BEFORE THE ENVIRONMENT COURT
I MUA I TE KOOTI TAIAO O AOTEAROA

UNDER	the Resource Management Act 1991
IN THE MATTER	of appeals under Clause 14 of the First Schedule of the Act
BETWEEN	**TRANSPOWER NEW ZEALAND LIMITED** (ENV-2018-CHC-26)
	FONTERRA CO-OPERATIVE GROUP (ENV-2018-CHC-27)
	HORTICULTURE NEW ZEALAND (ENV-2018-CHC-28)
	ARATIATIA LIVESTOCK LIMITED (ENV-2018-CHC-29)
	WILKINS FARMING CO (ENV-2018-CHC-30)

(Continued next page)

MEMORANDUM OF COUNSEL FOR SOUTHLAND REGIONAL COUNCIL ATTACHING AMENDED REPORT ON CAUSES OF WETLAND LOSS
5 December 2019

Judicial Officer: Judge Borthwick

Respondent's Solicitor
PO Box 4341 CHRISTCHURCH 8140
DX WX11179
Tel +64 3 379 7622
Fax +64 379 2467

Solicitor: P A C Maw
(philip.maw@wynnwilliams.co.nz)

WYNNWILLIAMS

GORE DISTRICT COUNCIL, SOUTHLAND DISTRICT COUNCIL & INVERCARGILL DISTRICT COUNCIL
(ENV-2018-CHC-31)

DAIRYNZ LIMITED
(ENV-2018-CHC-32)

H W RICHARDSON GROUP
(ENV-2018-CHC-33)

BEEF + LAMB NEW ZEALAND
(ENV-2018-CHC-34 & 35)

DIRECTOR-GENERAL OF CONSERVATION
(ENV-2018-CHC-36)

SOUTHLAND FISH AND GAME COUNCIL
(ENV-2018-CHC-37)

MERIDIAN ENERGY LIMITED
(ENV-2018-CHC-38)

ALLIANCE GROUP LIMITED
(ENV-2018-CHC-39)

FEDERATED FARMERS OF NEW ZEALAND
(ENV-2018-CHC-40)

HERITAGE NEW ZEALAND POUHERE TAONGA
(ENV-2018-CHC-41)

STONEY CREEK STATION LIMITED
(ENV-2018-CHC-42)

THE TERRACES LIMITED
(ENV-2018-CHC-43)

CAMPBELL'S BLOCK LIMITED
(ENV-2018-CHC-44)

ROBERT GRANT
(ENV-2018-CHC-45)

SOUTHWOOD EXPORT LIMITED, KODANSHA TREEFARM NEW ZEALAND LIMITED, SOUTHLAND PLANTATION FOREST COMPANY OF NEW ZEALAND
(ENV-2018-CHC-46)

TE RUNANGA O NGAI TAHU, HOKONUI RUNAKA, WAIHOPAI RUNAKA, TE RUNANGA O AWARUA & TE RUNANGA O ORAKA APARIMA
(ENV-2018-CHC-47)

PETER CHARTRES
(ENV-2018-CHC-48)

RAYONIER NEW ZEALAND LIMITED
(ENV-2018-CHC-49)

ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND
(ENV-2018-CHC-50)

Appellants

AND **SOUTHLAND REGIONAL COUNCIL**

Respondent

MAY IT PLEASE THE COURT

1 This Memorandum of Counsel is filed on behalf of the Southland Regional Council (**Council**) in respect of the appeals against the Council's decision on the proposed Southland Water and Land Plan.

2 In its Memorandum of Counsel dated 2 December 2019, Counsel attached a report produced by Kelvin Lloyd of Wildlands Consultants investigating the causes of wetland loss in the Southland Region.

3 Subsequent to the filing of the Memorandum on 2 December 2019, an error was discovered in the report. The report erroneously referred to "Plate 6" in the third paragraph of section 4.3. That reference has now been removed.

4 An updated copy of the report in attached as **Appendix A**. Counsel apologises for any inconvenience caused by the subsequent filing of this amended copy.

DATED this 5th day of December 2019

.....

P A C Maw / A M Langford
Counsel for the Southland Regional Council

Appendix A – Causes of Wetland Loss in Southland Region (updated report)

CAUSES OF WETLAND LOSS
IN SOUTHLAND REGION

providing
outstanding
ecological
services to
sustain
and improve our
environments

Wildlands

R5223

CAUSES OF WETLAND LOSS IN SOUTHLAND REGION

A wetland at Mt Prospect Station, showing both drainage (foreground) and inundation (background) activities.

Contract Report No. 5223

November 2019

Project Team:
Steve Rate - Report author
Kelvin Lloyd - Report author

Prepared for:
Environment Southland
Private Bag 90116
Invercargill 9840

CONTENTS

Reviewed and approved for release by:

_____

Tim Martin
Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Following on from the first round of Environment Court hearings (Topic A) on the Proposed Southland Water and Land Plan (PSWLP), and the compiling and hearing of associated evidence, the Court directed Environment Southland (and its expert witnesses) to undertake some further work regarding the Region's wetlands.

The purpose of the project is to identify the cause of a recent and continuing reduction in the extent of wetlands in Southland.

An appropriate methodology is envisaged to include:

- A reasonably-sized sample of wetlands, rather than an assessment of every wetland.
- Consideration of any wetlands that have completely disappeared in the last decade, provided those areas can be reasonably identified.
- Liaison between Environment Southland land management staff and the appointed ecologist to help with this assessment.
- Identification of the effects of clearance and modification on the wetland ecosystem and factors that caused the reduction.
- A determination as to whether most of the reduction has been caused by a limited number of factors.

2. METHODS

A two-stage assessment was undertaken, a desktop assessment of a reasonably large sample of wetlands considered at risk or lost, followed by a more limited field assessment to ground truth the desktop outcomes, and provide more detail on the potential causes of wetland modification and loss at specific wetlands.

2.1 Desktop assessment

Shape files for a recent assessment of wetland loss in Southland from 1990-2012 (Robertson *et al*. 2019) were obtained from the Department of Conservation.

Wetlands classified as "At Risk" or "Gone" in Robertson *et al*. (2019) were intersected with potential ecosystem mapping of the Southland Region (Wildland Consultants 2019), based on the ecosystem classification of Singers and Rogers (2014). This resulted in 130 wetlands (comprising 182 polygons) for which the clearance classification ("At Risk" and/or "Gone"), subregion ("Southland Plains", "Inland Southland", "Te Anau Basin"), wetland class ("bog", "fen", "marsh", "swamp"), and the potential ecosystem type ("WL22", "WL20", "WL18", "WL6", "WL12", "WL19", "WL16") were known (Figure 1).

There were 11 assessed wetlands in Inland Southland, 112 on the Southland Plains, and seven in the Te Anau basin. The majority of polygons (64) were WL6 Lesser wire rush, tangle fern restiad rushland/fernland bogs on the Southland Plains (Table 1).

