situated in the Tokomairiro Ecological District, a district which was not subject to a Protected Natural Areas Program (PNAP) survey by DOC. This sub-catchment features one of the largest tributaries of the Taieri River, the Waipori River, which has been heavily modified by a major hydro-electric power scheme operated by Trustpower. The Waipori River drains much plantation forestry before emerging onto the Taieri Plain near to

Lake Waipori and its wetland complex. The wider Lake Waipori/Waihola wetland complex is a regionally significant wetland and is a remnant of a much larger wetland/Lake complex that once covered the lower two-thirds of the Taieri Plain (until c. 1850). As well as having botanical and fauna values, the wetlands also have important hydrological values as they buffer flood flows in the Taieri River.

The wetland complex receives water from the Meggat Burn, Boundary Creek and several drains, the waters of which originate from surface runoff and farm discharges of the Taieri Plains. There is some evidence that the wetlands also receive groundwater (Schallenberg *et al.* 2003b). Owhiro Stream, another major stream in this sub-catchment, has the most degraded water quality in the Taieri River catchment (see Section 5).

Land use over the sub-catchment is farming, with stock still having intermittent access to the edge of waterways and wetlands, in places. The main channel of the Taieri River joins waters leaving the Lake Waipori/Waihola wetland complex and exits the plain to travel through coastal hills to the estuary and Pacific Ocean at the small settlement of Taieri Mouth. Some of the streams in this sub-catchment are mapped Esplanade Reserves in the DCC 2GP (see Appendix 4 for listed conservation values); e.g. Lee Creek and Owhiro Stream. The sub-catchment has 4 Regionally significant wetlands: Waipori Boot Swamp, Otokia Swamp, Henley Swamp and Waipori/Waihola wetland complex (Appendix 5). The wetland complex, and nearby wetlands such as Henley Swamp, are recognised as ASCVs (or equivalent) in the DCC 2GP and the Clutha District Plans.

### ***Estuary/Mouth single channel sub-catchment***

The Taieri River is estuarine in nature over the lower reaches, from Henley Ferry Bridge. The Taieri River (sometimes referred to as the Waipori River over the lower reaches) terminates in a long, generally narrow and irregularly shaped estuary that covers more than 270 ha (Ryder Consulting, 2008). The main estuary has been described as a drowned river estuary (Gloss and Schallenberg, 2011) and is moderately stratified, where mixing of fresh and salt water occurs at all depths, and is classified as a permanently open estuary, one where the sandbar across the mouth does not close it off entirely.

Large areas of what was estuary, or flood plain, along the margins of the upper estuary, have been developed for farming at some time in the past (grassland in Appendix 7). Plantation forestry lines parts of the channel where it leaves the Waipori/Waihola wetland complex, but the lower reaches are clad in indigenous vegetation, including stands of podocarp forest with superb specimens of Hall's totara (*Podocarpus laetus*) and regenerating kahikatea (*Dacrycarpus dacrydioides*), a species that prefers fertile land that has usually become farmland; regenerating stands are very rare<sup>16</sup>. Along the forested margins of the main channel, creeks and streams terminate in wetlands before draining into the Taieri River.

A large regionally significant wetland is present over this reach of the Taieri River, the Takitakitoa Swamp managed by Otago Fish and Game. In addition, the Dunedin City Council (DCC) recognises the Taieri Māori Reserve along this stretch of the catchment on the true

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<sup>16</sup><https://www.doc.govt.nz/parks-and-recreation/places-to-go/otago/places/waihola-taieri-mouth-area/things-to-do/taieri-river-track/>

left bank of the river; and the lower Taieri River is an esplanade reserve in the DCC 2GP (see Appendix 4 for conservation values listed). There are 3 regionally significant wetlands: Governors Point Swamp; Rocky Hill Tidal Marshes and Takitakitoa Swamp (Appendix 5).

The Taieri Estuary is listed as a coastal development area in the Regional Plan: Water with fishing facilities and recreational facilities (Otago Regional Council, 2004). ORC have a water level monitoring site at Henley Pump Drain Level and ORC carry out regular estuarine health assessments (e.g. Ryder Consulting, 2008; ORC, November 2010). The entire lower Taieri River is a mapped Esplanade Reserve in the DCC 2GP (see Appendix 4 for listed conservation values).

Habitats and vegetation types of the Taieri Estuary have been mapped by Ryder Consulting (2008); habitats mapped and the extent of each over the Taieri Estuary are reproduced here in Appendix 8. Compared to other Otago estuaries, the Taieri Estuary has relatively low cover of potentially nuisance causing macroalgal (e.g. sea lettuce, *Gracilaria* sp. and *Enteromorpha* sp.); moderate amounts of saltmarsh habitat (combined across multiple habitat classes in Appendix 8), and the lowest extent of soft mud sediment across all estuaries sampled by ORC for State of Environment Reporting (ORC, November 2010).

## Landcover Trends

Based on collated statistics from LCDB v4.1<sup>17</sup> on LAWA (presented in Table 2), the Taieri catchment is dominated with exotic grassland, representing 62 % of the land area, with 22 % or 135,716 ha of indigenous tussock grasslands making up the second largest landcover type. Trends in landcover noted in 2012 indicate conversion of tussock grasslands to exotic grasslands is the fastest trend, a trend that is obvious over the Macraes Ecological District where the catchments vulnerable ephemeral wetlands are concentrated. Over 16 years there was a loss of approximately 446 hectares of tussock grassland a year. An increase of exotic forest cover was also notable over the catchment with an estimated 34,744 ha of plantation forest occurring in 2012 (an increase of 4% from 1996).

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<sup>17</sup> The most widely-used source of land cover monitoring data in New Zealand is the New Zealand Land Cover Database (LCDB). The latest version of LCDB (version 4.1) provides a series of 'snapshots' of land cover in the form of maps derived from satellite imagery across the country, covering the dates: 1996, 2001, 2008 and 2012.

**Table 2** Landcover as at 2012 over the 605,128 ha Taieri catchment. Data have been collected from data shown in the LAWA website.

| Vegetation Cover Class                           | Cover (ha)     | % Cover as at 2012 | change in area of cover (ha) 1996-2012 | percentage change 1996-2012 |
|--|----------------|--------------------|--|-----------------------------|
| <b>Forest</b>                                    | <b>41191</b>   | <b>7 %</b>         |  |                             |
| Indigenous Forest                                | 6447           | 1 %                | 52                                     | 1%                          |
| Exotic Forest                                    | 34744          | 6 %                | 1,442                                  | 4%                          |
| <b>Scrub / shrubland</b>                         | <b>22671</b>   | <b>4 %</b>         |  |                             |
| Indigenous scrub / shrubland                     | 17226          | 3 %                | -111                                   | -1%                         |
| Exotic scrub / shrubland                         | 5445           | 1 %                | 7                                      | 0%                          |
| <b>Grassland / other herbaceous vegetation</b>   | <b>523,857</b> | <b>87 %</b>        |  |                             |
| Tussock grassland                                | 135,716        | 22 %               | -7,130                                 | -5%                         |
| Exotic grassland                                 | 377,666        | 62 %               | 5,583                                  | 1%                          |
| Other herbaceous vegetation                      | 10,474         | 2 %                | -40                                    | 0%                          |
| <b>Cropland</b>                                  | <b>1,955</b>   | <b>0 %</b>         |  |                             |
| Cropping / horticulture                          | 1,955          | 0 %                | 25                                     | 1%                          |
| <b>Urban / bare / lightly-vegetated surfaces</b> | <b>10,279</b>  | <b>2 %</b>         |  |                             |
| Natural bare / lightly-vegetated surfaces        | 8,687          | 1 %                | 0                                      | 0%                          |
| Artificial bare surfaces                         | 187            | 0 %                | 38                                     | 20%                         |
| Urban area                                       | 1,406          | 0 %                | 99                                     | 7%                          |
| <b>Water bodies</b>                              | <b>5,175</b>   | <b>1 %</b>         | 34                                     | 1%                          |
| <b>Total</b>                                     | <b>605,128</b> | <b>100 %</b>       |  |                             |

## 5. Water and Ecosystem Health

### Flow Statistics

ORC have flow monitoring sites at seven locations within the Taieri catchment (Table 2). Statistics in Table 2 represent flow conditions under the existing/actual environment where water is being diverted and abstracted for irrigation (and hydro). It is important to note, however, that the natural flows (especially the natural low flows) would be quite different (higher) than those reported below in Table 3; i.e. in the absence of abstraction activities. Nevertheless, the pattern of flows in the Taieri river seen today can vary considerably along its length, with high flows originating in the upper catchment taking several days to reach the plain, while high flows originating from tributaries closer to the coast can reach the plain in a matter of hours (ORC, March 2013).

### Water Allocation

Irrigation is the main abstraction activity along the length of the Taieri River mainstem, with small amounts also taken for drinking water. Mining rights account for much abstraction over the upper reaches of the catchment. Data on abstraction are currently being collated by ORC and were not available at the time of writing. A summary of consented surface water uses in 1999 indicated 195 consents had been issued for irrigation; 45 for water supply, 26 for industrial/commercial use and 7 for miscellaneous use (ORC, November 1999).

Although the Taieri catchment has both water storage on some tributaries and minimum flow limits set throughout the catchment, the river is known to reach these minimum flows. It is described on the LAWA website as: “*heavily over-allocated*”, *largely as a result of the use of historic deemed permits to allocate water*” (Skelton, 2019 referencing LAWA). Although RPS Plan Change 3A (operative in May 2011) redefined minimum flow for the Taieri, a minimum flow and allocation regime for the Taieri catchment, where hydrological modelling has yet to be started, is thought to be years away (Skelton, 2019). The status of the Taieri catchment is significant since it includes the highest number of deemed permits (75) (Skelton, 2019; Table 4).

**Table 3** Flow Statistics for monitoring stations throughout the Taieri River catchment (from LAWA).

| River/Site                | Mean (m <sup>3</sup> /s) | Median (m <sup>3</sup> /s) | 7-Day MALF (m <sup>3</sup> /s) | Median Annual Flood (m <sup>3</sup> /s) | Highest Recorded Flood (m <sup>3</sup> /s) |
|---------------------------|--------------------------|----------------------------|--------------------------------|---|--|
| Taieri Waipiata           | 9.88                     | 6.86                       | 1.45                           | 72                                      | 189  |
| Taieri Tiroiti            | 14.04                    | 9.6                        | 1.85                           | 136                                     | 521  |
| Taieri Sutton             | 18.06                    | 12.52                      | 2.29                           | 163                                     | 560  |
| Taieri Outram             | 31.7                     | 20.25                      | 4.04                           | 471                                     | 2526                                       |
| Silver Stream Gordon Road | 2.68                     | 1.53                       | 1.04                           | 108                                     | 194  |
| Nenthorn Mt Stoker Road   | 1                        | 0.28                       | 0.04                           | 42                                      | 364  |
| Deep Stream at SH87       | 3.08                     | 1.57                       | 0.45                           | 131                                     | 463  |

## Deemed Permits

Otago mining privileges, or deemed water permits, are due to expire on 1 October 2021 meaning the users of these permits need to apply for resource consent to continue to abstract water. The Taieri catchment has more deemed permits than any other Otago catchment (Table 4). It is possible that some of these will be surrendered by Trustpower in the Waipori catchment (Trustpower own and operate the Waipori Power Scheme). A recent high-level report commissioned by the Minister of the Environment has recommended ORC revamp the planning framework that will administer the transition from deemed permits to RMA-led consents (Skelton, 2019). An extension in the expiration date of the deemed permits (via section 413(3) of the Resource Management Act 1991) from 1 October 2021 to 31 December 2025 was included in the recommendations. This will ensure that the replacement consent applications are assessed against a robust policy framework.

Deemed permits include surface and groundwater takes. At the time of writing, no decision had been made on the extension of the expiry dates. As noted above, the Taieri catchment is considered to be an overallocated catchment (in terms of level of water abstraction) meaning the potential controversy around any transition, is immense. On the flip side, however, the potential benefit to the Taieri River ecosystem of increased flows, is potentially significant.

**Table 4** Otago catchments with the most deemed permits (as at 17 September 2019) and number of dairy farms in the region (Table from Skelton, 2019).

| Catchment with deemed permits | Deemed Permits (takes) | RMA Water Permits (takes) | Median Expiry Date of RMA water permits | Whether over-allocated | Whether subject to Schedule 2 allocation and flow limits | # Dairy farms |
|-------------------------------|------------------------|---------------------------|---|------------------------|--|---------------|
| Taieri                        | 74                     | 160                       | 2037                                    | Yes                    | Yes  | 76            |
|                               | (103)                  | (233)                     | (2019-2023)                             |                        |  |               |
| Manuherekia                   | 71                     | 122                       | 2023                                    | Yes                    | Yes (part of river – Falls Dam to Ophir)                 | 15            |
|                               | (124)                  | (255)                     | (2019-2052)                             |                        |  |               |
| Lindis                        | 19                     | 17                        | 2029                                    | Yes                    | Pending (notified and under appeal)                      | 0             |
|                               | (31)                   | (28)                      | (2021-2043)                             |                        |  |               |
| Cardona                       | 14                     | 31                        | 2038                                    | No                     | Yes  | 0             |
|                               | (27)                   | (55)                      | (2020-2050)                             |                        |  |               |
| Lowburn Creek                 | 13                     | 1                         | 2046                                    | No                     | Yes  | 0             |
|                               | (41)                   | (2)                       |   |                        |  |               |
| Arrow                         | 12                     | 8                         | 2030                                    | No                     | Yes  | 0             |
|                               | (18)                   | (19)                      | (2021-2048)                             |                        |  |               |
| Luggate                       | 12                     | 1                         | 1 Oct 2021                              | Yes                    | Yes  | 0             |
|                               | (16)                   | (1)                       |   |                        |  |               |
| All others (c. 50)            | 141                    | 544                       |   | Approx. 60%            | Approx. 30%  | 411           |
| Totals                        | 356                    | 884                       |   |                        |  | 502           |
|                               | (583)                  | (1399)                    |   |                        |  |               |

Sources quoted by Skelton, 2019: Otago Regional Council (consent and plan data); Agribase (dairy farm data)



## Water Quality & Indicators of Aquatic Ecosystem Health

### *General*

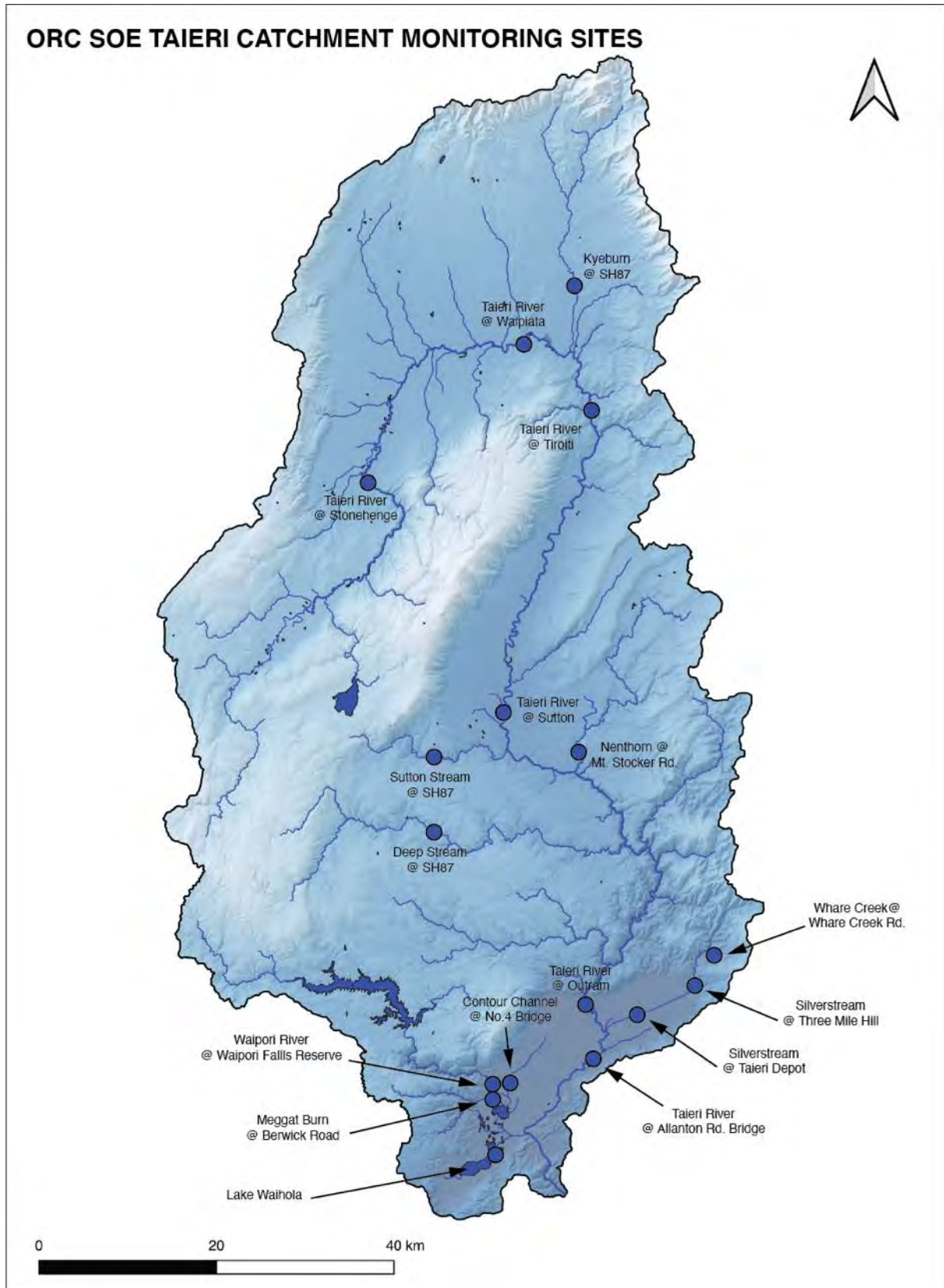
ORC have 20 water quality monitoring sites scattered across the Taieri catchment's rivers, and at Lake Waihola. Monitoring sites (Figure 6) are sampled 2-3 times every year with results for nitrogen, ammonium, dissolved phosphorus, *E. coli* bacteria and turbidity reported on the ORC website as part of ORC's obligations related to "State of Environment" (SOE) reporting under the Environmental Reporting Act (2015). Water quality results for 2014-2019 show that, although generally the Taieri catchment reports good water quality, the Owhiro Stream in the lower Taieri catchment had the worst level of compliance against Schedule 15 (Regional Plan: Water for Otago, "Water Plan") limits of any site across the Taieri River reporting region (Appendix 9). This site failed all Water Plan limits and was the most degraded site of all ORC monitoring sites over the 2006-2017 reporting period, Otago-wide (ORC, State of Environment Report for Surface Water Quality, 2006-2017).

Owhiro Stream receives surface run off from the most populated and heavily farmed area of the catchment, the Taieri Plains, and looking across other monitoring reports on water quality for the catchment, Owhiro Stream and Silver Stream at Taieri Depot consistently exhibit degraded water quality. In addition, some areas of the plains have elevated iron and manganese levels, with concentrations regularly exceeding drinking water standards for "appearance, taste, and odour" (Skelton, 2019). Salinity is also an issue over some areas of the Taieri plain, and it is anticipated salinity issues will worsen with sea level rise, and any further abstractions from the already overallocated catchment (Skelton, 2019).

*E. coli* compliance across sites of the Taieri catchment was deemed 'moderate' with 8 Taieri catchment sites failing to meet Water Plan standards, and 7 sites passing 80<sup>th</sup> percentile limit of 260 CFU/100ml for the 2014-2019 monitoring period (Appendix 9). Stock access to waterbodies has been cited as a major contributing factor to the elevated *E. coli* concentrations measured at some sites during the monitoring period (ORC, State of Environment Report for Surface Water Quality, 2006-2017). Stock access remains an intermittent issue over the Taieri plains and the Waipori/Waihola wetland sub-catchments despite the Water Plan Rule 13.5.1.8A which directs that: "*Stock can only have access to streams, rivers, lakes and Regionally Significant Wetlands (waterways) as long as they don't damage the banks and bed of the waterway or degrade the quality of the water*".

Looking across all variables measured by ORC for SOE monitoring, 4 sites were fully compliant with Water Plan limits, these sites being the Taieri River at Stonehenge, Deep Stream at SH87, the Taieri River at Outram and the Waipori River at Waipori Falls Reserve (Appendix 9).

Following the 2012 State of Environment Water Quality Report (ref#247) that showed water quality at two sites had shown a deterioration (Tiroiti and Sutton), ORC instigated additional monitoring. 16 years' data at sites in the upper Taieri River catchment was then used to determine that water quality had changed, commensurate with an increase in the irrigated area and land (McDowell and Kitto 2013).



**Figure 6** ORC water State of the Environment (SOE) monitoring sites.

Water quality is also measured at the Jetty of Lake Waihola. Lake Waihola has seen a gradual, natural, decrease in salinity over the last c. 4000 years with concomitant changes in flora and fauna. In addition, the Lake has seen a huge increase in sediment loading along with draining of surrounding wetlands since European settlement c. 1985s (Schallenberg, 2019). There has been concern that water quality in both lakes has deteriorated due to an increase in the intensity of land use, particularly dairying and forestry over the lower part of the Taieri, and that the flood control scheme and associated land drainage in the lower Taieri plain has changed the hydrological regime of the lakes (ORC, 2005). Water quality monitoring results for 2014-2019 for at Contour Channel at No.4 Bridge, a site situated immediately upstream from the Waipori/Waihola wetland complex and in the same sub-catchment, shows water quality limits are exceeded for nitrogen, phosphorus and *E. coli* (Appendix 9). At Lake Waihola Jetty, water quality over the same monitoring period exceeded the water quality limits for nitrogen, phosphorus and turbidity (Appendix 9).

This on-going water quality problem over this important wetland ecosystem was highlighted at the highest political level in a water quality/allocation overview report prepared for Ministry for the Environment in late 2019, in which the author, Professor Peter Skelton stated:

*“The Taieri catchment has variable quality along its length, with E. coli and phosphorus being the main water quality parameters of concern. Lake Waihola is particularly sensitive (due to its shallow nature) and has some signs of poor water quality and eutrophic status”* (Skelton, 2019).

In addition to the rivers and 1 lake monitoring site, ORC also carry out monitoring of Otago estuaries, including the Taieri Estuary. The Otago Estuaries State of Environment Reporting 2009/2010, prepared by ORC, have the stated overall objective to provide an assessment of the current state of estuarine health over Otago. Based on water quality data collected for the 2010 report, the Taieri Estuary has more degraded water quality compared to the Waikouaiti, Shag and Kakanui estuaries of Otago, but better water quality than the Kaikorai and Catlins estuaries (Table 5).

**Table 5** *Turbidity, chlorophyll-a, nitrite-nitrate nitrogen (NNN) and dissolved reactive phosphorus (DRP) levels assigned to each Otago estuary based on the 2010 State of Environment Report (ORC, November 2010). The best quality (or lowest concentration) is green; concentrations then increase from yellow to orange and finally to red.*

| Estuary     | Turbidity (NTU) | Chlorophyll-a (mg/L) | NNN (mg/L) | DRP (mg/L) |
|-------------|-----------------|----------------------|------------|------------|
| Catlins     | 5.7             | 2.71                 | 26.5       | 25         |
| Tokomairiro | 5.8             | 1.66                 | 46         | 25         |
| Taieri      | 5.4             | 1.36                 | 25         | 25         |
| Kaikorai    | 10              | 3.39                 | 56         | 22         |
| Waikouaiti  | 2.1             | 0.99                 | 25         | 25         |
| Shag        | 3.2             | 0.88                 | 48         | 25         |
| Kakanui     | 2.5             | 0.98                 | 40         | 25         |

### ***Periphyton (trophic state in Rivers)***

The NPS-FM has 4 classifications for periphyton (trophic state), based on chlorophyll-*a* as a surrogate for periphyton biomass (expressed as mg chl-*a*/m<sup>2</sup>, milligrams chlorophyll-*a* per square metre), including a national bottom line of 200 mg chl-*a*/m<sup>2</sup> (Appendix 3). For the 2018 survey, the Kye Burn site had the lowest algal community, Otago-wide, with only 3 diatom species found, and no filamentous algae, cyanobacteria or phytoplankton (ORC, Report Card for Water Quality and Ecosystem Health, July 2013 to June 2018).

Didymo (*Didymosphenia geminata*) has not been recorded in the Taieri catchment (ORC, Report Card for Water Quality and Ecosystem Health, July 2013 to June 2018). This nuisance species seems to proliferate mainly in South Island lake outlet rivers with high clarity and low nutrients (e.g., Hawea, upper Clutha, Mararoa/Waiiau, Owen, lower Waitaki), and to a lesser extent some braided rivers (Rangitata, Rakaia). The tannin-stained water of the Taieri, along with elevated nutrients, probably make it unlikely that didymo would proliferate in it.

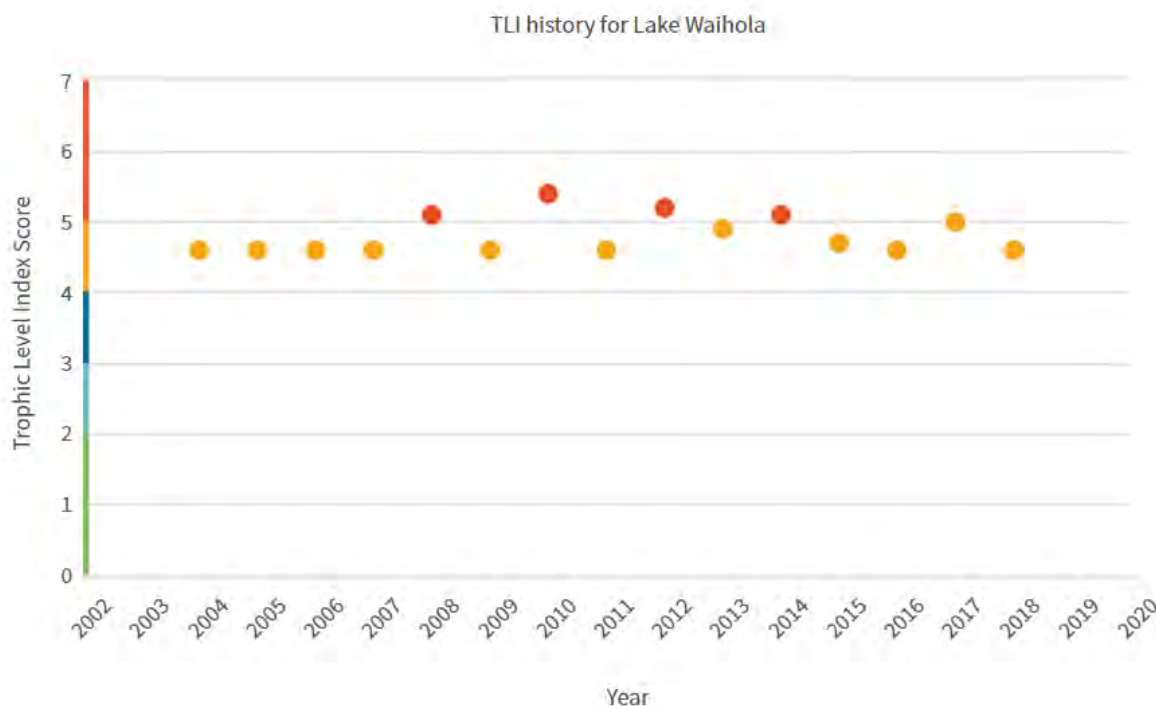
### ***Phytoplankton (trophic state in Lakes)***

The NPS-FM has 4 classifications for phytoplankton (trophic state) based on chlorophyll-*a* concentration, including a national bottom line (Appendix 3). Occasional algal blooms occur in Lake Waipori including the nuisance blue-green (cyanobacteria) algae *Dolichospermum* sp. (formerly *Anabaena*) (Ryder Consulting, 1995; Robertson, 1986). Lake Waihola also has a history of cyanobacteria being present, with alerts appearing in the media regularly warning the public about the dangers to people and pets of cyanobacteria. Blue-green algae occur naturally, but can increase rapidly to nuisance levels during summer months, and are capable of producing compounds toxic to humans and other animals.

ORC have also carried out more targeted lake water quality monitoring, including baseline water quality surveys of Lake Waipori and Lake Waihola between October 2002 and October 2004 (ORC, 2005). Four key variables were measured: chlorophyll-*a*, water clarity - secchi depth (SD), total phosphorus (TP) and total nitrogen (TN). Results from 2004 indicated that Lake Waihola was “supertrophic” and stable, and Lake Waipori was eutrophic and also stable. This baseline work was followed by additional surveys of Lake Waihola, and the development of a Trophic Level Index (TLI)<sup>18</sup> history for this lake. Data for the TLI of Lake Waihola has been collated and presented on the LAWA website for the monitoring period of 2004-2018 (Figure 7). Data indicate that the Lake Waihola TLI has remained either “poor” (eutrophic; orange circles) or “very poor” (supertrophic; red circles) since 2002.

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<sup>18</sup> The TLI number is calculated using four separate water quality measurements – total nitrogen, total phosphorous, water clarity (secchi depth), and chlorophyll-*a*.



**Figure 7** TLI data collected from Lake Waiholo Jetty and presented on the LAWA website. Orange circles represent poor (eutrophic) water quality and red are very poor (supertrophic). See LAWA for further details at <https://www.lawa.org.nz/learn/factsheets/lake-trophic-level-index/>

### Macroinvertebrates

Stream invertebrates, referred to commonly as macroinvertebrates, are used widely as indicators of stream health, with certain families (e.g. mayflies) proven to be particularly sensitive to degraded water quality. The macroinvertebrate community index (or MCI) has 4 classifications for macroinvertebrate community health (Table 6). Streams can range between excellent to poor, depending on the MCI score. Six sites are sampled annually for macroinvertebrates by the ORC in the Taieri catchment. Over the period 2006 to 2017, five sites have median MCI scores between 100 and 110 (mainly 'Fair', although 110 is classed as 'Good') while the Silver Stream site has a median MCI score of just below 90 ('Poor').

In a regional context, with the exception of the Silver Stream, the ORC reports that the Taieri River catchment generally ranks favourably against sites across Otago (Appendix G of ORC, State of Environment Report for Surface Water Quality, 2006-2017). Other macroinvertebrate community statistics for the ORC Taieri monitoring sites are presented in Table 7.

**Table 6** Macroinvertebrate community indices (MCI) bands for rivers.

| MCI Band | MCI Scores    | Classification |
|----------|---------------|----------------|
| A        | ≥ 130         | Excellent      |
| B        | ≥110 and <130 | Good           |
| C        | ≥90 and <110  | Fair           |

|   |     |      |
|---|-----|------|
| D | <90 | Poor |
|---|-----|------|

**Table 7** *Macroinvertebrate monitoring sites within the Taieri Catchment from ORC, State of Environment Report for Surface Water Quality, 2006-2017. Additional data collated from LAWA are indicated with\*. The LAWA data cover an unknown monitoring period. Percentage EPT is the total percentage of total taxa recorded that comprised pollution-sensitive Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). There are no bands for taxa richness or EPT richness. '-' = data not available.*

| Site                           | MCI (5-year median) | MCI (Class) | MCI 15-year trend* | Taxonomic Richness (5-year median) | % EPT (5-year median) |
|--------------------------------|---------------------|-------------|--------------------|------------------------------------|-----------------------|
| Kye Burn at SH85 Bridge        | 105                 | Fair        | Indeterminate*     | 19*                                | 50*                   |
| Taieri at Tiroiti              | 106                 | Fair        | Data not available | -                                  | -                     |
| Sutton Stream at SH87          | 107                 | Fair        | Data not available | -                                  | -                     |
| Taieri at Outram               | 110                 | Good        | Data not available | -                                  | -                     |
| Silver Stream at Taieri depot  | 89                  | Poor        | Likely decreasing* | 20*                                | 37.5*                 |
| Waipori River at Waipori Falls | 108                 | Fair        | Likely decreasing* | 21*                                | 47.6*                 |

### **Trace Elements in Lake and Estuary Sediments**

Riverine or swamp lakes such as Lakes Waihola and Waipori are shallow, and experience tidal surges. Soft sediment bottoms make them susceptible to eutrophication and build-up of trace elements. Silt accumulation and eutrophication for the wetlands of Lakes Waihola and Waipori were raised as significant issues in the Otago RPS (Issue 10.3.1). The mean rate of historic sediment accumulation in Lake Waihola before the start of major European settlement has been estimated from sediment core samples to be around  $0.18 \pm 0.01$  mm per year. From c. AD1860 onwards, this increased markedly by about 30-fold following major land use changes in the catchment (Schallenberg and Harper, 2012).

Little information is available, however, on the levels of trace elements in lake-bed sediments. The Waipori-Waihola lakes were analysed for lead sedimentation rates in 1997 (Ditchburn *et al.* 1997), which were recorded as 0.68 cm per year (3.5 kg/m<sup>2</sup> per year dry weight) for Lake Waihola, and 0.76 cm per year (4.0 kg/m<sup>2</sup> per year) for Lake Waipori. The researchers noted that the background lead values for Lake Waipori were lower than any others encountered so far in similar surveys within New Zealand, and attributed the source as rainfall. These sedimentation rates are very similar to those in other South Island lakes such as Lakes Ohau, Tekapo and Wakatipu (Ditchburn *et al.* 1997).

A 2001 study, undertaken before the treated wastewater from Mosgiel Sewage treatment plant was pumped to Green Island, found that the concentrations of dissolved zinc and copper in the lake water of both lakes showed much variability, especially in Lake Waihola. The researchers concluded that the variability was likely due to tidal mixing, or sediment remobilisation within the lake (Kim and Hunter, 2001).

Australian and New Zealand Environment and Conservation Council (ANZECC) provide guideline values for trace element compositions in the sediment. These values are provided

in Table 8. For estuaries in Otago, none had levels that exceeded the ANZECC values (see Ryder Consulting, 2008 for Taieri, and ORC (November 2010) across all Otago estuaries) (Table 9).

**Table 8** ANZECC Interim Sediment Quality Guideline (ISQG) values (mg/kg) for freshwater ecosystems.

| Guideline         | Arsenic | Cadmium | Chromium | Copper | Nickel | Lead | Zinc |
|-------------------|---------|---------|----------|--------|--------|------|------|
| ISQG Low (mg/kg)  | 20      | 1.5     | 80       | 65     | 21     | 50   | 200  |
| ISQG High (mg/kg) | 70      | 10      | 370      | 270    | 52     | 220  | 410  |

**Table 9** Sediment heavy metal contamination (mg/kg) in the Otago estuaries monitored and reported in 2010 (ORC, November 2010). The results presented are the average values for two sites within each estuary. Note: detectable levels of trace elements in sediments can either be due to natural processes or the result of anthropogenic activities.

| Estuary     | Arsenic | Cadmium | Chromium | Copper | Nickel | Lead | Zinc |
|-------------|---------|---------|----------|--------|--------|------|------|
| Kakanui     | 4.8     | 0       | 4.4      | 1.9    | 4.6    | 5.9  | 14.4 |
| Shag        | 10.1    | 0       | 10.4     | 4.5    | 6.9    | 5.2  | 31.9 |
| Waikouaiti  | 6.5     | 0       | 5.8      | 4.7    | 6      | 4.2  | 26.3 |
| Kaikorai    | 0       | 0.1     | 18.7     | 12     | 9.2    | 27.4 | 127  |
| Taieri      | 0       | 0       | 5.1      | 3.2    | 4.8    | 3.7  | 19.5 |
| Tokomairiro | 3.7     | 0.1     | 6.6      | 3.9    | 5.1    | 4.2  | 26.5 |
| Catlins     | 5       | 0       | 5.9      | 3.9    | 4.8    | 2.1  | 17   |

### Point-Source Discharge to Water

A number of community schemes discharge wastewater to water, or to land and then water, within the Taieri catchment. Such schemes are located at Ranfurly, Naseby, Middlemarch, Waiholo, and the Dunedin Airport<sup>19</sup> (see Table 10). In addition to these schemes, villages or communities with septic tanks occur at Taieri mouth, Berwick, Allanton, Outram, Outram Glen, Waipiata, Waipori Village, Mahinerangi huts and Berwick. A study carried out and published by ORC in 2005 identified “hot spot” areas where septic tank leachate contamination breached Water Plan rules (following Plan change 6A; see below), threatening water quality including the quality of aquifers (ORC, August 2005). These areas included two in the Taieri catchment – Outram and Allanton, with Momona and Owhiro also unidentified as problem areas (ORC, August 2005). Management strategies were suggested, including a Plan change to regulate ill performing tanks.

Recent information on the effects of point-source discharges on the Taieri River is not available. In the case of discharges onto the Taieri Plain waterways, these discharges no doubt contribute to the *E.coli* levels exceeding Water Plan standards for 3 of the 5 sites monitored, including one site that recorded the highest *E.coli* level of 900 cfu/100ml

<sup>19</sup> <https://www.waternz.org.nz/WWTPInventory>

(Contour Channel at No.4 Bridge; Appendix 9). Prior to consent renewal of the Mosgiel wastewater treatment plant discharge into the lower Taieri River (c. 25 m downstream of the Silver Stream confluence), a study detected adverse effects of the discharge on the aquatic ecosystem, with reduced numbers of pollution sensitive instream invertebrates than sites upstream of the discharge. Agricultural runoff and subsurface drainage also contributed to higher nutrient levels below the discharge point (Ryder Consulting, March 1998). Wastewater from the Mosgiel plant is now screened, clarified and filtered before being pumped to the Green Island Wastewater Treatment Plant, where it is UV treated before being discharged to the ocean. The Middlemarch oxidation ponds treat the township's effluent through a wetland before being discharged into the bed of a dry oxbow of the Taieri River, downstream of the confluence with March Creek.

**Table 10** Data for 2018-2019 on discharges into freshwater over the Taieri Catchment; blanks indicate no data available e.g. Dunedin Airport. Data are from the Waste Water Treatment Plant website (WWTP).

| Site            | Treatment Level | Maximum consented discharge limit (m <sup>3</sup> ) | Volume treated (L) | Freshwater discharge | Land/Ocean application | Trade waste (%) | Method                  |
|-----------------|-----------------|---|--------------------|----------------------|------------------------|-----------------|-------------------------|
| Naseby          | Primary         | -   | 30,000             |                      | 100% Land              | 0.3             | Aerated lagoon          |
| Ranfurlly       | Tertiary        | -   | 146,297            | 100%                 |                        | 0.5             | Oxidation pond          |
| Waihola         | Primary         | 1020  | 36,724             | 100%                 |                        | 0.0             | Wetlands                |
| Middlemarch     | Primary         | 360   | 21,900             | 100%                 |                        | 0.0             | Oxidation pond; Wetland |
| Mosgiel         | Tertiary        | -   | 1,533,000          |                      | 100% Ocean             | 5%              | Clarifier; Filter       |
| Dunedin Airport | -               | -   | -                  | -                    | -                      | -               | -                       |

### ***Non-Point Source Discharges to Water***

The possible impacts of contaminants in runoff, erosion, drainage and leaching are becoming more pronounced in the Taieri catchment as irrigation and dairying have become more prevalent. The RPS Plan change 6A (Water Quality) sought to maintain or improve water quality, through control of contaminants discharging from rural land to water. Council notified proposed Plan Change 6A (Water Quality) on 31 March 2012 and released its decisions on 20 April 2013. In combination with Plan Change 6A, a series of factsheets<sup>20</sup> were produced that highlight the relevant rules in the Water Plan, and expected compliance actions required. Factsheets include: Sediment in water, Effluent Management, Stock access

<sup>20</sup> <https://www.orc.govt.nz/managing-our-environment/water/good-practice-information>



to waterways, Silage and compost, Bridges and culverts, Working in waterways and What is a River?

