Before the Independent Commissioners of the Northland Regional Council (NRC)

In the Matter of	the Resource Management Act 1991
And	
In the Matter of	applications by members of the Aupōuri Aquifer Water Users Group for new groundwater takes from the Aupōuri Aquifer subzones: Other, Waihopo, Houhora, Motutangi, Waiparera, Paparore, Sweetwater.

Statement of Evidence of

Jon Williamson

for the Aupōuri Aquifer Water Permit Applicants

Dated: 14 August 2020

Contents

1. Introduction

1.1. Qualifications and Experience

1. My full name is Jonathan Lindsay Williamson.

2. I am the Managing Director of Williamson Water & Land Advisory (WWLA), a firm founded in January 2015 and currently employing 18 staff specialising in water, rural and contaminated land related resource management. From the year 2000 until 2015 I held various technical and managerial roles in the natural resource management and irrigation sectors within the Auckland office of Sinclair Knight Merz (now Jacobs). From 1995 to 1999 I was based in Sydney undertaking a range of hydrogeological work in the mining and municipal water supply sectors for a global multidisciplinary consulting firm.

3. I have a Bachelor of Science (BSc) in Earth Science (1993), and a Master of Science and Technology first class honours (MSc(Tech)[I]) (1995) in Hydrology and Geology from the University of Waikato.

4. I have 25 years' specialist technical expertise in hydrogeology, hydrology and irrigation engineering covering a wide spectrum of services including data collection and analysis; field investigations and testing; modelling; engineering design; construction contract management; technical report writing; community and stakeholder consultation; resource consent hearings; and technical working panels. I have provided independent advice across a wide spectrum of client types within New Zealand, including Regional Councils, District Councils, government agencies such as the Ministry of Business, Innovation and Employment; Te Puni Kōkiri (Ministry of Māori Development); Ministry For The Environment; and the Department of Conservation; sector interest groups such as Horticulture New Zealand, water management groups such as Wairarapa Water User Society; agricultural and horticultural businesses; energy companies; mining; and beverage companies.

1.2. Selected Local Experience

5. I have been involved in numerous water resource and hydrogeological assessments on the Aupōuri Peninsula since 2000, which has provided me with excellent knowledge of the hydrological systems in the area. Projects have included the following:

   (A) ***Te Kao / Te Hapua Water Solutions (2020).*** On behalf of Te Runanga Nui O Te Aupōuri Trust and Te Puni Kokiri, WWLA were commissioned to undertake a scoping study of potential irrigable land and community water demands, surface water and groundwater resources, along with concept development of high-level cost estimates for various water supply scheme options for the two isolated Far North communities.

(B) ***Irrigation Reservoir and Infrastructure Construction Procurement (2019 to now).*** On behalf of Te Waka Pūpuri Pūtea Trust (who are Te Rūnanga o Te Rarawa's asset holding group, with its primary function to hold, protect and grow the Iwi assets), WWLA were Owners Engineer for the PGF funded project to develop a water storage reservoir, and associated pumping and distribution networks for a further 200 ha of horticultural land development.

(C) ***Te Hiku Water Project (2019).*** WWLA were commissioned by the Far North Water Project Steering Group (whose members included representatives from Ngai Takoto, Te Rarawa, Te Aupōuri, NRC, DOC, FNDC, the horticultural industry and the Houhora Rate Payers Association), to participate in a pre-feasibility study of the Far North (Te Hiku) area. The aim of the study was to gain insight toward sustainable water resource management strategies that enhance the Far North's social, economic and environmental prosperity. Activities WWLA were involved in included analysis of land use potential, surface water and groundwater resources assessment, water allocation planning framework and allocation status assessments, and groundwater effects modelling of possible groundwater allocation management options.

(D) ***Various Land Use and Water Related Assignments (2019 to now).*** WWLA have been assisting Te Aupōuri Commercial Development Limited, which is the economic development arm of Te Aupōuri Iwi with various land use and water related projects on their Bull Rush, Pukekaroro and Te Raite properties.

(E) ***Motutangi-Waiharara Groundwater Take Applications (2016 to now).*** WWLA were commissioned by 17 separate applicants to prepare a model to assess the cumulative hydrological effects associated with irrigation takes from existing and the applicants takes. The work also comprised expert evidence in the Council Hearing, Environment Court Hearing and ongoing technical and planning advice.

(F) ***Far North Avocado and Pasture Irrigation Bore Procurements* (2000-now).** Procurement and contract management (NZ3910: 2013) of exploratory drilling and production bore drilling and hydraulic testing programmes. Multiple projects for different clients undertaken in the Paparore, Waiharara, Motutangi and Houhora groundwater management zones.

(G) ***Te Raite Station Water Supply Due Diligence (2015).*** On behalf of Landcorp Farming Limited I undertook a high-level review of the land use and water supply options for a 1,800 ha dry stock farm as part of development planning for optimising the economic utility of the land. Consideration was given to more intensive pastoral operations and land use change to horticulture in suitable areas.

(H) ***Aupōuri Aquifer Groundwater Model Update (2014).*** On behalf of Northland Regional Council (NRC), as the consultant for the 2000 model developed, I was asked to undertake a formal peer review of the work undertaken in the 2014 model update.

(I) ***Sweetwater Station Irrigation Groundwater Take Investigation and Consenting (2007).*** On behalf of Landcorp Farming Limited, I was the Technical Director for a study programme that involved approximately 3 years of physical investigation (drilling and testing), modelling, analysis, reporting and Council Hearings work associated with a large water take application. I also presented expert evidence at the NRC Hearing.

(J) ***Sweetwater Station Irrigation Concept Design and Cost Benefit Analysis (2006).*** On behalf of Landcorp Farming Limited, I lead a study that undertook a concept design of an irrigation system for approximately 700 ha and carried out cost benefits analysis using engineering cost data and production data.

(K) ***King Orchards Irrigation Water Supply and AEE (2006).*** On behalf of Far North Avocado Management Limited, I was Project Director for the King Avocado Orchard development at Paparore. The work comprised drilling and testing of irrigation bores, development of a groundwater model and preparation of an assessment of effects report that considered the effects on aquifer sustainability and the shallow dune wetland systems. The report was submitted as part of a water take resource consent application for a new 150 ha avocado orchard.

(L) ***Clearwater Orchard Irrigation Dam Design and AEE (2006).*** On behalf of Clearwater Orchards Limited, I was the Project Manager for a 450 ML dam design and consenting project located at Ngataki. I was directly responsible for undertaking hydrological yield modelling to determine optimal capacity of dam and residual flow requirements of contributing streams, as well as managing staff undertaking geotechnical investigations, dam design, RMA planning and coordination of consultation.

(M) ***Awanui Artesian Aquifer (2005).*** On behalf of the Northland Regional Council, I was Project Director for the development of a groundwater model for the Awanui Artesian aquifer. The objective of this work was to determine the likely effects of permanent closure of abandoned free flowing artesian bores on the surrounding environment, which assisted NRC to make sustainable groundwater resource management decisions in the area.

(N) ***Sweetwater Orchards Groundwater Abstraction Consent Renewal (2004).*** On behalf of Sweetwater Orchards, I was Project Director for preparation of a groundwater take resource consent renewal.

(O) ***Henderson Bay Avocado Water Supply Due Diligence (2004).*** Far North Avocado Management Limited. Orchard irrigation water supply pre-purchase due diligence assessment.

(P) ***Assessment of Bore Performance and Sustainability of Proposed Abstraction Rates (2002).*** On behalf of Stanisich Orchards at Waiharara, I undertook the analysis of bore drawdown data, and the assessment of sustainability and groundwater impact on neighbouring bores for a proposed abstraction of 500 m^3/day.

(Q) ***Lake Waimimiha Water Abstraction Consent (2002).*** On behalf of Kaitaia Golf Course at Ahipara, I undertook a hydrogeology and water balance modelling assessment of the lake for irrigation water supply (285 m^3/day) for the golf course greens, tees and fairways.

(R) ***Sweetwater Nurseries Bore Performance Analysis (2001).*** On behalf of Hamilton Nurseries Limited at Sweetwater, I undertook the reassessment of pump test data and extrapolation of results to assess the potential drawdown effects on neighbouring properties, and preparation of technical report to be used as part of consent renewal application.

(S) ***Aupōuri Aquifer Sustainable Yield Groundwater Modelling Study (2000).*** On behalf of the Northland Regional Council, I undertook the first groundwater modelling study of this aquifer, which was aimed at providing guidance on sustainable management and allocation of the groundwater resource. Study comprised review of hydrogeological data and development, transient calibration (1987-1999) and sensitivity analysis of a two-layered regional MODFLOW model representing an area of 430 square kilometres. The soil moisture water balance model (SMWBM) was used for preconditioning groundwater recharge to the MODFLOW model.

1.3. Selected Multidisciplinary Experience

6. A selection of other previous projects I have been involved is provided in the following paragraphs to demonstrate the breadth of experience and range of clients I routinely work for. A key point I would like to highlight in response to a number of comments by submitters

seeking an "independent" evaluation of the water resource – is that my company's ongoing success is dependent on us providing accurate and timely, independent and impartial advice to our clients. As is shown below, I have worked across a wide spectrum of client sectors and industry groups.

(A) **Northland Water Storage & Use Project: Pre-Feasibility (2019-2020) and Feasibility (2020 to 2021) Stages.** Project initiated by Northland Regional Council and in 2020 novated to Te Tai Tokerau Water Trust after securing $70M in funding from the Provincial Growth Fund. WWLA is the lead consultant on this project, which involved analysis of water storage, water abstraction and reticulation options, longlisting and shortlisting selection processes, cost benefit analyses, land owner discussions, Iwi and community engagement, and confirming preferred scheme configurations to be consented under Fast Track Legislation.

(B) **Hydrogeological Assessment of Dune Lakes.** On behalf of Northland Regional Council, I was Technical Director on a project that assessed the importance of groundwater flows with dune lakes at Kaiiwi and Pouto Point, through the development of a catchment and lake water balance simulator in GoldSim connected to the soil moisture water balance model (SMWBM).

(C) ***Lower Ruamahanga Valley Groundwater***. Initially on behalf of Ongaha Farms Limited & Wairarapa Water User Society Inc. and later at the request of Greater Wellington Regional Council. My firm undertook a review of the hydrogeological information available for the Lower Ruamahanga Groundwater Management Zone and conducted an investigation into the degree of connectivity between the Q2-Q4 aquifer and the Ruamahanga River, and the Proposed Natural Resources Plan (pRPN) classification of the groundwater take. A three-dimensional geological model was developed to better understand the geological context of the valley. MODFLOW and MT3D models were developed to simulate the groundwater surface water interaction, and differences in water quality between the river and aquifer water. I personally prepared Environment Court Evidence for the Ongaha Farm consent appeal, and Evidence for a submission on the Proposed Regional Plan Change, which then lead to further modelling and joint witness statements I co-authored with Council experts.

(D) ***Kaituna and Rangitaiki Catchment SOURCE Models.*** On behalf of Bay Of Plenty Regional Council, I am the technical leader on the development of two large eWater SOURCE catchment models being developed for the purposes of informing the setting of water management zone water quantity and quality limits.

(E) ***Whangamarino Wetland Water Quality Influx Modelling Options.*** On behalf of Department of Conservation, I was the Technical Director for advice on modelling methodologies that could be used to estimate sediment and nutrient loads entering the wetland and to assess the effectiveness of potential mitigation options to improve water quality within the wetland.

(F) ***Ruahuwai (Upper Waikato) Catchment Model.*** On behalf of Wairakei Pastoral Limited, I am senior member of a team comprising three consultants in NZ and Australia currently developing a calibrated daily time step catchment flow and water quality model (SOURCE) and a groundwater flow and water quality model (MODFLOW/MT3D) of the catchment between Lake Taupo and Lake Ohakuri. I led the construction, calibration and prediction simulation of the MODFLOW model, and personally undertook calibration of a number of sub-catchments with the Soil Moisture Water Balance Model (SMWBM), in support of the SOURCE modelling. The model is the scientific basis underpinning expert evidence on behalf of a water management group for Waikato Regional Council's Plan Change 1.

(G) ***Tasman Plan Change 52 – Upper Motueka.*** On behalf of Horticulture New Zealand, I undertook a reliability assessment for the water users in the Upper Motueka given the proposed water allocation rules under Tasman District Council Plan Change 52 (PC52) given actual use and various future use scenarios.

(H) ***Pūhoi to Wellsford Road of National Significance – Pūhoi to Warkworth Section***. On behalf of the New Zealand Transport Agency, I was lead hydrogeologist responsible for a team assessing the groundwater effects of the proposed road, and prepared and presented evidence to a Board of Inquiry.

(I) ***Waterview Connection Tunnel and Great North Road Interchange Project.*** During the Interim Project Alliance Agreement phase of this $1.4B project, I was lead hydrogeologist for a consortium comprising Leighton Contractors and Fulton Hogan. In my role, I was responsible for a team of four hydrogeologists assessing the potential impacts of the tunnel on local groundwater conditions with respect to stream baseflows and ground settlement effects.

(J) ***Tauhara II Geothermal Power Development.*** On behalf of Contact Energy Limited I provided evidence at Board of Inquiry relating to groundwater level and water quality effects from ground disposal of separated geothermal fluid from the proposed power station.

(K) ***Valletta-Ashburton Groundwater Management Zone Hearing***. On behalf of Canterbury Regional Council between 2008 and 2010 I undertook a peer review of a groundwater model developed for 78 joint applicants seeking a combined groundwater take of 3.6 m^3/s for pastoral irrigation purposes. I also prepared a Section 42 Officers Report and Hearings Evidence and participated in Environment Court joint witness conferencing.

1.4. Scope of Evidence

7. The evidence I have been asked to prepare by the Aupōuri Aquifer Water Users Group (AAWUG) relates to the technical hydrogeological work my firm Williamson Water & Land Advisory (WWLA) were separately commissioned to undertake by the various participants in the group (see **Section** Error! Reference source not found.).

8. My evidence will focus on the technical assessments relating to hydrogeological and surface water impacts, while my colleague Ms Martell Letica will present evidence on the RMA planning assessment and submissions.

9. I have read the Northland Regional Council's (NRC's) Section 42A **Staff Report** and support the overall conclusions and recommendations of that report, which was to grant the consents subject to conditions and in particular the adherence to zone specific Groundwater Monitoring and Contingency Plans (GMCPs).

10. The Staff Report also provides a thorough summary and peer review of the technical work WWLA produced to underpin the Assessment of Effects for the applications, hence for these two reasons, my evidence will seek to not replicate what is stated in the Staff Report, but instead will highlight any key matters that I feel need further explanation or attention.

11. However, prior to doing this I will provide some contextual scene setting, which I feel is important since a lot of information in mainstream and social media over the past year has lacked this context.

12. Therefore, the content of my evidence is structured as follows:

    (A) ***Contextual Scene Setting*** – a summary of the AAWUG applications and their volumetric context; and

    (B) ***Comments on the Staff Report;***

    (C) ***Comments on the Groundwater Monitoring & Contingency Plans;*** *and*

    (D) ***Comments on the DoC Submissions.***

1.5. Expert Code of Conduct

13. I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court's Consolidated Practice Note (2014), and I agree to comply with it. My qualifications are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2. Contextual Scene Setting

14. As alluded to above, WWLA were commissioned by twenty four (24) applicants to prepare resource consent applications and assessment of environmental effect reports between March 2108 and August 2019, as summarised in **Table 1**.

Table 1. WWLA commission and lodgement dates for each application.

Application No.	Client name	Commission Date	WWLA Lodgement Date	NRC Acceptance Date
APP.040121.01.01	J. Evans	03/01/2018	13/05/2018	14/06/2018
APP.040130.01.01	Tuscany	10/02/2018	18/06/2018	19/06/2018
APP.040231.01.01	P&G Enterprises	n/a [1.]	10/07/2018	11/07/2018
APP.040362.01.01	Valic	24/03/2018	02/08/2018	03/08/2018
APP.040363.01.01	Wataview	24/03/2018	02/08/2018	03/08/2018
APP.040361.01.01	Tiri	24/03/2018	02/08/2018	03/08/2018
APP.039644.01.01	D. Wedding & Doody	10/05/2018	10/08/2018	13/08/2018
APP.039841.01.02	Yelavich	19/05/2018	14/08/2018	14/08/2018
APP.040386.01.01	Robert Campbell	04/06/2018	21/08/2018	21/08/2018
APP.040364.01.01	Elbury Holdings	07/06/2018	02/08/2018	03/08/2018
APP.040397.01.01	A. Matthews	08/06/2018	28/08/2018	28/08/2018
APP.040558.01.01	M.Evans	15/08/2018	09/11/2018	09/11/2018
APP.039859.01.01 APP.039859.01.02 APP.039859.01.03	Te Aupōuri Commercial Development Ltd[2.]	05/09/2018	23/02/2018	23/02/2018
APP.040600.01.01	Far North Avocados (Blake Powell)	11/10/2018	26/11/2018	26/11/2018
APP.040601.01.01	Waikopu Avocados	24/10/2018	22/11/2018	26/11/2018
APP.017428.02.01	Henderson Bay Avocados	24/10/2018	22/11/2018	26/11/2018
APP.040652.01.01	S. & L. Blucher	30/10/2018	21/12/2018	21/12/2018
APP.040918.01.01	Byran	20/12/2018	12/04/2019	30/04/2019
APP.040919.01.01	Bryan Estate	20/12/2018	12/04/2019	01/05/2019
APP.020995.01.04	Te Rarawa Farming Ltd & Te Make Farms Ltd (Sweetwater Farms)*	08/01/2019	27/08/2019	28/08/2019
APP.039628.01.04	KSL	04/03/2019	29/03/2019	29/03/2019
APP.008647.01.06	Avokaha	02/04/2019	17/04/2019	17/04/2019
APP.040979.01.01	M. Evans	14/05/2019	30/05/2019	30/05/2019
APP.041211.01.01	Paul McGlaughlin	25/08/2019	10/09/2019	28/08/2019

Notes:
1. WWLA did not prepare this resource consent application.
2. WWLA provided support as sub-contractor for WSP Opus.

15. Table 1 of the Officers Report summarises the abstraction volumes sought by each applicant, which are largely consistent with our records although please note, some minor clarifications are requested to the consent details. These clarifications are confirmed in the GMCP contained in the evidence of Ms Letica.

16. Figure 1 of Attachment 5 of the Officers Report (Hughes, 2020b) provides a useful map of the distribution of the applications, which is reproduced for ease of access herein as Error! Reference source not found..

Figure 1. Distribution of the proposed AAWUG takes (yellow dots) across sub-aquifers of the Aupōuri Aquifer management unit (ref. Hughes, 2020).

17. The proposed takes are distributed from north to south across seven groundwater management zones, with the annual volumes as follows: Waihopo (332,760 m^3/year), Houhora (1,717,400 m^3/year), Motutangi (204,400 m^3/year), Paparore (788,700 m^3/year), Sweetwater (521,000 m^3/year), Ahipara (455,000 m^3/year) and Other (587,000 m^3/year).

18. ***Total Volume Sought*** - The total volume of groundwater being sought by the applications is 4,606,260 m^3/year or 4.6 billion litres of water. This volume of water would seem large to laypeople, but needs to be considered in the context of the hydrological system as a whole.

19. ***Aquifer Storage Volume*** - The aquifer itself stores an average of approximately 2,850 billion litres of groundwater.

20. ***Rainfall Volume*** - The average amount of rainfall that falls over the aquifer each year is approximately 687 billion litres.

21. ***Aquifer Recharge Volume*** - Of the rainfall that falls on the aquifer, approximately 238 billion litres (35%) recharges the deeper aquifer system.

22. The total amount of groundwater requested under these consents (4.6 billion litres) represents on average 0.16% of the groundwater stored in the aquifer, and 1.9% of the rainfall that recharges the aquifer on average.

23. As seen in recent media, it seems the preferred colloquial unit of volume to make approximate volume comparisons is an Olympic-size swimming pool, which typically holds approximately 2,500 m^3 or 0.0025 billion litres of water. Using this approach, the amount of water under these applications is equivalent to 1,840 Olympic swimming pools, while the annual recharge volume is equivalent to 95,200 pools.

24. Error! Reference source not found. provides a visual scale comparison of the physical dimensions for the Aupōuri Aquifer model domain and Lake Taupo, which was selected because it represents an easily recognisable New Zealand landmark.

25. **Table 2** provides summary statistics of the comparison and shows that the Aupōuri Aquifer is approximately 87% of the surface area of Lake Taupo and 80% of the total volume. Although the volume of water contained in the aquifer (2,850 billion litres) represents only a small fraction (6%) of the total aquifer matrix volume (47,526 billion litres) due to water only filling the void spaces between sediment particles.

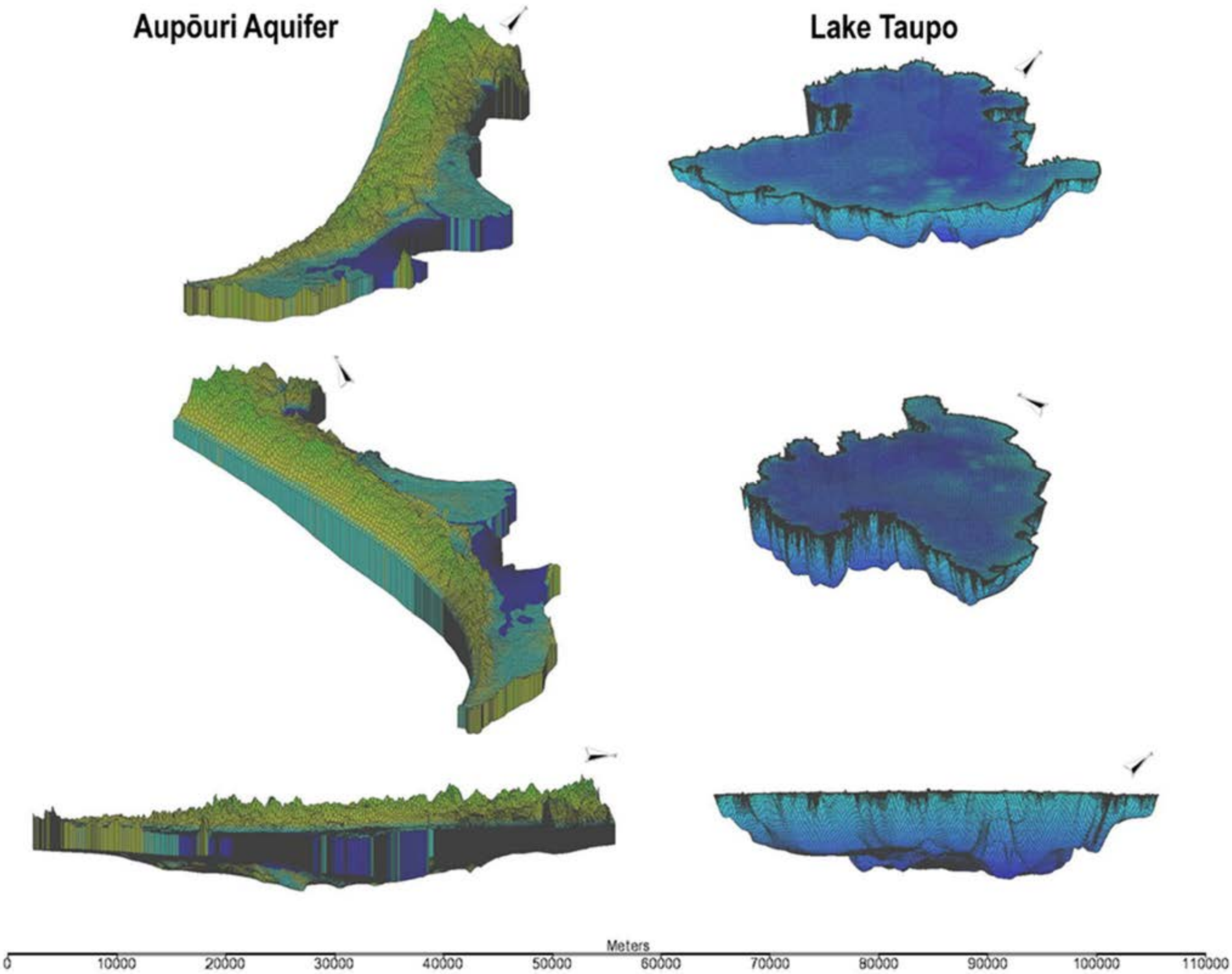

Figure 2. Scale comparison of the size of the Aupōuri Aquifer to Lake Taupo.

Table 2. Summary statistics comparing the size of the Aupōuri Aquifer to Lake Taupo.

Land Feature	Surface Area (km^2) [ha]	Average Depth (m)	Volume (billion litres)	
			Total	Void space
Aupōuri Aquifer	534 [53,400]	89	47,526	2,850
Lake Taupo	613 [61,300]	110	59,000	59,000
Comparison	87%	81%	81%	5%

3. Comments on the Staff Report

26. In paragraph 3 on page 191, Mr Hughes states the aquifer is approximately 75,000 ha in area, which we do not dispute as it is dependent on where the northern demarcation boundary is made. However, for clarity, the area we have used for the purposes of the water balance calculations presented above is approximately 53,500 ha (representing the model domain area).

27. In paragraph 13 on page 194, Mr. Hughes indicates that the iterative model development process has enabled incorporation of updated geological, topographical and groundwater monitoring data into the setup to the model. This is correct; however, the model is currently undergoing further structural refinement to incorporate results from drilling and geophysical surveying at Mervyn Evan's Orchard, geophysical surveying at Te Rarawa's property in the south of Sweetwater, and the monitoring bores drilled for the MWWUG GMCP including Norton Rd (Kaimaumau) and Motutangi. This will address the comment Mr Hughes makes in paragraph 26 on page 197 regarding the depth to basement being uncertain in some areas, in particular the basement was underestimated at Mervyn Evans bore and at the Norton Road (Kaimaumau) bore. However, I agree with Mr Hughes, that where the thickness of the high permeability shellbed aquifer is under-estimated, modelling will tend to overestimate drawdown.

28. In paragraph 21 on page 196 Mr Hughes describes topographical elevation changes that became necessary after the NRC LiDAR survey data became available. Fortunately for the applicants, NRC accepted the costs of updating the model to reflect the change in topographical elevation (Error! Reference source not found.), which also resulted in necessary changes to layer elevations and groundwater levels. As a consequence of these structural changes to the model and observation datasets, and slight adjustments to model properties, the global model accuracy increased, with root mean square error (RMSE) decreasing from 1.89 for the 2019 Model to 1.31 m for the 2020 Model.

29. The increase in model accuracy can predominantly be attributed to the adjusted elevation at three locations, namely the NRC Waterfront, Fishing Club and Paparore piezometers, both of which had been problematic to calibrate in both the WWLA and previous models. demonstrates the improvements achieved at these locations.

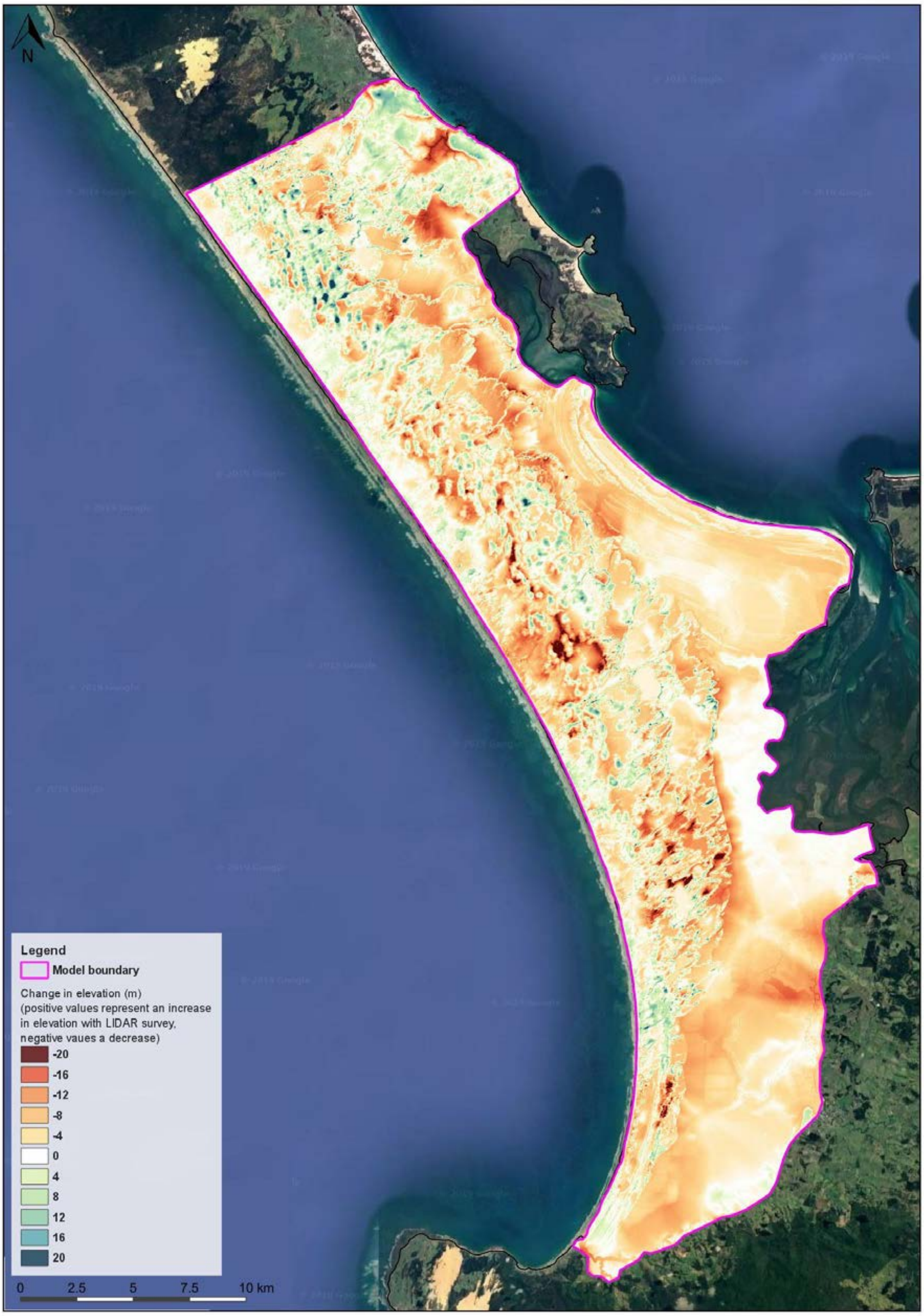

Figure 3. Map showing difference in land surface elevation from LIDAR and 8m DEM.

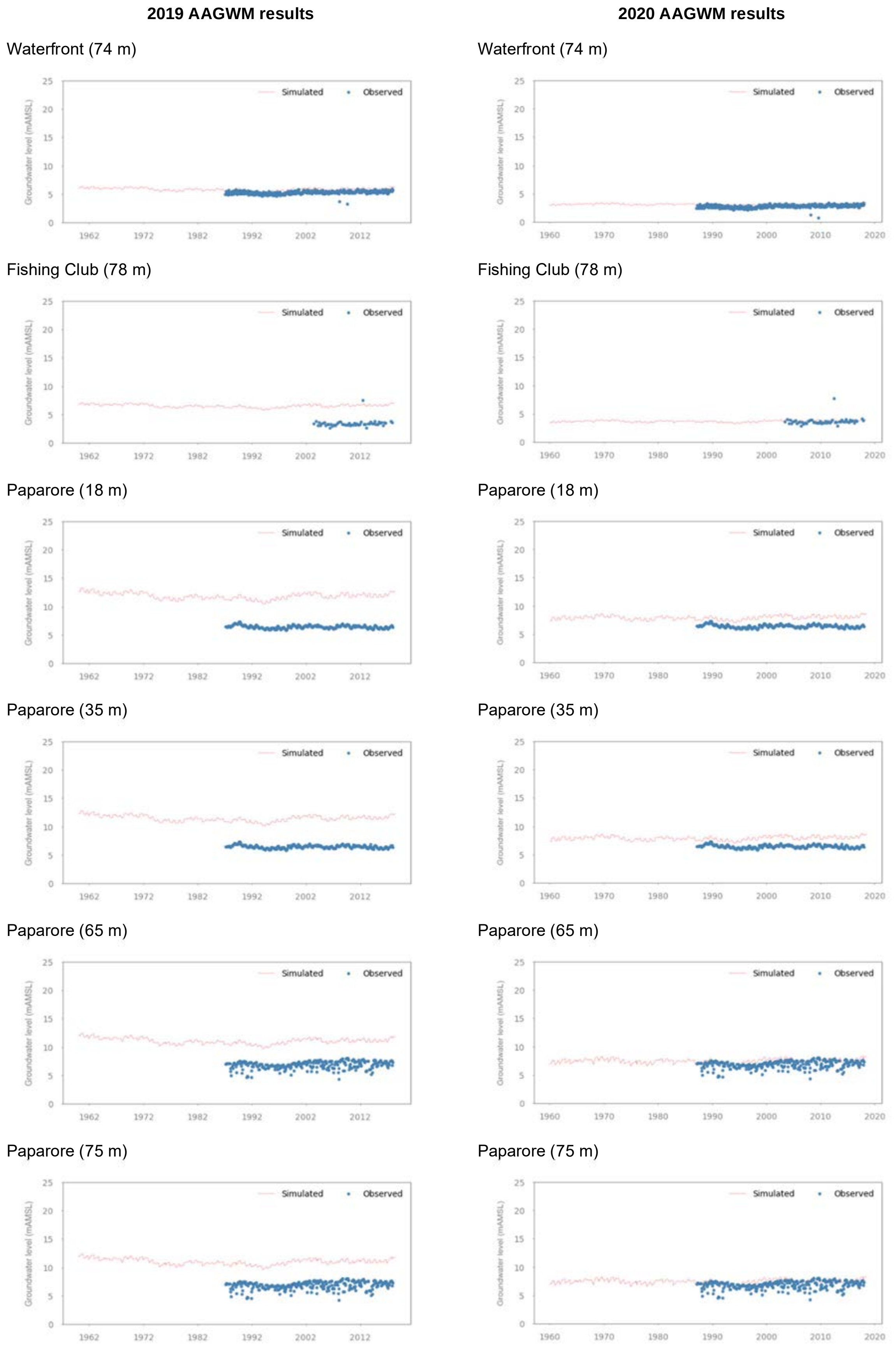

Figure 4. Comparison of calibration hydrographs between the 2019 and 2020 AAGWM for Waterfront and Paparore Piezometers.

30. In paragraph 7 of Mr Hughes second report on page 232 he discusses allocation from the Aupōuri Aquifer Management sub-aquifers and describes the approach that NRC have developed for apportioning allocation into each sub-zone regardless of where the bore is actually positioned.

31. I have been provided a copy of the NRC cross boundary adjustment methodology (NRC, 2020). In essence, the approach recognises that where bores are in close proximity to a sub-aquifer management boundary, a proportion of the abstraction will be derived from the neighbouring sub-aquifer. The approach also considers the extent of cross boundary effect will increase with the magnitude of pumping, as summarised in **Table 3**. I consider both these principals to be correct, and support the use of this approach. Whilst, the approach is new and undoubtably will be further refined in the future, I do not consider future refinements will materially change the outcome of this round of consenting given the allocation status of the aquifer even without consideration of cross boundary effects is not fully allocated according to my calculations.

Table 3. Cross boundary effects – groundwater volume bands (NRC, 2020).

Consent Volume (m^3/year)	Radius of Influence to apply (m)	Groundwater Net Take (m^3/year)	
		Use X-Boundary Net Take (apply X-Boundary adjustment)	Use current Net Take (do not apply adjustment)
< 20,000	0	For none	For all
20 – 40,000	500	<= 500m from boundary	> 500m from boundary
40 – 60,000	1,000	<= 1,000m	> 1,000m
60 – 80,000	1,500	<= 1,500m	> 1,500m
80 – 120,000	2,000	<= 2,000m	> 2,000m
120,000 +	2,500	<= 2,500m	> 2,500m

4. Comment on the Department of Conservation Submission relating to Kaimaumau Wetland

32. The Department of Conservation submit that the Kaimaumau Wetland is hydrologically connected to the Aupōuri Aquifer system. Since thew time of the MWWUG, there is mounting evidence that contradicts this including the recent water balance modelling and sensitivity analyses undertaken by myself (Williamson, 2020) and a recent Wildlands (2020) ecological state report, which states in a number of places (see Section 4.4 and Table 2 and Table 4 of that report reproduced below (highlighted added) and included as **Attachment B**).