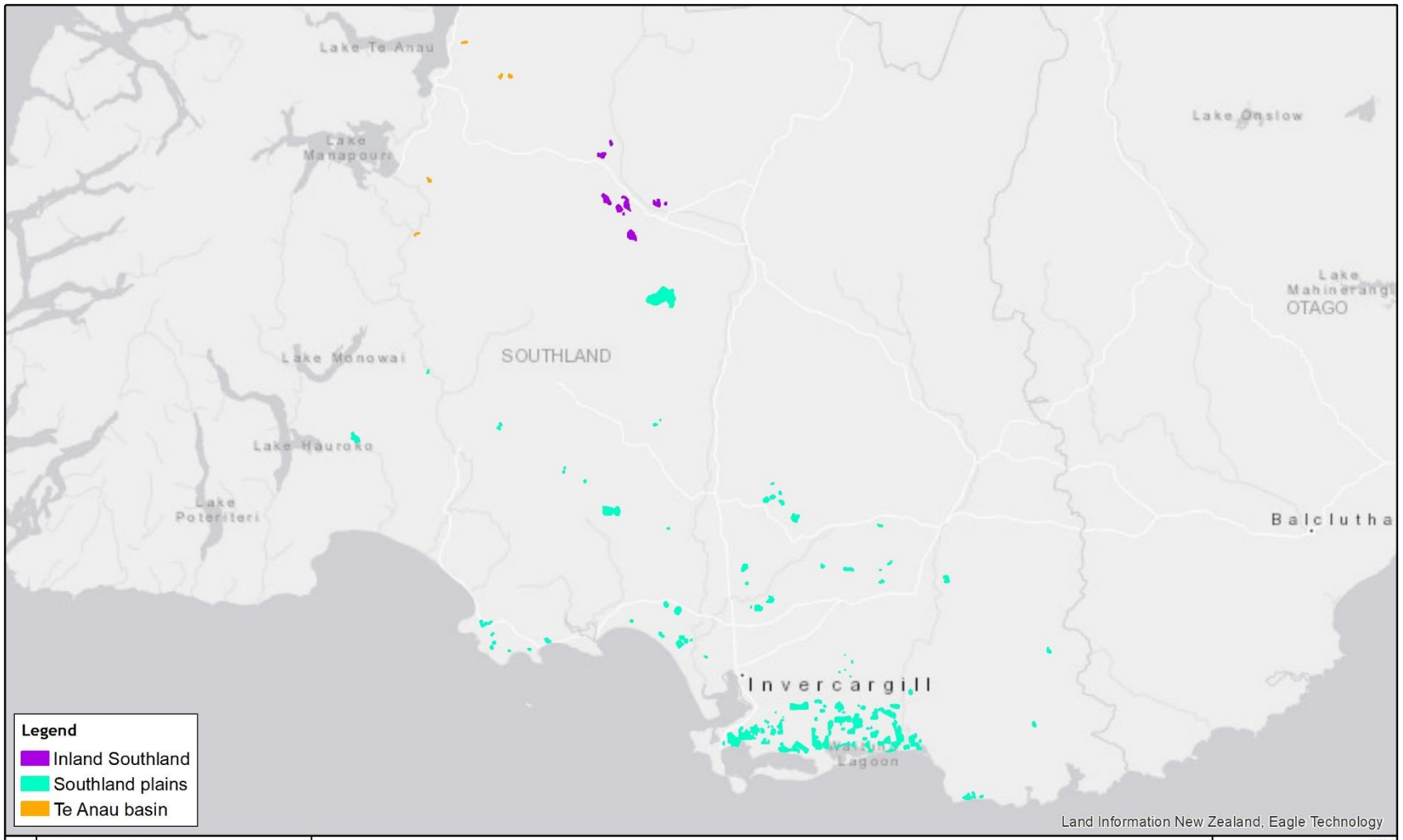


Figure 1. Wetlands assessed for causes of clearance

Table 1: Subregions, potential ecosystem types (Singers and Rogers 2014), and wetland classes for the assessed wetlands.

Name	Potential Ecosystem Type		Wetland Class	Total
Inland Southland	**WL6**	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	6
	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Bog Fen	3 2
Southland Plains	**WL6**	Lesser wire rush, tangle fern restiad rushland/fernland	Bog Fen Marsh	64 7 2
	WL12	Mānuka, tangle fern scrub/fernland	Bog Fen Marsh Swamp	10 3 1 1
	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	3
	WL18	Flaxland	Bog Fen Marsh Swamp	1 2 1 7
	WL19	Raupo reedland	Bog	1
	WL20	Coprosma, twiggy tree daisy scrub	Bog Fen Swamp	2 3 1
	WL22	Carex, *Schoenus pauciflorus* sedgeland	Fen	3
Te Anau basin	**WL6**	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	2
	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	3
	WL18	Flaxland	Swamp	1
	WL22	Carex, *Schoenus pauciflorus* sedgeland	Fen	1
Total				**130**

All of these wetlands were assessed by desktop methods. Wetland assessment involved viewing Google Earth aerial imagery of sufficient quality to enable the causes of wetland loss and modification to be established. This varied between wetlands, but overall, the year of the first suitable imagery ranged from 2001 to 2012, and the final suitable imagery ranged from 2015 to 2019.

The date of wetland loss or modification was noted, being the date of the imagery on which the loss was first noted. This sometimes resulted in multiple entries (up to 10) for dates of wetland clearance due to several phases of clearance.

Each instance of wetland loss was assigned a category:

- Afforestation
- Drainage
- Fire
- Inundation
- Herbicide
- Mechanical
- Quarry

- Weed invasion

Drainage was included when either marginal or internal drains were present. Road construction was classified as mechanical clearance.

The effects of grazing and trampling by livestock were generally difficult to assess in aerial imagery, thus this factor was not assessed in the desktop assessment.

The certainty of the determination was assigned a score of High, Moderate or Low.

The extent of loss of wetlands was very broadly estimated in three categories (complete loss, loss greater than or equal to 50%, other).

2.2 Field survey

Three days of field survey were undertaken on 5 November 2019 and 19-20 November 2019, accompanied by Environment Southland land management staff, to confirm the desktop assessment of selected wetlands (mainly those for which access was easy to obtain), and to focus on wetlands that could not be confidently assigned a cause of loss or modification in the desktop assessment.

3. RESULTS OF DESKTOP ASSESSMENT

3.1 Type and extent of loss

The most common type of activity resulting in wetland loss was drainage, occurring in 97% of assessed wetlands (Table 2). Mechanical clearance was observed in 65%, weed invasion in 56%, afforestation in 13%, inundation in 5%, herbicide application in 3%, fire in 3%, and quarrying in 2% of assessed wetlands. Examples of wetland loss/modification are provided in Appendix 2. Drainage and mechanical clearance often occurred as multiple events over several years. Although not specifically assessed as part of this study, these two types are likely to have resulted in the greatest loss in wetland extent over the assessment period.

Drainage typically involved the presence of ring drains, parallel drains through the wetland, or both. Maintenance of existing drains was also observed at several sites, often resulting in some clearance of indigenous riparian vegetation.

Weed invasion rates were high, and likely a result of wetland drainage, which dries out wetland substrates thus allowing dryland weeds to invade. The quality and timing of aerial imagery did not always allow a distinction to be made between indigenous and exotic vegetation types, so the extent of weed invasion is likely to be underestimated. Weed invasion was generally only identified when the bright yellow flowers of gorse (*Ulex europaeus*) and/or broom (*Cytisus scoparius*) were visible.

Mechanical clearance involved clearance of weeds, especially gorse, track/road formation and upgrades, and clearance of indigenous wetland vegetation, typically following drainage.

Afforestation of wetlands was localised, but sometimes extensive. For example, afforestation has occurred over 171 hectares of the mapped extent of Wetland 91, and has also extended into the adjacent Department of Conservation-administered Seaward Moss Conservation Area. Part of the afforested area at this site was subsequently harvested and converted to pasture. All of Wetland 500 (*c*.20 hectares) was lost due to afforestation.