A recent literature review commissioned by ORC summarised activities and associated discharges commonly encountered over Otago region (Streamlined Environmental Limited, 2017), and Ryder Consulting (1995) provide an excellent overview of historic discharges over the lower Taieri catchment. Four contaminants commonly entering waterways include nitrogen, phosphorous, sediment and faecal bacteria (*E.coli*).

Runoff from “flood’ irrigation was identified as a major issue in the Gimmerburn area, in the Upper Taieri/Maniototo sub-catchment, and is responsible for degrading water quality and even reducing upstream flow (ORC, May 2006). Other streams studied in the same area, namely the Pig Burn and Sow Burn, showed less pronounced effects of the runoff (ORC, May 2006). In addition, water quality improvement at Waipiata was attributed to improved irrigation methods and efficiency, the fencing of an increasing number of waterways, better management of wetland complexes and better effluent management on dairy farms (ORC, 2010 State of the Environment Report, Surface Water).

Erosion is still a major problem in the Taieri catchment, some exacerbated by stock having access to waterways, and other causes more natural. For example, as the river naturally changes course, erosion can occur. The ORC have produced riparian planting guidelines for Coastal, Central, Upper Clutha, East and South East Otago stating that “planting native grasses, sedges, flaxes, shrubs and/or trees in riparian zones can improve the health of Otago’s waterways by filtering nutrients before they reach the water, including nitrogen, phosphorus and bacteria such as *E. coli*”<sup>20</sup>.” In addition, over the Strath Taieri catchment, ORC developed a Riparian Management Strategy in 2006 in an effort to promote riparian plantings rather than *ad hoc* gravel extraction to control erosion and loss of arable land (ORC, May 2016).

## 6. Conservation Values

The following sections summarise conservation values and threats/pressures in the Taieri catchment. Various definitions of “conservation value” exist (Capmourteres and Anand, 2016), so for the sake of clarity, we broadly define conservation values as areas of high biodiversity, and rare and uncommon native species, habitats, and ecosystems (as per Burrell, 2019 for the Rangitata River).

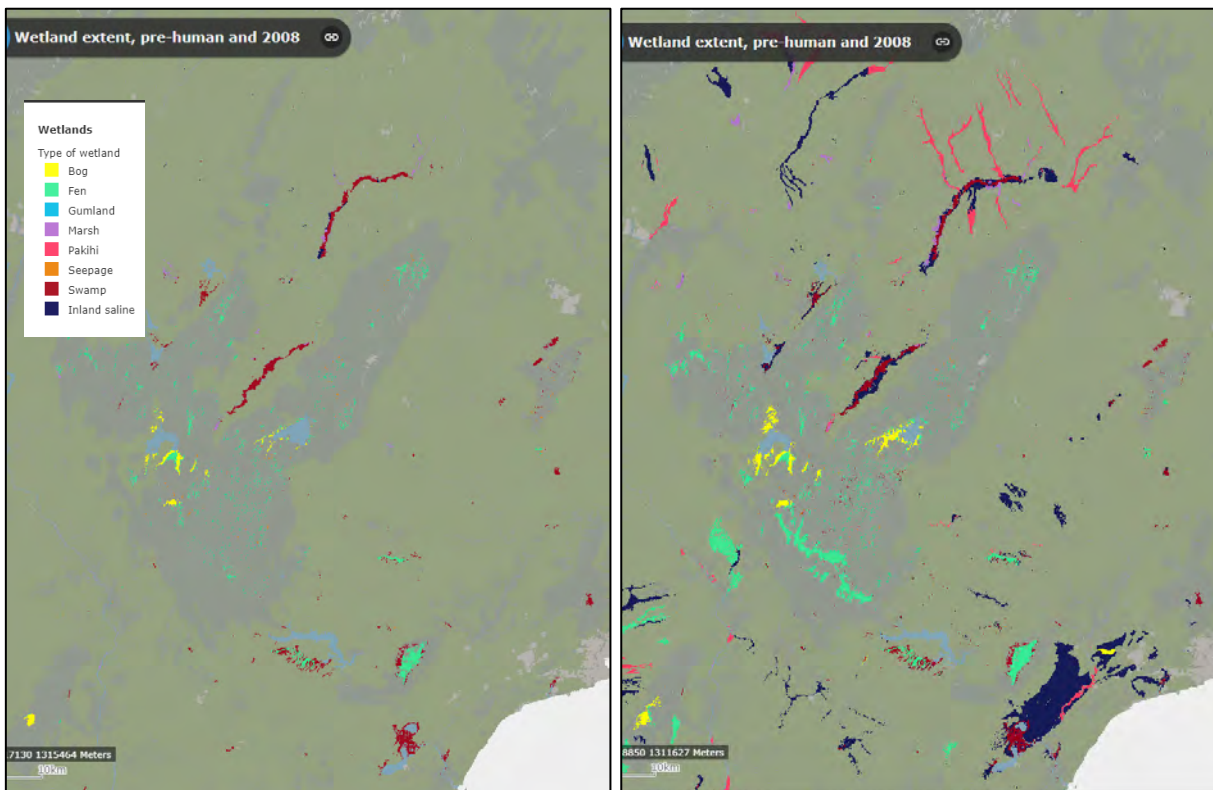
### Wetland Habitats

As noted in the catchment overview, the Taieri catchment has an immense coverage and diversity in wetland types with various hydrological systems. Wetlands of the catchment include those with inland saline, estuarine, riverine, lacustrine (associated with lakes) and palustrine (ocean derived) hydro systems<sup>21</sup>. Wetlands range from saltmarsh wetlands near to the Taieri Estuary, spring-fed streams on the Lammerlaw tops, salt pans of the Maniototo, ephemeral wetlands of the Strath Taieri, to extensive bogs and fens on the tops of the block mountains so characteristic of Otago (see Figure 3). The Lammerlaw Range wetlands are relied on for drinking water by residents of Dunedin city. Catchment-wide, high-altitude wetlands are important for sustaining summer stream flows, as well as being near-pristine ecosystems, worthy of protection. Wetland landscapes are valuable sanctuaries for wildlife, provide mahika kai for Kāi Tahu, and provide important ecosystem services such as improved water quality, flood mitigation and carbon sequestration (e.g. Clarkson *et al.* 2013).

Wetlands are also recognised nationally through multiple statutes and associated policy documents, for example, they are considered National Priorities for Protection (Ministry for the Environment, 2007), are recognised as being heavily reduced in extent with an ongoing negative trend in Te Mana o Te Taiao - Aotearoa New Zealand Biodiversity Strategy (ANZBS) 2020 (especially lowland wetlands and peat bogs) and are recognised in the RMA (1991) and its planning tools including multiple National Policy Statements and National Environment Standards. For example, some Taieri catchment wetland types (e.g. ephemeral wetlands, cushion bogs, lake margins, inland saline or salt pans, domed bogs, snow banks, string mires, tarns, seepages and flushes) have also been identified as historically uncommon or rare ecosystems. Nationally, only 8.8 % of inland saline wetlands are within protected areas (Biodiversity in Aotearoa 2020). Wetlands are also identified locally as priority habitats for protection, through the Otago RPS and Clutha/Waitaki/Dunedin City and Central Otago District Plans, all of which have jurisdiction over parts of the Taieri catchment (see Section 2).

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<sup>21</sup> Using terminology of Johnson and Gerbeaux, 2004. Wetland Types in New Zealand.



**Figure 9** Overview of pre-human (left) and 2008 mapped wetlands over the Taieri catchment showing a dramatic loss in saline wetlands, swamps and fens. Source: <http://statsnz.maps.arcgis.com/apps/weappviewer/index.html?id=86427d29e8334e5f908fdf7e76954872>

### **Wetland Loss**

Much wetland habitat has been altered (drained) or otherwise destroyed over the Taieri catchment, with substantial historical draining of the Taieri Plain in particular to allow for farm intensification. The FENZ index of wetland condition (overall index of integrity from completely degraded: 0 to pristine: 1) has a mean value for all wetlands in the catchment of 0.715 (range: 0.203 – 0.969) which indicates moderate levels of impact over the Taieri catchment wetlands (statistics cited in Skelton, 2019). It is estimated the Taieri catchment has a total 9,802 ha of wetlands (FENZ database; Figure 3), but historically, wetland extent totalled 34,126 ha. This represents a 71 % loss of wetland extent throughout the catchment (see Figure 8). Moreover, the mapped extent of Taieri catchment wetlands in FENZ, and elsewhere (e.g. ORC wetland layers being prepared) is likely to be an underestimate of the true amount of wetland habitat (Dr Peter N. Johnson, Landcare Research, pers. comm. June 2020). Only a portion of the Taieri catchment wetlands are identified as Regionally Significant wetlands (see Appendix 5), and of those, much of the surrounding vegetation has not been included in the mapping of wetland extent. This means the vegetation so vital in maintaining a buffer from land development and for maintaining the hydrological integrity of the wetland systems, is not protected. In addition, large areas of land surrounding some Taieri catchment wetlands (including Regionally Significant wetlands) is planted in plantation forestry that is still continuing to increase in the catchment (see Section 4). Plantation forestry can adversely affect wetlands by compromising their hydrology, and with that, the ability for some values to persist (see Davie *et al.* 2006).

At least three large wetlands, important to Kāi Tahu, have been lost over the Taieri catchment to make way for agriculture. Lake Taieri on the Maniototo was drained in the 1940s, and Kāi Tahu retain an active interest in restoring this Lake (see Section 8). Part of the lake-bed is public conservation land meaning a partnership project has much potential over this site. Lakes Tatawai and Marama Te Taha (Loch. Ascog), both situated on the lower Taieri Plains and once continuous with the Lake Waipori/Waihola wetland complex, were drained soon after European settlement. These areas are now on private land and the loss of these Lakes and their associated wetlands is clearly shown in the lower right of both images in Figure 9. Lake Tatawai is identified in Schedule 1D ‘Māori Land Reserves’ of the Otago RPS as a “native reserve”.

Perhaps the most controversial example of loss of significant wetland habitat in more recent times, relates to the loss of large areas of the Great Moss Swamp (now also known the Loganburn Reservoir), Rock and Pillar Range. Part of the Great Moss Swamp was flooded in the 1980’s to form the Loganburn Reservoir. There is ongoing pressure to raise the reservoir even further, and based on a recent newspaper article, the latest proposal is to raise the reservoir by 0.7 m to increase water storage capacity and physically divert high flows from two headwater streams of the Sutton Stream into the Loganburn reservoir<sup>22</sup>. For farmers of the Strath Taieri, this would increase the reliability of the current 1500 ha of irrigation operations and enable the expansion of irrigated areas by about 2000 ha. Water from this proposed scheme would also add electricity generation capacity through the at Paerau and Patearoa Power Stations. One of the affected streams, Burgan Stream, has very important lizard values in the riparian habitat.

### **Scroll Plain**

Some New Zealand wetlands are recognised internationally (reflected in the Ramsar Convention<sup>23</sup>) and, although not a Ramsar wetland, the upper Taieri scroll plain situated between the between the Kye Burn Confluence and Canadian Flat on the Taieri River, is thought to be one of the world’s most significant examples of this wetland type. The entire complex is also one of the largest freshwater wetlands in New Zealand. Most of the wetland is in private ownership, although several areas have been set aside for the protection of conservation values as covenanted and areas of public conservation land (Barkla *et al.* 2003; Rance, 2019). Frequent and prolonged high river flows inundate the flood plain creating multiple wetland types, themselves providing habitat for a diverse range of biodiversity. Throughout the flood plain, the following wetland features have been described: ox-bows, old braiding’s, backwaters, cut-offs, permanent shallow marshy areas & ponds, and temporary shallow marshy areas (Barkla *et al.* 2003.).

Although surrounded by farmed land, including deer and dairy, the upper reaches of the scroll plain still retain their characteristic wiggly patterns, thought to have been created by the flick of a taniwha tail in Māori folklore. The wetlands also play an important role in moderating water quality of the Taieri River, by biologically treating water from runoff from surrounding agricultural land. The wetland’s naturally fertile shallow waters provide a rich

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<sup>22</sup> <https://www.odt.co.nz/rural-life/rural-life-other/strath-taieri-new-food-bowl-dunedin>

<sup>23</sup> There are no Ramsar wetlands in the Taieri catchment; see <https://rsis.ramsar.org>

food supply for waterfowl. Dense vegetation, often close to water, provides good breeding habitat for ducks, while large bodies of open water are ideal for moulting waterfowl. Conservation values listed include being a breeding centre for the paradise shelduck population in the Otago region, with flocks exceeding 1000 birds common throughout the area during January/February (Grove, 1994). The wetlands are also used for up to 52 other birds' species, including migratory species and sedentary rare species such as bittern, marsh crakes and pukeko (Grove, 1994).

The scroll plain also supports multiple threatened plant species, such as *Lepidium sisymbrioides*, mousetail (*Myosurus minimus subsp. novae-zelandiae*), *Carex tenuiculmis* and *Deschampsia cespitosa* (Appendix 7). Salt pans and other areas of saline soils naturally occur on the Maniototo part of the scroll plain. These rare ecological areas contain a range of unique salt tolerating plants (see Plants and Weeds, below). Some of these specialised plants are endemic to Central Otago and are found nowhere else in the world. The Upper Taieri River also contains a regionally significant brown trout fishery. Native fish in the main river include long-fin eel, common bully and lamprey. Two unique species of non-migratory galaxiids are present in tributaries like the Eweburn, Linnburn and Totara Creek. These small native fish have suffered from trout predation and habitat modification, and persist only in small fragmented populations (ORC, undated).

Although the Upper Taieri River Scroll Plain is an internationally important waterfowl habitat, one of the ten most valuable in New Zealand (see Barkla *et al.* 2003; Rance, 2019 for the latest ecological assessments), there are no recent documented sightings of the rarest bird species such as Australasian bittern (see Rance, 2019).

### **Waipori/Waihola Wetland Complex**

Another nationally important wetland in the Taieri catchment is the c. 640 ha Waipori/Waihola Wetland Complex (classified as swamp) that includes the 315.4 ha Sinclair wetlands, and the Titri wetlands. In terms of biodiversity and conservation values, the wetland complex is extremely important habitat for native fish, wetland vegetation, and many species of birds (ORC, November 1999). The Waipori/Waihola Wetland complex is the largest wetland in Otago, and is covered by a Statutory Acknowledgement, an acknowledgement by the Crown that recognises the mana of a tangata whenua group in relation to specified areas - particularly the cultural, spiritual, historical and traditional associations with an area. The wetland complex was once one of the most significant food baskets in Otago for local communities (along with the lost lakes of Lake Tatawai and Marama Te Taha (Ausseil *et al.* 2008; and Cromarty and Scott, 1995).

The Waipori/Waihola Wetland Complex has complicated land ownership that includes land administered by the Department of Conservation as Wildlife Management Reserve (e.g. McClaren's Reserve and Gillander's Reserves and marginal strip (see Figure 2), lake beds (860 ha) and 640 ha of swampland that are vested in the Otago Regional Council as an endowment of the Taieri River Improvement Act 1920, 35 ha of islands in the northern end of Lake Waihola are also vested in the Otago Regional Council, small areas that are unalienated Crown land and leasehold Crown land (59 ha), and the 315.4 ha Sinclair wetlands, that are protected by a QEII covenant and have Wildlife Refuge status (see map in ref#214). A draft management statement for the Waipori/Waihola Wetland Complex was

produced by DOC in late 1996. The wetland's conservation values and related management issues were summarised in this document, and in ref#212. These two documents were not able to be sourced for this review.

### ***Existing Wetland Restoration Projects***

There have been little restoration activity focussed at wetland habitat over the catchment; exceptions include the Te Nohoaka o Tukiauau/ Sinclair Wetlands in the Waipori/Waihola sub-catchment. The catchment has undergone weed control and planting by the Sinclair Wetland Trust and supporters that include Te Rūnanga o Ngāi Tahu, the local Te Rūnanga o Ōtāko, and the Lake Waihola Waipori Wetlands Society.<sup>24</sup>

Another restoration example is the Takitakitoa Swamp, a large (63.73 ha) regionally significant valley-floor wetland is located on the true left of the Taieri River, surrounded by plantation forestry. The wetland receives waters from Surprise Stream, and most of the wetland is owned and administered by Otago Fish and Game Council. Approximately 10 ha of the wetland is owned by a Māori trust, and a small area is owned by City Forests Ltd, a subsidiary of Dunedin City Council. Indigenous vegetation values are low, and some woody weeds are present (Rate, 2011). Fish and Game have restored (re-flooded) c. 80 ha of the wetland, near Henley, that was drained in the 1960s, by installing a 400 m-long, 1 m high bund about 400 m from the Taieri River to create 30 ha of shallow, open-water wetland. This area of the wetland has allowed some native plant species to flourish and has created a habitat for dabbling ducks for nesting and brood rearing, and an ideal hunting area for novice and junior duck hunters. The bund has also meant that the area retains more water over Summer, allowing bird species to flourish and frequent the area. A drainage culvert was also installed with a fish ladder, but some impediments to indigenous fish passage remain (Rate, 2011).

### **River Habitats**

As noted above in the catchment overview Section 4, the Taieri River receives water from 8 major tributaries: Waipori River, Deep Stream, Lee Stream, Silver Stream, Sutton Stream, Nenthorn Stream, Kye Burn, and the Loganburn. The ORC Water Plan, DCC 2GP and various District Plans lists conservation values for all of these rivers/streams and many of their tributaries (see Appendix 4).

#### ***Waipori River***

The hydrology of the Waipori River which joins the Taieri River at Henley, is strongly influenced by Lake Mahinerangi inflows, and the operation of the Waipori Hydro-electric Power Scheme (WHEPS). The river is somewhat compartmentalised by the 4 dams, with multiple sections of the river having distinct river/reservoir characteristics that are reflected in the fauna present. Water quality is considered high, and the river has a very high diversity of indigenous fish species present, some of which are protected from salmonid predation by the dam structures (Trustpower 2004; Ryder Consulting, March 2001). The dams are a barrier to eel and other migratory fish.

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<sup>24</sup> <https://www.tenohoaka.org.nz/our-culture/vision-and-values/>

### **Deep Stream**

Deep Stream provides 80 % of drinking water to Dunedin city, and originates in tussock-clad public conservation land – Te Papanui Conservation Park. Trustpower run the Deep Stream Hydro Scheme, which channels water flowing from an existing Deep Stream diversion, impounds that water in a storage reservoir, and then allows the water to be released through canals containing two 2.5MW power stations to Lake Mahinerangi. Water quality is monitored regularly by ORC, and is considered good, and Deep Stream and its tributaries, including the small headwater streams, provide habitat for rare indigenous fish, including Taieri flathead galaxias, *Galaxias depressiceps*.

### **Lee Stream**

Lee Stream is located on the north to north-east side of Lake Mahinerangi and to the south-east of the Lammermoor Range and drains an area of 176 km<sup>2</sup> generally flowing south-eastwards to enter the Taieri River about 5 km upstream of Outram. Lee Stream and its main tributaries, Black Rock Stream, Broad Stream, Canton Stream and Fortification Stream are located within steeply rolling exotic pasture lands (elevation approximately 400m). There have been historic proposals by Trustpower to move water from Lee Stream, into Lake Mahinerangi to improve efficiency of the Waipori Hydro-electric Power Scheme. Such schemes have not eventuated.

### **Silver Stream**

Silver Stream, known in Māori as Whakaehu, originates in the Silverpeaks and reaches the Taieri River two kilometres north of Allanton. Its total length is about 30 kilometres. In the upper Silver Stream catchment, above the Taieri Plain, vegetation over much of the area is native bush and scrub with tussock at higher elevations. A substantial area of the catchment is planted in exotic forest. The lower catchment is dominated by pastoral and urban land. There are four separate DCC water supply abstractions in the Silver Stream catchment. These include Silver Stream at the 'Pumping Station', McQuilkans Creek, Sligos Creek and McKenzies Creek (Whare Creek). All water from this catchment is piped to the Southern Reservoir where it is treated and then distributed to various parts of Dunedin City.

Silver Stream is the site of a historic water race, finally abandoned in the 1960s. The river's flow is generally sluggish, and water quality is poor (see Section 5).

### **Sutton Stream**

Sutton Stream flows into the Strath Taieri and joins the Taieri River just upstream of Matarae. It has an approximate catchment area of 58.8 km<sup>2</sup>. The catchment is rugged and incised, and the stream bed is comprised of bedrock and boulders with lesser amounts of cobbles and gravels (Ryder Consulting, August 2006). Bedrock in the catchment is made up almost entirely of schist. An overview of land management in the Sutton Stream catchment is provided by Young *et al.* (1994).

There have been recent proposals made by the Strath Taieri Irrigation Company to move water from two tributaries of Sutton Stream (Stony Stream and Burgan Stream) into the Logan Burn, for release down the Taieri River. Water quality is best in the higher reaches that have a mainly tussock riparian cover.

### ***Nenthorn Stream***

Nenthorn Stream drains upland areas of the eastern Strath Taieri hill country, an area with a long history of gold mining. The Nenthorn stream joins the Taieri River near Pukerangi, and little is known of its instream habitat; except that it provides habitat for koura (Whitmore *et al.* 2000). The stream is sluggish in parts, and during summer-drought, can be reduced to bedrock platforms with isolated pools. Nenthorn Stream with its castle-like schist rock tors, is best known for its rare skink species and high lizard diversity, and presence of rare plants, such as *Simplicia laxa* (Bibby, 1997).

### ***Kye Burn***

The modern Kye Burn River drains the greywacke Mountains to the north of Otago, making it unique amongst the main tributaries of the Taieri River. The Kye Burn had an ancestral path that drained into the Clutha River, a path long-since blocked off with the rising of the Otago block mountains, especially the Lammerlaw/Lammermoor's. The Kye Burn is considered a naturally turbid stream, receiving water from unstable sediments, for example, from Timber Creek (Olsen, 2003). Instream habitat of the Key Burn is variable with ponds and riffles forming over a predominately gravel base (Olsen, 2003). An overview of land management in the Kye Burn Stream catchment is provided by Young *et al.* (1994), and current land use for the catchment is available on the LAWA website.

### ***Logan Burn***

The Logan Burn drains the Rock and Pillar Range and enters the Taieri River through the scroll plain above Paerau. As noted elsewhere, the hydrology of the Logan Burn has been modified by the damming upstream that formed the Loganburn Reservoir, and the stream has been subject to recent proposals to receive diverted water from Sutton Stream.

## **Lakes**

### ***Lake Waihola & Lake Waipori***

Lakes Waihola and Waipori are described as riverine or swamp lakes, and both have a heavy tidal influence. The lakes are shallow and drain through an extensive swamp into the Waipori River then the Taieri River. The swampland includes vegetated islands, lagoons, shallow pools, meandering channels and back swamps creating a variety of habitats for swamp, waterfowl and wading birds. Areas of shrubland and tree land provides additional habitat for a variety of local forest bird species.

### ***Sutton Salt Lake***

Sutton Salt Lake is a shallow inland Salt Lake, that can completely dry up during summer. The lake is on public conservation land and is New Zealand's only inland Salt lake. The lake has been identified as a priority ecosystem unit (Otago CMS, 2016). The lake supports saline soils and flora and fauna adapted to them. A record of the Central Otago roundhead galaxias has been recorded from the lake (Ausseil *et al.* 2008).

### ***Lake Mahinerangi***

Lake Mahinerangi is an artificial lake formed behind a dam on the Waipori River. The lake is drawn down for power generation that exposes large areas of bare littoral zones. Intensive efforts have been made to establish brown and rainbow trout populations, and now perch



are also common in the lake making it a popular fishing lake. The lake is rather barren, compared to other South Island hydro-lakes, being low in terms of macrophyte and invertebrate diversity (Ryder Consulting, 2000). This may be related to the extensive removal of organic overburden associated with historic goldmining that dominated the area prior to the construction of the Mahinerangi dam.

### ***The Lost Lakes***

At least three large Lakes of the Taieri catchment, all important to Kāi Tahu, have been lost over time to make way for agriculture. Lake Taieri on the Maniototo was drained in the 1940s, and Lakes Tatawai and Marama Te Taha (Loch Ascog), both situated on the lower Taieri Plains were drained soon after European settlement (see Wetland Habitats above).

## **Fish**

The Taieri River catchment contains a diverse fish fauna made up of 18 indigenous and native species, and 5 sport fishes (see Appendix 10; Figures 9-13). The diversity of indigenous and native species is due both to the diversity of habitats available and the geological history of the catchment. Current distributions of non-migratory galaxiid fish species, for example, indicate they have speciated in line with the evolution of the Taieri River landscape (McDowall, 2006). Of the 18 indigenous/native fishes, some must migrate to sea for part of their life-cycle, and these return as “whitebait” or “glass eels”, while others never migrate (the so-called non-migratory or non-diadromous species), and a few species can migrate, but are also known to form land-locked populations (e.g. giant kokopu *Galaxias argenteus* in Lake Waihola (Chadderton, 2004; Table 11). An assessment of fish barriers in 6 tributaries of the Taieri River catchment can be found in Dungey, 2005 - this report scores barriers against the ‘DOC barrier schedule’ (Dungey, 2005).

The indigenous/native species occupy a range of national threat classifications from “not threatened”, e.g. the common bully, to the second highest threat classification in New Zealand, “threatened – nationally vulnerable” for multiple non-migratory galaxiid species, and lamprey (Table 11). Fishes occupying the highest threat classifications span both non-migratory and migratory species (Table 11). The major threats to the Taieri catchments most threatened galaxiids, are detailed on the DOC website<sup>25</sup>.

### ***Non-Migratory Galaxiids***

Four of the most threatened<sup>26</sup> indigenous/native fishes of the Taieri catchment include non-migratory species (Eldon’s, dusky, Central Otago roundhead, and Taieri flathead galaxias) (Table 11). These species are generally found in the upper Taieri catchment, in small tributaries and headwater streams of the Taieri, above waterfalls and other impediments to salmonids (Allibone and Barrier, 2004). These species are endemic to the Otago region, and there is much information on the life history and ecology of these species (e.g. Allibone and Barrier, 2004 and references therein). The security of all four of the species in the Taieri catchment is an ongoing concern, with some sub-populations going extinct. The

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<sup>25</sup> <https://www.doc.govt.nz/nature/native-animals/freshwater-fish/non-migratory-galaxiids/>

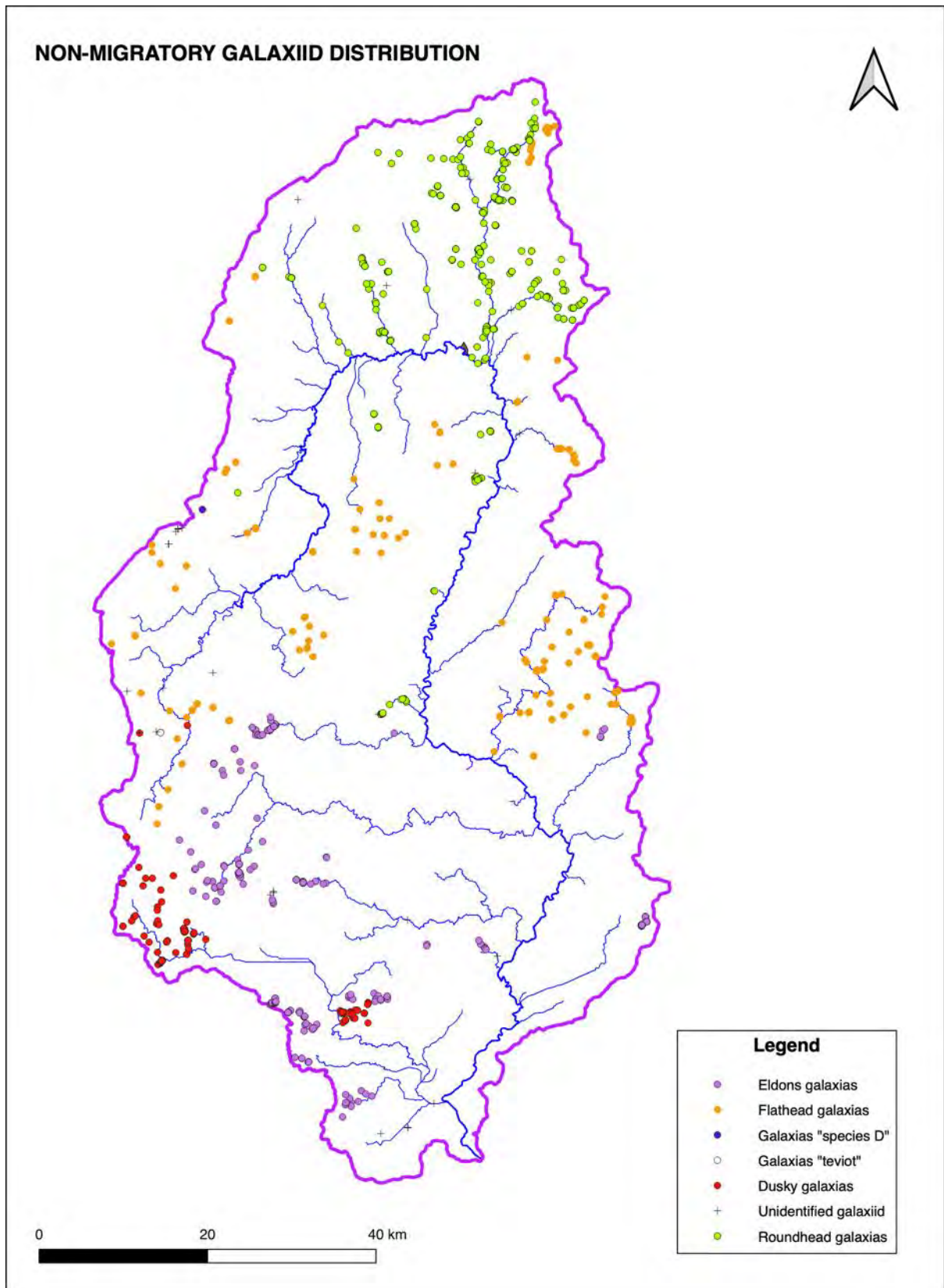
<sup>26</sup> As per Dunn *et al.* 2018.

documented environmental threats and pressures are common to all four species and include:

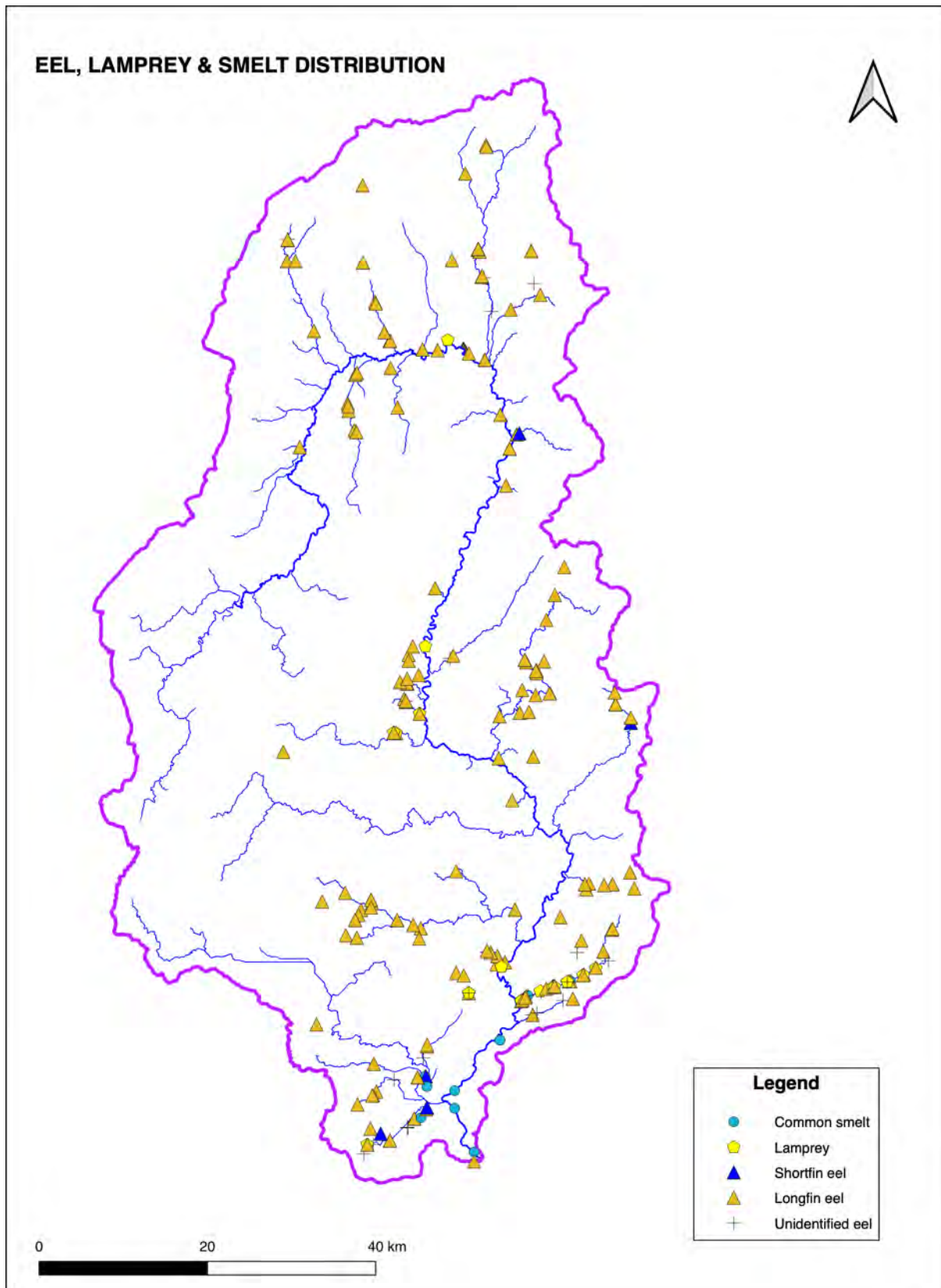
- Trout predation<sup>27</sup> and/or trout competition (review in McIntosh *et al.* 2010);
- Small area of occupancy (see Figures 10-14) that has led to population fragmentation and may eventually led to associated genetic dysfunction (Allibone and Barrier, 2004; Townsend and Crowl, 1991);
- Moderated river flows by hydro schemes/pumps and abstraction for irrigation that has multiple adverse impacts that are exacerbated by drought (Allibone, 2000);
- Water abstraction allowing the passage of fish to new areas via water races that transfer water from one stream to another (McDowell and Allibone, 1994); this can lead to heightened predation and even hybridization (Esa *et al.* 2000);
- Reduction of native vegetation, including riparian vegetation, through land development and fire resulting in increased stream temperatures and displacement (Allibone and Townsend, 1997);
- Deterioration in water quality, potentially affecting preferred food of stoneflies and mayflies (Allibone and Barrier, 2004 and references therein).
- Plantation forestry causing sedimentation when harvested, and affecting catchment hydrology leading to decreased summer flows and degraded spawning habitat (NIWA, June 2005);
- Stock access to streams increasing sedimentation & reducing or modifying habitat available for spawning (Allibone and Barrier, 2004 and references therein); and
- Inundation and loss of habitat from impoundment of water through creation of new dams or increasing water levels of existing dams (e.g. Closs *et al.* 2006).