4.4 Wetland condition index

The results of the wetland condition and pressure assessments are presented in Tables 2 and 3 below.

As Kaimaumau Wetland is rain fed, water does not flow through a wider 'catchment' before entering the wetland. As such, scores for factors relating to the 'catchment' (e.g. water quality within the catchment, connectivity barriers, and modifications to catchment hydrology) assumed that there has been no change or degradation of the wetland in relation to these factors.

Table 2: Result of wetland condition assessment carried out for Kaimaumau Wetland in January 2020. Note that a score of 0 indicates poor condition and a score of 5 indicates good condition.

Indicator	Indicator Components	Comment	Score	Mean Score
Change in Hydrological integrity	Impact of manmade structures	Large drain to the west of survey location.	4	4.67
	Water table depth	No detectable changes.	5	
	Dryland plant invasion	No/virtually no dryland plants in or around transects. Some Sydney golden wattle (*Acacia longifolia*) near edge of wetland to the southeast.	5	
Change in physico-chemical parameters	Fire damage	Fire in 2005 affected <25% of wetland.	4	4.25
	Degree of sedimentation/erosion	No evidence of sedimentation or erosion.	5	
	Nutrient levels	No evidence of eutrophication.	5	
	von Post index	von Post test carried out near A0.	3	
Change in ecosystem intactness	Loss in area of original wetland	<25% of original area lost.	4	4.50
	Connectivity barriers	None. Rain-fed wetland.	5	
Change in browsing, predations and harvesting regimes	Damage by domestic or feral animals	Small amount of localised browsing on wetland edges.	4	4.33
	Introduced predator impacts on wildlife	Susceptible species still present, e.g. fernbird (*Bowdleria punctata*).	4	
	Harvesting levels	No evidence of harvesting.	5	
Change in dominance of native plants	Introduced plant canopy cover	Some prickly hakea (*Hakea sericea*) present in canopy.	4	4.50
	Introduced plant understorey cover	No/virtually no introduced plants in understorey.	5	
Total Wetland Condition Index				**22.25**

Table 3: Result of wetland pressure assessment carried out for Kaimaumau Wetland in January 2020. Note that a score of 0 indicates low pressure and a score of 5 represents high pressure.

Pressure	Comment	Score
Modifications to catchment hydrology	None. Rain-fed wetland.	0
Water quality within the catchment	Very high water quality. Rain-fed.	0
Animal access	Low impediment to pest animal access. Mixed land use in surrounding area.	3
Key undesirable species	No key undesirable species found during survey.	0
% catchment in introduced vegetation	>25% of the catchment in introduced vegetation. Sydney golden wattle dominant in some areas.	1
Other pressures	N/A	0
Total Wetland Pressure Index		**4**

33. It should be noted that the methodology for this report was greed by the Department of Conservation staff as shown below.

ACKNOWLEDGMENTS

Stuart Savill (Northland Regional Council) provided client liaison, Meirene Hardy-Birch (Department of Conservation) provided permission to work at the site, and Hugh Robertson (Department of Conservation) provided advice for the design of the monitoring methods. Ben Schultz provided helicopter access to the site, and Ian Broadhurst provided the helicopter departure point.

5. Comment on the Groundwater Monitoring & Contingency Plans

5.1. Objectives

34. Objective 1 states "The abstractions must, individually and cumulatively, avoid: (a) saltwater intrusion into the Aupōuri aquifer".

35. The issue I have with this objective is that saline intrusion can not be avoided because it occurs naturally. For example, at the Norton Road (Kaimaumau) monitoring bore, salinity was recorded at approximately 80 mBGL. Likewise, the bore in Kaimaumau Settlement are mostly brackish around the costal fringe. The WWLA model predicts the position of the saline interface to be inland in areas such as around from north to south, the upper reaches of Houhora Harbour, East Beach to Kaimaumau settlement, and in the lower reaches of the Awanui Plains, as shown in Error! Reference source not found..

36. Ms Letica has accepted my concern and proffered the following suggested word changes (highlighted red):

    The abstractions must, individually and cumulatively, avoid:

    (a) adverse effects associated with saltwater intrusion into the Aupōuri aquifer;

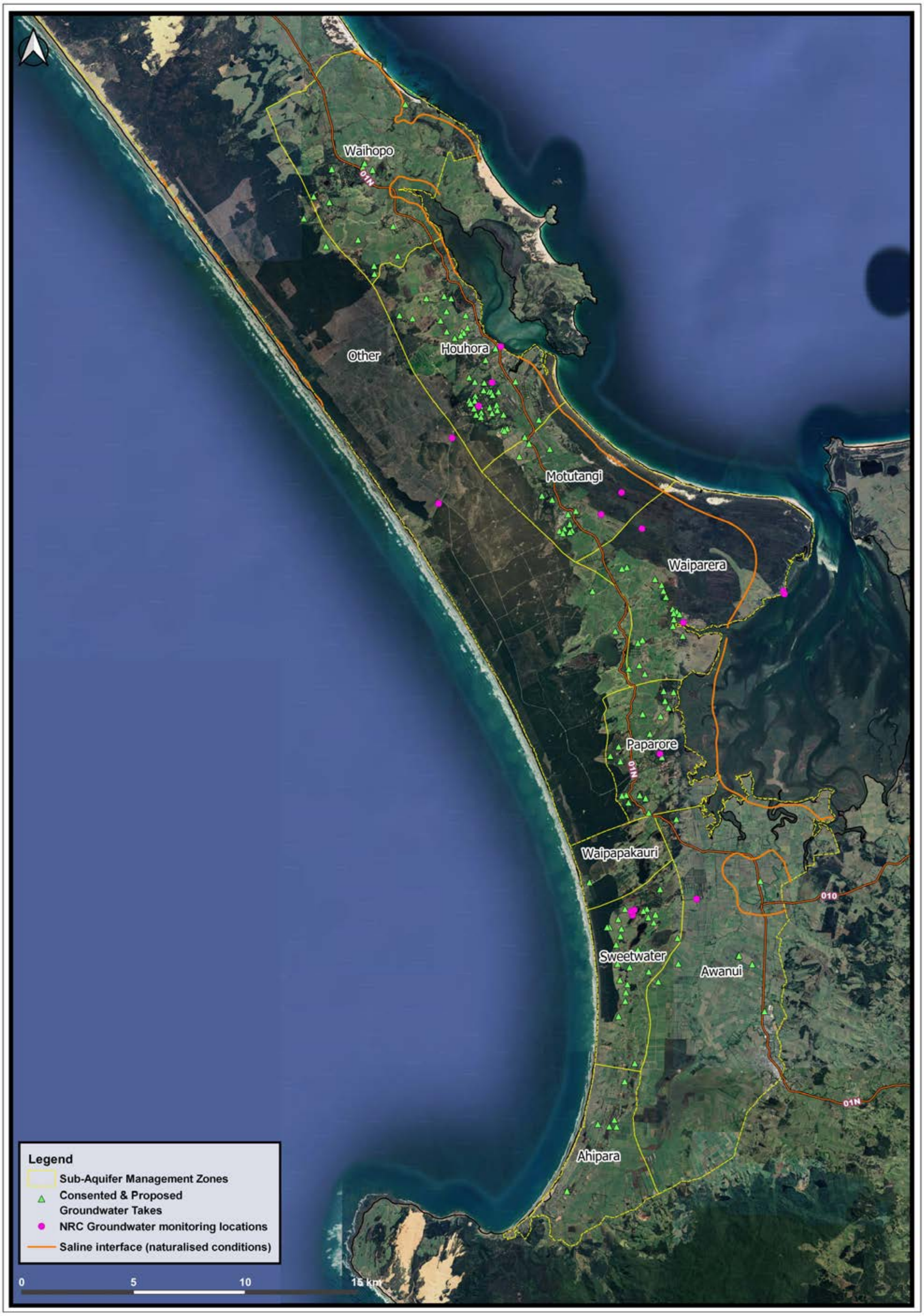

Figure 5. Map showing estimated position of the saline interface in the deep aquifer under Naturalised Conditions.

5.2. Stage 1 (Year 1) Management Regime

37. The Stage 1 (Year 1) Management Regime should not reference "full irrigation season" because if consents are not commenced until partly through an irrigation season, as happened for the MWWUG consents, on face value stakeholders may consider that another irrigation season is required before progressing to Stage 2. This would mean the consent holders may be required to wait for up to 18 months before being permitted to take Stage 2 volumes.

5.3. Trigger Levels in the Wetland-South Monitoring Piezometer

38. The proposed GMCP for the Paparore, Waiparera, Motutangi, and Houhora sub-areas of the Aupōuri Aquifer Management Unit, included in the Staff Report provides guidance for the establishment of trigger levels based on water level monitoring data from the Kaimaumau Wetland-South monitoring piezometer. In Table 3 of the GMCP it is indicated that a water level recession exceeding a weekly average of 5 mm/day will be in breach of Trigger Level 1 (TL1) and a weekly average recession exceeding 6.25 mm/day will be in breach of Trigger Level 2 (TL2).

39. Section 2.2.2 of the GMCP states that TL1 should serve as an alert that the parameter of concern [in this case water level] is approaching the outer limits of baseline data, and that TL2 should serve as a significant departure from baseline conditions, initiating a response that includes a reduced water take for consent holders.

40. The monitoring data collected over the past 12 months at the Kaimaumau Wetland-South piezometer converted to a weekly rolling average is presented in **Figure 6**[1]**.** This graph shows that the trigger levels are unrealistic because numerous exceedances of the proposed trigger levels would have occurred even during the winter months of August and September prior to the start of the irrigation season in October.

[1] On approximately 7/2/2020 the water level dropped below the sensor and therefore data after this date is unavailable.

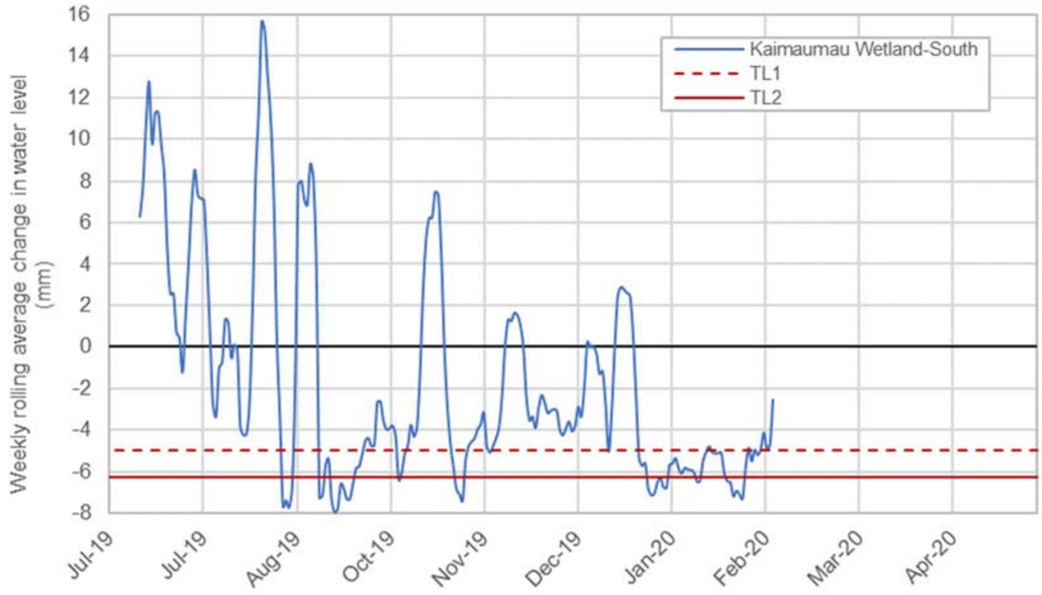

Figure 6. Weekly rolling average change in water level recorded at the NRC Kaimaumau Wetland-South piezometer.

41. Based on these findings the TL1 and TL2 trigger levels should be re-evaluated.

42. Using the Kaimaumau Wetland Water Balance Model, documented in Williamson (2020) and appended as **Attachment A**, we have provided an analysis that think provides guidance on appropriate trigger levels for the wetland. As shown in **Figure 8**, we recommend TL1 and TL2 of -7.8 and -10 mm/day[2], respectively.

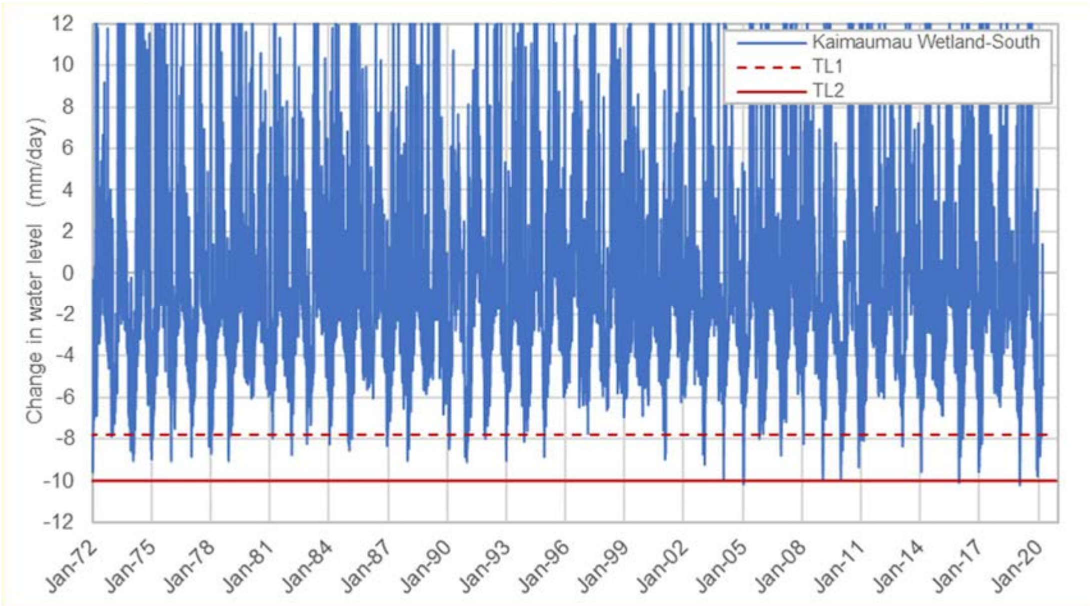

Figure 7. Kaimaumau Wetland - modelled weekly rolling average change in water level from 1960-2020.

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2 Calculated as the mean minus 2 and 3 standard deviations of recessional data (only).

5.4. Trigger Levels in the Waterfront Monitoring Piezometer

43. The proposed GMCP for the Waihopo and northern Houhora sub-zones, as included in the Staff Report, indicates that the Waterfront monitoring piezometer shown in Figure 1 of the GMCP should be included as a sentinel monitoring bore for water level and EC. The same bore is indicated as a monitoring bore in Figure 1 of the proposed GMCP for the Paparore, Waiparera, Motutangi, and Houhora sub-zones.

44. In Table 4 of the GMCP for the Northern Area, the suggested TL1 water levels for this bore are 2.3 mAMSL for the shallow piezometer and 4.4 mAMSL for the deep piezometer. The suggested TL2 water levels for this bore are 0.5 mAMSL for the shallow piezometer and 1.8 mAMSL for the deep piezometer.

45. The corresponding table (Table 6) in the proposed GMCP for the Central Area suggests different trigger levels for the same bore. Specifically, TL1 water levels are indicated to be 0.75 mAMSL for the shallow piezometer and 2.55 mAMSL for the deep piezometer, and TL2 water levels are indicated to be 0.65 mAMSL for the shallow piezometer and 2.35 mAMSL for the deep piezometer.

46. **Figure 8** shows daily average water level for the deep and shallow monitoring piezometers at the Waterfront bore. It is apparent that the trigger levels in the proposed GMCP for the Central Area are perhaps more appropriate given the data, albeit if the conditions from the 80-90s return these trigger levels will be regularly breached. However, there appears to be an error in the suggested values for the Northern Area because the water level would always be below the trigger level if this criteria was applied.

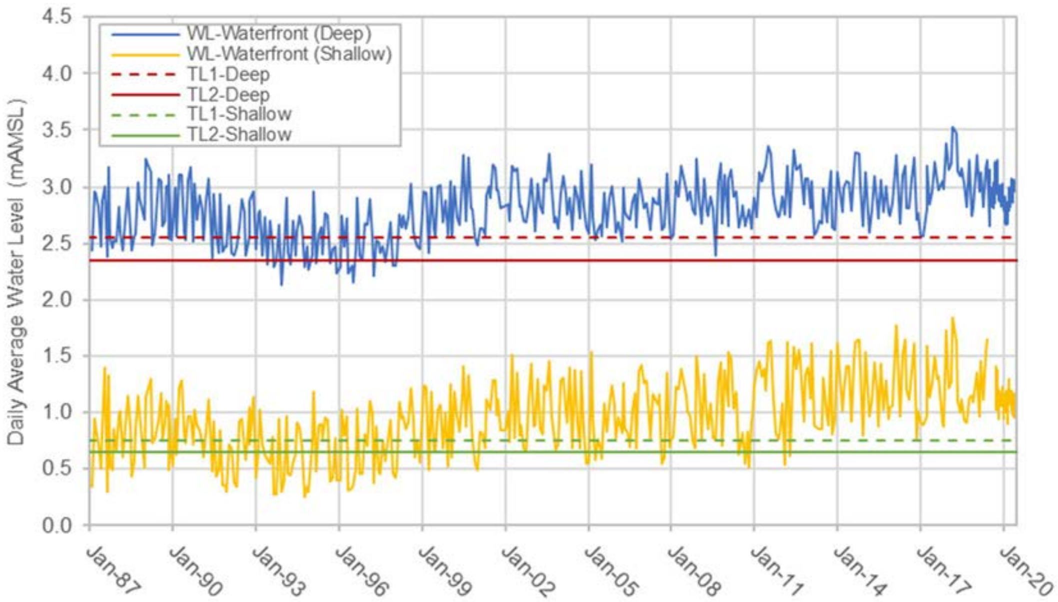

Figure 8. Daily average water level in the deep and shallow piezometers at the Waterfront monitoring bore.

J.L. Williamson

14 August 2020

6. References

47. Northland Regional Council, 2020. WAT (Water Allocation Tool) - Cross Boundary Allocation Logic, July 2020.

48. Zhao, H. and Williamson, J., 2017. Motutangi-Waiharara Groundwater Model, Factual Technical Report – Modelling. Report prepared by Williamson Water Advisory for the Motutangi-Waiharara Water User Group.

49. Wildlands, 2020. Ecological Monitoring at the Kaimaumau Wetland, Northland, July 2020. Consultancy Report prepared for Northland Regional Council.

50. Williamson, J., 2020. Kaimaumau Wetland Modelling Report. Assessment of Wetland Water Level Behaviour. Report prepared for the Motutangi-Waiharara Water User Group.

Attachment A. Kaimaumau Wetland Modelling Report. Assessment of Wetland Water Level Behaviour.

Kaimaumau Wetland Modelling Report

Assessment of Wetland Water Level Behaviour

MOTUTANGI-WAIHARARA WATER USER GROUP

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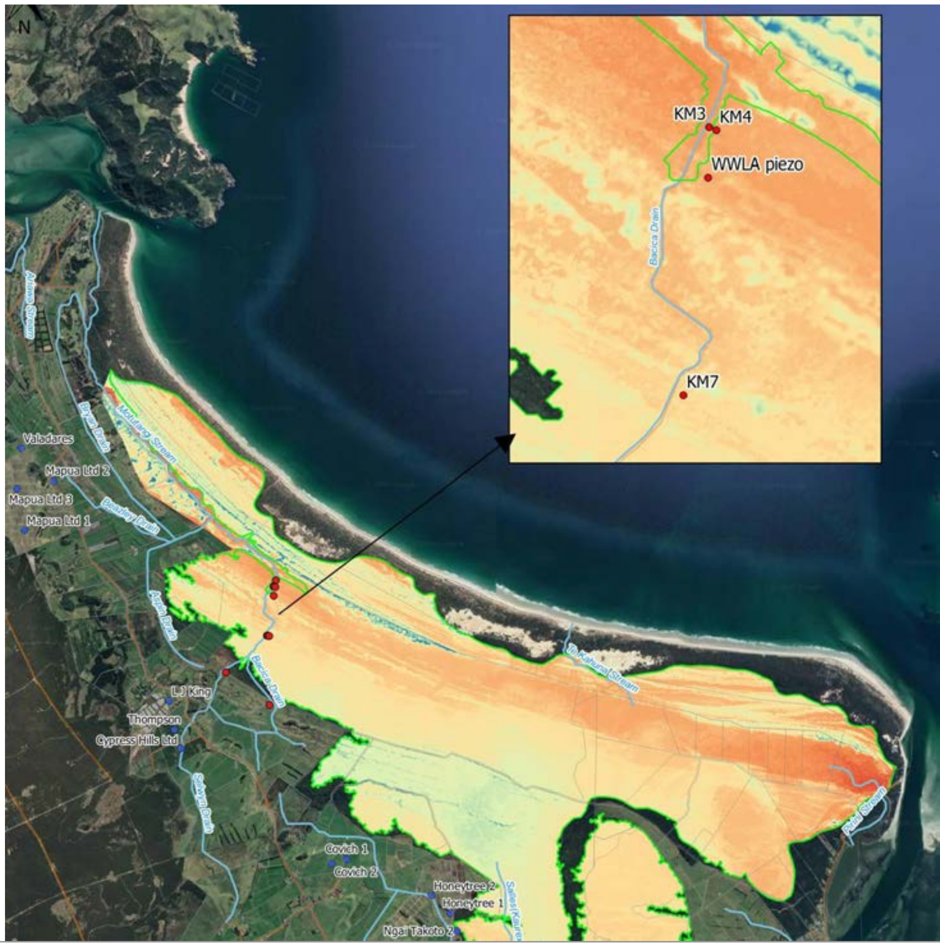


Kaimaumau Wetland Water Level Modelling

Project no: WWA0026
Document title: Kaimaumau Wetland Modelling Report
Revision: 3
Date: 24 June 2020
Client name: Motutangi-Waiharara Water User Group
Project manager: Jon Williamson
Author(s): Jon Williamson
File name: G:\Shared drives\Projects\Motutangi-Waiharara WUG\WWA0026_Houhora South_Motutangi_Waiparera Groundwater Model\Deliverables\Kaimaumau Wetland RSM\Kaimaumau Wetland Modelling Report_rev2.docx

Williamson Water & Land Advisory

P.O. Box 314
Kumeu
New Zealand
www.wwla.kiwi

Document history and status

Rev	Date	Description	By	Review	Approved
1	11 May 2020	Draft for review	Jon Williamson	Jake Scherberg	Jon Williamson
2	18 June 2020	Updated to reflect rainfall to early June 2020 and new wetland data obtained from MWWUG monitoring.	Jon Williamson		Jon Williamson
3	24 June 2020	Corrected typo in Section 4 Conclusions.	Jon Williamson		Jon Williamson

Distribution of copies

Rev	Date issued	Issued to	Comments
1	11 May 2020	Brookfield Lawyers	
2	18 June 2020	Brookfield Lawyers	For public release
3	24 June 2020	Brookfield Lawyers	For public release

Contents

1. Introduction

Williamson Water & Land Advisory (WWLA) were commissioned in accordance with WWLA's proposal dated 2 April 2020 by the Mapua Avocados Limited, Honeytree Farms Limited and Largus Avocado Limited Partnership, collectively referred to as the "Big User" sub-group of the Motutangi-Waiharara Water User Group (MWWUG).

The commission was to undertake a water level analysis on the Kaimaumau wetland to inform decision making with regard to the Staged Implementation Monitoring Programme Review (SIMPR) and ability to move to Stage 2 abstraction volumes under the granted water abstraction resource consents.

This information generated from simulation and sensitivity testing of the model will provide the Big Users an understanding of the magnitude of impact of pumping on the wetland in advance of the SIMPR being completed as required under the conditions of the NRC resource consent. The particular focus of this analysis is to determine the likely effects on the wetland that can be attributed to drought alone (i.e. assuming there was no groundwater pumping effects) and the magnitude of effects from pumping.

1.1 Methodology

The methodology employed in this study is shown in **Figure 11** and the following sections describe each step.

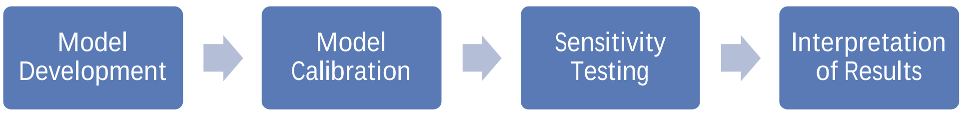


Figure 1. Kaimaumau wetland water balance modelling methodology process.

1.2 Report Structure

The report comprises descriptions of:

- ***Model development*** - including overview of the model, model calibration and sensitivity testing (**Section 2**);
- ***Model simulation analysis*** - including impacts from groundwater pumping and impacts of drought (**Section 3**); and
- ***Conclusions*** - drawn for the study (**Section 4**).

2. Model Development

2.1 Reservoir Storage Model

The analysis uses the "wetland mode" of WWLA's Reservoir Storage Model (RSM), shown in **Figure 11**.

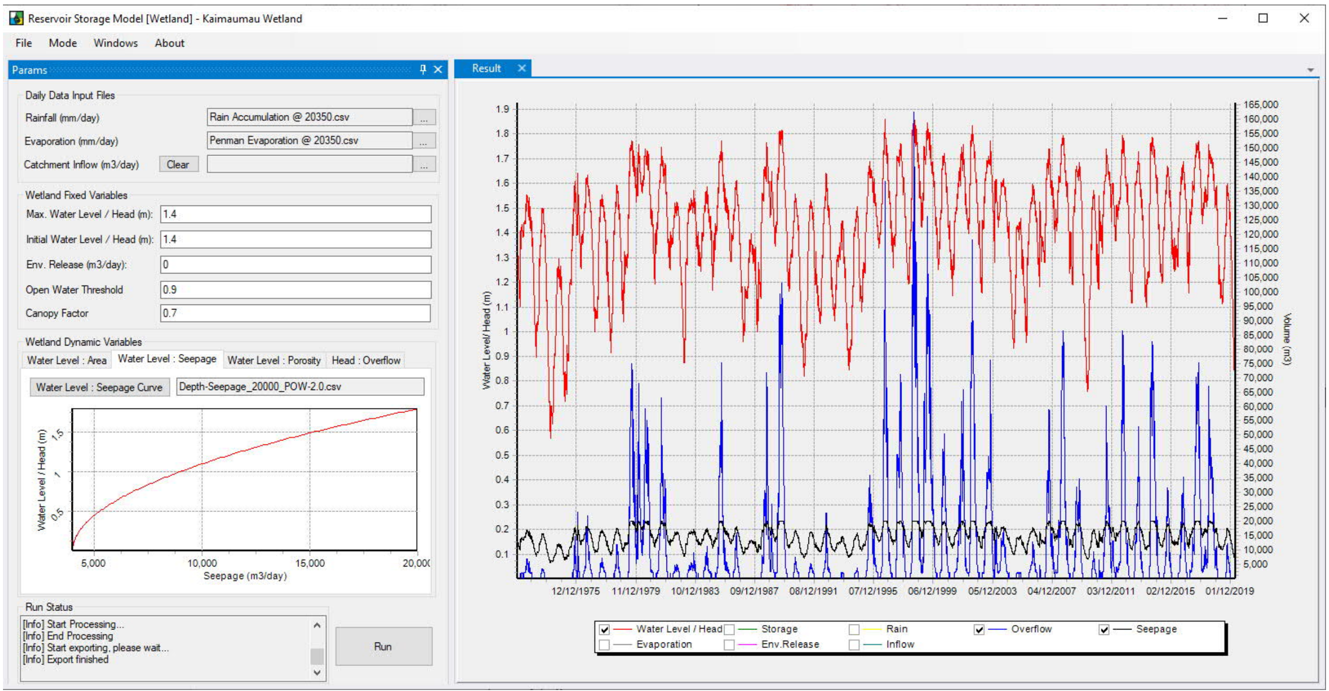


Figure 2. Screenshot of the Reservoir Storage Model GUI in Wetland Mode.

The RSM was designed originally to calculate the water balance of reservoirs with varying geometries, inputs and outputs. The model calculates daily storage volumes and overflows after accounting for the following configuration and input parameters:

- Rainfall into the reservoir surface;
- Evaporation from the reservoir surface;
- Catchment runoff inflows (if any);
- Water demands (if any);
- Environmental releases (if any);
- Surface area and its variability with storage volume; and
- Seepage from the reservoir and its variability with storage volume (effectively pressure of water).

The model was subsequently extended to include simulation of wetlands, which differ from open water reservoirs in that the storage void comprises soil materials. Hence, a porosity term was introduced to accommodate this functionality, which also varies with depth below the surface. For example, when a wetland is full, its hydraulic behaviour (oscillatory response) is similar to an open water body, which has 100% porosity, but when water level declines porosity reduces due to the presence of sediment and their degree of compaction.

Other changes included:

- the surface area and seepage relationships where changed to be a function of depth below the surface rather than reservoir volume; and

- an evaporation function was added to reflect the difference between open water evaporation when the wetland is full and wetland plant or canopy-controlled evaporation when the water level recedes below the surface.

2.1.1 Fixed Parameters

Table 1 provides a summary description of the parameters.

Table 1. Summary of fixed input parameters.

Parameter	Description
Rainfall (mm)	Daily rainfall for NIWA's Virtual Climate Station Network (VCSN) #20350 from Jan 1960 to 13 June 2020. The station is located within the northern portion of the wetland.
Evaporation (mm)	Daily Penman evaporation for the same VCSN station and time period as rainfall.
Area (m^2)	34,610,000 – constant.
Catchment Inflow (m^3/day)	None applied.
Max Water Level (m)	1.4 m. This is used to approximate the wetland thickness and the maximum water level prior to ponding.
Initial Water Level (m)	1.4 m.
Open Water Threshold (-)	0.9 – ratio of maximum water level, which sets the bottom line or threshold for open water evaporation.
Canopy Factor (-)	0.7 – ratio of actual evaporation to measured (Penman) evaporation.

Once the maximum water level is reached, ponding and overland flow occur. The combined water level comprising saturated peat plus ponded water was estimated as 1.8 m from the range in simulated groundwater levels at the middle of the wetland from the Aupouri Aquifer Groundwater Model (AAGWM) between 1972 and 2018.

2.1.2 Depth Variable Parameters

Parameters that are variable with wetland water level include area, porosity and drain seepage. The selected relationships for peat porosity and drain seepage selected for this study are shown in **Figure 3**[1] and **Figure 8**.

As indicated in **Figure 3**, peat porosity varies from a minimum of 50% at depth within the profile, and increases to 100% when the wetland is fully saturated or in open water condition. The profile reflects the high organic content of the peat soils and their compaction with depth.

[1] Please note that the graph deliberately shows depth on the y-axis even though the x-axis is the dependent variable. This was portrayed this way for practical purposes in order to depict how the dependent variable (in this case porosity) changes with depth. All similar graphs are represented in the same manner.

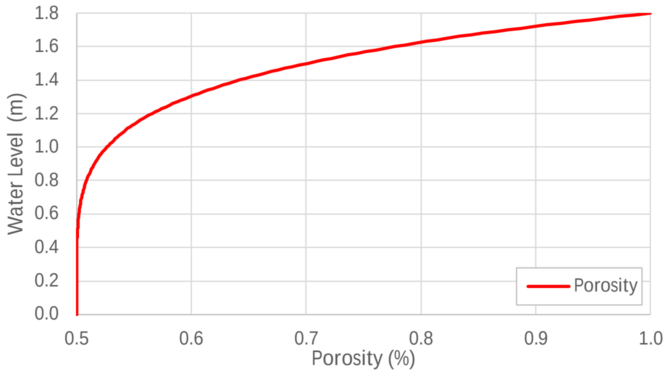


Figure 3. Relationship between wetland water levels and peat porosity.

Figure 4 shows that drain baseflow seepage from the wetland varies from approximately 4,050 m^3/day (~50 L/s) when the wetland is in a dry state to 20,000 m^3/day (~230 L/s) when the wetland is fully saturated. Data from AAGWM simulations was used to derive the relationship between wetland water levels and groundwater baseflow to drains, as shown in in **Figure 5**. Several regression equations were tested to determine the parameter best fit to apply in the calibration model simulation, with POW=1.2 being selected, although sensitivity testing using a range in values was undertaken as discussed in **Section 2.3.**

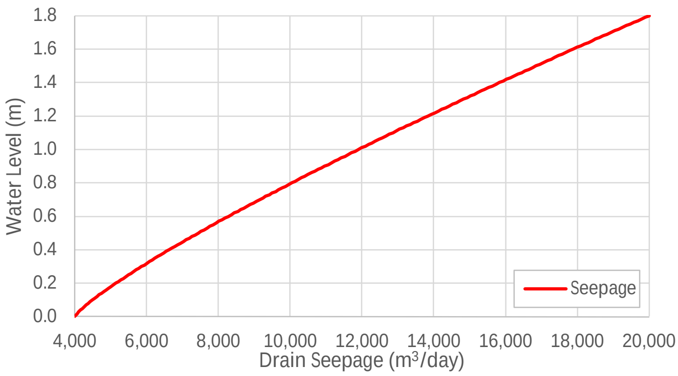


Figure 4. Relationship between wetland water levels and drain seepage.

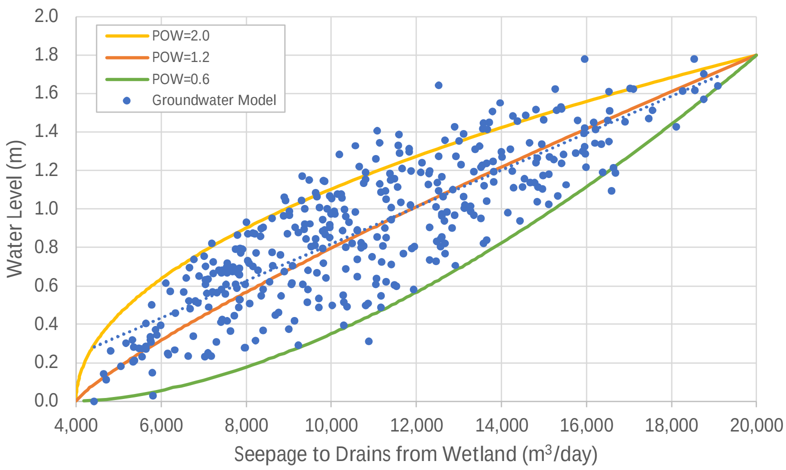


Figure 5. Relationship between wetland water levels and drain seepage from AAGWM.

Figure 6 shows the selected relationship between wetland water levels above the surface and overland flow, determined through model testing. The water levels represent ponded water that typically builds up in winter and is discharged from the wetland through the multiple natural swales and streams that have developed across the wetland.

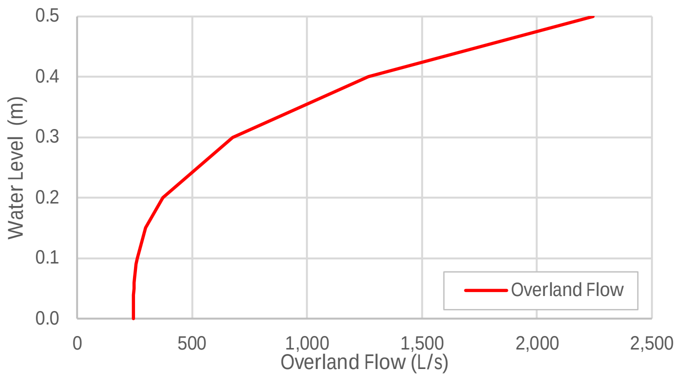


Figure 6. Relationship between wetland water levels and overland flow.

2.2 Calibration

The model was calibrated by matching simulated water levels with observed water levels at the WWLA wetland monitoring standpipe, which is located approximately 70 m from the Bacica Drain at the northern end of the wetland. In addition, three Department of Conservation monitoring standpipes (KM3, KM4, KM7) that were least affected by drain boundary conditions were also utilised. The location of the monitoring sites along with LIDAR ground surface elevation data within the wetland are shown in **Figure 7**.

As alluded to above, the proximity of the monitoring locations to external drains and internal wetland swales or streams have implications for the observed oscillatory response. For example, KM3 is located approximately 5 m from the Bacica Drain, while KM4 and KM7 are located approximately 30 m from the drain. Consequently, the range in oscillatory response is dampened in KM3, particularly as receding water levels occurred during the drought, which is presumably due to flow from upstream and outside of the wetland maintaining water levels.

