

Upper Rangitata River Ten Year Weed Plan

Weed Surveillance and Control Plan, 2019-2029
Prepared for Environment Canterbury

20 May 2019



Document Quality Assurance

Bibliographic reference for citation: Boffa Miskell Limited 2019. <i>Upper Rangitata River Ten Year Weed Plan</i> . Report prepared by Boffa Miskell Limited for Environment Canterbury.		
Prepared by:	Pete Caldwell Senior Biosecurity Consultant Boffa Miskell Limited	
Reviewed by:	Marcus Girvan Principal, Biosecurity Project Manager Boffa Miskell Limited	
Status: FINAL	Revision / version: 1	Issue date: 20 May 2019
Use and Reliance This report has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Boffa Miskell does not accept any liability or responsibility in relation to the use of this report contrary to the above, or to any person other than the Client. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate, without independent verification, unless otherwise indicated. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.		

Template revision: 20150331 0000

File ref: C18076_Upper_Rangitata_Weed_Plan.docx

Cover photograph: Forbes River, Upper Rangitata Catchment © Pete Caldwell, 2018

CONTENTS

1.0	Executive Summary	2
2.0	Introduction	3
3.0	Biodiversity	4
4.0	Research, Consultation and Survey Method	5
5.0	Weed Species	6
6.0	Weed Control Strategy	8
7.0	Funding	15
8.0	Protecting values	15
9.0	Managing weed spread vectors	16
10.0	Annual Operational Planning	16
11.0	Risks	17
12.0	Conclusion	18
13.0	Acknowledgements	18
14.0	References	19

Appendices

Appendix 1: Maps

Appendix 2: Weed Descriptions

Appendix 3: Alignment with Plans and Strategies

Appendix 4: Photos

1.0 Executive Summary

The Upper Rangitata 10 Year Weed Plan (referred to as the Plan in this report) has been produced to provide direction for the management of weed species within the upper Rangitata. The preparation of this plan included consultation with key agencies and landholders, field surveys within key areas of the catchment, and the provision of recommendations for future weed management.

The upper Rangitata River catchment, above the Rangitata Gorge, has extensive landscape and indigenous biodiversity values. The extensive braided river provides habitat for indigenous flora and fauna, including threatened braided river bird species. Compared with the lower catchment and adjacent river systems, the upper Rangitata has relatively low weed abundance, with few dense infestations present. Isolated and scattered weed species are spread throughout the catchment, with the upper tributaries generally having fewer weed species, and at lower densities.

Weed control within the upper Rangitata catchment has been consistent and coordinated, involving landholders, Department of Conservation, Environment Canterbury, Land Information New Zealand and Fish and Game. This management has enabled the control of weeds within significant areas of riverbed and has limited the spread of weed species considerably. Gorse, broom and Russell lupin have been controlled regularly throughout much of the Rangitata riverbed. The upper extent of these species has not changed significantly within the last 16 years, and areas of dense infestations have been removed and/or reduced. Conversely, the abundance and distribution of wind-dispersed species such as grey willow and false tamarisk have increased markedly within the catchment. These species can disperse more readily in an upstream direction and are less conspicuous when flowering compared to gorse, broom and lupins. This creates difficulties in surveillance activities aimed at recording weed presence. Ongoing monitoring and control of these species is required to further prevent an increase in range and abundance.

This Plan aims to direct the effective future management of weeds that affect the braided Rangitata River and its values. This report focuses largely on the efficient use of funding for surveillance and control activities and ensuring that timely control of weed species reduces the weeds' ability to set and disperse seed. A key efficiency is employing the use of helicopter operators already travelling sections of riverbed for aerial surveillance of flowering weeds. This allows for isolated weeds to be recorded and controlled before setting seed.

The funding allocated to the upper Rangitata control programme is insufficient to adequately control and survey the catchment regularly. Currently, some areas are being missed and weed species are seeding before surveillance and control returns. Further weed spread and establishment has the potential to radically change the habitat values of the braided river ecosystem, as can be seen in other river systems. Maintaining control of weeds and limiting their establishment in new areas is key for biodiversity conservation in this significant and highly-valued catchment. An increase in annual funding to \$200,000 would allow for the near-total control of key weed species before they set seed. Over time, the cost of surveillance and control would reduce as weed species become less abundant. This increase in funding would also enable the upper Rangitata weed control programme to better achieve the key outcomes of the Implementation Strategy for the Braided River Flagship Project.

2.0 Introduction

Environment Canterbury commissioned Boffa Miskell to prepare a 10 Year Weed Plan to assist in directing the future management of weeds that affect the braided Rangitata River and its values. Several documents guide the programmes relating to protecting braided river biodiversity in this area. In particular, the Implementation Strategy for the Braided River Flagship Programme guides the management of biodiversity in the upper Rangitata River, with priority actions such as weed control. The Plan focuses on the Rangitata River catchment upstream of the Rangitata Gorge and includes information on weed species within the riverbed and on adjacent land where weed dispersal may affect riverbed values.

The upper Rangitata River catchment (henceforth upper Rangitata), located between the Lake Tekapo and Rakaia/Ashburton River catchments, is a 145,000 hectare area of high country above the Rangitata Gorge. The upper Rangitata River ranges from subalpine riverbeds through to a braided river up to 4km wide in some areas. The catchment includes a range of habitat types and includes numerous smaller sub-catchments including the Havelock River, Clyde River, Potts River and Forest Creek.

General weed distribution and density in this area is relatively low, particularly when compared to the Rakaia River (a similar, but larger, catchment to the northeast) where weeds have established to form extensive, dense infestations in the riverbed. Conversely, the upper Rangitata River has long had consistent and coordinated weed management, ensuring weeds have not established into dense infestations throughout most of the riverbed. This is of particular importance for the indigenous biodiversity found within, and adjacent to, the Rangitata River.

The braided nature of the Rangitata River provides important habitat for numerous threatened species. Invasive weed species threaten these habitat values by establishing on the relatively sparsely vegetated open gravels, outcompeting indigenous plant species, removing the open gravel habitat for threatened braided river bird species and increasing the cover for their predators. These effects are amplified by the increasing woody weed cover causing changes in river morphology, creating fewer, deeper channels with weeds completely covering islands and river banks. Furthermore, the decrease in shallow braids removes important habitat for indigenous fish species and feeding habitat for wading birds. Woody weeds also invade wetlands, often associated with springs and tributaries, in the wider river floodplain, displacing indigenous plant species, altering wetland hydrology and reducing habitat for indigenous fauna.

There are several key groups involved in maintaining a consistent weed control programme in the upper Rangitata River, which includes agencies and landholders of private and leasehold land. The Upper Rangitata Gorge Landcare Group (URGLG) is made up of landholders throughout the upper Rangitata catchment. This group was established in 1992 following the disbandment of the local Rabbit Board. This group has been, and continues to be, fundamental to the management of weeds and pest animals throughout the catchment, whose vision statement is:

“To protect the indigenous flora and fauna and to enhance the natural environment of the Upper Rangitata River in a societal, environmental and economically sustainable way”

The URGLG continues to control areas of riverbed adjoining their properties, particularly from Forest Creek downstream, but also including other areas at times. Regular URGLG meetings are held to discuss management of the upper Rangitata River, and are attended by key agencies, including the Department of Conservation (DOC), Environment Canterbury (ECan), Land Information New Zealand (LINZ) and the New Zealand Fish and Game Council (F&G). These meetings allow information sharing on weed distribution and previous and planned control works.

An annual weed control programme within the upper Rangitata catchment is managed by DOC with support and financial contributions from DOC, ECan, LINZ and the URGLG. This programme predominantly uses ground control throughout the catchment, with some aerial surveillance, spot spraying and aerial boom spraying in areas of dense infestations. This management approach has been largely successful, with many areas of relatively sparse infestations through to dense weeds being controlled on a regular basis. However, there has been a lack of comprehensive control across the catchment which appears to be largely due to a

budget that is insufficient for the area under management. Due to this funding shortfall, infestations must be prioritised for control, which is dependent on species' invasiveness, density and location.

The Upper Rangitata River 10 Year Weed Plan seeks to provide objectives for planning weed monitoring and control from 2019-2029. It also provides more detailed priorities and timeframes for control in the short-term.

3.0 Biodiversity

The vegetation communities in the upper Rangitata are influenced by the topography and varied altitudinal range, from 2875m (Mt D'Archiac) down to approximately 400 metres in the riverbed upstream of the gorge. This catchment contains extensive, unmodified alpine and subalpine flora. This includes herbfields, tall tussock grasslands and shrublands occurring on stable slopes and valley floors at higher altitudes, including into the lower reaches of the Forbes River catchment. Montane forest of mountain beech (*Fuscopora cliffortioides*) occurs in patches on hillslopes, along with associated forest and forest-edge species including broadleaf (*Griselinia littoralis*), kowhai (*Sophora* spp.), Hall's totara (*Podocarpus laetus*), mountain toatoa (*Phyllocladus alpinus*) and mountain lacebark (*Hoheria* spp.) in valleys and gullies.

The upper catchment shrublands of *Dracophyllum* spp., spaniards (*Aciphylla* spp.) and hebe (*Veronica* spp.) include subalpine herbs such as Mt Cook buttercup (*Ranunculus lyallii*) (including in the Forbes River) and mountain daisies (*Celmisia* spp.). Further east the shrublands are dominated by matagouri (*Discaria toumatou*) and mingimingi (*Coprosma propinqua*) and the tall tussock grasslands (snow tussock, *Chionochloa rigida*, and red tussock, *Chionochloa rubra*) give way to short tussock and exotic grasslands.

In the floodplain of the upper catchment rivers, relatively stable islands include indigenous dominated communities of woolly moss (*Racomitrium lanuginosum*), and gravel fields with mat daisies/scabweeds (generally *Raoulia* spp.), creeping pohuehue (*Muehlenbeckia axillaris*), silver tussock (*Poa cita*), indigenous common broom (*Carmichaelia* spp.) and scattered matagouri (*D. toumatou*). The exotic species increase in abundance further downstream with grasses (browntop, *Agrostis capillaris*; sweet vernal, *Anthoxanthum odoratum*; and yorkshire fog, *Holcus lanatus*), clovers (*Trifolium* spp.), hawkweeds (*Hieracium* spp. and *Pilosella* spp.) and other herbs common. Wetlands adjacent to the riverbed include red tussock (*C. rubra*), bog rush (*Schoenus pauciflorus*), tussock sedge (*Carex stricta*) and other indigenous sedges (*Carex* spp.) and are increasingly dominated by exotic rushes and grasses further east.

The Rangitata River is of very high value for braided river birds. It has high species diversity, abundant potential feeding and breeding habitat (due to the lack of weeds) and supports important populations of nationally threatened and at-risk species, including wrybill (*Anarhynchus frontalis*), black-fronted tern (*Chlidonias albobristatus*), black-billed gulls (*Chroicocephalus bulleri*), banded dotterel (*Charadrius bicinctus*) and South Island pied oystercatcher (*Haematopus finschi*). Other threatened and at-risk fauna reported in the catchment include scree skink (*Oligosoma waimatense*) and jewelled gecko (*Naultinus gemmeus*).

4.0 Research, Consultation and Survey Method

Research on previous control and surveys within the upper Rangitata River was carried out alongside consultation with key stakeholders. Meetings to discuss weed management in the upper Rangitata River were held, involving discussions with DOC, URGLG, ECan, LINZ and F&G, to better understand the priorities from each group or agency. Relevant plans and strategies were also studied to ensure a Plan which aligns with higher-level goals, including the Canterbury Regional Pest Management Plan, the Implementation Strategy for the Braided River Flagship Programme, the Canterbury Water Management Strategy and the Canterbury Biodiversity Strategy.

