LANDCARE RESEARCH
MANAAKI WHENUA

Assessing Condition of Frost Flat Heathland at Waipunga, a Critically Threatened Rare Ecosystem in Hawke's Bay Region

Envirolink Advice Grant: 1553-HBRC209

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Landcare Research

Prepared for:

Hawke's Bay Regional Council

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Contents

Summary

Project and Client

- A network of permanent plots was established in January and March 2015 for the Hawke's Bay Regional Council to establish a baseline for monitoring change in the condition – 'ecological integrity' – of the substantial frost flat heathland in the upper Waipunga valley, a critically endangered historically rare ecosystem in Hawke's Bay Region.

Objectives

- To establish a baseline for monitoring change in the condition – 'ecological integrity' – of the upper Waipunga frost flat heathland to enable us to monitor changes in condition over time.

Methods

- Fifteen permanently marked 2 × 2-m plots were placed at random locations within the 535 ha area mapped as frost flat heathland.
- Within each plot, the following were recorded: all vascular species present, including invasive weeds, as well as bryophytes and lichens;quantitative cover estimates of each species in standard height tiers; height of the tallest individual monoao (*Dracophyllum subulatum*), or other vascular plant species if taller; physical parameters such as slope, altitude, and aspect; and human and introduced mammal impacts.
- Four measures of ecological integrity – presence of each of 11 diagnostic native frost flat species, presence of forest precursor species, invasive weed frequency, and exotic dominance (exotic/indigenous vegetative cover ratio) – were calculated from the raw data for each site.

Results

- All 11 diagnostic native frost flat species are present at Waipunga, but only half of them in more than 8 plots.
- Only one potential native precursor species of forest, mānuka (*Leptospermum scoparium*), was encountered, and in only 3 plots.
- Six invasive weed species were recorded in plots, but only one of them – Yorkshire fog (*Holcus lanatus*) – was widespread, although contributing minimally to vegetative cover.
- Several other threatening weeds, contorta pine (*Pinus contorta*), heather (*Calluna vulgaris*), broom (*Cytisus scoparius*), and silver birch (*Betula pendula*), are locally present.
- Waipunga has moderate ecological integrity relative to other frost flat heathlands.

Conclusions

- The original list of 11 diagnostic native frost flat species that was reduced to 7 after much more widespread sampling of forest flat heathland in the Bay of Plenty and Waikato Regions includes the 5 species that are widespread at Waipunga.
- Forest precursor species occur only locally at Waipunga, and are limited to frost-stunted mānuka.
- Only one species of invasive weed, Yorkshire fog, is widespread
- The scarcity of forest precursor species suggests that succession to native forest is unlikely in the foreseeable future on most of the frost flat heathland at Waipunga.
- Waipunga shares moderate ecological integrity with most other remaining frost flat heathland sites, and is worthy of management input in terms of periodic weed control.

Recommendations

- A comprehensive classification of vegetation associations across all remaining examples of this rare ecosystem has not been produced and is needed for decisions on where management resources would be best allocated. This requires a parallel suite of monitoring plots in the very substantial frost flat remaining in the upper Ripia Valley. Funding will be sought from Envirolink in conjunction with Hawke's Bay Regional Council to establish these.
- The two most important environmental drivers of compositionl and structural variation across frost flat heathlands are likely to be soil fertility and time since last fire. Soil fertility analyses across all frost flat regions would also help explain the reasons behind differences in vegetation pattern between them. Vegetation history of the sites derived from charcoal and pollen analyses would enable the fire frequency needed to maintain open communities to be ascertained.
- The most obvious immediate management priority is the control of woody weeds, particularly contorta pine and heather.
- Rapid decline of ecological integrity is highly likely if canopy-forming invasive woody species occupy these sites.
- All plots should be remeasured on a 5-yearly basis, next in the summer of 2020.

1 Introduction

A network of permanent plots was established by Landcare Research in January and March 2015 for Hawke's Bay Regional Council to establish a baseline for monitoring changes in the condition – 'ecological integrity' – of the frost flat heathland in the upper Waipunga valley in Hawke's Bay Region.

2 Background

'Frost flat' heathlands comprise short sclerophyllous shrublands dominated by the ericaceous shrub monoao (*Dracophyllum subulatum*) on mostly well-drained but universally infertile volcanic soils. Before human settlement, they were characteristic of shallow basins on the North Island Volcanic Plateau mantled by deep deposits of infertile rhyolitic tephra (Smale 1990). Despite their occurrence well below regional treeline under climates that are generally amenable for plant growth, the most ecologically stressed sites are subject to a year-round frost regime resulting from cold air ponding; this apparently maintains the treeless community (Bishop 2005). The potential additional role of soil infertility in excluding native forest from frost flats remains unexplored.

A long history of human burning has undoubtedly played a major role – as elsewhere – in reducing taller woody vegetation and replacing it by shorter woody vegetation and grassland. The taller shrub component – bog pine (*Halocarpus bidwillii*) and mountain toatoa (*Phyllocladus alpinus*) – of frost flat heathland is likely to have been severely reduced by burning and now survives only as scattered remnants, mostly on sites like dongas (deep, steep-sided dry erosion gullies) that are protected from fire. The floristic affinities of frost flat heathland with the largely fire-induced short tussock grasslands of the eastern South Island (Smale 1990) emphasise the role fire may have played in helping form and maintain these communities. The Kaingaroa Plateau has a long history of Maori fire (Nicholls 1978), and fire may well have played a role in maintaining frost flat heathland.