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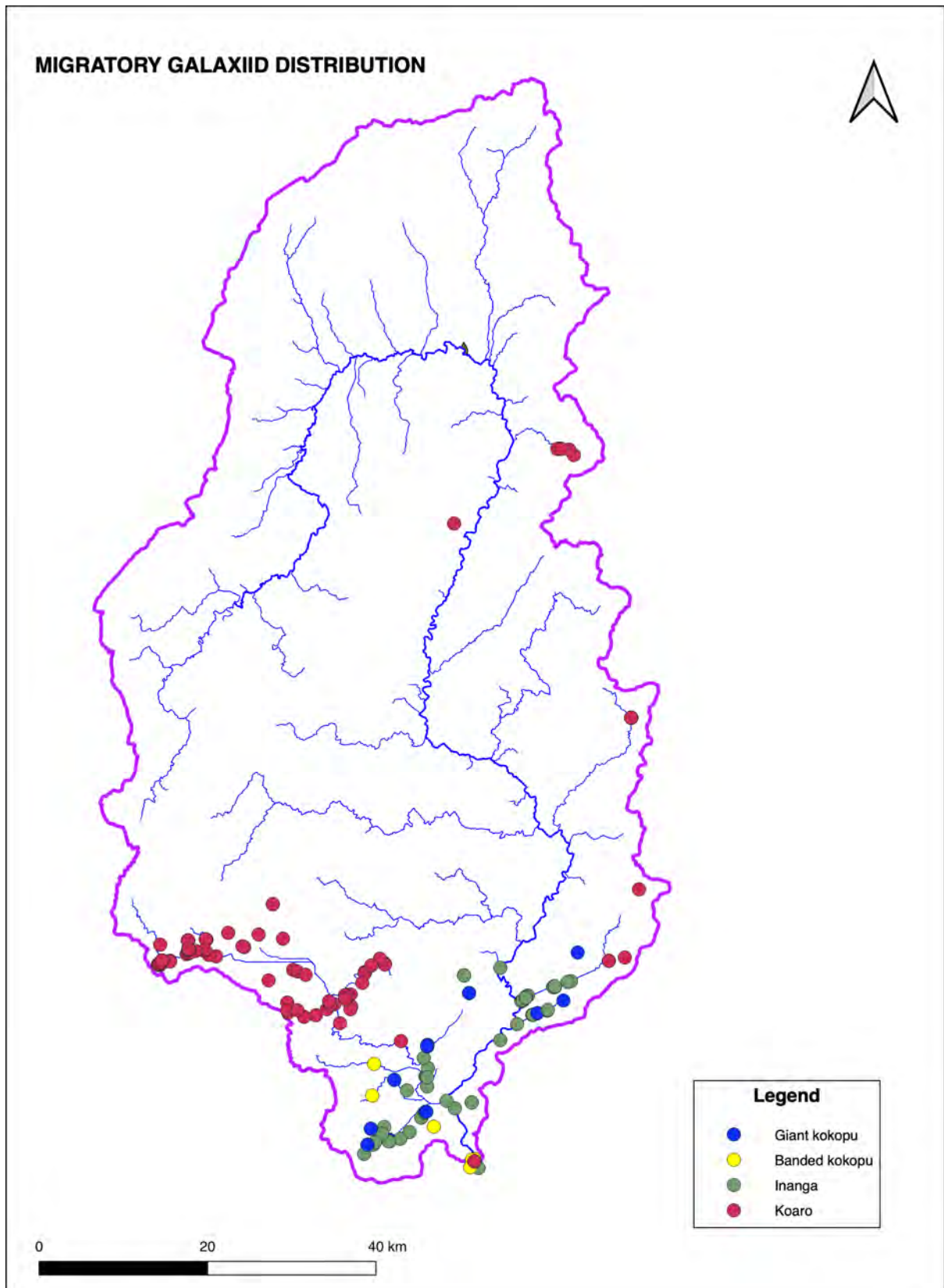
<sup>27</sup>Brown trout is the most commonly implicated species, but brook char and, occasionally, rainbow trout (*Oncorhynchus mykiss*) are also implicated. Ref#256



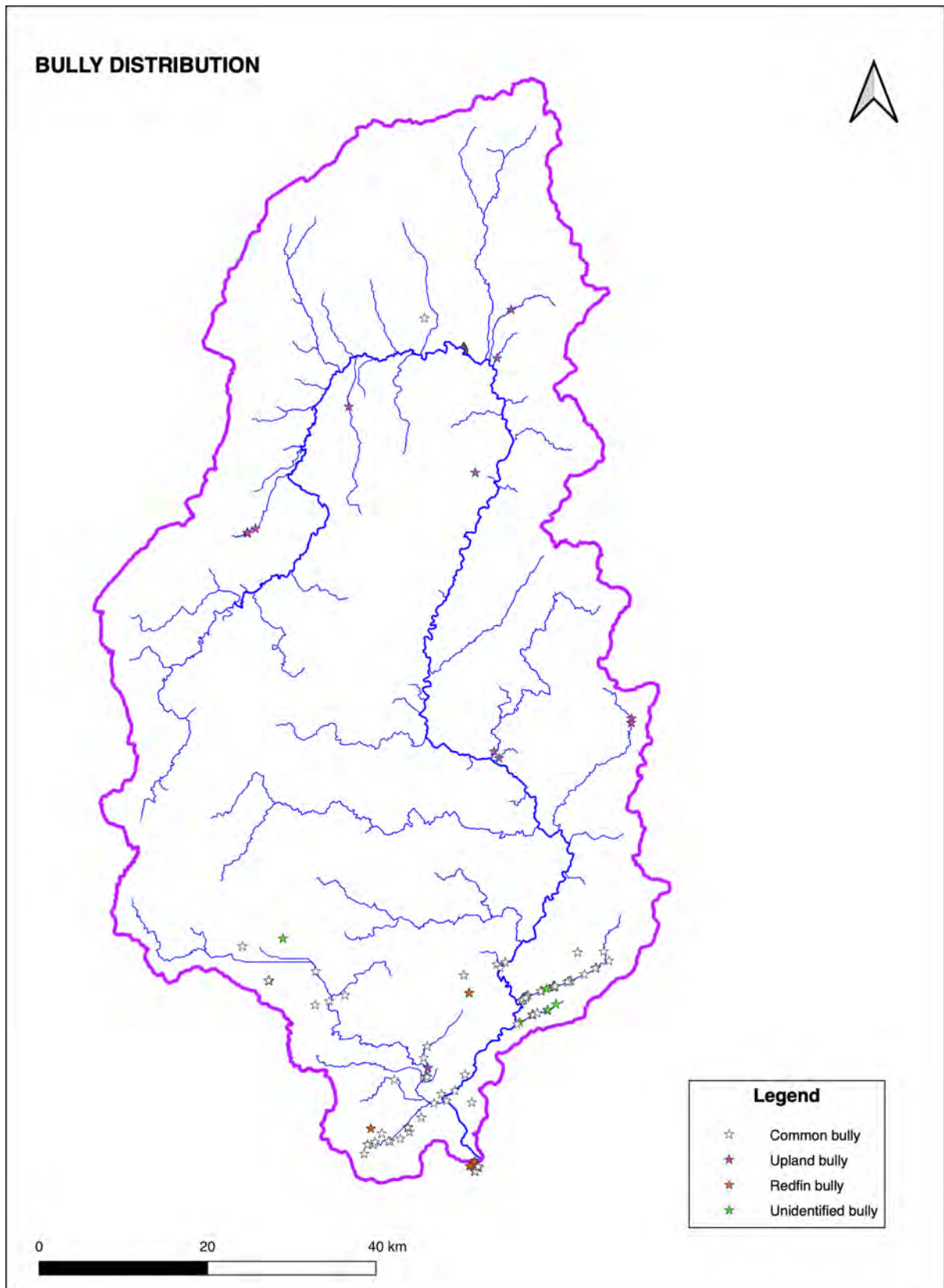
**Figure 9** Records for non-migratory galaxias species distribution (freshwater fisheries database).



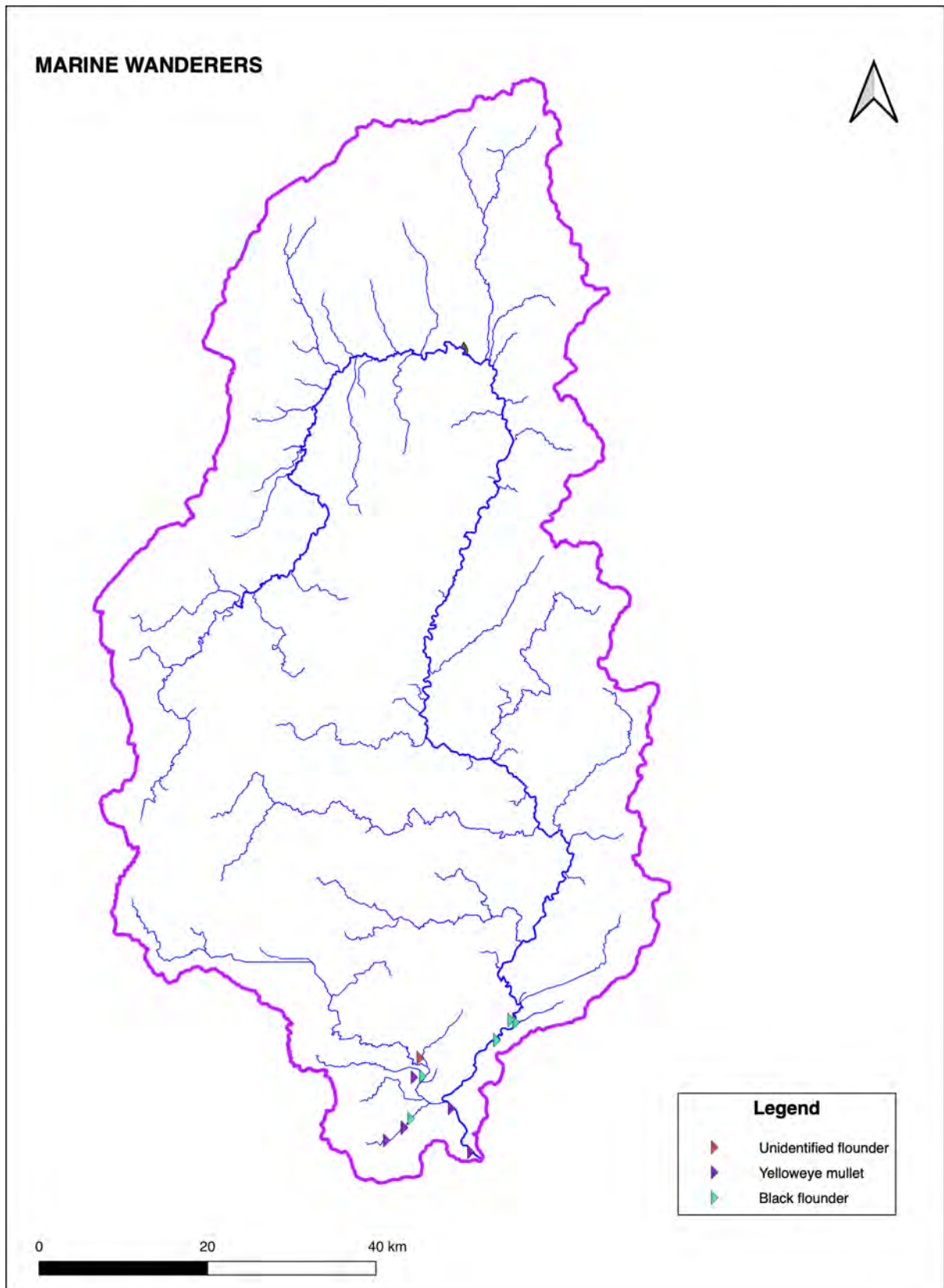
**Figure 10** Records for eel, lamprey and smelt species distribution (freshwater fisheries database).



**Figure 11** Records for migratory galaxias species distribution (freshwater fisheries database).



**Figure 12** Records for bully species distribution (freshwater fisheries database).



**Figure 13** Records for marine wanderers (freshwater fisheries database).

The effects of these threats and pressures differs across species, life-stages and habitats occupied. For some species and life-stages, the significance of some of these effects remains largely undocumented (e.g. climate change; see knowledge gaps below). An early attempt to separate out the impacts of trout from land use changes, on resident galaxias species, is still considered a landmark study (Townsend and Crowl, 1991). Since this study, however, it is now known that some non-migratory species, for example, Central Otago roundhead galaxias, can co-exist with trout in some larger river habitats (Baker *et al.* 2003). How exactly these species can coexist with trout, and whether instream manipulations can be carried out to allow greater coexistence, is a research gap (see below). At present, natural barriers to salmonids such as natural waterfalls in Stony Creek, in the Mahinerangi sub-catchment protect populations of Eldon's galaxias. However, there are concerns that any alteration in the flow regime may cause the barrier to fail (Ryder Consulting, August 2006). Climate change could also result in changes to flows that allow salmonids to colonise smaller streams (McIntosh *et al.* 2010).

A notable feature of the 4 non-migratory species is the range in life history traits across species; for example, longevity varies from 4 years in Central Otago roundhead galaxias to 20 years in dusky galaxias indicating a spectrum of 'r' versus 'k' life-history traits exists, that could be contributing to declines (Table 11). The work of McDowall (2010), and others, indicates non-migratory species tend to be r-selected, but the range in longevity estimates shown below indicate more work could be done on this aspect of their biology. Climate change effects is an emerging threat and may impact on non-migratory galaxiids in multiple ways e.g. by allowing extension in the range of existing predators.

### ***Migratory Fish Species***

#### **Lamprey (kanakana)**

The nationally vulnerable kanakana, or lamprey, are a widespread species outside Otago, and are an important fish species for Kāi Tahu. Kanakana are still harvested along with eels in the Lake Waipori/Waihola wetland complex. Records of lamprey in the Taieri catchment are sporadic, with most records in the lower catchment (e.g. Waipori River and Silver Stream), however, records also exist in the upper Taieri scroll plain (Closs *et al.* 2006; Ryder Consulting, August 2006). The life history, ecology and cultural significance of this species has been the subject of a review (James, 2008), but little is known on the distribution of kanakana life stages, their habitat requirements and the associated threats within the Taieri catchment (see Appendix 10 for additional threats), however, barriers to fish passage could be a problem. Overseas literature indicates lamprey are sensitive to degraded water quality and sedimentation. They have been reported as "common" in the Waipori/Waihola Wetland Complex (Ryder Consulting, 1995), an area of the catchment with well documented issues with both sedimentation and water quality.

The Regional Plan: Water for Otago Schedule 1A lists natural values of the Otago regions Lakes and streams; Silver Stream; the Taieri River upstream of Tiroiti; Taieri River between Tiroiti and Pukerangi and Taieri River between Pukerangi and Outram are listed as a significant (under Section 6c of the RMA, 1991), habitat for lamprey (Appendix 4).



## **Longfin eels**

Longfin eels are classified as ‘At Risk – Declining’ in the New Zealand Threat Classification System (Dunn et al. 2018), and are important mahika kai for Kāi Tahu, but are not listed as taoka species (Otago CMS, 2016; Kāi Tahu, 2005). The DOC website summarises threats and pressures faced by longfin eels, nationwide, all of which are present in the Taieri catchment. Pressures to eel include overfishing; habitat loss; continuing degradation of habitat, especially in lowland areas; and on-going issues with fish passage (both upstream and downstream) due to culverts and dams. Declines in water quality are thought to have resulted in the shortfin eel occupying habitat formerly held the longfin eel; this effect is thought to be more pronounced in the lowlands where shortfin/longfin eel coexist (longfin eels are able to penetrate further inland as they are better climbers).

The Otago CMS (2016) highlights iwi concerns about larger eels being removed and have asked for a ban on commercial eeling in the past (Ryder Consulting, March 1998). The latest fish threat classification document, however, suggests abundance of the longfin eel may be stable or increasing in commercial fisheries, and that new Total Allowable Commercial Catch limits in the South Island should further decrease pressure on populations (Dunn *et al.* 2018). Moreover, this same document indicates public perception of declines in longfin eels, does not match available population data. The lower reaches of the Taieri River support an important longfin eel fishery, including 2-3 commercial eelers (Ryder Consulting, March 1998) one of the largest in New Zealand (Ryder Consulting, August 2006). Eels have unimpeded access to the upper Taieri River and its tributaries as there are elver passes in place, for examples, on the Pareau Weir. The Taieri plains drainage and pumping systems create barriers to eel passage, and a review of such barriers is recommended.

Longfin eels are a long-lived and slow growing species, displaying r-selected life history traits making them vulnerable fishing pressure (they take many years to reach maturity). The high fat content of eels together with their feeding behaviour and longevity, also makes them vulnerable to bioaccumulation of heavy metal and organic contaminants, a potential risk to those who eat them. Given the status of longfin eels as mahiki kai, and the land use history of the Taieri Plain which includes historic wood processing plants and tanneries; an examination of heavy metal loading of river and stream sediments, and indeed the fish themselves, is well justified (Collier *et al.* 2017 provides a useful review).

## **Whitebait species (kōaro, inanga, giant kokopu, shortjaw kokopu & banded kokopu)**

These four species, a mix of ‘At Risk’ and ‘Not Threatened’ species, are considered together here as they all share similar life histories and collectively form the whitebait group in the Taieri catchment. These species, except inanga, were the subject of an expired DOC Recovery Plan, presumably because they were perceived to share similar threats and pressures (DOC, June 2005) and broadly share a similar range (Figure 11). Banded kokopu occupy the lower reaches of the Taieri River and Waipori River preferring well vegetated, boulder forest streams. The most significant known population of banded kokopu occurs in Picnic Gully at Taieri Mouth (Closs *et al.* 2006).

The large galaxiid recovery plan, and primary references therein indicates the immediate threat to whitebait species occurs over “areas of intensively utilised lowland plains”, such as

the Taieri Plains (DOC, June 2005). The Waipori-Waihola wetland complex forms part of the greater Taieri plains area and provides important habitat for threatened indigenous fish species including a breeding population of the giant kokopu (*Galaxias argenteus*) and multiple whitebait species (see Appendix 4). Water quality and sedimentation, however, are ongoing pressures over the wetlands. The lower Taieri River also supports an active whitebait fishery, the effects of which on Taieri fish communities are not well documented<sup>28</sup>. Inanga form the bulk of the annual whitebait run and are abundant within the lower Taieri and Waipori Rivers and the Waihola/Waipori wetland complex (Closs *et al.* 2006).

Giant Kokopu, a toaka species, are nationally 'at risk declining', and this species has been shown to form land-locked populations in the Taieri catchment, over the Waipori-Waihola wetland complex. This flexibility in life history is presumably a useful trait for a species living in streams and lakes of the Taieri Plains. Closs *et al.* 2006 listed Alex Stream (tributary of Lake Waihola) as critical for protection, as it may act as a source of recruitment of giant kokopu to the rest of the catchment. . Koaro are abundant within the tributary streams of Lake Mahinerangi where a landlocked population exists due to river impoundment by the dam. They are also present within many small streams draining into the lower Taieri catchment (Closs *et al.* 2006). The presence of landlocked populations highlights a possible opportunity to manage key pressures to species over areas of the Taieri Plains where known source populations are e.g. through the exclusion of trout or other predators.

Other threats cited for the Taieri whitebait species, include removal of forest habitat around their preferred streams, damage by stock and spread of riparian pest plants (e.g. crack willow and *Glyceria maxima*) to spawning sites, barriers to fish passage such as dams, weirs, pump stations and culverts (due to migratory lifecycle), loss of wetland habitat, and the potential threat of invasive fish species such as koi carp and *Gambusia affinis* (DOC, June 2005; Bowie, 2002). DOC have raised specific concerns about the presence of flood gates, weirs and culverts, citing they are an impediment to fish passage, restricting the distribution of some species of native fish within and outside of the Waipori-Waihola wetland complex (DOC, undated). Whitebait species do, however, have unimpeded access to the Taieri and Waipori River and Pacific Ocean from Lake Waihola (Chadderton, 2004).

Barriers to whitebait fish passage are, therefore, perhaps most relevant over the Taieri Plains, given the prevalence of migratory fish species and the low fall of the river. The habitat uses and relative densities of giant kokopu and other whitebait species over the Taieri Plains, and how fish passage is affected by existing barriers, is a significant knowledge gap (but see Bruno, 2002; Bruno, 2005; and Dungey, 2005). There is also potential to enhance streams of the plains to better suit a range of species e.g. instream rehabilitation of Silver Stream to create riffle habitat.

For all whitebait species, little information exists on the location and nature of key spawning sites, although we found reference to a draft DOC management statement (dated 1996) for the Waipori/Waihola wetland complex that may contain this information. Some further references can be found to whitebait spawning sites in and around the Lake

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<sup>28</sup> DOC have recently commenced a conservation program in Dunedin involving shortjaw kokopu, long-finned eel and bluegill bully.

Waipori/Waihola wetland complex, and stock access and stock grazing of riparian areas is often cited as a threat to such spawning grounds (Ryder Consulting, March 1998; Ryder Consulting, January 2001). For example, the Waipori/Waihola Wetland Complex is considered an important spawning and rearing ground for inanga (Sutherland and Gloss, 2001b) and giant kokopu (Chadderton, 2004). The impact of invasive aquatic weeds, e.g. reed sweet grass, *Glyceria maxima*, on the integrity of spawning sites is worthy of further investigation. For the Waipori/Waihola complex, there are potential threats too of terrestrial-based weeds such as willows, and of the herbicides used to control weeds. In our view, an inventory of whitebait spawning sites and the characteristics and pressures of each, the role and significance of Lakes Waipori and Waihola for larval growth and recruitment, and information on oceanic recruitment success, is an important knowledge gap.

### **Torrentfish (panoko)**

The 'at risk declining' torrentfish spends part of its lifecycle at sea, but little is known of its reproductive behaviour, or success in the Taieri catchment. Torrentfish maybe a long-lived fish, with anecdotal reports that fish slowly make their way upstream over the course of their lives; adults up to 12 cm long have been recorded, with larger females usually occurring further upstream than males. The torrentfish is considered a poor climber, so barriers such as natural falls and the construction of dams and weirs, are known to limit upstream migration (McDowall, 2000). Over the Taieri catchment, torrentfish are not considered a common species and this is thought to be in part due to the absence or sparseness of riverine gravels over some areas (McDowall, 2000). Torrentfish were found in a July 2000 survey of the lower Waipori River in the vicinity of (Ryder, July 2000).

### **Bully**

Three indigenous/native bully species occur throughout the catchment (Figure 12), with all three classed as "Not Threatened" (Table 11). The upland bully (East Coast South Island) is the only non-migratory species, and occurs over the mid and top reaches of the catchment. All other bullies tend to occur in the mid-lower reaches of the catchment, where they can access the sea. Taieri populations of upland bully may be important due to genetic structuring. However, further taxonomic research is required to determine the species complex status (Closs *et al.* 2006). As for so many fish species of the Taieri, barriers to fish passage limit access to some parts of the Taieri catchment by bullies, e.g. above the Patearoa power station. As noted for whitebait species, the Waipori-Waihola wetland complex is an important site for bullies, with common bully comprising 78.92 % of the total catch in one study (Kattel and Closs, 2007).

Pressures facing all the bully species are not well documented, presumably because of their lower threat status relative to the much more threatened non-migratory galaxias species. Cited pressures include perch predation (Ludgate and Gerard, 2007) and sedimentation in association with plantation forestry. A very thorough review of the impacts of forestry activities on freshwater fish in New Zealand was carried out by NIWA in 2005 that includes bully species (NIWA, June 2005). It is also very likely that reduced river and stream flows created by hydro-electric schemes and abstraction in the Taieri catchment also impact on these species (particularly upland bully which do colonise standing water). The potential adverse effects of degraded water quality on bully species is not well known.

**Table 11** Species and threat classifications as per Dunn et al. 2018. A \* indicates longevity, area of occupancy and number of populations were taken from the DOC website <https://www.doc.govt.nz/nature/native-animals/freshwater-fish/non-migratory-galaxiids/>.

| Common Name                                      | Scientific Name               | Threat Ranking (criteria) | Ranking Criterion  | Qualifiers                                  | Longevity (Years)    | Area of occupancy (ha) | No. populations  | Distribution in Catchment        |
|--|-------------------------------|---------------------------|--|---|----------------------|------------------------|--|----------------------------------|
| Eldon's galaxias (non-migratory)                 | <i>Galaxias eldoni</i>        | Nationally Endangered     | A(3) Total area of occupancy ≤ 10 ha (0.1 km <sup>2</sup> ), predicted decline 10–50%      | Partial Decline                             | 12*                  | 5.4*                   | 18*  | Upper                            |
| dusky galaxias (non-migratory)                   | <i>Galaxias pullus</i>        | Nationally Endangered     | A(3) Total area of occupancy ≤ 10 ha (0.1 km <sup>2</sup> ), predicted decline 10–50%      | Conservation Dependent, Partial Decline     | 20*                  | 7*                     | 25*  | Upper                            |
| Central Otago roundhead galaxias (non-migratory) | <i>Galaxias anomalus</i>      | Nationally Endangered     | C(3): Total area of occupancy ≤ 100 ha (1 km <sup>2</sup> ), predicted decline 50–70%      | Conservation Dependent Extreme Fluctuations | 4*                   | 22*                    | n/a  | Upper                            |
| Taieri flathead galaxias (non-migratory)         | <i>Galaxias depressiceps</i>  | Nationally Vulnerable     | C(3): Total area of occupancy ≤ 100 ha (1 km <sup>2</sup> ), predicted decline 10–50%      | Conservation Dependent Data Poor            | 8*                   | 21*                    | n/a  | Upper (headwater streams)        |
| shortjaw kokopu (migratory)                      | <i>Galaxias postvectis</i>    | Nationally Vulnerable     | D(1): 5000–20 000 mature individuals, predicted decline 30–70%                             | Data Poor                                   | c. 25 <sup>29</sup>  | ?                      | 1 (according to ref# recovery plan) except for land locked populations | Widespread (forestry catchments) |
| piharau/lamprey (migratory)                      | <i>Geotria australis</i>      | Nationally Vulnerable     | C(3): Total area of occupancy ≤ 100 ha (1 km <sup>2</sup> ), predicted decline 10–50%      | Data Poor, Secure Overseas                  | c. 8-9 <sup>30</sup> | ≤100                   | n/a  | Widespread                       |
| Longfin eel (migratory)                          | <i>Anguilla dieffenbachii</i> | At Risk Declining         | C(2): Total area of occupancy > 10 000 ha (100 km <sup>2</sup> ), predicted decline 10–70% | Conservation Dependent Data Poor            | 60*                  | >10 000                | ?  | Widespread                       |
| Kōaro (migratory)                                | <i>Galaxias brevipinnis</i>   | At Risk Declining         | C(2): Total area of occupancy > 10 000 ha (100 km <sup>2</sup> ), predicted decline 10–70% | Partial Decline                             | ?                    | >10 000                | 1 (according to ref# recovery plan) except for                         | Widespread                       |

| Common Name                    | Scientific Name                     | Threat Ranking (criteria) | Ranking Criterion  | Qualifiers                              | Longevity (Years) | Area of occupancy (ha) | No. populations  | Distribution in Catchment             |
|--------------------------------|-------------------------------------|---------------------------|--|---|-------------------|------------------------|--|---------------------------------------|
|                                |                                     |                           |  |   |                   |                        | land locked populations  |                                       |
| Inanga (migratory)             | <i>Galaxias maculatus</i>           | At Risk Declining         | C(2): Total area of occupancy > 10 000 ha (100 km <sup>2</sup> ), predicted decline 10–70% | Conservation Dependent, Secure Overseas | ?                 | >10 000                | ?  | Estuarine – lower                     |
| torrentfish/panoko (migratory) | <i>Cheimarrichthys fosteri</i>      | At Risk Declining         | C(2): Total area of occupancy > 10 000 ha (100 km <sup>2</sup> ), predicted decline 10–70% | -                                       | ?                 | >10 000                | ?  | Widespread                            |
| giant kokopu (migratory)       | <i>Galaxias argenteus</i>           | At Risk Declining         | B(1): 20 000–100 000 mature individuals, predicted decline 10–50%                          | Partial Decline                         | ?                 | widespread             | 1 (according to ref# recovery plan) except for land locked populations | Lower-Mid (can form land locked pops. |
| banded kokopu (migratory)      | <i>Galaxias fasciatus</i>           | Not Threatened            | n/a  | -                                       | ?                 | widespread             | 1 (according to ref# recovery plan) except for land locked populations | Lower-Mid                             |
| Redfin bully (migratory)       | <i>Gobiomorphus huttoni</i>         | Not Threatened            | n/a  | -                                       | ?                 | ?                      | ?  | Lower                                 |
| Common Bully (migratory)       | <i>Gobiomorphus cotidianus</i>      | Not Threatened            | n/a  | -                                       | ?                 | ?                      | ?  | Widespread                            |
| Upland bully                   | <i>Gobiomorphus breviceps</i>       | Not Threatened            | n/a  | -                                       | ?                 | ?                      | ?  | Mid-Upper                             |
| Shortfin eel (migratory)       | <i>Anguilla australis schmidtii</i> | Not Threatened            | n/a  | -                                       | ?                 | ?                      | ?  | Estuarine - mid                       |
| Black flounder (migratory)     | <i>Rhombosolea retiaria</i>         | Not Threatened            | n/a  | -                                       | ?                 | ?                      | ?  | Estuarine – lower                     |
| Yelloweye mullet (migratory)   | <i>Aldichetta forsteri</i>          | Not Threatened            | n/a  | -                                       | ?                 | ?                      | ?  | Estuarine                             |
| Common smelt (migratory)       | <i>Retropinna retopinna</i>         | Not Threatened            | n/a  | -                                       | ?                 | ?                      | ?  | Estuarine-Lower                       |
| Kawahai (migratory)            | <i>Arripis trutta</i>               | n/a                       | n/a  | -                                       | ?                 | ?                      | ?  | Estuarine-Lower                       |

## **Shortfin eel**

Shortfin eels are difficult to tell apart from longfin eels at a glance, but they are often very numerous in lowland lakes, wetlands, and streams. Shortfin eels form the basis of the commercial eel fishery that has existed for over 20 years in New Zealand. They are reported to be common in the Lake Waipori/Waihola wetland complex in the Taieri catchment (Ryder Consulting, 1995), with just sporadic records in the rest of the catchment. Shortfin eels are our most tolerant native fish species, they can survive environmental hazards like high water temperatures or low dissolved oxygen concentrations (NIWA, June 2005; Rowe *et al.* 2010). This tolerance means they can live in habitats where other species cannot survive, and as noted above, may occupy habitat where longfin eels were once dominant, especially over the lower Taieri catchment.

## **Estuarine Species**

There are four indigenous/native fish species that only occur over the estuarine reaches of the Taieri catchment: black flounder, yellow-eyed mullet, common smelt and kawahai (Appendix 10). None of the four species are considered nationally threatened (Table 11). The Waipori-Waihola wetland complex is a significant site for all species, as well as the Estuary and lower reaches of the Taieri river immediately above the estuary. At times, kawahai have been recorded in Lake Waihola during periods of high salinity (Ryder Consulting, January 2001). Black flounder can be common along the river and in the Lakes (Ryder Consulting, January 2001) and common smelt and yellow-eyed mullet are common in Lake Waihola.

## **Invertebrates**

### ***Marine Invertebrates - Estuary***

The Taieri Estuary is relatively poor in terms of mean number of benthic taxa and taxa/community richness (ORC, November 2010), but overall, the Taieri Estuary has been described as being “in good health”, with the main areas of concern being nutrient pollution and erosion (Ryder Consulting, 2008). Cockles (*Austrovenus stutchburyi*) occur at low densities (c. 0.66 per square metre; Ryder Consulting, 2008). Pressures at the Estuary, which will impact generally and more specifically on benthic communities, were presented for 2008 and summarised in Table 12 below. Nutrient pollution was highlighted as the biggest concern (Ryder Consulting, 2008), and erosion along some of the grassed banks in the upper estuary also being highlighted (Ryder Consulting, 2008).

Hyperbenthic invertebrate communities of the estuary were found to be typical of open estuaries elsewhere in Otago (Gloss and Schallenberg 2011). Adjacent to the estuary is a small area of closed estuary near the marina, where the causeway has changed the hydrology and effectively created an artificial closed estuary environment; this small estuary (c. 0.5 ha) is accessed via the Picnic Gully Track. Key fauna species recognised in the ORC Biodiversity Strategy 2018 include the squat lobster (*Munida gregaria*) (ORC Biodiversity Strategy, 2018).

**Table 12** Summary of environmental pressures on marine invertebrates at the Taieri River Estuary and level of concern from Ryder Consulting, 2008.

| Pressure                  | Level of Concern |
|---------------------------|------------------|
| Flooding                  | moderate         |
| Introduced Weeds          | present          |
| Nutrient Pollution        | High             |
| Stormwater                | Low              |
| Vehicles                  | Low              |
| Litter and dumped items   | Low              |
| Stock (grazing/trampling) | Low              |
| Erosion                   | moderate         |
| Reclamation               | moderate         |
| Degree of modification    | moderate         |
| Leachate from Landfills   | n/a              |

### Lake Invertebrates

There are little data on the macroinvertebrate communities of Lake Waihola and Lake Waipori, a shortfall also noted back in 2001 (Ryder Consulting, January 2001). Common taxa present in good numbers in Lake Waihola, that were found loosely associated with macrophytes, include *Potamopyrgus* snails, midge larvae, caddisfly larvae, amphipods, isopods, caterpillars, leeches, and shrimp (Schallenberg and Waite, 2004). A body of research has been carried out by the University of Otago on zooplankton (e.g. Levine *et al.* 2005) and mysid shrimps of the Taieri River catchment (e.g. Sutherland and Gloss, 2001). *Daphnia carinata*, a species often used to indicate good water quality, is also known to occur in Lake Waihola (Hall and Burns, 2003). Perch, an invasive fish species throughout the Waipori/Waihola wetland complex, feed on zooplankton (at small size) which may have the effect of increasing phytoplankton levels leading to nuisance algal blooms (E. Funnell, pers. comm. June 2020); this topic is worthy of further research.

Sutton Salt Lake in the Strath Taieri sub-catchment has a diverse aquatic microfauna that includes the rotifer *Brachionus plicatilis* (very abundant), the copepod *Microcyclops* (Metacyclops) *monacanthus* (scarce), the ostracod *Diacypris* spp. (abundant) and the fly *Ephydrella* spp. (scarce), including an endemic species of *Ephydrella novaezealandiae* (Cromarty and Scott, 1995). Little is known of the benthic fauna of the lake, however, the tadpole shrimp *Lepidurus apus viridis* has been recorded here. *Lepidurus apus viridis* is a freshwater invertebrate found only in New Zealand, Tasmania, and parts of coastal mainland Australia, and is classified as 'Threatened – Nationally Endangered' (see below).

### Freshwater mussel (Kakahi)

Kakahi (*Echyridella menziesii*), are considered nationally 'at risk-declining' (Grainger *et al.* 2018) and are extremely long-lived, living up to 40-50 years, and have importance to Kāi Tahu as both mahika kai, and for use in ceremonies. Kakahi are important to the ecosystem and can filter phytoplankton and bacteria, improving water quality as a result. Kakahi are present in lakes Waihola and Waipori and along edges of river channels over the lower

reaches of the Taieri catchment<sup>31</sup> (Schallenberg and Waite, 2004), but research is required to determine if a healthy range of age-classes are present. There is some anecdotal evidence that eutrophication of lakes and rivers they inhabit can reduce reproduction, leaving only older animals that will slowly die out; it is unknown if this effect is occurring in the Taieri catchment.

The larval stage attaches to a fish host (e.g. koaro) until they transform into juveniles. Larval and juvenile stages are sensitive to poor water quality, especially total ammoniacal-nitrogen (see review in Collier *et al.* 2017), but also copper, both of which are common in urban and agricultural pollution of the Taieri plains. Any pressures on the fish hosts will also impact on kakahi.

Translocations of microchipped kakahi have been attempted outside of the catchment, e.g. from Wairarapa Moana and Lake Kohangapiri to Zealandia eco-sanctuary in Wellington; but the success of such translocations is not yet known. NIWA has been trying to breed the mussels. Thousands of juveniles were produced in vitro, in petri dishes, but most died when they reached two months old. NIWA suspects two months represents a developmental milestone where the gut and gills are possibly formed. NIWA hope to find ways around this in the future so the mussels can be used to restock waterways.<sup>32</sup> In the Taieri catchment, translocated mussels into new locations could help secure important populations e.g. from Lake Waihola into Loganburn reservoir.

### **Tadpole Shrimp (*Lepidurus apus viridis*)**

The nationally endangered tadpole shrimp is a “living fossil” that occurs over ephemeral wetlands of the Strath Taieri sub-catchment. The species has recently been elevated in threat status to Threatened – Nationally Endangered due to concerns raised relating to the continual loss of ephemeral wetlands, nationwide (Grainger *et al.* 2018). Other threats are not known, and little is known of its life history except for its ability to form a hard cyst-like pod for larvae to survive droughts. Much of what is known is based on overseas species (see Section 7).

### **Freshwater crayfish (Koura)**

Koura (*Paranephrops zealandicus*) are considered ‘At Risk-Declining’ nationally (Grainger *et al.* 2018) and are known to be susceptible to poor water quality, particularly low dissolved oxygen (review in Collier *et al.* 2017). A review of ecology and distribution of the freshwater crayfish over the Taieri catchment, including a summary of implications for conservation has indicated that although koura are widespread over the Taieri catchment (see Figure 2 of Whitmore *et al.* 2000), over both lakes, rivers and stream; they are sparse over the upper catchment areas (Whitmore *et al.* 2000). Distribution was strongly linked to intactness of riparian vegetation, and a preference was shown to native vegetation on margins with occurrence of koura relatively low in plantation forestry. The research concluded, however, that the intensity of land use in the catchment showed little relationship with koura

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<sup>31</sup> A directory of Wetlands: Otago Conservancy <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nzwetlands12.pdf>

<sup>32</sup> <https://www.newsroom.co.nz/2018/12/21/370177/the-reproductive-trickery-of-nzs-freshwater-mussels>



distribution, which was primarily determined by the drainage history of the Taieri River and its tributaries (Whitmore *et al.* 2000).

Koura are common throughout the Waipori/Waihola wetlands complex, including the Sinclair wetlands<sup>33</sup>, and are important mahika kai species. A study in Powder Creek (Silver Stream sub-catchment) indicated the population could not sustain harvesting due to its slow life history brought about by low water temperatures (Whitmore *et al.* 2000). There are commercial koura fisheries in operation over the catchment; for example, fire ponds in plantation forestry blocks are used to raise koura for the restaurant trade. Knights Dam in the Mahinerangi/Lee Stream/Deep Stream sub-catchment has a resident population of koura (Trustpower, 2004). It is not known, however, the extent to which koura are harvested from the wild, and if so, whether the populations can sustain harvesting.

Other pressures and threats include predation by birds, eels, trout and perch and sedimentation. Drought or low water flows can make koura vulnerable to predation by feral cats and rodents; this has been observed in Emerald Stream (Strath Taieri) during drought conditions (MT pers. obs).

### ***River/Stream Invertebrates***

There are several rare and threatened freshwater invertebrate species over the Taieri catchment, including nationally critical species (as per Grainger *et al.* 2018). These taxa are summarised in Table 13. For most of these rare taxa, very little is known of them, representing a significant knowledge gap over the catchment. Of note, Lee stream (at 440 m a.s.l) is the type locality for the nationally critical caddisfly, *Oeconesus angustus*, and Maungatua was the first known location for the nationally critical stonefly, *Taraperla johnsi*. A new species of stonefly has recently been described from Maungatua, *Zelandoperla maungatuaensis* (Foster *et al.* 2020).

In addition to these rare species, the brown caddis, *Psilochorema tatoru* has been recorded in the Redbank Wetlands of the Strath Taieri District and the values of the Nenthorn Ridge Wetland Management Area include “a distinctive insect fauna” (Appendix C(1) Waitaki District Plan). Threats and pressures on freshwater invertebrates are similar to those cited for fish species over the Taieri catchment, but good water quality is of paramount importance to stoneflies and some caddisflies as these species are sensitive to pollution (Quinn *et al.* 1990).

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<sup>33</sup> <https://www.tenohoaka.org.nz/the-wetlands/>

**Table 13** Rare, threatened and data deficient stream Invertebrate fauna species (as per Grainger *et al.* 2018), of the Taieri catchment. Source: Mike Wakelin, Ryder Environmental.

| Insect group      | Name   | DOC Classification                |
|-------------------|--|-----------------------------------|
| caddisfly         | <i>Oeconesus angustus</i> Ward, 1997                 | Threatened - Nationally Critical  |
| stonefly          | <i>Taraperla johnsi</i> McLellan 2003                | Threatened - Nationally Critical  |
| stonefly          | <i>Zelandobius crawfordi</i> McLellan, 2008          | Threatened - Nationally Critical  |
| caddisfly         | <i>Pseudoeconesus</i> n. sp. T                       | Threatened - Naturally vulnerable |
| caddisfly         | <i>Philorheithrus harunae</i> Henderson & Ward, 2006 | At Risk - Naturally Uncommon      |
| caddisfly         | <i>Pycnocentria patricki</i> Ward, 1995              | At Risk - Naturally Uncommon      |
| amphipod          | <i>Paraleptamphopus</i> sp. "maniototo"              | At Risk - Naturally Uncommon      |
| freshwater beetle | <i>Hydora obsoleta</i> Broun, 1885                   | Data Deficient                    |
| freshwater beetle | <i>Orchymontia otagensis</i> Ordish, 1984            | Data Deficient                    |
| freshwater beetle | <i>Hydora nitida</i> Broun, 1885                     | Data Deficient                    |
| caddisfly         | <i>Neurochorema pilosum</i> McFarlane, 1964          | Data Deficient                    |
| stonefly          | <i>Zelandobius auratus</i> McLellan, 1993            | Data Deficient                    |

### Terrestrial Invertebrates

Over the PNAP reports reviewed (see reading list), there was a heavy bias towards records of moths, many of which were indeterminate species, and few were explicitly described as rare or threatened (as per Hoare *et al.* 2015). Many moth species have apparently also undergone changes in nomenclature since they were recorded in the PNAP reports. There were, however, two important records found. One was for a nationally vulnerable moth species, gingidium looper moth (*Gingidiobora nebulosa*), at Macraes Ponds (Strath Taieri sub-catchment) (Appendix C(1) Waitaki District Plan). This species feeds on *Gingidia montana*, a widespread plant species considered "not threatened". The second was a record for ghost moth, *Heloxycanus patricki* (At Risk - Declining) at Great Moss Swamp (Loganburn Reservoir). This site also has the moth "*Eurythecta*" *leucothrinca* and *Hemiandrus* 'Rocklands', and a small Data Deficient ground weta (Barratt and Patrick, 1987; Sherley, 1998). "Rare moths" were also reported for Swampy Hill, an area of Conservation Merit schedule in the Waitaki District Council Plan (Appendix C(1) Waitaki District Plan).