The riverbed weed survey of the upper Rangitata River was carried out between November 2018 and January 2019 during a period of extremely unsettled weather, which limited productive survey time. The areas searched during separate surveys were:

- Ground survey from the lower Clyde River downstream on the true left (left side, facing downstream) to opposite Mesopotamia homestead, including lower Potts River (November 2018);
- Brief helicopter survey of main riverbed areas, including upper Havelock River, Lawrence River and much of Clyde River, and ground survey of Forbes River and upper Havelock River, from Veil Stream confluence to Black Birch Creek (December 2018);
- Ground survey of true right from Black Birch Creek downstream to Forest Creek. Survey effort was reduced immediately above Forest Creek, and downstream to the gorge, with most areas only surveyed aurally (January 2019).

Areas of riverbed and the adjoining land were surveyed predominantly on foot and using 4WD vehicles. Due to the vast area of riverbed not all sections could be surveyed on foot. Most areas were surveyed with the aid of binoculars and, at times, a spotting scope. Weed species in some tributaries on the true right of the Rangitata River (e.g. Forest Creek, Neutral Creek) were recorded as they were found during other project work, however focus was not on the detection of weeds in these areas.

The timing of field surveys affected the detectability of key weed species. During the survey of the Clyde River (November 2018) to below the Potts River confluence, Russell lupin was still germinating and emerging making detection difficult, particularly across wide areas of riverbed.

The areas of focus for this weed survey were derived from the consultation with key stakeholders and expected weed dispersal patterns based on weed biology, weather patterns and bird and animal movement in the catchment. The weed maps have been developed so that any additional information from future weed surveys and control activities can be added to those maps.

5.0 Weed Species

The weed species below are separated into two categories, **key riverbed weed species** and **other weed species**. The key riverbed weed species are those that are considered more important to control in the short term and with limited budgets. They are generally associated with a high rate of spread within a riverbed or have a long seed viability.

The weed distribution maps produced (Appendix 1: Maps) show the extent of key weed species in the upper catchment, and where individual plants were found. Larger polygons of “expected area” were created to indicate where weeds were, and are, expected to be found (“scarce” and “occasional” infestation densities). Surveillance and control are recommended to be carried out in these areas. Most priority areas of the upper Rangitata are designated for control of key riverbed weed species, as this ensures an area can be comprehensively controlled without using resources on less invasive species, or those more difficult to detect or access. Where other weed species are detected in very low densities during control activities, it is recommended that these be treated if it is cost effective to do so.

The distributions of the key species are summarised below, with further details and other weed species described in Appendix 2.

The key riverbed weed species, in alphabetical order, are:

- Broom (*Cytisus scoparius*)
- Crack willow (*Salix fragilis*)
- False tamarisk (*Myricaria germanica*)
- Gorse (*Ulex europaeus*)
- Grey willow (*Salix cinerea*)
- Russell lupin (*Lupinus polyphyllus*)
- Tree lupin (*Lupinus arboreus*)

Broom (*Cytisus scoparius*)

In the upper Rangitata, isolated broom bushes were found in the Havelock and Clyde River catchments. Broom becomes more common downstream, throughout the riverbed and on adjacent land. The only dense infestations found were in the lower Potts River and downstream of this point on the true left of the Rangitata River. Greater abundance of broom plants was found near the confluence of Alma Stream and the Rangitata River, and within Bush Stream.

The upper extent of broom infestations recorded during the weed survey is similar to that of Mike Harding’s 2002 field survey (henceforth, 2002 field survey), aside from a lone broom bush recorded and controlled near Murphy Stream in the December 2018 survey.

The “expected area” polygon for broom (Appendix 1: Maps; Broom) shows the extent of observed or expected broom establishment, given the seed source and its dispersal through water movement. This area designates the area to be searched while broom is in flower.

Crack willow (*Salix fragilis*)

Crack willow has no obvious spread in the Havelock or Clyde River catchments. However, alongside the Rangitata riverbed, particularly in wetland areas, crack willow is spreading. There is also considerable regrowth within the previously controlled crack willow between Tui Stream and Scour Stream, and young trees are spreading in the area surrounding the Ice Rink. The upper extent is higher in the Havelock River than that recorded in the 2002 field survey but has a similar extent within the Clyde Catchment.

False tamarisk (*Myricaria germanica*)

False tamarisk has shown a marked increase in incidence and extent within the upper Rangitata since the 2002 field survey. The wind-dispersed seed of false tamarisk makes containment of this species more difficult than gorse or broom, as seed dispersal upstream and across riverbed areas is more likely. Only one false tamarisk plant was found in the 2002 field survey, whereas numerous individual plants and patches of scattered plants were observed on the true right of the riverbed, as far upstream as the confluence of The Growler and Havelock Rivers. False tamarisk is on a trajectory to rapidly increase in density in areas already present, extend its range further upstream, and become more common on the true left of the Rangitata River.

Compared to gorse and broom this species is less conspicuous when in flower. Therefore, biennial search on foot is preferable within areas of expected false tamarisk incidence to prevent plants from seeding. One false tamarisk plant was found in Forest Creek approximately 15km above the road bridge. This area requires a more thorough search to find if/where individuals are present within the riverbed, with these areas added to the “expected area” polygon for surveillance/control going forward.

Gorse (*Ulex europaeus*)

During the 2018 field survey, gorse was recorded from the Growler and Havelock confluence, down the true right of the Rangitata riverbed and becoming more common above Black Birch Stream. Scattered infestations downstream from this point were observed. Gorse has been controlled regularly at the confluence of the Lawrence and Clyde Rivers, with only isolated plants or small patches observed until the Potts River, where it becomes more commonly scattered. The upper extent of gorse has not changed significantly since the 2002 field survey, with only a single gorse site found higher than the previous upper extent at Alma Stream.

Grey willow (*Salix cinerea*)

Grey willow distribution and incidence has increased significantly since the 2002 field survey. This species now inhabits the edge of the riverbed and tributaries throughout the catchment. Aside from a single plant previously found in the upper Havelock River, the upper extent of the species range in the 2002 survey was Black Birch Creek. Grey willow can now be found within tributaries flowing into the Havelock River. During the 2018 weed survey grey willow was found and controlled on the true right of the Clyde River, and has previously been controlled within the Lawrence River. As this species has a wind-dispersed seed, it is more likely to travel in an upstream direction or across to, or from, adjacent terraces and hillsides. Control has not been adequate to contain grey willow to date. A coordinated approach is required across land tenures to ensure remaining individuals are not able to seed and reinvade controlled areas or spread further in the catchment.

Russell lupin (*Lupinus polyphyllus*)

The upper extent of Russell lupin in the upper Rangitata recorded during the 2018 field survey was similar to that of the 2002 field survey. It appears to be contained to the Forbes River, and is found up to the northern end of the Jumped Up Downs within the Clyde River. Russell lupin is scattered downstream to below the Potts River confluence, and then again around the Ice Rink. Patches of dense lupin were observed around the Ice Rink; these have since been boom-sprayed. Although Russell lupin seed has a long viability in the seedbank, it is also easier to contain compared to wind-dispersed species. Spread is predominantly via water, and, therefore, upstream spread is less common.

Tree Lupin (*Lupinus arboreus*)

Tree lupin is a priority species for surveillance and control, due to its invasive nature and its low incidence in the upper Rangitata. It was not recorded in the 2018 or 2002 field surveys but is known to be present in the riverbed downstream from Forest Creek. All tree lupins should be recorded when found and added to the weed distribution maps to ensure follow-up control in these areas.

6.0 Weed Control Strategy

The objectives and priorities set out below seek to achieve greater effectiveness in weed management within the upper Rangitata. The management of weeds in this area to date has been coordinated but not comprehensive. Through achieving the objectives below resources will be increased and optimised, ensuring control is implemented that progressively reduces weed abundance and distribution throughout the riverbed.

Key Objectives

1. Coordinate management and control activities

Continued communication between runholders and agencies is paramount for continued success. The URGLG meetings, involving relevant agencies, are an efficient way to share information and coordinate control activities, which leads to more effective weed management. This information sharing could be further improved with the inclusion of more landholders from the northern side of the Rangitata River. Weed control plans for surrounding properties would provide key agencies (DOC, ECan, LINZ, F&G) with a better understanding of planned control of surrounding seed sources. These plans would likely be agreed programmes between Environment Canterbury and landholders.

2. Progressively reduce weed abundance and distribution by effectively controlling key weed species before they set seed

To effectively manage key weed species, they must be controlled systematically, generally working from the upstream extent in a downstream direction. The prevailing nor'west wind will also more commonly spread wind-dispersed seed in a downstream direction. If weed species set seed, the seed-bank viability will be extended, and worse, may be dispersed over a greater area. Because of the high cost of searching for scattered weeds, seed dispersal into new areas should be restricted as much as possible. An important strategy for achieving this objective is to carry out aerial surveillance and controlling or recording (via GPS) infestations during peak flowering.

3. Systematically control weed infestations on land adjacent to riverbeds

Engaging with landholders to ensure complete removal of certain weed species is critical in preventing seed dispersal into riverbeds long-term. A number of weed species listed in this report are required to be controlled through rules under the Canterbury Regional Pest Management Plan (CRPMP), whereas others are not. Regardless of status, pest species which have the potential to adversely affect braided river values must be controlled in a coordinated way to ensure seed-source populations do not remain and propagate. At the time of writing this report, adjoining landholders were carrying out weed control on their properties to varying extents. A planned and systematic approach to this control will more efficiently reduce plants most likely to spread seed into the riverbed and save much greater control costs in the future.

4. Increase control works spend to \$200,000 by July 2021

The current funding levels are insufficient to comprehensively control all key weed species across the upper Rangitata. This is demonstrated by the increase in prevalence and distribution of some species over the past 16 years. Additional funding should be secured to target individual sites or species. The current control programme strategy for managing the spread of species such as grey willow and false tamarisk does not align with the key outcomes of the Implementation Strategy for the Braided River Flagship Project, particularly the aim to keep areas free of weeds from becoming infested (i.e. "keeping clear areas clear"). An annual budget of \$200,000 by July 2021 would enable more comprehensive control of key weed species. This 10 Year Weed Plan seeks to align with relevant plans and strategies (Appendix 3) to ensure that the funding required for sufficient control can be obtained.

5. Effectively manage weed spread vectors

Some mechanisms of weed dispersal could be better managed to reduce probability of moving seed into new areas. Vehicles are known to carry seed long distances and into remote areas, and access to some areas could be restricted if vehicles have soil and/or weeds present. This includes vehicles used road works and farm contractor activities. The movement of stock during seeding of weed species should also be limited to reduce the probability of dispersing seed.



Russell lupins flowering in the Forbes River. Weeds must be controlled before they set seed to ensure they do not spread further within the riverbed

Upper Rangitata Riverbed Control Priorities 2019-2022

The control priorities in the upper Rangitata are listed in Table 1 and shown in Priority Areas map below. Because the level of future funding and weed growth is uncertain, control and monitoring activities have been ordered from highest to lowest priority. Detailed descriptions of the area targeted are listed below the table.

Table 1: Control priorities for weed control in the upper Rangitata River, based on areas and species targeted and method, frequency and timing of control.

Priority	Area Targeted	Species Targeted	Control Type	Frequency and timing of control	Explanation
1	Clyde River and Lawrence River	All key weed species*	Aerial survey during broom and gorse flowering within upper section. Lower 3km section treated via ground control.	Annually. Ground survey every 3 rd year from Clyde/Lawrence confluence, downstream. Aerial survey during other years. Control completed before December 31	Very low weed abundance in this area. Stop seeding of weeds to limit spread and seedbank.
2	Forbes River and Havelock River	All key weed species*	Ground control in Forbes, aerial survey during broom and gorse flowering in Havelock.	Annually. Ground control every 3 rd year through Havelock. Control before December 31.	Very low weed abundance in this area. Stop seeding of weeds to limit spread and seedbank.
3	Potts River, above bridge	All key weed species*	Ground control in lower section (to 5km above Potts River Bridge) and aerial survey in upper river during flowering	Annually in lower section. Biennially in upper section. Control before December 31.	Very low weed presence in upper river. Ground control is required in lower river where weed abundance is scattered.
4	Rangitata River, from Clyde/Havelock River confluence to Black Birch Creek/Potts River	All key weed species*	Ground control. Aerial survey during flowering	Annually. Control before December 31.	Scattered key weed species requiring annual follow up control to prevent seeding.
5	Rangitata River downstream from Black Birch Creek/ Potts River	Broom, gorse, Russell lupin and false tamarisk, scattered willows	Aerial survey/control during flowering. Ground control in areas of densely scattered plants	Aerial survey/control, biennially. Ground control in areas with identified weeds, annually. Aerial control of isolated weeds completed before December 31, ground control areas completed before January 31.	Control must be completed prior to seeding to stop further spread of weeds. Areas where multiple plants have been found previously should be controlled via ground, other areas aerially surveyed/controlled during peak flowering for gorse and broom.