Conversely, during high or flood flow events, the oscillatory response is stronger nearer the drain due to the influence of flood waters.

The different characteristics of each monitoring location hydrograph infers that calibration must take an approach that applies progressively more weight towards the locations further into the wetland, which are away from the influence of boundary conditions, yet at the same time take notice of (apply some weight) to the general responses at the other standpipes closest to drains.

The model calibration graphs comparing relative observed and simulated water levels are shown in **Figure 8** and **Figure 9**. **Figure 8** compares the modelled response to the two standpipes that are furthest from any drains (WWLA and KM7). Key observations from this graph are:

- The modelled rate of recession matches the observed rates well, which suggest that when the wetland is uninfluenced by direct rainfall, losses water from the wetland (evaporation and seepages to the drains) are well represented by the model;
- Some events observed in the field are not simulated by the model, which is a function of the rainfall area interpolation approach used to generate the VCSN dataset. This approach may dampen or miss localised events, while picking up the larger regional weather system adequately.

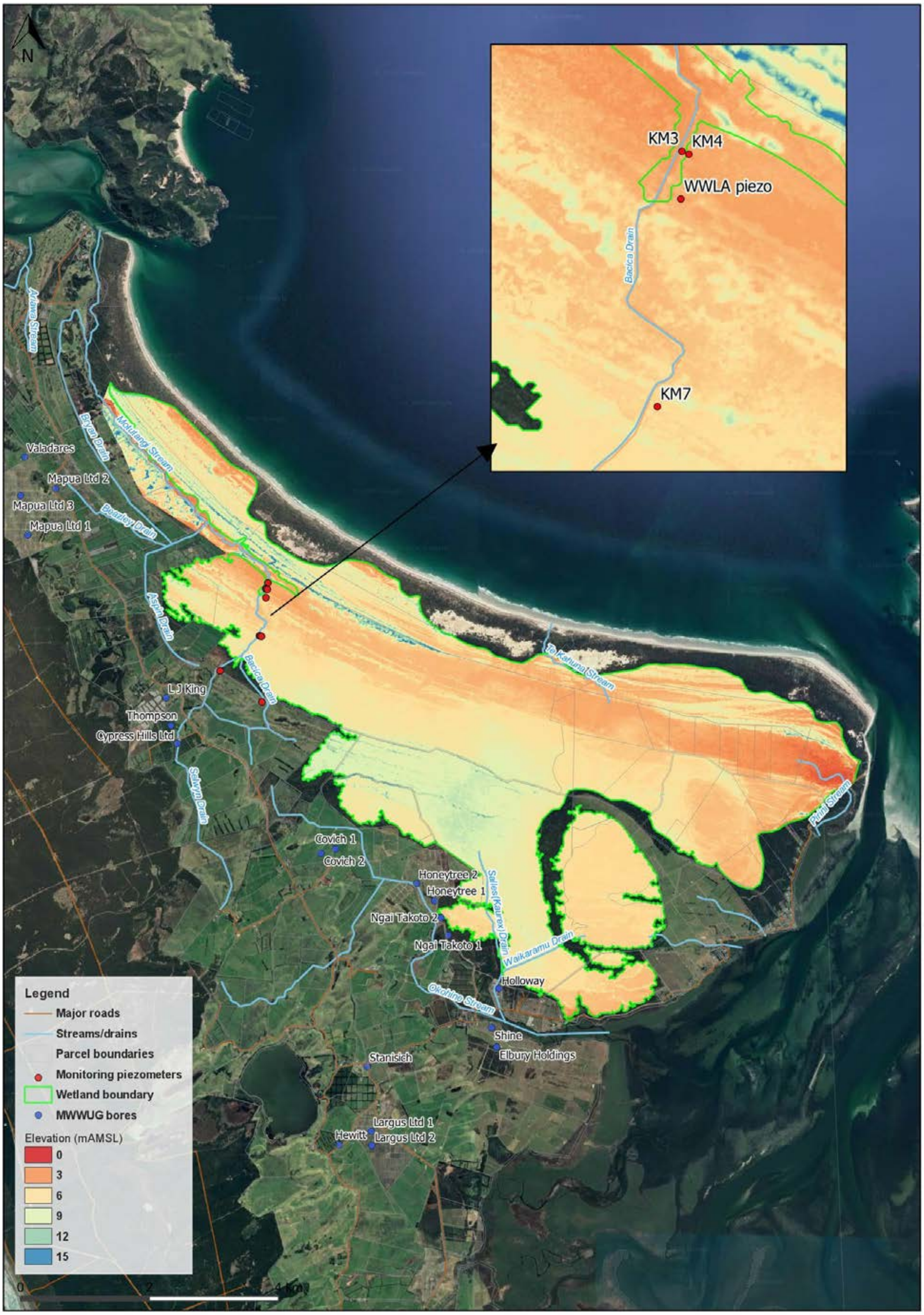


Figure 7. Kaimaumau wetland water level monitoring stations used in calibration.

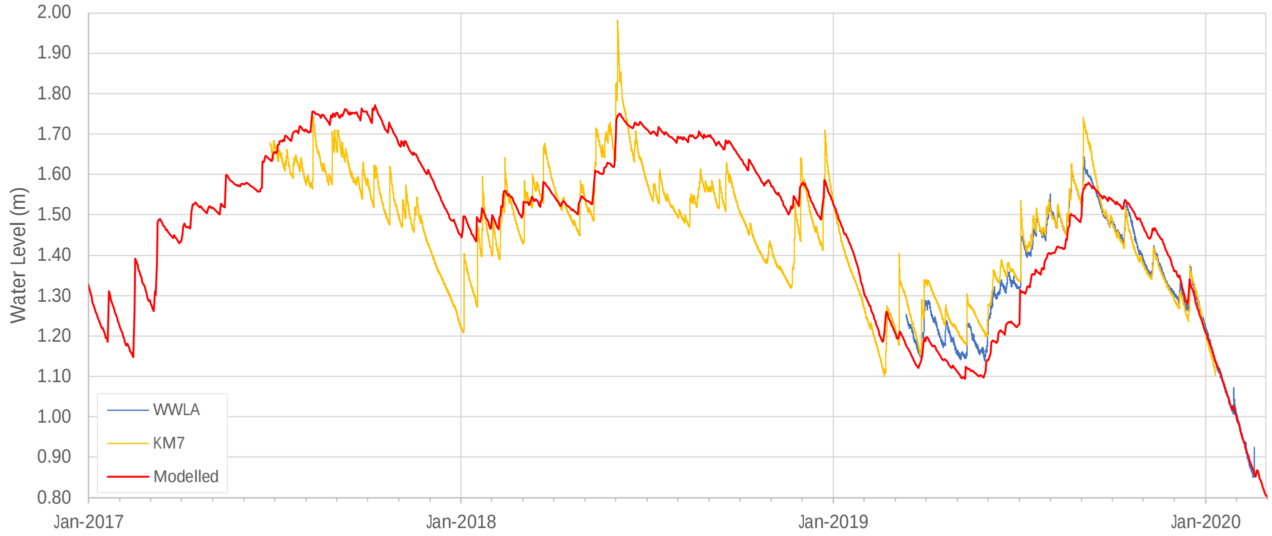


Figure 8. Wetland water level calibration hydrographs for WWLA and KM7 standpipes.

Figure 9 compares the modelled response to the two standpipes that are closest to the drains (KM3 and KM4). Key observations from this graph are:

- Water levels recorded in the standpipes adjacent to the drains do not recede as much as are modelled. As alluded to above, this is probably due to flow in the streams maintaining water levels in the margin adjacent to the stream during dry periods.

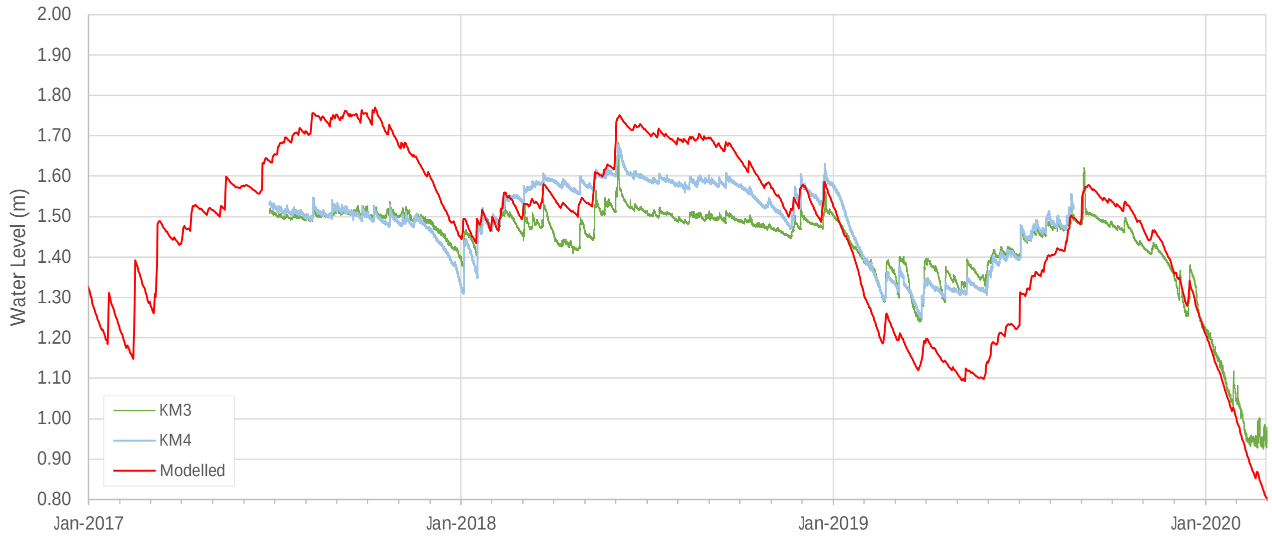


Figure 9. Wetland water level calibration hydrographs for KM3 and KM4 standpipes.

2.2.1 Calibrated Water Balance

Table 2 summarises the long-term water balance of the wetland, while **Figure 10** demonstrates the relative size of the key water balance components over the 50-year historical simulation period. The dashed red line in **Figure 10b** represents the maximum extent of the y-axis in **Figure 10c.**

The key water balance findings are as follows:

- ***Rainfall*** - has historically input up to approximately 6 Mm^3 or 174 mm/day over the 3,461-ha wetland area, with an average of 116,000 m^3/day;
- ***Evaporation*** – accounts for 78% of rainfall as losses from the wetland, with a maximum of approximately 280,000 m^3/day;
- ***Seepage*** – accounts for approximately 14% of rainfall as baseflow into drains, with a minimum of approximately 7,600 m^3/day (88 L/s) and a maximum of 20,000 m^3/day (230 L/s);
- ***Overland flow*** – accounts for 9% of rainfall on average, but significantly increases during storms with daily volumes up to 160,000 m^3/day (1,850 L/s).

Table 2. Calibrated model long term water balance.

	Component	**Volume (m^3/day)**			**TOTAL**
		Min.	**Max.**	**Ave.**	**(%)**
Inputs	Rain	0	6,029,062	115,996	100%
	Inflow	0	0	0	0%
	Sub-Total			115,996	
Outputs	Evap.	0	280,341	90,215	78%
	Seepage	7,625	20,000	16,263	14%
	Env. Release	0	0	0	0%
	Overland flow	0	159,411	10,273	9%
	∆Storage	-301,040	5,954,527	-760	-0.66%
	Sub-Total			115,991	
Water Balance Check					100%

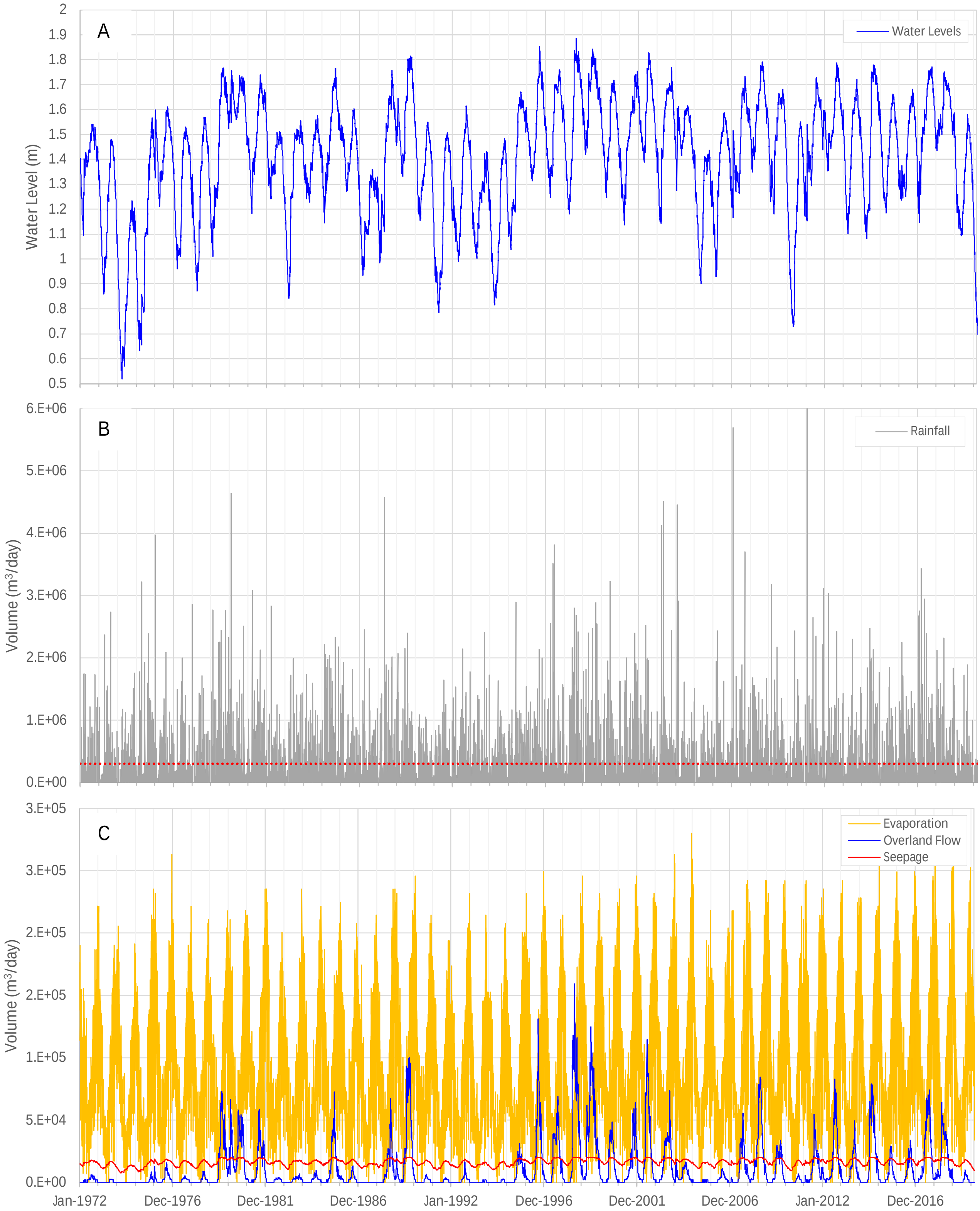


Figure 10. Simulated wetland water level from January 1972 to April 2020.

2.3 Verification

New wetland data was provided to WWLA on 13 June 2020 from the NRC monitoring programme in accordance with the conditions of the MWWUG consents and the Groundwater Monitoring and Contingency Plan (GMCP) agreed between NRC, DoC and MWWUG. The data provided includes water levels measured in the wetland at two sites named "Wetland North" and "Wetland South" between July 2019 and May 2020.

Furthermore, WWLA made a trip to the wetland on 16 June and downloaded the WWLA sensor, which provided additional data from February to June 2002.

Please note that all three sensors experienced a loss of data as water level receded below the level of the sensor during the summer, however as water levels recovery was initiated on 12 April 2020 due to rainfall, the sensors became operational again within a few weeks afterwards.

The VCSN rainfall and evaporation data was also updated from March 2020 to 13 June 2020.

The simulated water level from the calibration check or verification simulation is shown in **Figure 11**. The key conclusions drawn from this simulation are that the model:

- continues to provide a good representation of the measured data; and
- can be used to estimate water level during periods of data gaps.

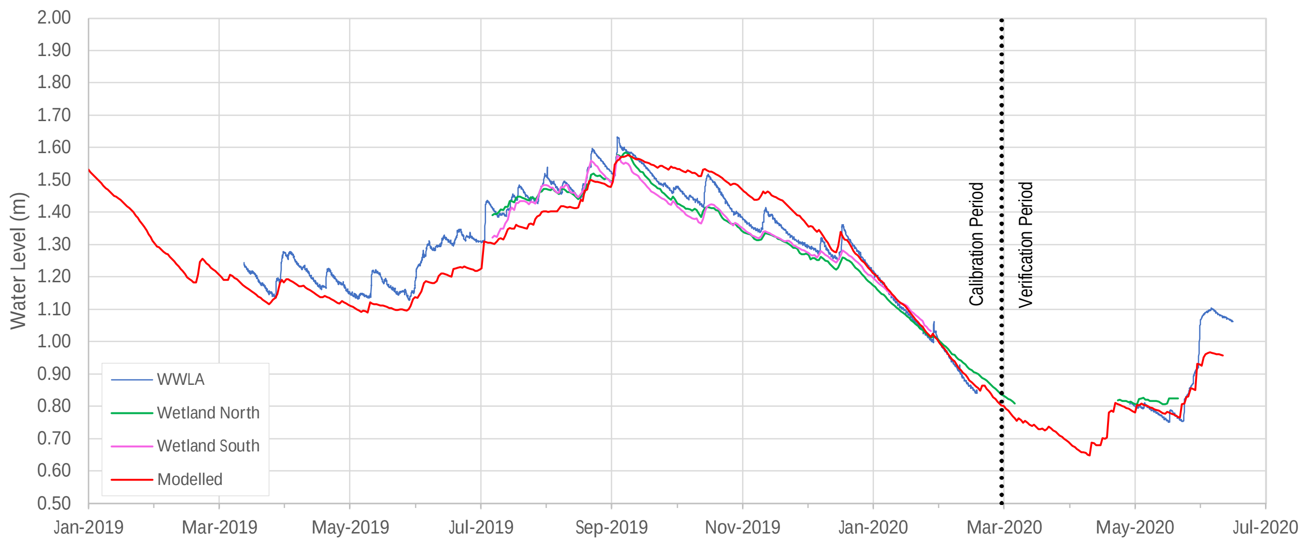


Figure 11. Wetland water level verification hydrographs for WWLA, Wetland North and Wetland South standpipes.

2.4 Sensitivity Testing

A range of tests were undertaken to demonstrate the sensitivity of modelled water levels to changes in key model parameters, including peat porosity, seepage rate to drains, and the evaporation rate.

2.4.1 Peat Porosity

Three runs were conducted using the calibrated model as a base, but with peat porosity set constant at 25%, 50% and 100%. The comparative responses are provided in **Figure 11**, which indicates that varying porosity makes very little difference during wet periods or winter when the wetland is at water level capacity. However, reducing the porosity has the effect of:

a) increasing oscillatory responses when water levels are less than capacity; and

b) significantly enhancing the rate of water level decline.

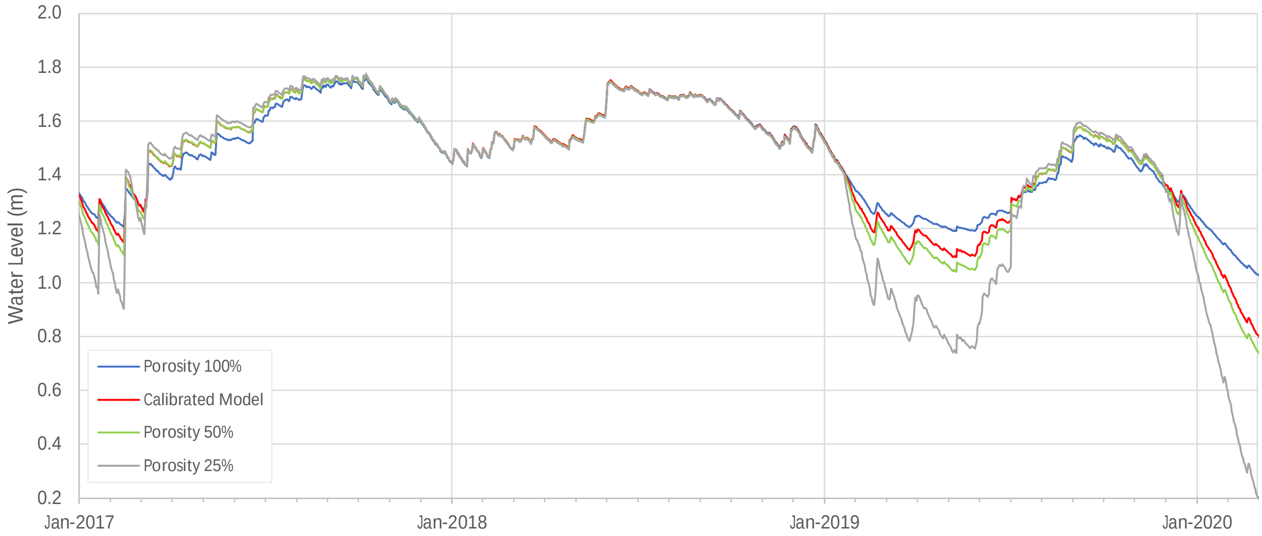


Figure 12. Sensitivity hydrographs with varying peat porosity.

2.4.2 Seepage Rate

Three runs were conducted using the calibrated model as a base, but with the seepage rate to the drains set constant at 0 m^3/day, 20,000 m^3/day or 50,000 m^3/day. The comparative responses are provided in **Figure 13**, which indicates that the overall water level is quite sensitive to seepage rates, with a relatively constant offset of approximately 0.1 m observed between 0 and 20,000 m^3/day. Increasing seepage to 50,000 m^3/day caused a decline in water level, with a seasonably variable difference of approximately 0.2 m in winter and 0.6 m in summer.

2.4.3 Evaporation Rate

Three runs were conducted using the calibrated model parameters, with the canopy factor adjusted to 1.0 (full), 0.5 (half) and 0.25 (quarter) to test the effect of transpiration rates on water levels. The comparative responses are provided in **Figure 14**, which indicates the following:

a) During winter when evaporation is very weak, adjusting the canopy factor makes no tangible difference;

b) During summer, when the canopy factor is effectively turned off (set to 1.0) and the full evaporative response occurs, water level decline accelerates particularly when water levels are receding below the surface and would have been subjected to lower evaporation when a canopy factor was in operation;

c) Conversely, a lower canopy factor reduced evaporation and therefore water levels increased relative to the other simulations.

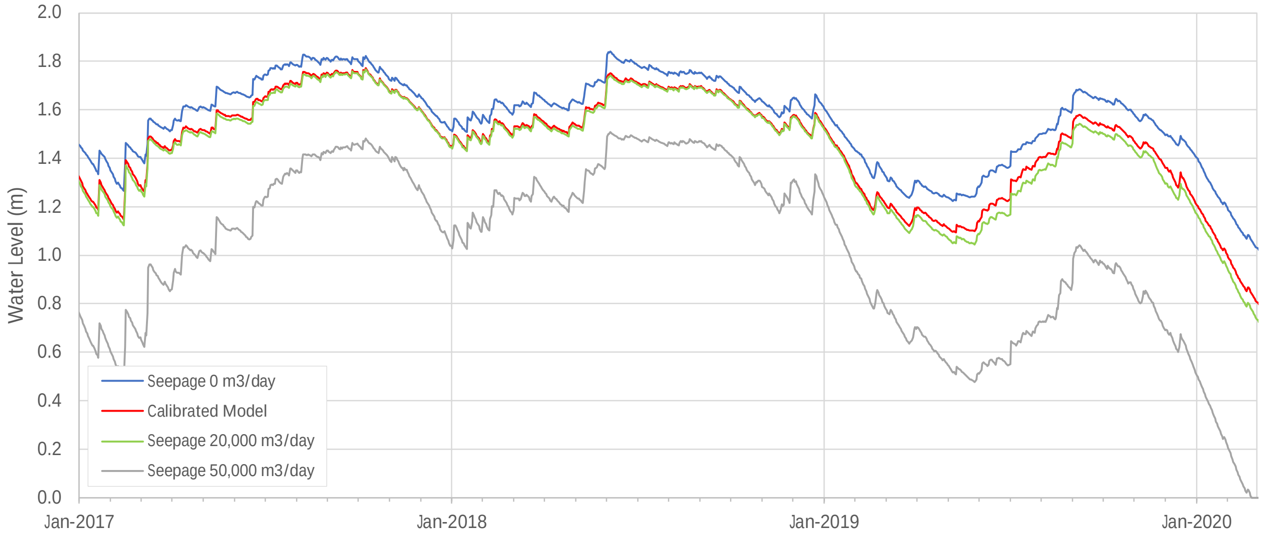


Figure 13. Sensitivity hydrographs with varying seepage rate to drains.

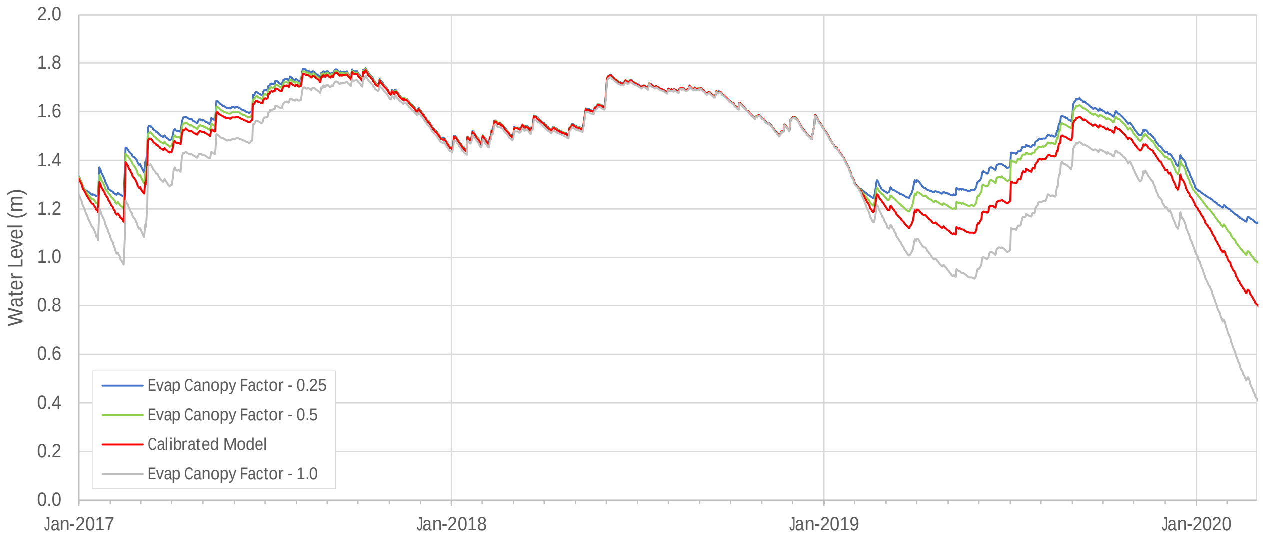


Figure 14. Sensitivity hydrographs with varying evaporation rate.

3. Model Simulation Analysis

3.1 Impact from Groundwater Abstractors

An analysis was performed using irrigator's groundwater pumping induced depressurisation simulated by the Aupouri Aquifer Groundwater Model (WWLA, 2020)[2]. The depressurisation data was obtained as the difference of the modelled net flux between Layer 1 and Layer 2 in the wetland area for the Naturalised (without pumping) Scenario and Scenario 2, which represents all current and pending groundwater take consents in operation. The difference in flux between these modelled scenarios is due to pumping induced vertical downward seepage.

The Aupouri Aquifer Groundwater Model was simulated for 58-years from April 1960 to July 2018. The net vertical downward flux from the wetland for each scenario and the difference due to pumping is shown in **Figure 15**, while **Table 3** summarises this data and places the flows into context of depth in millimetres, which is intended for comparison to rainfall and evaporation. As is shown, the impact due to pumping is a maximum of 2,224 m^3/day or 26 L/s or 0.064 mm/day over the 3,461-ha area, which compared to the metrics presented earlier in this report is minor in comparison. For example, the wetland water balance presented in **Table 2**, shows that average rainfall and evaporation volumes are 116,000 and 90,000 m^3/day, respectively compared to the average pumping induced effect of 867 m^3/day. Even the maximum pumping effect of 2,224 m^3/day is minor in relation to rainfall and evaporation.

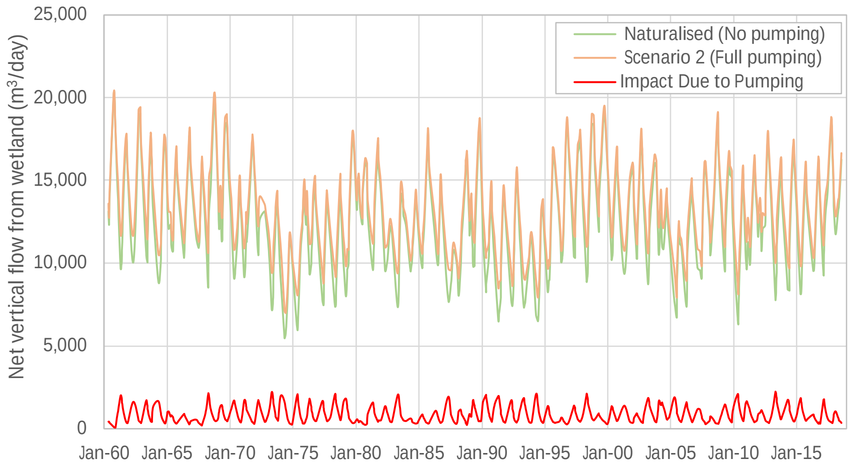


Figure 15. Simulated net flux from wetland to shallow groundwater.

Table 3. Summary statistics of pumping induced impacts on wetland.

	m^3/d	L/s	mm
Maximum	2,224	26	0.064
Average	867	10	0.025
Minimum	77	1	0.002

[2] WWLA, 2020. Aupouri Aquifer Groundwater Model. Factual Technical Report – Modelling. Prepared for the groundwater take applicants that form the Aupouri Aquifer Water Users Group. February 2020.

To demonstrate the impact from groundwater pumping on wetland water levels, the data in in **Figure 15** was simulated as a catchment outflow (negative catchment inflow in the RSM). The result of this simulation is compared to the calibrated model simulation in **Figure 11** using the drought of the 2009/2010 summer as an example. This drought period was selected because it represents the greatest simulated irrigation demand as simulated in the AAGWM.

The water balance from this simulation is summarised in **Table 4**, which shows that pumping induced downward seepage (highlighted) represents only 0.7% of the wetlands water balance.

Results indicate that the difference in water level is barely noticeable, with a maximum impact of 0.018 m. When you consider the volumetric comparison discussed above between the pumping induced impacts and rainfall and evaporation, the result in **Figure 11** should not be surprising.

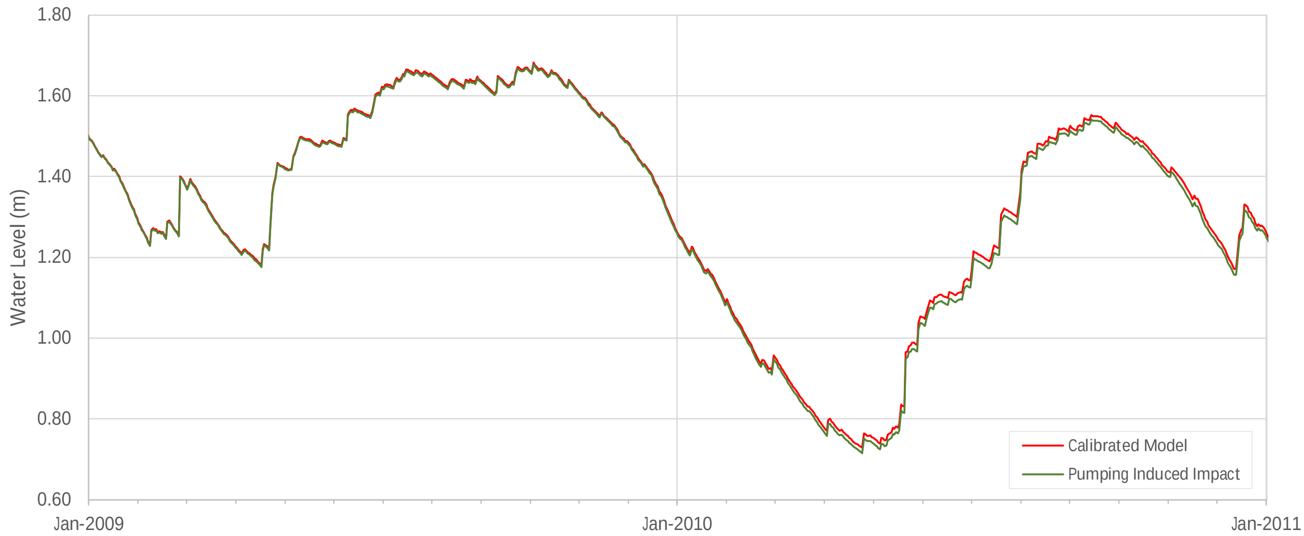


Figure 16. Comparison of wetland water levels from calibrated model to groundwater pumping scenario.

Table 4. Long term water balance with full groundwater pumping.

	Component	Volume (m³/day)			TOTAL
		Min.	Max.	Ave.	(%)
Inputs	Rain	0	6,029,062	115,996	100%
	Inflow	0	0	0	0%
	Sub-Total			115,996	
Outputs	Evap.	0	280,341	89,898	78%
	Seepage	7,423	20,000	16,176	14%
	Env. Release	0	0	0	0%
	Overland flow	0	156,224	9,875	9%
	Downward Seepage	225	2,224	807	0.70%
	∆Storage	-299,555	5,953,241	-765	-0.66%
	Sub-Total			115,991	
Water Balance Check					101%

3.2 Historical Drought Analysis

Figure 17 shows the simulated wetland water levels over the 48-year period from 1972 until the 13 June 2020. Highlighted in red bubbles are six significant droughts that have occurred in the past 48 years.

It is interesting to note that the drought of 2019/2020 ranks as the third most severe in terms of impact on wetland water levels during this period. In terms of the actual water level decline over the summer period from the previous winter, the 2019/2020 drought ranks second after 1973/1974 (0.94 m decline), 2019/2020 (0.93 m) and with the 2009/2010 (0.92 m) third.

While the back-to-back droughts during the early 1990's were not the most severe summer events, they were coupled with significantly drier than normal winters. The dry period of the early 1990's was widespread throughout Auckland and Northland and resulted in the initiation of the Waikato River potable water supply pipeline project for Auckland City.

The concluding remark from this analysis is that the simulated water levels shown in **Figure 17** place the 2019/2020 drought in context of historical events, and as can be seen, while the event is extreme, events with similar severity have occurred four times in the past 48 years.

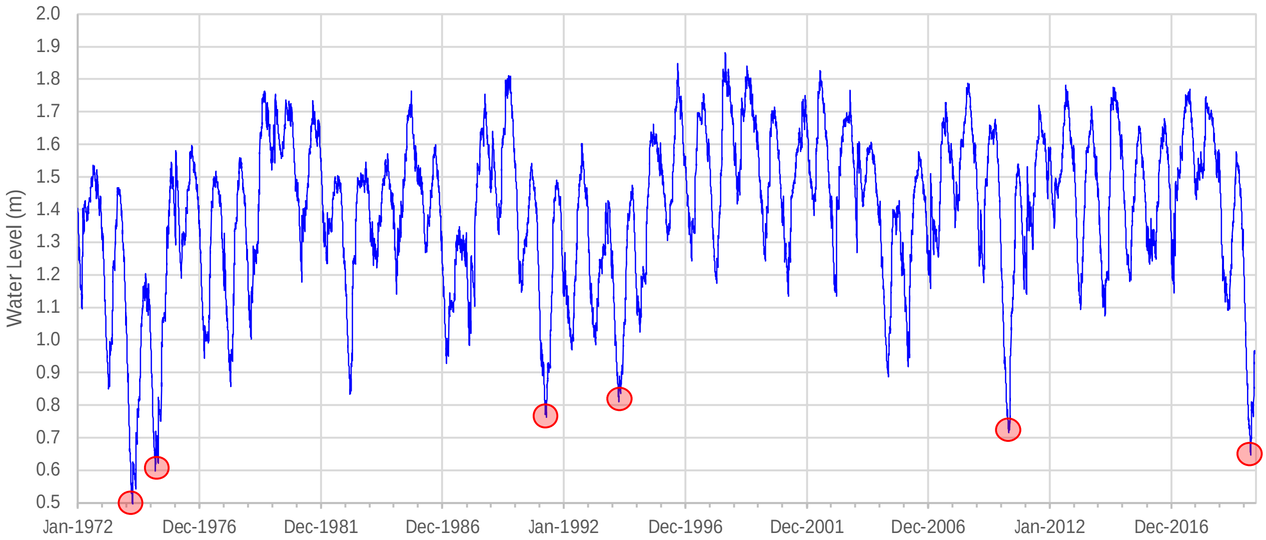


Figure 17. Simulated wetland water level from January 1972 to April 2020.