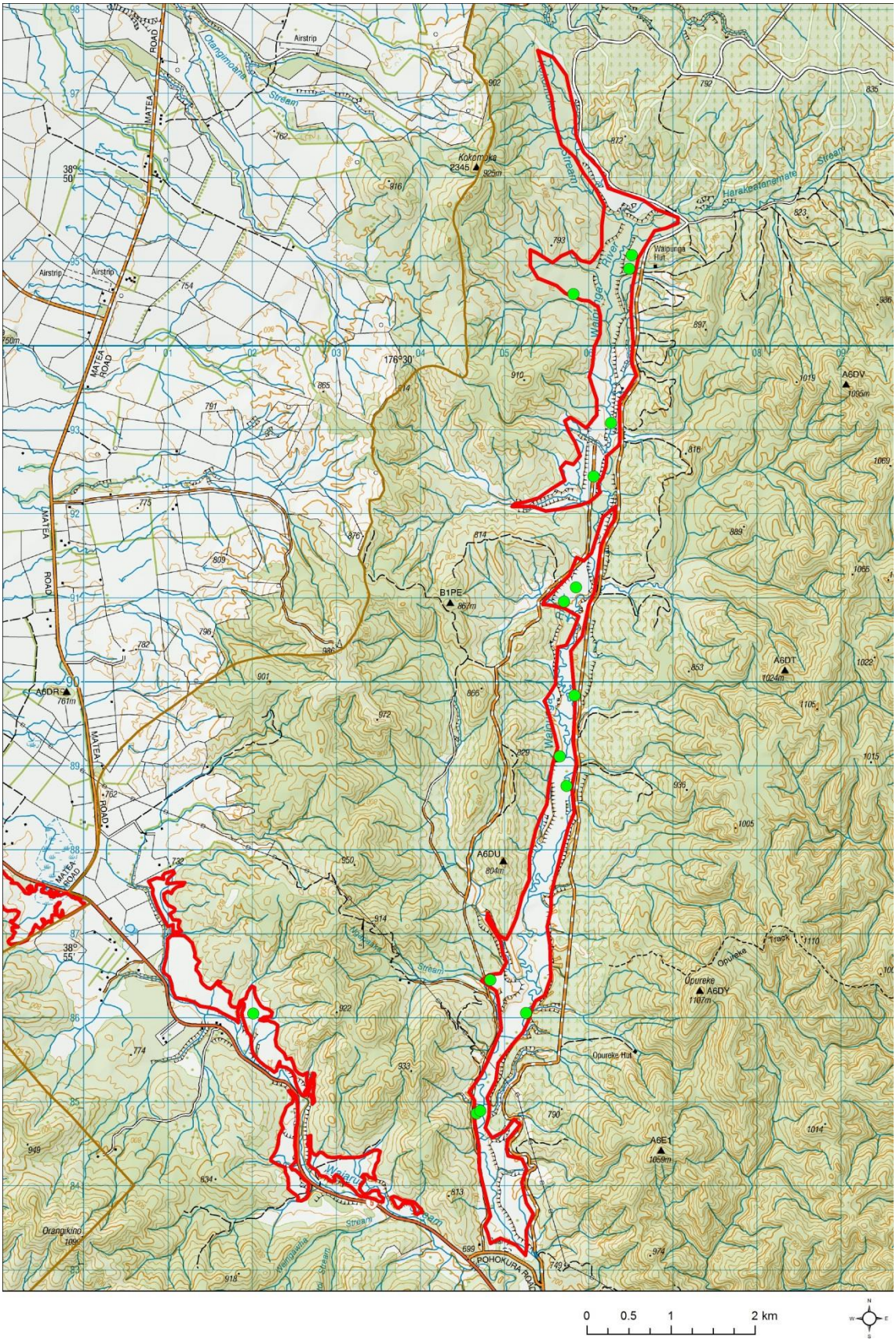

Figure 1 Location of frost flat heathland (red boundary) and sample plots (green circles) at Waipunga, Hawke's Bay.

The long-term persistence of non-forest communities on well-drained sites under reasonable rainfall is unusual in New Zealand. Frost flats provide habitat for a suite of plant and animal species that would otherwise be absent from these landscapes, raising questions about the successional status of this ecosystem. This suggests that as an historically rare ecosystem, frost flat heathland falls within National Priority 3 ('To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types') of the National Biodiversity Strategy (MfE/DOC 2007) and is now a Critically Endangered ecosystem (Holdaway et al. 2012).

Figure 2 Waipunga frost flat, Hawke's Bay Region, looking south. The Waipunga River is in the middle distance. January 2015.

The pre-European extent of frost flat heathland is estimated to have been several tens of thousands of hectares (Smale 1990), but has been reduced by an order of magnitude since c. 1930 by land development for agriculture and forestry to a few thousand hectares. The few intact remaining frost flats are highly fragmented and susceptible to a range of threats such as weed invasion – especially broom and heather – and nutrient enrichment through topdressing drift. The influence of the surrounding matrix on survival prospects is unknown, but likely to be significant, for example as a source of invasive weeds.

Until extensive land development after the Second World War, the Kaingaroa Plateau was the centre of frost flat heathland which now survives at only a handful of sites. A network of permanent plots has been established across them (Smale & Fitzgerald 2012), enabling us to

monitor changes in condition over time and also to assess the influence of the surrounding matrix on their prospects for survival.

Two substantial areas of frost flat heathland survive in the adjacent Hawke's Bay Region. After Rangitaiki Conservation Area, the upper Ripia valley (freehold) is the second largest site left in the country and the upper Waipunga valley (Crown land), the subject of this study, the third largest site (Figs. 1, 2).

3 Objective

To establish a baseline for monitoring the condition – 'ecological integrity' – of the frost flat heathland at Waipunga in Hawke's Bay Region to enable us to monitor changes in condition over time.

4 Methods

4.1 Permanent plots

Fifteen permanently marked 2 × 2-m permanent plots were placed at locations pre-selected by random sampling within GIS polygons manually derived from aerial photographs (Imagery sourced from Terralink International Limited (TIL) 2007 and is the property of TIL and the Waikato Regional Aerial Photography Syndicate (WRAPS) 2007). The total area of frost flat heathland was 535 ha and hence our 15 plots sampled 0.0001 % of the ecosystem. The 2 × 2-m plot size for frost flat heathland was arrived at after deriving the species/area curve at Rangitaiki Conservation Area before beginning the major sampling exercise there in 1988 (Smale 1990).

Within plots, the following raw data were recorded:

- All vascular plant species present, including invasive weeds, as well as prominent bryophytes and lichens
- Quantitative cover estimates of each sepcies in fixed height tiers (<30 cm, 30 cm –2 m, >2 m)
- Physical parameters such as slope, altitude and aspect
- Human impact (e.g. off-road vehicle tracking)
- Introduced mammal impact, including the presence of faecal pellets and trampling and presence and degree of browsing by species.

4.2 Data analysis

Levels of ecological integrity were calculated and averaged for 4 indicators (measures of ecological integrity) for each site from the raw data:

- Mean frequency (i.e., the percentage of plots in which a species occurs) of each of 11 diagnostic native frost flat species (Smale 1990).
- Mean frequency of forest precursor species, e.g. mānuka (*Leptospermum scoparium*). A high frequency of forest precursor species indicates that heathland vegetation at a site is ephemeral and that succession back to forest is likely in the foreseeable future.
- Mean frequency of invasive weeds, e.g. Yorkshire fog (*Holcus lanatus*).
- Exotic/indigenous cover ratio, i.e. total indigenous and total exotic cover summed over all tiers, the reverse of 'indigenous dominance' (Lee et al. 2005).

Overall ecological integrity was defined as the average mean frequency of the four individual indicators across all plots. Mean frequencies of each of the above measures below 20% were ranked very low, 20–50% low, 50–70% moderate, and above 70% high.