Priority	Area Targeted	Species Targeted	Control Type	Frequency and timing of control	Explanation
6	Rangitata tributaries, Murphy Stream to Forest Creek	Key weed species, particularly grey willow	Ground control	Biennially, before January 31.	Weed species increasing in prevalence in these tributaries.
7	Lower Potts River and below confluence, true left of Rangitata	Predominantly broom and other key weed species	Ground control, some boom spraying via helicopter where previously boom sprayed.	Biennially, before January 31.	Broom regrowth will occur, and seed will be spread by water and stock.
8	Ice Rink area	All key species, particularly Russell lupins and willow (grey and crack)	Ground control	Lupins controlled annually, before December 31. Remaining species controlled biennially.	Limited distribution, dense patches of Russell lupins in this area. Willow spreading vigorously through wetlands. Early control and follow-up will limit spread, particularly seed dispersal of lupins.
9	Havelock River, at Erewhon container	Deciduous tree species, particularly alders (<i>Alnus glutinosa</i>).	Ground control	As soon as practicable after satisfactory discussions with landholder. Follow-up control biennially.	Alders are on Erewhon Station, adjacent to the riverbed, with young plants spreading down a tributary.
10	Adjoining properties	Broom, gorse, grey willow, Russell lupin	Aerial and ground control	As soon as practicable after satisfactory discussions with landholders.	Weed species on properties adjoining the river are spreading seed into the riverbed, undermining the integrity of the programme
11	Lower Potts River, above bridge	Rowan (<i>Sorbus aucuparia</i>)	Ground control	As soon as additional funding can be acquired.	This area of Public Conservation Land (PCL) has a high abundance of rowan trees, which are being dispersed by birds and are increasing in density.
12	Adjoining properties	Rowan, cotoneaster (<i>Cotoneaster</i> spp.), poplar (<i>Populus</i> spp.), elderberry (<i>Sambucus nigra</i>) and other introduced deciduous species	Ground control, aerial wanding in inaccessible areas	Control while carrying out other aerial wanding operations. Follow-up every 3-4 years.	It is efficient to remove individual weed species while aerial control is being carried out.

* Except mature crack willow as flood-protection, see Appendix 2: Weed Descriptions, Crack willow.

This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Cadastre

Priority Areas

1

2

3a, 3b

4

5

6

7

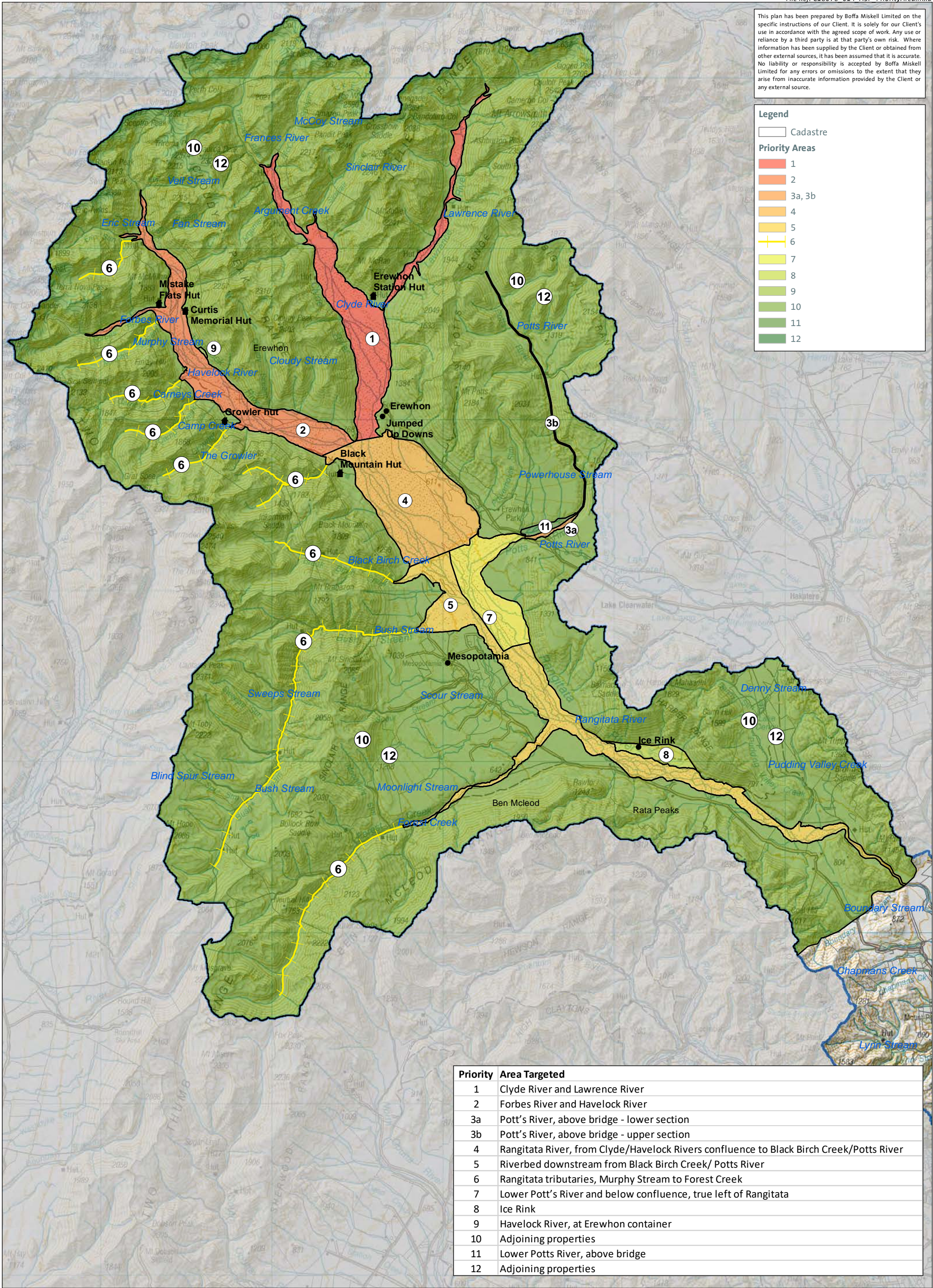
8

9

10

11

12



Priority	Area Targeted
1	Clyde River and Lawrence River
2	Forbes River and Havelock River
3a	Pott's River, above bridge - lower section
3b	Pott's River, above bridge - upper section
4	Rangitata River, from Clyde/Havelock Rivers confluence to Black Birch Creek/Potts River
5	Riverbed downstream from Black Birch Creek/ Potts River
6	Rangitata tributaries, Murphy Stream to Forest Creek
7	Lower Pott's River and below confluence, true left of Rangitata
8	Ice Rink
9	Havelock River, at Erewhon container
10	Adjoining properties
11	Lower Potts River, above bridge
12	Adjoining properties

Detailed Priority Descriptions

In the immediate future the current level of funding is likely to be insufficient to carry out ground control across all areas of riverbed. Therefore, it is important to focus ground control on areas where scattered weed species are likely to be found. In areas where key weed species have been recorded, but where they are not commonly found, aerial surveillance should be employed. This surveillance method is best utilised when species are flowering and are more easily detected. Because of the variable flowering times for multiple pest species, aerial surveillance may be undertaken at various times throughout the season to coincide with peak flowering. As these flowering times vary between seasons, local knowledge is vital in deciding when to carry out surveillance. The control timing dates are listed to encourage most areas to be controlled prior to seeding, particularly remote areas with low weed density. It is acknowledged that due to variable weather and other factors, control of all areas before seeding may not always be practicable. It is expected that priorities 1-8 and 11 are carried out in all future control plans, as these are all high priority for continued and increased control. Priorities 9, 10 and 12 are dependent on adjoining properties taking a proactive approach to managing weeds, but are nonetheless high priority to manage weeds long-term.

1. Clyde River and Lawrence River

The Clyde River and Lawrence River have relatively low weed incidence, making them priorities for exclusion of new weed species and suppression and/or eradication of species already present. The very low abundance of weeds makes eradication achievable, as these areas can be monitored and controlled to ensure no plants set seed. Known sites for gorse and broom should be checked annually, with other areas in the catchment flown during peak flowering for gorse and broom biennially. These surveys could be completed by a helicopter operator during back-loads to significantly save costs. A "back-load" is when a helicopter is being used on a one-way trip, and travel in the other direction may be utilised at a reduced cost. When a helicopter is in this area during peak broom or gorse flowering, a minimal budget could be allocated to a helicopter operator, experienced in weed control or surveillance, to check for and record flowering weeds. This is an efficient form of surveillance as there is no ferry time required to the site.

Control of lupins and broom on the Jumped Up Downs hillside above the lower Clyde River is a key priority to reduce seed into the riverbed. The Erewhon Station manager has discussed how these could be controlled in the future, but further discussions need to take place to ensure these are controlled in the short-term. Rules within the CRPMP are now in place that require Russell lupin to be controlled within 200 metres of a braided river (Environment Canterbury, 2018). The CRPMP also requires broom and gorse infestations up to 50 square metres, or within 10 metres of a boundary, to be controlled. These rules ensure that these species do not continue to spread onto adjacent property, and particularly into riverbed systems.

2. Havelock River and Forbes River

The Havelock River and Forbes River are relatively weed free, making them priorities for exclusion of new weed species and eradication of species already present. The Forbes River does have a significant infestation of Russell lupin, which is possible to eradicate in the long-term. The Russell lupin densities have reportedly been reduced significantly due to consistent control in this area. Control of Russell lupins and any other key weed species should be carried out annually by December 31 to avoid new seed entering the seedbank. No key weed species were found in the Havelock River above the Forbes River confluence, but these become scattered downstream. Aerial surveillance/control from the Forbes River confluence to Clyde River confluence should be undertaken annually during broom and gorse flowering. Any plants controlled should be recorded and added to a dataset to guarantee that these areas are checked in following years. The low abundance of weed sites and densities makes eradication in this catchment possible in the long term, as these areas can be monitored and controlled to ensure plants do not set seed. The Havelock River, above the Forbes confluence, should be aerially surveyed for all species biennially, during flowering. These surveys could be completed during back-loads to significantly save costs.

3. Potts River, above bridge

Weed distribution upstream of the Potts River Bridge is limited, with very sparse densities detected during the survey. All key weed species should be targeted annually to ensure plants do not set seed, to approximately 5 km upstream of the bridge (Priority Area Map, 3a). Above this there have only been occasional weeds found, particularly broom in the upper Potts catchment. A helicopter survey should be carried out biennially to ensure plants do not set seed in this area (Priority Area Map, 3b), with all plant locations recorded for sites to be checked in following seasons. This survey could be completed during back-loads to significantly save costs.

4. Rangitata River, from Clyde/Havelock Rivers confluence to Black Birch Creek/Potts River

There are numerous, scattered weed species present between the Clyde/Havelock River confluence downstream to approximately the Black Birch Creek and Potts River confluence with the Rangitata River. It is important that this area is controlled annually to prevent weeds adding to the local seedbank or being spread by wind and water. The true right, particularly around the confluence of Black Birch Creek and Rangitata River, has weeds present which have not been controlled in recent years, including gorse and grey willow. These areas require more consistent control to ensure plants do not set seed and do not continue to spread. Aerial surveillance on the true right during peak flowering of gorse and broom can direct ground control to areas of detected weed species to reduce the need for comprehensive ground control every year.