4. Conclusions

A water balance model for the Kaimaumau wetland has been developed. The model is not spatially explicit to any one point in the wetland, rather a simulator of relative water levels within the wetland. The model was calibrated to measured water levels at four locations in the northern part of the wetland recorded over the previous 2.5 years, and has been verified to new data obtained for two additional NRC sites in June 2020.

The model has been successful at replicating measured water level fluctuation, acknowledging site specific differences that will always be impossible to replicate exactly with a model that is not spatially explicit and uses interpolated rainfall. The calibration was strongest at gauges that were not influenced by drain flows.

The wetland water balance is dominated by rainfall and evaporation. Rainfall represents 100% of the inputs to the wetland, while evaporation represents 78% of the losses from the wetland. Shallow seepage to the drains represents 14% of water losses and overland flow mainly during winter represents 9%.

A number of sensitivity check simulations were performed, which showed that even an under realistic envelop of parameter assignments (i.e. very large and small parameters), the volume of seepages could not come close to the volume of water being lost from the wetland due to evaporation.

The model was used to simulate the impact on wetland water levels assuming all current and proposed groundwater abstractions were occurring. The scenario implemented data from the conservative (high leakage) model scenario from the Aupouri Aquifer Groundwater Model. The outcome of this scenario was a maximum additional impact over natural seasonal oscillation of approximately0.064 mm, which would be barely noticeable over natural seasonal oscillation. This is not surprising when the maximum shallow aquifer impact of additional vertical seepage induced by pumping of 2,224 m^3/day (26 L/s or 0.064 mm/day) is placed into context of evaporation over the 3,461 ha area, which averages 90,000 m^3/day (1,042 L/s or 2.6 mm) and is up to 280,000 m^3/day (3,240 L/s or 8.1 mm/day) in the peak of summer.

Analysis of historical droughts was undertaken, and the drought occurring in the 2019/2020 summer represents the third lowest water levels with the droughts of 1973/1974 and 1974/1975 having a more severe impact.

Attachment B. Ecological Monitoring at the Kaimaumau Wetland, Northland, July 2020.

ECOLOGICAL MONITORING AT THE KAIMAUMAU-MOTUTANGI WETLAND, NORTHLAND, 2020

providing outstanding ecological services to sustain and improve our environments

Wildlands

R5289

ECOLOGICAL MONITORING AT THE KAIMAUMAU-MOTUTANGI WETLAND, NORTHLAND, 2020


View facing south along Transect A, Kaimaumau Wetland.

Contract Report No. 5289

July 2020

Project Team:
Sarah Budd - Field survey, reporting
Tim Martin - Field survey, mapping, peer review
Marley Ford - Field survey

Prepared for:
Northland Regional Council
Private Bag 9021
Whangārei Mail Centre
Whangārei 0148

AUCKLAND OFFICE: 12 NIXON STREET, GREY LYNN, AUCKLAND 1021
P.O. BOX 46-299, HERNE BAY, AUCKLAND 1001, Ph 09-360-6083

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017; Fax 07-343-9018, email ecology@wildlands.co.nz, www.wildlands.co.nz

CONTENTS

Reviewed and approved for release by:

Tim Martin
Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Wildland Consultants was commissioned by Northland Regional Council to undertake an initial wetland condition survey and establish baseline monitoring at the Kaimaumau-Motutangi Wetland, Far North District. The Motutangi-Waiharara Water Users Group has been granted resource consent to take and use ground water from the Aupōuri-Waiharara sub-aquifer management units for the purposes of horticultural irrigation. As a condition of this consent, the effect of the water take must be monitored in accordance with the approved Groundwater Monitoring and Contingency Plan (GMCP). Objective 1 of this plan dictates that the water abstractions must avoid:

- Adverse effects on the hydrological functioning of the Kaimaumau-Motutangi wetland.
- Adverse effects on the significant indigenous vegetation and significant habitats of the indigenous fauna in terrestrial and freshwater environments of the Kaimaumau-Motutangi wetland.

Under the GMCP, environmental monitoring is required to establish if adverse effects are occurring and if so, to initiate the implementation of appropriate mitigation and remediation measures.

This report outlines the results of the initial wetland condition and baseline survey, as described in Section 3.4.3 of the GMCP.

2. OBJECTIVES

The environmental objective of this project was to fulfil the initial wetland condition survey requirements of the water abstraction resource consent, using the methods outlined in the GMCP.

3. METHODS

3.1 Timing

Initial fieldwork was carried out on 22-24 January 2020. During this period three transects and 15 vegetation plots were established and measured. Over the course of these three days, some refinements and additions were made to the methodology to improve the utility of the results as a measure of baseline condition, and ensure that future data could be more easily compared with the baseline results. As such, a further day of field work was carried out on 22 May 2020 to ensure that these additions were applied consistently to all transects and plots.

The additional day of field work was delayed as a result of the Covid-19 lockdown. Under normal circumstances, May would be considered too late for such work to be carried out at Kaimaumau Wetland due to safety concerns associated with high water levels. However, the autumn of 2020 was one of the driest on record and water levels within the wetland were still very low (lower than during the initial fieldwork period in January).

3.2 Scott height frequency transects

Three 100 metre transects (A, B, and C) were established running approximately north to northeast across a hydrological gradient, from drier habitats on low-lying sand ridges at one end (Point 0) to areas of open water and exposed peat at the other (Point 100) (Figure 1). The indicative locations of these transects were approved prior to the survey by the Department of Conservation. The centre of the transect (Point 50) was established at the boundary between these two hydrological zones. All transects were permanently marked using blue plastic stakes every 25 metres.

Scott Height Frequency (SHF) data was recorded at one metre intervals along each transect (Scott 1965, Wiser and Rose 1997, Rose 2005). At each point, the presence of all plant species was recorded within a five-centimetre diameter cylinder, at five centimetre height intervals to a maximum height of two metres (Plate 1).

Plate 1: SHF pole *in situ* along Transect C. Vegetation comprises *Gleichenia dicarpa*, wire rush, and *Schoenus brevifolius.*

The ground cover at the base of the five centimetre diameter cylinder at each point was categorised using the standard categories provided in Rose 2005. Where possible additional detail was also recorded, such as identifying 'bare ground' as comprising peat, or 'leaf litter' as comprising dead *Sphagnum* sp.

Live and dead vegetation was recorded separately to aid future analyses relating to the possible die off of particular species that may be susceptible to changing water levels.

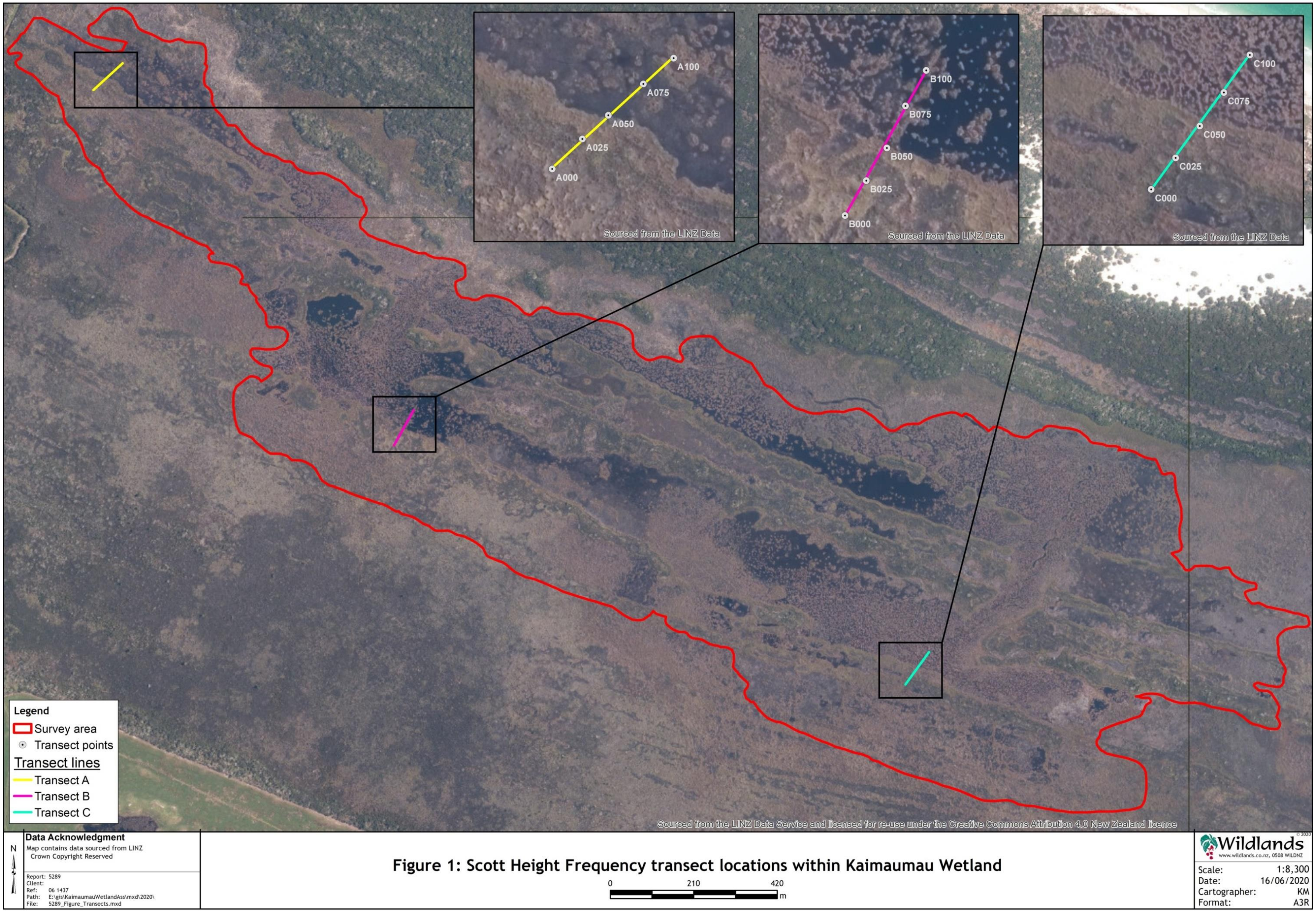


Figure 1: Scott Height Frequency transect locations within Kaimaumau Wetland

3.3 Vegetation plots

Five by five metre vegetation cover plots were established every 25 metres along each transect (five plots per transect, as shown in Figure 2).

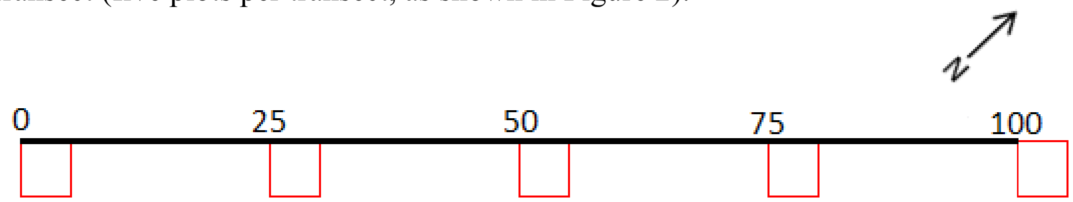


Figure 2: Layout of the 5 × 5 metre vegetation plots along each 100 metre transect. The black line shows the transect, while the red lines show the plot boundaries.

Within each plot the percent cover and maximum height of all canopy species (i.e. species that are visible from a bird's eye view) were recorded. For all plots it was ensured that the sum of all canopy cover values >1% (including vegetation, bare substrates/open water) was 100%.

A sketch of each plot was also made to allow the composition and layout of vegetation within the plots to be easily compared between monitoring rounds.

A photo was taken facing diagonally across each plot from the southwest corner, and other supplementary photos were taken, as needed, to document the vegetation composition and structure within each plot.

3.4 Soil sampling

Two soil samples were collected from within each plot (at approximately one metre from the southwest corner, Figure 3), and sent to Hills Laboratories for analysis (30 samples in total).

Samples were collected using a metal corer measuring 8.4 centimetres across (diameter) and 8.8 centimetres high. A knife was used to cut around the edge of the corer as it was pushed into the ground, to minimise compaction of the substrate.

A mini auger (21/4" × 3') was also trialed but was not appropriate for use in this environment. This device tended to compress peat and sphagnum substrates rather than cutting through them.

A petite ponar grab sediment sampler was also taken on site for use in areas where substrates were submerged by more than 20 centimetres. However, this device was not used. During the field work it was found that areas of standing water over soft peats posed a significant health and safety risk. As such, any areas where standing water would be deep enough to enable the use of the petite ponar sampler were not, and should not, be accessed on foot.

One of the samples from each plot was analysed to assess bulk density, which requires all of the water within the sample to be retained. The other was analysed to assess pH, conductivity, total carbon, total phosphorus, and total nitrogen.

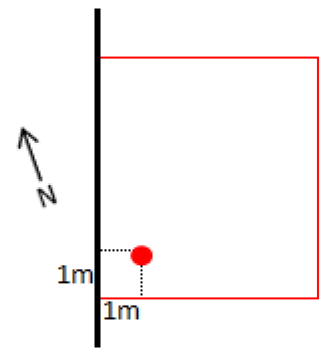


Figure 3: Diagram of approximate soil sampling location within each vegetation plot. The black line shows the transect, while the red lines shows the plot boundaries. The red dot shows the soil sampling location.

3.5 Wetland condition index

The overall wetland condition was assessed using the Wetland Condition Index described in Clarkson *et al.* (2004). This method includes the assessment of changes in five semi-independent indicators, including:

- Hydrological integrity.
- Physicochemical parameters.
- Ecosystem intactness.
- Browsing, predation and harvesting regimes.
- Dominance of native plants.

The following wetland pressures were also assessed (Clarkson *et al.* 2004):

- Modifications to catchment hydrology.
- Water quality within the catchment.
- Animal access.
- Key undesirable species.
- Proportion of catchment in introduced vegetation.
- Other pressures (if applicable).

While Clarkson *et al*. (2004) provide guidelines for assessing and scoring these condition indicators and pressures, this assessment method is subjective. The more quantitative monitoring methods described above (SHF transects and vegetation plots) will provide the more robust method for detecting changes in vegetation composition.

The guidelines for scoring wetland condition and pressures are provided in Appendices 1 and 2.

3.6 Aerial mapping

The vegetation and habitats within a key area of standing water (defined by the Department of Conservation) were delineated using high quality aerial photographs. This desktop mapping was then reviewed in the field at the three transect sites. Where possible, the vegetation types within each habitat type were identified and mapped using the Atkinson system (Atkinson 1985), noting the limitations posed by mapping from aerial photographs, including:

- The similarity in appearance of bog schoenus (*Schoenus brevifolius*) and *Machaerina* species in aerial photographs.
- The similarity in appearance of *Gleichenia* species and *Empodisma* in aerial photographs.
- Only being able to determine species that were dominant (i.e. common or abundant) or very visually distinctive (i.e. occasional emergent *Kunzea linearis*) in each type.
- Limitations of mapping scale, with some complex mosaics of vegetation types being grouped (i.e. undulating hummocky land with small pools).

4. RESULTS

4.1 Scott height frequency transects

A total of 21 species were recorded within the SHF data. The most dominant species recorded were wire rush (*Empodisma robustum*) (recorded at 51% of points), bog schoenus (recorded at 36% of points), *Gleichenia dicarpa* (recorded at 25% of points), and *Machaerina teretifolia* (also recorded at 25% of points).

Machaerina teretifolia, M. juncea, M. arthrophylla, and *M. rubiginosa* were all observed in the vicinity of the transects. *M. teretifolia* was recorded at all three transects, and *M. juncea* was confirmed at Transects A and B.

In the wetter habitat along Transect C (between Points 50 and 100), a lack of fruiting specimens and an abundance of dead material made differentiating between *M. teretifolia*, *M. rubiginosa* and *M. arthrophylla* very difficult. In this area, these three *Machaerina* species were recorded as *Machaerina* sp. It is noted however that *M. teretifolia* was generally more abundant, and is likely to comprise the majority of *Machaerina* sp. records.

During the survey *Lycopodiella serpentina* (Threatened-Nationally Vulnerable; de Lange *et al.* 2018) was rediscovered within the wetland. The New Zealand Plant Conservation Network (NZPCN) describes this species as "*formerly known from Kaimaumau and Motutangi Swamps... Now known only from Ahipara in Northland (it may still survive in Kaimaumau)*" (NZPCN 2020). *L. serpentina* was recorded at SHF points along Transect C (in wet habitat between Points 51-100), and in vegetation plots along Transect A and Transect C (Plate 2).

While it did not occur at any of the SHF points, *Fimbristylis velata* (Threatened-Naturally Uncommon; de Lange *et al.* 2018) was recorded in the vicinity of Transect A. This is a noteworthy find, as it is the northernmost record for this species. The NZPCN website (2020) describes the previously defined range of *Fimbristylis velata* as "*North Island from Ngawha Springs, the Bay of Islands, Pouto Peninsula and Great Barrier Island south to Lake Taupo*".

Plate 2: *Lycopodiella serpentina* at Transect A.

No live vegetation was recorded at 13 points, and these points (12 of the 13) generally corresponded to areas of exposed peat in the wettest parts of the transects (between Points 50 and 100).

As the habitats present between Points 1-50 and 51-100 were distinctly different (with drier habitats between 1-50 and wetter habitats between 51-100), the data for live vegetation has been presented separately for these key areas (Figures 4 and 5). All SHF data has also been provided in Appendix 3.

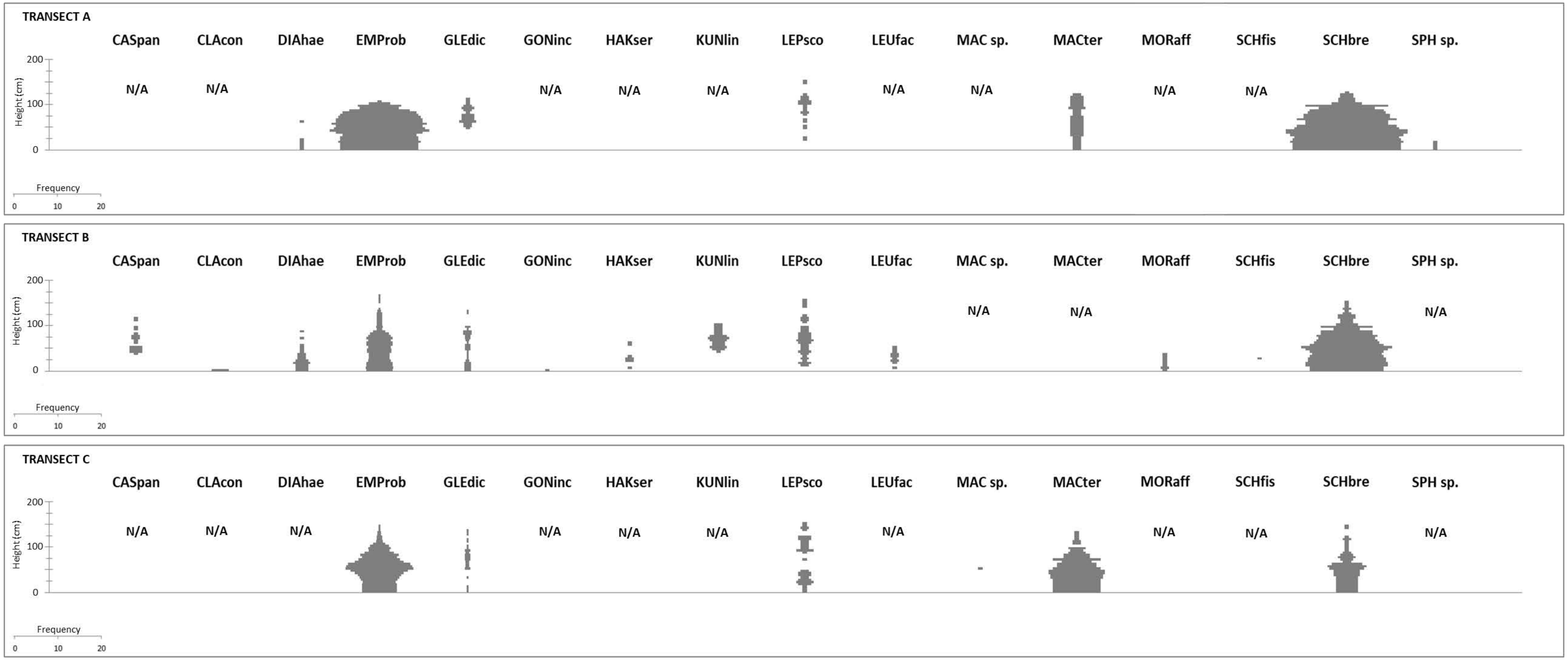
A full list of plant species recorded at the site is provided in Appendix 4.

Representative photographs of each transect are provided in Appendix 5.

4.2 Vegetation plots

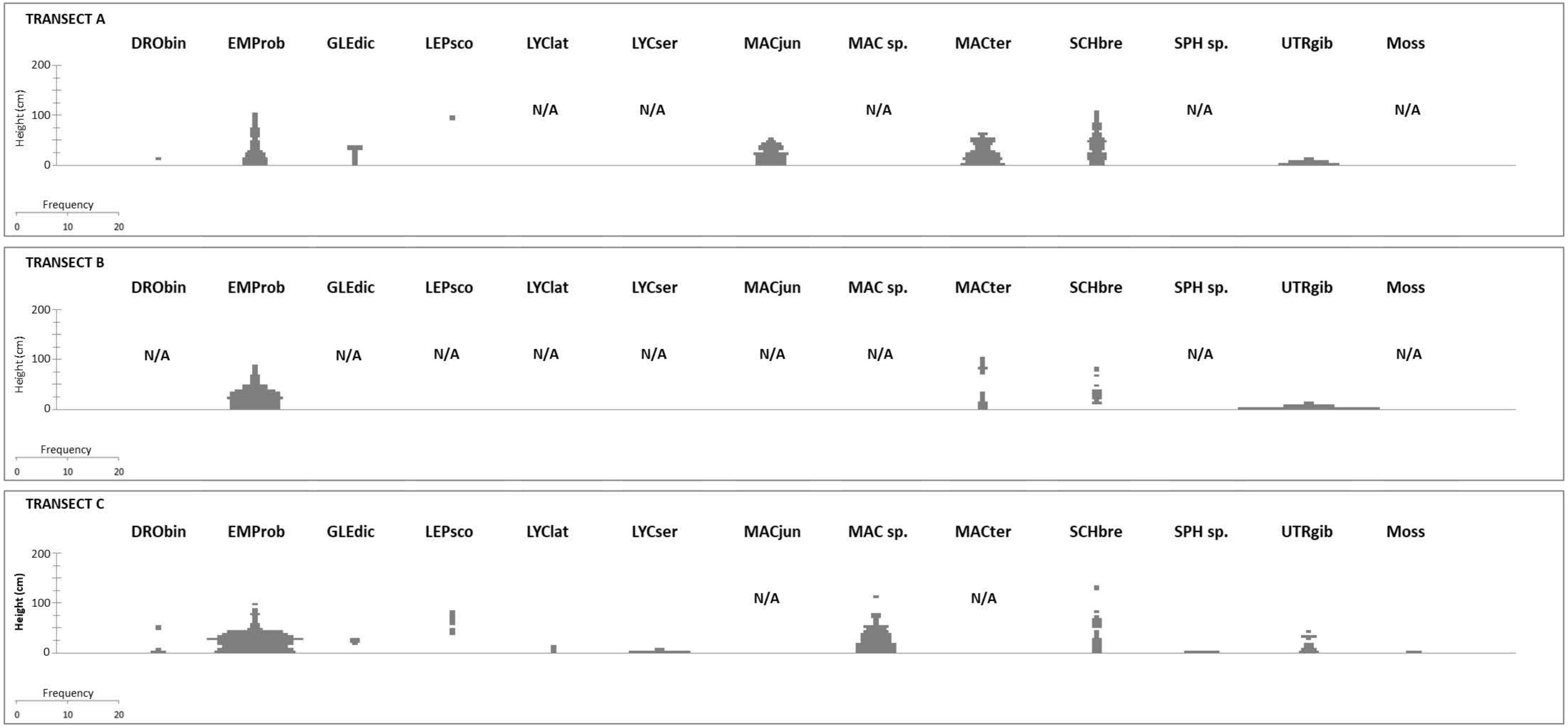
Twenty species of vascular plants were recorded in the 'canopy' within the 15 plots. Three species of *Cladonia* lichens and two mosses (one species of *Sphagnum* and one unidentified species) were also recorded. A full break down of the species recorded and a diagram of the species distribution within each plot is provided in Appendix 6. Plot photographs are provided in Appendix 7.

As mentioned above, *Lycopodiella serpentina* was rediscovered at Kaimaumau Wetland during this base line monitoring work. This species was recorded in vegetation plots at Transect A (Plot 5), and Transect C (Plots 4 and 5).



CASpan = *Cassytha paniculata*
CLAcon = *Cladonia confusa*
DIAhae = *Dianella haematica*
EMProb = *Empodisma robustum*
GLEdic = *Gleichenia dicarpa*
GONinc = *Gonocarpus incanus*
HAKser = *Hakea sericea*
KUNlin = *Kunzea linearis*
LEPsco = *Leptospermum scoparium* agg
LEUfac = *Leucopogon fasciculatus*
MAC sp. = *Machaerina* species
MACter = *Machaerina teretifolia*
MORaff = *Morelotia affinis*
SCHfis = *Schizaea fistulosa*
SCHbre = *Schoenus brevifolius*
SPH sp. = *Sphagnum* species

Figure 4: Kite diagrams of SHF data for live vegetation in dryer habitats (0-50 metres) within Transects A, B, and C.



DRObin = *Drosera binata*
EMProb = *Empodisma robustum*
GLEdic = *Gleichenia dicarpa*
LEPsco = *Leptospermum scoparium* agg
LYClat = *Lycopodiella lateralis*
LYCser = *Lycopodiella serpentina*
MACjun = *Machaerina juncea*
MAC sp. = *Machaerina* species
MACter = *Machaerina teretifolia*
SCHbre = *Schoenus brevifolius*
SPH sp. = *Sphagnum* species
UTRgib = *Utricularia gibba*
Moss = Unidentified moss

Figure 5: Kite diagrams of SHF data for live vegetation in wetter habitats (51-100 metres) within Transects A, B, and C.

4.3 Soil sampling

Data from the soil analysis is presented in Table 1 below.

Due to the absorbent nature of the soil samples taken at Plots A1, A3, A4, and B4, the liquid had to be separated from these samples under pressure to obtain enough extract for the electrical conductivity measurement. It was not possible to extract enough liquid from the samples collected at Plots A5, B5, C3, C4, and C5, so electrical conductivity values have not been provided for these samples.

4.4 Wetland condition index

The results of the wetland condition and pressure assessments are presented in Tables 2 and 3 below.

As Kaimaumau Wetland is rain fed, water does not flow through a wider 'catchment' before entering the wetland. As such, scores for factors relating to the 'catchment' (e.g. water quality within the catchment, connectivity barriers, and modifications to catchment hydrology) assumed that there has been no change or degradation of the wetland in relation to these factors.

4.5 Mapping of vegetation and habitat types

4.5.1 Overview

Eleven vegetation types were mapped and described as follows (Figure 6):

- [Wire rush] peatfield
- Wire rush peatfield
- <u>Wire rush</u> rushland
- Bog schoenus/wire rush-*machaerina* sedgeland
- <u>Mānuka</u>/bog schoenus shrubland
- [*Machaerina*]-[bog schoenus]/wire rush-tangle fern sedgeland
- <u>Mānuka</u>/bog schoenus/tangle fern shrubland
- <u>Raupō</u> reedland
- <u>Kuta</u> reedland
- *Machaerina* peatfield
- (Kānuka)/<u>mānuka</u> scrub

The use of brackets and underlining to denote relative abundance follows Atkinson (1985).

Table 1: Soil analysis data from within the 15 vegetation plots.

Transect	Plot	Substrate Description	Field Bulk Density (g/cm^3)	pH	Conductivity (mS/cm)	Total Carbon (%)	Total Phosphorus (mg/kg)	Total Nitrogen (%)
A	1	Moist peat	0.12	4.6	0.48*	36.1	246	1.77
A	2	Moist peat	0.26	4.5	0.11	23.1	< 65	0.30
A	3	Saturated peat	< 0.10	4.8	0.81*	32.2	241	1.70
A	4	Saturated/inundated peat	< 0.10	4.9	1.19*	29.7	229	1.66
A	5	Moist sphagnum/young peat	< 0.10	4.2	N/A**	42.4	126	0.67
B	1	Moist peat	0.15	4.6	0.05	17.0	143	0.79
B	2	Moist peat over sand	0.67	4.9	0.01	13.9	< 65	0.16
B	3	Saturated peat	0.13	4.8	1.28	30.5	370	1.66
B	4	Saturated/inundated peat	< 0.10	4.9	1.99*	38.5	475	2.03
B	5	Moist sphagnum/young peat	< 0.10	4.3	N/A**	43.6	124	0.66
C	1	Moist peat	0.36	4.2	0.44	25.3	< 65	0.80
C	2	Moist peat	0.20	4.4	0.51	25.7	67	0.62
C	3	Moist sphagnum/young peat	< 0.10	4.2	N/A**	37.5	143	0.87
C	4	Wet peat	< 0.10	4.5	N/A**	39.6	93	1.09
C	5	Moist sphagnum/young peat	< 0.10	4.5	N/A**	42.0	82	0.71

* Liquid separated from sample under pressure
** Unable to extract sufficient volume of liquid to assess electrical conductivity

Table 2: Result of wetland condition assessment carried out for Kaimaumau Wetland in January 2020. Note that a score of 0 indicates poor condition and a score of 5 indicates good condition.

Indicator	Indicator Components	Comment	Score	Mean Score
Change in Hydrological integrity	Impact of manmade structures	Large drain to the west of survey location.	4	4.67
	Water table depth	No detectable changes.	5	
	Dryland plant invasion	No/virtually no dryland plants in or around transects. Some Sydney golden wattle (*Acacia longifolia*) near edge of wetland to the southeast.	5	
Change in physico-chemical parameters	Fire damage	Fire in 2005 affected <25% of wetland.	4	4.25
	Degree of sedimentation/erosion	No evidence of sedimentation or erosion.	5	
	Nutrient levels	No evidence of eutrophication.	5	
	von Post index	von Post test carried out near A0.	3	
Change in ecosystem intactness	Loss in area of original wetland	<25% of original area lost.	4	4.50
	Connectivity barriers	None. Rain-fed wetland.	5	
Change in browsing, predations and harvesting regimes	Damage by domestic or feral animals	Small amount of localised browsing on wetland edges.	4	4.33
	Introduced predator impacts on wildlife	Susceptible species still present, e.g. fernbird (*Bowdleria punctata*).	4	
	Harvesting levels	No evidence of harvesting.	5	
Change in dominance of native plants	Introduced plant canopy cover	Some prickly hakea (*Hakea sericea*) present in canopy.	4	4.50
	Introduced plant understorey cover	No/virtually no introduced plants in understorey.	5	
Total Wetland Condition Index				**22.25**

Table 3: Result of wetland pressure assessment carried out for Kaimaumau Wetland in January 2020. Note that a score of 0 indicates low pressure and a score of 5 represents high pressure.

Pressure	Comment	Score
Modifications to catchment hydrology	None. Rain-fed wetland.	0
Water quality within the catchment	Very high water quality. Rain-fed.	0
Animal access	Low impediment to pest animal access. Mixed land use in surrounding area.	3
Key undesirable species	No key undesirable species found during survey.	0
% catchment in introduced vegetation	>25% of the catchment in introduced vegetation. Sydney golden wattle dominant in some areas.	1
Other pressures	N/A	0
Total Wetland Pressure Index		**4**

The vegetation types provided follow Atkinson (1985) with the following modifications:

- Within peatfield habitats (wholly or partly submerged during the wetter months), there was a clear division using the aerial photographs between peatfield with less than 10% cover of wire rush, peatfield with 10-90% cover of wire rush, and areas where wire rush occurred at >90% cover, with no bare peats exposed. These were therefore separated into three wire rush vegetation types. *Machaerina* at 10-80% cover occurred on the shallow margins of the larger peatfields, and in smaller peatfields within small depressions; this has been mapped as *Machaerina* peatfield and was not able to be further divided, according to abundance, using aerial photography.

- Elongated bands of a complex of vegetation types occurred on low-lying undulating dune ridges (above the peatfields but on wetland soils). Within this area, complete changeover in species occur over distances of 10-20 metres, and couldn't be separated at the mapping scale used (i.e. small depressions <10 metres across dominated by sedges, amongst mānuka scrub). This type has been mapped as "Mānuka/bog schoenus/tangle fern shrubland"

Vegetation Type 1: [Wire rush] peatfield

This ecological unit is extensive on the wettest dune slacks. Bare peats, which can be exposed or submerged, cover most of this habitat type, and raised hummocks dominated by wire rush cover 1-10%. Inspection in the field showed that *Machaerina* species and bog schoenus occur as emergent species (<10% cover) over the wire rush on the hummocks.

Vegetation Type 2: Wire rush peatfield

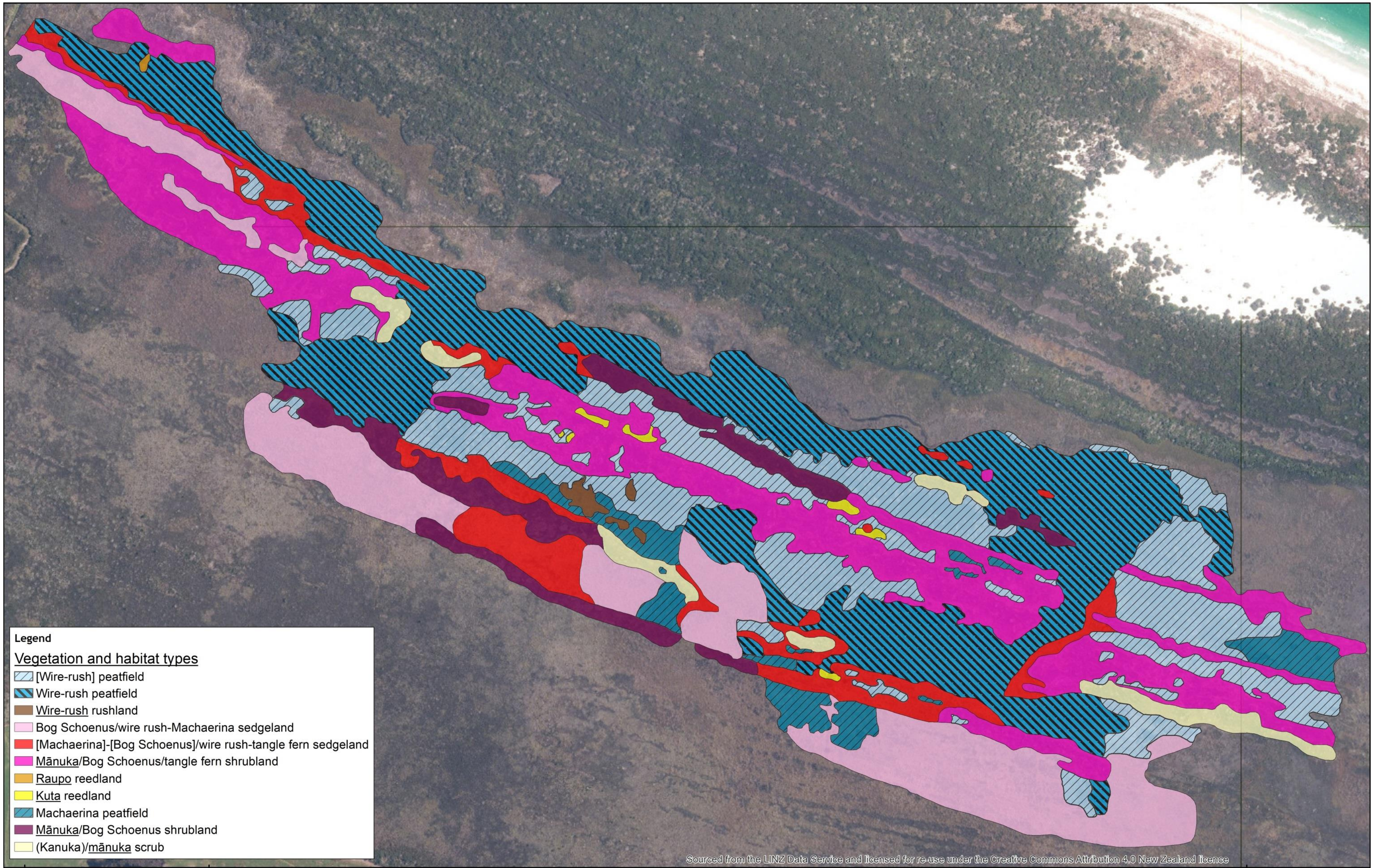
This ecological unit is also extensive on the wettest dune slacks. The habitat type also comprises bare peats, but with raised hummocks dominated by wire rush covering a variable 10-90% of the peatfield. For the habitat type as a whole, the raised hummocks are approximately 40-50% cover. Inspection in the field showed that *Machaerina* species and bog schoenus occur as emergent species (<10% cover) over the wire rush on the hummocks.