All data have been electronically deposited in the National Vegetation Survey (NVS) databank curated by Landcare Research and the plot sheets are stored in the physical data archive in Lincoln.

5 Results

5.1 Diagnostic native frost flat species

All 11 diagnostic native frost flat species (Smale 1990) are present at Waipunga, but only half of them consistently so (i.e. in at least half the plots).

Table 1 Mean frequency (% of plots in which recorded) of 11 diagnostic native frost flat species at Waipunga in Hawke's Bay Region. * denotes exotic. Common and scientific names of plants are given in Appendix 1

Species	Mean frequency (%)
Dracophyllum subulatum	93
Poa cita	93
Cladia retipora	60
Cladonia confusa	60
Rytidosperma gracile	53
Deyeuxia avenoides	47
Leucopogon fraseri	27
Pimelea prostrata	20
Racomitrium lanuginosum	20
Celmisia gracilenta	13
Cladonia capitellata	7

5.2 Forest precursor species

Only one potential native tree or shrub precursor species of forest, mānuka, was recorded in plots at Waipunga, present in 20% of plots. However, several exotic tree and shrub species that can function as forest precursors are locally present (see Discussion and Conclusions).

5.3 Invasive weeds

Six invasive weed species were encountered in plots, but only one of them, Yorkshire fog, was consistently present (Table 2). The remaining species were Chewing's fescue (*Festuca rubra*), sweet vernal (*Anthoxanthum odoratum*), lotus (*Lotus pedunculatus*), white clover (*Trifolium repens*), and mouse-ear hawkweed (*Pilosella officinarum*). A number of other exotic species are poresent outside plots (see Discussion and Conclusions).

Table 2 Mean frequency (%) of the six most widespread and any invasive weed at Waipunga in Hawke's Bay Region

Species	Mean frequency (%)
Any invasive weed species	80
Yorkshire fog	50
Chewing's fescue	30
Sweet vernal	30
Mouse-ear hawkweed	30
Lotus	10
White clover	10

5.4 Exotic dominance

Exotic species contributed minimally to vegetative cover, with mean exotic dominance of 0.1. Only one of the 15 plots was dominated (>50% cover) by exotic species, mostly Yorkshire fog.

5.5 Ecological integity

Waipunga has moderate ecological integrity (Table 3). A high frequency of any diagnostic native frost flat species, a low frequency of any forest precursor species, a high frequency of any invasive weed, and low exotic dominance contribute respectively to high integrity, and vica versa.

Table 3 Ecological integrity of Waipunga frost flat in Hawke's Bay Region. Measures are proportions.

Measure	Rank
Mean frequency of any diagnostic native frost flat species	1.0 (High)
Mean frequency of any native forest precursor	0.2 (Low)
Mean frequency of any invasive weed	0.8 (High)
Exotic dominance	0.1 (Very Low)
Overall	0.52 (Moderate)

6 Discussion and conclusions

The list of 11 diagnostic native frost flat species ('key' species in Smale 1990) – *Dracophyllum subulatum*, *Leucopogon fraseri*, *Pimelea prostrata*, *Celmisia gracilenta*, *Poa cita*, *Deyeuxia avenoides*, *Rytidosperma gracile*, *Racomitrium lanuginosum*, *Cladia retipora*, *Cladina confusa*, *Cladonia capitellata* – was derived from Rangitaiki Conservation Area on the southern Kaingaroa Plateau, and it was suggested that it be reduced to seven after much wider sampling in the region (Smale and Fitzgerald 2012). Those seven species – *Dracophyllum subulatum*, *Poa cita*, *Deyeuxia avenoides*, *Rytidosperma gracile*, *Racomitrium lanuginosum*, *Cladia retipora*, *Cladina confusa* – include the five – *Dracophyllum subulatum*, *Poa cita*, *Rytidosperma gracile*, *Cladia retipora*, *Cladina confusa* – that are widespread at Waipunga. Like Rangitaiki, frost flat heathland at Waipunga is characterised by open short shrubland; denser, taller scrub on more fertile (Yeates et al. 2004), and probably moister, sites is more localised.

Frost flat heathland at Waipunga is more similar in structure and composition to other sites on the eastern Volcanic Plateau, particularly the closest one – a small, degraded site on Rangitaiki Station at Matea (Smale & Fitzgerald 2012) – than to those at west Taupo (Smale & Fitzgerald 2014). Like the other eastern sites and unlike the western ones, Waipunga is likely to remain as open shrubland for the foreseeable future. Although one forest precursor species, mānuka, occurs quite widely, almost everywhere it is reduced to short (<15 cm tall) seedlings, severely stunted by frost, and possibly low soil fertility as well.

Along with mouse-ear hawkweed, present in nearly one-third of plots, several other threatening weeds are locally present at Waipunga: contorta pine (*Pinus contorta*), especially on the western arm parallel with SH5 (Fig. 3); heather (*Calluna vulgaris*), locally present on the forestry road on the true right of the valley (Fig. 4); broom (*Cytisus scoparius*), locally present on margins and probably increasing (Fig. 5); hawthorn (*Crataegus monogyna*), very local and increasing at the western end (Fig. 6); and silver birch (*Betula pendula*), very local and increasing at the western end, probably from planting at the site of a former dwelling on the former route of State Highway 5 (Fig. 7).

Figure 3 Contorta pine, the most threatening weed of frost flat heathland, on the western arm of Waipunga frost flat. January 2015.

Figure 4 Heather and broom establishing on the forestry road on the western side of the upper Waipunga valley. January 2015.

Figure 5 A local infestation of broom towards the western end of Waipunga frost flat. January 2015.

Figure 6 Hawthorn near the western end of Waipunga frost flat. January 2015.

Figure 7 Silver birch (foreground) spreading from an old planting near the western end of Waipunga frost flat. January 2015.

Contorta pine, heather, and broom are all ruinous weeds in frost flat heathland. Contorta pine rapidly forms a dense canopy that overtops and eliminates all native frost flat vegetation (MCS, pers. obs.), greatly modifying microclimate. Furthermore, it exploits much greater volumes of regolith, thereby probably elevating soil fertility to the point where invasive exotic grasses can become dominant. Heather is an ecological analogue of monoao and can almost completely oust it, as has already happened at Kuratau, west Taupo (Smale & Fitzgerald 2014). As a nitrogen fixer, broom alters the key attribute of heathland ecosystems – low soil chemical fertility – and therefore enables species of moderately fertile sites to replace heathland vegetation. A small area of monoao-dominant frost flat heathland at Mihi (30 km NNE of Taupo) first visited in 1966 had been completely ousted by broom when revisited 22 years later (MCS, pers. obs.). Survival of frost flat heathland at Waipunga depends on control of contorta pine, heather, and broom.