5. Riverbed downstream from Black Birch Creek/ Potts River to the Rangitata Gorge

Ground control across this extensive area of riverbed, although ideal, is not practical within realistic timeframes and budgets. Consequently, sparsely infested areas where ground control is not planned for a given season requires aerial survey during peak flowering. At sites where plants are expected to be found, a helicopter with wanding capabilities is recommended, particularly when encountering broom/gorse in flower. Weed species found during this work should be sprayed or recorded for follow up ground work, depending on what is determined to be most cost-effective. Surveying areas in this way provides good data to give to ground contractors for follow-up control of densely scattered weed species, while ensuring mature plants do not set seed. If increased funding is allocated to this programme, this aerial survey could be carried out annually. Initially, areas of densely scattered willow may need to be overlooked to ensure the total area can be surveyed. If budgets permit, these areas can be revisited for control.

6. Rangitata tributaries, Murphy Stream to Forest Creek

Grey willow incidence and range in this area is increasing rapidly. Seed sources must be controlled to prevent dense infestations from establishing throughout wetland areas, and from continued spread into remote tributaries. Grey willow has been recorded in the tributaries from Forbes River to Forest Creek. Control must be undertaken as soon as practicable to slow the spread of this wind-dispersed species. Although ground control is the most reliable method of detecting and controlling willow, aerial wanding could also be used in upper catchments to cover these areas more efficiently.

7. Lower Potts River and below confluence, true left of Rangitata River

It is important to undertake follow-up control of regrowth where dense, key weed species have been controlled. Re-establishment of broom may begin rapidly, with plants likely producing viable seed in the second year. This seeding cycle must be stopped to reduce further recruitment immediately around, and downstream from, these historically high-density sites. Follow-up boom spraying will likely be the most efficient control in areas where dense seedlings have re-established. Where broom is growing in scattered infestations, particularly around the edges of boom-sprayed areas, ground control is recommended as it reduces collateral damage to indigenous species.

8. Ice Rink area

Russell lupins are not common throughout the lower riverbed below Potts River, except in the area surrounding the Ice Rink. These dense infestations should be treated via aerial boom spraying or ground control initially, with follow-up ground control in subsequent seasons. Willows are also spreading throughout this wetland area. Control of these scattered populations will be required to prevent these areas becoming dense willow monocultures that are ultimately more expensive and difficult to remove.

9. Havelock River, at Erewhon container

Alders are spreading in an isolated area adjacent to the Havelock River (true left, opposite Carneys Creek) from mature trees upstream. Alders are a significant threat to wetland areas and river edges and are a significant control cost in other river systems in the South Island. If the seeding trees are treated in the short-term, this species can be eradicated from the area, with follow-up control carried out on any remaining regrowth. Planting other species, that are not potential weeds, may be required before these alders are removed, due to their current positioning being desired by the landholder. Discussions should seek to resolve this as soon as practicable to limit the alders' opportunity to spread seed.

10. Adjoining properties

Work carried out on properties adjoining the riverbed is generally at the landholders' expense. It is important for key weed infestations on surrounding land to be controlled over the following three seasons. Surrounding properties have scattered weed infestations, with some also having areas of dense weeds. Denser infestations of gorse and broom over 50 square metres are not required to be controlled under the CRPMP. However, seed from these infestations will undoubtedly disperse into the braided riverbed at times. A two- or three-year control plan of weeds on adjacent land is a practical way of ensuring an achievable control programme, focusing on the high priority areas which are a higher threat to the braided river.

11. Lower Potts River, above bridge

Rowans in the Public Conservation Land (PCL) above Potts River Bridge are undoubtedly spreading and becoming denser within this area, particularly on the true right hillside. If left uncontrolled, birds will disperse their seeds within the Potts River catchment, along hillsides and into the Rangitata riverbed. Although this species is less invasive than other key weed species in the short-term, it will likely establish within the wider riverbed, adversely affecting braided river values long-term. It is also a threat to indigenous forest, shrublands and tussock grasslands in the upper catchment. Due to the limited area of this relatively dense infestation, acquiring separate/additional funding to control this population may be feasible. It would be valuable to eliminate this infestation and remove the significant seed source. This species has been added to control programmes in other areas of Canterbury due to its propensity to spread widely and establish across landscapes.

12. Adjoining properties

Aerial wanding of tree weed species may be able to be included alongside wilding conifer control if National Wilding Conifer Control Programme (NWCCP) work is carried out in this catchment. Wilding conifer control is largely dependent on landholders agreeing to pay for control of the trees that are found on their property. If control is already occurring across the landscape through the NWCCP, the cost to treat additional species will generally be lower than controlling a single property through shared ferry costs. Areas identified as too dense for aerial wanding should be marked for follow-up ground control.

7.0 Funding

An average of approximately \$140,000 annually has been spent on the upper Rangitata River weed management programme over the past few years, in addition to landholders' own control works in some areas of riverbed adjacent to their properties. This budget does not allow for comprehensive control across the catchment, with some areas harbouring scattered weeds that have been allowed to set seed, producing new seedlings and adding to the seedbank. Controlling weeds at low densities using aerial wanding or ground-based control methods is significantly cheaper than allowing infestations to increase in density and geographic distribution. Treating sparse infestations also significantly reduces by-kill, as ground control methods are more targeted than aerial boom spraying. Although broom, gorse and Russell lupin distributions are similar to those observed in the 2002 field survey, there has been a marked increase in grey willow and false tamarisk. These wind-dispersed species more quickly spread into new areas, requiring more comprehensive surveillance, when compared to species with a heavy seed, such as gorse, broom and lupin.

A significant increase in funding is required to effectively stop the seeding cycle of key weed species in the catchment. A recommended total annual budget of approximately \$200,000 would begin to bring weed species more efficiently under control and allow for more surveillance. The upper Rangitata is a relatively large catchment and, therefore, there will always be a significant cost of surveillance of weed species, even if very few are detected. However, this cost is still much lower than if weeds are left to increase to moderate or high densities.

If control budgets are not increased in this catchment, efficiencies must be made, or some areas only controlled biennially to cover the riverbed area. Some key species or sites may even need to be removed from the control programme. Due to gorse, broom and lupin having a more conspicuous flower, these can be more efficiently controlled at low densities with aerial wanding. Additionally, the CRPMP requires the control of these species when they are at scattered densities and/or near boundaries.

Efficiencies can also be made by compiling GPS data of recorded weed locations into a GIS system. Over time, this allows land managers to observe exact areas of likely weed presence and control those areas on a more regular basis. This does require contractors to consistently record what species they are finding. However, with wind-dispersed species present, more remote areas harbouring weeds may be missed, giving those weeds the opportunity to seed. Overlaying GPS tracking shows areas that have been missed during control/surveillance over consecutive years and subsequent surveillance can target these areas.

8.0 Protecting values

Weed control is carried out in the upper Rangitata to protect biodiversity values within the riverbed. While controlling weed species that would otherwise displace indigenous species, it is also important to minimise by-kill of indigenous species when carrying out control works. Numerous indigenous biodiversity values are present across the upper Rangitata River landscape.

To protect these indigenous communities aerial boom spraying should be avoided throughout the catchment where possible, except areas where it has been carried out in the recent past. This is predominantly between the Potts River bridge and approximately 8km downstream of the Potts/Rangitata confluence, on the true left of the Rangitata River. Where dense weeds re-establish within these areas, aerial boom spraying may be repeated in the short term. It is expected that weed emergence in these areas will reduce as the seedbank is depleted, resulting in scattered weeds that can be controlled via ground-based methods. Elsewhere within the riverbed only ground control and aerial wanding should be carried out to reduce by-kill of indigenous species.

9.0 Managing weed spread vectors

Numerous vectors are capable of spreading weeds, including machinery, people and animals. These can be managed to reduce the probability of moving seed into remote areas that are less intensively monitored.

Educating recreational users who drive vehicles within the upper Rangitata catchment about biosecurity issues may reduce the likelihood of seeds being carried into new areas. Furthermore, landowners who refuse access to vehicles with significant soil or plants attached will encourage improved vehicle hygiene behaviours. Vehicle and soil/gravel movement during gravel extraction, road works, riverbed engineering works and farm contractor activities also increase the risk of spreading weeds. Continued communication about biosecurity pathway management with all who drive vehicles in the upper Rangitata is crucial to slow weed spread.

Providing recreation users with the tools and knowledge to identify and record information can be valuable. The Recreational User Tool (attached to this Plan) for weed observations provides a summary of the reason for controlling weeds, and a link to useful information on weed identification. It also provides georeferenced maps of the upper Rangitata and an example of an electronic mapping app that can be freely used to accurately record weed locations.

Moving stock upstream during seeding of key weed species should be avoided if possible, particularly if the stock have been in proximity to known weed infestations during seed release. Alternatively, delaying stock movement to remote areas, or shearing sheep before moving them, will aid in reducing seed dispersal to these areas. Moving stock to a clear and accessible paddock for a time after they have been in contact with key weed species is one approach to manage this. Furthermore, buying in stock and feed from outside the catchment will increase the probability of new weed incursions. It is important landholders understand where stock and feed are coming from to reduce the likelihood of bringing in new weed species.

Wild animals may carry weed seeds some distance, particularly in their coats, before depositing them into new areas. Reducing populations of mobile wild animals (particularly ungulates) can reduce the probability seed will be moved into areas that are not commonly surveyed or controlled. Bennett's wallabies (*Macropus rufogriseus*) are increasing in density within the Rangitata catchment. High densities of wallabies may move seed within their coats, as they are known to reside in thick cover, such as broom and gorse, and then move to more open areas to feed. Southern black-backed gulls (*Larus dominicanus*) also move weed species throughout riverbed areas, particularly when using vegetation from weed species as nest-building material. Well-planned programmes to keep animal populations at low densities are an effective long-term strategy to reduce the spread of weed species.

10.0 Annual Operational Planning

An operational plan is developed (by DOC) before control works commence each season. Information gathered during an annual, aerial assessment by DOC, ECan and LINZ representatives provides useful feedback on the previous season's success and valuable intelligence on sites requiring control. DOC then proposes a programme that is discussed and agreed with the key agencies and the URGLG. This gives all key stakeholders the opportunity to collaborate on the programme before control is undertaken. It is recommended that this process continues, as it is vital to ensuring a programme that can adapt to changing priorities and new weed invasion and is a great opportunity to receive valuable input from adjacent landholders.

11.0 Risks

It is important to understand risks to achieving effective, long-term weed management in the upper Rangitata. There are several key risks to achieving the objectives set out in this plan.

1. Funding

A loss or significant reduction in funding from one (or more) of the agencies would significantly reduce the effectiveness of the weed control programme. This would require further prioritisation of areas and/or species, and would likely result in some areas becoming densely infested by weed species. Similarly, increasing costs of control (which is inevitable over time) will result in a reduction in total control work completed. To safeguard against these risks, it is vital that additional funding avenues are explored and secured soon.

2. New incursions

The incursion of a new, invasive weed species to the upper Rangitata could significantly undermine the current programme. If deemed a high priority for control, this would draw funding from current weed species, reducing the effectiveness of the programme. This is similar to the gradual response to lupin, false tamarisk and grey willow, which were not originally controlled in the area. An identification guide of new risk species for familiarity among agencies and runholders would reduce the risk of a new weed species becoming established. *Nassella tussock* (*Nassella trichotoma*) and Chilean needle grass (*Nassella neesiana*) are key examples of invasive weeds present in Canterbury, which could establish widely within the upper Rangitata.

3. Control works continuity

If a key contractor fails to deliver the control works programme, liquidates or otherwise is unable to carry out the control required, it may not be possible to find another appropriate contractor in time to complete the programme for that season. This may result in weed species seeding and not being controlled for a season. Additionally, valuable knowledge may be lost if it is not recorded and managed well. It is important to ensure contractors document important information including the GPS location of individual plants where they are in very low abundance.

4. Climate change

Changing climatic conditions may affect weed species' ability to invade new territory. This could affect weed management in many ways, including well-established weed species spreading more vigorously, or new weed species being able to survive in environments they previously could not. It is important to monitor trends in weed progression to understand if a weed species is becoming more invasive, and to react to this quickly. Changing weather patterns could also further limit adequate spraying opportunities within required timeframes. Although this can be countered with additional contractors, it can make management of the programme more challenging.