Wetland loss as a result of herbicide application, inundation, fire, or quarrying (for peat) were each noted in less than 5% of assessed wetlands, but the extent of single events could be quite large. For example, the 2016 fire near Lawson Road (Mack 2016) burnt approximately 15 hectares of Wetland 820, while the fire north of Talls Road burnt approximately 66 hectares of Wetland 580, 50 hectares of Wetland 578, and 260 hectares of wetlands in the Department of Conservation-administered Toetoes Conservation Area (the latter is outside the scope of this report). Inundation occurred as a result of pond construction. Ponds were generally small (*c*.2-3 hectares), although three ponds covering approximately 38 hectares have been created in Rakatu Wetlands and the adjacent Redcliff Wildlife Reserve on the lower Waiau River. Loss due to quarrying was approximately 3.5 hectares in Wetland 174, 0.02 hectares in Wetland 1369, and 0.8 hectares in Wetland 1505.

Table 2: Number of wetlands in which each type of loss has occurred.

Loss Type	Number	Percentage
Drainage	126	96.9
Mechanical	85	65.4
Weed invasion	73	56.2
Afforestation	17	13.1
Inundation	6	4.6
Fire	4	3.1
Herbicide	4	3.1
Quarry	3	2.3

3.2 Spatial distribution

Of the "At Risk" and "Gone" wetlands:

- in Inland Southland, drainage was noted in 11 (100%) of the assessed wetlands, mechanical clearance in five (45%) wetlands, and weed invasion and quarrying in one wetland each (9%);

- on the Southland Plains, 109 wetlands (97%) had been drained, 79 (71%) had been mechanically cleared, 17 (15%) had been afforested, 71 (63%) had weed invasion, four (4%) had been sprayed with herbicide, four (4%) had been burnt, four (4%) had ponds/inundation, and two (2%) had been quarried; and

- in the Te Anau basin, six wetlands (86%) were drained, two (29%) had had ponds constructed, and one each (14%) had mechanical clearance and weed invasion.

3.3 Post-2012 clearance

The study of Robertson *et al*. (2019) was undertaken by comparing satellite imagery dating from 1990 and from 2012. In our study, wetland loss was noted in 54 (42%) of the assessed wetlands after 2012. Activities resulting in modification or loss after 2012 were predominantly mechanical clearance (40 wetlands) and drainage (16 wetlands), but also included weed invasion (5 wetlands), herbicide application (3 wetlands), and afforestation, inundation, quarrying, and fire (1 wetland each).

3.4 Mechanisms resulting in wetland loss

Ewans (2016) identifies a common clearance strategy for bogs in Southland:

Bogs are ring drained which allows bog margins to dry out and gorse to invade. Weed control obligations are ignored and gorse eventually dominates areas previously occupied by indigenous wetland vegetation. Gorse is then cleared (thus avoiding indigenous vegetation clearance rules) and a new ring drain dug to further dry out the bog, and so on until the bog is destroyed.

Other mechanisms identified in this study include afforestation, subsequent harvesting, then conversion to pasture; clearance of burnt vegetation following fires; quarrying, and inundation. Figure 2 below shows the interaction between clearance mechanisms noted during this study.

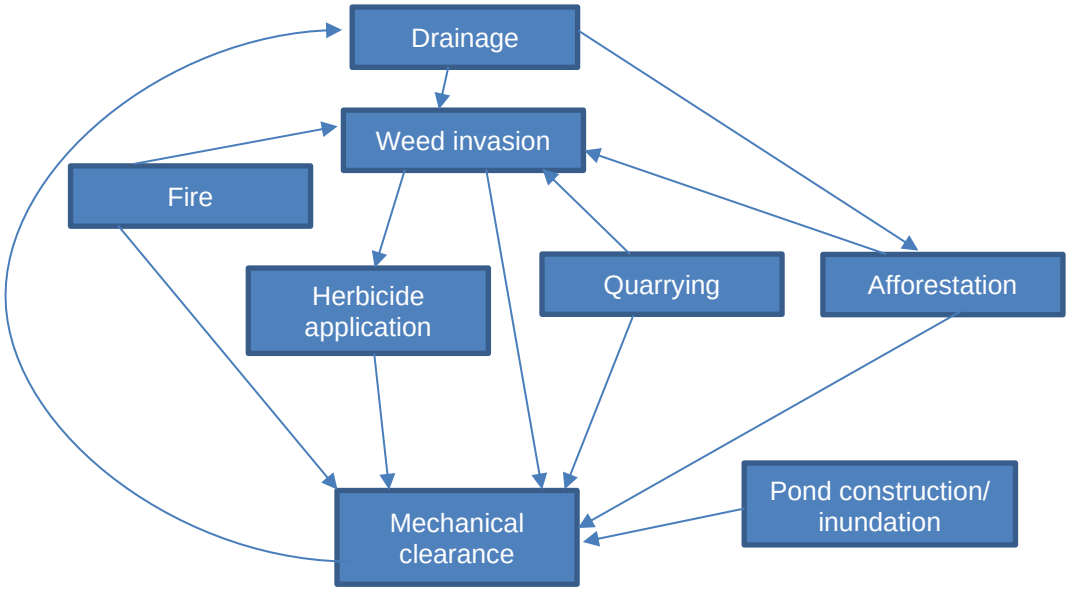


Figure 2: Observed relationships between wetland clearance mechanisms.

3.5 Loss of wetlands

Seventeen wetlands, all on the Southland Plains, had been completely lost during the time span of this study (2001-2019). A further 19 wetlands on the Southland Plains and one wetland in Inland Southland had lost half or more of their indigenous wetland

vegetation. No wetlands in Te Anau basin were completely lost. A further 10 wetlands had some uncertainty over whether they were still present or not. The remaining 87 wetlands were deemed to have retained most of their indigenous wetland vegetation.

Most of the completely lost wetlands were classified as bogs (12 out of 17), with an ecosystem classification of 'WL6 Lesser wire rush, tangle fern restiad rushland/fernland' (11 out of 17). A further 13 bogs had 50% or more wetland loss. Twelve WL6 wetlands, seven 'WL12 Mānuka, tangle fern scrub/fernland' wetlands, five 'W18 Flaxland', and two 'WL16 Red tussock, *Schoenus pauciflorus* tussockland' wetlands also had 50% or more wetland loss.

4. RESULTS OF THE FIELD ASSESSMENT

Field-assessed wetlands included three wetland complexes (comprising four mapped wetlands) in the Te Anau basin, four wetlands on the Southland Plains and three wetlands in the inland Southland area.

4.1 Te Anau Basin wetlands

4.1.1 Rakatu Wetlands

The Rakatu wetlands are approximately 11 kilometres south of Manapouri, on alluvial terraces of the Waiau River that are owned and managed by the Waiau Trust. The Trust aims to create an ecologically sustainable wetland/small stream ecosystem complex, for the benefit of fisheries and wildlife in the Rakatu/Redcliff area of the Lower Waiau River catchment[1].

Two adjacent wetland polygons were assessed as "At Risk" by Robertson *et al*. (2019). The upstream portion of the upstream wetland is dominated by dense harakeke (*Phormium tenax*) with scattered pūkio (*Carex secta*), mānuka (*Leptospermum scoparium* agg.) and tī kōuka/cabbage tree (*Cordyline australis*). The stream that feeds this wetland has been mechanically straightened at some time in the past (prior to 2012), so as to pass along the north side of the wetland.

The downstream portion of the upstream wetland is divided from the upstream wetland by a gravel path created for walking access. Pūkio is dominant adjacent to the stream, which becomes broad and slow moving due to a bund further downstream. Wet flats are occupied by rautahi (*Carex geminata*) and exotic grasses, apart from some planted tī kōuka, and harakeke, mānuka, and tī kōuka that have naturally regenerated in areas disturbed during walking track construction.