*Megadromus fultoni*, a threatened beetle species, has been recorded from the Taieri Mouth<sup>34</sup>, along with trapdoor spider, genus *Cantuaria* (inaturalist). In addition, a few non threatened indigenous moth species, prickly stick insect (*Acanthoxyla prasina*) and wide-banded tiger beetle (*Neocicindela latecincta*) have been recorded from the areas bordering the Taieri River and Estuary (inaturalist). The mountain stone weta, *Hemidema Māori* was recorded on Taieri Lake Pastoral Lease along with the black cicada, *Māoricicada clamitans* (Taieri Lake Pastoral Lease Conservation Resources report).

Little is known about the invertebrate fauna of the Waipori-Waihola wetland complex. Terrestrial insects and crustaceans have been described as "prominent" within the Waipori-

<sup>34</sup> The conservation requirements of New Zealand's nationally threatened invertebrates. <https://www.doc.govt.nz/Documents/science-and-technical/tsop20d.pdf>

Waihola wetland complex<sup>35</sup>. “Giant dragonflies” (presumably *Uropetala chiltoni*) and “tussock moths” are recorded on the Sinclair wetlands website<sup>36</sup>. Given the proximity of the Waipori-Waihola wetland complex to the Dunedin city and its strong conservation and academic community, it seems likely other terrestrial invertebrate data are available, but were not located for this review.

Few records of beetles were found across the catchment. Exceptions include the beetle *Metaglymma tibiale*, which is reported as common in the Maniototo (Grove, 1994), huhu beetles (*Prionoplus reticularis*), which are regularly recorded at Whare Flat (inaturalist), and *Holcaspis placida*, *Holcaspis catenulata* and *Holcaspis thoracica* are known to occur over the catchment (Butcher, 1984). None of these *Holcaspis* species are considered rare or threatened, but members of the same genus in Canterbury are nationally critical.

The salt pan habitats of the Maniototo and Strath Taieri support a diverse moth fauna including the orange underwing moth *Paranotoreas fulva* (At Risk - Relict; Hoare *et al.* 2015), *P. brephosata*, *Zizina oxleyi*, *Scopula rubraria*, *Scythris triatma*, *Stenoptilia celidota*, *Sporophylla oenospora*, *Crocodypora cinigerella*, *Eurythecta zelaea*, *Lycaena boldenarum*, *Orocrambus corruptus*, *Capua semiferana*, *Scoriodyta suttonensis*, and *Phaeosaces* n.sp. (Grove, 1994; Allen and McIntosh, 1997). The crambid snout moth (*Loxostege* sp. “salt pan”; At Risk - Relict) has also been recorded from salt pans and the grasshopper, *Sigaus campestris*, is also known from these habitats (Grove, 1994).

Threats to the saltpan fauna arise from threats to the plants they live and feed on including cultivation and irrigation and eventual conversion of salt pans to exotic pasture. A critical factor for the survival of native moth fauna is the mixture of low vegetation (herbs and grasses), native or exotic, and bare areas associated with salty soils (Grove, 1994). The planting of salt bush is listed as threat in Grove (1994). Introduced alkali bees (*Normia melanderi*) nest in the alkali soils of the salt-pans, but do not appear to be a threat to native species.

New Zealand peripatus/ngaokeoke populations occur throughout the Taieri catchment, including in riparian areas. The species thought to occur over Otago is considered by DOC to be “Not Threatened” (as per Trewick *et al.* 2018). Populations are known to occur at the following areas of the catchment: Silverpeak, Whare Flat, Maungatua, Waipori Falls, Outram, and Taieri Mouth (DOC, March 2014). Current knowledge, conservation and future research needs threats to peripatus are well documented (see review in DOC, March 2014).

## Lizards

The Taieri catchment has a diverse lizard fauna, with 10 species, 9 of which are rare or threatened (Table 14). All species can be found in wetland and/or terrestrial habitats close to the Taieri River and its tributaries. The threats and pressures on lizards relate primarily to terrestrial habitat loss, fire and predation by exotic mammalian predators (Hitchmough *et al.* 2016).

<sup>35</sup> A directory of Wetlands: Otago Conservancy <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nzwetlands12.pdf>

<sup>36</sup> <https://www.tenohoaka.org.nz/the-wetlands/>

The Waitaki District Council, in an effort to manage activities over habitat for the most threatened species of the district, have included a Mapped skink Management Area surrounding stronghold grand and Otago skink populations (Appendix C(1) Waitaki District Plan). This area, in combination with the Rural Scenic zoning, restricts earthworks, afforestation and indigenous vegetation clearance over a mix of public conservation land and private land of the Macraes Ecological District.

**Table 14** *Lizards of the Taieri catchment, their threat status and habitat use across sub-catchments.*

| Common Name          | Scientific Name   | Threat Status                      | Habitat Use  | Sub-catchment/s |
|----------------------|---|------------------------------------|--|-----------------|
| Burgan skink         | <i>Oligosoma burganae</i>                               | Threatened - Nationally critical   | <i>This information has been deliberately removed.</i> |                 |
| Otago skink          | <i>Oligosoma otagense</i>                               | Threatened - Nationally Endangered |  |                 |
| Grand skink          | <i>Oligosoma grande</i>                                 | Threatened - Nationally Endangered |  |                 |
| Green skink          | <i>Oligosoma chloronoton</i>                            | At Risk - Declining                |  |                 |
| Southern grass skink | <i>Oligosoma</i> aff. <i>polychroma</i> clade 5         | At Risk - Declining                |  |                 |
| Cryptic skink        |   | At Risk - Declining                |  |                 |
| Korero gecko         | <i>Woodworthia</i> "Otago/Southland large"              | At Risk - Declining                |  |                 |
| Jewelled gecko       | <i>Naultinus gemmeus</i>                                | At Risk - Declining                |  |                 |
| Oteake skink         | <i>Oligosoma</i> aff. <i>inconspicuum</i> 'North Otago' | Data Deficient                     |  |                 |
| McCann's skink       | <i>Oligosoma maccanni</i>                               | Not Threatened                     |  |                 |

DOC have invested a large effort in restoring lizard values on public conservation land of the Macraes Ecological District (Strath Taieri sub-catchment), focussing on grand and Otago skinks of the Redbank Scenic Reserve. The restoration involves extensive and on-going predator control since 1999 that must continue if populations are to remain viable (Hitchmough *et al.* 2016; Tocher, 2006). A range of less threatened lizards also benefit from this project, namely green skink, korero gecko, Southern grass skink, cryptic skink and McCann's skink. No other restoration projects are currently in operation for lizards over the catchment.

OceanaGold (OGL) are a major industry of the Strath Taieri sub-catchment, that impact on lizard values of the Macraes Ecological District. As part of mitigation for a mine extension termed "Coronation North", OGL are supporting research, led by Dr Cathy Rufaut, into rehabilitation methods over post-mining sites. Separate to this work, OGL are drafting a

lizard management strategy that will cover past, current and future mining areas with the goal of maximising outcomes, in terms of lizard values, over the next 20-years.

## Birds

At least seventy-one bird species, a mix of native, indigenous and exotic have been recorded for the Taieri catchment, including up to 40 species associated with the myriad of wetlands present, and up to 31 species associated with forest or open country (Appendix 11). Lakes Waihola and Waipori and their associated wetlands are the most significant waterfowl habitat in Otago and the area supports a variety of 'At Risk' and 'Threatened' species present as breeding birds (e.g. Australasian bittern and crested grebes), or occasional visitors (white heron), along with a range of indigenous and exotic species (Appendix 11).

The upper Taieri wetland complex, including the Serpentine Wildlife management area, is second only to the Waipori/Waihola wetland complex at providing regionally significant bird habitat, including for threatened bird species such as the 'Threatened - Nationally Critical' Australasian bittern and grey duck. A total of fifty-two bird species have been recorded in the area. Of these, twenty-seven species are dependent on the wetland to meet their specialised needs (Grove, 1994). Other important avian habitat of the Taieri catchment are wetland complexes on the tops of the Lammerlaws and the Rock and Pillar range, and wetlands of the Strath Taieri, including ephemeral wetlands. These wetland habitats provide significant habitat for banded dotterels (Ryder Consulting, August 2006), black billed gulls, and a range of other waders and waterfowl, including migratory species and occasional visitors such as black fronted terns. Lake Mahinerangi supports a thriving population of black shag (*Phalacrocorax carbo*), with up to 30 sighted at times (Ryder Consulting, 2000). This species predate on perch and trout in the lake, putting them in conflict with anglers. Key fauna species recognised in the ORC Biodiversity Strategy 2018 are sea birds (including Otago shag (*Leucocarbo chalconotus*) and southern blue penguin (*Eudyptula minor minor*)) and waterfowl (ORC Biodiversity Strategy, 2018).

The charismatic eastern falcon (*Falco novaeseelandiae* "eastern") is widespread over the Taieri catchment and has been the subject of 3-year research that was jointly funded by forestry companies Wenita, City Forests and Rayonier-Matariki, and the Otago Regional Council. Research has discovered a "robust" falcon population in the forests consisting of 28-plus pairs. Pressures and threats cited in the Dunedin area include predators such as stoats, ferrets and feral cats. They are also shot as pests or electrocuted by power infrastructure. Hunting, sometimes illegal, took place in the forests, and roaming pig dogs were said to be a problem.<sup>37</sup>

Many of the regionally significant wetlands of the catchment provide important habitat for waterfowl (Appendix 11). These wetlands were oftentimes identified as "Recommended Areas for Protection (RAPs) in PNAP reports and tend also to be listed in relevant District Plans and Significant areas. As an example, the Takitakitoa Swamp, a regionally significant wetland near the Taieri Estuary, and an "Area of significant Biodiversity Value" in the DCC 2GP provides habitat for eight bird species including the 'At Risk – Declining' South Island

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<sup>37</sup> <https://www.odt.co.nz/news/dunedin/falcons-flock-forest-establish-new-home>

fernbird (*Bowdleria punctata*). Of the other bird species present four are indigenous - pukeko, paradise shelduck, New Zealand shoveler, and Australasian harrier (Rate, 2011).

Over the wider Taieri catchment area with bush and forest exist, a range of forest bird species exist, including a remnant South Island robin (*Petroica australis*) population in the Silver Stream sub-catchment near Whare Flat. Of note, a rare sighting of this species was made in the Ross Creek Reserve in July 2019 indicating they can survive, at least temporarily, in the presence of exotic mammalian predators.

## Plants & Weeds

### *Terrestrial Plants*

At least 78 'At Risk' or 'Threatened' plant species have been recorded from wetlands and riparian margins of the Taieri catchment (Appendix 7). Twenty-four species of plants are Nationally Threatened ('Nationally Critical', 'Endangered' and 'Vulnerable', as per Barkla *et al.* 2017). These species all occupy wetland habitats, many of them ephemeral wetlands (an originally rare ecosystem) and dryland/saline soil habitats, Williams *et al.* 2007; Table 15).

Many rare and threatened wetland species have come from plant species lists generated in the Macraes Ecological District for activities associated with OceanaGold. Plants of ephemeral wetlands are well documented (see Ryder Consulting, April 2011). A review of ephemeral wetland plants of the Strath Taieri is provided in Johnson and Rogers (2003), including a comprehensive plant species listed as an appendix. Plants specialised to live in saline soils, so called, halophytes, are also well documented for the Upper Taieri Plain/Maniototo and Strath Taieri sub-catchments (Allen and McIntosh 1997; Allen, 1992; Allen and McIntosh 1993). These plants tend to occupy the highest threat classifications, along with ephemeral wetland plants, a reflection of the extreme pressures such communities are under through cultivation and irrigation (Grove, 1994; Allen and McIntosh 1997). That said, important salt pan/saline sites are protected on a mix of public conservation land and district plan schedules e.g. Patearoa Inland Saline Wetland that although on private land is covered by QEII covenant (see Appendix 4 for listed values).

Other sources of information on rare plants was derived from information held by councils for scheduled significant sites and places (e.g. Appendix 4); PNAP report, and Botany Division, DSIR reports for upland wetlands. Apart from botanical lists from these sources, very few plant species lists were located for the catchment. Those that were located tended to be older resources with plants listed subject to multiple nomenclature changes. A list of rare and threatened lichens was also sourced, with four species occurring over the Taieri catchment (sourced from the DOC Data Deficient database, administered by Mike Wakelin, Ryder Environmental; Table 16).

**Table 15** *Rare and Threatened vascular plant species of the Taieri catchment. Threat classifications are from Barkla et al. 2017.*

| Scientific Name            | Common Name      | Threat Classification            | Common Habitats |
|----------------------------|------------------|----------------------------------|-----------------|
| <i>Cardamine mutabilis</i> | Cardamine "tarn" | Threatened - Nationally Critical | wetlands        |

| Scientific Name   | Common Name                              | Threat Classification              | Common Habitats  |
|---|--|------------------------------------|--|
| <i>Ceratocephala pungens</i>                                      |  | Threatened - Nationally Critical   | riparian gravels   |
| <i>Crassula peduncularis</i>                                      |  | Threatened - Nationally Critical   | wetlands   |
| <i>Lagenophora montana</i>  | papataniwha                              | Threatened - Nationally Critical   | wetlands   |
| <i>Lepidium kirkii</i>  | salt pan cress                           | Threatened - Nationally Critical   | saline soils   |
| <i>Lepidium solandri</i>  | Maniototo peppergrass                    | Threatened - Nationally Critical   | saline soils   |
| <i>Lepidium sisymbrioides</i>                                     |  | Threatened - Nationally Critical   | cliff faces, sparsely vegetated clay pan and semi-saline soils |
| <i>Puccinellia rariflorens</i>                                    | saltgrass                                | Threatened - Nationally Critical   | saline soils   |
| <i>Lepidium juvencum</i>  | scurvy Grass                             | Threatened - Nationally Critical   | wetlands   |
| <i>Simplicia laxa</i>   | Simplicia                                | Threatened - Nationally Critical   | riparian dry rock ledges                                       |
| <i>Triglochin palustre</i>  | Marsh arrow grass                        | Threatened - Nationally Critical   | wetlands   |
| <i>Crassula multicaulis</i>                                       |  | Threatened - Nationally Endangered | wetlands/saline soils  |
| <i>Gratiola concinna</i>  |  | Threatened - Nationally Endangered | wetlands   |
| <i>Hypericum rubicundulum</i>                                     |  | Threatened - Nationally Endangered | wetlands   |
| <i>Isolepis basilaris</i>   | Pygmy clubrush                           | Threatened - Nationally Endangered | wetlands   |
| <i>Pachycladon cheesemanii</i>                                    | Dryland cress                            | Threatened - Nationally Endangered | riparian dry rock ledges                                       |
| <i>Senecio dunedinensis</i>                                       | Fireweed                                 | Threatened - Nationally Endangered | riparian dry rock ledges                                       |
| <i>Wurmbea novae-zelandiae</i>                                    |  | Threatened - Nationally Endangered | wetlands   |
| <i>Atriplex buchananii</i>  | Buchanan's orache                        | Threatened - Nationally Critical   | saline soils   |
| <i>Carmichaelia kirkii</i>  | Climbing broom, Kirk's broom             | Threatened - Nationally Critical   | riparian shrublands  |
| <i>Myosurus minimus subsp. novae zelandiae</i>                    | New Zealand mousetail, bearded mousetail | Threatened - Nationally Critical   | wetlands   |
| <i>Raoulia monroi</i>   | Fan-leaved mat daisy                     | Threatened - Nationally Critical   | river gravel   |
| <i>Sonchus (b) (CHR 596666; aff. S. novae-zelandiae; "cliff")</i> |  | Threatened - Nationally Critical   | wetlands   |
| <i>Tetrachondra hamiltonii</i>                                    |  | Threatened - Nationally Critical   | wetlands   |

The vegetation of the Waipori/Waihola Wetland complex has been described at a high level by ORC<sup>38</sup>; in the DOC Directory of Wetlands in New Zealand, Otago Conservancy<sup>39</sup>; and in more detail in Tangney (1987) and references therein. More recently, a vegetation assessment collated from a variety of sources, and including geo-referenced locations for two at risk/threatened plant species, is provided in Rate (2009). Of note, at Lake Waipori, *Urtica linearifolia* (at risk declining) has been recorded amongst re-sprayed crack willow on the northern and eastern margins of the Lake (Rate, 2009).

<sup>38</sup> <https://www.orc.govt.nz/managing-our-environment/water/wetlands-and-estuaries/clutha-district/waiporiwaihola-wetland-complex>

<sup>39</sup> A directory of Wetlands: Otago Conservancy <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nzwetlands12.pdf>

**Table 16** Rare and Threatened lichen species of the Taieri catchment, sourced from the DOC Data Deficient database, administered by Mike Wakelin, Ryder Environmental. Threat classifications are from Barkla et al. 2017.

| Scientific Name  | Threat Classification        |
|--|------------------------------|
| <i>Cladonia coccifera</i> (L.) Willd.                          | At Risk - Naturally Uncommon |
| <i>Cladonia deformis</i> (L.) Hoffm.                           | At Risk - Naturally Uncommon |
| <i>Placynthium rosulans</i> (Th.Fr.) Zahlbr.                   | Data Deficient               |
| <i>Verrucaria austroschisticola</i> P.M.McCarthy & P.N.Johnson | Data Deficient               |

## Aquatic Plants

Apart from water cress (watakirihi), that is an important mahika kai species for Kāi Tahu, little is documented on which (if any) native species of aquatic plants over the Taieri catchment are rare or threatened. That said, many of the wetland plants detailed in Table 17 can withstand submergence and could be considered semi-aquatic. Macrophytes of Lake Waihola were studied over the summer of 2002-2003; 11 species were recorded, none of which were considered rare (Schallenberg and Waite, 2004). The study concluded that Lake Waihola had a diverse macrophyte community, which had not (at the time of writing) been seriously degraded by the invasion of exotic macrophytes such as *Lagarosiphon major*, *Potamogeton crispus* and *Egeria densa*, despite the high level of recreational use of the Lake (Schallenberg and Waite, 2004). Overall, however, Lake Waihola scored low for macrophyte cover when compared to a range of other New Zealand brackish Lakes; high macrophyte cover is an attribute thought to be important for maintaining ecosystem health (Hamill et al. 2014).

## Weeds

Focus on aquatic plants tends to focus on invasive freshwater species, that degrade wetlands and waterways. DOC lists several species that pose the greatest risks, nationally, to wetlands and waterways, some of which may have been recorded over the Taieri catchment<sup>40</sup>. The ORC also lists aquatic plants that pose a risk locally. These are provided in Table 17. DOC recently completed a survey of 31 sites Otago-wide on private and public land and did not find new aquatic weed infestations of hornwort (*Ceratophyllum demersum*) and lagarosiphon (*Lagarosiphon major*)<sup>41</sup>, neither of which are known to be present in the Taieri catchment. The Canadian pondweed, *Elodea canadensis* was found during a survey of Lake Waihola (Schallenberg and Waite, 2004) and the alga Didymo (*Didymosphenia geminata*) has not been recorded in the Taieri catchment.

**Table 17** Aquatic, riparian and estuarine plants and algae of concern to ORC and listed in the Otago Pest Management Plan 2019-2029.

<sup>40</sup> <https://www.doc.govt.nz/nature/pests-and-threats/weeds/common-weeds/freshwater-weeds/>

<sup>41</sup> <https://www.doc.govt.nz/news/media-releases/2020-media-releases/no-new-freshwater-pests-found-in-otago/>



| Scientific Name                 | Common Name          | Threatened Habitat             | Taiari Catchment |
|---------------------------------|----------------------|--------------------------------|------------------|
| <i>Lagarosiphon major</i>       | African oxygen weed  | Freshwater                     | ?                |
| <i>Egeria Densa</i>             | Egeria               | Freshwater                     | ?                |
| <i>Ceratophyllum demersum</i>   | Hornwort             | Freshwater/wetlands            | ?                |
| <i>Glyceria maxima</i>          | Reed sweetgrass      | Freshwater/wetlands            | Yes              |
| <i>Spartina sp.</i>             | Spartina             | Estuarine                      | Yes              |
| <i>Juncus squarrosus</i>        | Heath rush           | Freshwater/wetlands            | Yes              |
| <i>Juncus gerardii</i>          | Saltmarsh rush       | Estuarine/wetlands             | ?                |
| <i>Undaria pinnatifida</i>      | Undaria              | Estuarine                      | ?                |
| <i>Heracleum mantegazzianum</i> | Giant hogweed        | Riparian/Lake Margins          | ?                |
| <i>Lythrum salicaria</i>        | Purple loosetrife    | Riparian/Lake Margins          | ?                |
| <i>Salix cinera</i>             | Grey willow          | Riparian/Lake Margins          | Yes              |
| <i>Ulex europeaus</i>           | Gorse                | Riparian/Lake Margins/Wetlands | Yes              |
| Wilding Conifers                | Various species      | Wetlands/drylands/tussocklands | Yes              |
| <i>Buddleja davidii</i>         | Buddleia             | Riparian margins               | Yes              |
| <i>Arctium minus</i>            | burdock              | Creek beds                     | ?                |
| <i>Crataegus monogyna</i>       | Hawthorne            | Wetlands/riparian areas        | ?                |
| <i>Lonicera japonica</i>        | Japanese honeysuckle | Riparian & lake margins        | ?                |
| <i>Lindavia intermedia</i>      | Lake Snow            | Instream                       | ?                |
| <i>Erica lusitanica</i>         | Spanish heath        | Wetlands                       | Yes              |
| <i>Hedychium gardnerianum</i>   | Wild ginger          | Riparian                       | ?                |
| <i>Clematis vitalba</i>         | Old man's beard      | Riparian                       |                  |
| <i>Alnus glutinosa</i>          | Alder                | Riparian                       |                  |
| <i>Cytisus scoparius</i>        | Broom                | Riparian                       |                  |
| <i>Salix fragilis</i>           | Crack willow         | Riparian                       |                  |
| <i>Sambucus nigra</i>           | Elderberry           | Riparian                       |                  |

Appendix 6.2 of the Otago CMS (2016) lists threats and pests present in the Otago region that will be managed only in priority places for action. Species that could be present in the Taiari catchment include various rush species (*Juncus gerardii*; *J. subnodulosus*; *J. squarrosus*; *J. articulatus*; *J. subnodulosus*; *J. effusus* and *J. bulbosus*), floating sweetgrass (*Glyceria fluitans*; *G. maxima*<sup>42</sup>, *G. declinate*), giant reed (*Arundo donax*), *Spartina spp.*, Yellow flag iris (*Iris pseudacorus*), *Undaria pinnatifida*, *Lagarosiphon major*, *Equisetum arvense*, *Ceratophyllum demersum* and *Didymosphenia geminata* (see Appendix 6.2 of Otago CMS (2016) for a full list).

Under climate change, conditions in the Taiari catchment may become more suitable for the establishment of new pest-plants or the expansion in distribution of existing plants (see review in McGlone and Walker, 2011).

Terrestrial based weeds abound throughout the catchment, with gorse in the Taiari Gorge identified as a high risk to wetlands of the catchment (Dr Peter Johnson, LCR, pers. comm. July 2020). Both crack and grey willow are also problematic for wetland habitats, catchment wide.

<sup>42</sup> *G. maxima* has been reported in the Sinclair wetlands and the Waipori River (Lynne Huggins, pers. comm.).

## **7. Summary of Threats, Information Gaps, Opportunities and Actions**

Table 18 provides a summary of the key threats, information gaps and recommended opportunities and actions for addressing issues identified in this report. The table is split into:

- habitat (wetlands, lakes, rivers and the estuary);
- key biological groups (invertebrates, fish, avifauna, lizards, plants and weeds); and
- advocacy.

Table 18

| VALUE           | CONDITION/STATUS  | THREATS   | INFORMATION GAPS   | OPPS & ACTIONS   |
|-----------------|---|---|--|--|
| <b>HABITAT</b>  |   |   |  |  |
| <b>WETLANDS</b> | <p>Historically uncommon or rare wetland ecosystems are found in the Taieri catchment, however, much wetland habitat has been altered (drained) or otherwise destroyed largely for agricultural development.</p> <p>Wetlands in the upper catchment are generally in better condition than in the lower catchment, but some are still subject to modification due to land use practices in the surrounding catchment (see Threats). Ephemeral wetlands on private land are particularly vulnerable.</p> <p>The most important wetland habitat in the catchment is the upper Taieri Scroll plain. A 45-ha area of the plain in the Styx Basin on Logan Burn Station has recently been designated as a wetland reserve. The protection was achieved with the help of the Nature Heritage Foundation<sup>43</sup>.</p> <p>Wetlands in the lower Taieri catchment are generally degraded or at least modified physically and biologically. They are subject to poor water quality, rapid sedimentation relative to historic sediment deposition rates and algal blooms.</p> <p>Only a portion of the Taieri catchment wetlands are identified as Regionally Significant wetlands, and of those, much of the surrounding vegetation has not been included in the mapping of wetland extent.</p> <p>The recently released NES for freshwater 2020 has provisions to improve wetland protection, but these are yet to be tested for their effectiveness.</p> | <p>Threats to wetland habitat include:</p> <ul style="list-style-type: none"> <li>• drainage</li> <li>• stock access</li> <li>• invasive weeds</li> <li>• plantation forestry</li> <li>• inundation for storage</li> <li>• altered hydrology</li> <li>• elevated nutrient and sediment levels in inflows and runoff from surrounding land.</li> </ul> | <p>Assessment of stock access to the catchment's wetlands, and the compatibility of conservation values to grazing is required.</p> <p>Analysis of the Resource Management (Stock Exclusion) Regulations 2020 and their ability to adequately protect wetlands of the Taieri catchment.</p> <p>Research on wetland creation or test wetland restoration tools.</p> <p>Survey work to support accurate mapping of wetland extent, understand conservation values, and threats to those values. Mapping of small wetlands, and buffer areas, to provide adequate protection.</p> | <p><b>Collaboration</b></p> <p>The NPS-FM (2020) requires that every regional council must identify and map every natural inland wetland in its region that is:</p> <ol style="list-style-type: none"> <li>0.05 ha or greater in extent; or</li> <li>of a type that is naturally less than 0.05 ha in extent (such as an ephemeral wetland) and known to contain threatened species.</li> </ol> <p>Work with ORC and other stakeholders to map wetlands, develop action plans and identify restoration opportunities.</p> <p><b>Support catchment-wide inventory of wetlands smaller than 0.25 ha</b></p> <p>For sub-catchments where plantation forestry is on the increase, an inventory of wetlands of all sizes is required, but in particular wetlands smaller than 0.25 ha (the minimum size specified under the NES for plantation forestry), such as ephemeral wetlands on private land of the Strath Taieri.</p> <p><b>Assess values/threats of existing protected wetlands, advocate for buffer mapping</b></p> <p>Although a good number of Taieri Catchment wetlands are scheduled as either Regionally Significant wetlands (Appendix 5) or SNAs (Appendix 4); some of these have little to no conservation values listed.</p> <p>As a part of a wetland assessment for threats and values, we recommend that each wetland is simultaneously assessed for required setbacks to allow its long-term persistence.</p> <p><b>Restoration of Waipori/Waihola Wetland complex</b></p> <p>Restoration opportunities abound in this sub-catchment. For example, reinstating inanga and/or giant kokopu spawning habitat.</p> <p><b>Scroll Plain restoration</b></p> <p>Maintaining and enhancing the integrity of the scroll wetland could be achieved by:</p> |

<sup>43</sup><https://www.thenews.co.nz/news/scroll-plain-wetland-protected/>

| VALUE               | CONDITION/STATUS  | THREATS  | INFORMATION GAPS  | OPPS & ACTIONS  |
|---------------------|---|--|---|---|
|                     |   |  |   | <ul style="list-style-type: none"> <li>• enhancement of fauna habitats, especially habitats of toaka species (Appendix 1)</li> <li>• formal protection</li> <li>• on-site interpretation (also flagged by Patearoa community; Section 3);</li> <li>• maintenance and improvement of hydrological regime</li> <li>• restoration to increase indigenous vegetation</li> <li>• recognition and celebration of features and values</li> <li>• maintenance of threatened plant habitats</li> <li>• grazing management (see Section 7).</li> </ul> <p><b>Restoration of Paerau Wetland</b><br/>Restoration of the newly protected “Paerau Wetland” has been suggested by DOC (see Rance, 2019).</p> <p><b>Assist with restoration of Takitakitoa Swamp</b><br/>Takitakitoa Swamp had been heavily modified by drainage and vegetation clearance. Very few indigenous vegetation values were recorded during a 2011 survey. Reintroductions of regionally and locally rare wetland plants would increase the naturalness of the wetland and provide habitat for a wider range of wetland species (Rate, 2011).</p> <p><b>Creation of constructed wetlands on Taieri Plain to intercept nutrients</b><br/>Opportunities exist to construct wetlands upstream of the Lake Waipori/Waihola wetland complex to intercept nutrients originating from Taieri Plains. The goal of this project would be to ultimately improve water quality in the two lakes. A similar initiative was investigated for the Waituna Catchment, Southland (NIWA, 2013), that culminated in a land purchase to host the constructed wetlands.</p> |
| <p><b>LAKES</b></p> | <p>Lake habitat is variable throughout the catchment with progressively poorer ecosystem health further down the catchment.</p> <p>Lakes Waihola and Waipori are generally degraded in terms of their physical and biological characteristics, as well as water quality. Despite this, they provide habitat for a range of native flora and fauna, as well as providing cultural and recreational values. They receive limited protection due largely to their location at the bottom of the catchment.</p> | <p>Threats to lake habitat are similar to those identified for wetlands and include:</p> <ul style="list-style-type: none"> <li>• invasive plants, weeds &amp; pest fish</li> <li>• altered hydrology</li> <li>• elevated nutrient and sediment levels in inflows and runoff from surrounding land</li> <li>• nuisance phytoplankton blooms</li> </ul> | <p>There is a lack of information on the benthic fauna of many lakes in the Taieri Catchment, including unique habitats such as the Sutton Salt Lake.</p> <p>The presence of invasive or nuisance aquatic plants is not well understood due to a lack of regular and comprehensive surveys.</p> | <p><b>Weed management of lakes Waihola and Waipori</b><br/>Weed and plant infestations (alder and crack willow) are being addressed by various parties (e.g., the Lake Waihola Waipori Wetlands Society, Fish &amp; Game, ORC). A re-evaluation of priorities and an update of management plans is required given the progress that has been made to date (e.g. the aerial spraying of crack willow around Lake Waihola/ Waipori-Waihola wetland).</p> <p><b>Macrophyte Cover in Lake Waipori/Waihola</b></p>   |

| VALUE                       | CONDITION/STATUS   | THREATS  | INFORMATION GAPS  | OPPS & ACTIONS   |
|-----------------------------|--|--|---|--|
|                             | <p>Two large artificial lakes in the catchment (Loganburn and Mahinerangi) are managed primarily for water supply needs (hydro generation and irrigation) rather than for ecosystem values.</p> <p>Some lakes have been lost from the catchment due to historic land use development (e.g., Lake Taieri)</p>   |  |   | <p>Consideration could be given to exploring methods to increase the macrophyte cover of the main two Lakes; this action would result in a greater biofiltering of nutrients as well as more extensive benthic habitat for fauna of the lakes.</p> <p><b>Restoration of Lake Taieri</b><br/>Lake Taieri, or tuna-heke-taha, situated in the Upper Taieri/Maniototo sub-catchment, was once a special place for Kāi Tahu on their journeys inland. The lake was drained in the 1940s. Kāi Tahu have developed a policy to promote the re-establishment of Lake Taieri as a mahika kai (Kāi Tahu, 2005). Part of the historic lake bed is protected as a 51.3 ha Conservation Area - Taieri Lake (Figure 15) meaning restoring longfin eel populations from mountains to sea could be enhanced through restoration of this site.</p> <p>Although Lake Taieri could be restored for mahika kai, restoring lost wetland plant values will be much more challenging, at least over the short-term. Active and sustained management would be required to restore even some of the lost plant values (Dr Peter Johnson, pers. comm. July 2020).</p> <p><b>Floating Wetlands in Lake Waipori/Waihola</b><br/>Floating wetlands have some potential to biologically remove nutrients and sediment from Lakes Waipori/Waihola, and thereby limiting the occurrence of nuisance algal blooms. Because the lakes are popular for recreation, the feasibility of floating wetlands requires careful consideration (see Schallenberg, 2019).</p> |
| <b>RIVERS &amp; ESTUARY</b> | <p>The Taieri River and many of its tributaries are subject to abstraction for irrigation and hydro generation, and the Taieri catchment is regarded as being over-allocated. This means that the natural hydrology is altered, particularly at the low flow end of the hydrology spectrum. This situation can have widespread ramifications for river ecology and water quality.</p> <p>Due to the number of deemed permits in the catchment, altered hydrology has been a feature for many decades. It is likely that the upcoming transition from deemed permits to resource consents will result in better protection of surface hydrology with consequential improvements to river ecology.</p> | <p>Threats to river habitat include:</p> <ul style="list-style-type: none"> <li>• over-allocation/abstraction, particularly in mid to upper catchment tributaries – affecting low flow hydrology</li> <li>• inappropriately designed pumping stations, culverts and flap gates – all affecting fish habitat and fish migration</li> <li>• increasing land for production forestry resulting in lower water yields under warmer climate conditions</li> <li>• continued stock access to river banks and wetted areas</li> <li>• elevated nutrient and sediment levels in inflows and runoff from surrounding land</li> <li>• nuisance periphyton growths</li> </ul> | <p>There is a general lack of information on the ecological health and habitat quality of many tributaries of the Taieri River, and parts of the estuarine environment have not been assessed for flora and faunal values.</p> <p>Barriers to fish movement in the lower catchment are not well documented.</p> | <p><b>Catchment-wide surveys to document river ecosystem health</b><br/>Coordinate with ORC to develop a comprehensive survey of rivers and streams throughout the Taieri catchment to determine current ecosystem health and to identify priority areas for closer attention to understand pressures.</p> <p><b>Surveys to determine the level of fine sediment deposition in naturally hard surface tributaries</b><br/>This could be a component of the ecosystem health survey above.</p> <p><b>Inventory of barriers to fish movement</b><br/>A GIS-based inventory of barriers to fish movement in the Taieri catchment would assist</p>   |

| VALUE                    | CONDITION/STATUS   | THREATS  | INFORMATION GAPS   | OPPS & ACTIONS   |
|--------------------------|--|--|--|--|
|                          | <p>Rivers in other parts of the catchment are subject to elevated nutrient and sediment runoff from catchments that are largely dominated by agricultural and production forestry. Elevated levels of <i>E. coli</i> are also a feature of some rivers in developed catchments.</p> <p>Some smaller tributaries such as the Silver Stream and Owhiro Stream have been physically modified for flood protection and urban development, and receive urban stormwater.</p> <p>Water quality is generally poorer in rivers located further down the catchment.</p> <p>Flood protection initiatives over many decades has meant that the natural physical character of rivers and streams, particularly in the lower part of the catchment (including the estuary), have been highly modified and constrained by channelization, stop banks, pumping stations and control gates.</p> <p>Being a drinking water supply catchment and located in public conservation land (Te Papanui Conservation Park), Deep Stream is relatively well protected from land use development although it is subject to abstraction.</p> | <ul style="list-style-type: none"> <li>• fine sediment deposition on natural hard substrate rivers and streams</li> <li>• climate change causing water temperatures to generally increase</li> <li>• invasive plants, weeds &amp; pest fish</li> <li>• inundation and loss of habitat through impoundments</li> </ul>  |  | <p>in the management and prioritisation for improving them to allow fish movement of desirable species.</p> <p><b>Instream rehabilitation of Silver Stream</b><br/>Parts of Silver Stream have banks that are bare of shade-vegetation, and instream habitat is barren and unsuitable for native fish species such as giant kokopu. Despite ORC's interest in managing flood-risk of Silver Stream, opportunities exist to increase habitat variety (especially create more riffles habitat) of Silver Stream without affecting flood risk.</p> <p><b>Planting riparian margins of the Taieri River and Estuary</b><br/>Planting riparian margins, especially over the lower catchment and Taieri Plains would help minimise erosion, restore stock-damaged margins and to provide shade and cover.</p> <p>ORC have produced riparian planting guidelines for Coastal, Central, Upper Clutha, East and South East Otago<sup>44</sup>. These guidelines are useful, but are targeted at nutrient interception, rather than improving instream habitat.</p> <p>We recommend further planting is carried out along all waterways of the Taieri Plains including Silver Stream, Owhiro Stream, Lee Stream and the drainage channels of the plains.</p> |
| <b>FLORA &amp; FAUNA</b> |  |  |  |  |
| <b>INVERTEBRATES</b>     | <p>Benthic invertebrates are monitored by ORC at six river sites for ecosystem health purposes (i.e., using a health index approach). This has limited value in terms of identifying rare communities or understanding the distribution and abundance of valued species (e.g., koura and kakahi). The sites that are monitored show that river invertebrate communities are generally in a degraded state relative to unmodified ecosystems.</p> <p>The health of aquatic invertebrate communities in other parts of the Taieri catchment is unknown, but can be inferred from catchment land use activities and protection of riparian habitat. Community diversity and health are likely to be greatest in catchments dominated</p>  | <p>Threats to aquatic invertebrate communities include:</p> <ul style="list-style-type: none"> <li>• over-allocation/abstraction, particularly in mid to upper catchment tributaries – affecting low flow hydrology</li> <li>• elevated nutrient and sediment levels in runoff from surrounding land and upstream catchments</li> <li>• nuisance periphyton growths</li> <li>• fine sediment deposition on natural hard substrate rivers and streams</li> <li>• climate change causing water temperatures to generally increase</li> <li>• generally poor water quality, including low water clarity and emerging contaminants</li> <li>• inadequate protection of riparian margins</li> </ul> | <p>The general health of benthic communities in flowing waters of the Taieri catchment.</p> <p>Descriptions of lake benthic fauna, and wetland species (both aquatic and terrestrial).</p> <p>The population status of 'Threatened', 'At Risk' and 'Data Deficient' invertebrate species. Specifically, the population status of kakahi freshwater mussels) and koura (freshwater mussels).</p> <p>The distribution, ecology and population status of tadpole shrimps.</p> <p>The benthic fauna of Sutton Salt Lake, including the population status of <i>Holcaspis</i> species within the catchment.</p> | <p><b>General surveys to determine invertebrate community health</b><br/>There are significant gaps in knowledge relating to invertebrates of the Taieri catchment. Knowledge gaps can be addressed with targeted surveys and research.</p> <p>More comprehensive and widespread surveys of stream and lake invertebrate communities is recommended to determine community and ecosystem health and to target problem sub-catchments.</p> <p><b>Specific surveys to determine species' distribution, abundance and level of protection</b><br/>Specific surveys of the catchment for kakahi, koura and tadpole shrimp are recommended.</p>   |

<sup>44</sup> <https://www.orc.govt.nz/managing-our-environment/water/good-practice-information>

| VALUE       | CONDITION/STATUS   | THREATS   | INFORMATION GAPS  | OPPS & ACTIONS  |
|-------------|--|---|---|---|
|             | <p>by native forest and tussock land with minimal stock and sediment deposition.</p> <p>Little is known about the condition of invertebrate communities associated with the estuary, lakes and wetlands, however it is likely that communities of the lower catchment lakes and the estuary will be dominated by pollution-tolerant species.</p>   |   |   | <p><b>Restoration projects</b><br/>Restoration projects for koura, include Sinclair wetlands (Ingle, 2002), but no other restoration projects are known for invertebrates of the catchment. The feasibility of translocations of kakahi into new locations such as the Loganburn reservoir could be considered.</p>   |
| <b>FISH</b> | <p>The Taieri River catchment has a diverse native fish fauna consisting of 18 species.</p> <p>Four of the most threatened<sup>45</sup> indigenous/native fishes of the Taieri catchment include non-migratory species (Eldon's, dusky, Central Otago roundhead, and Taieri flathead galaxias) with limited geographical distribution. The first three are classed as 'Nationally Endangered' while the Taieri flathead is 'Nationally Vulnerable'.</p> <p>Two other species are classed as 'Nationally Vulnerable' and five species are classed as 'At Risk Declining'.</p> <p>While native fish are protected under various legislation, the sub-populations of some species are small and fragmented.</p> | <p>Threats to fish and fish communities include:</p> <ul style="list-style-type: none"> <li>• over-allocation/abstraction, particularly in mid to upper catchment tributaries – affecting low flow hydrology</li> <li>• fine sediment deposition on natural hard substrate rivers and streams – affecting spawning habitat for some species</li> <li>• generally poor water quality</li> <li>• inadequate protection of riparian margins including the removal of vegetation that provide shade and filter nutrients and sediment, and access by stock elevating nutrients and causing bank erosion</li> <li>• barriers to fish movement, particularly for migration to complete life cycles</li> <li>• species that are predatory or compete for habitat, such as brown trout</li> <li>• channelization of smaller watercourses altering habitat and changing local hydrology</li> <li>• introduction or expansion of undesirable species (e.g., due to climate change)</li> <li>• commercial and recreational harvesting</li> </ul> | <p>Climate change effects on threatened species including emerging biosecurity threats, such as invasive freshwater fauna and flora species, and disease.</p> <p>Genetic interchange between fragmented populations of non-migratory galaxiids.</p> <p>Distribution, population trends and patterns of recruitment for giant kokopu, longfin eel and lamprey.</p> <p>Barriers to passage of migratory species (already addressed above under rivers).</p> <p>Location of spawning habitat and potential for stream restoration (focussed on Taieri Plains; see Bruno, 2003; Hickford and Schiel, 2014).</p> <p>Effective restoration methodology for spawning habitat (out of stream), and instream (to promote fish-species diversity and co-existence with salmonids).</p> <p>Translocation opportunities/methodologies. Ecology of poorly known species in Taieri, particularly lamprey.</p> <p>Possible role perch play in exacerbating algal blooms in Lake Waipori/Waihola.</p> <p>The extent of whitebait spawning habitat in the lower catchment is not well understood, nor the distribution of some threatened native fish species.</p> | <p><b>Species distribution &amp; habitat mapping</b><br/>Little is known about the native fish values of the upper reaches of Deep Creek and general survey work should be undertaken<sup>46</sup>.</p> <p>Instream habitats of almost all the main tributaries of the Taieri River are not known including Nenthorn Stream, Logan Burn, Lee Stream and Deep Stream, and especially the small headwater streams of these tributaries.</p> <p><b>Survey to identify significant spawning sites for whitebait fishes</b><br/>There is no up-to-date information on the location and current threats to important whitebait spawning grounds (spawning sites for kōaro, inanga, giant kokopu, and banded kokopu). Priority spawning grounds for indigenous fish species need to be identified and their level of protection assessed.</p> <p>Given the threats and pressures to the lower Taieri catchment, an assessment of recruitment success for these species would also be prudent to undertake, over the longer term. Many community stakeholders would have an interest in this project, including Kāi Tahu, ORC, DCC, white baiters and Fish and Game.</p> <p><b>Inventory of weirs, culverts and other impediments to fish passage over Taieri Plains</b><br/>As noted above under Rivers, information on barriers to movement and dispersal of native fishes over the wider Taieri Plains is sparse.</p> <p>The NPS-FM (2020) requires that every regional council must make or change its regional plan(s) to promote the remediation of existing structures that cause a barrier to fish passage (unless the barriers protect native fish</p> |

<sup>45</sup> As per Dunn *et al.* 2018.