12.0 Conclusion

The upper Rangitata River is an area of very high biodiversity value, with numerous threatened species reliant on the braided river system. Increasing weed density can turn braided rivers into deeper river systems with fewer braids and significantly reduce shallow braided riverbed habitat, significantly affecting our threatened braided river birds.

The historic and current weed programme in the upper Rangitata River is managing weed species well, due to proactive and engaged landholders in the catchment, and funding from key agencies. However, due to a funding shortfall, not all areas of the riverbed are able to be controlled on a regular basis. Looking forward, some efficiencies can be made to ensure all areas are surveyed at the correct time before seed is set. If this is achieved, the seeding cycle can be further limited for key weed species and gains made in reducing their abundance and distribution. Acquiring additional funding is also an important step in accelerating the removal of weeds from the upper Rangitata River catchment.

13.0 Acknowledgements

Many people contributed to this Plan, providing information on weed distribution and taking part in the field survey. Liz Gunning (DOC), Matt Ford and Graeme Larcombe provided information on weed distribution and past control works. Di Robertson, Frances Schmechel, Bruce Allan and Rob Carson-Iles worked tirelessly in the field survey and control of isolated weeds, thanks for putting in some long days on foot. Frances and Rob (Environment Canterbury) also provided information on ECan priorities. Hamish Stevens provided information on F&G priorities in the catchment. The URGLG provided a wealth of knowledge around weed distribution and general catchment information. All landholders contacted provided access through properties and information on weed locations; particular thanks to Laurie Prouting, Malcolm Prouting (Mesopotamia), Gerald Aubrey (Ben McLeod), Sally Stevens (Whiterock), Colin Drummond (Erewhon), Ash O'Donnell (Mt Potts) and Ryan Hussey (Mt Possession). Brian McAuslan provided invaluable GIS support and mapping.

14.0 References

- Doody J.P. (2013) Introduction. In: Sand Dune Conservation, Management and Restoration. Coastal Research Library, vol 4. Springer, Dordrecht.
- Environment Canterbury (2018). Canterbury Regional Pest Management Plan 2018-2038.
- Gross, K. L., & Werner, P. A. (1978). THE BIOLOGY OF CANADIAN WEEDS.: 28. *Verbascum Thapsus* L. and *V. Blattaria* L. *Canadian Journal of Plant Science*, 52(2), 401–413.
- Harding, M. (2002). Upper Rangitata River, Weed infestations on unoccupied crown land in the upper catchment of the Rangitata River, Canterbury.
- Harding, M. (2018). Rakaia Riverbed Weed Control Strategy
- Harman, H. (2004). Feasibility of biological control of grey willow *Salix cinerea*. *Department of Conservation, DOC Science Internal Series*(183).
- Heenan, P. B., de Lange, P. J., Glenney, D., Breitwieser, I., Brownsey, P. J., & Ogle, C. (2010). Checklist of dicotyledons, gymnosperms, and pteridophytes naturalised or casual in New Zealand: Additional records 1997–1998. *New Zealand Journal of Botany*, 37:4, 629–642.
- Hill, R. L., Gourlay, A. H., & Barker, R. J. (2001). Survival of *Ulex europaeus* seeds in the soil at three sites in New Zealand. *New Zealand Journal of Botany*, (39:2, 235–244).
- Hilton, M., Duncan, M., & Jul, A. (2005). Processes of *Ammophila arenaria* (Marram Grass) Invasion and Indigenous Species Displacement, Stewart Island, New Zealand. *Journal of Coastal Research*, 21(1), 175–185. <https://doi.org/10.2112/01041.1>
- Hilton, M., Konlechner, T., McLachlan, K., Lim, D., & Lord, J. (2019). Long-lived seed banks of *Ammophila arenaria* prolong dune restoration programs. *Journal of Coastal Conservation*, 1–11. <https://doi.org/10.1007/s11852-018-0675-0>
- New Zealand Plant Conservation Network. (2019). New Zealand Plant Conservation Network. Retrieved August 5, 2013, from <http://www.nzpcn.org.nz/>
- Nielsen, J. A., Whigham, R. D., Frew, R. M., Callaway, K. J., & Dickinson, J. M. (2015). Thyme and space invasion: *Thymus vulgaris* decreases exotic plant species diversity in Central Otago, New Zealand. *Biological Invasions*, 17(8), 2261–2274.
- Rogers, G. M. (1995). *Control, demography, and post-control response of heather in the central North Island*. (Science for Conservation: 9). Department of Conservation.
- Roy, B., Popay, I., Champion, P., James, T., & Rahman, A. (2004). *An illustrated guide to common weeds of New Zealand*. (Second).
- Sambrook Smith, G., Best, J., Bristow, C., & Petts, G. (2006). *Braided Rivers: Process, Deposits, Ecology and Management*. International Association of Sedimentologists.
- Semenza, R. J., Young, J. A., & Evans, R. A. (1978). Influence of Light and Temperature on the Germination and Seedbed Ecology of Common Mullein (*Verbascum thapsus*). *Weed Science*, 26(6), 577–581.
- Smale, M. C. (1990). Ecological Role of *Buddleia* (*Buddleja Davidii*) in Streambeds in the Te Urewera National Park. *New Zealand Ecological Society*.
- Timmins, S. M., & MacKenzie, I. W. (1995). Weeds in New Zealand protected natural areas database. Department of Conservation Technical Series No. 8. Department of Conservation, Wellington, New Zealand.

Weedbusters. (2019). Weedbusters. Retrieved December 3, 2019.

Williams. (1983). Secondary vegetation succession on the Port Hills Banks Peninsula, Canterbury, New Zealand. *New Zealand Journal of Botany*, (21:3, 237–247).

Williams, p. A. (1981). Aspects of the ecology of broom (*Cytisus scoparius*) in Canterbury, New Zealand. *New Zealand Journal of Botany*, 19, 31–43.

Appendix 1: Maps

Weed presence has been grouped into categories for mapping purposes. These categories are shown below.

Points

Small - one plant

Medium - 2-5 plants

Large - 6+ plants

Polygons

The categories below describe the coverage of an area in descending densities.

Dominant – Covering over half the area

Abundant – Large, thick patches throughout area

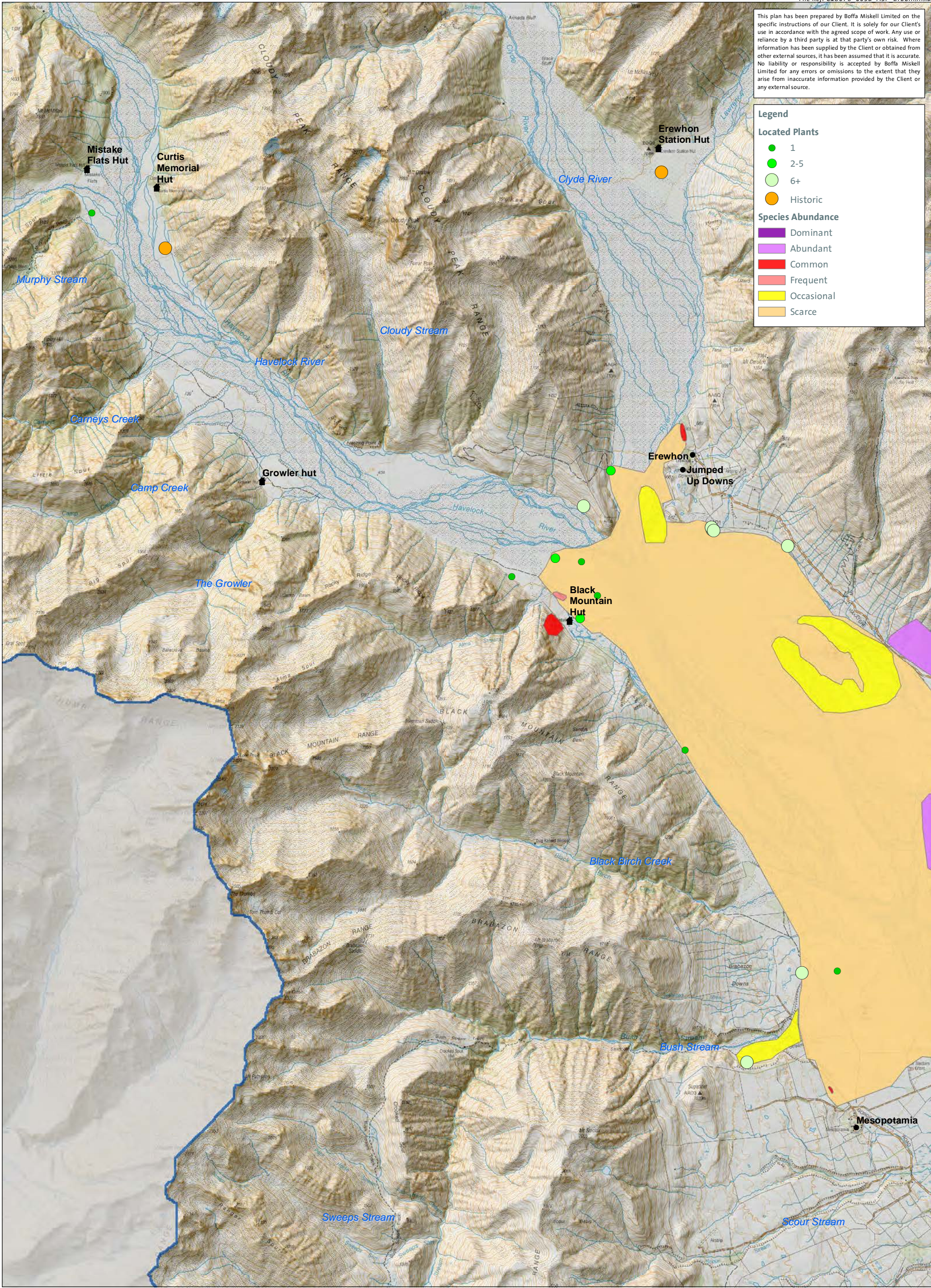
Common – Small patches and/or densely scattered plants

Frequent – Moderately scattered

Occasional – Lightly scattered

Scarce – Found only at times, generally only individual plants.

Scarce and Occasional polygons are the “expected area” for each species, particularly downstream of seed sources to the Rangitata Gorge. This area will likely have plants present or establishing at times through seed dispersal. Weeds may still be present outside these sites, particularly wind-dispersed species, but generally at a much lower incidence.