The downstream wetland has similarly-vegetated wet flats, pūkio on open water margins, and expanses of open water (Plate 1) resulting from the creation of two bunds

[1] http://waiautrust.org.nz/waterways/rakatu-wetlands

across the wetland in 2005 (Mark Sutton, Waiau Trust, personal communication). The bunds were created partly to flood and destroy areas of Scotch broom (*Cytisus scoparius*) scrub which formerly dominated the wetland areas. Dead Scotch broom emerging from the water is evidence of its former distribution within the wetland. Prior to the Waiau Trust purchasing the land in 2000, stock had access to the wetland vegetation and had heavily modified it (Mark Sutton, Waiau Trust, personal communication).

Plate 1: The downstream wetland showing wet flats, pūkio lining open water margins, and open water ponded behind one of the bunds

As well as the local modifications to the hydrology of these wetlands, they have experienced significant changes to the flood regime from the nearby Waiau River, due to the reduction in volume of that river caused by the Manapouri hydro-power scheme.

The "At Risk" status given to these wetlands by Robertson *et al*. (2019) would have been because the bund and extensive open water creation in 2005, the walking track across the wetland, and possibly the straightening of the stream feeding the wetland, could all be observed in satellite imagery and recorded as changes.

The changes have had positive effects, including destruction of exotic scrub, creation of shallow-water habitat for indigenous wetland birds and fish, and creating shoreline habitat suitable for colonisation by pūkio.

4.1.2 Riverslea Farm wetlands

Two of the assessed wetlands occur on Riverslea Farm, approximately 6 kilometres south-east of Manapouri. Both are bog wetlands protected by Queen Elizabeth the Second National Trust open space covenants. The two wetlands are approximately 150 metres apart. A stream flows down excavated ditches on the western side of both wetlands, through mineral soils outside the areas of bog wetland habitat.

The larger, southern-most bog wetland was assessed on foot. Away from the wetland margins, the wetland was notable for a very high degree of intactness, with sizeable areas containing only indigenous plant species (mainly bog pine (*Halocarpus bidwillii*), wire rush (*Empodisma minus*) and *Dracophyllum* spp.) and no exotic species (Plate 2). This changed near drains that form a T-shape within the wetland. In these areas, pūkio dominated the drain margins, while Scotch broom and gorse dominated the mounds of excavated material beside the drains (Plate 3). Gorse also occurred locally slightly further away from the drains. The internal drains were excavated at some stage prior to 2007.

Plate 2: Intact bog wetland within the southern wetland, dominated by *Dracophyllum* spp. and bog pine.

Plate 3: The drain through the southern wetland, with Scotch broom scrub on excavated mounds and pūkio sedges on the drain margins.

The northern wetland was observed from the hillside above the wetland, but not inspected on foot. It appeared to be more sedge-dominated than the southern wetland, and more intact overall, with one additional drain outside the wetland, along the margin of the farm track that crosses between the two wetlands.

These wetlands would likely have been assessed as "At Risk" by Robertson *et al*. (2019) due to the presence of nearby drains, drains within the southern wetland, and areas of Scotch broom and gorse scrub adjacent to drains within the southern wetland.

4.1.3 Mt Prospect wetland

The wetland assessed at Mt Prospect Station is located adjacent to the Whitestone River (on the eastern side) some 13 kilometres east of Te Anau. The wetland comprised remnants of copper tussock marsh on the northwestern side and on the wetland margins elsewhere, and cushion bog in the centre of the wetland. A network of drains affects all of these areas. The cushion bog vegetation was also quite modified, with exotic grassess occuring throughout, but with frequent cushions of indigenous comb sedge (*Oreobolus pectinatus*), and occasional patches of wire rush, copper tussock, and indigenous herbs such as sundew (*Drosera arcturi*), *Hydrocotyle novae-zelandiae*, *Plantago triandra*, *Gonocarpus micranthus*, and *Lobelia angulata*. Drainage has probably been the key factor resulting in wetland modification and invasion by exotic grasses.

Plate 4: Cushion bog vegetation in the Mt Prospect wetland, with common exotic grasses among the cushion bog species, and the recently created pond in the background.

The wetland would have been assessed as "At Risk" by Robertson *et al*. (2019) because of the presence of drains within the wetland. At some stage after 12 January 2014 (outside the period analysed by Robertson *et al.* 2019), the wetlands have been significantly affected by pastoral development in the northwestern copper tussock marsh wetlands, and by excavation of a large pond in the modified cushion bog wetland (see the Inundation example, Appendix 2). These develoments subsequent to 2013 have resulted in loss of approximately four hectares of copper tussock marsh and approximately 1.9 hectares of cushion bog.

4.2 Inland Southland wetlands

Three wetlands (FID_ES_wet 1364, 1367, and 1384) located on private land to the west of Mossburn (adjacent to Chewings Road and West Dome Station Road) were visited on 19 November 2019. The wetlands had been classified as "Gone"/"Little Change", "At Risk", and "Little Change" respectively by Robertson *et al*. (2019). On-site discussions were held with the three land owners. The wetlands comprised mānuka-inaka (*Dracophyllum longifolium*)/wire rush bogs and copper tussock/wire rush wetlands.

At one site, the copper tussock wetland had recently had a duck pond excavated in it and a maimai built, and several strips of copper tussock mown to facilitate the installation of electric fencing for grazing. Some parts of the wetland had been previously ripped and had regenerated, including on the neighbouring property, which now mostly comprised rushes with only a few small patches of copper tussock. The

wetland had historic drains and gorse was present. The landowner had maintained some drains, and was keen to graze and/or clear parts of the wetland and appeared largely unaware of rules regarding these activities.

The central parts of the two manuka-dominated wetlands were in good condition, but both wetlands had historic drains and weeds (broom, silver birch (*Betula pendula*), soft rush (*Juncus effusus*), and wilding conifers). At one site, parts of the wetland had been humped and hollowed when the landowner first arrived about 27 years ago, and part had been mulched, but no recent clearance was obvious on aerial imagery or during the site visit. At the other site, substantial mechanical clearance was seen in aerial imagery after 2012 on two properties. This was confirmed by the site visit, where paddocks of soft rush over pasture were present at the site of former wetland vegetation (Plate 5). Of the three landowners, two stated they had no further intentions for wetland development, while one wanted to continue wetland clearance.

The wetlands classifications of Robertson *et al*. (2019) were only partly accurate, in part due to effects on wetlands occurring after the 2012 end date of their analysis. North-western parts of wetland 1364 (classified as "Gone") still contained areas of indigenous wetland vegetation, albeit modified (Plate 5). There had been mechanical clearance in wetland 1384 (classified as "Little Change") between 2013 and 2018, and the field assessment and discussion with the landowner for another part of this wetland indicated that it was also at risk of clearance, with historic drainage, and recent inundation and mowing. "At Risk" status would currently be more appropriate for this wetland. Northern parts of wetland 1367 (classified as "At Risk") would be currently classified as "Gone", with indigenous wetland vegetation having been replaced by the exotic soft rush over pasture (Plate 6).

Plate 5: Drain, humping and hollowing, and indigenous vegetation in wetland 1364 (classified as "Gone", but retaining some wetland character).

Plate 6: The northern part of wetland 1367 (classified as “At Risk”) comprises soft rush/pasture.

4.3 Southland Plains wetlands

Four wetlands (all FID_ES_wet 84) located near the mouth of the Mataura River were visited on 20 November 2019. Different parts of the wetland complex had been classified as “Gone”, “At Risk”, and “Little Change” by Robertson *et al*. (2019). Most of the land that these wetlands are located on is owned by Environment Southland and leased for farming, with one wetland on private land viewed from its edge. The wetlands were predominantly mānuka peat bogs, with some modified copper tussock wetland on the margins of one site.