<sup>46</sup> Non-migratory galaxiid key site - Taieri flathead, Deep Creek trib - DOCDM-339002.doc

| VALUE           | CONDITION/STATUS   | THREATS   | INFORMATION GAPS   | OPPS & ACTIONS   |
|-----------------|--|---|--|--|
|                 |  |   |  | <p>populations upstream from undesirable species).</p> <p>To achieve this, every regional council must prepare an action plan to support the achievement of the fish passage.</p> <p>The Department should seek to work with the ORC in developing an inventory of fish passage barriers, and formulating action plans to prioritise barriers for remediation (where appropriate).</p> <p><b>Use of eDNA Techniques to Map Distribution of native Fishes over Taieri plains</b></p> <p>New eDNA techniques offer accurate, but cost-effective methods to map and monitor native fishes over the Taieri catchment, including over land when access is problematic. The use of eDNA will be the subject of a special issue of the New Zealand Journal of Zoology, scheduled for publication in 2021.</p>   |
| <b>AVIFAUNA</b> | <p>At least 71 bird species have been recorded in the Taieri catchment, including up to 40 species associated with wetlands and up to 31 species associated with forest or open country (Appendix 11). Lakes Waihola and Waipori and their associated wetlands are the most significant waterfowl habitat in Otago and the area supports a variety of 'At Risk' and 'Threatened' species.).</p> <p>Some aquatic habitat used by birds is protected and/or is identified under district and regional plans.</p> | <p>Threats to birds include:</p> <ul style="list-style-type: none"> <li>• predation by exotic mammalian predators (stoats, ferrets and cats)</li> <li>• human-related mortality (e.g., hunting, falcons shots as pests, electrocution from power lines)</li> <li>• loss of habitat through the likes of drainage</li> </ul> | <p>Distribution and population status of threatened bird species of the Taieri catchment.</p> <p>Habitat use and management of habitat of threatened species.</p> <p>Up-to-date information pertaining to the distribution and population status of species across the catchment could not be found. This information gap is particularly important for the Australasian bittern.</p> <p>Habitat for black billed gulls and black fronted terns occurs over the Taieri catchment, but how important this habitat is to the national populations of these species is another information gap.</p> | <p><b>Species distribution - general</b></p> <p>A general update on the distribution of threatened or uncommon native bird species of the Taieri catchment is recommended. This should be coupled with an assessment of the abundance and distribution of habitat for specific species.</p> <p><b>Population status</b></p> <p>Recent DOC-led research<sup>47</sup> using GPS tracking has shown that the Australasian bittern relies on a network of wetlands and may be rarer than first thought, possibly because the same individual is counted over several wetlands. Obtaining information on the population status and habitat use of bitterns, crested grebes and grey duck is considered an important survey requirement. This work would inform restoration options to suit these species, that could include facilitating the passage of native fishes that provide food e.g. eiders.</p> |
| <b>LIZARDS</b>  | <p>The Taieri catchment has a diverse lizard fauna, with 10 recorded species, 9 of which are rare or threatened. Three are classed as 'Threatened - Nationally critical', five are classed as 'At Risk - Declining', and one is classed as 'Data Deficient'.</p>   | <p>Threats to lizards include:</p> <ul style="list-style-type: none"> <li>• predation by exotic mammalian predators</li> <li>• loss of habitat</li> <li>• fire</li> </ul>   | <p>Distribution of lizards within the Taieri catchment.</p> <p>Population status and conservation needs of the green skink.</p>  | <p>Large areas of the catchment have no lizard records (i.e., in the DOC Herpetofauna database), yet recent discoveries of, for example, Burgan skink in the Te Papanui Conservation Park following a fire (Knox <i>et al.</i> 2020); and the Oteake skink in Oteake Conservation Park (Knox <i>et al.</i> 2020b), indicate</p>  |

<sup>47</sup> <https://www.doc.govt.nz/news/media-releases/2019/double-up-means-dip-for-bittern-population/>



| VALUE                     | CONDITION/STATUS  | THREATS   | INFORMATION GAPS  | OPPS & ACTIONS  |
|---------------------------|---|---|---|---|
|                           |   |   |   | search effort is at least part of the reason. Basic survey to address gaps is recommended. In terms of priority species of the catchment, the green skink is thought to have disappeared from historic sites (Jensen, 2015), and research into the current population status of this species, and determining its conservation management needs, is a priority for the Taieri catchment. Knowledge gaps can be addressed with targeted survey and research.   |
| <b>PLANTS &amp; WEEDS</b> | <p>Seventy eight 'At Risk' or 'Threatened' plant species have been recorded from wetlands and riparian margins of the Taieri catchment (Appendix 7). Twenty-four species of plants are Nationally Threatened ('Nationally Critical', 'Endangered' and 'Vulnerable').</p> <p>Important salt pan/saline sites are protected on a mix of public conservation land and district plan schedules.</p> | <p>Threats to wetland and riparian native plants include:</p> <ul style="list-style-type: none"> <li>• drainage</li> <li>• irrigation</li> <li>• cultivation</li> <li>• invasion of wetlands by terrestrial-based plants such as gorse, crack and grey willow (Table 19).</li> <li>• invasion of lakes by invasive macrophyte species such as hornwort and <i>Lagarosiphon</i>.</li> </ul>  | <p>Recent and up-to-date plant lists for the Taieri catchment.</p> <p>Population status of 'Threatened' plant species. Very little is known about the conservation status of indigenous aquatic plants, with most available literature for the Taieri being from 10 or more years ago.</p> <p>Status of macrophyte cover in Lake Waihola.</p> | <p><b>Survey for aquatic weeds in Lake Waihola</b><br/>Aquatic weeds have the potential to have a big impact on freshwater values of Lake Waihola. As identified in section 6 (weeds), only the Canadian pondweed, <i>Elodea canadensis</i> has been found during surveys in Lake Waihola. Explore the benefit and opportunity to establish an annual or two-yearly survey for aquatic weeds.</p> <p><b>Investigate and review the efficacy of any weed plans in the catchment</b><br/>Establishment and invasion of weeds into wetlands and other freshwater habitats are known to impact on biodiversity values and degrade condition. Any existing weed plans should be reviewed and updated, and opportunities to develop weed plans for key sites investigated.</p> <p><b>Restoration of Paerau Wetland</b><br/>Restoration of the newly protected "Paerau Wetland" has been suggested by DOC (see Rance, 2019). Suggested restoration, with a focus on botanical values, includes restoration planting to provide greater structure and provide additional habitat within the wetland. A list of suitable species is suggested for multiple habitats within the wetland, including some threatened plants species such as <i>Olearia lineata</i>, <i>O. hectorii</i>, <i>O. fimbriata</i> and <i>Coprosma wallii</i> (Rance, 2019).</p> |
| <b>ADVOCACY</b>           |   |   |   |   |
|                           |   | <p>There are many special areas over the Taieri catchment, with important conservation values, that are not currently protected under district plans as SNAs. Once designated an SNA, these areas are protected by plan rules directed by various National Policy Statements and National Environmental Standards. Under the draft NPS Indigenous biodiversity (NPSIB), councils are required to identify any areas that meet the</p> |   | <p><b>Submissions on District Plans &amp; classifying stewardship land</b><br/>DOC has an important role on private land to protect fauna and flora by submitting to councils on regional and district plan changes and plan reviews. For the Taieri catchment, many of the land uses of primary concern to conservation values on private land are regulated under the RMA (1991). For example, surface runoff into</p>  |

| VALUE | CONDITION/STATUS | THREATS  | INFORMATION GAPS | OPPS & ACTIONS  |
|-------|------------------|--|------------------|---|
|       |                  | <p>significance levels laid out in the NPSIB document. However, until it becomes fully operative, such areas are vulnerable. Identifying wetlands and their buffer area, is important for areas already planted in conifers, or where afforestation is permitted by plans.</p> |                  | <p>waterbodies, wetland drainage, afforestation, cultivation, irrigation/abstraction and cattle grazing/dairying.</p> <p>Blanket protection for many problematic land use practices can be achieved through scheduling a site as a “significant natural area” (SNA) or equivalent, e.g. area of significant biodiversity value (ASBV) under the DCC 2GP.</p> <p>Submitting on Plan changes and plan reviews is important in the Waitaki District. Submitting on plan zoning is important to ensure important conservation values are protected from afforestation and dairying.</p> <p>In terms of PCL (see Appendix 2), many areas are not classified beyond “Stewardship Land”. Such areas are vulnerable to future development. The classification of areas of Stewardship Land that contain important conservation values as for example, Scenic Reserve, offer them much more robust protection from future central government policy.</p> |

**Table 18** Priority 1,2 and 3 weeds in the Waihola-Waipori wetland complex. Each weed is rated on a scale of 1-3 for each criterion, with higher numbers indicating higher risk of spread, higher impacts, more widespread distribution, and greater ease of management (Table from Rate, 2009).

| Weed Classification | Species  | Risk of spread | Impact | Distribution | Management | Totals |
|---------------------|--|----------------|--------|--------------|------------|--------|
| Priority 1          | Alder ( <i>Alnus glutinosa</i> )   | 3              | 3      | 2            | 2          | 10     |
|                     | Crack willow ( <i>Salix fragilis</i> )   | 3              | 3      | 3            | 1.5        | 10.5   |
|                     | Grey willow ( <i>Salix cinerea</i> )   | 3              | 2      | 2            | 2          | 9      |
|                     | Reed sweet grass ( <i>Glyceria maxima</i> )  | 3              | 2      | 2            | 1.5        | 8.5    |
| Priority 2          | Blackberry ( <i>Rubus fruticosus</i> agg.)   | 2              | 1.5    | 2            | 1          | 6.5    |
|                     | Elder ( <i>Sambucus nigra</i> )  | 2              | 1      | 2            | 2          | 7      |
|                     | Gorse ( <i>Ulex europaeus</i> )  | 2              | 2      | 2            | 2          | 8      |
|                     | Montpellier broom ( <i>Teline monspessulana</i> )  | 2              | 1      | 1            | 1          | 5      |
|                     | Red alder ( <i>Alnus rubra</i> )   | 3              | 1      | 1            | 1          | 6      |
|                     | Scotch broom ( <i>Cytisus scoparius</i> )  | 2.5            | 2      | 2            | 2          | 8.5    |
|                     | Silver birch ( <i>Betula pendula</i> )   | 2              | 1      | 1            | 3          | 7      |
|                     | Wilding conifers ( <i>Alies alba</i> , <i>Chamaecyparis</i> sp., <i>Picea sitchensis</i> , <i>Pinus radiata</i> , <i>Pseudotsuga menziesii</i> ) | 2              | 1      | 2            | 2          | 7      |
| Priority 3          | Bittersweet ( <i>Solanum dulcamara</i> )   | 1              | 1      | 1            | 1          | 4      |
|                     | Cotoneaster sp.  | 1              | 1      | 1            | 2          | 5      |
|                     | Elm ( <i>Ulmus x hollandica</i> )  | 2              | 1      | 1            | 2          | 6      |
|                     | Eucalyptus spp.  | 1              | 1      | 1            | 3          | 6      |
|                     | Hawthorn ( <i>Crataegus monogyna</i> )   | 1              | 1      | 1            | 2          | 5      |
|                     | Macrocarpa ( <i>Cubressus macrocarpa</i> )   | 1              | 1      | 1            | 3          | 6      |
|                     | Rowan ( <i>Sorbus aucuparia</i> )  | 1              | 1      | 1            | 3          | 6      |
|                     | Swamp cypress ( <i>Taxodium distichum</i> )  | 1              | 1      | 1            | 3          | 6      |
|                     | Sweet briar ( <i>Rosa rubiginosa</i> )   | 1              | 1      | 1            | 2          | 5      |



**Figure 15** *Public conservation land, 51.3 ha Conservation Area - Taieri Lake over part of the historic Taieri Lake bed (blue shaded polygon). There are also DOC-managed esplanade reserves in and around the Conservation area. The Kye Burn is pictured to the right of the Conservation Area flowing from north to south.*

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## Appendix 1 Taoka species of the Taieri catchment

Sources: Otago CMS (2016), and Kāi Tahu Natural Resource Management Plan 2005.

| Name in Māori          | Name in English         | Scientific Name   |
|------------------------|-------------------------|---|
| Pipi/Kākahi            | Pipi                    | <i>Paphies australe</i>                                 |
| Tuaki                  | Cockle                  | <i>Austrovenus stutchburgi</i>                          |
| Pipi/Kākahi            | Pipi                    | <i>Paphies australe</i>                                 |
| Waikaka/Pūpū           | Mudsnail                | <i>Amphibola crenata, Turbo smaragdus, Zedilom spp.</i> |
| Paraki/Ngaiore         | Common smelt            | <i>Retropinna retropinna</i>                            |
| Piripiripōhatu         | Torrentfish             | <i>Cheimarrichthys fosteri</i>                          |
| Taiwharu               | Giant kōkopu            | <i>Galaxias argenteus</i>                               |
| Hoiho                  | Yellow-eyed penguin     | <i>Megadyptes antipodes</i>                             |
| Kāhu                   | Australasian harrier    | <i>Circus approximans</i>                               |
| Kakaruai               | South Island robin      | <i>Petroica australis australis</i>                     |
| Kakī                   | Black stilt             | <i>Himantopus novaeseelandiae</i>                       |
| Kāmana                 | Crested grebe           | <i>Podiceps cristatus</i>                               |
| Kārearea               | New Zealand falcon      | <i>Falco novaeseelandiae</i>                            |
| Karoro                 | Black-backed gull       | <i>Larus dominicanus</i>                                |
| Kōau                   | Black shag              | <i>Phalacrocorax carbo</i>                              |
| Kōau                   | Little shag             | <i>Phalacrocorax melanoleucos brevirostris</i>          |
| Koekoeā                | Long-tailed cuckoo      | <i>Eudynamis taitensis</i>                              |
| Kōparapara or Korimako | Bellbird                | <i>Anthornis melanura melanura</i>                      |
| Kororā                 | Little penguin          | <i>Eudyptula minor</i>                                  |
| Kōtare                 | Kingfisher              | <i>Halcyon sancta</i>                                   |
| Kōtuku                 | White heron             | <i>Egretta alba</i>                                     |
| Kūaka                  | Bar-tailed godwit       | <i>Limosa lapponica</i>                                 |
| Kūkupa/Kererū          | New Zealand wood pigeon | <i>Hemiphaga novaeseelandiae</i>                        |
| Kuruwhengu/Kuruwhengi  | New Zealand shoveller   | <i>Anas rhynchos</i>                                    |
| Matuku moana           | Reef heron              | <i>Egretta sacra</i>                                    |
| Mātā                   | Fernbird                | <i>Bowdleria punctata punctata</i>                      |
| Miromiro               | South Island tomtit     | <i>Petroica macrocephala macrocephala</i>               |
| Pākura/Pūkeko          | Swamp hen/Pūkeko        | <i>Porphyrio porphyrio</i>                              |
| Pārera                 | Grey duck               | <i>Anas superciliosa</i>                                |
| Pateke                 | Brown teal              | <i>Anas aucklandica</i>                                 |
| Pīhoihoi               | New Zealand pipit       | <i>Anthus novaeseelandiae</i>                           |
| Pipīwharau             | Shining cuckoo          | <i>Chrysococcyx lucidus</i>                             |
| Pīwakawaka             | South Island fantail    | <i>Rhipidura fuliginosa fuliginosa</i>                  |
| Poaka                  | Pied stilt              | <i>Himantopus himantopus</i>                            |
| Pūtakitaki             | Paradise shelduck       | <i>Tadorna variegata</i>                                |
| Riroriro               | Grey warbler            | <i>Gerygone igata</i>                                   |
| Ruru koukou            | Morepork                | <i>Ninox novaeseelandiae</i>                            |
| Tara                   | Terns                   | <i>Sterna spp.</i>                                      |
| Tete                   | Grey teal               | <i>Anas gracilis</i>                                    |
| Tūi                    | Tui                     | <i>Prosthemadera novaeseelandiae</i>                    |

## Appendix 2 Public Conservation Land over the Taieri Catchment

| Name   | Section                        | Area (ha) | Type              |
|--|--------------------------------|-----------|-------------------|
| Allanton Wildlife Management Reserve               | S22_GOVERNMENT_PURPOSE_RESERVE | 11.2      | RESERVE           |
| Black Rock Scientific Reserve                      | S21_SCIENTIFIC_RESERVE         | 143.2     | RESERVE           |
| Burgan Creek Marginal Strip                        | S24_3_FIXED_MARGINAL_STRIP     | 4.0       | MARGINAL_STRIP    |
| Canadian Flats Wildlife Management Reserve         | S22_GOVERNMENT_PURPOSE_RESERVE | 108.3     | RESERVE           |
| Chalkies Scenic Reserve                            | S19_1_A_SCENIC_RESERVE         | 201.4     | RESERVE           |
| Conservation Area - Access to Taieri River         | S25_STEWARDSHIP_AREA           | 1.4       | CONSERVATION_AREA |
| Conservation Area - Aitken Road                    | S25_STEWARDSHIP_AREA           | 0.3       | CONSERVATION_AREA |
| Conservation Area - Allanton Wildlife Reserve      | S25_STEWARDSHIP_AREA           | 5.3       | CONSERVATION_AREA |
| Conservation Area - Canadian Flats Quarry Reserve  | S25_STEWARDSHIP_AREA           | 1.7       | CONSERVATION_AREA |
| Conservation Area - Christie Gully Road            | S25_STEWARDSHIP_AREA           | 0.3       | CONSERVATION_AREA |
| Conservation Area - Cliffs Road                    | S25_STEWARDSHIP_AREA           | 0.2       | CONSERVATION_AREA |
| Conservation Area - Cogans Bush Bridge Ford        | S25_STEWARDSHIP_AREA           | 8.0       | CONSERVATION_AREA |
| Conservation Area - Deep Stream                    | S25_STEWARDSHIP_AREA           | 5.6       | CONSERVATION_AREA |
| Conservation Area - Deep Stream                    | S25_STEWARDSHIP_AREA           | 2.1       | CONSERVATION_AREA |
| Conservation Area - Duffy Lane Gravel Reserve      | S25_STEWARDSHIP_AREA           | 1.2       | CONSERVATION_AREA |
| Conservation Area - Ewe Burn                       | S25_STEWARDSHIP_AREA           | 36.4      | CONSERVATION_AREA |
| Conservation Area - Geddes Rd Gravel Reserve       | S25_STEWARDSHIP_AREA           | 1.2       | CONSERVATION_AREA |
| Conservation Area - George King Drive / Lee Stream | S25_STEWARDSHIP_AREA           | 3.0       | CONSERVATION_AREA |
| Conservation Area - Gibson Rd Gravel Reserve       | S25_STEWARDSHIP_AREA           | 1.9       | CONSERVATION_AREA |
| Conservation Area - Glendhu "Tussock Reserve"      | S25_STEWARDSHIP_AREA           | 322.3     | CONSERVATION_AREA |
| Conservation Area - Hamilton Diggings              | S25_STEWARDSHIP_AREA           | 16.9      | CONSERVATION_AREA |
| Conservation Area - Henley                         | S25_STEWARDSHIP_AREA           | 1.0       | CONSERVATION_AREA |
| Conservation Area - Henley                         | S25_STEWARDSHIP_AREA           | 0.9       | CONSERVATION_AREA |
| Conservation Area - Hog Burn                       | S25_STEWARDSHIP_AREA           | 1.4       | CONSERVATION_AREA |
| Conservation Area - Hyde / Tiroiti                 | S25_STEWARDSHIP_AREA           | 0.4       | CONSERVATION_AREA |
| Conservation Area - Johnson Road                   | S25_STEWARDSHIP_AREA           | 3.1       | CONSERVATION_AREA |

| Name  | Section              | Area (ha) | Type              |
|---|----------------------|-----------|-------------------|
| Conservation Area - Kowhai Spur                           | S25_STEWARDSHIP_AREA | 1.3       | CONSERVATION_AREA |
| Conservation Area - Kowhai Spur                           | S25_STEWARDSHIP_AREA | 0.6       | CONSERVATION_AREA |
| Conservation Area - Kye Burn                              | S25_STEWARDSHIP_AREA | 0.0       | CONSERVATION_AREA |
| Conservation Area - Kye Burn Diggings Road Gravel Reserve | S25_STEWARDSHIP_AREA | 0.5       | CONSERVATION_AREA |
| Conservation Area - Lee Flat Gravel Reserve               | S25_STEWARDSHIP_AREA | 3.3       | CONSERVATION_AREA |
| Conservation Area - Lee Stream Road Quarry Reserve        | S25_STEWARDSHIP_AREA | 3.7       | CONSERVATION_AREA |
| Conservation Area - Mahinerangi Road Quarry Reserve       | S25_STEWARDSHIP_AREA | 2.0       | CONSERVATION_AREA |
| Conservation Area - Maungatua Range Quarry Reserve        | S25_STEWARDSHIP_AREA | 4.3       | CONSERVATION_AREA |
| Conservation Area - Mill Creek "Scenic Reserve"           | S25_STEWARDSHIP_AREA | 384.2     | CONSERVATION_AREA |
| Conservation Area - Moonlight Quarry Reserve              | S25_STEWARDSHIP_AREA | 3.3       | CONSERVATION_AREA |
| Conservation Area - Mt Stoker Quarry Reserve              | S25_STEWARDSHIP_AREA | 3.8       | CONSERVATION_AREA |
| Conservation Area - Mundell Road Quarry Reserve           | S25_STEWARDSHIP_AREA | 2.5       | CONSERVATION_AREA |
| Conservation Area - Naseby Ice Skating Dam                | S25_STEWARDSHIP_AREA | 1.8       | CONSERVATION_AREA |
| Conservation Area - Nenthorn Bridge                       | S25_STEWARDSHIP_AREA | 3.3       | CONSERVATION_AREA |
| Conservation Area - Orangapai                             | S25_STEWARDSHIP_AREA | 0.6       | CONSERVATION_AREA |
| Conservation Area - Otago Pioneer Quartz (OPQ)            | S25_STEWARDSHIP_AREA | 58.9      | CONSERVATION_AREA |
| Conservation Area - Otokia Road                           | S25_STEWARDSHIP_AREA | 0.1       | CONSERVATION_AREA |
| Conservation Area - Paerau                                | S25_STEWARDSHIP_AREA | 31.8      | CONSERVATION_AREA |
| Conservation Area - Patearoa                              | S25_STEWARDSHIP_AREA | 9.0       | CONSERVATION_AREA |
| Conservation Area - Patearoa "Water Race & Creek Reserve" | S25_STEWARDSHIP_AREA | 6.1       | CONSERVATION_AREA |
| Conservation Area - Pukerangi                             | S25_STEWARDSHIP_AREA | 4.0       | CONSERVATION_AREA |
| Conservation Area - Puketoi Runs Road Gravel Reserve      | S25_STEWARDSHIP_AREA | 1.9       | CONSERVATION_AREA |
| Conservation Area - Ranfurly "Cemetery Reserve"           | S25_STEWARDSHIP_AREA | 0.2       | CONSERVATION_AREA |
| Conservation Area - Ranfurly Back Rd Gravel Reserve       | S25_STEWARDSHIP_AREA | 1.1       | CONSERVATION_AREA |
| Conservation Area - Ranfurly Naseby Rd Gravel Reserve     | S25_STEWARDSHIP_AREA | 2.8       | CONSERVATION_AREA |
| Conservation Area - Ranfurly Patearoa Rd Gravel Reserve   | S25_STEWARDSHIP_AREA | 2.0       | CONSERVATION_AREA |
| Conservation Area - Rocky Point Creek                     | S25_STEWARDSHIP_AREA | 13.9      | CONSERVATION_AREA |
| Conservation Area - Rocky Point Creek                     | S25_STEWARDSHIP_AREA | 3.8       | CONSERVATION_AREA |
| Conservation Area - Rocky Point Creek                     | S25_STEWARDSHIP_AREA | 2.8       | CONSERVATION_AREA |

| Name   | Section                    | Area (ha) | Type              |
|--|----------------------------|-----------|-------------------|
| Conservation Area - School Track                                     | S25_STEWARDSHIP_AREA       | 0.7       | CONSERVATION_AREA |
| Conservation Area - Scorgie Road Quarry Reserve                      | S25_STEWARDSHIP_AREA       | 1.8       | CONSERVATION_AREA |
| Conservation Area - SH 85 / Wedderburn Gravel Reserve                | S25_STEWARDSHIP_AREA       | 1.0       | CONSERVATION_AREA |
| Conservation Area - SH 85 / Wedderburn Gravel Reserve                | S25_STEWARDSHIP_AREA       | 1.7       | CONSERVATION_AREA |
| Conservation Area - SH 85 / Wedderburn Gravel Reserve                | S25_STEWARDSHIP_AREA       | 4.9       | CONSERVATION_AREA |
| Conservation Area - SH 87 / Woodside Road                            | S25_STEWARDSHIP_AREA       | 0.4       | CONSERVATION_AREA |
| Conservation Area - Shepherds Creek                                  | S25_STEWARDSHIP_AREA       | 5.3       | CONSERVATION_AREA |
| Conservation Area - Sow Burn   | S24_3_FIXED_MARGINAL_STRIP | 6.2       | MARGINAL_STRIP    |
| Conservation Area - Sullivans Bush                                   | S25_STEWARDSHIP_AREA       | 3.4       | CONSERVATION_AREA |
| Conservation Area - Taieri Gorge / Outram Glen "Scenic Reserve"      | S25_STEWARDSHIP_AREA       | 0.4       | CONSERVATION_AREA |
| Conservation Area - Taieri Lake                                      | S25_STEWARDSHIP_AREA       | 51.3      | CONSERVATION_AREA |
| Conservation Area - Taieri River / Island                            | S25_STEWARDSHIP_AREA       | 1.6       | CONSERVATION_AREA |
| Conservation Area - Taieri River / Middlemarch                       | S25_STEWARDSHIP_AREA       | 2.4       | CONSERVATION_AREA |
| Conservation Area - Taioma Road                                      | S25_STEWARDSHIP_AREA       | 0.4       | CONSERVATION_AREA |
| Conservation Area - Taioma Road                                      | S25_STEWARDSHIP_AREA       | 0.6       | CONSERVATION_AREA |
| Conservation Area - Town of Nenthorn                                 | S25_STEWARDSHIP_AREA       | 16.3      | CONSERVATION_AREA |
| Conservation Area - Tregonning Rd                                    | S25_STEWARDSHIP_AREA       | 0.2       | CONSERVATION_AREA |
| Conservation Area - Upper Taieri - Paerau Road Quarry Reserve        | S25_STEWARDSHIP_AREA       | 4.8       | CONSERVATION_AREA |
| Conservation Area - Waihola / Taieri Mouth Road                      | S25_STEWARDSHIP_AREA       | 0.5       | CONSERVATION_AREA |
| Conservation Area - Waipiata / Taieri River                          | S25_STEWARDSHIP_AREA       | 36.4      | CONSERVATION_AREA |
| Conservation Area - Waipiata Gravel Reserve                          | S25_STEWARDSHIP_AREA       | 1.1       | CONSERVATION_AREA |
| Conservation Area - Waipiata Kye Burn Rd Gravel Reserve              | S25_STEWARDSHIP_AREA       | 0.6       | CONSERVATION_AREA |
| Conservation Area - Waipiata Kye Burn Rd Gravel Reserve              | S25_STEWARDSHIP_AREA       | 1.2       | CONSERVATION_AREA |
| Conservation Area - Waipori Falls "Scenic Reserve" (Pt)              | S25_STEWARDSHIP_AREA       | 210.5     | CONSERVATION_AREA |
| Conservation Area - Waipori River                                    | S25_STEWARDSHIP_AREA       | 1.7       | CONSERVATION_AREA |
| Conservation Area - Waipori River                                    | S25_STEWARDSHIP_AREA       | 5.1       | CONSERVATION_AREA |
| Conservation Area - Wedderburn Gravel Reserve                        | S25_STEWARDSHIP_AREA       | 1.3       | CONSERVATION_AREA |
| Conservation Area - Wedderburn Maniototo Station Road Gravel Reserve | S25_STEWARDSHIP_AREA       | 2.0       | CONSERVATION_AREA |

| Name  | Section                        | Area (ha) | Type              |
|---|--------------------------------|-----------|-------------------|
| Conservation Area - West Eweburn Dam                                | S25_STEWARDSHIP_AREA           | 40.1      | CONSERVATION_AREA |
| Conservation Area - Wilkinsons Road                                 | S25_STEWARDSHIP_AREA           | 8.9       | CONSERVATION_AREA |
| Conservation Area - Wilson Rd Gravel Reserve                        | S25_STEWARDSHIP_AREA           | 0.7       | CONSERVATION_AREA |
| Conservation Area -Town of Hull Cemetery                            | S25_STEWARDSHIP_AREA           | 1.6       | CONSERVATION_AREA |
| Conservation Area -Wedderburn Maniototo Station Road Gravel Reserve | S25_STEWARDSHIP_AREA           | 2.7       | CONSERVATION_AREA |
| Cotton Scenic Reserve   | S19_1_A_SCENIC_RESERVE         | 189.7     | RESERVE           |
| Danseys Pass Recreation Reserve                                     | 17_RECREATION_RESERVE          | 6.2       | RESERVE           |
| Deep Creek / Waipori River Marginal Strip                           | S24_3_FIXED_MARGINAL_STRIP     | 5.0       | MARGINAL_STRIP    |
| Deep Creek Scenic Reserve   | S19_1_A_SCENIC_RESERVE         | 86.4      | RESERVE           |
| Deep Stream Marginal Strip  | S24_3_FIXED_MARGINAL_STRIP     | 85.0      | MARGINAL_STRIP    |
| Deep Stream Marginal Strip  | S24_3_FIXED_MARGINAL_STRIP     | 20.0      | MARGINAL_STRIP    |
| Deep Stream Marginal Strip  | S24_3_FIXED_MARGINAL_STRIP     | 12.9      | MARGINAL_STRIP    |
| Deighton Creek Marginal Strip                                       | S24_3_FIXED_MARGINAL_STRIP     | 15.0      | MARGINAL_STRIP    |
| Deighton Creek Nature Reserve                                       | S20_NATURE_RESERVE             | 603.5     | RESERVE           |
| Eden Creek Marginal Strip   | S24_3_FIXED_MARGINAL_STRIP     | 4.0       | MARGINAL_STRIP    |
| Eden Creek Wildlife Management Area                                 | S22_GOVERNMENT_PURPOSE_RESERVE | 37.5      | RESERVE           |
| Ford Road Plantation Reserve  | S23_LOCAL_PURPOSE_RESERVE      | 5.2       | RESERVE           |
| Fortification Creek Marginal Strip                                  | S24_3_FIXED_MARGINAL_STRIP     | 5.0       | MARGINAL_STRIP    |
| Gimmerburn - Waipiata Road Gravel Reserve                           | S23_LOCAL_PURPOSE_RESERVE      | 2.0       | RESERVE           |
| Gimmerburn Marginal Strip   | S24_3_FIXED_MARGINAL_STRIP     | 30.0      | MARGINAL_STRIP    |
| Hall Road Wetlands  | S22_GOVERNMENT_PURPOSE_RESERVE | 44.0      | RESERVE           |
| Henley Scenic Reserve   | S19_1_A_SCENIC_RESERVE         | 26.4      | RESERVE           |
| Hindon Community Centre   | 17_RECREATION_RESERVE          | 2.2       | RESERVE           |
| Hone Creek Marginal Strip   | S24_3_FIXED_MARGINAL_STRIP     |           | MARGINAL_STRIP    |
| Hyde - Macraes Road Gravel Reserve                                  | S23_LOCAL_PURPOSE_RESERVE      | 2.1       | RESERVE           |
| Kakaunui Conservation Area  | S25_STEWARDSHIP_AREA           | 6356.8    | CONSERVATION_AREA |
| Kinvara Track (Access to Rock & Pillar Cons Area)                   | S22_GOVERNMENT_PURPOSE_RESERVE | 5.7       | RESERVE           |
| Knights Dam Marginal Strip  | S24_3_FIXED_MARGINAL_STRIP     | 2.5       | MARGINAL_STRIP    |
| Kye Burn Marginal Strip   | S24_3_FIXED_MARGINAL_STRIP     | 5.0       | MARGINAL_STRIP    |

| Name  | Section                        | Area (ha) | Type              |
|---|--------------------------------|-----------|-------------------|
| Kye Burn Marginal Strip                               | S24_3_FIXED_MARGINAL_STRIP     | 75.0      | MARGINAL_STRIP    |
| Lake Mahinerangi Conservation Area                    | S25_STEWARDSHIP_AREA           | 12.3      | CONSERVATION_AREA |
| Lake Mahinerangi Marginal Strip                       | S24_3_FIXED_MARGINAL_STRIP     | 80.0      | MARGINAL_STRIP    |
| Lake Mahinerangi Marginal Strip                       | S24_3_FIXED_MARGINAL_STRIP     | 15.0      | MARGINAL_STRIP    |
| Lake Waihola - Gillanders Wildlife Management Reserve | S22_GOVERNMENT_PURPOSE_RESERVE | 26.9      | RESERVE           |
| Lake Waipori Wildlife Management Reserve              | S22_GOVERNMENT_PURPOSE_RESERVE | 63.7      | RESERVE           |
| Lee Stream Marginal Strip                             | S24_3_FIXED_MARGINAL_STRIP     | 12.0      | MARGINAL_STRIP    |
| Lee Stream Marginal Strip                             | S24_3_FIXED_MARGINAL_STRIP     | 5.0       | MARGINAL_STRIP    |
| Logan Burn Marginal Strip                             | S24_3_FIXED_MARGINAL_STRIP     | 15.0      | MARGINAL_STRIP    |
| Manuka Stream Conservation Area                       | S25_STEWARDSHIP_AREA           | 332.5     | CONSERVATION_AREA |
| Maukaatua Scenic Reserve                              | S19_1_A_SCENIC_RESERVE         | 1419.0    | RESERVE           |
| McKays Triangle Wildlife Management Reserve           | S22_GOVERNMENT_PURPOSE_RESERVE | 42.0      | RESERVE           |
| Mill Creek Scenic Reserve (Pt)                        | S19_1_A_SCENIC_RESERVE         | 472.4     | RESERVE           |
| Nardoo Stream Marginal Strip                          | S24_3_FIXED_MARGINAL_STRIP     | 10.0      | MARGINAL_STRIP    |
| Naseby Post Office                                    | S22_GOVERNMENT_PURPOSE_RESERVE | 0.1       | RESERVE           |
| Naseby Post Office Museum Site                        | S23_LOCAL_PURPOSE_RESERVE      | 0.0       | RESERVE           |
| Nenthorn Creek Marginal Strip                         | S24_3_FIXED_MARGINAL_STRIP     | 10.0      | MARGINAL_STRIP    |
| Nenthorn Stream Marginal Strip                        | S24_3_FIXED_MARGINAL_STRIP     | 10.0      | MARGINAL_STRIP    |
| Omnibus Creek Marginal Strip                          | S24_3_FIXED_MARGINAL_STRIP     |           | MARGINAL_STRIP    |
| Orbells Creek Marginal Strip                          | S24_3_FIXED_MARGINAL_STRIP     | 7.0       | MARGINAL_STRIP    |
| Otago Central Rail Trail                              | 17_RECREATION_RESERVE          | 748.0     | RESERVE           |
| Oteake Conservation Park                              | S19_CONSERVATION_PARK          | 64054.7   | CONSERVATION_AREA |
| Pig Burn Marginal Strip                               | S24_3_FIXED_MARGINAL_STRIP     | 30.0      | MARGINAL_STRIP    |
| Pioneer Stream Historic Reserve                       | S18_HISTORIC_RESERVE           | 217.1     | RESERVE           |
| Ranfurly Cemetery                                     | S23_LOCAL_PURPOSE_RESERVE      | 6.5       | RESERVE           |
| Redbank Scenic Reserve                                | S19_1_A_SCENIC_RESERVE         | 1460.8    | RESERVE           |
| Rock and Pillar Conservation Area                     | S25_STEWARDSHIP_AREA           | 9610.7    | CONSERVATION_AREA |
| Rock and Pillar Scenic Reserve                        | S19_1_A_SCENIC_RESERVE         | 443.0     | RESERVE           |
| Rocklands Road Quarry Reserve                         | S25_STEWARDSHIP_AREA           | 3.7       | CONSERVATION_AREA |