This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

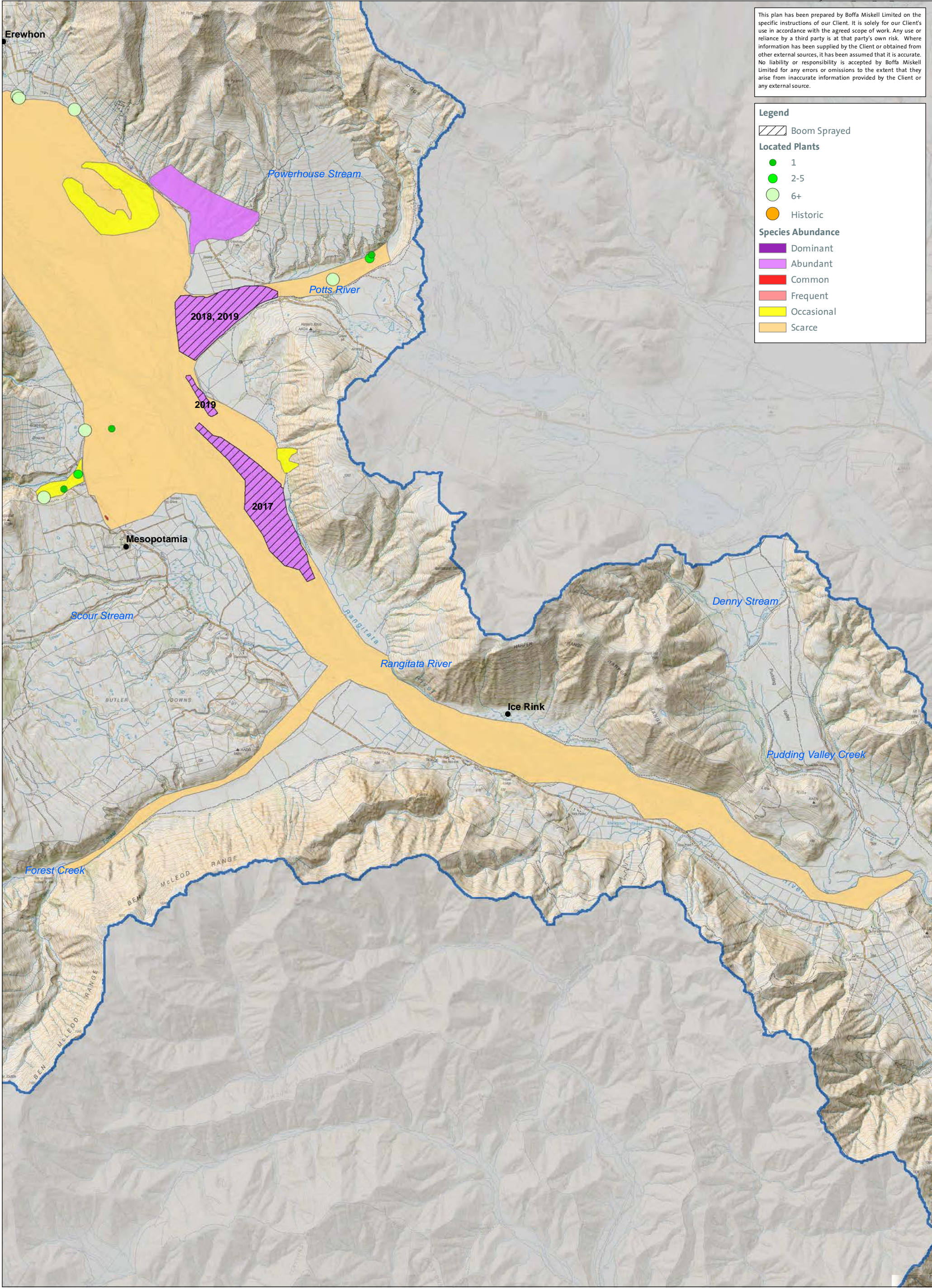
Legend

Located Plants

- 1
- 2-5
- 6+
- Historic

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce



This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Located Plants

● 1

● 2-5

● 6+

● Historic

Species Abundance

Dominant

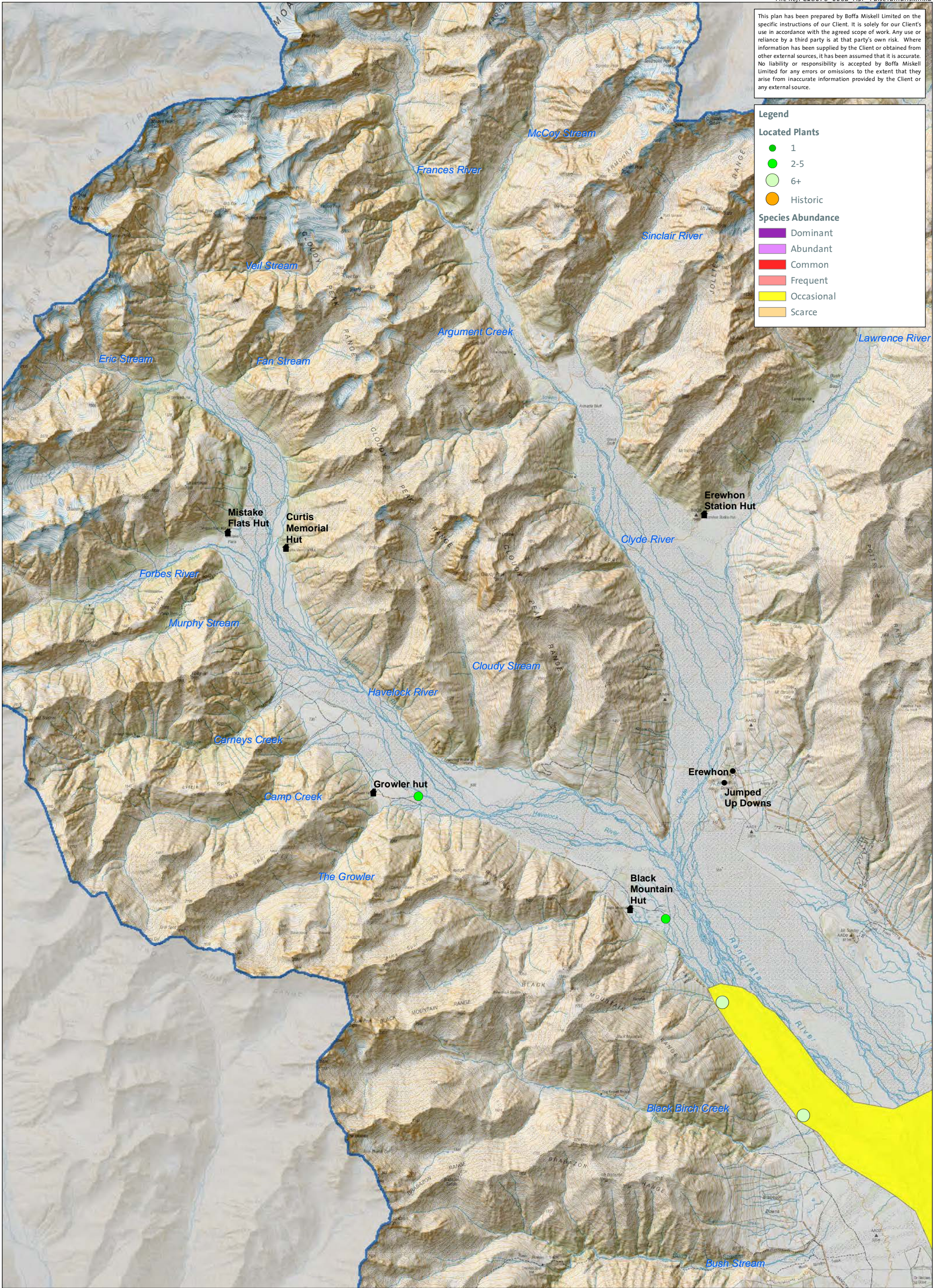
Abundant

Common

Frequent

Occasional

Scarce



This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Located Plants

1

2-5

6+

Historic

Species Abundance

Dominant

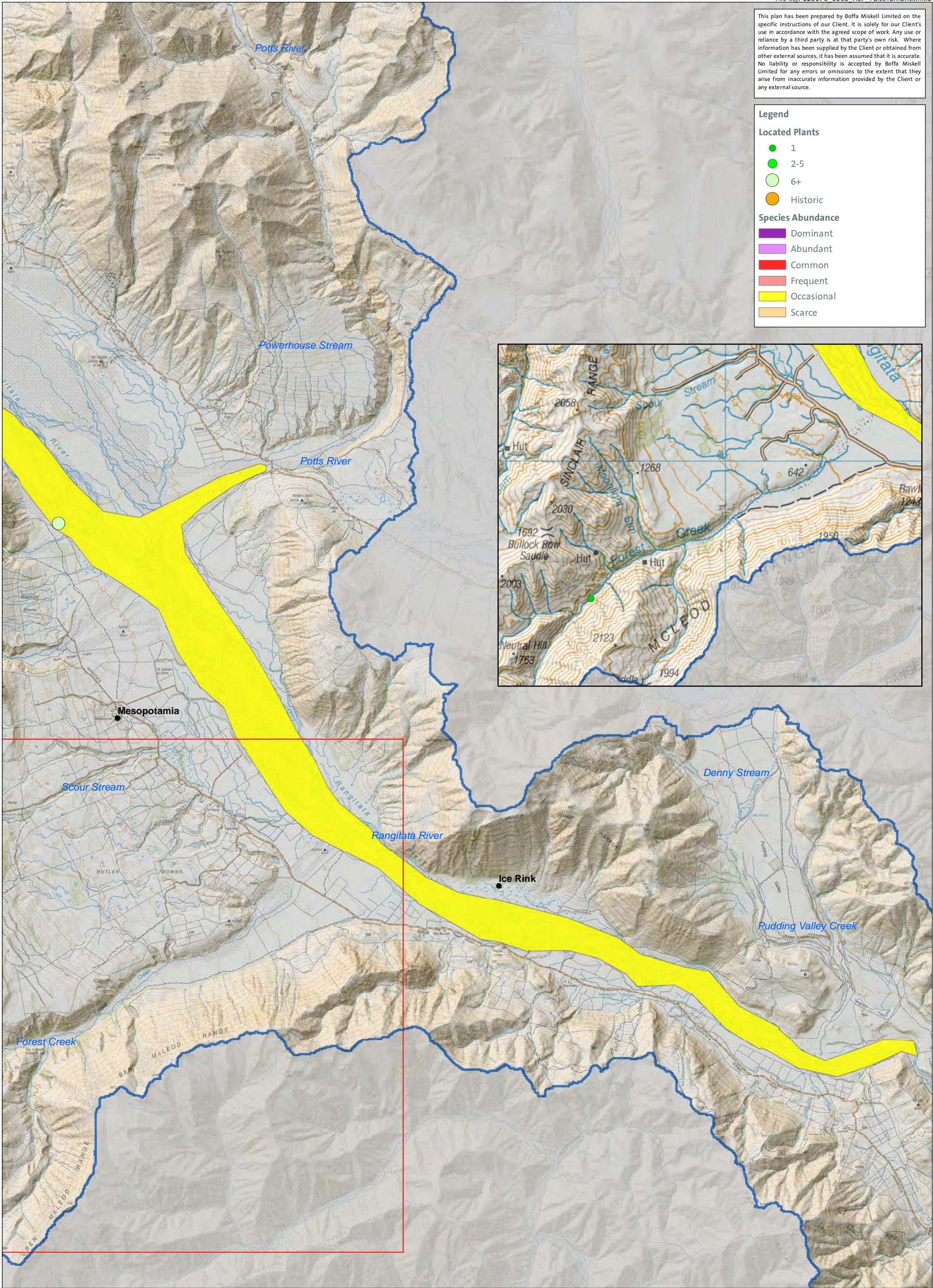
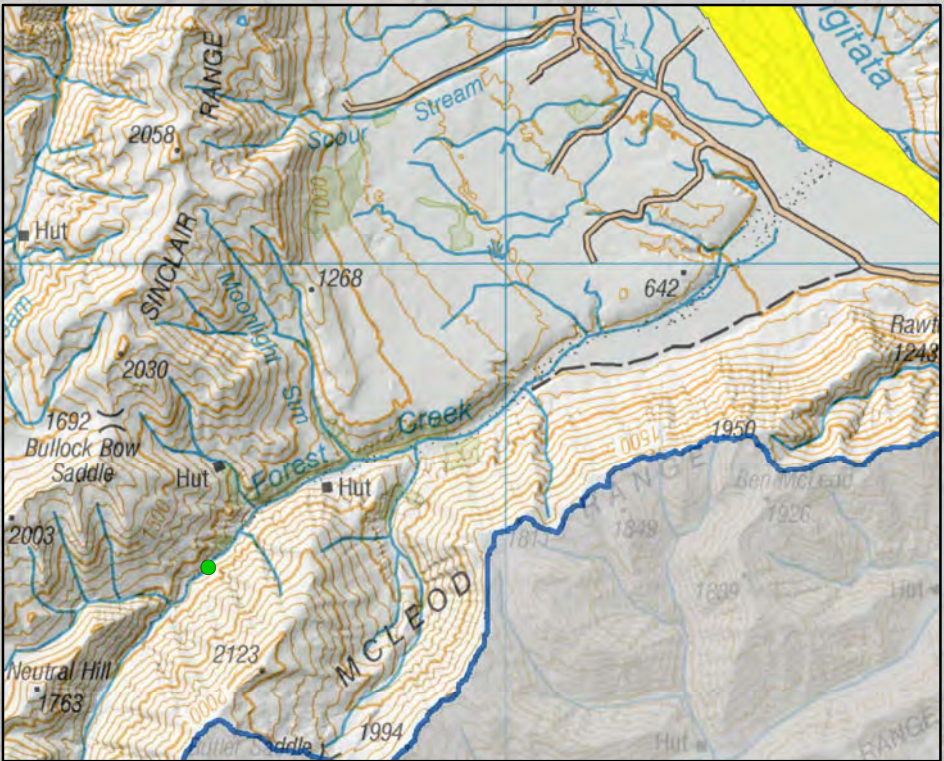
Abundant