From aerial imagery it was observed that draining of these wetlands had occurred prior to 2003[1], and that new marginal and internal drainage ditches were excavated between May 2010 and October 2011 in one ES wetland, with some mechanical clearance of wetland vegetation outside the marginal drain. Mechanical clearance of wetland vegetation occurred in one other ES wetland over the same period. Further mechanical clearance of wetland vegetation occurred between January 2012 and August 2013 in two other ES wetlands. Weed invasion was apparent in all wetlands. One ES wetland was assessed as “Gone” and three were “At Risk”.

[1] Southland Regional Council has owned the land since 1974.

The field visit confirmed the presence of drains and subsequent invasion of weeds, particularly gorse and broom. Several of the ES wetlands were grazed by cattle, and it was evident that peat substrates were adversely affected by pugging, that trampling, nutrification, and browsing of wetland habitats was occurring, and that weed spread was likely facilitated by stock. Cultivation of some wetland areas had occurred following vegetation clearance. Activities resulting in complete wetland clearance were ongoing, with disking and raking of mānuka logs from peat occurring in the area where the wetland had been completely removed.

The wetland status classifications of Robertson *et al*. (2019) are now partly out of date for these wetlands. The privately-owned wetland (classified as "At Risk") did not appear to have any recent activity in it, and apart from the historic drains and a low incidence of marginal weeds, wetland condition was relatively good (Plate 7). The "At Risk" status would have been applied due to the historic drainage and is still appropriate. However, the wetland closest to Ryan Road (classified as "Little Change") had been partly cleared and a marginal drain excavated between 2010 and 2011. An "At Risk" part of the wetland to the south is protected by QEII covenant, but the classification likely relates to the presence of marginal drains. The boundaries of the wetlands just to the south of Chisholme Road and in the southeast of the property that were classified as "Gone" were largely correct (Plate 8). However, a large proportion of the "At Risk" part of the wetland in the central part of the site is also now "Gone" or nearly so. The part of the wetland in the southwest (classified as "Little Change") appears to have been sprayed with herbicide between 2011 and 2013 (the vegetation has now partially recovered), which may have been a result of overspray when former wetlands further to the west were cleared.

Plate 7: Large drains and historic clearance of tall mānuka on the at risk wetland on private land.

Plate 8: Drains in former wetland partly cleared between 2011 and 2013 (classified as gone), with likely overspray of herbicide occurring over the same period onto now partly recovered mānuka to the right (classified as little change).

5. CONCLUSIONS

From a pool of 420 wetlands assessed by Robertson *et al*. (2019), 130 wetlands identified as "At Risk" or "Gone" were assessed for causes of wetland loss.

Wetland loss and modification has been predominantly caused by drainage and mechanical clearance. Subsequently, weed invasion often occurs due to the hydrological changes that result from wetland drainage.

Afforestation and fire have also been important mechanisms for wetland loss and modification, due to the large areas of wetland habitat affected by these activities.

Many wetlands were affected by multiple mechanisms, and causes such as drainage, weed invasion, and mechanical vegetation clearance occur in repeated cycles over many years, ultimately resulting in entire wetland loss.

Seventeen wetlands have been completely lost over the study period, and another 19 had lost half or more of their indigenous wetland vegetation.

Recent wetland loss (post 2012) has mostly been caused by mechanical clearance and drainage.

Ground-truthing of the causes of wetland loss largely confirmed the desktop results, with the effects of drainage observed to cause significant modification to wetland

vegetation, and cultivation and inundation resulting in complete loss of wetland vegetation, and some of these effects having occurred subsequent to 2012. Ground truthing also revealed the effects of grazing, trampling, and nutrient inputs at one wetland. These effects are likely to be occurring at most wetlands that are not fenced to exclude adjacent cattle or deer.

ACKNOWLEDGMENTS

We are very grateful to the Department of Conservation for making available shapefiles of wetlands assessed for change between 1990 and 2012. We thank Nathan Cruickshank for assistance with field assessment of wetlands, including contacting landholders and guidance to wetland sites. Mark Sutton (Waiau Trust) is thanked for providing information on wetland restoration at the Rakatu Wetlands site. Landcorp Farming is thanked for providing access to and information on a wetland assessed on Riverslea Farm. Mt Prospect Station is thanked for providing access to and information on a wetland on that property. Rex Carter, Chris Brown, Allan Stalker, Clive Wilson, and Matthew Taylor are thanked for access to wetlands on their properties, and discussion of wetland history and issues. Environment Southland provided access to wetlands near the Mataura River mouth.

REFERENCES

Ewans R. 2016: Environment Southland Wetland Inventory Project: Monitoring wetland extent on non-public conservation land in the Southland region - Interim report for 2016. Prepared for Environment Southland. 42 pp.

Mack B. 2016: Large scrub fire southeast of Invercargill contained. 4 January 2016. https://www.stuff.co.nz/national/75901361/large-scrub-fire-southeast-of-invercargill-contained.

Robertson H.A., Ausseil A.-G., Rance B., Betts H., and Pomeroy E. 2019: Loss of wetlands in Southland. *New Zealand Journal of Ecology 43(1)*: 3355.

Singers N.J.D. and Rogers G.M. 2014: A classification of New Zealand's terrestrial ecosystems. *Science for Conservation 325*. Department of Conservation, Wellington.

Wildland Consultants 2019: Potential natural ecosystems and significant natural areas for indigenous biodiversity in Southland Region. *Wildland Consultants Contract Report No. 4580.* Prepared for Environment Southland.

WETLANDS ASSESSED

FID_ES_wet	Potential Ecosystem Type		Wetland Class	Robertson *et al*. (2019) Classification	Subregion	Earliest Google Earth Image	Latest Google Earth Image	Easting	Northing
7	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	At risk	Southland Plains	2001	2019	1263064	4867366
25	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2010	2019	1227443	4893996
26	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2010	2019	1228412	4894859
30	WL18	Flaxland	Swamp	At risk, gone	Southland Plains	2005	2018	1286219	4825481
31	WL18	Flaxland	Swamp	Gone	Southland Plains	2005	2018	1286124	4826056
36	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, gone	Southland Plains	2009	2018	1242863	4836293
57	WL22	Carex, *Schoenus pauciflorus* sedgeland	Fen	At risk	Te Anau basin	2010	2019	1191955	4964350
84	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, gone	Southland Plains	2005	2019	1274895	4835308
91	WL12	Mānuka, tangle frern scrub/fernland	Bog	At risk, gone	Southland Plains	2003	2018	1254024	4842101
92	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2018	1250502	4838589
108	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2009	2019	1245136	4860441
160	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Fen	At risk, gone	Southland Plains	2012	2019	1195726	4857309
161	WL12	Mānuka, tangle frern scrub/fernland	Swamp	At risk, gone	Southland Plains	2012	2019	1196775	4857476
163	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2012	2019	1197793	4853867
165	WL12	Mānuka, tangle frern scrub/fernland	Marsh	At risk	Southland Plains	2001	2019	1262426	4851593
170	WL12	Mānuka, tangle frern scrub/fernland	Bog	At risk	Southland Plains	2003	2019	1263768	4850324
172	WL22	Carex, *Schoenus pauciflorus* sedgeland	Fen	At risk, gone	Southland Plains	2003	2019	1262445	4848878
174	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, gone	Southland Plains	2003	2018	1270461	4840894
175	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2003	2018	1271599	4839101
176	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Fen	Gone	Southland Plains	2003	2019	1271722	4842129
178	WL18	Flaxland	Swamp	Gone	Southland Plains	2005	2018	1287556	4825527
179	WL18	Flaxland	Swamp	Gone	Southland Plains	2005	2018	1284893	4825360
180	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, gone	Southland Plains	2003	2018	1258999	4835502