Waipunga shares moderate ecological integrity with most remaining frost flat heathland sites in the Bay of Plenty and Waikato Regions (Smale & Fitzgerald 2012, 2014).

7 Recommendations

- A comprehensive classification of vegetation associations across all remaining examples of this rare ecosystem has not been produced and is needed for decisions on where management resources would be best allocated. This requires a parallel suite of monitoring plots in the very substantial frost flat remaining in the upper Ripia Valley. Funding is being sought from Envirolink in conjunction with Hawke's Bay Regional Council to establish these.
- Soil fertility analyses across both regions would also help elucidate the reasons behind differences in vegetation pattern between them.
- Vegetation history of the sites from charcoal and pollen analysis would enable the fire frequency needed to maintain open communities to be ascertained.
- The most obvious immediate management priority is the control of woody weeds, particularly contorta pine and heather.
- Rapid decline of ecological integrity is highly likely if canopy-forming invasive woody species occupy these sites.
- Given the speed with which these can establish and grow and the need to respond with management accordingly, we recommend a 5 year measurement cycle for these plots, next in the summer of 2020.

8 Acknowledgements

We would like to thank Envirolink for funding this project, Dr Barry Lynch and Keiko Hashiba (Hawke's Bay Regional Council) for facilitating and managing the contract and providing useful comments, and providing field assistance. Dr Sarah Richardson (Landcare Research, Lincoln) provided helpful comments.

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Appendix 1 – Common and scientific names and biostatus of plant species in text

Common name	*Scientific name*	*Biostatus*
bog pine	*Halocarpus bidwillii*	Native
Broom	*Cytisus scoparius*	Exotic
catsear	*Hypochoeris radicata*	Exotic
Chewing's fescue	*Festuca rubra*	Exotic
	Celmisia gracilenta	Native
coral lichen	*Cladia retipora*	Native
	Cladonia capitellata	Native
danthonia	*Rytidosperma gracile*	Native
hawthorn	*Crataegus monogyna*	Exotic
heather	*Calluna vulgaris*	Exotic
contorta pine	*Pinus contorta*	Exotic
lotus	*Lotus pedunculatus*	Exotic
mānuka	*Leptospermum scoparium*	Native
monoao	*Dracophyllum subulatum*	Native
mountain toatoa	*Phyllocladus alpinus*	Native
mouse-ear hawkweed	*Pilosella officinarum*	Exotic
silver birch	*Betula pendula*	Exotic
silver tussock	*Poa cita*	Native
sweet vernal	*Anthoxanthum odoratum*	Exotic
white clover	*Trifolium repens*	Exotic
Yorkshire fog	*Holcus lanatus*	Exotic

Appendix 2 – Flora of frost flat heathland at Waipunga (including species not present in plots) * only recorded outside plots

Scientific name	Common name	Biostatus
Acaena agnipila	sheep's burr	Exotic
Acaena microphylla		Endemic
Androstoma empetrifolia	bog mingimingi	Endemic
Anthoxanthum odoratum	sweet vernal	Exotic
*Betula pendula	silver birch	Exotic
Blechnum penna-marina		Native
*Calluna vulgaris	heather	Exotic
Carex geminata		Endemic
Celmisia gracilenta		Endemic
Cladia retipora	coral lichen	Native
Cladina leptoclada		Native
Cladonia capitellata		Native
Cladonia confusa	reindeer lichen	Native
Coprosma acerosa		Endemic
Coprosma cheesemanii		Endemic
Coprosma dumosa		Endemic
Coprosma propinqua	mingimingi	Endemic
*Crataegus monogyna	hawthorn	Exotic
Crepis capillaris	smooth hawksbeard	Exotic
*Cytisus scoparius	broom	Exotic
Dactylis glomerata	cocksfoot	Exotic
Deyeuxia avenoides	mountain oat grass	Endemic
Dicranoloma robustum	golden shaggy moss	Native
Dracophyllum subulatum	monoao	Endemic
Euphrasia cuneata	eyebright	Endemic
Festuca rubra	Chewing's fescue	Exotic
Geranium microphyllum	small-leaved cranesbill	Endemic
Gonocarpus aggregatus		Endemic
Hierochloe redolens	karetu	Endemic
Holcus lanatus	Yorkshire fog	Exotic
Hypnum cupressiforme		Native
Hypochaeris radicata	catsear	Exotic
Lepidosperma australe	square sedge	Endemic
Leptospermum scoparium	mānuka	Endemic

Leucopogon fraseri	patotara	Endemic
Lotus pedunculatus	lotus	Exotic
Lycopodium fastigiatum	alpine clubmoss	Native
Muehlenbeckia axillaris		Native
Pilosella officinarum	mouse-ear hawkweed	Exotic
Pimelea prostrata	New Zealand daphne	Endemic
*Pinus contorta	contorta pine	Exotic
Poa cita	silver tussock	Endemic
Racomitrium lanuginosum	woolly moss	Native
Ranunculus acris	giant buttercup	Exotic
Ranunculus repens	creeping buttercup	Exotic
Rumex acetosella	sheep's sorrel	Exotic
Rytidosperma gracile	danthonia	Native
Thuidium furfurosum		Native
Trifolium repens	white clover	Exotic
Uncinia rubra	red hook sedge	Endemic
Veronica stricta	koromiko	Endemic

Appendix 3 – Glossary of scientific terms

Exotic	Accidentally or deliberately introduced from elsewhere into New Zealand
Endemic	Native to New Zealand and nowhere else
Native	Native to New Zealand and other countries as well

Appendix 4 – Plot sheets

See next page.