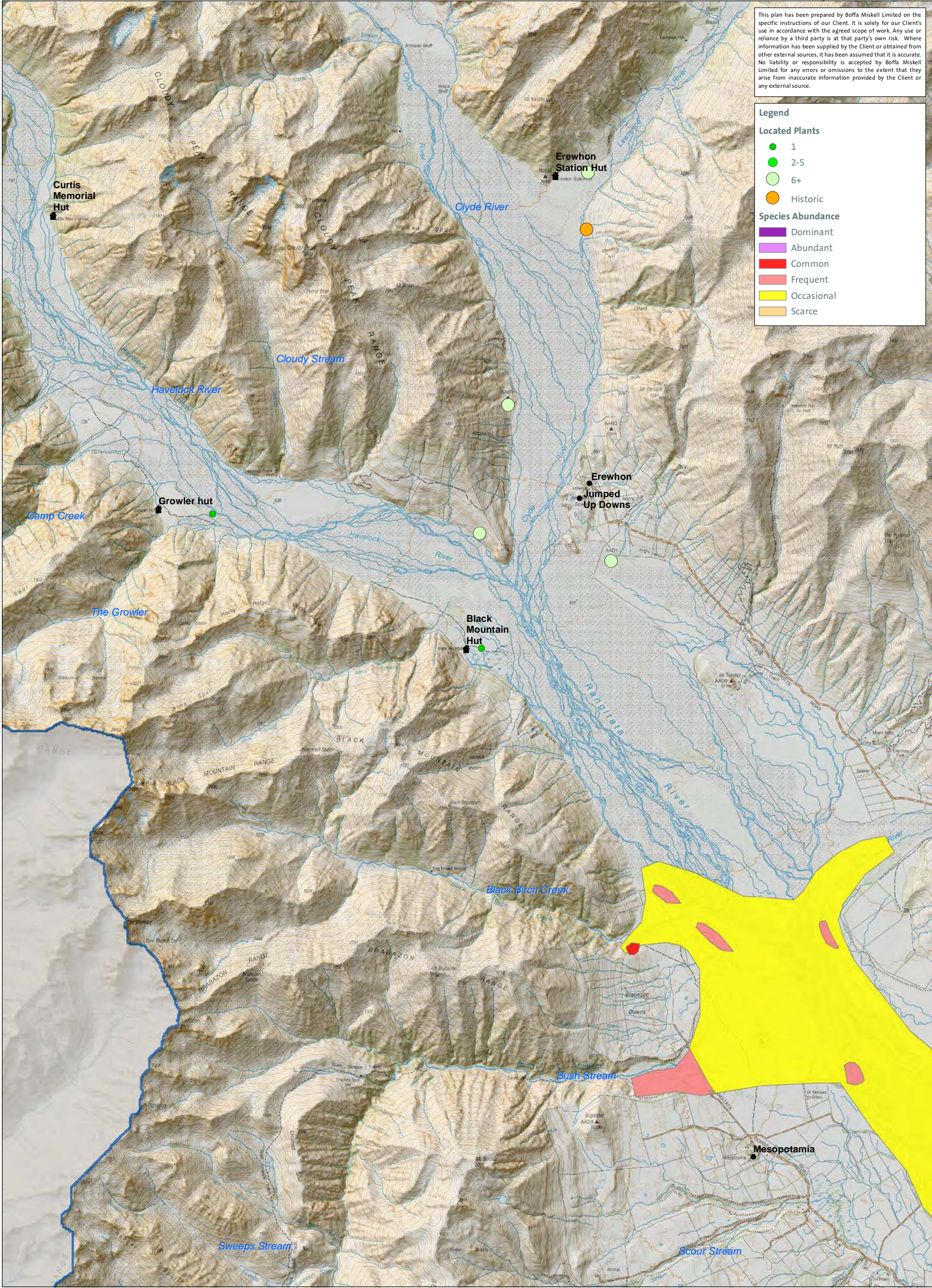
Common

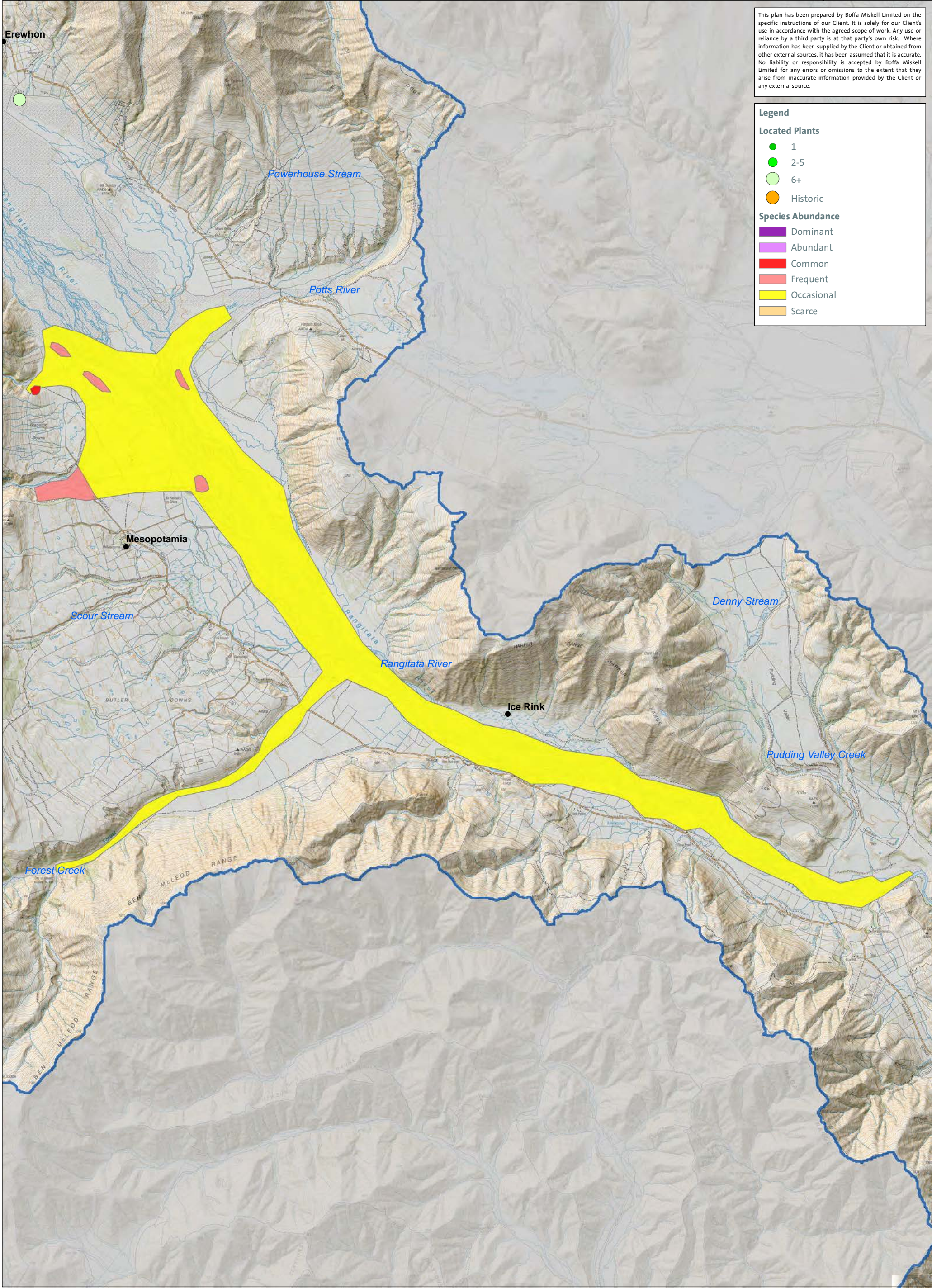
Frequent

Occasional

Scarce







This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Species Abundance

Dominant

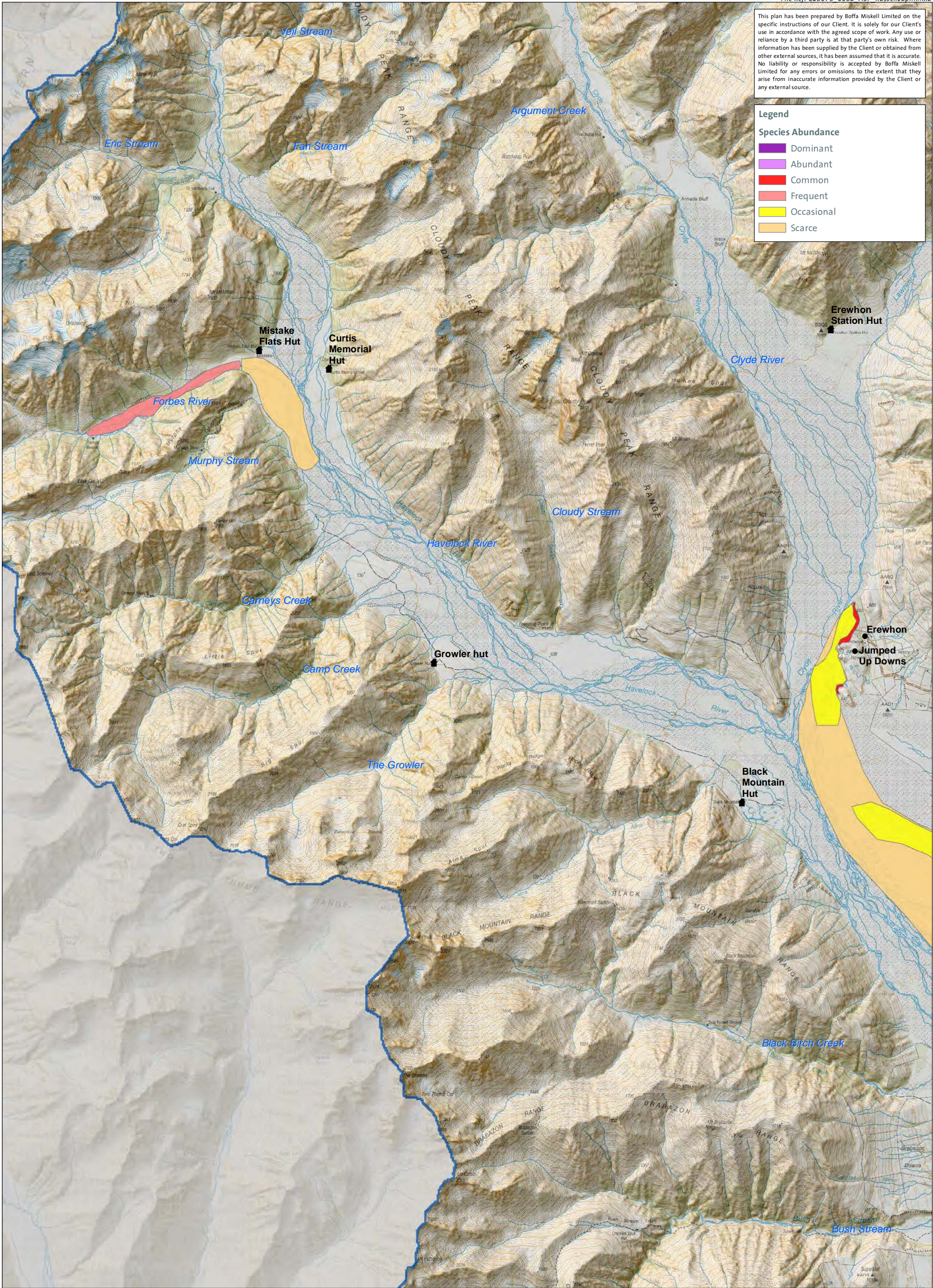
Abundant

Common

Frequent

Occasional

Scarce