| Name   | Section                        | Area (ha) | Type              |
|--|--------------------------------|-----------|-------------------|
| Scrub Burn (Hyde) Marginal Strip                   | S24_3_FIXED_MARGINAL_STRIP     | 3.4       | MARGINAL_STRIP    |
| Serpentine Scenic Reserve                          | S19_1_A_SCENIC_RESERVE         | 750.9     | RESERVE           |
| Serpentine Wildlife Management Reserve             | S22_GOVERNMENT_PURPOSE_RESERVE | 135.8     | RESERVE           |
| Shepherds Hut and Stony Creek Wildlife Mgt Reserve | S22_GOVERNMENT_PURPOSE_RESERVE | 82.2      | RESERVE           |
| Shepherds Hut Creek Marginal Strip                 | S24_3_FIXED_MARGINAL_STRIP     |           | MARGINAL_STRIP    |
| Silverpeaks Scenic Reserve                         | S19_1_A_SCENIC_RESERVE         | 3649.8    | RESERVE           |
| Silver Stream Marginal Strip                       | S24_3_FIXED_MARGINAL_STRIP     | 1.5       | MARGINAL_STRIP    |
| Sow Burn Marginal Strip                            | S24_3_FIXED_MARGINAL_STRIP     | 4.0       | MARGINAL_STRIP    |
| Sow Burn Marginal Strip                            | S24_3_FIXED_MARGINAL_STRIP     | 16.0      | MARGINAL_STRIP    |
| Stony Stream Marginal Strip                        | S24_3_FIXED_MARGINAL_STRIP     | 10.0      | MARGINAL_STRIP    |
| Stony Stream Scenic Reserve                        | S19_1_A_SCENIC_RESERVE         | 163.7     | RESERVE           |
| Sullivans Bush Scenic Reserve                      | S19_1_A_SCENIC_RESERVE         | 36.1      | RESERVE           |
| Sutton Salt Lake Scenic Reserve                    | S19_1_A_SCENIC_RESERVE         | 143.0     | RESERVE           |
| Sutton Stream Marginal Strip                       | S24_3_FIXED_MARGINAL_STRIP     |           | MARGINAL_STRIP    |
| Swinburn Cemetery                                  | S23_LOCAL_PURPOSE_RESERVE      | 1.4       | RESERVE           |
| Swinburn Marginal Strip                            | S24_3_FIXED_MARGINAL_STRIP     | 6.0       | MARGINAL_STRIP    |
| Swinburn Marginal Strip                            | S24_3_FIXED_MARGINAL_STRIP     | 20.0      | MARGINAL_STRIP    |
| Taieri Gorge / Outram Glen Scenic Reserve (Part)   | S19_1_A_SCENIC_RESERVE         | 741.7     | RESERVE           |
| Taieri Lake Marginal Strip                         | S24_3_FIXED_MARGINAL_STRIP     | 12.8      | MARGINAL_STRIP    |
| Taieri Mouth Conservation Area                     | S25_STEWARDSHIP_AREA           | 1.4       | CONSERVATION_AREA |
| Taieri Rapids Scenic Reserve                       | S19_1_A_SCENIC_RESERVE         | 22.0      | RESERVE           |
| Taieri River (Allanton) Marginal Strip             | S24_3_FIXED_MARGINAL_STRIP     | 0.8       | MARGINAL_STRIP    |
| Taieri River (Deep Stream) Marginal Strip          | S24_3_FIXED_MARGINAL_STRIP     | 12.0      | MARGINAL_STRIP    |
| Taieri River (Hindon) Marginal Strip               | S24_3_FIXED_MARGINAL_STRIP     | 12.0      | MARGINAL_STRIP    |
| Taieri River (Un-named tributary) Marginal Strip   | S24_3_FIXED_MARGINAL_STRIP     | 5.0       | MARGINAL_STRIP    |
| Taieri River Marginal Strip                        | S24_3_FIXED_MARGINAL_STRIP     | 5.0       | MARGINAL_STRIP    |
| Taieri River Marginal Strip                        | S24_3_FIXED_MARGINAL_STRIP     | 4.0       | MARGINAL_STRIP    |
| Taieri River Marginal Strip                        | S24_3_FIXED_MARGINAL_STRIP     | 0.5       | MARGINAL_STRIP    |
| Taieri River Marginal Strip                        | S24_3_FIXED_MARGINAL_STRIP     | 20.0      | MARGINAL_STRIP    |

| Name  | Section                        | Area (ha) | Type              |
|---|--------------------------------|-----------|-------------------|
| Taieri River Marginal Strip                   | S24_3_FIXED_MARGINAL_STRIP     | 15.0      | MARGINAL_STRIP    |
| Taieri River Marginal Strip                   | S24_3_FIXED_MARGINAL_STRIP     | 10.0      | MARGINAL_STRIP    |
| Taieri River Marginal Strip                   | S24_3_FIXED_MARGINAL_STRIP     |           | MARGINAL_STRIP    |
| Taieri River Marginal Strip                   | S24_3_FIXED_MARGINAL_STRIP     | 30.0      | MARGINAL_STRIP    |
| Taieri River Marginal Strip                   | S24_3_FIXED_MARGINAL_STRIP     | 80.0      | MARGINAL_STRIP    |
| Taieri River Marginal Strip                   | S24_3_FIXED_MARGINAL_STRIP     | 20.0      | MARGINAL_STRIP    |
| Taieri River Scenic Reserve                   | S19_1_A_SCENIC_RESERVE         | 484.7     | RESERVE           |
| Taieri River Wildlife Management Reserve      | S22_GOVERNMENT_PURPOSE_RESERVE | 20.7      | RESERVE           |
| Te Papanui Conservation Area                  | S25_STEWARDSHIP_AREA           | 2153.5    | CONSERVATION_AREA |
| Te Papanui Conservation Park                  | S19_CONSERVATION_PARK          | 20591.0   | CONSERVATION_AREA |
| Three O'clock Stream Marginal Strip           | S24_3_FIXED_MARGINAL_STRIP     | 10.0      | MARGINAL_STRIP    |
| Three O'clock Stream Marginal Strip           | S24_3_FIXED_MARGINAL_STRIP     | 12.0      | MARGINAL_STRIP    |
| Timber Creek Conservation Area                | S25_STEWARDSHIP_AREA           | 2856.0    | CONSERVATION_AREA |
| Town of Nenthorn Historic Reserve             | S18_HISTORIC_RESERVE           | 0.1       | RESERVE           |
| Verter Burn Marginal Strip                    | S24_3_FIXED_MARGINAL_STRIP     | 20.0      | MARGINAL_STRIP    |
| Waiora Scientific Reserve                     | S21_SCIENTIFIC_RESERVE         | 5.3       | RESERVE           |
| Waipori / Waihola Wildlife Management Reserve | S23_LOCAL_PURPOSE_RESERVE      | 4.0       | RESERVE           |
| Waipori Cemetery Reserve                      | S23_LOCAL_PURPOSE_RESERVE      | 3.1       | RESERVE           |
| Waipori Falls "Scenic Reserve" (Pt)           | S23_LOCAL_PURPOSE_RESERVE      | 72.9      | RESERVE           |
| Waipori Falls Scenic Reserve (Pt)             | S19_1_A_SCENIC_RESERVE         | 1365.1    | RESERVE           |
| Waipori River Marginal Strip                  | S24_3_FIXED_MARGINAL_STRIP     | 5.0       | MARGINAL_STRIP    |
| Waipori River Marginal Strip                  | S24_3_FIXED_MARGINAL_STRIP     | 0.5       | MARGINAL_STRIP    |
| Waipori River Marginal Strip                  | S24_3_FIXED_MARGINAL_STRIP     | 30.0      | MARGINAL_STRIP    |
| Waipori River Marginal Strip                  | S24_3_FIXED_MARGINAL_STRIP     | 3.0       | MARGINAL_STRIP    |
| Waipori/Waihola Wildlife Management Reserve   | S22_GOVERNMENT_PURPOSE_RESERVE | 118.6     | RESERVE           |
| Wether Burn Marginal Strip                    | S24_3_FIXED_MARGINAL_STRIP     |           | MARGINAL_STRIP    |
| Wilson Road Plantation Reserve                | S23_LOCAL_PURPOSE_RESERVE      | 7.4       | RESERVE           |



## Appendix 3 The NPS-FM 2020 Appendix 2A attribute bands for periphyton (rivers) and phytoplankton (lakes)

Numeric states expressed as milligrams chlorophyll-a per square metre (rivers) or per cubic metre (lakes)

| Attribute Band                          | Numeric Attribute State (default class) <sup>1</sup> | Numeric Attribute State (productive class) <sup>2</sup> | Description   |
|---|--|---|---|
| <b>Periphyton (Rivers) <sup>3</sup></b> |  |   |   |
| A                                       | ≤50  | ≤50   | Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.  |
| B                                       | >50 and ≤120   | >50 and ≤120  | Occasional blooms reflecting low nutrient enrichment and/ or alteration of the natural flow regime or habitat.  |
| C                                       | >120 and ≤200  | >120 and ≤200   | Periodic blooms reflecting moderate nutrient enrichment and/ or moderate alteration of the natural flow regime or habitat.  |
| <b>National Bottom Line</b>             | <b>200</b>   | <b>200</b>  |   |
| D                                       | >200   | >200  | Regular and/or extended-duration nuisance blooms reflecting very high nutrient enrichment and/or very significant alteration of the natural flow regime or habitat. |

| Attribute Band               | Numeric Attribute State (default class) | Numeric Attribute State (productive class) | Description  |
|------------------------------|---|--|--|
| <b>Phytoplankton (Lakes)</b> |   |  |  |
| A                            | ≤2                                      | ≤10  | Lake ecological communities are healthy and resilient, similar to natural reference conditions.  |
| B                            | >2 and ≤5                               | >10 and ≤25                                | Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions  |
| C                            | >5 and ≤12                              | >25 and ≤60                                | Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions. Reduced water clarity is likely to affect habitat available for native macrophytes.   |
| <b>National Bottom Line</b>  | <b>12</b>                               | <b>60</b>                                  |  |
| D                            | >12                                     | >60  | Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/ seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes. |

<sup>1</sup> Exceeded no more than 8% of samples. <sup>2</sup> Exceeded no more than 17% of samples. <sup>3</sup> Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chlorophyll-a) is 3 years.

## Appendix 4 Scheduled Significant Natural Areas, or equivalents of the Taieri Catchment

| District/Regional Plan | Reference # | Name  | Sub catchment                                      | Size    | Listed Values   |
|------------------------|-------------|---|--|---------|---|
| Dunedin City           | C099        | Great Moss Swamp                            | Logan Burn   | 378.74  | Swamp/Lake - restiad bog and tussockland, rush and sedge swamp. National/Regional Significance.   |
| Dunedin City           | CO25        | McKays Triangle Wildlife Management Reserve | Silver Stream, Maungatua, Taieri Plain and coastal | 40.84   | Wetland area on the Taieri Plain 10 km south west of Mosgiel. Important wildfowl breeding area  |
| Dunedin City           | C027        | Allanton Wildlife Management Reserve        | Silver Stream, Maungatua, Taieri Plain and coastal | 13.61   | Oxbow of Taieri River. The quality of the margins of this reserve are important in maintaining the habitat values of the wetland for native wildfowl.   |
| Dunedin City           | CO26        | Allanton Wildlife Management Reserve        | Silver Stream, Maungatua, Taieri Plain and coastal | 6.05    | Oxbow of Taieri River. The quality of the margins of this reserve are important in maintaining the habitat values of the wetland for native wildfowl.   |
| Dunedin City           | CO23        | Taieri Gorge                                | Silver Stream, Maungatua, Taieri Plain and coastal | 514.93  | Long narrow reserve made up of steep forested slopes adjacent to the Taieri River. Botanical and fauna values - long-tailed bat habitat.  |
| Dunedin City           | CO24        | Taieri Gorge Scenic Reserve                 | Silver Stream, Maungatua, Taieri Plain and coastal | 0.51    | Steep forested slopes of Taieri River Gorge. Two uncommon vegetation types. Reported sightings of long tailed bat.  |
| Dunedin City           | CO69        | Part of the Taieri Gorge Scenic Reserve     | Silver Stream, Maungatua, Taieri Plain and coastal | 120.83  | Native bush margins to Scenic Reserve on steep slope.   |
| Dunedin City           | CO64        | Taieri Gorge-Blair Acquisition              | Silver Stream, Maungatua, Taieri Plain and coastal | 50.35   | Part of bush-clad Taieri River Valley system. Large stands of kanuka with occasional podocarp present.  |
| Dunedin City           | C147        | Lamb Hill Fen Complex                       | Silver Stream, Maungatua, Taieri Plain and coastal | 37.52   | Area of copper tussock wetland / swamp on gully floors (640m-740m above sea level) in the southern part of Macraes Ecological District. Copper tussock, toetoe, purei and common rush make up the canopy and various mosses, liverworts, rushes and herbs make up the ground layer. Scarce in Otago with less than 15% of swamps remaining. |
| Dunedin City           | CO31        | Silverpeaks                                 | Silver Stream, Maungatua, Taieri Plain and coastal | 3421.44 | The Silverpeaks hills west of Dunedin. Contains silver beech forest, snow tussocklands, broadleaf forest, kanuka, cassinia/inaka shrubland and is the habitat for native falcon, fernbirds and a large number of invertebrates.   |

| District/Regional Plan | Reference # | Name   | Sub catchment                                      | Size   | Listed Values  |
|------------------------|-------------|--|--|--------|--|
| Dunedin City           | CO77        | Flagstaff Scenic Reserve and adjacent parks area           | Silver Stream, Maungatua, Taieri Plain and coastal | 100.45 | Natural area of sub alpine tussock grasslands, flaxes, native herbs, and shrubs, with many important insect species.   |
| Dunedin City           | C144        | City Forests Whare Flat Silver Stream and Flagstaff Forest | Silver Stream, Maungatua, Taieri Plain and coastal | 176.84 | Extensive area of representative dry land forest vegetation within City Forests plantation. Supports a high diversity of indigenous habitats and species some of which are nationally or locally uncommon  |
| Dunedin City           | CO36        | Chalkies   | Silver Stream, Maungatua, Taieri Plain and coastal | 202.9  | Area of native vegetation on the western side of the Silver Stream Valley approximately 10.5 km north west of Dunedin city. This area contains podocarp broadleaf forest merging into snow tussock grasslands.   |
| Dunedin City           | CO35        | Reserve for Waiora Yellow Grey Earth                       | Silver Stream, Maungatua, Taieri Plain and coastal | 5.3    | Area of land on spur between Boulder Hill and Powder Hill. A site of international importance supporting a rare soil type (Waiora Yellow Grey Earth) and manuka scrub threatened with extinction.  |
| Dunedin City           | CO81        | QEI Trust Covenant   | Silver Stream, Maungatua, Taieri Plain and coastal | 6.88   | Forest remnant and mineral spring.   |
| Dunedin City           | CO22        | Taieri River Gorge   | Silver Stream, Maungatua, Taieri Plain and coastal | 4.92   | Marginal strip along Taieri River adjoining the Taieri Gorge Scenic Reserve. Botanical and fauna values - including long-tailed bat habitat.   |
| Dunedin City           | C157        | Takitoa Swamp  | Estuary / Mouth                                    | 65.55  | Large flat valley floor wetland located 2.3km southwest of the intersection of Takitakitoa Road and Otokia-Kuri Bush Road East, Henley. Habitat for nationally or internationally rare or threatened species or communities, including South Island Fern Bird. Also habitat for inanga and potential habitat for kokopu. Scarce with less than 15% of swamps remaining in Otago. Vegetation includes rushlands, shrubs , ribbonwood and tussock in the southern part of the wetland. |
| Dunedin City           | C114        | Waipori Boot Wildlife Management Reserve                   | Waipori-Waihola                                    | 80.86  | Lagoon - rush and sedge swamp, broadleaved tree swamp, lowland swamp. Regional Significance.   |
| Dunedin City           | C161        | Braeside Swamp   | Waipori-Waihola                                    | 2.64   | Located 1.6km northeast of Waipori Falls, Berwick. Less than 15% of swamps remain in Otago.  |
| Dunedin City           | C154        | Otokia Swamp   | Waipori-Waihola                                    | 8.37   | Rush and sedge swamp adjacent to SH1 near Henley. Water levels fluctuate throughout the year. Scarce with less than 15% of swamps remaining in Otago. Regionally significant breeding area for waterfowl including NZ Shoveller, Pukeko, Pied Stilt and Spur-winged Plover   |

| District/Regional Plan | Reference # | Name  | Sub catchment                                      | Size     | Listed Values  |
|------------------------|-------------|---|--|----------|--|
| Dunedin City           | C073        | Part of Taieri River Scenic Reserve                                   | Estuary / Mouth                                    | 41.13    | Steep sided bush clad gully flowing the Taieri River upstream from Taieri Mouth. Includes Podocarp, silver beech, broadleaf species and kanuka.  |
| Dunedin City           | C142        | Henley Swamp  | Waipori-Waihola                                    | 9.18     | Significant swamp located south of Henley. Important habitat for waterfowl. Scarce with less than 15% of swamps remaining in Otago.  |
| Dunedin City           | C156        | Reefs Pond Margins  | Silver Stream, Maungatua, Taieri Plain and coastal | 0.49     | Swamp (320m-340m above sea level) located 4km southeast of the intersection of Reefs Road and Barewood Road, Clarks Junction. Scarce less than 15% of swamps remain in Otago.  |
| Dunedin City           | C066        | Sullivans Bush  | Silver Stream, Maungatua, Taieri Plain and coastal | 39.52    | Bush remnant including podocarps and native fauna in small catchment above Taieri plains.  |
| Dunedin City           | C008        | Maungatua Summit Wetland Management Area and Maungatua Scenic Reserve | Waipori-Waihola                                    | 1440.45  | Rolling tussock and boggy tops descending to deeply dissected gullies with beech forest remnants. Tarn restiag bog and tussockland cushion bog. Typical alpine wetland cushionfield, shrubland and grassland at low altitude of National Significance. Forested slopes on the eastern side of the Maungatua Range at the end of Grainger Road which contains regenerating native forest and remnant silver beech forest. |
| Dunedin City           | C005        | Mill Creek  | Waipori-Waihola                                    | 1,136.45 | Deep sided valley that flows into the Waipori Valley. Area contiguous with Waipori Falls and the Maungatua Range Scenic Reserve. Largest remnant of silver beech forest in eastern Otago north of the Catlins.   |
| Dunedin City           | C152        | Office Creek Seepage  | Mahinerangi/Lee Stream/Deep Stream                 | 2.79     | Seepage area (500m-600m above sea level) surrounded by forestry, located 8km northwest of the intersection of Maungatua Road and Waipori Falls Road. Habitat for nationally and internationally rare or threatened species or communities, which includes eldon's galaxias.  |
| Dunedin City           | C162        | Andersons Pond Margins  | Mahinerangi/Lee Stream/Deep Stream                 | 2.59     | Swamp located north east of Clarks Junction 360m above sea level. Swamps are scarce with less than 15% remaining in Otago. Swamp located north east of Clarks Junction 360m above sea level. Swamps are scarce with less than 15% remaining in Otago.  |
| Dunedin City           | C127        | Fortification Stream Headwaters Swamp                                 | Mahinerangi/Lee Stream/Deep Stream                 | 25.84    | Swamp 500m above sea level located south west of Wallace Ford Road and Mount Gowie Road intersection in Clarks Junction. Swamps are scarce in Otago with less than 15% remaining. Contains red tussock, Juncus species   |
| Dunedin City           | C153        | Old Dunstan Road Swamp  | Strath Taieri                                      | 8.37     | Rush and sedge swamp adjacent to SH1 near Henley. Water levels fluctuate throughout the year. Scarce with less than 15% of swamps remaining in Otago. Regionally significant breeding area for waterfowl including NZ Shoveller, Pukeko, Pied Stilt and Spur-winged Plover   |
| Dunedin City           | C001        | Rock and Pillar Scenic Reserve  | Logan Burn/Scroll Plain/Styx                       | 7453.92  | High altitude subalpine/alpine herbfields with four species unique to the Rock and Pillar Range. Includes a bog wetland area- cushion bog of Regional Significance.  |

| District/Regional Plan | Reference # | Name   | Sub catchment                                      | Size   | Listed Values  |
|------------------------|-------------|--|--|--------|--|
| Dunedin City           | C002        | Salt Lake Scenic Reserve and Wetland Management Area | Strath Taieri                                      | 147.46 | Rocky tor landscape with lowland tussock grassland and a Salt Lake. The association of the Salt Lake and tussock grassland and rock face flora (including succulent herb swamp, rush and sedge swamp) is a unique feature in the District. Regional/Local Significance   |
| Dunedin City           | C003        | Mt McKay Covenant                                    | Strath Taieri                                      | 1.64   | Small area of rocky tors with undisturbed native grasses which is a habitat for giant skink and Otago skink.   |
| Dunedin City           | C156        | Reefs Pond Margins                                   | Silver Stream, Maungatua, Taieri Plain and coastal | 0.49   | Swamp (320m-340m above sea level) located 4km southeast of the intersection of Reefs Road and Barewood Road, Clarks Junction. Scarce less than 15% of swamps remain in Otago.  |
| Dunedin City           | C072        | Tappers Conservation Covenant                        | Mahinerangi/Lee Stream/Deep Stream                 | 0.64   | Small outcrop of tors with native grasses which are a habitat for skinks.  |
| Dunedin City           | C155        | Peat Moss Hills Fen Complex                          | Strath Taieri                                      | 35.23  | Fen and seepage area (620-680m above sea level) located 8km southwest of the intersection of Ramrock Road and Townsend Road, Middlemarch. Has as a high degree of naturalness.   |
| Dunedin City           | C133        | Black Rock Marshes                                   | Strath Taieri                                      | 40.5   | Located 1.5km southwest of Black Rock and 16km east of Middlemarch at 480m above sea level. Marshes scarce in Otago with less than 15% remaining. Contains red tussock   |
| Dunedin City           | C145        | Glyn Wye Wetland Management Area                     | Strath Taieri                                      | 43.32  | Medium turf ephemeral tarns on broad ridge crest (380-440m above sea level), east of Middlemarch. Habitat for threatened herbaceous species and high diversity of indigenous rushes, herbs and other species.  |
| Dunedin City           | C004        | Black Rock   | Mahinerangi/Lee Stream/Deep Stream                 | 51.73  | Lowland snow tussock area (now rare within the Waipori Ecological District). Scientifically important as an opportunity to monitor changes occurring in tussock grassland  |
| Dunedin City           | C131        | Fernhill Marsh                                       | Strath Taieri                                      | 0.70   | Marsh located 2km south east of Sutton and 200m above sea level. Scarce with less than 15% of marshes remaining in Otago   |
| Dunedin City           | C151        | Murrays Road Inland Saline Wetland Management Area   | Strath Taieri                                      | 1.48   | A salt pan (180m-200m above sea level) on the Tor Plateau which flows into a small wetland. Located south of the intersection of Longford Road and Murrays Road, Middlemarch. Scarce wetland type and only known salt pan within the Macraes Ecological District. Less than 18% of inland saline areas remain in Otago. Salt pan contains native salt tolerant plants and wet area natives' sedges and rushes. |
| Waitaki District       | 102         | Deighton Creek                                       | Strath Taieri                                      |        | Priority habitat area for Otago skink and Grand skink. Common skink, spotted common gecko also present. Deeply entrenched stream with extensive outcrops and bluffs. Vegetation includes snow tussock grassland, manuka and matagouri shrubland and outcrop vegetation. Significant historic values.   |

| District/Regional Plan  | Reference # | Name                                   | Sub catchment                                    | Size    | Listed Values   |
|-------------------------|-------------|--|--|---------|---|
| Waitaki District        | 103         | Emerald Stream                         | Strath Taieri                                    |         | Priority habitat area for Grand skink and Otago skink. Most diverse lizard population in the South Island. Other species include green skink, common skink, spotted common skink, speckled common skink and common gecko. Shallow valleys and gentle rolling ridges with extensive outcrops and bluffs along streams and standing tors. Vegetation includes snow tussock vegetation, manuka shrubland and outcrop vegetation. Falcon present.   |
| Waitaki District        | 106         | Macraes Ponds                          | Strath Taieri                                    |         | SSWI: Important waterfowl area. Rare moth <i>Gingidiobora nebulosa</i> (Nationally vulnerable) present on local form of plant <i>Gingidia montana</i> .   |
| Waitaki District        | a           | Nenthorn Ridge Wetland Management Area | Strath Taieri                                    |         | This area contains a wide variety of wetland types including a low turf ephemeral tarn, a medium turf ephemeral tarn, Purei wetlands, pools, bogs and moist red tussock grasslands in a relatively small area (112 ha) on upper slopes and ridge crests at altitude 540 – 570m. The threatened herb <i>Gratiola nana</i> is present in the low turf ephemeral tarn at Emerald Creek, one of only 23 known locations throughout the South Island (Johnson 1993). Two locally rare species <i>Elatine gratiolooides</i> and <i>Glossostigma sp.</i> Occur in the medium turf ephemeral tarns. A very diverse range of wetland vegetation, a distinctive insect fauna and a diverse and relatively abundant waterfowl fauna are present. A wetland which is highly valued by Kāi Tahu for mahika kai or other waahi taoka. |
| Waitaki District        | b           | Redbank Wetland Management Area        | Strath Taieri                                    |         | A copper tussock wetland and a low turf ephemeral tarn. Altitude 470 – 654m. The threatened plant species <i>Isolepis basilaris</i> and <i>Myosurus minimus</i> subsp. <i>novae zelandiae</i> are present in the low turf ephemeral tarn. A high diversity of wetland species is present. A diverse and interesting aquatic insect fauna in seepages and creeks, including the brown caddis ( <i>Psilochorema tautoru</i> ).  |
| Waitaki District        | c           | Paddy's Rock Ephemeral Tarn            | Strath Taieri                                    |         | A small low turf ephemeral tarn supports the threatened plant <i>Tetrachondra hamiltonii</i> on the tarn margin. The tarn has a high plant diversity. The tarn contains the native herb <i>Hypselia rivalis</i> , the sedge <i>Carex gaudichaudina</i> and the rush <i>Eleocharis acuta</i> .   |
| Waitaki District        | n/a         | Skink management area                  | Strath Taieri                                    |         | Otago, grand, southern grass, McCann's, cryptic and green skinks, and korero geckos. Significant botanical values too, in ephemeral wetlands.   |
| Clutha District Council |             | No SNAs or equivalents listed          |  |         |   |
| Central Otago           | 10          | Upper Taieri Wetlands                  | Scroll Plain/Styx & Upper Taieri Plain/Maniototo | 2450 ha | Schedule 19.6   |
| Central Otago           | 11          | Serpentine Reserve                     | Scroll Plain/Styx                                | 750 ha  | Schedule 19.6   |

| District/Regional Plan | Reference #                            | Name                                   | Sub catchment                      | Size   | Listed Values   |
|------------------------|--|--|------------------------------------|--------|---|
| Central Otago          | 12                                     | Serpentine Wildlife Management Reserve | Scroll Plain/Styx                  | 135 ha | Schedule 19.6   |
| Central Otago          | 14                                     | Taieri Lake                            | Upper Taieri Plain/Maniototo       | 4 ha   | Schedule 19.6   |
| Central Otago          | 40                                     | Fortification Creek Wetland            | Mahinerangi/Lee Stream/Deep Stream | 470 ha | Schedule 19.6   |
| Central Otago          | 46                                     | Patearoa Saline Area                   | Upper Taieri Plain/Maniototo       | 6 ha   | Schedule 19.6   |
| Central Otago          | 51                                     | Totara Creek Saline Area               | Upper Taieri Plain/Maniototo       | 11 ha  | Schedule 19.6   |
| Central Otago          | 5                                      | Cross Eden Burn Swamps                 |                                    |        | Additional Wetlands in Schedule 19.6A                         |
| Central Otago          | 13                                     | Laws Road Swamp                        |                                    |        | Additional Wetlands in Schedule 19.6A                         |
| Central Otago          | 14                                     | Linnburn Runs Road Wetlands            |                                    |        | Additional Wetlands in Schedule 19.6A                         |
| Central Otago          | 19                                     | Old Dunstan Road Wetlands Complex      |                                    |        | Additional Wetlands in Schedule 19.6A                         |
| Central Otago          | 22                                     | Wetland Adjacent to Stony Creek Dams   |                                    |        | Additional Wetlands in Schedule 19.6A                         |
| ORC                    | Schedule 1A Water Plan: Natural Values | Ailsa Creek                            |                                    |        | Weedfree, Rarefish Significant habitat for flathead galaxiid. |
| ORC                    |  | Bullocky Creek                         |                                    |        | Weedfree, Rarefish Significant habitat for flathead galaxiid. |
| ORC                    | Schedule 1A: Natural Values            | Elbow Creek                            |                                    |        | Weedfree, Rarefish Significant habitat for flathead galaxiid. |

| District/Regional Plan | Reference #                    | Name  | Sub catchment | Size | Listed Values   |
|------------------------|--------------------------------|---|---------------|------|---|
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed tributary of the Taieri River at H43:600125 |               |      | Weedfree, Rarefish Significant habitat for flathead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Horse Burn  |               |      | Weedfree, Rarefish Significant habitat for flathead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Linn Burn   |               |      | Weedfree, Rarefish Significant habitat for flathead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Totara Creek  |               |      | Significant habitat for unidentified galaxiid species.  |
| ORC                    | Schedule 1A:<br>Natural Values | Cambridge Creek                                     |               |      | Significant habitat for flathead galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Ewe Burn  |               |      | Significant habitat for roundhead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Kye Burn  |               |      | Significant habitat for flathead and roundhead galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Healy Creek   |               |      | Significant habitat for unique community of flathead and roundhead galaxiids. Type locality for flathead galaxiid |
| ORC                    | Schedule 1A:<br>Natural Values | Little Kye Burn                                     |               |      | Significant habitat for roundhead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Swin Burn   |               |      | Significant habitat for roundhead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Burgan Stream                                       |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Stony Creek   |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Spratts Creek                                       |               |      | Significant habitat for roundhead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Nenthorn Stream                                     |               |      | Significant habitat for flathead galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Black Rock stream (Strath Taieri)                   |               |      | Significant habitat for flathead galaxiid.  |



| District/Regional Plan | Reference #                    | Name  | Sub catchment | Size | Listed Values   |
|------------------------|--------------------------------|---|---------------|------|---|
| ORC                    | Schedule 1A:<br>Natural Values | Manuka stream   |               |      | Significant habitat for flathead galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Washpool Stream   |               |      | Significant habitat for flathead galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Deighton Stream   |               |      | Significant habitat for flathead galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Prices Creek  |               |      | Significant habitat for roundhead galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Taieri River<br>between Tiroiti<br>and Pukerangi        |               |      | Significant habitat for flathead galaxiid (including many tributaries). Significant habitat for lamprey (uncommon in Otago) Significant habitat for Lower Taieri galaxiid and koaro in many tributaries below Middlemarch |
| ORC                    | Schedule 1A:<br>Natural Values | Toll Bar Creek  |               |      | Significant habitat for koaro.  |
| ORC                    | Schedule 1A:<br>Natural Values | Taieri River<br>between<br>Pukerangi and<br>Outram      |               |      | Significant habitat for Lower Taieri galaxiid (tributaries). Significant habitat for lamprey (uncommon in Otago).   |
| ORC                    | Schedule 1A:<br>Natural Values | Traquair Burn   |               |      | Eel   |
| ORC                    | Schedule 1A:<br>Natural Values | Smugglers Creek   |               |      | Significant habitat (and type locality) for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Deep Stream   |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Clarkes Stream  |               |      | Significant habitat for Lower Taieri galaxiid at H44:682930.  |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributary of Deep<br>Stream at<br>H44:660958 |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributary of Deep<br>Stream at<br>H44:678947 |               |      | Significant habitat for Lower Taieri galaxiid.  |

| District/Regional Plan | Reference #                    | Name  | Sub catchment | Size | Listed Values   |
|------------------------|--------------------------------|---|---------------|------|---|
| ORC                    | Schedule 1A:<br>Natural Values | Barbours Stream   |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Three<br>O'clock Stream   |               |      | Significant habitat for flathead galaxiid and koaro.  |
| ORC                    | Schedule 1A:<br>Natural Values | Lee Stream  |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Black Rock Stream   |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Broadstream   |               |      | Eel. Significant habitat for Lower Taieri galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Canton Stream   |               |      | Significant habitat for Lower Taieri galaxiid.  |
| ORC                    | Schedule 1A:<br>Natural Values | Otokia Creek  |               |      | Significant habitat for banded kokopu   |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributary of the<br>Taieri River a.k.a.<br>Takitakitoa<br>Stream |               |      | Significant habitat for giant kokopu and banded kokopu.   |
| ORC                    | Schedule 1A:<br>Natural Values | Taieri River<br>between Henley<br>and the sea                               |               |      | Significant habitat for giant kokopu and banded kokopu.   |
| ORC                    | Schedule 1A:<br>Natural Values | Lakes<br>Waipori/Waihola  |               |      | Significant habitat: Presence of variety of waterfowl and native fish, including a breeding population of fernbird and giant kokopu |
| ORC                    | Schedule 1A:<br>Natural Values | Mary Hill Creek   |               |      | Significant habitat for giant kokopu.   |
| ORC                    | Schedule 1A:<br>Natural Values | Mill Creek  |               |      | Significant habitat for koaro.  |
| ORC                    | Schedule 1A:<br>Natural Values | Meggat Burn   |               |      | Significant habitat for banded kokopu.  |
| ORC                    | Schedule 1A:<br>Natural Values | Waipori River   |               |      | Significant habitat for koaro upstream of dam.  |

| District/Regional Plan | Reference #                    | Name   | Sub catchment                    | Size | Listed Values  |
|------------------------|--------------------------------|--|----------------------------------|------|--|
| ORC                    | Schedule 1A:<br>Natural Values | Tributaries of<br>Waipori River  |                                  |      | Significant habitat for dusky galaxiid and koaro. Munro's Dam Stream type locality for dusky galaxiid. |
| ORC                    | Schedule 1A:<br>Natural Values | Lake<br>Mahinerangi  |                                  |      | Significant habitat for koaro  |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributaries of Lake<br>Mahinerangi at<br>H44:709803,<br>H44:714801, and<br>H44:724797 |                                  |      | Significant habitat for koaro.   |
| ORC                    | Schedule 1A:<br>Natural Values | Lammerlaw<br>Stream  |                                  |      | Significant habitat for koaro.   |
| ORC                    | Schedule 1A:<br>Natural Values | North West<br>Stream   |                                  |      | Significant habitat for koaro.   |
| ORC                    | Schedule 1A:<br>Natural Values | Nardoo Stream  |                                  |      | Significant habitat for koaro.   |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributary of Lake<br>Mahinerangi at<br>H44:705754                                     |                                  |      | Significant habitat for Lower Taieri galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributary of Lake<br>Mahinerangi at<br>H44:720766                                     |                                  |      | Significant habitat for Lower Taieri galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributary of<br>Pioneer Stream at<br>H44:703752                                       |                                  |      | Significant habitat for Lower Taieri galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Unnamed<br>tributaries of Lake<br>Mahinerangi at<br>H44:775772,<br>H44:778770, and<br>H44:775770 |                                  |      | Significant habitat for Lower Taieri galaxiid.   |
| ORC                    | Schedule 1A:<br>Natural Values | Verter Burn  | Significant habitat<br>for koaro |      |  |

| District/Regional Plan | Reference #                    | Name              | Sub catchment   | Size | Listed Values                                  |
|------------------------|--------------------------------|-------------------|---|------|--|
| ORC                    | Schedule 1A:<br>Natural Values | Post Office Creek | Significant habitat for Lower Taieri galaxiid.  |      |  |
| ORC                    | Schedule 1A:<br>Natural Values | Silver Stream     | Significant habitat for koaro upstream of I44:114899 and including several tributaries.<br>Significant habitat for lamprey (uncommon in Otago). |      |  |
| ORC                    | Schedule 1A:<br>Natural Values | Whare Creek       |   |      | Significant habitat for Lower Taieri galaxiid. |