Landcare Research
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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 01 DAY/MONTH/YEAR: 05 MARCH 2015

SURVEY: WAIPUNGA FROST FLATS

REGION: HAWKES BAY NZTM Easting: 1902011

CATCHMENT: WAIPUNGA NZTM Northing: 5686054

SUB-CATCHMENT: Single / Averaged waypoint Accuracy ± 1·2 m

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

SIZE OF RECCE	2 x 2
ALTITUDE (m)	725
PHYSIOGRAPHY	~~Ridge, Face, Gully~~, (Terrace)
ASPECT (0–359°)	0
SLOPE (°)	0 ~~Convex, Concave~~, (Linear)
PARENT MATERIAL	Pumice ~~Mapped~~ / (Observed)
DRAINAGE	~~Good~~, (Moderate) ~~Poor~~
CULTURAL	~~None~~, Burnt, Logged, Mined, Grazed, Tracked

APPROACH

Walk from SH5 @ layby

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial), ~~Moraine, Volcanic~~

GROUND COVER %:	
Vegetation	~~33~~ 33
Non-vascular	~~64~~ 64
Litter	3
Bare Ground	0
Rock	0
Max Top Height (m)	1·1 DRASUS

NOTES (including cultural)

Pinus up to 4m tall common in surrounding area. Felled and rotten Pinus in and around plot

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

Pipit		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	

RECCE IDENTIFIER: WAIPUNGA 01 MEASURED BY: MARK

DAY/MONTH/YEAR: 05 MARCH 2015 RECORDED BY: NEIL

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover						
					DRAsub 10	~~3~~ 10
Tier 7					POAcit 1	~~3~~ 15
Epiphytes					LEPsce 0.01	3
					RYTgra 0.01	0.01
						PIMpro 1
						PILoff 3
						EUPcun 0.01
						COPche 0.01
						GONagg 0.01
						HYPrad 0.5
						LEUfra 0.01
						RACLan 0.1
						DEYave 0.5
						CLAret 61
						CLAlep 3

Landcare Research
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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 02 DAY/MONTH/YEAR: 21 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1905705

NZTM Northing: 5690957

~~Single~~ / Averaged waypoint Accuracy ± 1.6 m

SIZE OF RECCE	2x2
ALTITUDE (m)	706
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ Terrace
ASPECT (0–359°)	060
SLOPE (°)	2 ~~Convex, Concave,~~ Linear
PARENT MATERIAL	PUMICE ~~Mapped~~ / Observed
DRAINAGE	Good, ~~Moderate, Poor~~
CULTURAL	None, ~~Burnt, Logged, Mined, Grazed, Tracked~~

APPROACH

Through pines (drive track) from road on true right of valley

SURFACE CHARACTERISTICS:

~~Alluvial~~, Colluvial, ~~Moraine, Volcanic~~

GROUND COVER %:	
Vegetation	20
Non-vascular	70
Litter	10
Bare Ground	0
Rock	0
Max Top Height (m)	1.0 DRASUB

NOTES (including cultural)

BROWSE none

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

redpoll		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	

RECCE IDENTIFIER: WAIPUNGA 07 MEASURED BY: MARK

DAY/MONTH/YEAR: 21 JANUARY 2014 RECORDED BY: NEIL

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—	—		
					DRAsub 80	~~5~~ 12
Tier 7					COPpro 0.1	2
Epiphytes					DEYaur 0.1	3
					HYPrad 0.1	1
					POAcit 2	2
						RYTgraa1
						DICrob ~~5~~ 20
						CLAret 35
						CLAlep 8
						RACton ~~1~~ 4
						HYPcup 3

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 03 DAY/MONTH/YEAR: 20 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1906510

NZTM Northing: 5695084

Single / (Averaged) waypoint Accuracy ± 1·6 m

SIZE OF RECCE	2x2
ALTITUDE (m)	746
PHYSIOGRAPHY	~~Ridge~~, (Face), ~~Gully~~, ~~Terrace~~
ASPECT (0–359°)	320
SLOPE (°) 20	(Convex), ~~Concave~~, ~~Linear~~
PARENT MATERIAL	PUMICE
	Mapped? (Observed)
DRAINAGE	(Good), ~~Moderate~~, ~~Poor~~
CULTURAL	(None), Burnt, Logged,
	Mined, Grazed, Tracked

APPROACH

Direct from WAIPUNGA RD

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial), ~~Moraine~~, ~~Volcanic~~

GROUND COVER %:	
Vegetation	20
Non-vascular	74
Litter	5
Bare Ground	1
Rock	0
Max Top Height (m)	1·0 DRASUS

NOTES (including cultural)

Target BAK01 to replace original 03 which ~~was~~ was too far and non-frosty

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

RECCE IDENTIFIER: _____ MEASURED BY: _____

DAY/MONTH/YEAR: _____ RECORDED BY: _____

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—	—		
					DRAsub 25	20
Tier 7					POAcil 0.1	2
Epiphytes					LEPaus 0.1	0.1
					HYPrad 0.1	0.5
						LYCfas ~~0.2~~ 1
						CLAlep 2
						RACLan 8
						CLAvet 63

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: Waipunga 04 (WAIPUNGA)
SURVEY: ~~HAWKES BAY~~ FROST FLATS
REGION: HAWKES BAY
CATCHMENT: WAIPUNGA
SUB-CATCHMENT:
MEASURED BY: MARK SMALE
RECORDED BY: NEIL FITZGERALD

DAY/MONTH/YEAR: 05 MARCH 2015
NZTM Easting: 1905254
NZTM Northing: 5686060
Single / Averaged waypoint Accuracy ± 1.5 m

SIZE OF RECCE	2x2
ALTITUDE (m)	673
PHYSIOGRAPHY	~~Ridge, Face, Gully~~, (Terrace)
ASPECT (0–359°)	270°
SLOPE (°)	5° ~~Convex, Concave~~, (Linear)
PARENT MATERIAL	PUMICE
	~~Mapped~~ / (Observed)
DRAINAGE	~~Good~~, (Moderate), ~~Poor~~
CULTURAL	(None), ~~Burnt, Logged, Mined, Grazed, Tracked~~

APPROACH

Down [redacted] stream from ford / washed out culvert on Waipunga Rd.

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial), ~~Moraine, Volcanic~~

GROUND COVER %:	
Vegetation	35
Non-vascular	25
Litter	20
Bare Ground	0
Rock	0
Max Top Height (m)	2-4 DRAGO

NOTES (including cultural)

BROWSE None.

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

Silvereye, bellbird heard.
Feral bird.

RECCE IDENTIFIER: WAIPUNGA 04 MEASURED BY: MARK SMALE

DAY/MONTH/YEAR: 05 MARCH 2015 RECORDED BY: NEIL FITZGERALD

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover						
				DRAsub 15	65	0.1
Tier 7				COPpro 3	10	1
Epiphytes					LEPans 0.1	0.1
					POAcit 0.1	1
					HYPrad 001	1
					RYTgra 0.01	0.01
					HOLlan 0.01	0.01
						BLEpen 2
						ANTodo 2
						MUEaxi 26
						UNCrub 0.1
						DEYave 0.01
						GONagg 2
						DICrob 15
						HYPcub 8
						THUfer 2
						CELgra 0.1

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA_05 DAY/MONTH/YEAR: 21 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1904665

NZTM Northing: 5684867

~~Single~~ / Averaged waypoint Accuracy ± 1.9 m

SIZE OF RECCE	2 x 2
ALTITUDE (m)	679
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ Terrace
ASPECT (0–359°)	060
SLOPE (°) 2	~~Convex, Concave,~~ Linear
PARENT MATERIAL	PUMICE
	~~Mapped~~ / Observed
DRAINAGE	Good, ~~Moderate, Poor~~
CULTURAL	None, ~~Burnt, Logged,~~
	~~Mined, Grazed, Tracked~~