FID_ES_wet	Potential Ecosystem Type		Wetland Class	Robertson *et al*. (2019) Classification	Subregion	Earliest Google Earth Image	Latest Google Earth Image	Easting	Northing
182	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2008	2018	1257008	4835897
185	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2018	1259736	4838747
188	WL12	Mānuka, tangle frern scrub/fernland	Bog	Gone,	Southland Plains	2004	2018	1232659	4854543
189	WL18	Flaxland	Fen	At risk, Gone	Southland Plains	2009	2018	1231945	4853628
191	WL20	Coprosma, twiggy tree daisy scrub	Bog	Gone	Southland Plains	2004	2018	1234109	4854361
194	WL22	Carex, *Schoenus pauciflorus* sedgeland	Fen	At risk	Southland Plains	2003	2019	1263431	4847684
196	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1258231	4867898
197	WL12	Mānuka, tangle frern scrub/fernland	Bog	At risk	Southland Plains	2010	2018	1220434	4878061
198	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2009	2019	1246458	4860200
199	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1248742	4861710
206	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Te Anau basin	2010	2019	1192515	4964435
220	WL18	Flaxland	Swamp	Gone	Southland Plains	2005	2018	1285896	4825379
221	WL18	Flaxland	Swamp	Gone	Southland Plains	2005	2018	1286016	4825485
257	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	At risk	Te Anau basin	2010	2019	1200760	4958182
356	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1172253	4891528
366	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2005	2019	1297263	4838842
372	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2012	2019	1281160	4865555
421	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2010	2018	1218743	4878116
422	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2009	2019	1245815	4837749
439	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2009	2018	1231630	4859792
500	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2009	2019	1243381	4838133
502	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	At risk, Gone	Southland Plains	2001	2019	1270614	4868495
507	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Fen	At risk, Gone	Southland Plains	2001	2019	1268936	4875424
533	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2003	2019	1249118	4883163
553	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2011	2019	1244075	4868188
554	WL18	Flaxland	Bog	At risk	Southland Plains	2009	2019	1244332	4864800

FID_ES_wet	Potential Ecosystem Type		Wetland Class	Robertson *et al*. (2019) Classification	Subregion	Earliest Google Earth Image	Latest Google Earth Image	Easting	Northing
557	WL18	Flaxland	Fen	At risk	Southland Plains	2001	2019	1269138	4865071
559	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	Gone	Southland Plains	2001	2019	1268958	4867246
568	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2019	1250474	4881442
569	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2003	2019	1250824	4879679
578	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2005	2019	1272142	4836499
579	WL12	Mānuka, tangle frern scrub/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1272714	4835917
580	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1269862	4835721
581	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Fen	At risk, Gone	Southland Plains	2005	2019	1270362	4833864
588	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Fen	At risk, Gone	Southland Plains	2007	2019	1207659	4854222
592	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1274518	4844774
642	WL22	Carex, *Schoenus pauciflorus* sedgeland	Fen	At risk, Gone	Southland Plains	2009	2018	1228595	4855283
643	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2009	2018	1229467	4860872
658	WL12	Mānuka, tangle frern scrub/fernland	Fen	At risk	Southland Plains	2003	2018	1265779	4841871
661	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1264438	4838884
662	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2005	2018	1267942	4840472
665	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2003	2018	1262070	4837948
667	WL19	Raupo reedland	Bog	At risk	Southland Plains	2010	2018	1262066	4835013
668	WL12	Mānuka, tangle frern scrub/fernland	Bog	At risk	Southland Plains	2010	2018	1264028	4835081
672	WL12	Mānuka, tangle frern scrub/fernland	Bog	Gone	Southland Plains	2003	2019	1261714	4838879
737	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2007	2019	1198991	4894080
759	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2007	2019	1198635	4893399
763	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1247886	4880145
764	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1249087	4880650
772	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2007	2019	1210796	4886049
805	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1253218	4876823
810	WL20	Coprosma, twiggy tree daisy scrub	Fen	At risk, Gone	Southland Plains	2009	2018	1248194	4839140

FID_ES_wet	Potential Ecosystem Type		Wetland Class	Robertson *et al*. (2019) Classification	Subregion	Earliest Google Earth Image	Latest Google Earth Image	Easting	Northing
811	WL20	Coprosma, twiggy tree daisy scrub	Fen	At risk, Gone	Southland Plains	2009	2018	1248339	4839276
813	WL20	Coprosma, twiggy tree daisy scrub	Swamp	At risk, Gone	Southland Plains	2009	2018	1247829	4839436
815	WL12	Mānuka, tangle frern scrub/fernland	Bog	Gone	Southland Plains	2003	2018	1249677	4841039
818	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1261373	4842115
820	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2003	2018	1261650	4839726
822	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2018	1263230	4839793
824	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2018	1264973	4842273
841	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Fen	At risk, Gone	Southland Plains	2009	2018	1247210	4837607
843	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Marsh	At risk, Gone	Southland Plains	2009	2018	1249000	4838421
844	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Marsh	At risk	Southland Plains	2009	2018	1249207	4837468
845	WL20	Coprosma, twiggy tree daisy scrub	Fen	At risk	Southland Plains	2009	2018	1248338	4838373
846	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2018	1250547	4837409
847	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2009	2018	1247821	4835580
850	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2004	2019	1236872	4851202
877	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Te Anau basin	2010	2019	1198992	4958157
892	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2010	2017	1228759	4917462
1052	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2019	1185602	4903692
1124	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	At risk	Te Anau basin	2007	2019	1185601	4939366
1125	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	At risk	Te Anau basin	2007	2019	1185919	4938932
1144	WL18	Flaxland	Swamp	At risk	Te Anau basin	2012	2019	1183531	4929164
1245	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2005	2019	1300009	4852381
1362	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Inland Southland	2012	2019	1223134	4928867
1363	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Inland Southland	2012	2019	1224206	4930176
1364	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Inland Southland	2012	2019	1222752	4931372