Vegetation Type 3: Wire rush rushland

Within the wettest dune slacks, larger islands of wire rush have been mapped as wire rush rushland. This vegetation type also occurs on the margins of the peatfields. As per other wire rush vegetation types, *Machaerina* species and bog schoenus occur as emergent species (<10% cover) over the wire rush.

Vegetation Type 4: Bog schoenus/wire rush-*Machaerina* sedgeland

Bog schoenus/wire rush-*Machaerina* sedgeland occurs in the drier dune slacks, often adjacent and grading into the wire rush vegetation types. This vegetation type is likely to be shallowly inundated during the wetter months of the year. Bog schoenus, wire rush and *Machaerina* species dominate these areas with local *Gleichenia* and mānuka.



Data Acknowledgment
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Report: 5289
Client: Wildlands GIS
Ref: 06 1437
Path: E:\gis\KaimaumauWetlandAss\mxd\2020\
File: 5289_Figure_Vegetation2020_V2.mxd

Figure 6. Vegetation and habitat types at Kaimaumau Wetland

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Scale: 1:8,300
Date: 16/06/2020
Cartographer: KM
Format: A3R

Vegetation Type 5: [*Machaerina*]-[bog schoenus]/wire rush-tangle fern sedgeland

This vegetation type occurs on the gently sloping margins of the peatfields. Wire rush and tangle fern dominate these areas, with frequent emergent *Machaerina* spp. and bog schoenus.

Vegetation Type 6: Manuka/bog schoenus/tangle fern shrubland

This vegetation type occurs on low-lying, undulating dune ridges. Manuka is abundant on the higher ground, interspersed with small hollows dominated by either bog schoenus or tanglefern. *Machaerina* spp. are also present.

Vegetation Type 7: Raupō reedland

Raupō (*Typha orientalis*) occurs as the sole dominant over small areas of the wettest dune slacks. Most of this vegetation type lay to the north, beyond the boundary of the mapped area.

Vegetation Type 8: Kuta reedland

Kuta (*Eleocharis sphaceolata*) occurs as the sole dominant over small areas of the wettest dune slacks. This vegetation type also occurs in smaller depressions within the raised dune ridges.

Vegetation Type 9: *Machaerina* peatfield

Machaerina peatfield occurs on the margins of the dune slacks, and in smaller depressions within the dune ridges. Most of this habitat type is bare peats, with *Machaerina* spp. (likely to be *Machaerina teretifolia* in most places), forming a variable 10-80% cover. This vegetation type is likely to be inundated for most of the year.

Vegetation Type 10: Mānuka/bog schoenus shrubland

Mānuka/bog schoenus shrubland occurs on slightly raised dune ridges. Mānuka is abundant, forming a low canopy *c.*1-2 metres tall, with frequent patches of sedgeland dominated by bog schoenus.

Vegetation Type 11: (Kānuka)/mānuka scrub

(Kānuka)/mānuka scrub occurs on podzolised soils on the higher dune ridges. Mānuka is abundant, forming a broken, low canopy at 1-2 metres tall, with scattered kānuka (*Kunzea linearis*), which is often slightly emergent over the mānuka canopy. Field inspections show the presence of bog schoenus, *Gleichenia*, *Cassytha paniculata*, *Hakea sericea* and *Leucopogon fasciculatus*. Canopy gaps often have a ground cover of lichens, dominated by *Cladonia* species.

5. HEALTH AND SAFETY CONSIDERATIONS

It was initially indicated that this monitoring work could require personnel to work in areas of open water up to 1.2 metres deep. However, experience from the first round of monitoring highlighted that working in areas of standing water, when the underlying substrates are soft, poses a significant health and safety risk.

In some area the peat substrates are extremely soft for at least the first 1.5-2 metres. There would therefore be a very high risk of personnel sinking into the peat and finding themselves stuck with their head below water level.

Future work should only be carried out when the wetland is as dry as possible; installation of the monitoring equipment to span 100 metres of the land to water transition was only possible in the wettest habitats due to the dry summer conditions. Staff should also use wooden planks to help distribute their weight when moving across soft peat areas, and ensure that at least one member of the field team is on solid ground at all times. A throw bag should also be carried to allow personnel who become stuck to be assisted out.

During fine weather in the summer, working conditions become very hot due to the lack of shade. The field team for future work should ensure ample water is taken on site (i.e. a minimum of 10L of drinking water per day per two person team).

6. REPEAT SURVEYS

As stated in the GMCP, the next monitoring round is required in 2025. The next monitoring round will enable a comparison to this baseline survey, and an assessment of whether the water abstractions avoid adverse effects on the ecology of the Kaimaumau-Motutangi wetland.

ACKNOWLEDGMENTS

Stuart Savill (Northland Regional Council) provided client liaison, Meirene Hardy-Birch (Department of Conservation) provided permission to work at the site, and Hugh Robertson (Department of Conservation) provided advice for the design of the monitoring methods. Ben Schultz provided helicopter access to the site, and Ian Broadhurst provided the helicopter departure point.

REFERENCES

Atkinson I.A.E. 1985: Derivation of vegetation mapping units for an ecological survey of Tongariro National North Island, New Zealand, New Zealand Journal of Botany 23 (3) 361-378.

de Lange P.J., Rolfe J.R., Barkla J.W., Courtney S.P., Champion P.D., Perrie L.R., Beadel S.M., Ford K.A., Breitwieser I., Schonberger I., Hindmarsh-Walls R., Heenan P.B. and

Ladley K. 2018: Conservation status of New Zealand indigenous vascular plants, 2017. *New Zealand Threat Classification Series 22*. Department of Conservation, Wellington.
NZPCN. https://www.nzpcn.org.nz/flora/species/lycopodiella-serpentina/. Accessed 15 June 2020

Rose A. 2005: Vegetation: Scott height frequency transects. *Department of Conservation DOCDM-359455*. 21pp.

Scott D. 1965: A height frequency method for sampling tussock and shrub vegetation. *New Zealand Journal of Botany* 3: 253-260.

Wiser S.K. and Rose A.B. 1997: Two permanent plot methods for monitoring changes in grasslands: A field manual. Prepared for the Department of Conservation. *Landcare Research Contract Report: LC.*

APPENDIX 1

WETLAND CONDITION SCORING GUIDELINES

(Clarkson *et al.* 2004)

Indicator and components	Score and degree of modification					
	5	**4**	**3**	**2**	**1**	**0**
	None/very low	**Low**	**Moderate**	**High**	**Very high**	**Extreme**
Δ Hydrological integrity H1: Impact of manmade structures	None or not impacting on wetland.	Affect less than 25% of the wetland.	Affect 25–49% of the wetland.	Affect 50–75% of the wetland.	Dominate wetland (>75%)	Totally dominated or affected by man-made structures.
H2: Δ Water table depth	No detectable changes.	Abnormally lowered (or raised) only occasionally and temporarily	Noticeably lower for short periods during dry spells. Average water table shows small but definite decline over time.	Lowered for long periods during dry spells. Average water table in wetland has noticeably declined over time.	Very low for most of year, not recharged fully by high rainfall events. Average water table much lower than previously.	Unable to be easily measured throughout season. Now a 'dryland' Or artificially totally flooded.
H3: Dryland plant invasion	No/ virtually no dryland plants in wetland.	<25% of wetland has dryland plant species present	25–49% of wetland has dryland plant species present.	50–75% of wetland has dryland plant species present.	>75% of wetland has dryland plant species present.	All species (100%) in community are dryland species
Δ Physicochemical parameters P1: Fire damage	No evidence of fire damage.	Recent fires (<2 years) removed vegetation in <25% of wetland; Or vegetation virtually recovered from older fires.	Recent fires (<2 yr) affected 25–49% of wetland; Or veg in 50–75% wetland still recovering from older fires.	Recent fires (<2 yr) affected 50–75% of wetland; Or veg in >75% wetland still recovering from older fires.	Recent fires (<2 yr) affected >75% of wetland. Or fire sensitive species now extinct.	Above ground vegetation completely destroyed (immediately post-fire).
P2: Degree of sedimentation/ erosion	None: high water clarity (<40 NTU), no visible sediment, stable banks and soil.	Water clarity 41–80 NTU; Or visible sediment deposits affect <25% of wetland; Or some minor spot erosion visible.	Water clarity 81–120 NTU; Or visible sediment deposits affect 25–49% of wetland; Or erosion spots linked and causing minor structural damage.	Water clarity 121–160 NTU; Or visible sediment deposits affect 50–75% of wetland; Or widespread erosion or scouring over greater than 50% of area.	Water clarity >160 NTU; Or visible sediment deposits affect >75% of wetland; Or widespread erosion causes severe damage throughout.	All wetland character lost due to prolonged extreme turbidity, almost total infilling by sediment, or unchecked erosion and scouring.

Indicator and components	Score and degree of modification					
	5	4	3	2	1	0
	None/very low	**Low**	**Moderate**	**High**	**Very high**	**Extreme**
P3: Nutrient levels	No evidence of eutrophication.	Localised (<25%) or infrequent signs of algal blooms or changes in nutrient concentrations or vegetation composition.	25–49% of area shows algal blooms, increased nutrients or vegetation change to high-nutrient species.	50–75% of area shows algal blooms, increased nutrients or vegetation change to high-nutrient species.	Eutrophication has shifted >75% of system to almost continuous algal blooms or monospecific stands of high-nutrient plants.	All wetland character lost due to eutrophication: now just a pond or dryland with no higher wetland plants present.
P4: von Post index Relevant to peat bogs only	1 undecomposed; plant structure unaltered, yields clear colourless water.	2–3; plant structure distinct, yields clear, yellow or brown water.	4–5; plant structure becoming indistinct. Yields turbid brown water, some peat may escape between fingers, residue mushy.	6–7; plant structure indistinct, about half the peat escapes between fingers, residue strongly mushy.	8–9; plant structure very indistinct, two-thirds to almost all peat escapes between fingers.	10 completely decomposed; plant structure unrecognisable, all peat escapes between fingers.
Δ Ecosystem intactness E1: Loss in area of original wetland	No loss: original wetland area essentially intact.	<25% of original area lost.	25–49% of original area lost.	50–75% of original area lost.	>75% of original area lost, remnants still retain some original character.	Wetland lost, or almost lost but remnants completely modified.
E2: Connectivity barriers	None: All natural upstream and downstream connections retained.	<25% of upstream or downstream connection lost.	25–49% of upstream or downstream connection lost.	50–75% of upstream or downstream connection lost.	>75% of connection lost with some minor links remaining.	Isolated: all former connections to other water bodies lost.
Δ Browsing, predation & harvesting regimes B1: Damage by domestic or feral animals	No domestic animal or feral animal browsing or trampling damage.	<25% of wetland showing light-medium damage; Or very light or localised browsing throughout wetland.	25–49% of wetland showing medium-heavy browsing and/or trampling damage.	50–75% of wetland medium-heavily browsed and/or trampled.	>75% of wetland heavily browsed and/or trampled.	All wetland character lost due to severity of browsing and trampling activity.

Indicator and components	Score and degree of modification					
	5	4	3	2	1	0
	None/very low	**Low**	**Moderate**	**High**	**Very high**	**Extreme**
B2: Introduced predator impacts on wildlife	No/virtually no predator access or impact; Or wetland & catchment under long term effective predator control.	Low levels of predators – susceptible wildlife spp still present Or pulsed predator control. Low predator reinvasion from catchment.	Medium predator impact, decline in numbers of some wildlife species. Or control very intermittent /or of not all predators. Medium reinvasion from catchment.	High declines in populations and/or loss of 1 or 2 wildlife species. Or no or ineffective predator control. High reinvasion from catchment.	Severe declines in wildlife population and species number. Or no predator control. Very high reinvasion from catchment Predators/signs visible.	Extreme: most native wildlife species extinct in wetland. Predators/signs highly visible.
B3: Harvesting levels	No harvesting (plants, birds, fish or other components) activity in wetland.	<25% of wetland with medium-heavy harvesting damage; Or light damage throughout wetland Or virtually recovered from earlier harvesting.	25–49% of wetland affected by active harvesting; Or 50–75% of wetland recovering from earlier harvesting.	50–75% of wetland affected by active harvesting; Or >75% of wetland recovering from earlier harvesting.	Active harvesting affecting >75% of wetland.	All wetland character lost due to harvesting activity.
Δ Dominance of native plants D1: Introduced plant canopy cover	No introduced plants in canopy i.e., all plants are native.	<25% canopy cover of introduced plants.	25–49% canopy cover of introduced plants.	50–75% canopy cover of introduced plants.	>75% canopy cover of introduced plants.	All canopy plants are introduced.
D2: Introduced plant understorey cover	No/ virtually no (<1%) plants in understorey are introduced.	<25% cover of introduced plants in understorey.	25–49% cover of introduced plants in understorey.	50–75% cover of introduced plants in understorey.	>75% cover of introduced plants in understorey.	All/virtually all (>99%) plants in understorey are introduced.

APPENDIX 2

WETLAND PRESSURES SCORING GUIDELINES

(Clarkson *et al.* 2004)

Pressure	Score and degree of modification					
	None/very low (0)	Low (1)	Moderate (2)	High (3)	Very high (4)	Extreme (5)
Modifications to catchment hydrology	No hydrological modifications to the catchment.	<25% of catchment has been subject to hydrological modification. NB urban (impervious surface) catchment would score higher than grass.	25–49% of the catchment has been subject to hydrological modification.	50–75% of the catchment has been subject to hydrological modification.	Over 75% of the catchment has been subject to hydrological modification.	The entire catchment has been subject to hydrological modification.
Water quality with-in the catchment. (Using water quality index, e.g., SQMCI by Stark, 1998)	Very high water quality.	Good water quality.	Possible mild pollution.	Probable moderate pollution.	Probable severe pollution.	Severe pollution.
Animal access	No animal access (either no pest animals in the catchment or wetland surrounded by predator proof fence).	High impediment to animal access, low edge:area ratio, intensive trapping /eradication programs within catchment, mostly surrounded by native ecosystems.	Moderate impediment to animal access, moderate edge to area ratio, control of some key undesirable species, some of the catchment in one modified land use.	Low impediment to animal access, moderate edge to area ratio, control of some key undesirable species, several different land-uses within catchment.	Low impediment to animal access, high edge to area ratio, surrounded by a mix of intensive land uses, no control programmes in the catchment.	No impediment to animal access, high edge to area ratio, surrounded by a mix of intensive land uses, no control programmes in the catchment.
Key undesirable species (found in region that could invade wetland type being monitored)	No key undesirable species found within the catchment	Less than 25% of key undesirable species are found within the catchment.	Between 25–49% of key undesirable species are found within the catchment.	Between 50–74% of key undesirable species are found within the catchment.	Over 75% of key undesirable species are found within the catchment.	All key undesirable species are found within 100m of the wetland.
% Catchment in introduced vegetation	None of the catchment in introduced vegetation.	Less than 25% of the catchment in introduced vegetation.	Between 25–49% of the catchment in introduced vegetation.	Between 50–74% of the catchment in introduced vegetation.	Over 75% of the catchment in introduced vegetation.	All the catchment in introduced vegetation.
Other pressures	Additional pressures should be scored based on their potential impact to the wetland type being monitored.					

SCOTT HEIGHT FREQUENCY DATA

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	A	0	A000	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead	1	1	1	1	1	1																																		
2020	A	0	A000	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive							1	1	1																															
2020	A	1	A001	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	A	2	A002	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead	1	1	1	1	1	1																																		
2020	A	2	A002	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive							1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	A	3	A003	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	A	4	A004	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive								1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
2020	A	4	A004	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1																																	
2020	A	5	A005	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1														
2020	A	6	A006	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	A	7	A007	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1																								
2020	A	8	A008	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1																													
2020	A	9	A009	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	A	10	A010	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1			1	1	1	1																								
2020	A	11	A011	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1			1	1	1																								
2020	A	12	A012	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive																	1																							
2020	A	12	A012	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																								
2020	A	13	A013	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive				1	1	1	1	1	1	1	1	1	1	1																										
2020	A	13	A013	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1																															
2020	A	14	A014	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive								1	1	1	1	1	1	1	1																									
2020	A	14	A014	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	A	14	A014	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	15	A015	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	A	15	A015	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	16	A016	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																					1	1																		
2020	A	16	A016	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive											1	1	1	1	1	1	1	1	1	1																				
2020	A	16	A016	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1																				
2020	A	16	A016	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	17	A017	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
2020	A	17	A017	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1							1																								
2020	A	17	A017	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1	1																																						
2020	A	18	A018	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1																			
2020	A	18	A018	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																1																								
2020	A	18	A018	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive								1	1	1	1																													
2020	A	18	A018	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	19	A019	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive														1																										
2020	A	19	A019	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	A	19	A019	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1	1																																						
2020	A	20	A020	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																					1	1	1	1																
2020	A	20	A020	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																								
2020	A	20	A020	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive																	1	1																						
2020	A	20	A020	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive													1	1	1	1																								
2020	A	20	A020	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	21	A021	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive													1	1	1																									
2020	A	21	A021	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1																											
2020	A	21	A021	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	22	A022	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	A	22	A022	DIAhae	Leaf Litter (Sphagnum)	Dianella haematica	Alive													1																											
2020	A	22	A022	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1																													
2020	A	22	A022	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	A	23	A023	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				
2020	A	23	A023	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1																				
2020	A	23	A023	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																	1	1	1	1																				
2020	A	23	A023	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																1	1																							
2020	A	23	A023	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	24	A024	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1															1	1	1																			
2020	A	24	A024	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive															1	1	1	1	1	1																				
2020	A	24	A024	LEPsco	Bare Ground (Peat)	Leptospermum scoparium	Alive					1	1							1	1			1	1	1	1																				
2020	A	24	A024	DIAhae	Bare Ground (Peat)	Dianella haematica	Alive	1	1	1	1	1																																			
2020	A	25	A025	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																	
2020	A	25	A025	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																				1																				
2020	A	25	A025	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead						1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	A	26	A026	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																
2020	A	26	A026	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive															1	1																								
2020	A	26	A026	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive												1	1	1	1	1	1																							
2020	A	27	A027	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																														1	1									
2020	A	27	A027	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
2020	A	27	A027	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	A	28	A028	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																					1	1	1	1	1															
2020	A	28	A028	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
2020	A	29	A029	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1																						
2020	A	29	A029	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive										1	1	1	1	1	1	1																								
2020	A	29	A029	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	30	A030	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	A	30	A030	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive													1	1																										
2020	A	30	A030	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	31	A031	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	A	31	A031	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive															1																									
2020	A	31	A031	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	32	A032	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1				1	1																															
2020	A	32	A032	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead					1	1	1																																	
2020	A	32	A032	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	33	A033	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1					1	1	1	1	1	1																								
2020	A	33	A033	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead							1	1	1	1																														
2020	A	33	A033	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	34	A034	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2020	A	34	A034	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	A	34	A034	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive											1																													
2020	A	34	A034	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	35	A035	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1																				
2020	A	35	A035	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive									1	1	1	1	1	1	1	1	1	1																						
2020	A	35	A035	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead															1	1	1																							
2020	A	35	A035	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead									1	1	1	1	1	1																										
2020	A	35	A035	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	36	A036	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive																			1					1	1															
2020	A	36	A036	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead															1	1	1																							
2020	A	36	A036	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2020	A	36	A036	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	A	36	A036	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive										1																														
2020	A	36	A036	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	A	37	A037	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																				1	1																			
2020	A	37	A037	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				
2020	A	37	A037	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																								
2020	A	37	A037	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	38	A038	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1															
2020	A	38	A038	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																						1	1																	
2020	A	38	A038	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive																		1	1	1	1	1																		
2020	A	38	A038	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead							1	1	1	1	1	1	1	1	1	1	1	1																						
2020	A	38	A038	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																
2020	A	38	A038	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	39	A039	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				
2020	A	39	A039	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive								1	1	1	1	1	1	1	1																									
2020	A	39	A039	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead								1	1	1	1	1																												
2020	A	39	A039	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	A	39	A039	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	40	A040	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead																					1																			
2020	A	40	A040	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive																1	1	1	1	1																				
2020	A	40	A040	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead																1	1	1	1	1																				
2020	A	40	A040	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																								
2020	A	40	A040	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																								
2020	A	41	A041	GLEdic	Bare Ground (Peat)	Gleichenia dicarpa	Alive																		1	1																					
2020	A	41	A041	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive														1	1	1	1																							
2020	A	41	A041	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead												1	1																											
2020	A	41	A041	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive								1	1	1	1						1	1	1	1	1	1	1																	
2020	A	41	A041	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1																																	
2020	A	41	A041	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive																				1	1	1	1	1	1															
2020	A	41	A041	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead																														1										
2020	A	42	A042	SCHbre	Vegetation	Schoenus brevifolius	Alive																1	1	1	1	1	1																			
2020	A	42	A042	EMProb	Vegetation	Empodisma robustum	Alive																1	1	1	1																					
2020	A	42	A042	SCHbre Dead	Vegetation	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	A	42	A042	GLEdic	Vegetation	Gleichenia dicarpa	Alive										1	1	1																												
2020	A	42	A042	Sphagnum sp.	Vegetation	Sphagnum sp.	Alive	1	1	1	1																																				
2020	A	42	A042	MACter	Vegetation	Machaerina teretifolia	Alive																			1	1	1	1	1	1	1															
2020	A	42	A042	MACter Dead	Vegetation	Machaerina teretifolia	Dead																			1	1	1	1	1																	
2020	A	43	A043	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive																				1																				
2020	A	43	A043	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead																	1	1	1	1	1																			
2020	A	43	A043	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive									1	1																														
2020	A	43	A043	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2020	A	43	A043	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive														1	1	1	1	1	1																					
2020	A	44	A044	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																		
2020	A	44	A044	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1	1											1	1	1	1																				
2020	A	44	A044	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive												1	1	1	1	1	1																							
2020	A	45	A045	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	A	45	A045	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive	1	1	1	1	1																																			
2020	A	45	A045	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive									1	1	1																													
2020	A	45	A045	SCHbre Dead	Vegetation	Schoenus brevifolius	Dead																	1	1																						
2020	A	46	A046	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive							1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	A	46	A046	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	A	47	A047	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive				1	1	1	1	1	1			1	1	1																										
2020	A	47	A047	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1																											

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	A	47	A047	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead									1	1																														
2020	A	47	A047	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2020	A	48	A048	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1							1	1																									
2020	A	48	A048	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive											1	1	1																											
2020	A	48	A048	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	A	48	A048	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1																																	
2020	A	48	A048	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	A	48	A048	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	A	48	A048	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	49	A049	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	A	49	A049	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive							1	1	1																															
2020	A	49	A049	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead							1	1	1	1																														
2020	A	49	A049	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	50	A050	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead				1	1	1	1																																	
2020	A	51	A051	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	A	52	A052	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	A	53	A053	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive									1	1																														
2020	A	53	A053	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1																																			
2020	A	54	A054	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1																																		
2020	A	55	A055	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive			1	1	1	1																																		
2020	A	55	A055	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead			1	1																																				
2020	A	55	A055	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	A	56	A056	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1																																				
2020	A	56	A056	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive			1																																					
2020	A	57	A057	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1						1	1																													
2020	A	57	A057	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1																																				
2020	A	58	A058	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1																																				
2020	A	58	A058	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	A	59	A059	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1																																				
2020	A	59	A059	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive								1																																
2020	A	60	A060	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive											1																													
2020	A	60	A060	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1																																				
2020	A	61	A061	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1						1	1																														
2020	A	61	A061	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive	1	1	1	1	1	1	1	1	1																															
2020	A	62	A062	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1	1																													
2020	A	63	A063	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive													1																											
2020	A	63	A063	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1	1																													
2020	A	63	A063	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1	1	1	1	1	1																																	
2020	A	64	A064	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1																											
2020	A	64	A064	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1																																					
2020	A	65	A065	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1																																			
2020	A	65	A065	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive	1	1	1	1	1																																			
2020	A	66	A066	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1																																	
2020	A	67	A067	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead										1																														
2020	A	67	A067	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	A	68	A068	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1																																						
2020	A	68	A068	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	A	69	A069	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive					1																																			
2020	A	69	A069	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1		1																																					
2020	A	70	A070	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead		1																																						

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	A	71	A071	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1																																		
2020	A	72	A072	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1																																		
2020	A	72	A072	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	A	73	A073	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead							1	1	1	1																														
2020	A	73	A073	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1	1																																					
2020	A	74	A074	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead				1																																				
2020	A	74	A074	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1																																							
2020	A	74	A074	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1	1																																					
2020	A	75	A075	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive					1																																			
2020	A	75	A075	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1																																						
2020	A	75	A075	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	A	76	A076	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive				1	1																																			
2020	A	76	A076	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead			1																																					
2020	A	76	A076	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	A	77	A077	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive	1	1																																						
2020	A	78	A078	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	A	78	A078	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	A	78	A078	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	79	A079	MACjun Dead	Leaf Litter (Sphagnum)	Machaerina juncea	Dead			1																																					
2020	A	79	A079	DRObin	Leaf Litter (Sphagnum)	Drosera binata	Alive			1																																					
2020	A	79	A079	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	80	A080	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive										1	1																													
2020	A	80	A080	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive	1	1	1	1	1	1	1	1	1																															
2020	A	80	A080	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	A	81	A081	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1	1	1																																		
2020	A	82	A082	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive	1	1	1	1	1																																	
2020	A	82	A082	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1	1	1																																		
2020	A	83	A083	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive							1	1	1	1																														
2020	A	83	A083	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1	1	1																																		
2020	A	83	A083	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	A	84	A084	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive	1	1	1	1	1	1	1	1	1	1	1																													
2020	A	84	A084	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1	1	1	1	1																																
2020	A	85	A085	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive	1	1	1	1	1																																	
2020	A	86	A086	MACjun	Bare Ground (Peat)	Machaerina juncea	Alive							1																															
2020	A	86	A086	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead					1	1																																
2020	A	86	A086	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1																																						
2020	A	87	A087	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive					1																																	
2020	A	87	A087	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	A	88	A088	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive						1	1	1	1																													
2020	A	88	A088	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1																																			
2020	A	89	A089	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1								1	1																										
2020	A	90	A090	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive									1	1	1																													
2020	A	90	A090	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead				1	1	1	1	1	1	1																														
2020	A	90	A090	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive	1	1	1	1	1	1	1	1																														
2020	A	90	A090	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1																																
2020	A	90	A090	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1																																
2020	A	91	A091	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive			1	1	1																																	
2020	A	91	A091	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1																																	
2020	A	91	A091	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1																																							
2020	A	92	A092	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1					1	1	1	1	1	1	1	1	1	1																					

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	A	92	A092	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	A	92	A092	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive							1	1																																
2020	A	92	A092	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead						1	1	1	1	1	1																													
2020	A	93	A093	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1							1	1										
2020	A	93	A093	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1																		
2020	A	93	A093	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																			1	1																				
2020	A	93	A093	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive														1	1	1	1	1	1	1	1																			
2020	A	93	A093	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead														1	1	1	1	1	1	1	1																			
2020	A	93	A093	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead			1	1	1	1	1	1	1	1	1	1	1																											
2020	A	93	A093	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	94	A094	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive							1										1																							
2020	A	94	A094	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead													1		1																									
2020	A	94	A094	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive												1	1																											
2020	A	94	A094	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	A	94	A094	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1																																		
2020	A	94	A094	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	95	A095	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive															1	1																								
2020	A	95	A095	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead								1	1	1																														
2020	A	95	A095	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	A	95	A095	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																																
2020	A	95	A095	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	96	A096	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive								1																																
2020	A	96	A096	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive							1	1																																
2020	A	96	A096	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1																																
2020	A	96	A096	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	A	97	A097	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1																																						
2020	A	98	A098		Bare Ground (Peat)																																										
2020	A	99	A099		Bare Ground (Peat)																																										
2020	A	100	A100	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead									1	1	1																													
2020	A	100	A100	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive											1																													
2020	A	100	A100	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1																																					
2020	A	100	A100	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1																																							
2020	B	0	B000	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1					1	1	1	1																									
2020	B	0	B000	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1																																			
2020	B	0	B000	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive			1	1																																				
2020	B	0	B000	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	B	1	B001	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive									1	1	1	1	1	1																										
2020	B	1	B001	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1																																				
2020	B	1	B001	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1																																					
2020	B	2	B002	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead																1																								
2020	B	2	B002	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive											1	1	1																											
2020	B	2	B002	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1																																				
2020	B	2	B002	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead					1	1	1	1																																
2020	B	2	B002	DIAhae	Leaf Litter (Sphagnum)	Dianella haematica	Alive	1	1	1	1																																				
2020	B	3	B003	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1																			
2020	B	3	B003	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				
2020	B	3	B003	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																1	1	1	1	1																				
2020	B	3	B003	DIAhae	Leaf Litter (Sphagnum)	Dianella haematica	Alive	1	1	1	1	1	1	1	1																																
2020	B	4	B004	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead																											1	1												
2020	B	4	B004	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																	

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	B	4	B004	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive			1	1	1	1	1	1																																
2020	B	5	B005	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1			1	1		1	1																					
2020	B	5	B005	DIAhae	Leaf Litter (Sphagnum)	Dianella haematica	Alive																		1																						
2020	B	5	B005	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive															1	1																								
2020	B	5	B005	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	B	6	B006	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1				1	1	1	1	1																									
2020	B	6	B006	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1					1	1	1																										
2020	B	6	B006	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive								1	1	1	1	1	1																											
2020	B	6	B006	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	B	7	B007	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive											1																													
2020	B	7	B007	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	B	7	B007	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																																
2020	B	8	B008	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1													1	1																				
2020	B	8	B008	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	B	8	B008	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive									1	1	1	1																												
2020	B	8	B008	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead								1	1	1																														
2020	B	8	B008	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	B	9	B009	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead											1	1				1	1	1	1	1																				
2020	B	9	B009	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead																1	1	1	1																					
2020	B	9	B009	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead								1	1	1	1		1	1	1	1	1	1																						
2020	B	9	B009	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1						1	1																												
2020	B	9	B009	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1																																			
2020	B	10	B010	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive									1	1	1	1	1	1	1	1	1																							
2020	B	10	B010	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1			1	1	1	1																								
2020	B	10	B010	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1																																
2020	B	11	B011	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1		1	1																									
2020	B	11	B011	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive													1	1	1	1	1	1																						
2020	B	11	B011	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead								1	1	1	1	1																												
2020	B	11	B011	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive										1	1	1																												
2020	B	11	B011	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1																																	
2020	B	12	B012	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1														
2020	B	12	B012	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1														
2020	B	12	B012	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead																					1																			
2020	B	12	B012	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	B	12	B012	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	B	13	B013	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1																				1	1	1	1	1	1	1	1	1
2020	B	13	B013	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																													1	1	1	1								
2020	B	13	B013	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
2020	B	13	B013	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive											1	1	1	1	1	1	1	1	1												1	1	1	1						
2020	B	13	B013	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead																					1	1	1	1																
2020	B	14	B014	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1																						1												
2020	B	14	B014	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive									1	1										1	1	1	1	1	1	1	1	1												
2020	B	14	B014	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																										1	1													
2020	B	14	B014	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1															
2020	B	15	B015	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive																		1	1						1															
2020	B	15	B015	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive												1	1		1	1	1	1	1	1	1																			
2020	B	15	B015	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive	1	1	1	1						1	1	1																												
2020	B	15	B015	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	B	15	B015	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	B	16	B016	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																	1	1																						

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	B	16	B016	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	B	16	B016	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1																													
2020	B	16	B016	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead |1|																																							
2020	B	17	B017	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1							1																					
2020	B	17	B017	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead																				1	1																				
2020	B	17	B017	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	B	17	B017	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive									1	1	1	1	1																												
2020	B	18	B018	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead																			1	1																					
2020	B	18	B018	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	B	18	B018	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead											1	1	1	1	1	1																									
2020	B	18	B018	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead											1	1	1	1	1																										
2020	B	19	B019	EMProb	Leaf Litter	Empodisma robustum	Alive												1	1	1	1	1	1	1																							
2020	B	19	B019	SCHbre	Leaf Litter	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1																											
2020	B	19	B019	GLEdic Dead	Leaf Litter	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	B	19	B019	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead |1|																																							
2020	B	20	B020	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	B	20	B020	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead									1	1	1	1	1																												
2020	B	20	B020	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	B	20	B020	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1																														
2020	B	21	B021	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead																								1	1	1	1												
2020	B	21	B021	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										1												
2020	B	21	B021	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive																	1	1	1	1	1	1	1	1	1	1	1												
2020	B	21	B021	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead																	1	1	1	1	1	1	1	1	1	1	1												
2020	B	21	B021	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	B	22	B022	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive																			1																				
2020	B	22	B022	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	B	22	B022	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	B	23	B023	SCHbre	Leaf Litter	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						1															
2020	B	23	B023	SCHbre Dead	Leaf Litter	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	B	23	B023	GLEdic Dead	Leaf Litter	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	B	24	B024	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive																						1	1	1															
2020	B	24	B024	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1																			
2020	B	24	B024	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																			1	1																					
2020	B	24	B024	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead											1	1	1	1	1	1	1																								
2020	B	25	B025	KUNlin	Leaf Litter	Kunzea linearis	Alive										1	1				1	1	1	1	1	1	1																		
2020	B	25	B025	GLEdic Dead	Leaf Litter	Gleichenia dicarpa	Dead						1	1	1	1	1																													
2020	B	25	B025	SCHfis Dead	Leaf Litter	Schizaea fistulosa	Dead		1	1	1	1																																		
2020	B	26	B026	KUNlin	Leaf Litter	Kunzea linearis	Alive														1	1																								
2020	B	26	B026	CASpan Dead	Leaf Litter	Cassytha paniculata	Dead									1																														
2020	B	26	B026	GLEdic	Leaf Litter	Gleichenia dicarpa	Alive					1																																		
2020	B	27	B027	LEPsco	Leaf Litter	Leptospermum scoparium	Alive													1	1		1	1	1																					
2020	B	27	B027	SCHbre	Leaf Litter	Schoenus brevifolius	Alive										1	1																													
2020	B	27	B027	GONinc	Leaf Litter	Gonocarpus incanus	Alive |1|																																							
2020	B	28	B028	LEUfas	Leaf Litter	Leucopogon fasciculatus	Alive		1		1	1		1	1	1	1	1																													
2020	B	28	B028	CASpan	Leaf Litter	Cassytha paniculata	Alive									1	1																													
2020	B	29	B029	LEPsco	Leaf Litter	Leptospermum scoparium	Alive						1	1						1	1																									
2020	B	29	B029	SCHbre	Leaf Litter	Schoenus brevifolius	Alive													1	1																									
2020	B	29	B029	CLAcon	Leaf Litter	Cladonia confusa	Alive |1|																																							
2020	B	30	B030	LEPsco	Leaf Litter	Leptospermum scoparium	Alive									1	1	1	1	1																												
2020	B	30	B030	CASpan	Leaf Litter	Cassytha paniculata	Alive										1	1																													