APPROACH

Direct from road on true right of Waipunga river

SURFACE CHARACTERISTICS:

~~Alluvial~~, Colluvial, ~~Moraine, Volcanic~~

GROUND COVER %:

Vegetation	~~97~~ 84
Non-vascular	1
Litter	~~10~~ 15
Bare Ground	0
Rock	0
Max Top Height (m)	0.9 POAcit

NOTES (including cultural)

RUB rub (sweet brier) 10m away from plot

BROWSE

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

Feral bird, ~~rat~~ possum

	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

RECCE IDENTIFIER: WARUNGA 05 MEASURED BY: MARK SMALE

DAY/MONTH/YEAR: 21 JANUARY 2015 RECORDED BY: NEIL FITZGERALD

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—	—		
					POAcil 2	~~15~~ 20
Tier 7					Hollan 2	~~50~~ 48
Epiphytes					ANTodo 0.5	8
					RUMace 0.1	0.5
					CREsp 0.1	~~0~~ 1
					RANacr 0.1	1
						HYPcup 1
						COPace 2
						LEPsco 0.1
						VERstr 1
						LOTped 1
						GERmic 0.5
						TRIrep 0.5
						HYPrad 1

87
1.5
2

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 06 ~~29 JANUARY 2015~~ DAY/MONTH/YEAR: 21 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1904827

NZTM Northing: 5686455

~~Single~~ / (Averaged) ~~waypoint~~ Accuracy ± 1.6 m

SIZE OF RECCE	2 x 2
ALTITUDE (m)	704
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ (Terrace)
ASPECT (0–359°)	
SLOPE (°)	~~Convex, Concave,~~ (Linear)
PARENT MATERIAL	PUMICE ~~Mapped~~ / (Observed)
DRAINAGE	(Good) ~~Moderate, Poor~~
CULTURAL (Recent)	(None) ~~Burnt, Logged, Mined, Grazed, Tracked~~

APPROACH

off road on true right of valley

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial) ~~Moraine, Volcanic~~

GROUND COVER %:

Vegetation	25
Non-vascular	~~80~~ 70
Litter	5
Bare Ground	0
Rock	0

Max Top Height (m) 0.8 DRASub

NOTES (including cultural)

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

pipit fernbird

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

RECCE IDENTIFIER: WAIPUNGA 06 MEASURED BY:

DAY/MONTH/YEAR: 21 JANUARY 2015 RECORDED BY:

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—	—		
					DRAsub 25	18
Tier 7					POAcil 0.1	5
Epiphytes					DEYave 0.1	0.5
					HYPrad 0.1	1
						PILoff 0.1
						PIMpro 0.5
						RYTgra 0.1
						DIC rob 0.1
						LEUfra 0.1
						CLAlep 5
						CLAret 65

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RECCE IDENTIFIER: WAIPUNGA_07 DAY/MONTH/YEAR: 06 MARCH 2015

SURVEY: WAIPUNA: FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1905735

NZTM Northing: 5688763

~~Single~~ (Averaged) waypoint Accuracy ± 1.9 m

SIZE OF RECCE	2x2
ALTITUDE (m)	692
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ (Terrace)
ASPECT (0–359°)	0
SLOPE (°)	0 ~~Convex, Concave,~~ (Linear)
PARENT MATERIAL	PUMICE
	~~Mapped~~ (Observed)
DRAINAGE	~~Good,~~ (Moderate), ~~Poor~~
CULTURAL	(None) ~~Burnt, Logged,~~
	~~Mined, Grazed, Tracked~~

APPROACH

WALK FROM WAIPUNGA RD

SURFACE CHARACTERISTICS:

~~Alluvial,~~ (Colluvial) ~~Moraine, Volcanic~~

GROUND COVER %:

Vegetation	8
Non-vascular	67
Litter	25
Bare Ground	0
Rock	0
Max Top Height (m)	2.5 DRAsub
	2.6 Colpro

NOTES (including cultural)

Here browse on ACI squ on walk in.

~~Re-~~ original BAK 02

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

Fernbird heard + silvereye,		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	

RECCE IDENTIFIER: WAIPUNGA 07 MEASURED BY: MARK SMALE

DAY/MONTH/YEAR: 04 MARCH 2015 RECORDED BY: NEIL FITZGERALD

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover						
				DRAsub 10	55	3
Tier 7				COPpro 3	3	0.5
Epiphytes						COPace 1
						MUEaxi 10
						~~RYTgra~~ POAcit 0.01
						HYPrad 0.1
						DICrob 56
						HYPcup 10
						CLAlep 1
						RYTgra 0.1

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 08 DAY/MONTH/YEAR: 21 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1905848

NZTM Northing: 5691127

~~Single~~ (Averaged) waypoint Accuracy ± ~~29~~ 1.9 m

SIZE OF RECCE	2x 2
ALTITUDE (m)	702
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ (Terrace)
ASPECT (0–359°)	120
SLOPE (°)	2 ~~Convex, Concave,~~ (Linear)
PARENT MATERIAL	PUMICE
	Mapped (Observed)
DRAINAGE	Good, Moderate, Poor
CULTURAL	(None), ~~Burnt, Logged,~~
	~~Mined, Grazed, Tracked~~

APPROACH

Walk from road on true right of valley

SURFACE CHARACTERISTICS:

~~Alluvial,~~ (Colluvial) ~~Moraine, Volcanic~~

GROUND COVER %:	
Vegetation	10
Non-vascular	85
Litter	5
Bare Ground	0
Rock	0
Max Top Height (m)	1·90 COPROS
	1·85 DRACS

NOTES (including cultural)

BROWSE None.

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate) Heard redpoll,

RECCE IDENTIFIER: WAIANGA 08 MEASURED BY: _____

DAY/MONTH/YEAR: 21 JANUARY 2015 RECORDED BY: _____

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—	—		
					COPpro 15	0.1
Tier 7					DRAsub 70	3
Epiphytes					POAcit 0.1	5
					HOLlan 0.1	0.5
					HYPrad 0.1	0.5
						CLAret 3
						GONagg 2
						DICrob 81
						GERmic 0.1
						RYTgra 0.1
						CLAlep 1

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 09 DAY/MONTH/YEAR: 05 MARCH 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1906481

NZTM Northing: 5694921

~~Single~~ / Averaged waypoint Accuracy ± 1·9 m

SIZE OF RECCE	2 x 2
ALTITUDE (m)	
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ Terrace
ASPECT (0–359°)	020°
SLOPE (°)	8° ~~Convex, Concave,~~ Linear
PARENT MATERIAL	PUMICE ~~Mapped~~ Observed
DRAINAGE	Good, ~~Moderate, Poor~~
CULTURAL	None, ~~Burnt, Logged, Mined, Grazed, Tracked~~

APPROACH

Walk direct from Waipunga Rd.