### Conservation Values for DCC 2GP Mapped Streams

| Waterbody       | Sub Catchment  | Conservation Values  | Recreation Values               |
|-----------------|--|--|---------------------------------|
| Deep Creek      | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Ecological values - <i>Galaxias depressiceps</i> (nationally vulnerable).                    | Recreation values               |
| Deep Stream     | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Ecological values - Eldon's galaxias (nationally endangered) in upper tributaries.           | Recreation values - brown trout |
| Flagstaff Creek | Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment | Kokopu, eel species  | Trout                           |
| Flat Stream     | Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment | Possible <i>Galaxias eldons</i> (nationally endangered)                                      |                                 |
| Lee Creek       | Waipori-Waihola wetland  | High values for giant kokopu in upper reaches, also perch, common bully, freshwater mussel.  |                                 |
| Lee Stream      | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Eldon's galaxias (upper tributaries), longfin eel  | Brown trout                     |
| Lug Creek       | Strath Taieri  | Potentially <i>Galaxias anomalus</i> (nationally endangered)                                 | Brown trout in lower reaches    |
| Nenthorn Stream | Strath Taieri  | <i>Galaxias depressiceps</i> (nationally vulnerable), freshwater mussel, longfin eel, koura. | Trout                           |
| Orbells Creek   | Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment | Potential habitat for <i>Galaxias depressiceps</i> (nationally vulnerable).                  |                                 |

| Waterbody                   | Sub Catchment  | Conservation Values   | Recreation Values  |
|-----------------------------|--|---|--|
| Owhiro Stream               | Waipori-Waihola wetland  | Longfin and shortfin eel habitat, perhaps inanga.   | Mahika kai values. Potential transportation and recreation corridor.                                     |
| Post Office Creek (Waipori) | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Eldon's galaxias (nationally endangered), koaro, koura  |  |
| Silver Stream               | Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment | Mitigating flooding and erosion. Migratory value for species in upper reaches   | Transportation corridor. High trout values, with high demand for fishing opportunities near urban areas. |
| Smugglers Creek             | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Eldon's galaxias (nationally endangered), longfin eel, koura  | Brown trout  |
| Stony Creek                 | Logan Burn   | Eldon's galaxias (nationally endangered)  |  |
| Sutton Stream               | Strath Taieri  | Ecological values   | Important for trout  |
| Taieri River (upper)        | Multiple   | Mitigating flooding and erosion (Hyde to Sutton). Ecological values   | Mahika kai values. Important for trout   |
| Taieri River (lower)        | Multiple   | High biodiversity - inanga, lamprey, longfin, shortfin, black flounder, smelt, blue gill bully, torrent fish. Tidal zone important for whitebait (especially near Henley) and flounder. | Mahika kai values. Important for trout   |
| Three O'clock Stream        | Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment | <i>Galaxias depressiceps</i> (nationally vulnerable).   | Trout angling  |
| Toll Bar Creek              | Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment | Potential for <i>Galaxias depressiceps</i> (nationally vulnerable)  |  |
| Traquair Burn               | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Longfin eel, common bully. <i>Galaxias eldoni</i> (nationally endangered) at top end.   | Brown trout  |
| Verter Burn                 | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Koaro, koura. Potential for <i>Galaxias eldoni</i> (nationally endangered) at top end.  | Brown trout, rainbow trout   |
| Waipori River               | Mahinerangi/Lee Stream/Deep Stream & Waipori-Waihola wetland     | Mitigating flooding and erosion. All migratory galaxias, <i>Galaxias pullus</i> and eldons (nationally endangered) in the headwaters. Koura.  | Mahika kai values. Some hunting and angling  |
| Whare Creek                 | Silver Stream, Maungatua, Taieri Plain and coastal sub-catchment | <i>Galaxias eldoni</i> (nationally endangered).   | Brown trout  |

## Appendix 5 Regionally Significant Wetlands in the Taieri Catchment and Listed Conservation Values

| ORC reference #               | Name                               | Area (ha) | ORC Description   | Conservation Values   | Sub-catchment                |
|-------------------------------|------------------------------------|-----------|---|---|------------------------------|
| <b>Central Otago District</b> |                                    |           |   |   |                              |
| 26                            | Clachanburn Marsh                  | 3.0       | Marsh   | Scarce in Otago in terms of its ecological or physical character. Less than 15% of marshes remain in Otago. See Ausseil <i>et al.</i> 2008.   | Upper Taieri Plain/Maniototo |
| 32                            | Cross Eden Creek Marsh Complex     | 20.8      | Shallow water wetlands. Ephemeral wetlands and spring fed wetlands located on the Maniototo Plains on either side of Cross Eden Creek | High diversity of wetland habitat types. Wetland complex with a high diversity of wetland types, represented by at least four, and possibly five wetland classes. See Grove, 1994.  | Upper Taieri Plain/Maniototo |
| 80                            | Laws Road Swamp                    | 1.4       | Inland Saline   | Scarce in Otago in terms of its ecological or physical character. Less than 18% of inland saline areas remain in Otago. See Ausseil <i>et al.</i> 2008.   | Upper Taieri Plain/Maniototo |
| 121                           | Patearoa Inland Saline Wetland     | 4.5       | A moderately large saline site near the Upper Taieri River consisting of small bare salty areas at the base of surrounding hillsides. | On farmland but covered by QEII covenant; presence of threatened plant species <i>Myosurus minimus subsp. novae zelandiae</i> (nationally endangered); High diversity of salt tolerant plants and moths, its combined botanical and entomological values making it the most important example of such habitat in Central Otago and New Zealand. Ref#54 Presence of native halophytes such as <i>Apium</i> sp., <i>Selliera microphylla</i> , <i>Atriplex buechananii</i> (all with threat statuses of naturally uncommon), <i>Puccinellia rariflorens</i> (nationally critical), and <i>Lepidium kirkii</i> (nationally critical), the rare <i>Carmichaelia vexillata</i> , <i>Lepidium sisymbrioides</i> , with other dry land plant species such as <i>Leptinella maniototo</i> , white fuzzweed ( <i>Vittadinia australis</i> ) and common mat daisy ( <i>Raoulia australis</i> ). See Ausseil <i>et al.</i> 2008. | Upper Taieri Plain/Maniototo |
| 155                           | Totara Creek Inland Saline Wetland | 8.8       | Scattered saline areas lying along an old river terrace   | Presence of the threatened plant marsh arrow grass ( <i>Triglochin palustris</i> ). High degree of wetland  | Upper Taieri Plain/Maniototo |

| ORC reference # | Name                                   | Area (ha) | ORC Description   | Conservation Values  | Sub-catchment     |
|-----------------|--|-----------|---|--|-------------------|
|                 | Management Area                        |           | on the true left of Totara Creek.   | naturalness.   |                   |
| 141             | Styx Ephemeral Wetland Management Area | 10.9      | A relatively extensive area of ephemeral wetlands in shallow depressions of schist rock that occurs on two rounded spur crests north-east of the Reservoir. | Habitat for <i>Myosurus minimus subsp. novae-zelandiae</i> (Nationally Critical), <i>Crassula peduncularis</i> (Nationally Critical), <i>Crassula multicaulis</i> (Nationally Critical) and <i>Crassula mataikona</i> (at risk naturally uncommon). See DOC, 2010. | Scroll Plain/Styx |

| ORC reference # | Name  | Area (ha) | ORC Description   | Conservation Values   | Sub-catchment                                   |
|-----------------|---|-----------|---|---|---|
| 161             | Upper Taieri Wetlands Complex (three sub areas) | 2727      | The Upper Taieri Wetlands Complex consists of three sub-areas, the Styx (Paerau) Basin Wetlands, the Maniototo Basin Wetlands and Taieri Lake Wetlands. All 3 wetlands are on the floodplain of the Taieri River. | Habitat for several threatened species, including the nationally threatened Australasian Bittern ( <i>Botaurus poiciloptilus</i> ) and the Banded Dotterel ( <i>Charadrius bicinctus bicinctus</i> ) (Grove, 1994, p52 86), and the threatened plant tufted hair-grass ( <i>Deschampsia caespitosa</i> ) and <i>Myosurus minimus subsp. novae-zelandiae</i> (Nationally Critical). High degree of wetland naturalness and diversity Refs#34 &73 Regionally significant wetland habitat for waterfowl (ref#34). Native fish present include longfin eel/kuuwharuwharu ( <i>Anguilla dieffenbachii</i> ), lamprey/kanakana ( <i>Geotria australis</i> ), common bully/Pako ( <i>Gobiomorphus cotidianus</i> ), upland bully ( <i>Gobiomorphus breviceps</i> ) and non-migratory galaxiids. Native waterfowl that breed in the scroll plain include New Zealand Shoveller/Kuruwhengi ( <i>Anas rhynchotis variegata</i> ), Grey Teal/Tete ( <i>Anas gracilis</i> ), Grey Duck ( <i>Anas superciliosa</i> ), Black Swan ( <i>Cygnus atratus</i> ) and Paradise Shelduck/Putangitangi ( <i>Tadorna variegata</i> ). Waders that have been recorded include Marsh Crane ( <i>Porzana pusilla affinis</i> ), Australasian Bittern/Matuku ( <i>Botaurus poiciloptilus</i> ), White-faced Heron ( <i>Ardea novaehollandiae</i> ), Swamp Hen/Pukeko ( <i>Porphyrio porphyrio melanotus</i> ), Pied Stilt ( <i>Himantopus himantopus</i> ) and South Island Pied Oystercatcher/Torea ( <i>Haematopus ostralegus finschi</i> ). The New Zealand Landform Inventory has given the scroll plain a high rating, describing it as having scenic, scientific and educational importance. Highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses, including mahika kai and waahi taoka. Valued by Kāi Tahu as traditional mahika kai area. See Peat and Patrick, 1999. | Upper Taieri Plain/Maniototo/ Scroll Plain/Styx |



| ORC reference #                | Name                                  | Area (ha) | ORC Description  | Conservation Values  | Sub-catchment                      |
|--------------------------------|---------------------------------------|-----------|--|--|------------------------------------|
| <b>Clutha District Council</b> |                                       |           |  |  |                                    |
| 54                             | Governors Point Swamp                 | 2.5       | A wetland area including river terrace and gully floor plant communities on the western side of the Taieri River, about 2 km from its mouth.   | High diversity of wetland habitat types. High variety of plant communities, some quite unique, eg. the marsh areas which have some salt and some fresh water marsh characteristics, and the small white pine/kahikatea ( <i>Dacrycarpus dacrydioides</i> )-totara-black pine/matai ( <i>Prumnopitys taxifolia</i> )-brown pine/miro ( <i>Prumnopitys ferruginea</i> ) stand on the west river terrace. High degree of wetland Naturalness (see Appendix 2 of Ryder Consulting, 1995).                                | Estuary/Mouth single channel       |
| 46                             | Fortification Stream Headwaters Swamp | 26.0      | Swamp  | Scarce in Otago in terms of its ecological or physical character. Less than 15% of marshes remain in Otago (Ausseil <i>et al.</i> 2008).   | Mahinerangi/Lee Stream/Deep Stream |
| 84                             | Loch Loudon Fen Complex               | 33.3      | Complex of wetland gullies draining into Loch Loudon. Fen.   | High diversity of indigenous wetland flora and fauna. Diverse plant communities. Wetland areas may also be a habitat for dusky galaxiids. See Ingle, 2002.   | Mahinerangi/Lee Stream/Deep Stream |
| 85                             | Loch Luella Fen Complex               | 871       | Red tussock ( <i>Chionochloa rubra</i> ) wetland, swamps and ponds on the floodplain of the upper Pioneer Stream, south of the western arm of Lake Mahinerangi, and draining into Loch Luella. | Recorded sightings of the threatened Australasian Bittern ( <i>Botaurus poiciloptilus</i> ) and the South Island Fernbird/Matata ( <i>Bowdleria punctata punctata</i> ). Site of old gold mining and partly Historic Reserve administered by Department of Conservation. Called Pioneer Creek in the Clutha District Plan, where it is listed as a Significant Wetland. Valued as waterfowl habitat (see Appendix 2 of Ryder Consulting, 1995). High degree of wetland naturalness (See Ausseil <i>et al.</i> 2008). |                                    |
| 131                            | Rocky Hill Tidal Marshes              | 3.2       | Tidal Marsh. An area of wetland including marsh and river terrace plant communities on both sides of the Taieri River, about 3 km from its mouth.  | High variety of plant communities, some quite unique, eg. the marsh areas which have some salt and some fresh water marsh characteristics, and the small white pine/kahikatea ( <i>Dacrycarpus dacrydioides</i> )-totara-black pine/matai ( <i>Prumnopitys taxifolia</i> ) – brown pine/miro ( <i>Prumnopitys ferruginea</i> ) stand on the west river terrace. High degree of wetland naturalness (see Appendix 2 of Ryder Consulting, 1995).   | Estuary/Mouth single channel       |

| ORC reference # | Name                            | Area (ha) | ORC Description   | Conservation Values  | Sub-catchment           |
|-----------------|---------------------------------|-----------|---|--|-------------------------|
| 167             | Waipori/Waihola Wetland Complex | -         | The wetland complex consists of two large shallow lakes, Waipori (220 ha) and Waihola (640 ha) and an extensive system of lagoons, ponds, vegetated islands, channels and swamps, situated on the lower Taieri Plain, 30 km south-west of Dunedin. Inflows are from the Waipori River, the Meggatburn, Boundary Creek and several man-made drains. The wetlands drain into the Waipori River, then into the Taieri River. | Habitat for the threatened indigenous fish species the giant kokopu ( <i>Galaxias argenteus</i> ) and the banded kokopu ( <i>Galaxias fasciatus</i> ). Presence of the threatened plant species swamp nettle ( <i>Urtica linearifolia</i> ) and tufted hair-grass ( <i>Deschampsia caespitosa</i> ). Swamp birds present include Australasian Bittern/Matuku ( <i>Botaurus poiciloptilus</i> ), Marsh Crake ( <i>Porzana pusilla affinis</i> ), Pukeko/Swamp Hen ( <i>Porphyrio porphyrio melanotus</i> ) and South Island Fernbird/Matata ( <i>Bowdleria punctata punctata</i> ). Two species of shag breed in the wetland - <i>Phalacrocorax</i> spp., White-faced Heron ( <i>Egretta novaehollandiae</i> ) and Southern Black-backed Gull ( <i>Larus dominicanus</i> ). Shorebirds include Pied Stilt ( <i>Himantopus leucocephalus</i> ), South Island Pied Oystercatcher/Torea ( <i>Haematopus ostralegus finschi</i> ), Spur-winged Plover ( <i>Vanellus miles</i> ) and Banded Dotterel ( <i>Charadrius bicinctus</i> ). Visitors include Brown Teal ( <i>Anas aucklandica chlorotis</i> ), Banded Rail ( <i>Rallus philippensis assimilis</i> ), Spotless Crake ( <i>Porzana tabuensis plumbea</i> ), Cattle Egret ( <i>Bubulcus ibis</i> ), Little Egret ( <i>Egretta garzetta</i> ), White Heron ( <i>E. alba</i> ), and Royal Spoonbill/Kotuku-ngutupapa ( <i>Platalea regia</i> ). Four species of Terns have been recorded. Common waterfowl include Black Swan ( <i>Cygnus atratus</i> ), Paradise Shelduck/Putangitangi ( <i>Tadorna variegata</i> ), Grey Teal/Tete ( <i>Anas gracilis</i> ), Mallard ( <i>A. platyrhynchos</i> ), Grey Duck ( <i>A. superciliosa</i> ), New Zealand shoveller ( <i>A. rhynchotis variegata</i> ) and New Zealand Scaup/Papango ( <i>Aythya novaeseelandiae</i> ). Covered by a Statutory Acknowledgement. Was once one of the most significant food baskets in Otago, and was once a settlement of Tukiauau an important tūpuna of Ngāi Tahu Whānui (Cromarty and Scott, 1995; See Ausseil <i>et al.</i> 2008). | Waipori/Waihola wetland |

| ORC reference #                 | Name                             | Area (ha) | ORC Description | Conservation Values   | Sub-catchment                      |
|---------------------------------|----------------------------------|-----------|-----------------|---|------------------------------------|
| <b>Dunedin District Council</b> |                                  |           |                 |   |                                    |
| 3                               | Andersons Pond Margins           | 2.6       | Swamp           | Scarce in Otago in terms of its ecological or physical character. Less than 15% of swamps remain in Otago. See Ausseil <i>et al.</i> 2008.  |                                    |
| 9                               | Black Rock Marshes               | 61.3      | Marsh           | Scarce in Otago in terms of its ecological or physical character. Less than 15% of marshes remain in Otago. See Ausseil <i>et al.</i> 2008.   | Strath Taieri                      |
| 16                              | Braeside Swamp                   | 2.6       | Swamp           | Scarce in Otago in terms of its ecological or physical character. Less than 15% of marshes remain in Otago. See Ausseil <i>et al.</i> 2008.   | Mahinerangi/Lee Stream/Deep Stream |
| 42                              | Fernhill Marsh                   | 0.7       | Marsh           | Scarce in Otago in terms of its ecological or physical character. Less than 15% of marshes remain in Otago.   | Strath Taieri                      |
| 53                              | Glyn Wye Wetland Management Area | 43.3      | Marsh           | Habitat for nationally or internationally rare or threatened species or communities. Habitat for threatened Banded Dotterel ( <i>Charadrius bicinctus bicinctus</i> ) and Black-fronted Tern ( <i>Sterna albobriata</i> ). Presence of <i>Deschampsia cespitosa</i> (At Risk – Declining). High diversity of indigenous wetland flora and fauna. High diversity of fauna. The wetland complex that comprises Diamond Lake Wetland and the nearby Lake Reid Wetland provide nesting and feeding habitat for Paradise Shelduck ( <i>Tadorna variegata</i> ), Black Swan ( <i>Cygnus atratus</i> ), Pied Stilt ( <i>Himantopus himantopus</i> ), Southern Black-backed Gull ( <i>Larus dominicanus</i> ), South Island Pied Oystercatcher ( <i>Haematopus ostralegus finschi</i> ) and Shags ( <i>Phalacrocoracidae</i> ). | Strath Taieri                      |
| 55                              | Great Moss Swamp                 | 422.6     | Fen             | Remnant of a previously more extensive, 500-ha swamp flooded by the Logan Burn Reservoir. Areas of red tussock ( <i>Chionochloa rubra</i> ), silver tussock ( <i>Poa cita</i> ), sedge tussock ( <i>Schoenus pauciflorus</i> ) and <i>Sphagnum squarrosum</i> . One of the few remaining subalpine swamp areas in the Rock and Pillar Ecological District. Habitat for nationally or internationally rare or threatened species or communities. Presence of threatened plant species tufted hair-grass ( <i>Deschampsia</i>   | Logan Burn                         |

| ORC reference # | Name                                     | Area (ha) | ORC Description | Conservation Values  | Sub-catchment                                      |
|-----------------|--|-----------|-----------------|--|--|
|                 |  |           |                 | <i>caespitosa</i> ) and <i>Carex secta</i> var. <i>tenuiculmus</i> . High degree of wetland naturalness.   |  |
| 60              | Henley Swamp                             |           |                 | Regionally important habitat for waterfowl   | Waipori/Waihola wetland                            |
| 79              | Lamb Hill Fen Complex                    |           |                 | High diversity of indigenous wetland flora and fauna. The moist copper tussock wetland, although modified, contains a wide variety of wetland species. Copper tussock, toetoe, purei and common rush ( <i>Juncus effusus</i> ) make up the canopy and various mosses, liverworts, rushes and herbs make up the ground layer (see Bibby, 1997 for full description).  | Strath Taieri                                      |
| 99              | Maungatua Summit Wetland Management Area | 1213      | Fen             | Area containing cushion herb vegetation, <i>Sphagnum</i> sp. bogs, flushes and small tarns on the summit and western slopes of Maungatua overlooking Taieri Plains. Scarce in Otago in terms of its ecological or physical character. Scarce wetland type. Although highly modified by fires, grazing and trampling, the Maungatua wetlands are the only remaining examples of high-altitude wetlands on the eastern side of the Waipori Ecological District. Cushion-forming plants are confined to poorly drained areas on the summit ridge. Scattered tarns are surrounded by <i>Sphagnum</i> spp. and sedges. Highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses, including mahika kai and waahi taoka. Some 10 different cushion plant species can be found in the wetland, together with an insectivorous sundew ( <i>Drosera arcturi</i> ) and several lichens. The prominent rounded cushions are of <i>Donatia novae-zelandiae</i> , a species confined to cool peaty wetlands between the Tararua Range and Stewart Island. | Silver Stream, Maungatua, Taieri Plain and coastal |
| 101             | McKays Triangle Wetland                  | 41.4      | Not available   | Wetland area on the Taieri Plain located 10 km south west of Mosgiel. Habitat for nationally or internationally rare or threatened species or communities. Habitat for the threatened Australasian Bittern ( <i>Botaurus poiciloptilus</i> ).  | Silver Stream, Maungatua, Taieri Plain and coastal |

| ORC reference # | Name   | Area (ha) | ORC Description | Conservation Values  | Sub-catchment                                      |
|-----------------|--|-----------|-----------------|--|--|
|                 |  |           |                 | Regionally significant wetland habitat for waterfowl. Regionally significant habitat for waterfowl.  |  |
| 111             | Murrays Road Inland Saline Wetland Management Area |           |                 | Scarce in Otago in terms of its ecological or physical character. Scarce wetland type. This is the only known salt pan within the Macraes Ecological District. The salt pan is a mosaic of bare exposed saline soil and the native salt tolerant plants <i>Apium sp.</i> and <i>Selliera microphylla</i> . The wet area contains native sedges and rushes (see Bibby, 1997). Less than 18% of inland saline areas remain in Otago.   | Strath Taieri                                      |
| 114             | Office Creek Seepage                               | 2.8       | Seepage         | Habitat for nationally or internationally rare or threatened species or communities. Presence of Eldon's galaxias.   | Mahinerangi/Lee Stream/Deep Stream                 |
| 116             | Old Dunstan Road Swamp                             | 5.72      | Swamp           | Scarce in Otago in terms of its ecological or physical character. Less than 15% of swamps remain in Otago. 6.5 km Northwest of the intersection of Old Dunstan Road and Rocklands Road, Clarks Junction.   | Strath Taieri                                      |
| 118             | Otokia Swamp                                       | 9.4       | Swamp           | Regionally significant wetland habitat for waterfowl. Regionally significant breeding area for waterfowl, including New Zealand Shoveller/Kuruwhengi ( <i>Anas rhynchos variegata</i> ), Swamp Hen/Pukeko ( <i>Porphyrio porphyrio melanotus</i> ), Pied Stilt ( <i>Himantopus himantopus</i> ) and Spur-winged Plover ( <i>Vanellus miles novaehollandiae</i> ). Highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses, including mahika kai and waahi taoka. | Waipori/Waihola wetland                            |
| 122             | Peat Moss Hills Fen Complex                        | 35.9      | Fen and Seepage | High degree of wetland naturalness.  | Silver Stream, Maungatua, Taieri Plain and coastal |
| 128             | Reefs Pond Margins                                 | 0.67      | Swamp           | Scarce in Otago in terms of its ecological or physical character. Less than 15% of swamps remain in Otago.   | Mahinerangi/Lee Stream/Deep Stream                 |
| 142             | Sutton Salt Lake Wetland Management Area           | 131.2     | Marsh           | Salt Lake (2 ha, near Sutton) is a shallow saline lake on the southern edge of the Strath Taieri Plain. Swampy margins with succulent herb, rush   | Strath Taieri                                      |

| ORC reference # | Name          | Area (ha) | ORC Description | Conservation Values   | Sub-catchment                |
|-----------------|---------------|-----------|-----------------|---|------------------------------|
|                 |               |           |                 | and sedge vegetation. Part of Sutton Salt Lake Scenic Reserve (142 ha) which embraces other tarns, seepages, grassland and shrubland communities. Habitat for nationally or internationally rare or threatened species or communities. Presence of threatened plant species <i>Gratiola nana</i> , <i>Isolepis basilaris</i> and <i>Crassula peduncularis</i> . Scarce in Otago in terms of its ecological or physical character. Scarce wetland type. Sutton Salt Lake is New Zealand's only inland Salt Lake. The lake has an important sequence of salt tolerant vegetation around its margin. Native plants include <i>Lilaeopsis ruthiana</i> , <i>Apium</i> sp., and <i>Chenopodium glaucum subsp. ambiguum</i> . A range of water birds and waders use the lake, feeding on the tiny shrimp-like organisms which occur there. Less than 15% of marshes remain in Otago.  |                              |
| 147             | Takitoa Swamp | 67.73     | Swamp           | Large, flat, valley-floor wetland. Habitat for nationally or internationally rare or threatened species or communities. South Island Fernbird ( <i>Bowdleria punctata punctata</i> ) and inanga ( <i>Galaxias maculatus</i> ) have been recorded in wetland. Potential habitat for giant kokopu ( <i>Galaxias fasciatus</i> ). Wetland which is highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses, including waahi taoka and mahika kai. Meets six of eight Kāi Tahu beliefs, values, and uses including mahika kai and waahi taoka. Significant hydrological values including maintaining water quality or low flows, or reducing flood flows. Maintains water quality, takes flood flows from the Taieri River. Eight bird species have been recorded in the wetland, including the threatened South Island Fernbird ( <i>Bowdleria punctata</i> ) which is classified as At Risk-Declining. Of the other bird species present four are indigenous - pukeko, paradise shelduck, NZ shoveler, and Australasian harrier - and three are | Estuary/Mouth single channel |

| ORC reference # | Name               | Area (ha) | ORC Description | Conservation Values   | Sub-catchment           |
|-----------------|--------------------|-----------|-----------------|---|-------------------------|
|                 |                    |           |                 | introduced – mallard and goldfinch. Four other species have been observed on the wetland margins, three indigenous – grey warbler, yellow-breasted tit, and tui – and the introduced. Surprise stream is a habitat for fish species, including inanga ( <i>Galaxias maculatus</i> ), which is classified as At Risk – Declining. The wetland is a potential habitat for giant kokopu ( <i>Galaxias argenteus</i> ), also classified as At Risk-Declining, and banded kokopu ( <i>Galaxias fasciatus</i> ) but there are no records for these species. |                         |
| 166             | Waipori Boot Swamp | 11.3      | Swamp           | Habitat for nationally or internationally rare or threatened species or communities. Habitat for threatened Australasian Bittern ( <i>Botaurus poiciloptilus</i> ) and the Marsh Crane ( <i>Porzana pusilla affinis</i> ). High diversity of indigenous wetland flora and fauna. A high diversity of waterfowl species present.   | Waipori/Waihola wetland |

## Appendix 6 Taieri Catchment RAPS associated with the Taieri River

Macraes ED= Bibby, 1997; Maniototo= Grove, 1994; Waipori= Carter, 1994

| Ecological District (ED) | Site Name                              | RAP#      | Values   |
|--------------------------|--|-----------|--|
| Macraes ED               | Golden Bar                             | RAP 7     | has small area of gully floor purei wetland with associated tussockland with <i>Carmichaelia kirkii</i> (nationally vulnerable) and <i>Celmissia hookeri</i>   |
| Macraes ED               | Redbank                                | RAP 8     | Presence of rare Otago and grand skinks; <i>Celmissia hookeri</i> and <i>Myosurus minimus</i> subsp. <i>novae-zelandiae</i> (Nationally Critical) and the best population of <i>Halocarpus bibwillii</i> in the ED. RAP has areas of copper tussock wetland and an ephemeral tarn.   |
| Macraes ED               | Nenthorn Ridge                         | RAP 10    | has ephemeral tarns and purei wetlands which has <i>Gratiola nana</i>  |
| Macraes ED               | Emerald Creek                          | RAP 11    | has small area of copper tussock wetland; <i>Simplicia laxa</i> and rare grand, Otago and Southern grass skinks  |
| Macraes ED               | Glynwae                                | RAP 14    | has ephemeral tarn with <i>Myosurus minimus</i> subsp. <i>novae-zelandiae</i> (Nationally Critical), <i>Gratiola nana</i> and <i>Cardamine mutabilis</i> (was Cardamine "tarn") nationally critical ref#55   |
| Macraes ED               | Sheepwash Creek, Macraes ED            | RAP 15    | matagouri at risk declining at southern limit pers. comm. in ref#55; largest population of <i>Carmichaelia kirkii</i> (nationally vulnerable) in the ED; <i>Coprosma virescens</i> also present - not common in the ED.  |
| Maniototo ED             | Upper Taieri Wetlands (Part) Styx      | RAP AOI4A | in ref #54. Values listed include: D. Bruce (unpub, report) noted the presence of the halophyte <i>Selliera microphylla</i> at G.R. H42 755 506 (Maniototo Basin) growing in turfy patches along and near the banks of the Taieri River. This is in part of an area mapped as "very salty" soils on the DSIR soil map. <i>Apium filliforme</i> and <i>Puccinellia sp</i> are also found in this area. Bruce adds that <i>Selliera</i> may be common elsewhere near the banks of the Taieri particularly south of this site. text from ref #54 A total of fifty-two bird species have been recorded in the area. Of these, twenty-seven species are dependent on the wetland to meet their specialised needs. |
| Maniototo ED             | Upper Taieri Wetlands (Part) Maniototo | RAP AOI4B | in ref #54. Values listed include: D. Bruce (unpub, report) noted the presence of the halophyte <i>Selliera microphylla</i> at G.R. H42 755 506 (Maniototo Basin) growing in turfy patches along and near the banks of the Taieri River. This is in part of an area mapped as "very salty" soils on the DSIR soil map. <i>Apium filliforme</i> and <i>Puccinellia sp</i> are also found in this area. Bruce adds that <i>Selliera</i> may be common elsewhere near the banks of the Taieri particularly south of this site. A total of fifty-two bird species have been recorded in the area. Of these, twenty-seven species are dependent on the wetland to meet their specialised needs.                   |
| Maniototo ED             | Totara Creek                           | RAP 14    | Values listed include: <i>Selliera microphylla</i> is common here. <i>Sarcocornia quinqueflora</i> , <i>Samolus repens</i> , <i>Puccinellia</i> spp. and the rare plant <i>Triglochin palustre</i> are all found on flat, salty soils. <i>Atriplex buchananii</i> grows at the foot of nearby clay banks.  |
| Maniototo ED             | Wilson Road                            | RAP 15    | Floodplain. A mound spring is present at this site where a saline aquifer emerges and deposits salts around the spring. <i>Atriplex buchananii</i> , <i>Lepidium kirkii</i> , <i>Hordeum spp.</i> , <i>Puccinellia sp.</i>   |



| Ecological District (ED) | Site Name          | RAP#       | Values   |
|--------------------------|--------------------|------------|--|
| Maniototo ED             | Omnibus Creek      | RAP AOI 17 | ref #54. Stream gully entrenched 10-20m below plain. Values listed include: Dense shrublands cover gully side slopes for c. 1.5km downstream of Highfield Runs Road Bridge. Shrub species include <i>Discaria toumatou</i> , <i>Carmichaelia petriei</i> , <i>Coprosma</i> spp. and the liane <i>Muehlenbeckia complexa</i> .  |
| Maniototo ED             | Gibson Road        | RAP AOI 18 | Gibson Road ref #54. Values listed include: A distinctive semi-natural vegetation. The original shrub and tussock cover has long been removed by burning and grazing. However, the remaining short grasses and low herbs are mostly native species. Of special significance is the presence of a new species of cushion-forming <i>Galium</i> . This <i>Galium n.sp.</i> , the herb <i>Leptinella maniototo</i> and the grass <i>Rytidosperma maculatum</i> form the dominant ground cover in places while three species of <i>Raoulia</i> ( <i>R. parkii</i> , <i>R. beauverdii</i> and <i>R. australis</i> ) are also common. Other plants present are <i>Puccinellia</i> sp., <i>Dichelachne crinita</i> , <i>Geranium sessiliflorum</i> and scattered <i>Melicytus alpinus</i> and <i>Carmichaelia monroi</i> . The grasses <i>Elymus solandri</i> and <i>Poa colensoi</i> are present on the roadside verge where they are protected from grazing and would probably spread back into the paddock if grazing ceased. There is an abundance of moss and lichens growing among the vascular plants and sarsen stones are also present in the paddock. |
| Maniototo ED             | Puketoi Runns Road | RAP AOI 19 | in ref #54. Alluvium plain. Values listed include: Excellent shrublands at this site, a small area (several hectares) bordering the roadside and surrounded by exotic pasture and pine shelter belts. <i>Olearia odorata</i> is the dominant shrub, reaching about two metres in height. Native grasses are present also: <i>Elymus apricus</i> (often growing through the <i>Melicytus</i> ), <i>Dichelachne crinita</i> , <i>Poa cita</i> , <i>Festuca novae-zelandiae</i> and <i>Rytidosperma maculatum</i> . <i>Raoulia beauverdii</i> is common here.   |
| Waipori ED               | Lammerlaw Tops     | RAP 3      | Subtle change from wetland to grassland to snowbank.   |
| Waipori ED               | Lammermoor         | RAP 4      | Sedge and rush Sphagnum bog on hill side flush. Tussock and shrubland on sideslope and rock areas, fellfield on dry ridge tops. <i>Chionochloa rigida</i> grassland with <i>Coprosma cheesemanii</i> and native inter-tussock herbs on side slopes. <i>Chionochloa rigida</i> and bog pine sphagnum wetland on shallow valley bottom and lower side slopes; presence of At Risk – Naturally Uncommon <i>Veronica trifida</i> . <i>Kelleria paludosa</i> and sedge wetland in valley bottom; <i>Oreobolus pectinatus</i> , <i>Dracophyllum prostratum</i> and lichen wetland on lower sideslope. Some rare plants, not found anywhere else in the District, e.g. <i>Veronica trifida</i> . ref#50   |
| Waipori ED               | Fiddlers Creek     | RAP 5      | <i>Halocarpus bidwillii</i> , sedge and moss wetland on upland rolling tops.   |
| Waipori ED               | Deep Stream Gorge  | RAP 6      | falcon habitat present.  |
| Waipori ED               | Deep Stream Gorge  | RAP 7      | Mature and regenerating <i>Podocarpus hallii</i> stand on the sunny slopes. Skinks and Geckos on rock outcrops at the top of the gorge slopes.   |
| Waipori ED               | Taieri Rapids      | RAP 8      | NZ flacon habitat present.   |
| Waipori ED               | Lammerlaw Stream   | RAP 10     | <i>Halocarpus bidwillii</i> , cushion and Sphagnum wetland on poorly drained tops.   |
| Waipori ED               | Verterburn         | RAP 11     | at risk declining <i>Coprosma intertexta</i> found here and in Lammerlaw Stream.   |

| Ecological District (ED) | Site Name                        | RAP#   | Values   |
|--------------------------|----------------------------------|--------|--|
| Waipori ED               | Fortification Stream             | RAP 14 | Sedge wetland on stream headwaters flush.  |
| Waipori ED               | Pioneer                          | RAP 15 | <i>Chionochloa rubra</i> and sedge wetland on fluvial floodplain. Regionally significant wetland called "Loch Luella Fen Complex" 871 ha fen and swamp. High diversity of indigenous wetland flora and fauna. Diverse plant communities. In swampy areas on valley floor <i>Carex gaudichaudiana</i> sedgeland occurs with exotic grasses, rushes and some large Sphagnum sp. cushions and other cushion species. Habitat for nationally or internationally rare or threatened species or communities. Recorded sightings of the threatened Australasian Bittern ( <i>Botaurus poiciloptilus</i> ) and the South Island Fernbird/Matata ( <i>Bowdleria punctata punctata</i> ). 1 Called Pioneer Creek in the Clutha District Plan, where it is listed as a Significant Wetland. Valued as waterfowl habitat. Composition of red tussock ( <i>Chionochloa rubra</i> ), <i>Carex</i> sp., Sphagnum sp., wire rush/oioi ( <i>Leptocarpus similis</i> ), wilding pine. see Ausseil, A.G., Newsome, P., Johnson, P. (2008) Wetland Mapping in the Otago Region. Landcare Research Contract Report prepared for the Otago Regional Council. |
| Waipori ED               | Fortification Peak               | RAP 16 | Sedge wetland in stream course. Only example of <i>Poa cita</i> grassland.   |
| Waipori ED               | Johnson Road                     | RAP 17 | <i>Carex secta</i> wetland (near Shannon Stream) <i>Arthropodium candidum</i> lily and common brown skinks.  |
| Manorburn ED             | No RAPs in the Taieri catchment. |        |  |

## Appendix 7 Rare and Threatened Plants of the Taieri Catchment

Nationally at risk and threatened species, with some locally uncommon species collated across multiple sources. \*planted species.