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	B	30	B030	SCHbre Dead	Leaf Litter	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1																																
2020	B	30	B030	CLAcon	Leaf Litter	Cladonia confusa	Alive	1																																									
2020	B	31	B031	LEPsco	Leaf Litter	Leptospermum scoparium	Alive								1	1										1	1																				
2020	B	31	B031	SCHbre	Leaf Litter	Schoenus brevifolius	Alive											1	1																												
2020	B	31	B031	LEUfas	Leaf Litter	Leucopogon fasciculatus	Alive					1	1	1	1																																
2020	B	32	B032	CASpan	Leaf Litter	Cassytha paniculata	Alive															1																									
2020	B	32	B032	LEPsco	Leaf Litter	Leptospermum scoparium	Alive			1	1										1	1																									
2020	B	32	B032	KUNlin	Leaf Litter	Kunzea linearis	Alive										1	1	1	1																											
2020	B	33	B033	LEPsco	Leaf Litter	Leptospermum scoparium	Alive			1	1	1	1																																
2020	B	34	B034	LEPsco	Leaf Litter	Leptospermum scoparium	Alive										1									1	1																				
2020	B	34	B034	MORaff	Leaf Litter	Morelotia affinis	Alive		1	1	1																																				
2020	B	35	B035	LEPsco	Leaf Litter	Leptospermum scoparium	Alive								1							1	1	1																							
2020	B	35	B035	HAKser	Leaf Litter	Hakea sericea	Alive					1	1	1					1	1																											
2020	B	35	B035	CASpan	Leaf Litter	Cassytha paniculata	Alive											1																													
2020	B	36	B036	LEPsco	Bare Ground	Leptospermum scoparium	Alive									1		1	1																												
2020	B	36	B036	LEPsco Dead	Bare Ground	Leptospermum scoparium	Dead						1																																		
2020	B	36	B036	CLAcon	Leaf Litter	Cladonia confusa	Alive	1																																									
2020	B	37	B037	CASpan	Leaf Litter	Cassytha paniculata	Alive																			1	1																				
2020	B	37	B037	LEPsco	Bare Ground	Leptospermum scoparium	Alive																1	1	1																						
2020	B	37	B037	LEPsco Dead	Bare Ground	Leptospermum scoparium	Dead											1																													
2020	B	37	B037	HAKser	Leaf Litter	Hakea sericea	Alive		1																																						
2020	B	38	B038	SCHbre Dead	Leaf Litter	Schoenus brevifolius	Dead							1	1	1	1																												
2020	B	38	B038	SCHbre	Leaf Litter	Schoenus brevifolius	Alive									1	1	1	1																										
2020	B	38	B038	HAKser	Leaf Litter	Hakea sericea	Alive					1	1																																
2020	B	38	B038	LEPsco	Bare Ground	Leptospermum scoparium	Alive				1																																				
2020	B	39	B039	KUNlin	Vegetation	Kunzea linearis	Alive											1	1	1	1	1	1																								
2020	B	39	B039	CASpan	Vegetation	Cassytha paniculata	Alive								1	1					1	1	1																								
2020	B	39	B039	SCHbre Dead	Vegetation	Schoenus brevifolius	Dead					1	1	1	1	1																													
2020	B	39	B039	CLAcon	Vegetation	Cladonia confusa	Alive	1																																									
2020	B	40	B040	KUNlin	Leaf Litter	Kunzea linearis	Alive												1	1	1	1	1																								
2020	B	40	B040	CASpan	Leaf Litter	Cassytha paniculata	Alive													1																											
2020	B	40	B040	SCHbre	Leaf Litter	Schoenus brevifolius	Alive													1																											
2020	B	40	B040	MORaff	Leaf Litter	Morelotia affinis	Alive	1	1			1	1	1	1																														
2020	B	40	B040	SCHbre Dead	Leaf Litter	Schoenus brevifolius	Dead			1	1																																		
2020	B	41	B041	KUNlin	Leaf Litter	Kunzea linearis	Alive									1	1	1			1	1	1	1	1	1	1	1																			
2020	B	41	B041	LEPsco	Leaf Litter	Leptospermum scoparium	Alive														1	1																									
2020	B	41	B041	CASpan	Leaf Litter	Cassytha paniculata	Alive									1	1	1																													
2020	B	41	B041	SCHfis	Leaf Litter	Schizaea fistulosa	Alive						1																																		
2020	B	42	B042	LEPsco	Leaf Litter	Leptospermum scoparium	Alive																							1	1	1															
2020	B	42	B042	CASpan	Leaf Litter	Cassytha paniculata	Alive																							1	1																
2020	B	42	B042	EMProb	Leaf Litter	Empodisma robustum	Alive																		1	1																					
2020	B	42	B042	SCHbre	Leaf Litter	Schoenus brevifolius	Alive						1	1	1	1	1						1	1																							
2020	B	42	B042	SCHbre Dead	Leaf Litter	Schoenus brevifolius	Dead	1	1	1	1		1	1	1	1	1																												
2020	B	42	B042	GLEdic	Leaf Litter	Gleichenia dicarpa	Alive	1	1	1	1										1	1	1	1																							
2020	B	43	B043	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive										1	1				1	1	1	1	1																					
2020	B	43	B043	CASpan	Leaf Litter (Sphagnum)	Cassytha paniculata	Alive																1	1																							
2020	B	43	B043	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive															1	1																								
2020	B	43	B043	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive	1	1	1	1										1	1																									
2020	B	43	B043	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead										1	1																													
2020	B	43	B043	DIAhae	Leaf Litter (Sphagnum)	Dianella haematica	Alive				1	1																																			

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	B	44	B044	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1																			
2020	B	44	B044	DIAhae	Leaf Litter (Sphagnum)	Dianella haematica	Alive	1	1	1	1	1	1	1	1	1	1	1	1			1																									
2020	B	44	B044	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1							1	1																							
2020	B	44	B044	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1	1	1																													
2020	B	45	B045	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive															1	1	1	1																					
2020	B	45	B045	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																	1	1																					
2020	B	45	B045	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2020	B	45	B045	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1																											
2020	B	46	B046	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive																1	1																						
2020	B	46	B046	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive	1	1	1	1	1	1	1	1								1	1																						
2020	B	46	B046	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	B	46	B046	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	B	47	B047	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																1																							
2020	B	47	B047	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	B	47	B047	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	B	48	B048	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	B	48	B048	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1																															
2020	B	49	B049	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1																													
2020	B	49	B049	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																																
2020	B	50	B050	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive		1																																						
2020	B	51	B051	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	B	51	B051	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1																																					
2020	B	52	B052	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	B	53	B053	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	B	53	B053	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1																																						
2020	B	54	B054	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive					1	1	1	1						1		1																								
2020	B	54	B054	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	B	54	B054	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1			1	1																												
2020	B	55	B055	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1																																
2020	B	55	B055	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead							1																																	
2020	B	56	B056	UTRgib	Leaf Litter	Utricularia gibba	Alive	1																																							
2020	B	57	B057	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	B	57	B057	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead	1	1	1	1																																				
2020	B	58	B058	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1	1	1	1	1	1																																	
2020	B	58	B058	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead	1	1	1																																					
2020	B	59	B059	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1	1	1																																	
2020	B	60	B060	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive						1	1																																	
2020	B	60	B060	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead	1	1	1	1	1																																			
2020	B	61	B061	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive										1																														
2020	B	61	B061	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive			1																																						
2020	B	61	B061	UTRgib	Leaf Litter	Utricularia gibba	Alive	1																																							
2020	B	62	B062	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive																		1																							
2020	B	62	B062	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2020	B	62	B062	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1																													
2020	B	63	B063	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1																																	
2020	B	63	B063	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive															1	1	1	1	1	1	1																			
2020	B	64	B064	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	B	65	B065	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																						
2020	B	66	B066	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1	1																																					
2020	B	66	B066	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1																																							

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	B	67	B067	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	67	B067	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1																																					
2020	B	68	B068	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1	1																																			
2020	B	68	B068	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1																																					
2020	B	69	B069	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	70	B070	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1																																				
2020	B	71	B071	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	71	B071	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1																																				
2020	B	72	B072	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1																																					
2020	B	73	B073	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																				
2020	B	74	B074	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																				
2020	B	75	B075	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	76	B076	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1																																	
2020	B	76	B076	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1																																					
2020	B	77	B077	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	B	77	B077	SCHbre	Vegetation	Schoenus brevifolius	Alive			1					1																																
2020	B	78	B078	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1																																				
2020	B	79	B079	EMProb	Leaf Litter	Empodisma robustum	Alive	1	1	1	1	1	1	1	1																														
2020	B	79	B079	SCHbre	Leaf Litter	Schoenus brevifolius	Alive					1																																	
2020	B	80	B080	EMProb	Leaf Litter	Empodisma robustum	Alive	1	1	1	1	1	1	1	1																														
2020	B	80	B080	SCHbre	Leaf Litter	Schoenus brevifolius	Alive			1	1																																		
2020	B	81	B081	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	81	B081	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1																																					
2020	B	82	B082	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	83	B083	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	84	B084		Bare Ground (Peat)																																								
2020	B	85	B085	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive				1	1	1	1																																	
2020	B	86	B086	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive										1							1																							
2020	B	86	B086	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead							1	1	1	1																														
2020	B	86	B086	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive					1	1	1	1	1																															
2020	B	86	B086	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead				1	1	1	1	1	1																															
2020	B	86	B086	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	87	B087	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1																																					
2020	B	88	B088	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																				
2020	B	89	B089	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	89	B089	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1																																				
2020	B	90	B090	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Dead	1	1																																				
2020	B	91	B091		Bare Ground (Peat)																																								
2020	B	92	B092	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	93	B093	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	94	B094	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	95	B095	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																					
2020	B	96	B096		Bare Ground (Peat)																																								
2020	B	97	B097	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																				
2020	B	98	B098	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1																																				
2020	B	99	B099	UTRgib	Vegetation	Utricularia gibba	Alive	1																																					
2020	B	100	B100	MACjun Dead	Bare Ground (Peat)	Machaerina juncea	Dead	1	1																																				
2020	C	0	C000	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive																				1	1	1	1																	
2020	C	0	C000	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																	
2020	C	1	C001	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1										

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	C	1	C001	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive																							1	1	1	1	1													
2020	C	1	C001	LEPsco Dead	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Dead																									1															
2020	C	1	C001	GLEdic	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Alive																							1	1																
2020	C	1	C001	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																		
2020	C	1	C001	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1	1																															
2020	C	2	C002	LEPsco Dead	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Dead																								1	1															
2020	C	2	C002	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	2	C002	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive											1	1	1	1	1	1	1	1	1	1	1	1																		
2020	C	3	C003	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
2020	C	3	C003	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead													1	1	1	1	1																							
2020	C	3	C003	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive					1	1																																		
2020	C	3	C003	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1	1																															
2020	C	4	C004	MACter	Leaf Litter (Sphagnum)	*Machaerina teretifolia*	Alive															1				1																					
2020	C	4	C004	GLEdic	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Alive																	1																							
2020	C	4	C004	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	C	4	C004	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead										1	1	1	1																											
2020	C	4	C004	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive	1	1																																						
2020	C	5	C005	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive																				1				1	1															
2020	C	5	C005	GLEdic	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Alive																				1																					
2020	C	5	C005	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive										1					1	1	1	1	1																					
2020	C	5	C005	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead										1	1	1	1																											
2020	C	5	C005	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1	1																															
2020	C	6	C006	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive				1				1	1											1	1																		
2020	C	6	C006	GLEdic	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Alive							1									1	1	1																						
2020	C	6	C006	MACter Dead	Leaf Litter (Sphagnum)	*Machaerina teretifolia*	Dead														1	1	1	1																							
2020	C	6	C006	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive										1	1	1	1	1	1																									
2020	C	6	C006	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1																																		
2020	C	7	C007	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive																				1	1	1	1	1	1															
2020	C	7	C007	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	C	7	C007	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead														1	1																									
2020	C	7	C007	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1	1																															
2020	C	8	C008	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1															
2020	C	8	C008	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	C	8	C008	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				
2020	C	8	C008	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive										1																														
2020	C	9	C009	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive																												1	1	1	1									
2020	C	9	C009	MACter Dead	Leaf Litter (Sphagnum)	*Machaerina teretifolia*	Dead																		1	1	1	1	1																		
2020	C	9	C009	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive							1	1	1		1	1	1	1	1	1	1	1	1	1	1	1																		
2020	C	9	C009	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1																							
2020	C	10	C010	LEPsco	Leaf Litter (Sphagnum)	*Leptospermum scoparium*	Alive																		1	1	1				1	1															
2020	C	10	C010	MACter Dead	Leaf Litter (Sphagnum)	*Machaerina teretifolia*	Dead																1																								
2020	C	10	C010	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive										1	1	1	1	1	1	1	1	1																					
2020	C	10	C010	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1	1																															
2020	C	10	C010	GLEdic	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Alive	1	1	1																																					
2020	C	11	C011	SCHbre Dead	Leaf Litter (Sphagnum)	*Schoenus brevifolius*	Dead																	1	1	1	1	1	1	1	1	1															
2020	C	11	C011	EMProb	Leaf Litter (Sphagnum)	*Empodisma robustum*	Alive															1	1	1	1	1	1	1	1																		
2020	C	11	C011	GLEdic	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Alive															1	1																								
2020	C	11	C011	SCHbre	Leaf Litter (Sphagnum)	*Schoenus brevifolius*	Alive												1	1																										
2020	C	11	C011	EMProb Dead	Leaf Litter (Sphagnum)	*Empodisma robustum*	Dead	1	1	1	1	1	1	1	1		1	1	1																												
2020	C	11	C011	GLEdic Dead	Leaf Litter (Sphagnum)	*Gleichenia dicarpa*	Dead	1	1	1	1	1	1	1	1																																

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	C	12	C012	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive									1	1					1							1	1						1											
2020	C	12	C012	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive																									1	1	1													
2020	C	12	C012	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive																	1	1	1	1	1																			
2020	C	12	C012	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
2020	C	12	C012	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead											1	1	1	1																										
2020	C	13	C013	EMProb	Leaf Litter	Empodisma robustum	Alive																	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
2020	C	13	C013	GLEdic	Leaf Litter	Gleichenia dicarpa	Alive																										1	1	1												
2020	C	13	C013	LEPsco	Leaf Litter	Leptospermum scoparium	Alive																			1																					
2020	C	13	C013	GLEdic Dead	Leaf Litter	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1	1	1								1	1																			
2020	C	13	C013	EMProb Dead	Leaf Litter	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																												
2020	C	13	C013	LL	Leaf Litter		Dead	1																																					
2020	C	14	C014	EMProb	Leaf Litter	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1																	
2020	C	14	C014	GLEdic Dead	Leaf Litter	Gleichenia dicarpa	Dead	1	1	1	1												1	1	1	1	1																		
2020	C	14	C014	GLEdic	Leaf Litter	Gleichenia dicarpa	Alive																				1																		
2020	C	14	C014	EMProb Dead	Leaf Litter	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2020	C	14	C014	LEPsco	Leaf Litter	Leptospermum scoparium	Alive			1																																			
2020	C	15	C015	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
2020	C	15	C015	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead																	1	1	1	1																				
2020	C	15	C015	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive											1	1	1																											
2020	C	15	C015	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1																												
2020	C	15	C015	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive					1																																	
2020	C	16	C016	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1												1	1																	
2020	C	16	C016	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1																		
2020	C	16	C016	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead											1	1	1																											
2020	C	16	C016	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1																													
2020	C	16	C016	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																					
2020	C	17	C017	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1																				
2020	C	17	C017	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive														1	1	1	1																							
2020	C	17	C017	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	C	17	C017	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead										1	1	1	1																											
2020	C	18	C018	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				
2020	C	18	C018	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive													1	1	1																									
2020	C	18	C018	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1																													
2020	C	19	C019	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1												1	1	1																
2020	C	19	C019	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																				
2020	C	19	C019	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive											1	1	1	1	1	1	1	1	1																					
2020	C	20	C020	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive															1	1	1	1																						
2020	C	20	C020	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive											1	1	1																											
2020	C	20	C020	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1																											
2020	C	21	C021	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive											1	1	1	1	1	1	1																							
2020	C	21	C021	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	C	21	C021	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead								1	1	1																														
2020	C	22	C022	MACter	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1																										
2020	C	22	C022	MACter Dead	Bare Ground (Peat)	Machaerina teretifolia	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									
2020	C	22	C022	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive									1	1	1	1	1																											
2020	C	22	C022	GLEdic	Bare Ground (Peat)	Gleichenia dicarpa	Alive											1	1																												
2020	C	22	C022	GLEdic Dead	Bare Ground (Peat)	Gleichenia dicarpa	Dead	1	1	1	1	1	1	1	1																														
2020	C	23	C023	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive													1																											
2020	C	23	C023	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive								1	1	1	1				1																									
2020	C	23	C023	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1																													

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	C	23	C023	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	24	C024	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive										1	1	1	1	1	1	1	1	1																								
2020	C	24	C024	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead									1	1	1		1	1	1																									
2020	C	24	C024	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																																
2020	C	24	C024	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	25	C025	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	C	25	C025	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive											1			1	1																									
2020	C	25	C025	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1																																
2020	C	25	C025	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	26	C026	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive					1	1	1	1	1																																
2020	C	26	C026	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead								1	1	1																															
2020	C	26	C026	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1																																				
2020	C	26	C026	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive				1																																				
2020	C	26	C026	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	27	C027	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive						1	1					1																												
2020	C	27	C027	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead							1	1																																	
2020	C	27	C027	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1																																		
2020	C	27	C027	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	28	C028	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive																1																							
2020	C	28	C028	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive								1	1	1	1	1																												
2020	C	28	C028	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead					1	1	1	1	1	1																													
2020	C	28	C028	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																																
2020	C	29	C029	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive											1	1	1	1																										
2020	C	29	C029	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive											1	1	1																											
2020	C	29	C029	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	29	C029	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive				1	1	1	1	1																																
2020	C	30	C030	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive										1	1	1	1	1	1	1	1																							
2020	C	30	C030	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead	1	1	1	1	1	1	1	1	1					1																									
2020	C	30	C030	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead												1																											
2020	C	30	C030	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1																														
2020	C	30	C030	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive					1	1	1	1	1																														
2020	C	30	C030	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead								1	1	1	1	1																											
2020	C	31	C031	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead																1	1	1																					
2020	C	31	C031	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	C	31	C031	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive														1	1	1																							
2020	C	31	C031	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1				1																											
2020	C	31	C031	LEPsco Dead	Leaf Litter (Sphagnum)	Leptospermum scoparium	Dead					1	1																																	
2020	C	31	C031	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1																																		
2020	C	31	C031	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	32	C032	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1												1	1															
2020	C	32	C032	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive																	1	1	1	1																			
2020	C	32	C032	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	C	32	C032	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	33	C033	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1						1	1	1	1	1	1	1																									
2020	C	33	C033	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive										1	1	1	1																											
2020	C	33	C033	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																																
2020	C	33	C033	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1																																							
2020	C	34	C034	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive													1																										
2020	C	34	C034	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive											1	1	1																											
2020	C	34	C034	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1					1	1	1	1	1																											
2020	C	34	C034	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	35	C035	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	C	35	C035	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	35	C035	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1	1	1	1																												
2020	C	36	C036	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead																							1																
2020	C	36	C036	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive										1	1	1	1	1	1	1	1																							
2020	C	36	C036	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	37	C037	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive													1	1	1	1	1																							

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	C	37	C037	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1		1	1		1	1	1	1	1	1	1	1																								
2020	C	37	C037	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	38	C038	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive											1	1				1																								
2020	C	38	C038	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead												1																												
2020	C	38	C038	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1																											
2020	C	38	C038	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																														
2020	C	39	C039	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive															1																									
2020	C	39	C039	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead												1																												
2020	C	39	C039	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1					1	1	1	1	1	1	1	1	1																									
2020	C	39	C039	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1																															
2020	C	40	C040	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead											1							1																						
2020	C	40	C040	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive															1																									
2020	C	40	C040	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
2020	C	40	C040	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	41	C041	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead														1					1																					
2020	C	41	C041	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive					1	1					1	1	1	1																										
2020	C	41	C041	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1																												
2020	C	42	C042	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead													1																											
2020	C	42	C042	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive			1	1					1	1	1	1	1	1																										
2020	C	42	C042	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1																												
2020	C	43	C043	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive											1	1	1		1	1	1																							
2020	C	43	C043	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1																											
2020	C	43	C043	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1																													
2020	C	43	C043	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead											1	1																												
2020	C	44	C044	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive			1	1	1	1	1	1	1	1	1																												
2020	C	44	C044	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead			1	1	1	1																																
2020	C	45	C045	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive										1	1	1	1																											
2020	C	45	C045	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive								1	1	1																														
2020	C	45	C045	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1	1																												
2020	C	46	C046	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive														1	1																									
2020	C	46	C046	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive				1	1	1	1	1	1	1	1																												
2020	C	46	C046	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead							1	1																														
2020	C	46	C046	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead			1	1	1	1																																
2020	C	46	C046	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1	1																																				
2020	C	47	C047	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive								1	1	1	1	1	1																											
2020	C	47	C047	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	47	C047	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead							1	1	1	1																														
2020	C	47	C047	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive									1	1																														
2020	C	48	C048	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive						1	1	1	1	1	1	1	1																											
2020	C	48	C048	MACter Dead	Leaf Litter (Sphagnum)	Machaerina teretifolia	Dead							1	1	1																													
2020	C	48	C048	MACter	Leaf Litter (Sphagnum)	Machaerina teretifolia	Alive							1																															
2020	C	48	C048	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1																													
2020	C	49	C049	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive											1	1	1	1	1	1	1	1																						
2020	C	49	C049	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead							1	1	1	1	1	1	1	1																									
2020	C	49	C049	LLS	Leaf Litter (Sphagnum)	Sphagnum sp.	Dead	1	1	1	1	1	1																																
2020	C	50	C050	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1				1	1	1	1	1	1	1																											
2020	C	50	C050	MAC sp.	Leaf Litter (Sphagnum)	Machaerina sp.	Alive											1																													
2020	C	50	C050	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead								1	1	1																														
2020	C	50	C050	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1																															
2020	C	51	C051	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive	1	1	1	1							1												1																	

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	C	51	C051	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																					
2020	C	52	C052	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive						1																																		
2020	C	52	C052	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive	1	1	1	1																																				
2020	C	52	C052	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	53	C053	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive	1	1	1	1																																				
2020	C	53	C053	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead	1	1	1	1	1	1																																		
2020	C	54	C054	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead	1	1	1	1							1																													
2020	C	55	C055	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive															1	1																								
2020	C	55	C055	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1																							
2020	C	55	C055	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead		1	1	1	1																																			
2020	C	56	C056	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1		1		1	1																																	
2020	C	56	C056	LYClat	Bare Ground (Peat)	Lycopodiella lateralis	Alive			1																																					
2020	C	56	C056	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive											1	1	1	1																										
2020	C	56	C056	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive	1	1	1	1	1	1	1	1	1	1	1																													
2020	C	57	C057	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1																																
2020	C	57	C057	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead			1	1	1	1																																		
2020	C	57	C057	LYClat	Leaf Litter (Sphagnum)	Lycopodiella lateralis	Alive	1	1																																						
2020	C	57	C057	MAC sp.	Leaf Litter (Sphagnum)	Machaerina sp.	Alive					1	1	1	1																																
2020	C	58	C058	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	C	58	C058	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive	1	1	1	1	1	1																																		
2020	C	59	C059	EMProb Dead	Vegetation	Empodisma robustum	Dead			1	1																																				
2020	C	59	C059	LYCser	Vegetation	Lycopodiella serpentina	Alive	1																																							
2020	C	59	C059	MAC sp.	Vegetation	Machaerina sp.	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	C	59	C059	MAC sp. Dead	Vegetation	Machaerina sp.	Dead	1	1	1	1		1																																		
2020	C	60	C060	EMProb	Vegetation	Empodisma robustum	Alive	1	1		1	1	1	1	1	1																															
2020	C	60	C060	EMProb Dead	Vegetation	Empodisma robustum	Dead	1	1																																						
2020	C	60	C060	Sphagnum sp.	Vegetation	Sphagnum sp.	Alive	1																																							
2020	C	60	C060	LYCser	Vegetation	Lycopodiella serpentina	Alive	1	1																																						
2020	C	61	C061	LYCser	Bare Ground (Peat)	Lycopodiella serpentina	Alive	1																																							
2020	C	61	C061	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	C	62	C062	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive							1																																	
2020	C	63	C063	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead																	1	1	1																					
2020	C	63	C063	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive											1																													
2020	C	64	C064	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive							1																																	
2020	C	65	C065	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1	1																														
2020	C	65	C065	EMProb Dead	Vegetation	Empodisma robustum	Dead	1	1	1																																					
2020	C	65	C065	LYCser	Vegetation	Lycopodiella serpentina	Alive	1																																							
2020	C	65	C065	Sphagnum sp.	Vegetation	Sphagnum sp.	Alive	1																																							
2020	C	66	C066	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1			1	1	1																																
2020	C	66	C066	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1					1	1	1	1																															
2020	C	66	C066	LYCser	Leaf Litter (Sphagnum)	Lycopodiella serpentina	Alive	1																																							
2020	C	67	C067		Bare Ground (Peat)																																										
2020	C	68	C068	DRObin	Bare Ground (Peat)	Drosera binata	Alive										1	1																													
2020	C	68	C068	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive									1																															
2020	C	68	C068	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive									1																															
2020	C	69	C069		Bare Ground (Peat)																																										
2020	C	70	C070	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive								1	1																															
2020	C	70	C070	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead				1	1	1	1																																	
2020	C	70	C070	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1																																							
2020	C	70	C070	DRObin	Bare Ground (Peat)	Drosera binata	Alive	1	1																																						

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	C	71	C071	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive		1																																						
2020	C	71	C071	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive						1	1	1	1																															
2020	C	72	C072	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1																																	
2020	C	72	C072	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1																																					
2020	C	73	C073	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead							1																																	
2020	C	73	C073	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive							1																																	
2020	C	74	C074	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead						1	1	1	1	1	1	1																												
2020	C	74	C074	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive						1	1																																	
2020	C	75	C075	SCHbre	Bare Ground (Peat)	Schoenus brevifolius	Alive											1	1	1	1	1																									
2020	C	75	C075	SCHbre Dead	Bare Ground (Peat)	Schoenus brevifolius	Dead																	1	1																						
2020	C	75	C075	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1																																
2020	C	75	C075	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead	1	1	1	1	1	1	1																																	
2020	C	76	C076	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive								1	1	1																														
2020	C	76	C076	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive					1	1	1	1	1	1																														
2020	C	76	C076	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1																																
2020	C	76	C076	LYCser	Leaf Litter (Sphagnum)	Lycopodiella serpentina	Alive	1																																							
2020	C	76	C076	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive	1	1	1	1	1	1																																
2020	C	77	C077		Bare Ground (Peat)																																										
2020	C	78	C078		Bare Ground (Peat)																																										
2020	C	79	C079		Bare Ground (Peat)																																										
2020	C	80	C080	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead	1	1	1																																					
2020	C	80	C080	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1																																						
2020	C	81	C081		Bare Ground (Peat)																																										
2020	C	82	C082	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																								
2020	C	83	C083	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive	1	1	1	1	1	1	1	1	1	1	1																													
2020	C	84	C084	MAC sp. Dead	Bare Ground (Peat)	Machaerina sp.	Dead	1	1	1	1	1	1	1	1	1	1				1																										
2020	C	85	C085	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive		1																																						
2020	C	86	C086	GLEdic	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Alive					1	1																																		
2020	C	86	C086	GLEdic Dead	Leaf Litter (Sphagnum)	Gleichenia dicarpa	Dead					1	1																																		
2020	C	86	C086	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive				1	1	1	1	1	1																															
2020	C	86	C086	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1																																
2020	C	87	C087	SCHbre	Leaf Litter (Sphagnum)	Schoenus brevifolius	Alive																	1									1	1													
2020	C	87	C087	SCHbre Dead	Leaf Litter (Sphagnum)	Schoenus brevifolius	Dead																1		1																						
2020	C	87	C087	LEPsco	Leaf Litter (Sphagnum)	Leptospermum scoparium	Alive												1	1	1	1	1	1																							
2020	C	87	C087	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive											1	1				1																								
2020	C	87	C087	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1	1	1	1	1	1	1																														
2020	C	88	C088	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1	1	1	1	1																															
2020	C	88	C088	GLEdic	Vegetation	Gleichenia dicarpa	Alive				1	1	1																																		
2020	C	88	C088	EMProb Dead	Vegetation	Empodisma robustum	Dead	1	1	1	1	1	1	1																																	
2020	C	88	C088	Sphagnum sp.	Vegetation	Sphagnum sp.	Alive	1																																							
2020	C	89	C089	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1	1																																
2020	C	89	C089	EMProb Dead	Vegetation	Empodisma robustum	Dead	1	1	1	1																																		
2020	C	89	C089	LYCser	Vegetation	Lycopodiella serpentina	Alive	1																																							
2020	C	89	C089	DRObin	Vegetation	Drosera binata	Alive	1																																							
2020	C	89	C089	Moss	Vegetation	Unidentfied Moss	Alive	1																																							
2020	C	90	C090	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive			1	1																																		
2020	C	91	C091	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1	1																																
2020	C	91	C091	EMProb Dead	Vegetation	Empodisma robustum	Dead	1	1	1	1	1																																	
2020	C	91	C091	LYCser	Vegetation	Lycopodiella serpentina	Alive	1																																							
2020	C	91	C091	Sphagnum sp.	Vegetation	Sphagnum sp.	Alive	1																																							

Year	Transect	Point No.	Full Point Name	Tag name	Ground cover	Species	Notes	0-5cm	5-10cm	10-15cm	15-20cm	20-25cm	25-30cm	30-35cm	35-40cm	40-45cm	45-50cm	50-55cm	55-60cm	60-65cm	65-70cm	70-75cm	75-80cm	80-85cm	85-90cm	90-95cm	95-100cm	100-105cm	105-110cm	110-115cm	115-120cm	120-125cm	125-130cm	130-135cm	135-140cm	140-145cm	145-150cm	150-155cm	155-160cm	160-165cm	165-170cm	170-175cm	175-180cm	180-185cm	185-190cm	190-195cm	195-200cm
2020	C	91	C091	DRObin	Vegetation	Drosera binata	Alive	1																																							
2020	C	92	C092	EMProb Dead	Vegetation	Empodisma robustum	Dead			1		1																																			
2020	C	92	C092	LYCser	Vegetation	Lycopodiella serpentina	Alive	1	1																																						
2020	C	92	C092	Sphagnum sp.	Vegetation	Sphagnum sp.	Alive	1																																							
2020	C	93	C093	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive	1	1	1																																					
2020	C	93	C093	MAC sp.	Bare Ground (Peat)	Machaerina sp.	Alive								1	1																															
2020	C	94	C094	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive			1			1	1	1	1																															
2020	C	94	C094	Moss	Bare Ground (Peat)	Unidentfied Moss	Alive	1																																							
2020	C	95	C095	UTRgib	Bare Ground (Peat)	Utricularia gibba	Alive				1																																				
2020	C	96	C096	EMProb	Bare Ground (Peat)	Empodisma robustum	Alive	1	1	1	1	1	1	1																																	
2020	C	96	C096	EMProb Dead	Bare Ground (Peat)	Empodisma robustum	Dead	1	1	1	1	1	1																																		
2020	C	96	C096	Sphagnum sp.	Bare Ground (Peat)	Sphagnum sp.	Alive	1																																							
2020	C	97	C097	SCHbre	Vegetation	Schoenus brevifolius	Alive	1	1	1	1	1	1	1	1	1																															
2020	C	97	C097	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1																																			
2020	C	97	C097	SCHbre Dead	Vegetation	Schoenus brevifolius	Dead	1	1	1	1	1	1																																		
2020	C	97	C097	EMProb Dead	Vegetation	Empodisma robustum	Dead	1	1	1	1																																				
2020	C	97	C097	LYCser	Vegetation	Lycopodiella serpentina	Alive	1																																							
2020	C	97	C097	Sphagnum sp.	Vegetation	Sphagnum sp.	Alive	1																																							
2020	C	98	C098		Bare Ground (Peat)																																										
2020	C	99	C099	EMProb	Leaf Litter (Sphagnum)	Empodisma robustum	Alive	1	1	1	1	1	1	1	1																																
2020	C	99	C099	EMProb Dead	Leaf Litter (Sphagnum)	Empodisma robustum	Dead	1	1	1	1																																				
2020	C	99	C099	LYCser	Leaf Litter (Sphagnum)	Lycopodiella serpentina	Alive	1																																							
2020	C	100	C100	EMProb	Vegetation	Empodisma robustum	Alive	1	1	1	1	1	1																																		
2020	C	100	C100	EMProb Dead	Vegetation	Empodisma robustum	Dead	1	1	1	1	1	1																																		
2020	C	100	C100	LYCser	Vegetation	Lycopodiella serpentina	Alive	1																																							
2020	C	100	C100	Moss	Vegetation	Unidentfied Moss	Alive	1																																							

APPENDIX 4

LIST OF PLANT SPECIES RECORDED AT KAIMAUMAU WETLAND

INDIGENOUS SPECIES

Dicot. trees and shrubs

Dracophyllum lessonianum	
Kunzea linearis	
Leptospermum scoparium agg.	mānuka
Leucopogon fasciculatus	mingimingi
Pimelea orthia	

Dicot. lianes

Cassytha paniculata	taihoa, mawhai

Lycopods and psilopsids

Lycopodiella lateralis
Lycopodiella serpentina

Ferns

Gleichenia dicarpa	tangle fern, swamp umbrella fern
Schizaea fistulosa	

Sedges

Fimbristylis velata	
Machaerina arthrophylla	
Machaerina juncea	
Machaerina rubiginosa	
Machaerina teretifolia	
Morelotia affinis	
Schoenus brevifolius	bog Schoenus

Rushes

Empodisma robustum	wire rush

Monocot. herbs (other than orchids, grasses, sedges, and rushes)

Dianella haematica	
Typha orientalis	raupō

Dicot. herbs (other than composites)

Drosera binata	sundew, wahu
Drosera spatulata	sundew, wahu
Gonocarpus incanus	piripiri

MOSSES

Sphagnum sp.

LICHENS

Cladonia confusa
Cladonia inflata
*Cladonia "*spaghetti*"*

NATURALISED AND EXOTIC SPECIES

Dicot. trees and shrubs

Hakea sericea	prickly hakea

Dicot. herbs (other than composites)

Utricularia gibba	bladderwort

APPENDIX 5

TRANSECT PHOTOGRAPHS

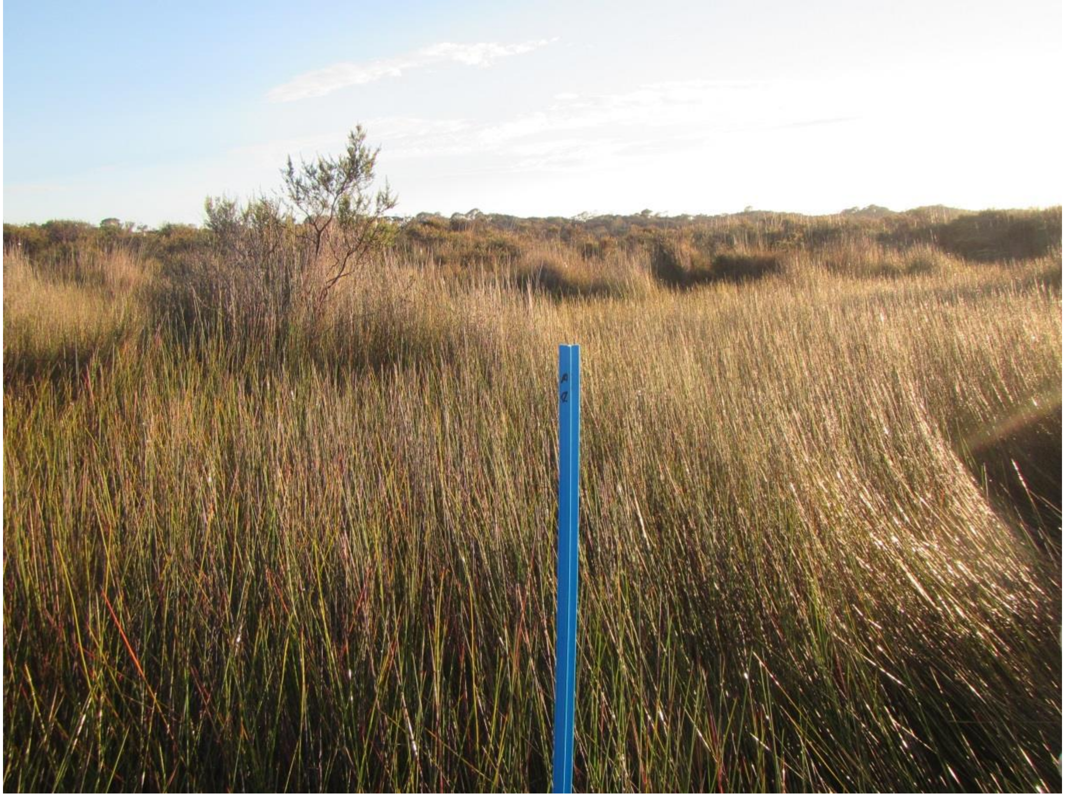


Plate 3: Transect A. Point 0 surrounded by dense bog Schoenus. 22 January 2020.