SURFACE CHARACTERISTICS:

~~Alluvial,~~ Colluvial, ~~Moraine, Volcanic~~

GROUND COVER %:

Vegetation	25
Non-vascular	68
Litter	5
Bare Ground	2
Rock	0
Max Top Height (m)	0·9 DRAsub

NOTES (including cultural)

Using BAK-04 original 09 not accessible due to very high cliffs

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

RECCE IDENTIFIER: WAIPUNGA 09 MEASURED BY: MARK SMALE

DAY/MONTH/YEAR: 05 MARCH 2015 RECORDED BY: NEIL FITZGERALD

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover						
					DRAsub 55	22
Tier 7					RYTgra 0.01	0.5
Epiphytes					DEYave 0.01	0.25
					POAcil 0.1	3
						LYCfas 0.1
					HYPrad 0.01	0.1
						[illegible]
						DICrab 0.01
						CLAlep 1
						CLAret 67

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 10 DAY/MONTH/YEAR: 21 JANUARY 2019

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1904708

NZTM Northing: 5684897

Single / (Averaged) waypoint Accuracy ± 1.9 m

SIZE OF RECCE	2x2
ALTITUDE (m)	672
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ (Terrace)
ASPECT (0–359°)	150
SLOPE (°)	4 ~~Convex, Concave,~~ (Linear)
PARENT MATERIAL	PUMICE ~~Mapped~~ (Observed)
DRAINAGE	~~Good,~~ (Moderate) ~~Poor~~
CULTURAL recent	(None) ~~Burnt, Logged, Mined, Grazed, Tracked~~

APPROACH

From road on true right of Waipunga river

SURFACE CHARACTERISTICS:

~~Alluvial,~~ (Colluvial) ~~Moraine, Volcanic~~

GROUND COVER %:

Vegetation	70
Non-vascular	0
Litter	30
Bare Ground	0
Rock	0
Max Top Height (m)	1.0 ~~Station~~
	1.75 DRA sub ~~Hieracium~~

NOTES (including cultural)

BROWSE none

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

redpoll, fernbird, silvereye.

RECCE IDENTIFIER: WAIPUNGA 10 MEASURED BY:

DAY/MONTH/YEAR: 21 JANUARY 2015 RECORDED BY:

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—	—		
					DRAsub 3	3
Tier 7					HIEred 5	~~25~~ 30
Epiphytes					DACglo 2	~~10~~ 15
					HOLlan 1	1
					FESrub 1	8
					CEPaus 0.5	0.5
					CARgem 0.5	5
					ANTodo 1	5
					RANac 0.1	2

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: Waipunga II
DAY/MONTH/YEAR: 20 JANUARY 2015
SURVEY: Waipunga Frost Flat
REGION: HAWKES BAY
CATCHMENT: WAIPUNGA
SUB-CATCHMENT:
MEASURED BY: MARK SMALE
RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1905818
NZTM Northing: 5694618
~~Single~~ / Averaged waypoint Accuracy ± 1·9 m

SIZE OF RECCE	2x2
ALTITUDE (m)	749
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ (Terrace)
ASPECT (0–359°)	110°
SLOPE (°)	5° ~~Convex, Concave,~~ (Linear)
PARENT MATERIAL	PUMICE ~~Mapped~~ / (Observed)
DRAINAGE	(Good), ~~Moderate, Poor~~
CULTURAL	(None), Burnt, Logged, Mined, Grazed, Tracked

APPROACH

Walk direct from Waipunga Rd.

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial), ~~Moraine, Volcanic~~

GROUND COVER %:	
Vegetation	23
Non-vascular	75
Litter	5
Bare Ground	2
Rock	0
Max Top Height (m)	1·4 Dracophyllum

NOTES (including cultural)

PINcon scattered about, some 20m away.

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

fernbird <20m away
Swarms of manuka beetles
Redpoll

RECCE IDENTIFIER: Waipunga II MEASURED BY: MARK SMALE

DAY/MONTH/YEAR: 20 JANUARY 2015 RECORDED BY: NEIL FITZGERALD

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—	—	44·2	100
					DRAsub 40	~~50~~ 25
Tier 7					LEPaus 2	5
Epiphytes					POAcit 0.1	5
					DEYave 0.1	1
					LEPsco 2	1
						AND ~~EPI~~ emp 2
						CLAlep 3 ~~5~~
						DICrob 10
						RYTgra 1
						GONag 0.5
						CLAcet 65.4
						HOLlan 0.1
						LYCfas 1

54·6
65·4

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 12 DAY/MONTH/YEAR: 20 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY NZTM Easting: 1906262

CATCHMENT: WAIPUNGA NZTM Northing: 5693083

SUB-CATCHMENT: Single / ~~Averaged~~ waypoint Accuracy ± 1.9 m

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

SIZE OF RECCE	2x2
ALTITUDE (m)	710
PHYSIOGRAPHY	~~Ridge~~, ~~Face~~, ~~Gully~~, (Terrace)
ASPECT (0–359°)	260
SLOPE (°)	9 ~~Convex~~, (Concave), ~~Linear~~
PARENT MATERIAL	PUMICE ~~Mapped~~ (Observed)
DRAINAGE	~~Good~~, (Moderate), Poor
CULTURAL	(None), ~~Burnt~~, ~~Logged~~, ~~Mined~~, ~~Grazed~~, ~~Tracked~~

APPROACH

Direct from Waipunga Rd.