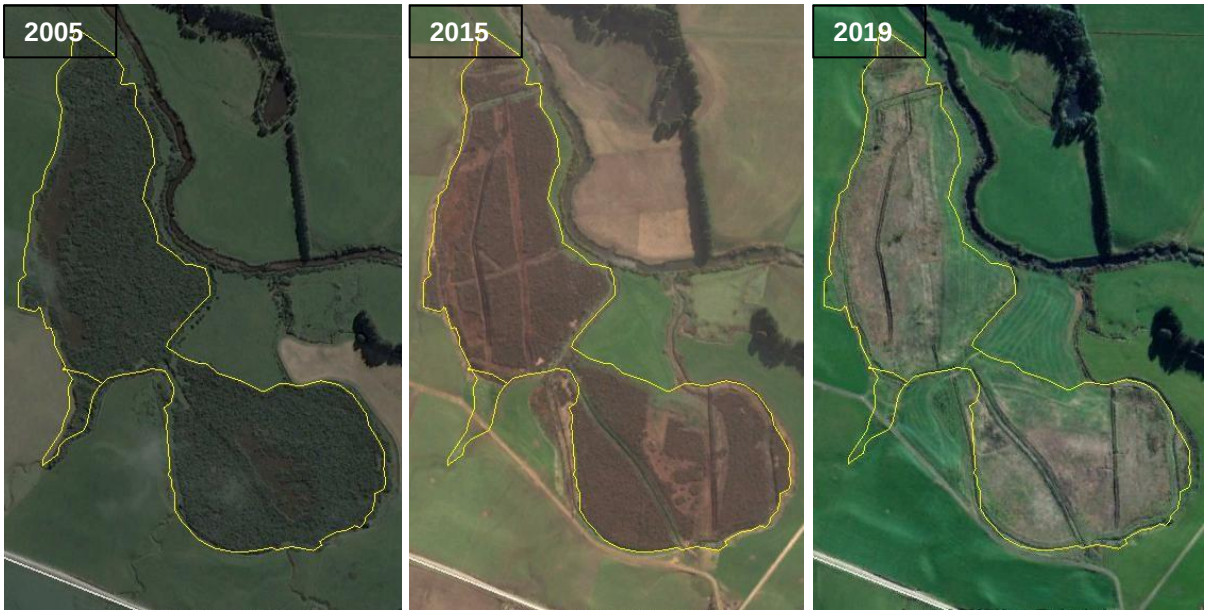
FID_ES_wet	Potential Ecosystem Type		Wetland Class	Robertson *et al*. (2019) Classification	Subregion	Earliest Google Earth Image	Latest Google Earth Image	Easting	Northing
1366	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Inland Southland	2012	2019	1221667	4932802
1367	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Inland Southland	2012	2019	1220806	4933796
1368	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Inland Southland	2012	2019	1222175	4934665
1369	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	At risk	Inland Southland	2012	2019	1217621	4943633
1384	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Fen	Gone	Inland Southland	2012	2019	1227836	4934751
1385	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Bog	At risk	Inland Southland	2012	2019	1229374	4934717
1388	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Bog	At risk	Inland Southland	2012	2019	1218474	4935486
1430	WL16	Red tussock, *Schoenus pauciflorus* tussockland	Bog	At risk	Inland Southland	2012	2019	1219315	4945891
1494	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1257541	4843056
1495	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1258709	4842166
1496	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2018	1257066	4839789
1497	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1258259	4841302
1498	WL12	Mānuka, tangle frern scrub/fernland	Bog	Gone	Southland Plains	2005	2018	1266619	4838035
1499	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1267240	4838171
1500	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1267873	4837037
1501	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2003	2018	1266052	4836131
1503	WL20	Coprosma, twiggy tree daisy scrub	Bog	At risk	Southland Plains	2003	2018	1266713	4834815
1504	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2008	2018	1250809	4835191
1505	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2008	2018	1251837	4834227
1506	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2008	2018	1253883	4833799
1507	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk, Gone	Southland Plains	2008	2018	1254398	4834656
1512	WL18	Flaxland	Marsh	At risk, Gone	Southland Plains	2009	2018	1223105	4857857
1515	WL12	Mānuka, tangle frern scrub/fernland	Fen	Gone	Southland Plains	2007	2015	1204317	4852646
1519	WL18	Flaxland	Swamp	Gone	Southland Plains	2010	2018	1200598	4852360
1573	WL12	Mānuka, tangle frern scrub/fernland	Bog	At risk, Gone	Southland Plains	2003	2019	1261434	4848414

FID_ES_wet	Potential Ecosystem Type		Wetland Class	Robertson *et al*. (2019) Classification	Subregion	Earliest Google Earth Image	Latest Google Earth Image	Easting	Northing
1574	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Fen	At risk	Southland Plains	2012	2019	1197346	4852995
1587	WL12	Mānuka, tangle frern scrub/fernland	Fen	Gone	Southland Plains	2005	2018	1271048	4834049
1589	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2007	2018	1214519	4883575
1591	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	Gone	Southland Plains	2010	2018	1229870	4874878
1592	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2007	2018	1210624	4885291
1595	WL6	Lesser wire rush, tangle fern restiad rushland/fernland	Bog	At risk	Southland Plains	2003	2018	1262222	4840997

EXAMPLES OF WETLAND CLEARANCE AND MODIFICATION

Drainage and Mechanical Clearance

Drainage and mechanical clearance in Wetland 1589, Southland Plains.

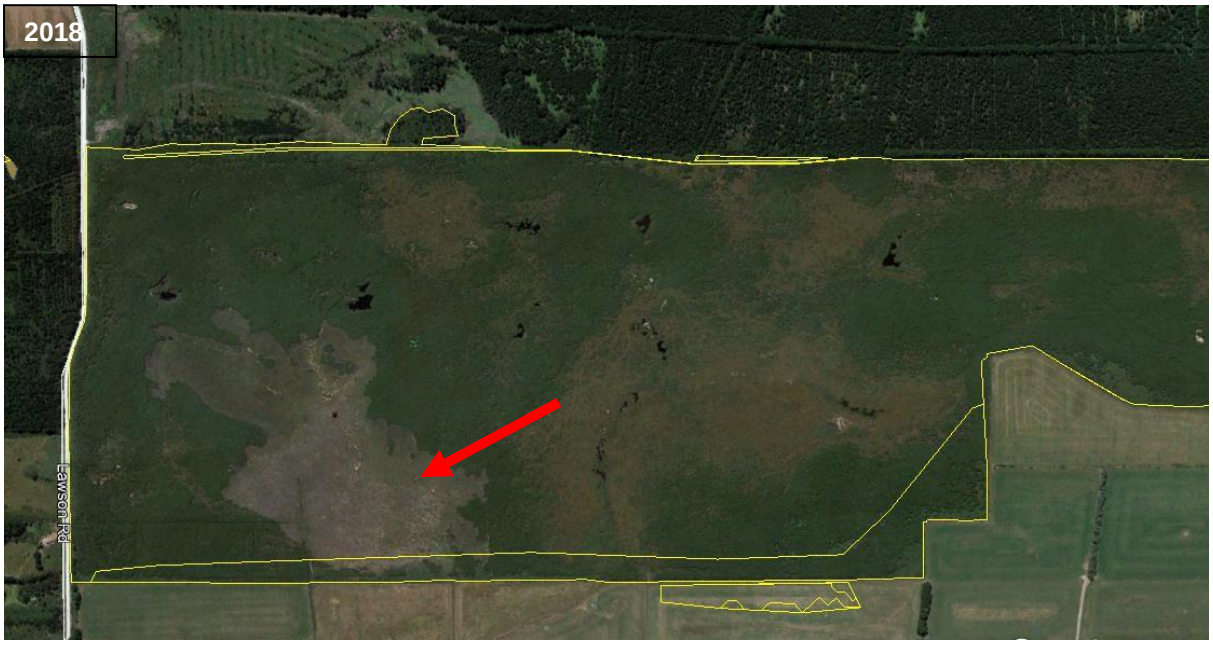


Drainage and mechanical clearance in Wetland 1245, Southland Plains.