Plate 4: Transect A. Facing south (back along the transect) from near point 95. *Gleichenia dicarpa,* bog Schoenus and wire rush are visible on hummocks (foreground), and *Machaerina teretifolia* dominates wet peat areas (middle ground). 22 January 2020.

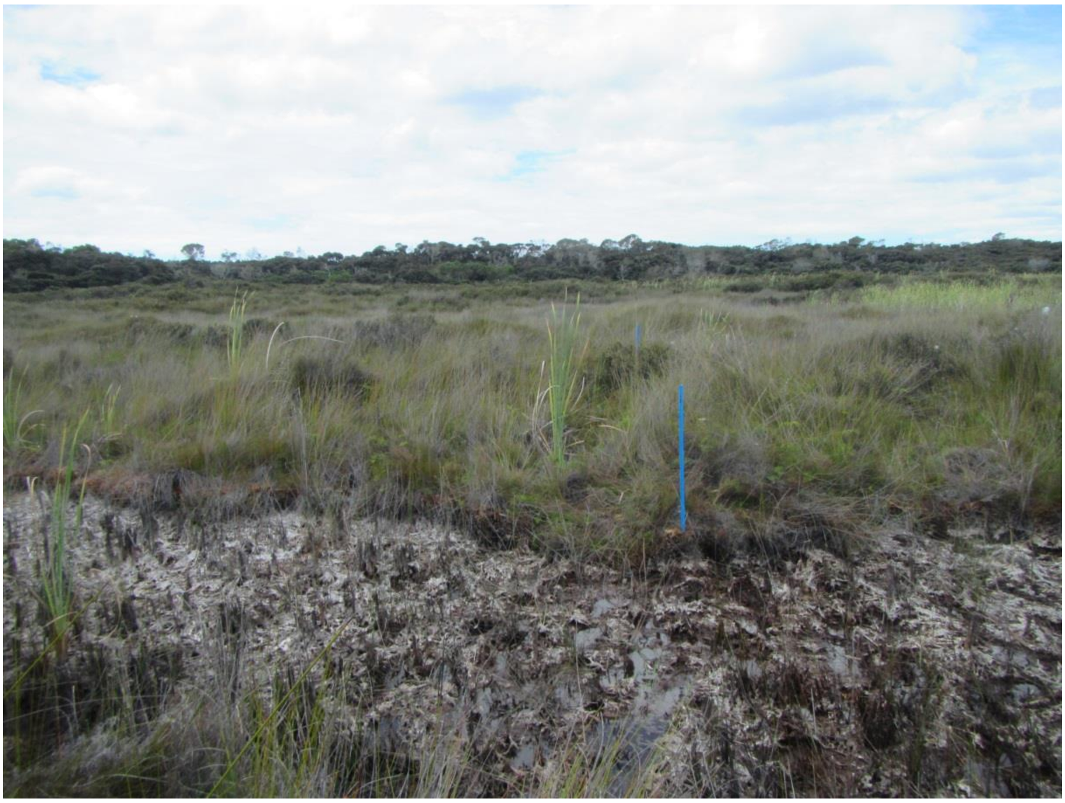


Plate 5: Transect A. Facing north from near the end of the transect. The nearest blue pole marks point 100. A patch of raupō (pale green) can be seen in the back ground (right). Plot 5 is partially visible to the right of the blue poles. 22 January 2020.

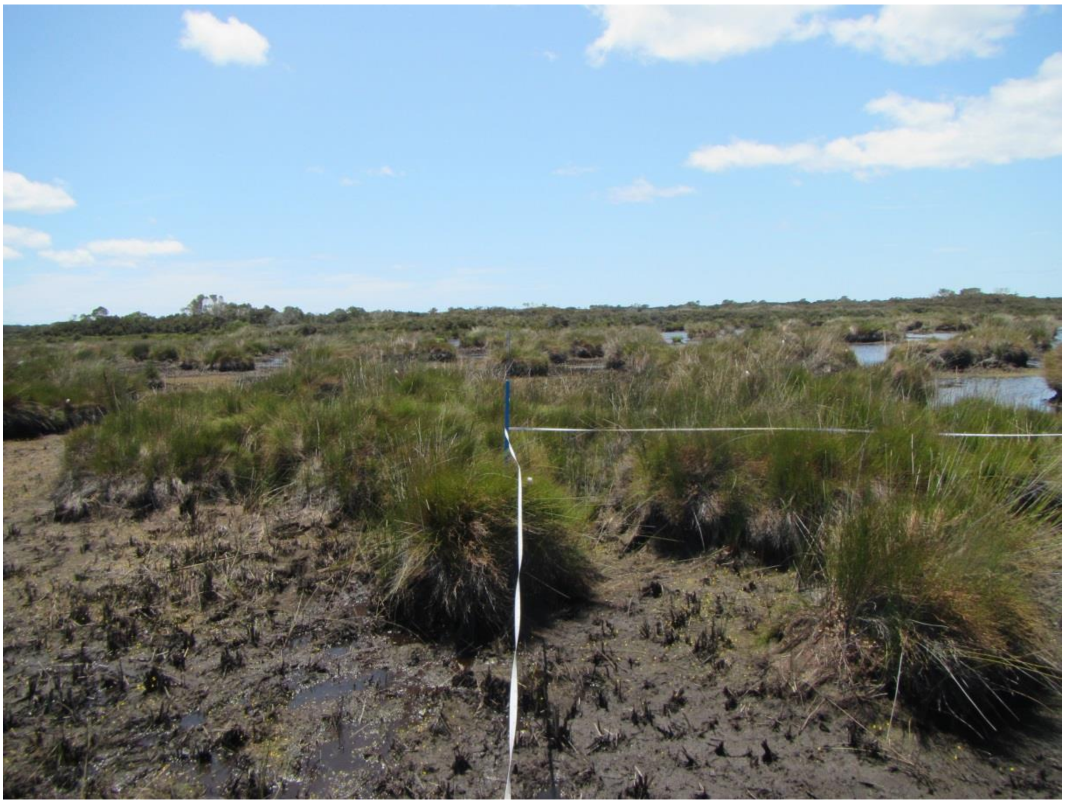


Plate 6: Transect B. Facing north from point 50. Plot 3 is visible in the lower right corner (as indicated by tape). 23 January 2020.

Plate 7: Transect B. Facing south (back along transect) from point 100. A large area of submerged peat is visible in the foreground. Hummocks are dominated by wire rush.
23 January 2020.

m

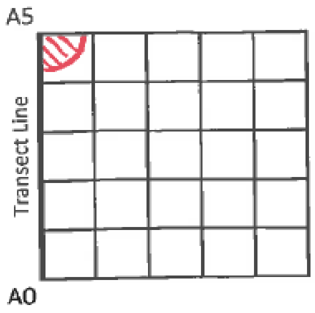
Plate 8: Transect C. Facing north along transect from point 25. Foreground vegetation comprises *Leptospermum scoparium, Gleichenia dicarpa,* wire rush and bog Schoenus.
24 January 2020.

APPENDIX 6

VEGETATION PLOT DATA

Date: 22-Jan-20
Transect: Transect A

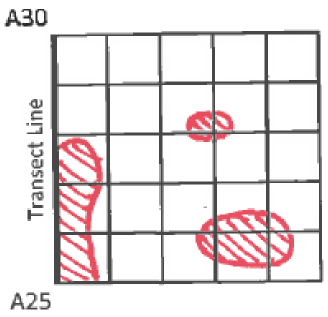
Plot 1		
Canopy Species	% Cover	Max Height (cm)
Schoenus brevifolius	99%	135
Machaerina teretifolia	1%	90
Gleichenia dicarpa	<1%	40
Empodisma robustum	<1%	40



Machaerina teretifolia

Schoenus brevifolius

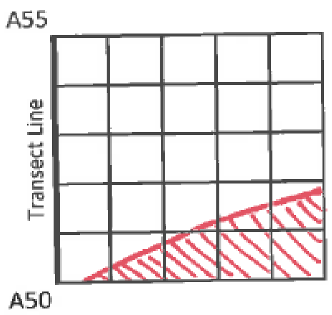
Plot 2		
Canopy Species	% Cover	Max Height (cm)
Gleichenia dicarpa	45%	120
Empodisma robustum	35%	110
Schoenus brevifolius	15%	150
Leptospermum scoparium	5%	175
Dianella haematica	<1%	130
Machaerina teretifolia	<1%	120



Leptospermum scoparium

All other species (mixed)

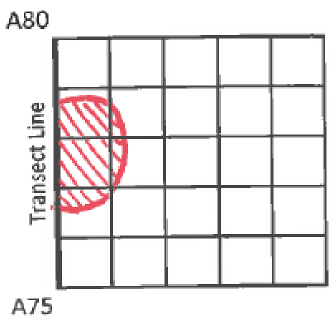
Plot 3		
Canopy Species	% Cover	Max Height (cm)
Exposed peat	35%	0
Gleichenia dicarpa	20%	75
Machaerina teretifolia	23%	80
Machaerina juncea	15%	75
Schoenus brevifolius	1%	135
Utricularia gibba	1%	10
Sphagnum sp.	1%	5
Leptospermum scoparium	1%	115
Drosera binata	<1%	50



Hummock featuring *Gleichenia dicarpa, Leptospermum scoparium, Machaerina teretifolia* and *Schoenus brevifolius*

Peat pool featuring *Machaerina teretifolia* and *Machaerina juncea*

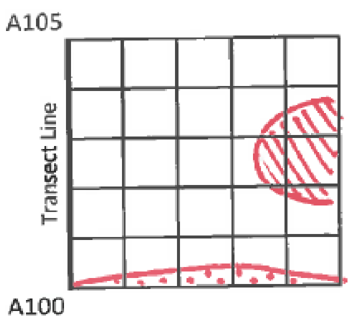
Plot 4		
Canopy Species	% Cover	Max Height (cm)
Exposed peat	50%	0
Machaerina juncea	30%	85
Machaerina teretifolia	14%	85
Sphagnum sp.	5%	10
Utricularia gibba	3%	10
Schoenus brevifolius	2%	100
Drosera binata	<1%	20



Hummock featuring *Sphagnum* sp., *Schoenus brevifolius, Machaerina teretifolia, Machaerina juncea,* and *Drosera binata*

Exposed peat with *Machaerina juncea, Machaerina teretifolia, Utricularia gibba*, and *Drosera binata*

Plot 5		
Canopy Species	% Cover	Max Height (cm)
Empodisma robustum	66%	70
Schoenus brevifolius	10%	140
Sphagnum sp.	10%	5
Leptospermum scoparium	5%	135
Machaerina teretifolia	5%	55
Exposed peat	2%	0
Gleichenia dicarpa	1%	40
Machaerina juncea	1%	50
Drosera binata	<1%	5
Lycopodiella serpentina	<1%	2
Typha orientalis	<1%	135



Leptospermum scoparium, *Empodisma robustum* and *Typha orientalis*

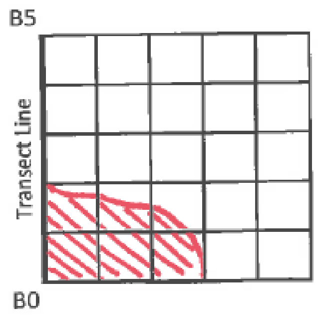
Exposed peat (edge of pool)

Empodisma robustum, Schoenus brevifolius, *Gleichenia dicarpa et al.*

Date: 23-Jan-20

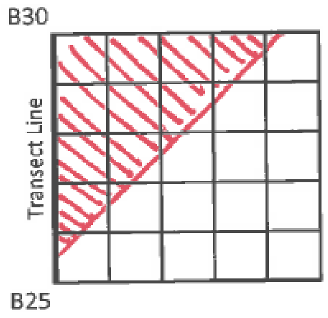
Transect: Transect B

Plot 1		
Canopy Species	% Cover	Max Height (cm)
Gleichenia dicarpa	45%	95
Schoenus brevifolius	35%	185
Empodisma robustum	15%	155
Leptospermum scoparium	3%	160
Kunzea linearis	1%	175
Dianella haematica	1%	165
Cassytha paniculata	<1	145



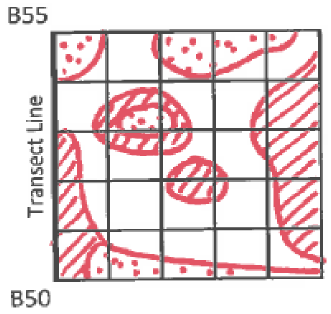
- *Kunzea linearis* (1), *Leptospermum scoparium* (3), *Gleichenia dicarpa,* and *Schoenus brevifolius*
- *Gleichenia dicarpa, Schoenus brevifolius* and *Dianella haematica*

Plot 2		
Canopy Species	% Cover	Max Height (cm)
Gleichenia dicarpa	45%	85
Leptospermum scoparium	25%	150
Schoenus brevifolius	12%	140
Kunzea linearis	10%	145
Dianella haematica	4%	90
Leucopogon fasciculatus	1%	95
Morelotia affinis	1%	50
Hakea sericea	1%	85
Cladonia confusa	1%	5
Cassytha paniculata	<1%	95
Pimelea orthia	<1%	10
Cladonia inflata	<1%	1
Cladonia "spaghetti"	<1%	1



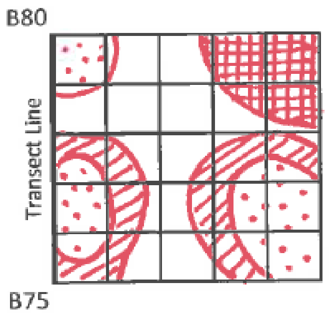
- *Leptospermum scoparium et al.*
- *Gleichenia dicarpa et al.*

Plot 3		
Canopy Species	% Cover	Max Height (cm)
Exposed peat	50%	0
Utricularia gibba	30%	15
Empodisma robustum	15%	50
Gleichenia dicarpa	2%	50
Schoenus brevifolius	2%	75
Machaerina teretifolia	1%	80



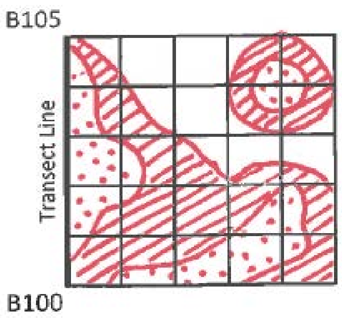
- Peat with *Utricularia gibba*
- Hummock with *Empodisma robustum et al.*
- Exposed peat

Plot 4		
Canopy Species	% Cover	Max Height (cm)
Exposed peat	50%	0
Empodisma robustum	22%	50
Open water	20%	0
Utricularia gibba	5%	10
Schoenus brevifolius	3%	95
Machaerina teretifolia	<1%	35
Machaerina arthrophylla	<1%	80



- Peat with *Utricularia gibba*
- Hummock with *Empodisma robustum, Schoenus brevifolius,* and *Machaerina arthrophylla*
- Open water
- Exposed peat

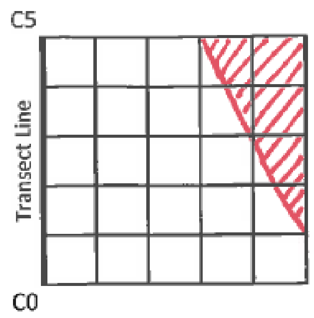
Plot 5		
Canopy Species	% Cover	Max Height (cm)
Empodisma robustum	40%	65
Open water	35%	0
Utricularia gibba	10%	10
Exposed peat	10%	0
Schoenus brevifolius	4%	100
Machaerina teretifolia	1%	110
Machaerina arthrophylla	<1%	100



- Exposed peat
- Hummock with *Empodisma robustum et al.*
- Open Water

Date: 24-Jan-20
Transect: Transect C

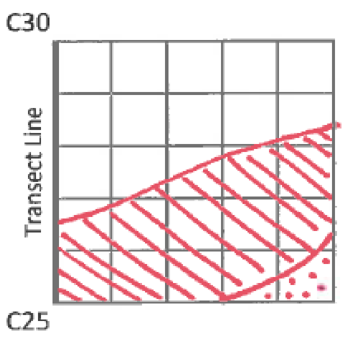
Plot 1		
Canopy Species	% Cover	Max Height (cm)
Empodisma robustum	49%	195
Leptospermum scoparium	39%	220
Gleichenia dicarpa	6%	130
Dracophyllum lessonianum	1%	230
Kunzea linearis	1%	145
Cassytha paniculata	1%	200
Schoenus brevifolius	1%	240
Machaerina teretifolia	1%	240
Bare ground	1%	0



Leptospermum scoparium, *Dracophyllum lessonianum* and *Kunzea linearis*

Empodisma robustum, Gleichenia dicarpa and *Leptospermum scoparium*

Plot 2		
Canopy Species	% Cover	Max Height (cm)
Empodisma robustum	70%	170
Gleichenia dicarpa	15%	115
Schoenus brevifolius	8%	175
Leptospermum scoparium	5%	170
Machaerina teretifolia	2%	75
Drosera binata	<1%	175

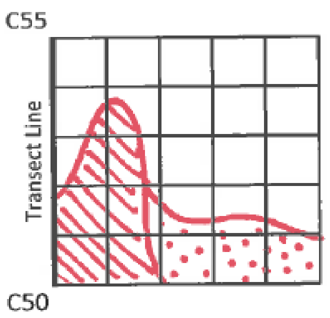


Mounded vegetation: *Empodisma robustum, Gleichenia dicarpa et al.*

Lower vegetation: *Empodisma robustum, Gleichenia dicarpa et al.*

Slack: *Schoenus brevifolius*

Plot 3		
Canopy Species	% Cover	Max Height (cm)
Machaerina sp.	52%	155
Empodisma robustum	40%	95
Schoenus brevifolius	8%	120
Gleichenia dicarpa	<1%	82
Leptospermum scoparium	<1%	110

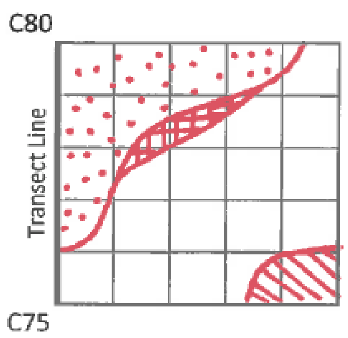


Hummock: *Empodisma robustum* and *Schoenus brevifolius*

Hummock: *Empodisma robustum* domininant, with *Schoenus brevifolius*

Pool: *Machaerina* sp.

Plot 4		
Canopy Species	% Cover	Max Height (cm)
Empodisma robustum	50%	65
Open water	29%	0
Exposed peat	5%	0
Schoenus brevifolius	3%	110
Leptospermum scoparium	2%	65
Machaerina sp.	1%	10
Gleichenia dicarpa	<1%	40
Lycopodiella serpentina	<1%	5
Drosera binata	<1%	20
Moss	<1%	2



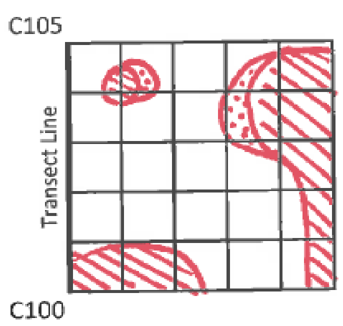
Exposed peat

Open water

Moss, *Drosera binata et al.*

Empodisma robustum, Schoenus brevifolius et al.

Plot 5		
Canopy Species	% Cover	Max Height (cm)
Open water	63%	0
Empodisma robustum	20%	60
Machaerina sp.	15%	135
Schoenus brevifolius	1%	80
Lycopodiella serpentina	1%	7
Drosera binata	<1%	12
Drosera spathulata	<1%	1
Utricularia gibba	<1%	10



Empodisma robustum et al.

Exposed Peat

Open water with *Machaerina* sp.

APPENDIX 7

VEGETATION PLOT
PHOTOGRAPHS

Plate 9: Plot A1. Facing north. 22 January 2020.

Plate 10: Plot A1. Facing diagonally across the plot form the southwest corner.
22 January 2020.

Plate 11: Plot A2. Facing north. 22 January 2020.

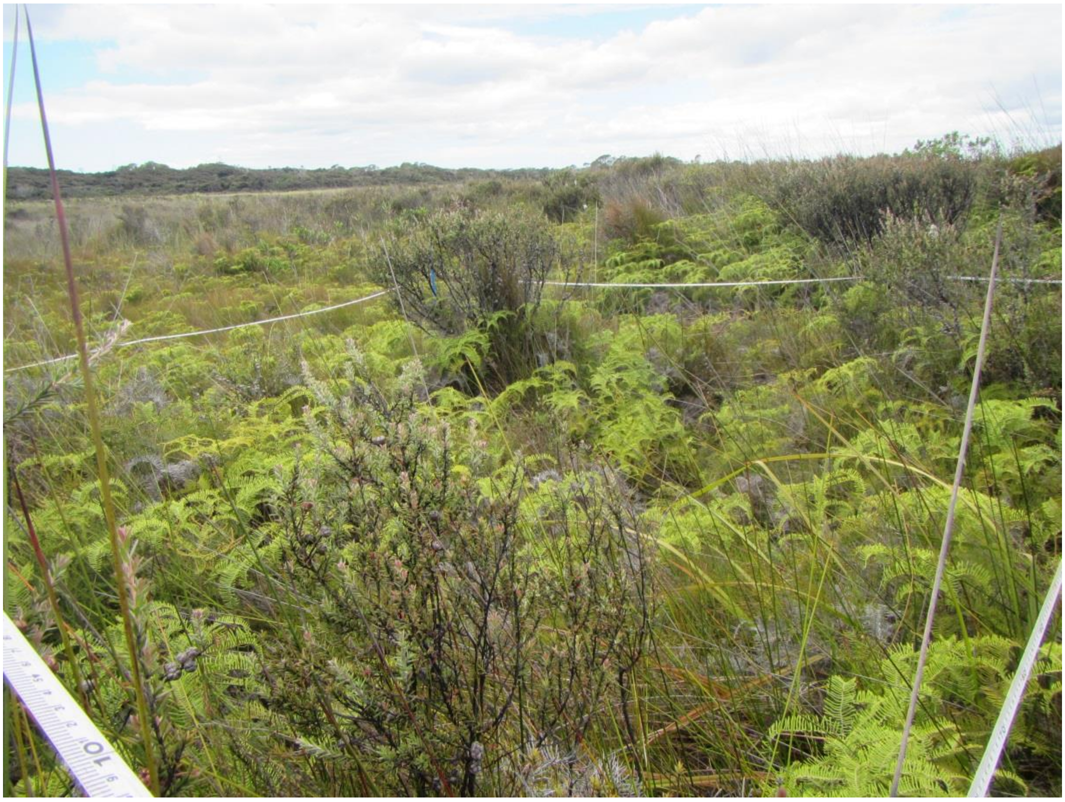


Plate 12: Plot A2. Facing diagonally across the plot form the southwest corner.
22 January 2020.

Plate 13: Plot A3. Facing north. 22 January 2020.

Plate 14: Plot A3. Facing diagonally across the plot form the southwest corner.
22 January 2020.

Plate 15: Plot A4. Facing north. 22 January 2020.

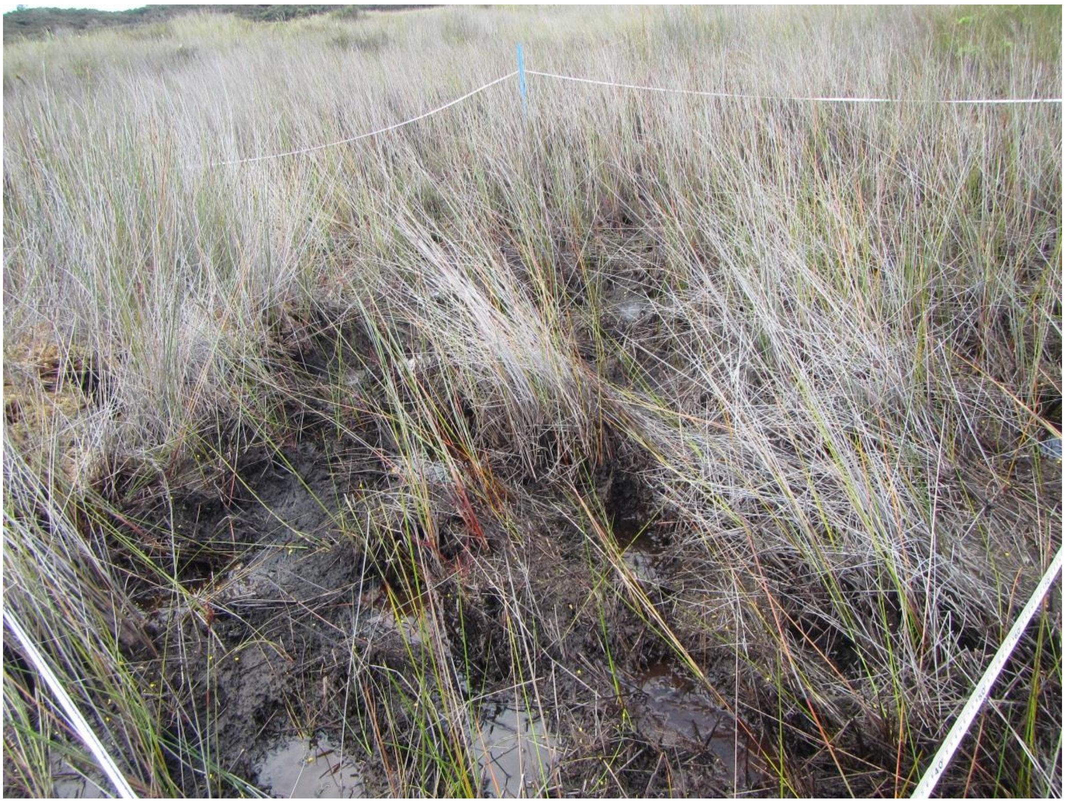


Plate 16: Plot A4. Facing diagonally across the plot form the southwest corner.
22 January 2020.

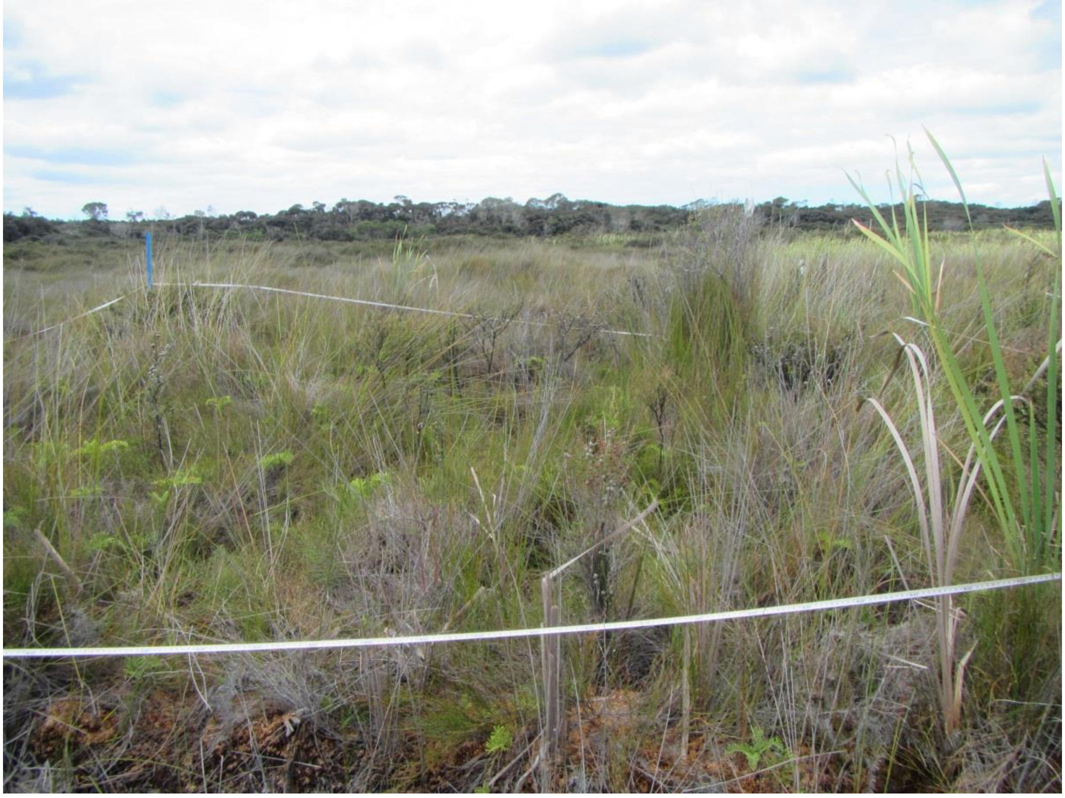


Plate 17: Plot A5. Facing north. 22 January 2020.

Plate 18: Plot A5. Facing diagonally across the plot form the southwest corner.
22 January 2020.

Plate 19: Plot B1. Facing north. 23 January 2020.

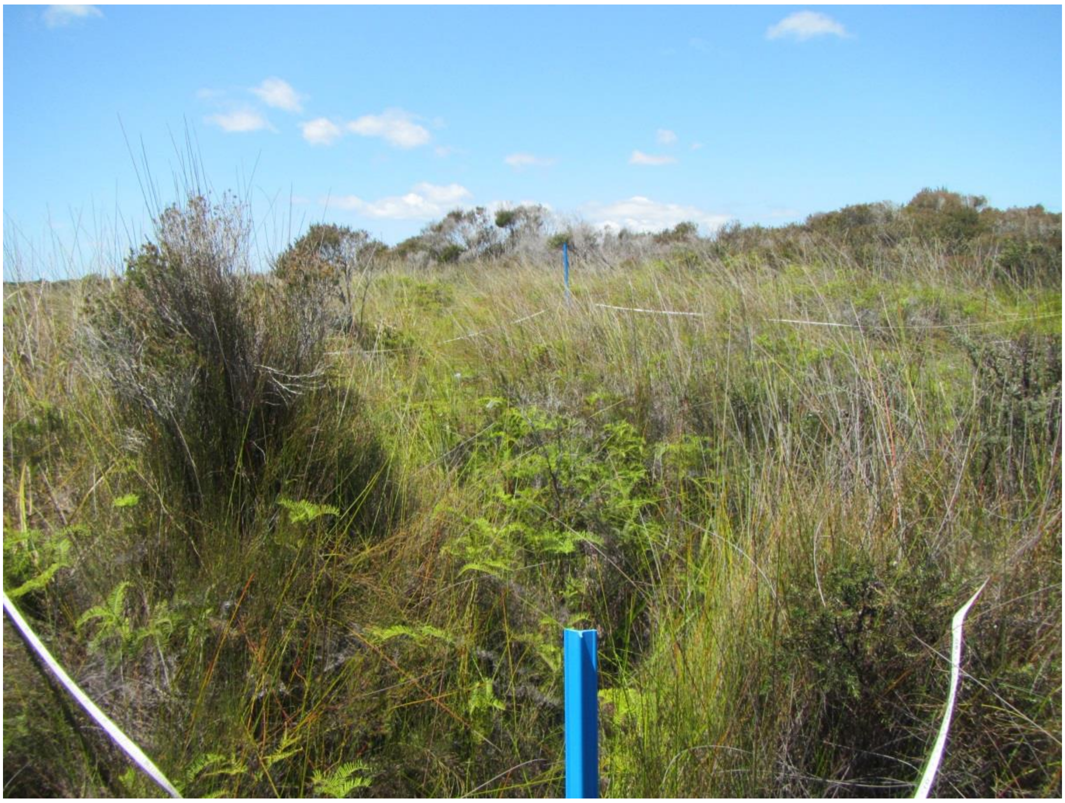


Plate 20: Plot B1. Facing diagonally across the plot form the southwest corner.
23 January 2020.

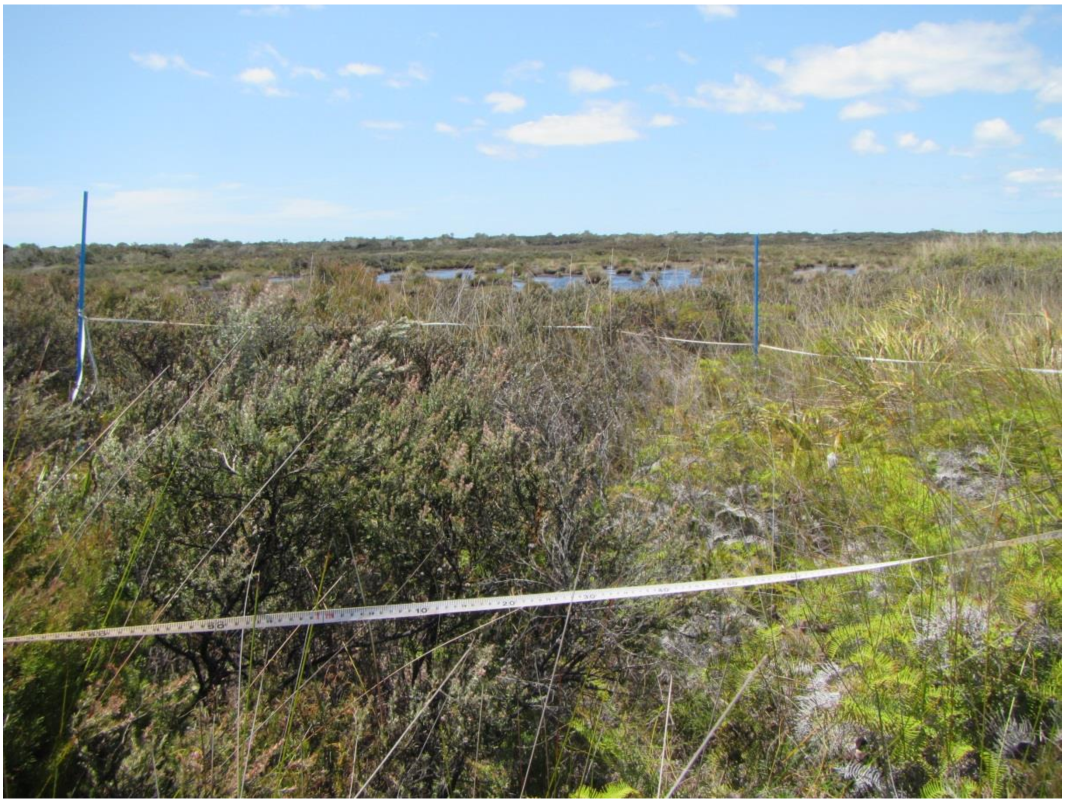


Plate 21: Plot B2. Facing north. 23 January 2020.