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial), ~~Moraine~~, ~~Volcanic~~

GROUND COVER %:

Vegetation	~~50~~ ~~55~~ 50
Non-vascular	35
Litter	~~15~~ ~~10~~ 15
Bare Ground	0
Rock	0
Max Top Height (m)	2.1 DRASub

NOTES (including cultural)

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

Fernbird, redpoll, Blackbird, Grey warbler		L M H			L M H	
Fantail		L M H			L M H	
		L M H			L M H	
		L M H			L M H	
		L M H			L M H	

RECCE IDENTIFIER: WAIPUNGA 12 MEASURED BY: MARK SMALE

DAY/MONTH/YEAR: _____ RECORDED BY: NEIL FITZGERALD

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	—	—			
Tier 7			—	DRAsub 1	60	~~10~~ 13
Epiphytes					POAcil ~~2~~	~~10~~ 15
					HYPrad 0.1	3
					~~Hollan~~ ✓	0.1
					COPbm 2	4
						UNKmb 1
						BLEpen ~~3~~ 5
						MUEmxi ~~2~~ 2
						LEUfra 0.2
						GERmic 0.1
						ACAagn 0.1
						DICrob 2
						HYPmup 40
						RYTgra 0.1

82-5 15

38-5 10

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 13 DAY/MONTH/YEAR: 21 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1905829

NZTM Northing: 5689841

Single / Averaged waypoint Accuracy ± 2·0 m

SIZE OF RECCE	2x2
ALTITUDE (m)	695
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ (Terrace)
ASPECT (0–359°)	060
SLOPE (°)	6 ~~Convex, Concave,~~ (Linear)
PARENT MATERIAL	PUMICE ~~Mapped~~ / (Observed)
DRAINAGE	~~Good,~~ (Moderate) ~~Poor~~
CULTURAL	(None) ~~Burnt, Logged, Mined, Grazed, Tracked~~

APPROACH

Walk from Waipunga Rd.

SURFACE CHARACTERISTICS:

~~Alluvial,~~ (Colluvial) ~~Moraine, Volcanic~~

GROUND COVER %:

Vegetation	25
Non-vascular	50
Litter	25
Bare Ground	0
Rock	0
Max Top Height (m)	1·9 DRASub

NOTES (including cultural)

BROWSE None.

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate) Land

Redpoll, fantail, chaffinch, Bell bird

	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

RECCE IDENTIFIER: WAIPUNGA 13 MEASURED BY: _____

DAY/MONTH/YEAR: _____ RECORDED BY: _____

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	/	/	/	/		
					DRAsub 75	~~CEL~~ 17
Tier 7					COPpro 2	0.5
Epiphytes					LEPaus 0.1	0.2
					PDAcit 0.1	2
					HYPrad 0.1	0.1
						CELgra 0.1
						PILoff 5
						CLAcit 3
						HYPcap 44
						CLAlep ~~3~~ 3

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 14 DAY/MONTH/YEAR: 04 MARCH 2015
SURVEY: WAIPUNGA FROST FLATS
REGION: HAWKES BAY
CATCHMENT: WAIPUNGA
SUB-CATCHMENT:
MEASURED BY: MARK SMALE
RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1905653
NZTM Northing: 5689116
~~Single~~ / Averaged waypoint Accuracy ± 2.0 m

SIZE OF RECCE	2x2
ALTITUDE (m)	688
PHYSIOGRAPHY	~~Ridge, Face, Gully,~~ (Terrace)
ASPECT (0–359°)	~~N~~ 100°
SLOPE (°)	7° ~~Convex, Concave,~~ (Linear)
PARENT MATERIAL	PUMICE
	~~Mapped~~ / (Observed)
DRAINAGE	~~Good~~, (Moderate), ~~Poor~~
CULTURAL	~~None~~, ~~Burnt, Logged,~~ ~~Mined, Grazed, Tracked~~

APPROACH

WALK FROM WAIPUNGA ROAD.

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial), ~~Moraine, Volcanic~~

GROUND COVER %:	
Vegetation	79
Non-vascular	0
Litter	20
Bare Ground	1
Rock	0
Max Top Height (m)	0.9 DRASub
	1.1 HOKlan

NOTES (including cultural)

Some lagomorph droppings in plot.

original BAK03

BROWSE None

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

RECCE IDENTIFIER: WAIPUNGA 14 MEASURED BY: MARK SMALE

DAY/MONTH/YEAR: 04 MARCH 2015 RECORDED BY: NEIL FITZGERALD

585
20

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover						
					COPdum 3	0
Tier 7					COPpro 2	0
Epiphytes					DRAsub 3	1
					HIEred 1	10
					POAcit 1.5	3
					UNCrub 0.01	1
					COPace 5	35.5
					CREcap 0.01	1
					ANTodo —	5
					HOLlan —	20
					HYPrad —	2
						ACEmic 0.1
						Grass © 0.1
						RANrep 0.1
						GERmic 0.1

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Frost Flat Heathland Monitoring

RECCE IDENTIFIER: WAIPUNGA 15 DAY/MONTH/YEAR: 21 JANUARY 2015

SURVEY: WAIPUNGA FROST FLAT

REGION: HAWKES BAY

CATCHMENT: WAIPUNGA

SUB-CATCHMENT:

MEASURED BY: MARK SMALE

RECORDED BY: NEIL FITZGERALD

NZTM Easting: 1906056

NZTM Northing: 5692449

~~Single~~ (Averaged) waypoint Accuracy ± 23 m

SIZE OF RECCE	2x2
ALTITUDE (m)	713
PHYSIOGRAPHY	~~Ridge~~, ~~Face~~, ~~Gully~~, (Terrace)
ASPECT (0–359°)	070
SLOPE (°)	5
	~~Convex~~, ~~Concave~~, (Linear)
PARENT MATERIAL	PUMICE
	~~Mapped~~ / (Observed)
DRAINAGE	~~Good~~, (Moderate), ~~Poor~~
CULTURAL	~~None~~, Burnt, Logged,
	~~Mined~~, ~~Grazed~~, (Tracked)

APPROACH

Walk along road from washout; Road on true right of valley.

SURFACE CHARACTERISTICS:

~~Alluvial~~, (Colluvial), ~~Moraine~~, ~~Volcanic~~

GROUND COVER %:

Vegetation	~~40~~ ~~13~~ 14
Non-vascular	~~81~~ ~~78~~ 77
Litter	5
Bare Ground	2
Rock	5
Max Top Height (m)	0.95 DRASH

NOTES (including cultural)

Plot is in middle of old bulldozed vehicle track, no longer used by vehicles due to washout 200m away.

Hebe paniculata 5m east of plot.

BROWSE NONE

Species	Severity	Herbivore	Species	Severity	Herbivore
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	
	L M H			L M H	

FAUNA (e.g. mammal, bird, reptile, invertebrate)

Pipits, skylark, redpoll

RECCE IDENTIFIER: WAIPUNGA 15 MEASURED BY: _____

DAY/MONTH/YEAR: _____ RECORDED BY: _____

Percent foliar cover

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
	>25 m	12–25 m	5–12 m	2–5 m	0.3–2 m	<0.3 m
Overall cover	—	-	—	—		
					DRAsub 5	6
Tier 7						~~HYPer~~ PIlon 0.5
Epiphytes						HYPrad 0.2
						PIMpio 0.5
						COPace 4
						LEUfra 1
						POAcit 1
						CLArap 51
						CLAret 25
						CLAlep 1
						DEYave 1

78
28
52