Afforestation

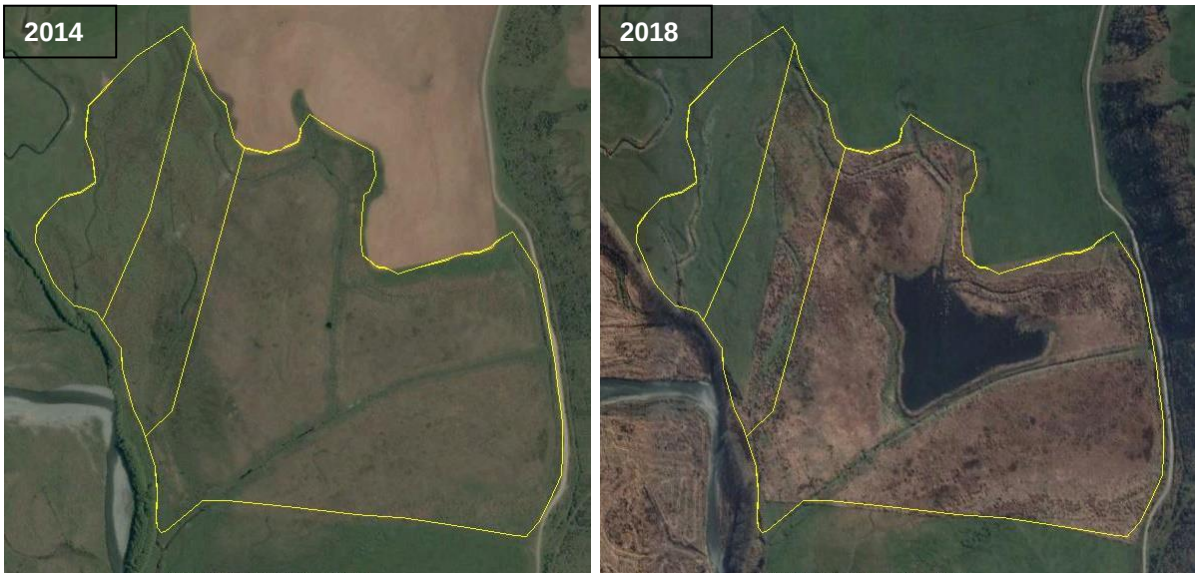
Afforestation in Wetland 91, Southland Plains. The area at centre has been harvested and was subsequently converted to pasture. Afforestation extends into wetlands in conservation estate to the south (arrowed).

Fire



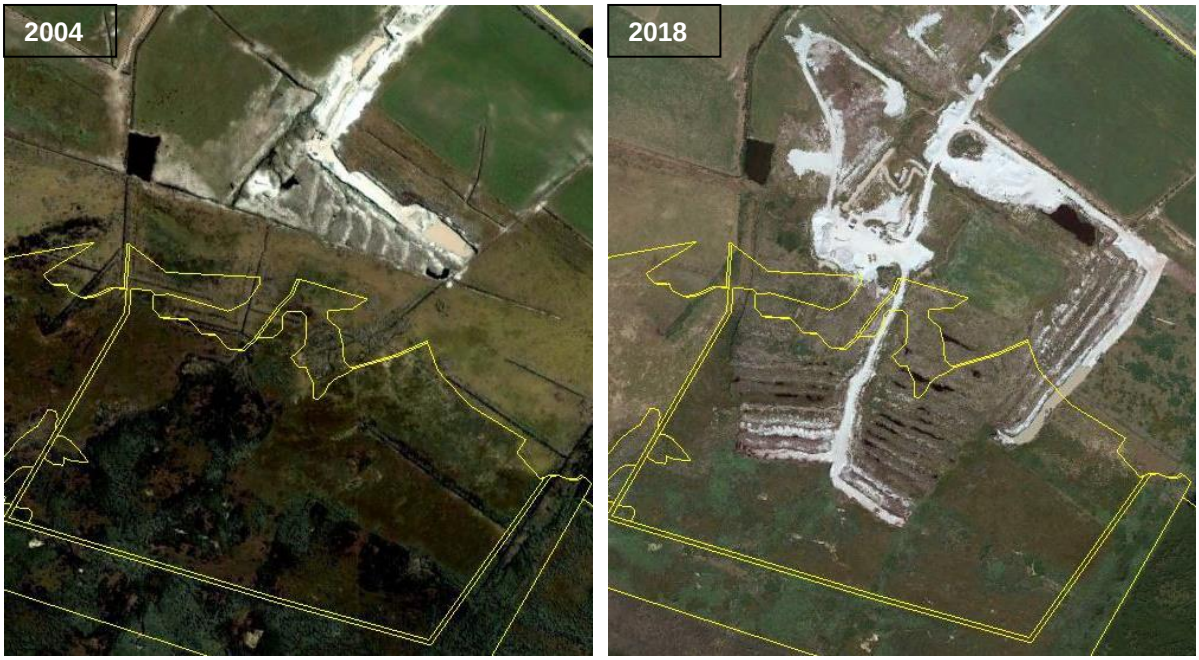
Result of a fire in Wetland 820, Southland Plains (arrow indicating lighter-coloured area). The fire occurred in 2016.

Inundation



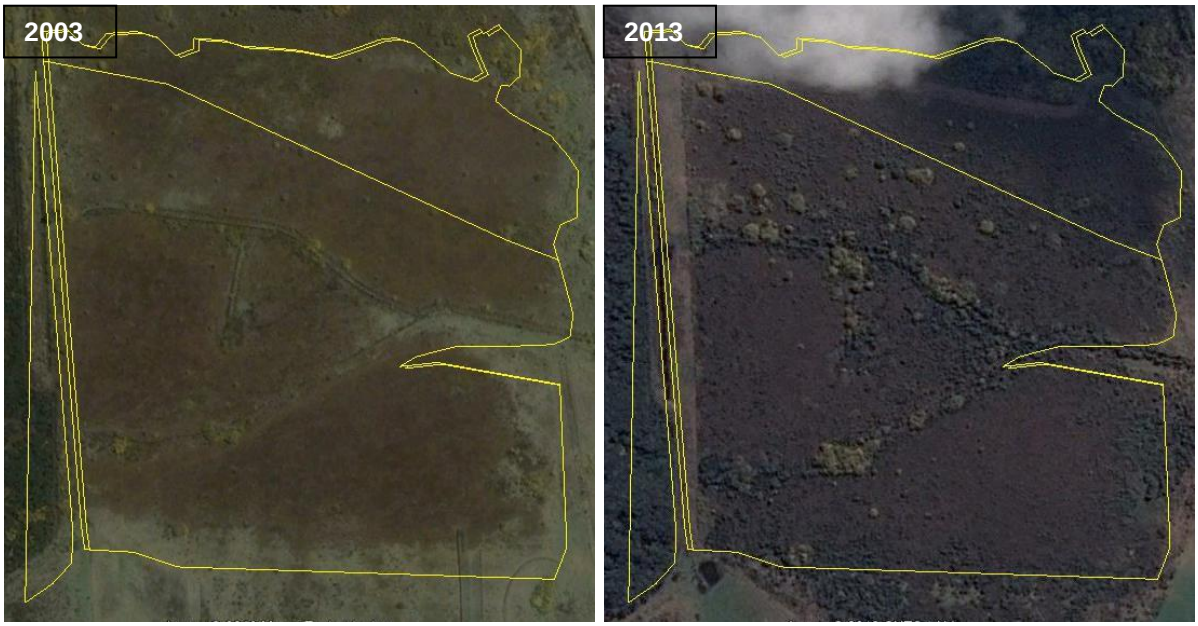
Inundation in Wetland 257, Te Anau basin. The pond covers *c*.1.8 hectares of the *c*.25.8 hectare wetland.

Quarry



Quarry in Wetland 174, Southland Plains.

Weed Invasion



Weed invasion and spread following drainage in Wetland 1051.

Herbicide Application

Herbicide application in Wetlands 163 (left) and 507 (middle), which was mostly of gorse on wetland margins, and what appears to be bands of aerially-applied herbicide in Wetland 174 (right).

Providing outstanding ecological services to sustain and improve our environments

Call Free 0508 WILDNZ
Ph: +64 7 343 9017
Fax: +64 7 3439018
ecology@wildlands.co.nz

99 Sala Street
PO Box 7137, Te Ngae
Rotorua 3042,
New Zealand

Regional Offices located in
Auckland, Hamilton, Tauranga,
Whakatane, Wellington,
Christchurch and Dunedin

ECOLOGY RESTORATION BIODIVERSITY SUSTAINABILITY

www.wildlands.co.nz