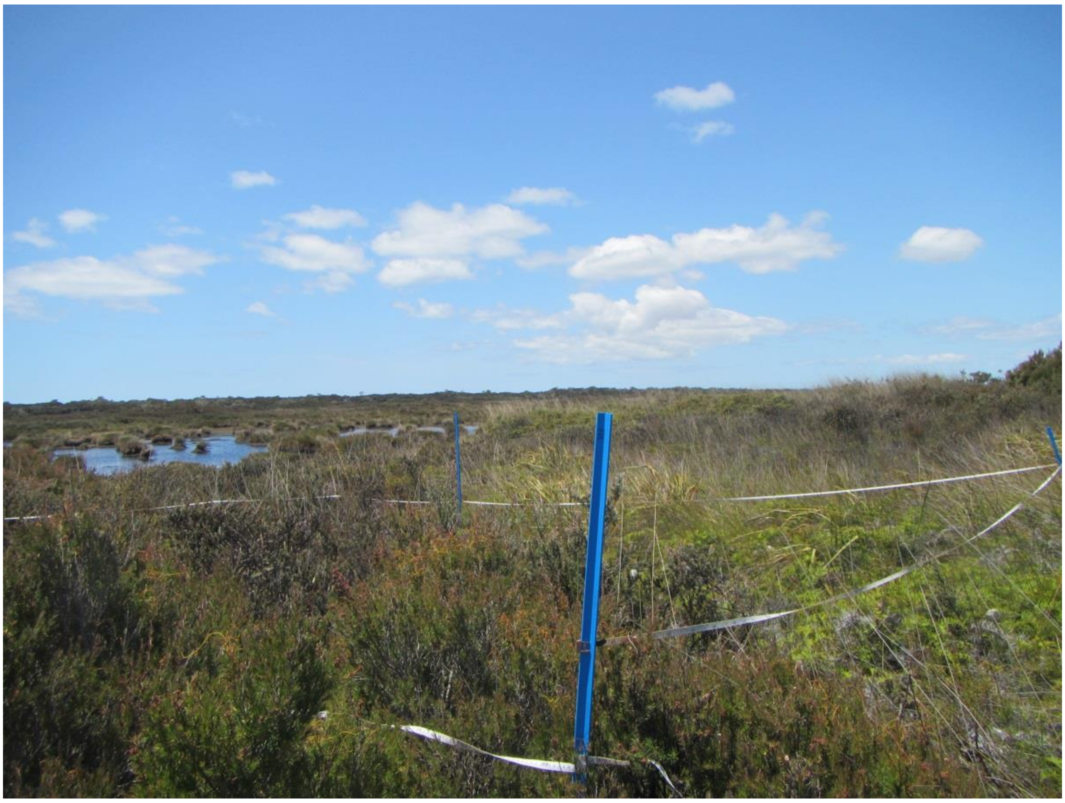


Plate 22: Plot B2. Facing diagonally across the plot form the southwest corner.
23 January 2020.

Plate 23: Plot B3. Facing north. 23 January 2020.

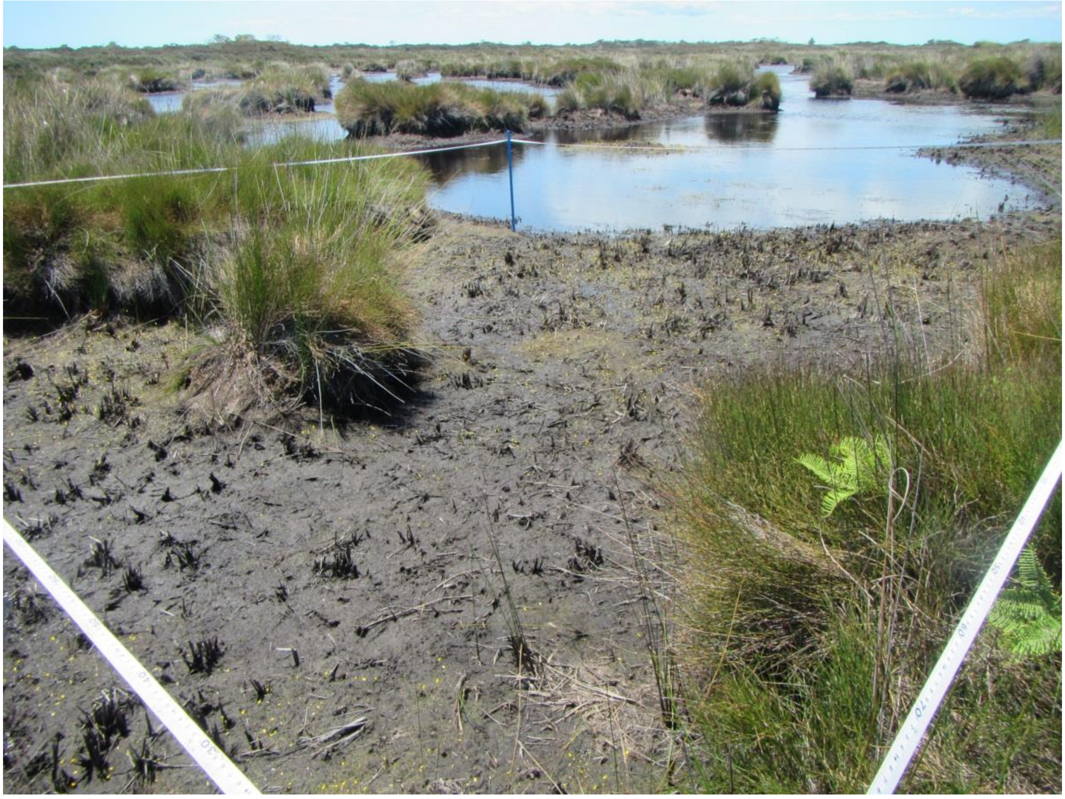


Plate 24: Plot B3. Facing diagonally across the plot form the southwest corner. 23 January 2020.

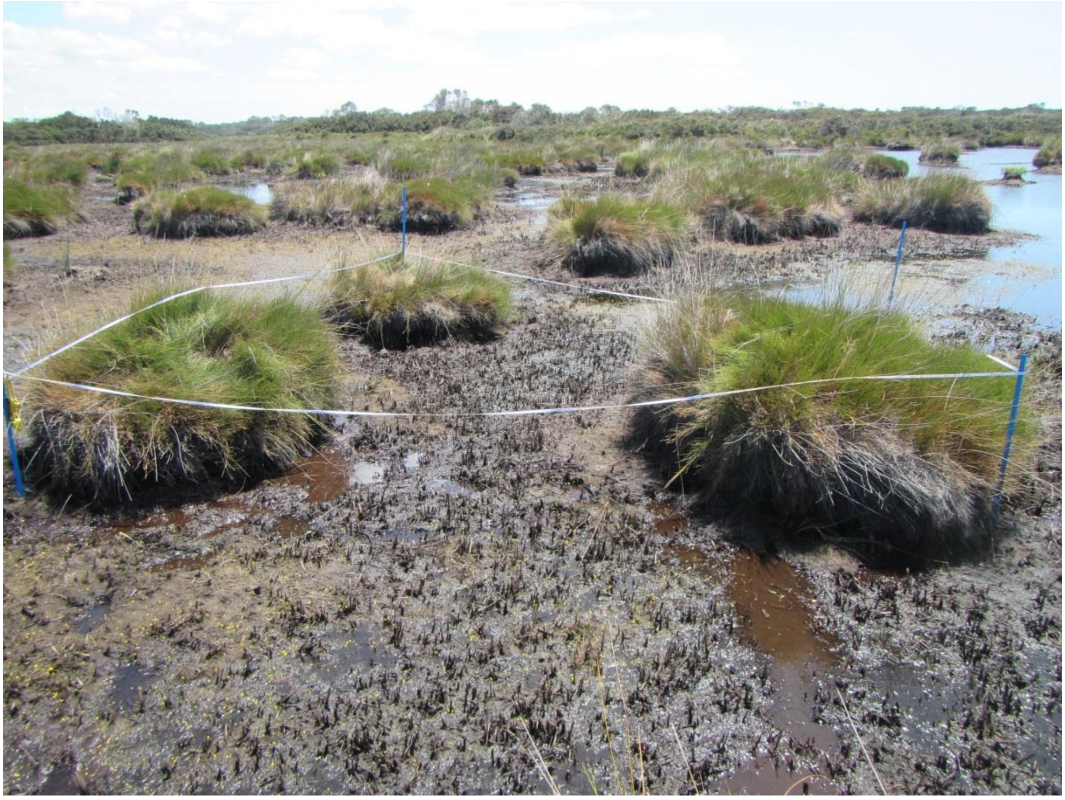


Plate 25: Plot B4. Facing north. 23 January 2020.

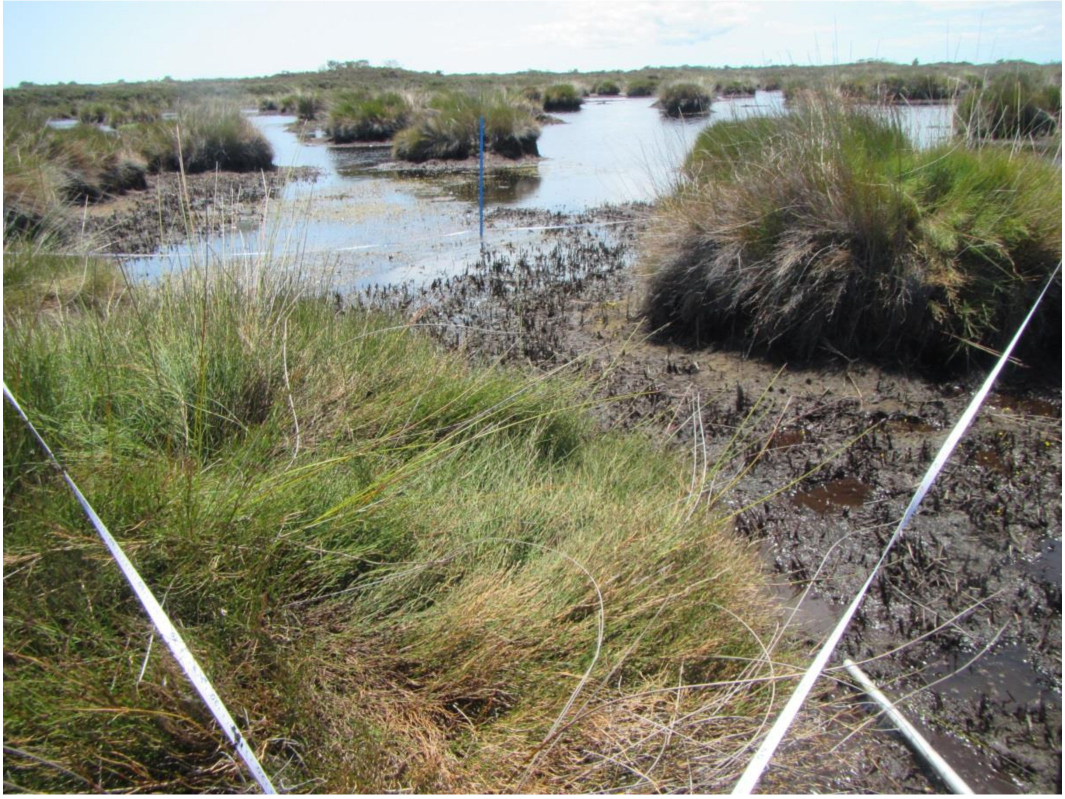


Plate 26: Plot B4. Facing diagonally across the plot form the southwest corner.
23 January 2020.

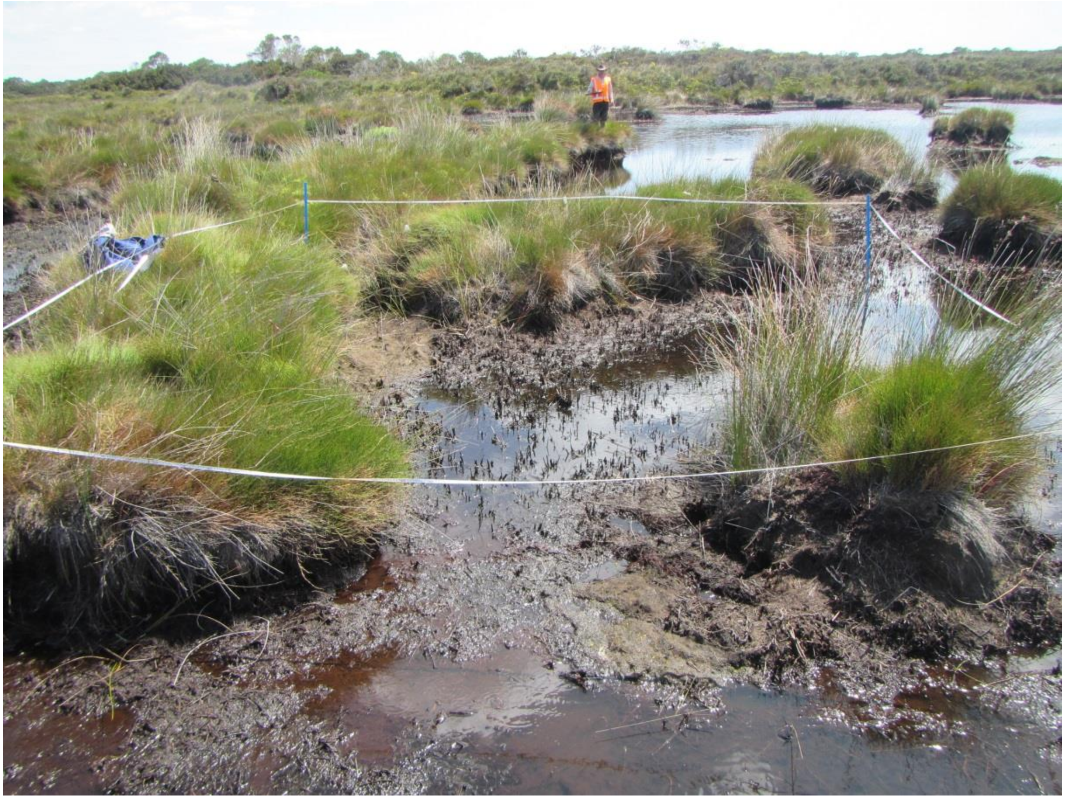


Plate 27: Plot B5. Facing north. 23 January 2020.

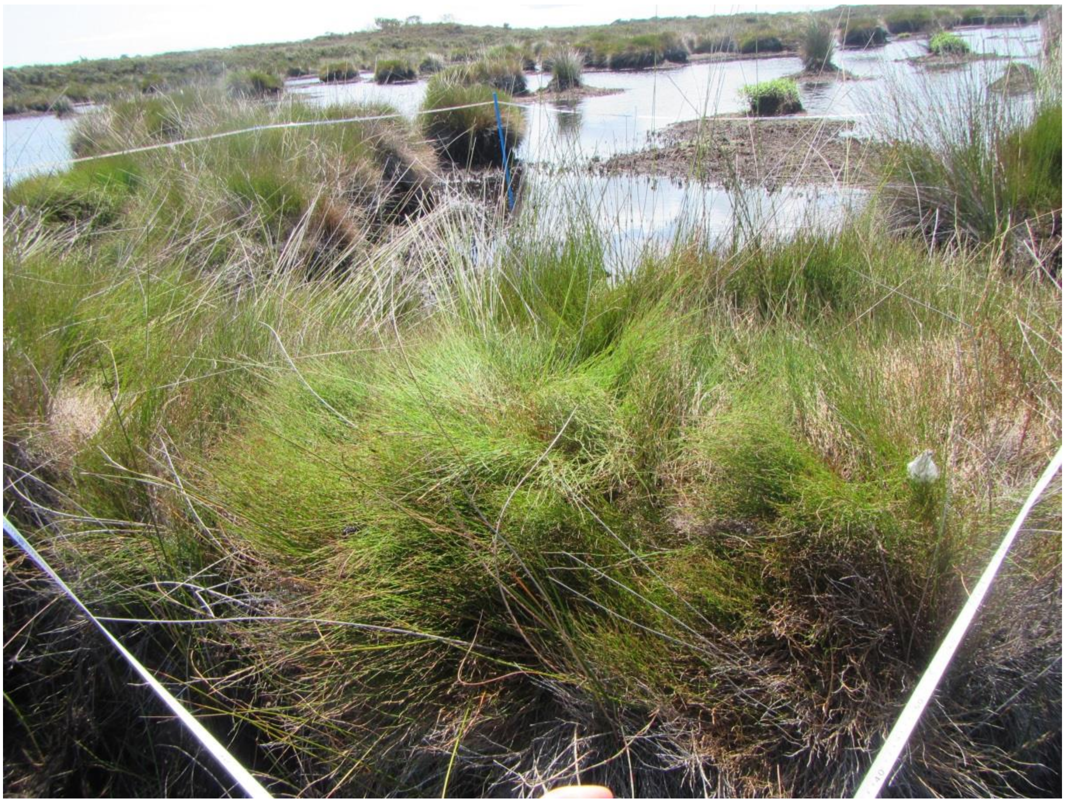


Plate 28: Plot B5. Facing diagonally across the plot form the southwest corner.
23 January 2020.

Plate 29: Plot C1. Facing north. 24 January 2020.

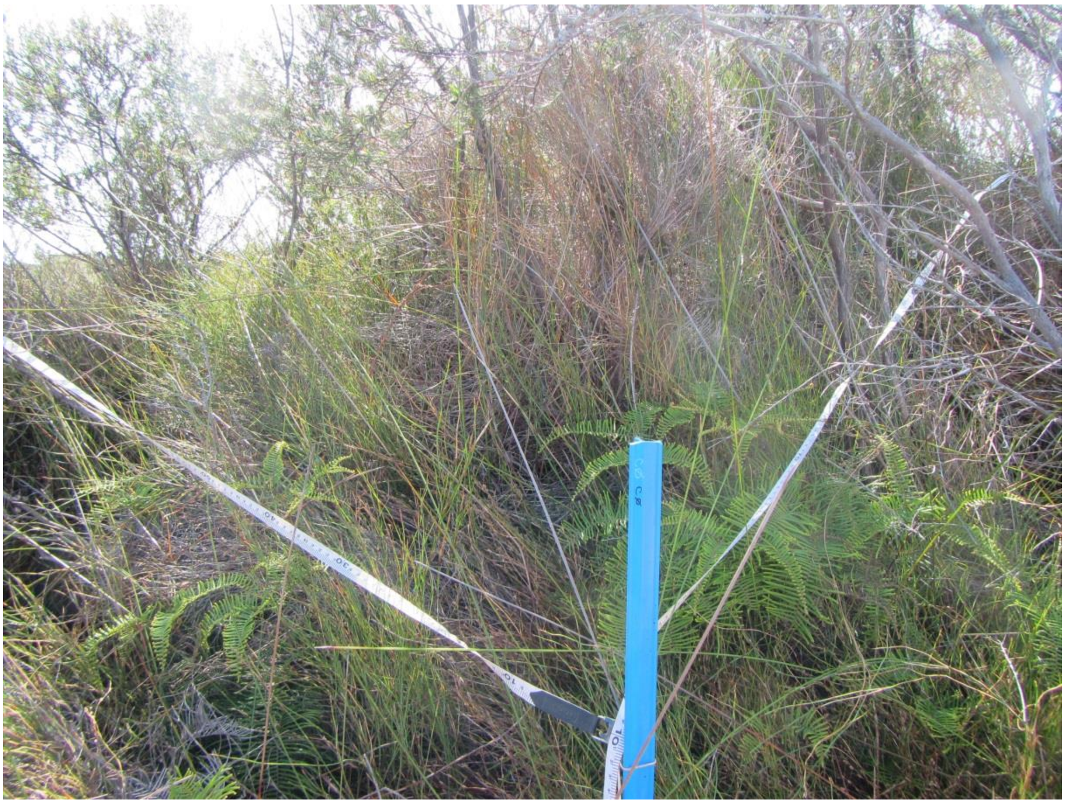


Plate 30: Plot C1. Facing diagonally across the plot form the southwest corner.
24 January 2020.

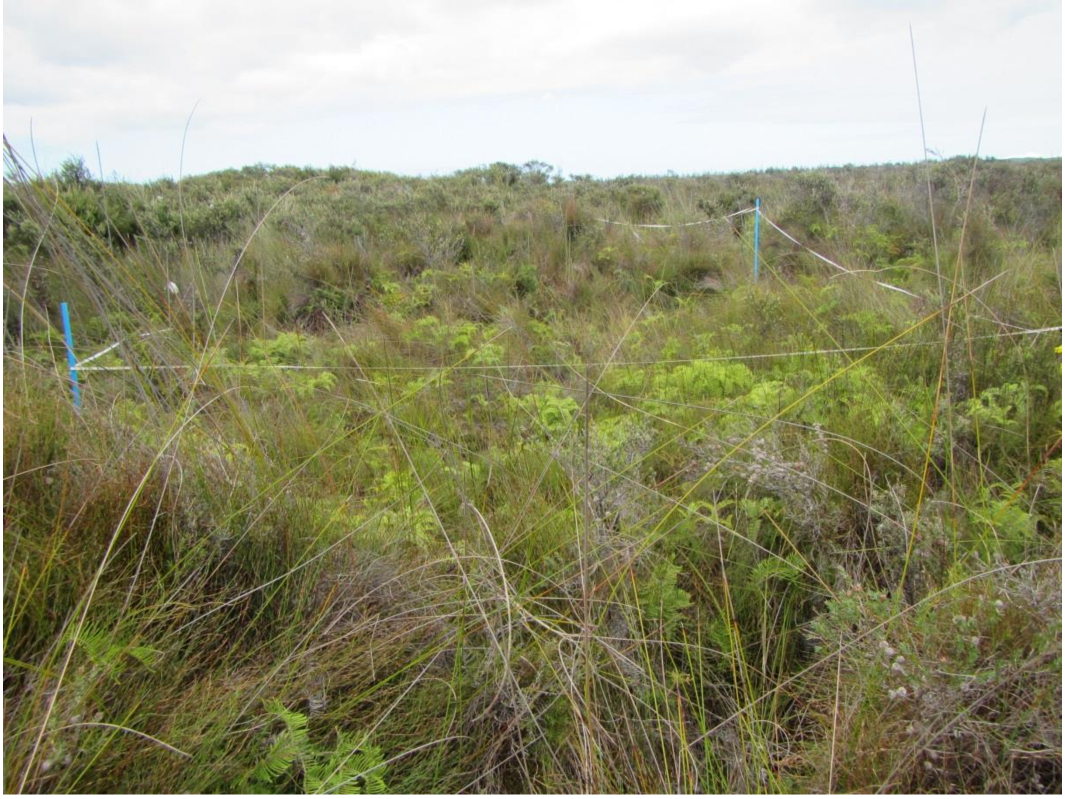


Plate 31: Plot C2. Facing south. 24 January 2020.

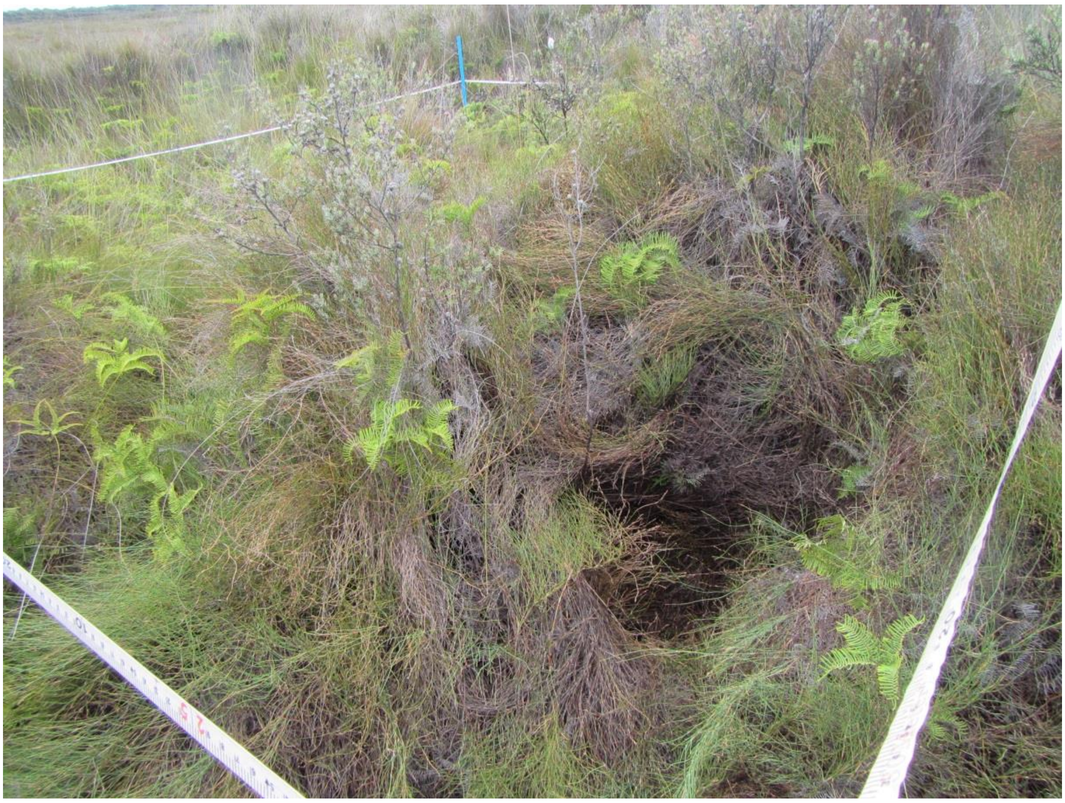


Plate 32: Plot C2. Facing diagonally across the plot form the southwest corner. Note the hole in the vegetation was created while collecting the soil sample. This occurred after the plot data had been collected. 24 January 2020.

Plate 33: Plot C3. Facing north. 24 January 2020.

Plate 34: Plot C3. Facing diagonally across the plot form the southwest corner.
24 January 2020.

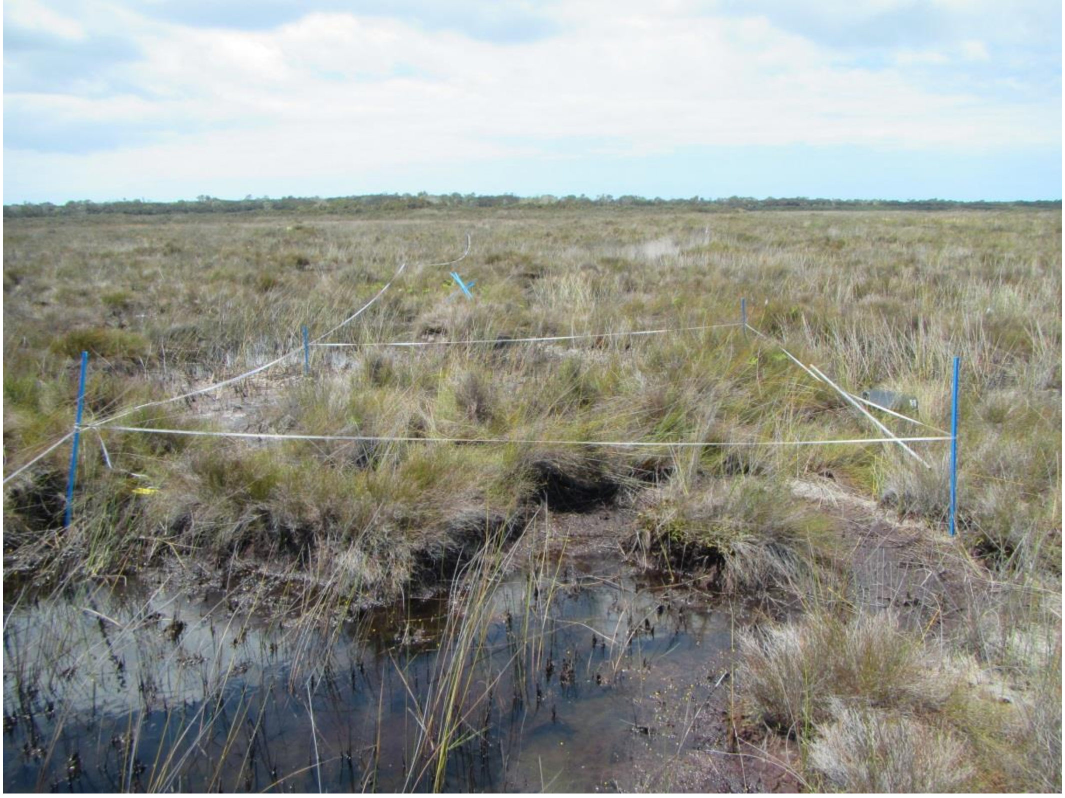


Plate 35: Plot C4. Facing north. 24 January 2020.

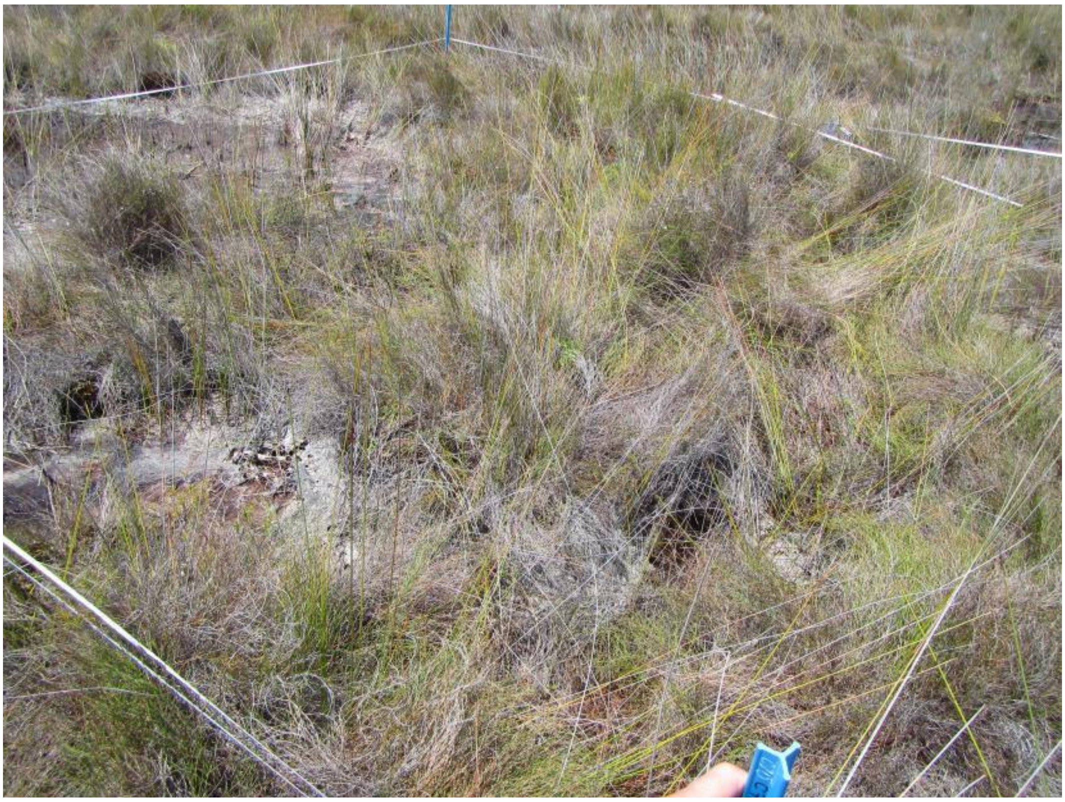


Plate 36: Plot C4. Facing diagonally across the plot form the southwest corner.
24 January 2020.

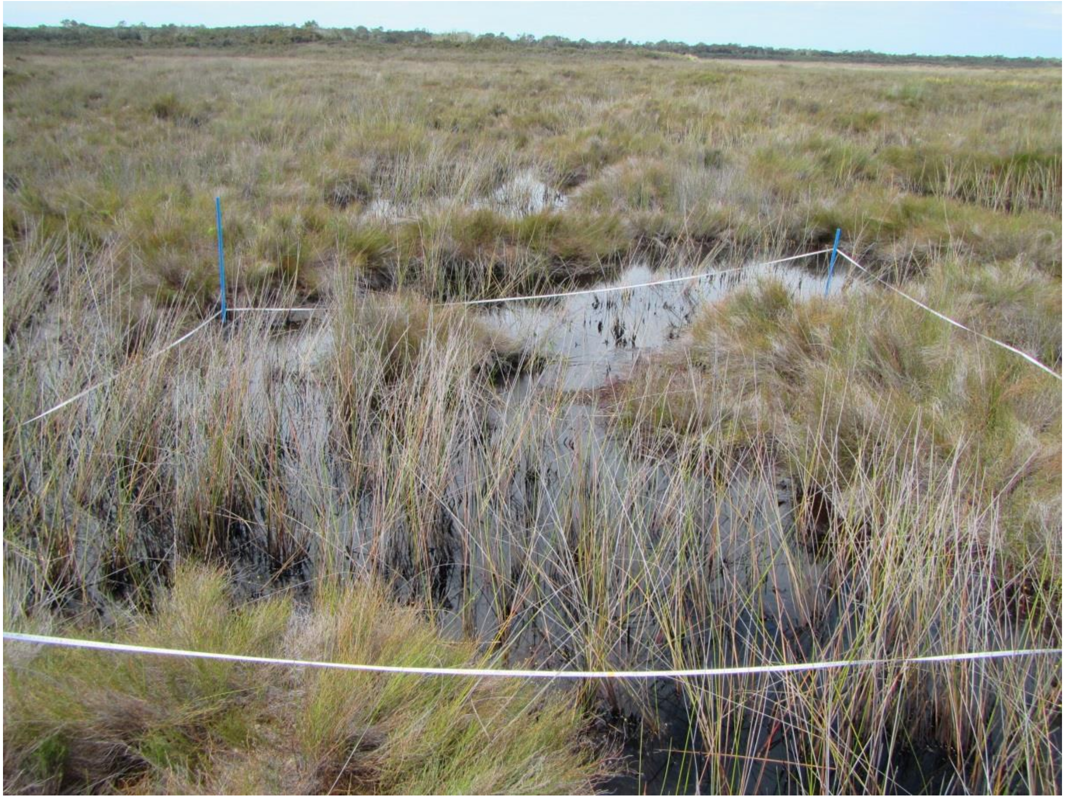


Plate 37: Plot C5. Facing north. 24 January 2020.

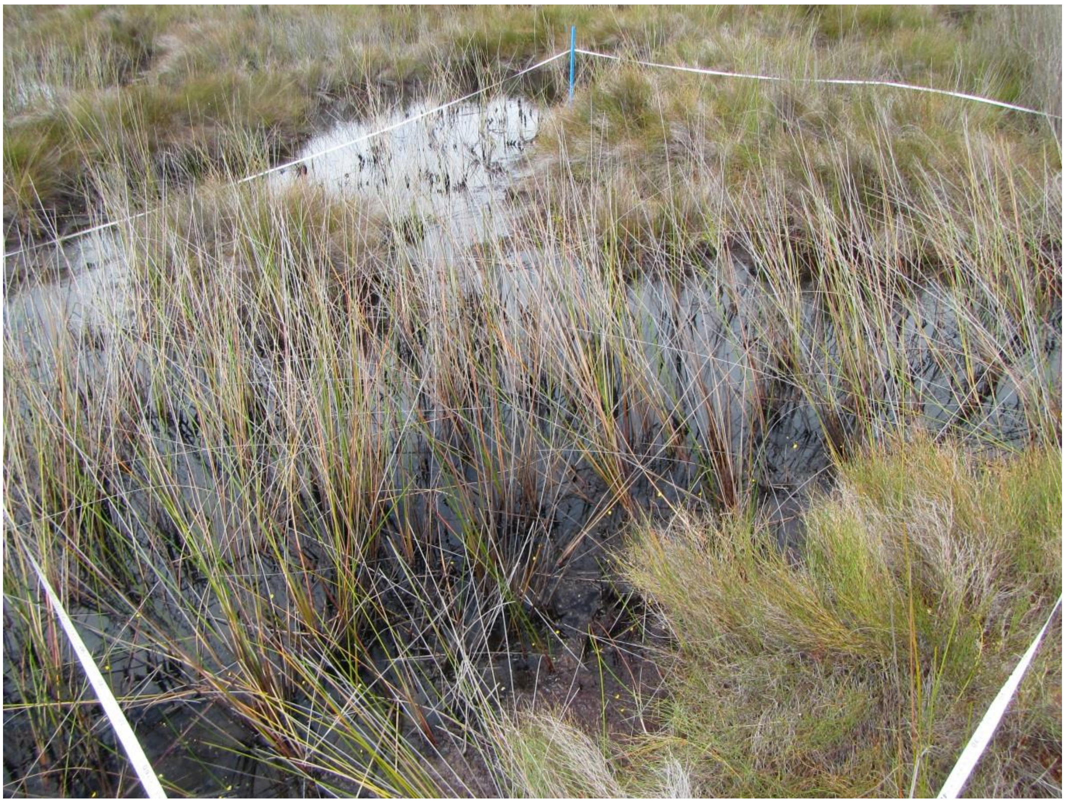


Plate 38: Plot C5. Facing diagonally across the plot form the southwest corner.
24 January 2020.

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