| Common Name   | Scientific Name              | National Threat Classification |
|---|------------------------------|--------------------------------|
| <i>Aciphylla subflabellata</i>                      |                              | At Risk – Declining            |
| <i>Althenia bilocularis</i>                         |                              | Nationally Vulnerable          |
| <i>Anemanthele lessoniana</i>                       | Gossamer grass*              | At Risk – Relict               |
| <i>Anthosachne aprica</i>                           | Blue wheat grass             | At Risk – Naturally Uncommon   |
| <i>Atriplex buchananii</i>                          | Buchanan's orache            | Nationally Vulnerable          |
| <i>Botrychium australe</i>                          |                              | At Risk- Naturally Uncommon    |
| <i>Cardamine mutabilis</i>                          | Cardamine "tarn"             | Nationally Critical            |
| <i>Carex buchananii</i>                             | Buchanans sedge              | At Risk – Declining            |
| <i>Carex purpurata</i>                              | Purple Bastard Grass         | At Risk- Naturally Uncommon    |
| <i>Carex tenuiculmis</i>                            |                              | At Risk – Declining            |
| <i>Carmichaelia kirkii</i>                          | Climbing broom, Kirk's broom | Nationally Vulnerable          |
| <i>Carmichaelia monroi</i>                          | Stout dwarf broom            | At Risk – Declining            |
| <i>Carmichaelia petriei</i>                         | desert broom                 | At Risk – Declining            |
| <i>Carmichaelia vexillata</i>                       |                              | At Risk – Declining            |
| <i>Celmisia haastii</i> var. <i>tomentosa</i>       |                              | At Risk- Naturally Uncommon    |
| <i>Celmisia hookeri</i>                             | Hooker's mountain daisy      | At Risk- Naturally Uncommon    |
| <i>Ceratocephala pungens</i>                        |                              | Nationally Critical            |
| <i>Chenopodium allanii</i>                          |                              | At Risk – Naturally Uncommon   |
| <i>Coprosma intertexta</i>                          |                              | At Risk – Declining            |
| <i>Coprosma virescens</i>                           |                              | At Risk – Declining            |
| <i>Crassula mataikona</i>                           |                              | At Risk- Naturally Uncommon    |
| <i>Crassula multicaulis</i>                         |                              | Nationally Endangered          |
| <i>Crassula peduncularis</i>                        |                              | Nationally Critical            |
| <i>Deschampsia cespitosa</i>                        | Tufted hair-grass            | At Risk – Declining            |
| <i>Discaria toumatou</i> Raoul                      | matagouri                    | At Risk – Declining            |
| <i>Dracophyllum uniflorum</i> var. <i>frondosum</i> |                              | At Risk- Naturally Uncommon    |
| <i>Epilobium insulare</i>                           | willowherb                   | At Risk – Declining            |
| <i>Euchiton polylepis</i>                           |                              | At Risk – Naturally Uncommon   |
| <i>Geum pusillum</i>                                |                              | At Risk – Naturally Uncommon   |
| <i>Gingidia grisea</i>                              |                              | At Risk – Naturally Uncommon   |
| <i>Gratiola concinna</i>                            |                              | Nationally Endangered          |
| <i>Hypericum rubicundulum</i>                       |                              | Nationally Endangered          |
| <i>Isolepis basilaris</i>                           | Pygmy clubrush               | Nationally Endangered          |
| <i>Juncus distegus</i>                              |                              | At Risk – Naturally Uncommon   |
| <i>Juncus pusillus</i>                              |                              | At Risk – Naturally Uncommon   |
| <i>Korthalsella clavata</i>                         |                              | At Risk – Declining            |
| <i>Lagenophora barkeri</i>                          |                              | At Risk – Naturally Uncommon   |
| <i>Lagenophora montana</i>                          | papataniwha                  | Nationally Critical            |
| <i>Lepidium juvencum</i>                            | scurvy Grass                 | Nationally Critical            |
| <i>Lepidium kirkii</i>                              | salt pan cress               | Nationally Critical            |
| <i>Lepidium sisymbrioides</i>                       |                              | Nationally Critical            |
| <i>Lepidium solandri</i>                            | Maniototo pepperpress        | Nationally Critical            |
| <i>Leptinella maniototo</i>                         |                              | At Risk – Relict               |
| <i>Leptinella pusilla</i>                           |                              | At Risk – Declining            |

| Common Name   | Scientific Name                  | National Threat Classification |
|---|----------------------------------|--------------------------------|
| <i>Linum monogynum</i>  | New Zealand linen flax           | At Risk – Declining            |
| <i>Lobelia ionantha</i>   |                                  | At Risk – Declining            |
| <i>Mazus novaezeelandiae</i>                                      |                                  | At Risk – Declining            |
| <i>Melicytus aff. alpinus (d) (CHR 541567; "dark")</i>            |                                  | Data Deficient                 |
| <i>Mentha cunninghamii</i>  | New Zealand mint, Hihoi          | At Risk – Declining            |
| <i>Montia angustifolia</i>  |                                  | At Risk – Naturally Uncommon   |
| <i>Myosotis aff. australis (c) (CHR 572827; Lammerlaw)</i>        |                                  | Data Deficient                 |
| <i>Myosotis tenericauli</i>                                       |                                  | At Risk – Naturally Uncommon   |
| <i>Myosurus minimus subsp. novae zelandiae</i>                    | New Zealand mousetail            | Nationally Vulnerable          |
| <i>Olearia fragrantissima</i>                                     | Fragrant Tree Daisy              | At Risk – Declining            |
| <i>Olearia lineata</i>  |                                  | At Risk – Declining            |
| <i>Oxybasis glauca subsp. ambigua</i>                             |                                  | At Risk – Declining            |
| <i>Pachycladon cheesemanii</i>                                    | Dryland cress                    | Nationally Endangered          |
| <i>Plantago obconica</i>  |                                  | At Risk – Naturally Uncommon   |
| <i>Pseudopanax ferox</i>  | Fierce Lancewood                 | At Risk – Naturally Uncommon   |
| <i>Pterostylis tanypona</i>                                       |                                  | At Risk – Declining            |
| <i>Pterostylis tristis</i>  |                                  | At Risk – Declining            |
| <i>Puccinellia raroflorens</i>                                    | saltgrass                        | Nationally Critical            |
| <i>Ranunculus macropus</i>  | Swamp buttercup                  | Data Deficient                 |
| <i>Raoulia australis</i>  | Common mat daisy                 | At Risk – Declining            |
| <i>Raoulia beauverdii</i>   |                                  | At Risk – Declining            |
| <i>Raoulia monroi</i>   | Fan-leaved mat daisy             | Nationally Vulnerable          |
| <i>Raoulia parkii</i>   |                                  | At Risk – Declining            |
| <i>Rytidosperma buchananii</i>                                    | slender danthonia, bristle grass | At Risk – Declining            |
| <i>Rytidosperma maculatum</i>                                     |                                  | Data Deficient                 |
| <i>Rytidosperma merum</i>   |                                  | At Risk – Declining            |
| <i>Samolus repens</i>   |                                  | At Risk – Naturally Uncommon   |
| <i>Senecio dunedinensis</i>                                       | Fireweed                         | Nationally Endangered          |
| <i>Simplicia laxa</i>   | Simplicia                        | Nationally Critical            |
| <i>Sonchus (b) (CHR 596666; aff. S. novae-zelandiae; "cliff")</i> |                                  | Nationally Vulnerable          |
| <i>Stuckenia pectinata</i>  | sago pondweed                    | At Risk – Naturally Uncommon   |
| <i>Tetrachondra hamiltonii</i>                                    |                                  | Nationally Vulnerable          |
| <i>Triglochin palustre</i>  | Marsh arrow grass                | Nationally Critical            |
| <i>Urtica linearifolia</i>  | Swamp nettle                     | At Risk – Declining            |
| <i>Veronica lilliputiana</i>                                      | Tarn Speedwell                   | At Risk – Declining            |
| <i>Veronica trifida</i>   | Hebejeebie                       | At Risk – Naturally Uncommon   |
| <i>Wurmbea novae-zelandiae</i>                                    |                                  | Nationally Endangered          |

## Appendix 8 Habitat Types at Taieri River Estuary

Summary of habitat types at the Taieri River Estuary, and the extent of each, as per Ryder Consulting, 2008 (See Robertson *et al.* 2002) for definitions of each habitat classification). Saltmarsh habitat covers 12.9 % of the Taieri estuary, and combines habitat classes denoted by bold text (as per ORC, November 2010).

| Habitat Type       | Area (ha)     | % of Total Area |
|--------------------|---------------|-----------------|
| Boulderfield       | 0.06          | 0.02            |
| Cobblefield        | 2.5           | 0.91            |
| Firm mud/sand      | 23.96         | 8.73            |
| Firm sand          | 56.82         | 20.71           |
| Grassland          | 91.57         | 33.38           |
| Gravelfield        | 0.9           | 0.33            |
| Macroalgae         | 0.85          | 0.31            |
| Mobile sand        | 43.91         | 16              |
| <b>Reedland</b>    | 0.11          | 0.04            |
| Rockfield          | 3.02          | 1.1             |
| <b>Rushland</b>    | 23.37         | 8.52            |
| Scrubland          | 0.39          | 0.14            |
| <b>Shrubland</b>   | 7.64          | 2.79            |
| Soft sand          | 4.24          | 1.54            |
| Soft sand/mud      | 10.55         | 3.85            |
| Treeland           | 0.55          | 0.2             |
| <b>Tussockland</b> | 3.94          | 1.44            |
| <b>Total</b>       | <b>274.36</b> | <b>100</b>      |

## Appendix 9 Water Quality Statistics for Taieri River collected from 2014-2019

In the table below, red font indicates non-compliance with Water Plan Schedule 15 limits. Note: SOE monitoring results are based on five years of data taken when the flow site was at or below median flow, and where the top 20% of the data are removed from the final information so the data are not skewed by extreme results (ORC Website, State of the Environment Water Quality Reports - report cards for all major Otago catchments).

| River & Site                       | NNN (mg/L)   | NH <sub>4</sub> -N (mg/L) | DRP (mg/L)   | <i>E. coli</i> (cfu/100ml) | Turbidity (NTU) |
|------------------------------------|--------------|---------------------------|--------------|----------------------------|-----------------|
| <b>Kye Burn Area</b>               |              |                           |              |                            |                 |
| Taieri at Tiroiti                  | 0.0328       | 0.0118                    | 0.022        | 197.9                      | 4.51            |
| Kye Burn at SH85 Bridge            | 0.072        | 0.01                      | 0.006        | 195                        | 1.7             |
| <b>Water Plan Limit</b>            | <b>0.075</b> | <b>0.10</b>               | <b>0.010</b> | <b>260</b>                 | <b>5.0</b>      |
| <b>Maniototo area</b>              |              |                           |              |                            |                 |
| Taieri at Waipiata                 | 0.0265       | 0.0137                    | 0.04         | 254.7                      | 3.18            |
| Taieri at Stonehenge               | 0.0079       | 0.009                     | 0.008        | 160                        | 1.77            |
| <b>Water Plan limit</b>            | <b>0.075</b> | <b>0.10</b>               | <b>0.010</b> | <b>260</b>                 | <b>5.0</b>      |
| <b>Maungatua area</b>              |              |                           |              |                            |                 |
| Sutton Stream at SH87              | 0.0149       | 0.0025                    | 0.0097       | 843                        | 3.52            |
| Nenthorn at Mt Stoker Road         | 0.0029       | 0.0165                    | 0.0173       | 117                        | 1.7             |
| Three O'clock Stream               | 0.0516       | 0.0099                    | 0.005        | 37.2                       | 0.88            |
| Deep Stream                        | 0.0017       | 0.007                     | 0.0035       | 202.5                      | 1.2             |
| Taieri at Outram                   | 0.043        | 0.0105                    | 0.0115       | 78                         | 2.25            |
| <b>Water Plan limit</b>            | <b>0.075</b> | <b>0.10</b>               | <b>0.010</b> | <b>260</b>                 | <b>5.0</b>      |
| <b>Strath Taieri area</b>          |              |                           |              |                            |                 |
| Taieri at Sutton                   | 0.0499       | 0.0166                    | 0.0146       | 461                        | 2.85            |
| <b>Water Plan limit</b>            | <b>0.075</b> | <b>0.10</b>               | <b>0.010</b> | <b>260</b>                 | <b>5.0</b>      |
| <b>Styx area</b>                   |              |                           |              |                            |                 |
| Taieri at Linnburn                 | 0.003        | 0.009                     | 0.005        | 312                        | 1.5             |
| <b>Water Plan limit</b>            | <b>0.075</b> | <b>0.10</b>               | <b>0.010</b> | <b>260</b>                 | <b>5.0</b>      |
| <b>Taieri Plains area - Rivers</b> |              |                           |              |                            |                 |
| Silver Stream at Taieri Depot      | 0.624        | 0.0164                    | 0.007        | 284.6                      | 1.92            |
| Owhiro Stream at Riverside Rd      | 0.349        | 0.153                     | 0.0492       | 812                        | 22              |
| Taieri at Allanton Bridge          | 0.061        | 0.022                     | 0.0145       | 440                        | 5.1             |
| Waipori at Waipori Falls Reserve   | 0.032        | 0.007                     | 0.003        | 41.5                       | 1.76            |
| Contour Channel at No.4 Bridge     | 0.13         | 0.039                     | 0.044        | 900                        | 4.1             |
| <b>Water Plan limit</b>            | <b>0.075</b> | <b>0.10</b>               | <b>0.010</b> | <b>260</b>                 | <b>5.0</b>      |
| <b>Taieri Plains area - Lakes</b>  |              |                           |              |                            |                 |
| Lake Waiholo at Jetty              | 0.67         | 0.015                     | 0.078        | 90                         | 19.1            |
| <b>Water Plan limit</b>            | <b>0.55</b>  | <b>0.10</b>               | <b>0.033</b> | <b>126</b>                 | <b>5.0</b>      |
| <b>Water Plan limit</b>            | <b>0.444</b> | <b>0.10</b>               | <b>0.026</b> | <b>260</b>                 | <b>5.0</b>      |

## Appendix 10 Fish of the Taieri catchment

Threat classification as per Dunn *et al.* 2018.

| Species                      | Common name                      | Threat Classification | Life History   | Threats  |
|------------------------------|----------------------------------|-----------------------|--|--|
| <b>Non-Migratory Species</b> |                                  |                       |  |  |
| <i>Galaxias eldoni</i>       | Eldon's galaxias                 | Nationally Endangered | They can live up to 12 years. They make their home under banks and amongst the gravels of very small headwater streams that are typically about 200–900 m above sea level and surrounded by vegetation such as tussock, mānuka and coprosma. c. 5.4 ha of habitat remaining.   | Over the last decade we have lost 20% of known Eldon's populations. This can be directly linked to the spread of sports fish (trout and brook char), which eat galaxiids; and changes in land use such as stock access to streams, reduction of native vegetation, land development and forest harvesting. These land use changes impact on the streams in which galaxiids live, increasing sedimentation, changing natural flows through water abstraction, and reducing the amount of habitat available for spawning. [from DOC website]   |
| <i>Galaxias anomalus</i>     | Central Otago roundhead galaxias | Nationally Endangered | Short lived (up to 4 years), can co-exist with trout unless habitat limiting; c. 22 ha of habitat remains. Central Otago roundhead galaxias live in headwater tributaries of the Taieri (upstream of Sutton) and Manuherikia rivers (tributaries of the Pool Burn and Ida Burn), with population strongholds in the Ewe Burn and Kye Burn. They are generally found in shallow gravel- and cobble-laden headwater streams and braided rivers 350–800 m above sea level.  | Their main threats are habitat loss from land development and predation by trout. Because they're so short-lived, they can be really vulnerable to predation and to drought. Although some larger river habitats have enough space for galaxiids and trout to co-exist. Changes in land use, such as stock access to streams, reduction of native vegetation, and forest harvesting are also contributing factors to its decline. This is due to increased sedimentation in the streams in which they live, changes in natural flows through water abstraction, and reduced habitat available for spawning. [from DOC website] |
| <i>Galaxias pullus</i>       | dusky galaxias                   | Nationally Endangered | They can live up to 20 years. With only 25 known populations, dusky galaxias are becoming increasingly rare. Their total remaining habitat can fit in an area less than 7 hectares. Dusky galaxias are found in eastern areas of Otago in small tributaries of the Waipori River surrounding Lake Mahinerangi. A few populations have been discovered in pockets of the Clutha and Taieri rivers. They make their home under banks and amongst the gravels of very small headwater streams small enough to step across. These streams are typically about 400–1000 m above sea level and are | Over the last decade we have lost 25% of known dusky populations. This can be directly linked to the spread of sports fish (trout and brook char), which eat galaxiids; and changes in land use such as stock access to streams, reduction of native vegetation, land development and forest harvesting. These land use changes impact on the streams in which galaxiids live, increasing sedimentation, changing natural flows through water abstraction, and reducing the amount of habitat available for spawning. [from DOC website]   |

| Species   | Common name              | Threat Classification | Life History   | Threats  |
|---|--------------------------|-----------------------|--|--|
|   |                          |                       | surrounded by vegetation such as tussock, mānuka, hebes and coprosma.  |  |
| <i>Galaxias depressiceps</i>                          | Taieri flathead galaxias | Nationally Vulnerable | Their entire remaining habitats total only 21 hectares. They can live up to 8 years. Taieri flathead galaxias ( <i>Galaxias depressiceps</i> ) are found in tributaries of the Taieri, Waikouaiti and Shag rivers, and as far as Akatore Creek in the north. They make their home in headwater streams that are small enough to step across and are surrounded by grasses and tussock. | Over the last decade, we have lost 25% of known galaxiid populations. This can be directly linked to the spread of sports fish (trout and brook char), which eat galaxiids; and changes in land use such as stock access to streams, reduction of native vegetation, land development and forest harvesting. These land use changes impact on the streams in which galaxiids live, increasing sedimentation, changing natural flows through water abstraction, and reducing the amount of habitat available for spawning. [from DOC website] |
| <i>Gobiomorphus hubbsi</i>                            | Bluegill bully           | At Risk - Declining   | The bluegill bully usually grows to about 5 cm long. It has an 'upturned' mouth which it uses to pick its food (aquatic insects) from beneath rocks. This fish prefers swiftly flowing gravelly streams, just like the torrentfish.  | Destruction of riparian vegetation; Competition and predation from introduced fish species; Habitat destruction from: Modification of riparian margins, Introduction of aquatic weeds, Siltation, Eutrophication (high nutrients), Erosion of banks through grazing by livestock, goats and deer, Artificial barriers to upstream migration (e.g. culverts, fords with large lips creating a drop off) and Depleted flows caused by water abstraction (McDowall, 2000). [from IUCN redlist.org page]   |
| <i>Gobiomorphus breviceps</i>                         | Upland bully             | Not Threatened        | The upland bully is stockily built with a large head They grow to about 8 cm long and can be found in a variety of habitats. The upland bully does not undertake a migration.  | Potential threats to this species include local extirpations and site-specific loss of larval backwater spawning and rearing habitats, through channelization and water abstraction. [from IUCN redlist.org page]  |
| <b>A Mix of Migratory and Land-Locked Populations</b> |                          |                       |  |  |
| <i>Gobiomorphus cotidianus</i>                        | Common Bully             | Not Threatened        | Even though they are well camouflaged against sand and rocks, common bully is often seen darting in the shallows during the day. The male guards the nest and when the eggs hatch, the larvae go to sea to return to freshwater after a few months. However, some populations become landlocked and complete their life cycle without the sea phase.                                   | Habitats are likely to be impacted by water abstraction, agricultural development and land use changes (and this species is also a major prey item of introduced salmoniids, particularly Brown Trout ( <i>Salmo trutta</i> ). <i>G. cotidianus</i> exhibits tolerance to highly eutrophic conditions and as it is present and abundant in a number of large water bodies and a variety of habitats, it is not considered to be significantly threatened by these processes. [from IUCN redlist.org page]                                    |
| <i>Galaxias argenteus</i>                             | Giant kokopu (Taiwharu)  | At Risk – Declining   | Giant kōkopu are the largest of all the galaxiids, not only in New Zealand, but around the world. Although individuals are usually 300–  | Loss and degradation of habitat through activities such as drainage of wetlands and straightening of river channel systems are the biggest   |



| Species                    | Common name     | Threat Classification | Life History  | Threats   |
|----------------------------|-----------------|-----------------------|---|---|
|                            |                 |                       | <p>400 mm long, one specimen has been found weighing 2.8 kg and measuring 580 mm long. Not the most adept of climbers, giant kōkopu are generally found close to the sea. They inhabit wetlands, lakes and forest streams, and rely on good bush surrounds. Giant kōkopu are skulking predators, lurking under cover and making speedy dashes to nab their prey. They are slow-growing and can live for more than 20 years. Like the banded kōkopu, giant kōkopu are also called native or Māori trout.</p>                                       | <p>threat to this species. Current and historic land use change and intensification has resulted in an incremental habitat loss for this species. Around 85% to 90% of New Zealand's wetlands have been lost over the last 100 years and this species is now essentially absent from most of New Zealand's intensively utilised lowland plains. Mechanical clearance of drains causes direct mortality, where this wide scale drain 'management' is known to directly remove and strand fish on the banks. There is on-going pressure to increase efforts to clear drains in key regions (e. see Greer <i>et al.</i> 2012). Also, areas that have been recolonized (following long periods of no drain disturbance) are subjected to being uprooted. Additionally, the loss of riparian vegetation (potential spawning habitat) is likely to change the water temperature and reduces the terrestrial food supply. Other threats include artificial barriers to migration (which disrupt river connectivity and access to adult habitats, thereby negatively affecting the distribution of <i>Galaxias argenteus</i>) and predation and competition by introduced salmonids, primarily brown trout <i>Salmo trutta</i>. Impacts on the population resulting from the harvest of whitebait are possible, but are currently un-quantified. [from IUCN redlist.org page]</p> |
| <b>Migratory Species</b>   |                 |                       |   |   |
| <i>Galaxias postvectis</i> | shortjaw kokopu | Nationally Vulnerable | <p>Shortjaw kōkopu are rare, secretive and seldom seen. As the name suggests, they have an undercut jaw, which is probably designed to scrape aquatic insects from rocks. Shortjaw kōkopu usually grow to between 150 and 200 mm, but can reach 370 mm. Mostly found at low to moderate elevations, they inhabit bouldery forest streams. They can only survive in certain types of habitat, many of which have been degraded by forest clearance, which has probably contributed to their rarity. Shortjaw kōkopu are unique to New Zealand.</p> | <p>Considering its habitat preferences, the historical rapid and extensive deforestation is considered to have been the biggest threat to this species and is likely to have significantly reduced and fragmented its distribution and abundance. Most remaining suitable adult habitat exists in protected high county locations; however, some suitable habitat at lower altitudes is susceptible to further development for agriculture and forestry. Evidence of poor recruitment suggests migratory juveniles are particularly susceptible to impacts within the lower catchment and /or are limited by a sparse, highly fragmented adult population. Other potential threats</p>  |

| Species                       | Common name         | Threat Classification | Life History  | Threats   |
|-------------------------------|---------------------|-----------------------|---|---|
|                               |                     |                       |   | include predation and competition by introduced salmonids, primarily Brown Trout ( <i>Salmo trutta</i> ). Impacts on the population resulting from the harvest of whitebait are possible, but unquantified. [from IUCN redlist.org page]  |
| <i>Geotria australis</i>      | Lamprey/<br>piharau | Nationally Vulnerable | Lamprey juveniles (ammocoetes) live in burrows in silty river edges and migrate out to sea after 4-5 years. Whilst at sea, the lamprey are parasites on marine life until, after another 4-5 years they migrate back up streams to breed and die. Māori consider lamprey or piharau to be a delicacy. | Hydropower development is a specific threat in New Zealand and Chile. The location of spawning and nursery sites is unknown for many of the rivers inhabited by Lamprey. Whilst measures are being implemented to mitigate barriers (e.g. fishway construction), obstruction of migration will remain an issue into the future. Changes to river flow regimes (i.e. reductions in overall discharge and altered seasonality) have likely altered migratory cues (presence of juvenile pheromones) and the quality of juvenile nursery habitats. In addition, altered land use (conversion to farmland) has likely resulted in degradation of spawning/nursery habitats (e.g. siltation) in many parts of the species range. In New Zealand, adults now likely have to travel greater distances to find suitable spawning habitat (as a result of land use), which may impact on adult condition, whilst the overall area of suitable spawning habitat has likely decreased. In south-western. Climate change and drought may reduce the quality of juvenile habitat (increased temperature, reduced DO), particularly in streams with altered flow regimes, and migratory cues and connectivity for freshwater entry. Predation of juveniles and adults by introduced Brown Trout and Rainbow Trout is considered a threat. Specific studies are lacking, but since larval/juvenile stages live in sediment for a prolonged period of time, they are likely to be susceptible and affected by contaminants associated with sediments. Across the species range, threats to the adult marine life stage are unknown but may include alterations of prey abundance and distribution, and accumulation of contaminants. [from IUCN redlist.org page] |
| <i>Anguilla dieffenbachii</i> | Longfin eel         | At Risk - Declining   | They live mainly in rivers and inland lakes but can be found in almost all types of waters, usually well inland from the coast. They are legendary  | Biological resource use: Fishing & harvesting aquatic resources. Natural system modifications: Dams & water management/use. Other ecosystem   |

| Species                        | Common name            | Threat Classification  | Life History   | Threats   |
|--------------------------------|------------------------|------------------------|--|---|
|                                |                        |                        | climbers and have made their way well inland in most river systems, even those with natural barriers. Elvers (young eels) swimming up river will climb waterfalls and even dams by leaving the water and wriggling over damp areas. It is not unheard of for an eel to climb a waterfall of up to 20 metres.   | modifications: Pollution: Agricultural & forestry effluents. Climate change & severe weather; Droughts Temperature extremes. [from IUCN redlist.org page]. Refer to IUCN redlist page for an in-depth summary of threats.   |
| <i>Cheimarrichthys fosteri</i> | Torrentfish/<br>panoko | At Risk -<br>Declining | This aptly named fish is found amongst swift tumbling riffles and is related to the blue cod. Like the whitebait family, the larvae get washed out to sea and the juveniles return to freshwater in spring and summer. Torrentfish are relatively common with most adults growing to about 10 cm.  | This species is a poor climber and therefore barriers to upstream migration limit inland penetration in many river systems throughout this species' range (Tana 2009). Habitat loss through water abstraction and land use changes causing increased sedimentation of interstitial spaces in the river substrate are also threats to this species. Additionally, considering long-term climate trends and water abstraction pressures, the availability of fast-flowing water for this very habitat-specific species will probably continue to decline. [from IUCN redlist.org page]  |
| <i>Galaxias maculatus</i>      | Inanga                 | At Risk -<br>Declining | Inanga are found in a wide variety of habitats, from tiny creeks, to coastal rivers, lowland streams, lakes and wetlands. They are the only migratory galaxiid species where the adults swim in shoals. Inanga are small and short-lived, with most only surviving for 1 year and reaching around 100 mm in length – although the longest on record is 190 mm. Because they are poor climbers, inanga are usually found near the coast. Their silvery belly and somewhat forked tail make them easy to distinguish. Found in places as far flung as Chile, Australia and Argentina, inanga are the most widely distributed native freshwater fish in the world. They are New Zealand's most commonly caught species. | In New Zealand, the loss of rearing and spawning habitat due to land clearance, loss of river connectivity through tide and flood gates and stop banking, channelization, weirs, dams and land and wetland drainage has significantly reduced the distribution of this species. Loss of riparian vegetation (e.g. through stock trampling, grazing and mowing), is also a threat to spawning sites (Hickford and Schiel 2014). Prior to fishery regulations, the whitebait fishery in New Zealand also contributed to a major decline of this species. Predation by introduced salmonids is another potential threat to this species in New Zealand. [from IUCN redlist.org page] |
| <i>Galaxias brevipinnis</i>    | Kōaro                  | At Risk -<br>Declining | Kōaro are accomplished climbers, being able to negotiate near-vertical waterfalls using specially formed broad fins that have a grippy texture underneath. Living for 15 years or more, kōaro travel as far as 400 km inland, and climb as high as 1300 m. These solitary fish are often found in fast-flowing, cool, tussock or forest streams. They commonly grow to about 160–180 mm, but can reach 290 mm. In bright light, their skin shines with iridescence.  | Several common causes of decline have been implicated in the general range contraction and decrease in abundance of large galaxiid. These include overharvesting of the juvenile whitebait stage in New Zealand, artificial barriers to migration, habitat destruction, pollution of waterways, changes in catchment land use and the impacts of introduced species. The primary threats to <i>G. brevipinnis</i> are habitat degradation in the lowland and foothill areas through loss of riparian habitat and the  |

| Species                     | Common name    | Threat Classification | Life History   | Threats  |
|-----------------------------|----------------|-----------------------|--|--|
|                             |                |                       |  | <p>impact of introduced predators. Changes in flow and water temperatures are also significant threats to this species. Despite their excellent climbing abilities, large or perched artificial barriers can pose upstream and downstream issues for migration of adults. Fishing may be a threat to this species in New Zealand, where a large proportion of the recruiting juveniles are caught. Introduced salmonids (specifically Brown Trout (<i>Salmo trutta</i>) and Rainbow Trout (<i>Oncorhynchus mykiss</i>)) predate directly on this species and compete for food and space resources when small. The significance of each of these individual threats varies geographically throughout the species' range. For example, in New Zealand, a high proportion of the heavy fishing occurs on the west coast of the South Island, where the pressures on habitat are less significant. Combined impacts of these most significant threats have no doubt caused a rapid decline in populations in the past, however these declines are thought to have now slowed (McDowall 2000). [from IUCN redlist.org page]</p> |
| <i>Retropinna retopinna</i> | Common smelt   | Not Threatened        | <p>The small shimmering silver fish occur in large shoals in estuaries and lowland rivers. They spend most of their lives at sea. Some return to freshwater as juveniles in spring but most return as adults in summer when they are about 10 cm long. They can also be found in some lakes.</p>   |  |
| <i>Rhombosolea retiaria</i> | Black flounder | Not Threatened        | <p>The black flounder is the only member of the flatfish family, or Pleuronectidae, that is a truly freshwater species. The black flounder is found throughout New Zealand but is unique to this country. They are primarily a coastal species, although they can penetrate well inland if the river gradient is not too steep; specimens have been recorded more than 100 km inland in some river systems. Little is known about the life cycle of the black flounder. The larvae are undoubtedly marine, but where and when spawning takes place is a mystery. Black flounder are a carnivorous species and probably eat a variety of bottom dwelling insects and molluscs. They are also known to</p> |  |

| Species                     | Common name      | Threat Classification | Life History   | Threats   |
|-----------------------------|------------------|-----------------------|--|---|
|                             |                  |                       | feed on whitebait during the spring migration.   |   |
| <i>Gobiomorphus huttoni</i> | Redfin bully     | Not Threatened        | Redfins are distinguished from other bullies by having diagonal cheek stripes and grow up to 12 cm long. Male redfin bullies are our most colourful native fish, with bright orange-red fins. Like other bully species, the male guards the nest before the larvae get washed out to sea, and migrate back to freshwater as small juveniles. They are very good climbers, able to traverse waterfalls when going upstream, and prefer to live near the coast; they do not establish landlocked populations.                              | Habitat loss and alteration are the primary causes of threat to this species. Loss of riparian vegetation and increased sedimentation is likely to reduce instream cover and change the water temperature and reduce feeding success (Rowe <i>et al.</i> 2002). Artificial barriers to migration, particularly undercut culverts and hydro dams, disrupt river connectivity and access to adult habitats. Additionally, there is a potential threat from predation and competition by introduced salmonids, primarily Brown Trout ( <i>Salmo trutta</i> ). [from IUCN redlist.org page]   |
| <i>Galaxias fasciatus</i>   | banded kokopu    | Not Threatened        | Banded kōkopu have pale vertical stripes across their sides. Also called Māori or native trout, they dwell in pools with overhanging banks, logs and boulders. Like other galaxiids, banded kōkopu have sensors on their heads to detect when and where something hits the water, enabling them to feed on insects that fall from overhanging plants. They are good climbers and can be found up to 550 m above sea level. Most grow to around 200 mm long, but they can reach 260 mm. Banded kōkopu need stream-side plants to survive. | Several common causes of decline have been implicated in the general range contraction and decrease in abundance of large galaxiids. These include overharvesting of the juvenile whitebait stage, artificial barriers to migration, habitat destruction, pollution of waterways, changes in catchment land use and the impacts of introduced species. The primary threat to this species is thought to be the loss and degradation of adult habitat through deforestation and other land use changes, which have impacted their preferred native forest stream habitats. Loss of wetlands is also likely to have negatively affected the distribution of this species. It is considered that partial obstruction and/or complete loss of fish passage due to artificial barriers (particularly undercut culverts and hydro dams that disrupt river connectivity and access to adult habitats), in many regions has also negatively affected the distribution of this species. There is a potential threat of predation and competition by introduced salmonids, primarily Brown Trout ( <i>Salmo trutta</i> ). Furthermore, the loss of riparian vegetation impacts on spawning success, is likely to change water temperatures and reduce the availability of terrestrial food supply (McDowall 2000). [from IUCN redlist.org page] |
| <i>Aldichetta forsteri</i>  | Yelloweye mullet | Not Threatened        | Yellow-eye mullet are small, near-shore fish that usually reach 30–40 cm. Yellow-eyed Mullet fish is gray-green at the top, silver at the  |   |

| Species                             | Common name    | Threat Classification      | Life History  | Threats |
|-------------------------------------|----------------|----------------------------|---|---------|
|                                     |                |                            | bottom, yellow at the bottom, bright yellow eyes. They like to feed on algae on rocks and eat some tiny reptiles. |         |
| <i>Anguilla australis schmidtii</i> | Shortfin eel   | Not Threatened             | Found in New Zealand, Australia and some Pacific Islands.   |         |
| <b>Introduced Species</b>           |                |                            |   |         |
| <i>Oncorhynchus mykiss</i>          | Rainbow trout  | Introduced and Naturalised |   |         |
| <i>Oncorhynchus tshawytscha</i>     | Chinook salmon | Introduced and Naturalised |   |         |
| <i>Perca fluviatilis</i>            | Perch          | Introduced and Naturalised |   |         |
| <i>Salvelinus fontinalis</i>        | Brooke char    | Introduced and Naturalised |   |         |
| <i>Salmo trutta</i>                 | Brown Trout    | Introduced and Naturalised |   |         |
| <i>Arripis trutta</i>               | kawahai        | Not Ranked                 |   |         |

## Appendix 11 Birds of the Taieri Catchment

| Common Name   | Scientific Name                            | National Threat Ranking<br>(Robertson <i>et al.</i> 2016) |
|---|--|---|
| <b>Waterfowl</b>                                    |  |   |
| Black swan*, kakiānau                               | <i>Cygnus atratus</i>                      | Not Threatened  |
| Mallard duck  | <i>Anas platyrhynchos</i>                  | Introduced and Naturalised                                |
| New Zealand shoveler, kuruwhengi                    | <i>Anas rhynchos variegata</i>             | Not Threatened  |
| Grey teal, tētē moroiti                             | <i>Anas gracilis</i>                       | Not Threatened  |
| Grey duck, Pacific black duck, pāreera              | <i>Anas superciliosa</i>                   | Nationally Critical                                       |
| Paradise shelduck, pūtangitangi                     | <i>Tadorna variegata</i>                   | Not Threatened  |
| Brown teal / brown duck, pāteke                     | <i>Anas chlorotis</i>                      | Recovering  |
| Australian Coot                                     | <i>Fulica atra</i>                         | At Risk - Naturally Uncom                                 |
| New Zealand scaup, pāpango                          | <i>Aythya novaeseelandiae</i>              | Not Threatened  |
| Canada goose*, honker                               | <i>Branta canadensis</i>                   | Introduced and Naturalised                                |
| Greylag goose, feral goose, kuihi                   | <i>Anser anser</i>                         | Introduced and Naturalised                                |
| <b>Swamp Birds</b>                                  |  |   |
| Australasian bittern, matuku hūrepo                 | <i>Botaurus poiciloptilus</i>              | Nationally Critical                                       |
| Marsh crake, Baillon's crake, koitareke             | <i>Porzana pusilla affinis</i>             | Declining   |
| Spotless crake, sooty rail, pūweto                  | <i>Porzana tabuensis</i>                   | Declining   |
| Banded rail / mioweka, konini, kata tei, mohopererū | <i>Gallirallus philippensis</i>            | Declining   |
| Pukeko / pūkeko                                     | <i>Porphyrio melanotus</i>                 | Not Threatened  |
| South Island fernbird / mātātā                      | <i>Bowdleria punctata punctata</i>         | At Risk - Declining                                       |
| Australasian crested grebe pūteketeki               | <i>Podiceps cristatus australis</i>        | Nationally vulnerable                                     |
| <b>Waders</b>                                       |  |   |
| South Island pied oystercatcher, tōrea              | <i>Haematopus finschi</i>                  | At Risk - Declining                                       |
| Spur-winged plover, masked lapwing, spur-wing       | <i>Vanellus miles novaehollandiae</i>      | Not Threatened  |
| Pied stilt / poaka                                  | <i>Himantopus himantopus leucocephalus</i> | Not Threatened  |
| Black-fronted dotterel                              | <i>Eiseyornis melanops</i>                 | At Risk - Naturally Uncom                                 |
| Banded dotterel / tūturiwhatu                       | <i>Charadrius bicinctus</i>                | Nationally Vulnerable                                     |
| Black Stilt   | <i>Himantopus novaeseelandiae</i>          | Nationally Critical                                       |
| <b>Other Waterbirds</b>                             |  |   |
| White-faced heron / matuku moana                    | <i>Egretta novaehollandiae</i>             | Not Threatened  |
| Cattle egret  | <i>Ardea ibis</i>                          | Migrant   |
| Variable oystercatcher                              | <i>Haematopus unicolor</i>                 | Recovering  |
| White heron / great egret, kotuku                   | <i>Ardea modesta</i>                       | Nationally Critical                                       |
| Royal spoonbill / kōtuku ngutupapa                  | <i>Platalea regia</i>                      | At Risk - Naturally Uncom                                 |
| Little egret  | <i>Egretta garzetta immaculata</i>         | Migrant   |
| Southern black-backed gull / karoro                 | <i>Larus dominicanus</i>                   | Not Threatened  |
| Little shag / kawau paka                            | <i>Phalacrocorax melanoleucos</i>          | Not Threatened  |
| Bar-tailed godwit                                   | <i>Limosa lapponica</i>                    | At Risk - Declining                                       |
| Black shag / black cormorant/ kawau                 | <i>Phalacrocorax carbo</i>                 | At Risk - Naturally Uncommon                              |
| Swamp harrier / Australasian harrier/ kāhu          | <i>Circus approximans</i>                  | Not Threatened  |
| Sacred kingfisher / New Zealand kingfisher, kōtare, | <i>Todiramphus sanctus</i>                 | Not Threatened  |

| Common Name                       | Scientific Name                              | National Threat Ranking<br>(Robertson <i>et al.</i> 2016) |
|-----------------------------------|--|---|
| Red billed gull, tarāpunga        | <i>Larus novaehollandiae</i>                 | At risk declining   |
| Black-billed gull, tarāpuka       | <i>Larus bulleri</i>                         | Nationally Critical                                       |
| Black-fronted tern                | <i>Chlidonias albostratus</i>                | Nationally Endangered                                     |
| White-fronted tern                | <i>Sterna striata</i>                        | At risk declining   |
| <b>Other Birds</b>                |  |   |
| New Zealand pipit, pīhoihoi       | <i>Anthus novaeseelandiae</i>                | At risk declining   |
| New Zealand pigeon / kererū       | <i>Hemiphaga novaeseelandiae</i>             | Not Threatened  |
| Grey warbler / riroriro           | <i>Gerygone igata</i>                        | Not Threatened  |
| Brown creeper, pīpipi             | <i>Mohoua novaeseelandiae</i>                | Not Threatened  |
| South Island fantail, pīwakawaka  | <i>Rhipidura fuliginosa fuliginosa</i>       | Not Threatened  |
| Shining bronze-cuckoo, pīpīwharau | <i>Chrysococcyx lucidus</i>                  | Not Threatened  |
| Tui, tūi, koko                    | <i>Prosthemadera novaeseelandiae</i>         | Not Threatened  |
| Bellbird, korimako                | <i>Anthornis melanura</i>                    | Not Threatened  |
| Eurasian skylark*, kaireka        | <i>Alauda arvensis</i>                       | Introduced and Naturalised                                |
| Silveryeye / white-eye, tauhou    | <i>Zosterops lateralis</i>                   | Not Threatened  |
| Yellowhammer* / yellow bunting    | <i>Emberiza citrinella</i>                   | Introduced and Naturalised                                |
| Welcome swallow, warou            | <i>Hirundo neoxena neoxena</i>               | Not Threatened  |
| Morepork / ruru,                  | <i>Ninox novaeseelandiae novaeseelandiae</i> | Not Threatened  |
| New Zealand falcon, kārearea,     | <i>Falco novaeseelandiae "eastern"</i>       | Recovering  |
| California Quail                  | <i>Callipepla californica</i>                | Introduced and Naturalised                                |
| Rock Pigeon                       | <i>Columba livia</i>                         | Introduced and Naturalised                                |
| Wood pigeon                       | <i>Hemiphaga novaeseelandiae</i>             | Not Threatened  |
| South Island Robin                | <i>Petroica australis</i>                    | At risk declining   |
| Tomtit                            | <i>Petroica macrocephala</i>                 | Not Threatened  |
| Little Owl                        | <i>Athene noctua</i>                         | Introduced and Naturalised                                |
| Hedge sparrow                     | <i>Prunella modularis</i>                    | Introduced and Naturalised                                |
| Common Starling                   | <i>Sturnus vulgaris</i>                      | Introduced and Naturalised                                |
| Brown Creeper                     | <i>Mohoua novaeseelandiae</i>                | Not Threatened  |
| Australian Magpie                 | <i>Gymnorhina tibicen</i>                    | Introduced and Naturalised                                |
| Redpoll                           | <i>Carduelis flammea</i>                     | Introduced and Naturalised                                |
| European goldfinch                | <i>Carduelis carduelis</i>                   | Introduced and Naturalised                                |
| European Greenfinch               | <i>Carduelis chloris</i>                     | Introduced and Naturalised                                |
| Chaffinch                         | <i>Fringilla coelebs</i>                     | Introduced and Naturalised                                |
| Eurasian blackbird                | <i>Turdus merula</i>                         | Introduced and Naturalised                                |
| Song thrush                       | <i>Turdus philomelos</i>                     | Introduced and Naturalised                                |
| <b>Estuarine/Coastal species</b>  |  |   |
| Southern blue penguin             | <i>Eudyptula minor minor</i>                 | At risk declining   |
| Otago Shag                        | <i>Leucocarbo chalconotus</i>                | Recovering  |