This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce

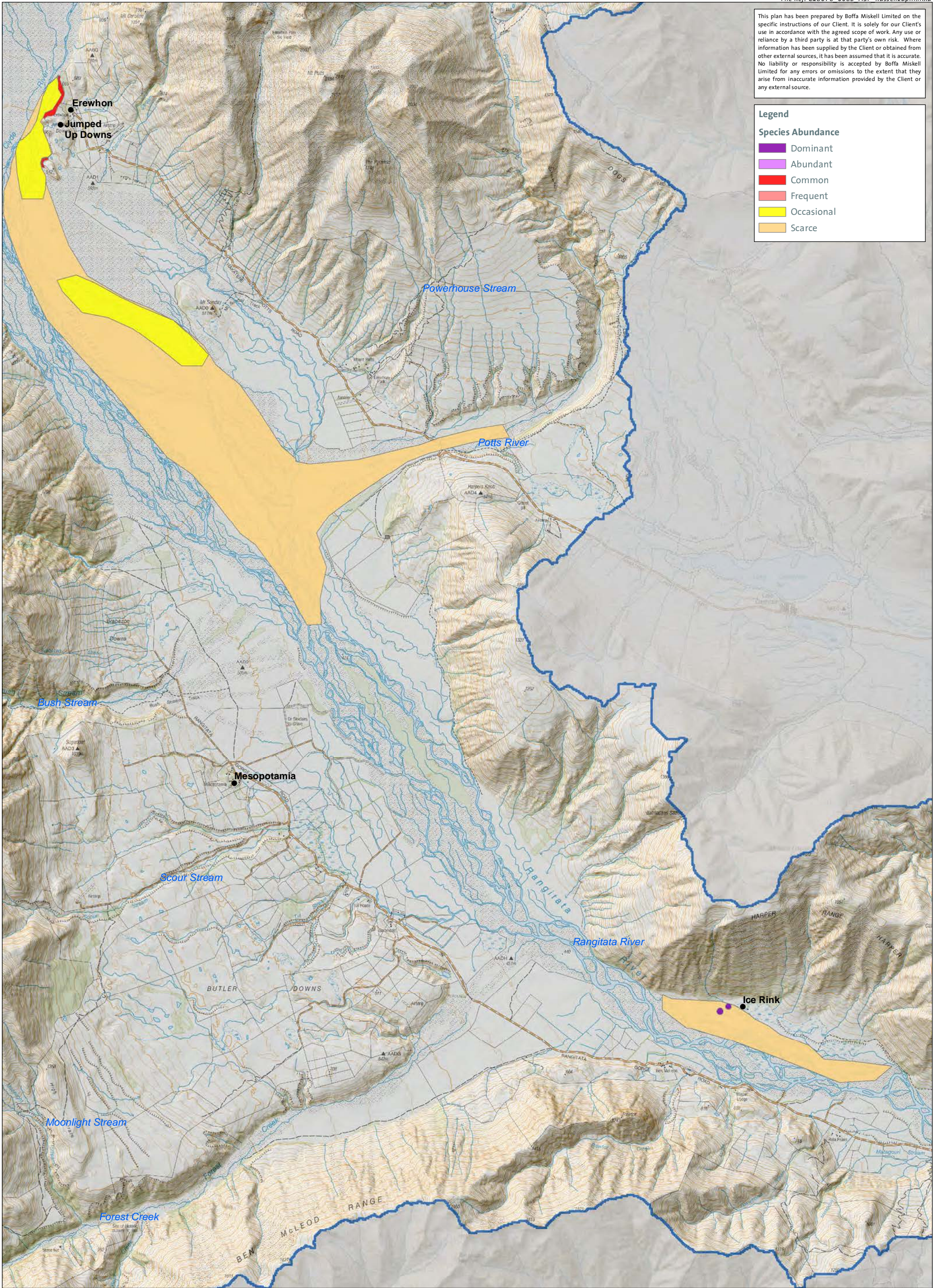


Figure 8b

This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

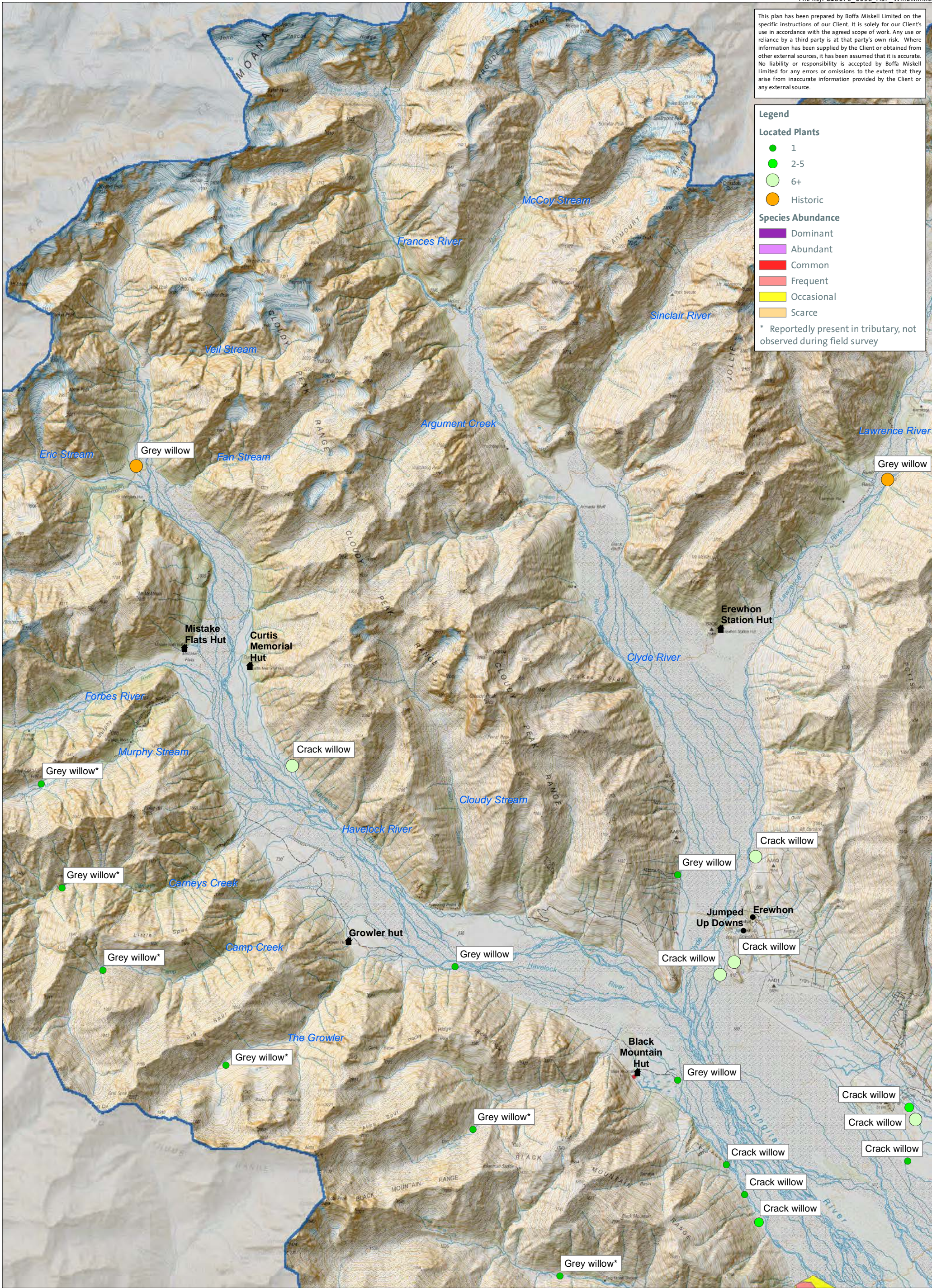
Located Plants

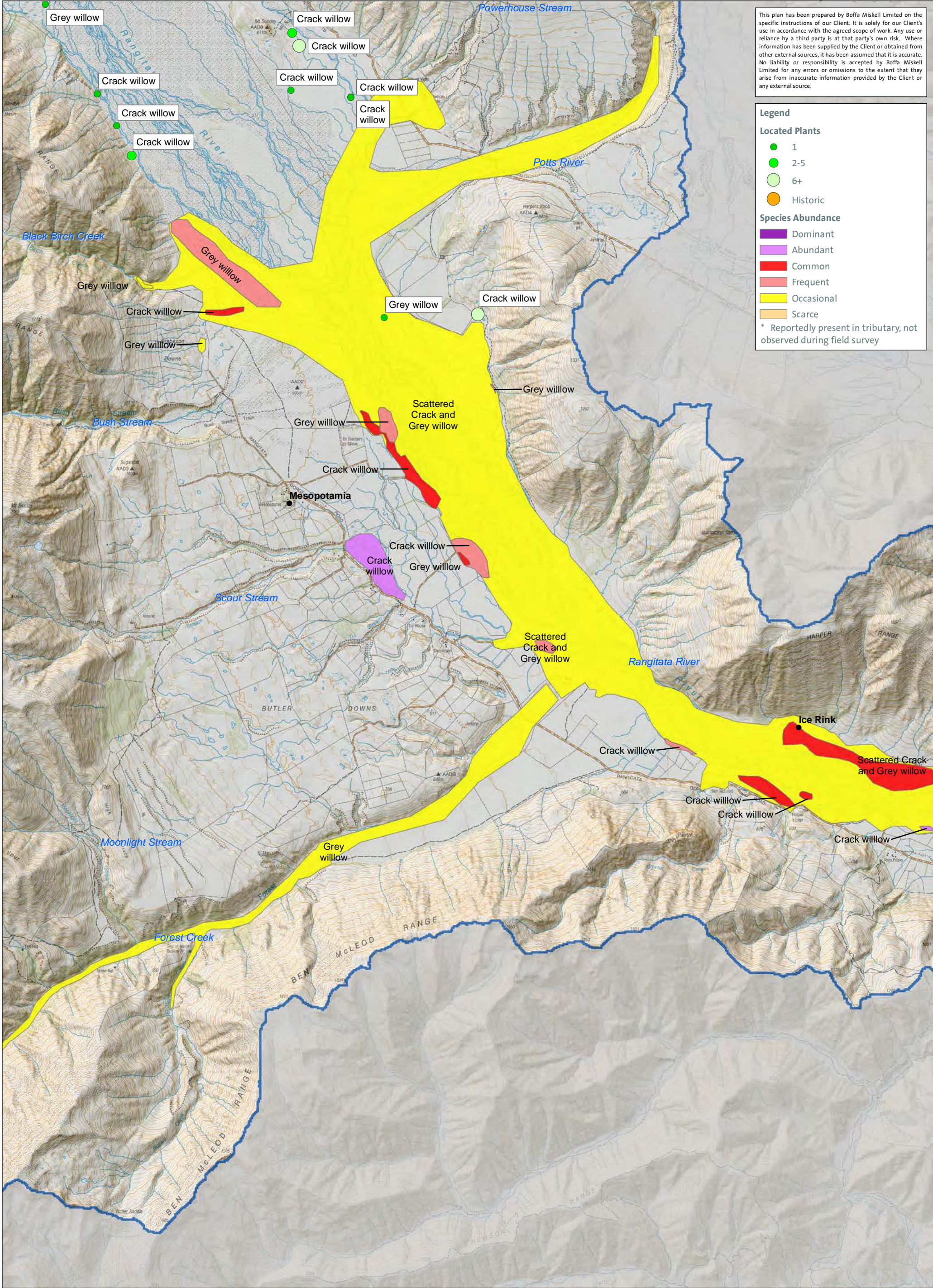
- 1
- 2-5
- 6+
- Historic

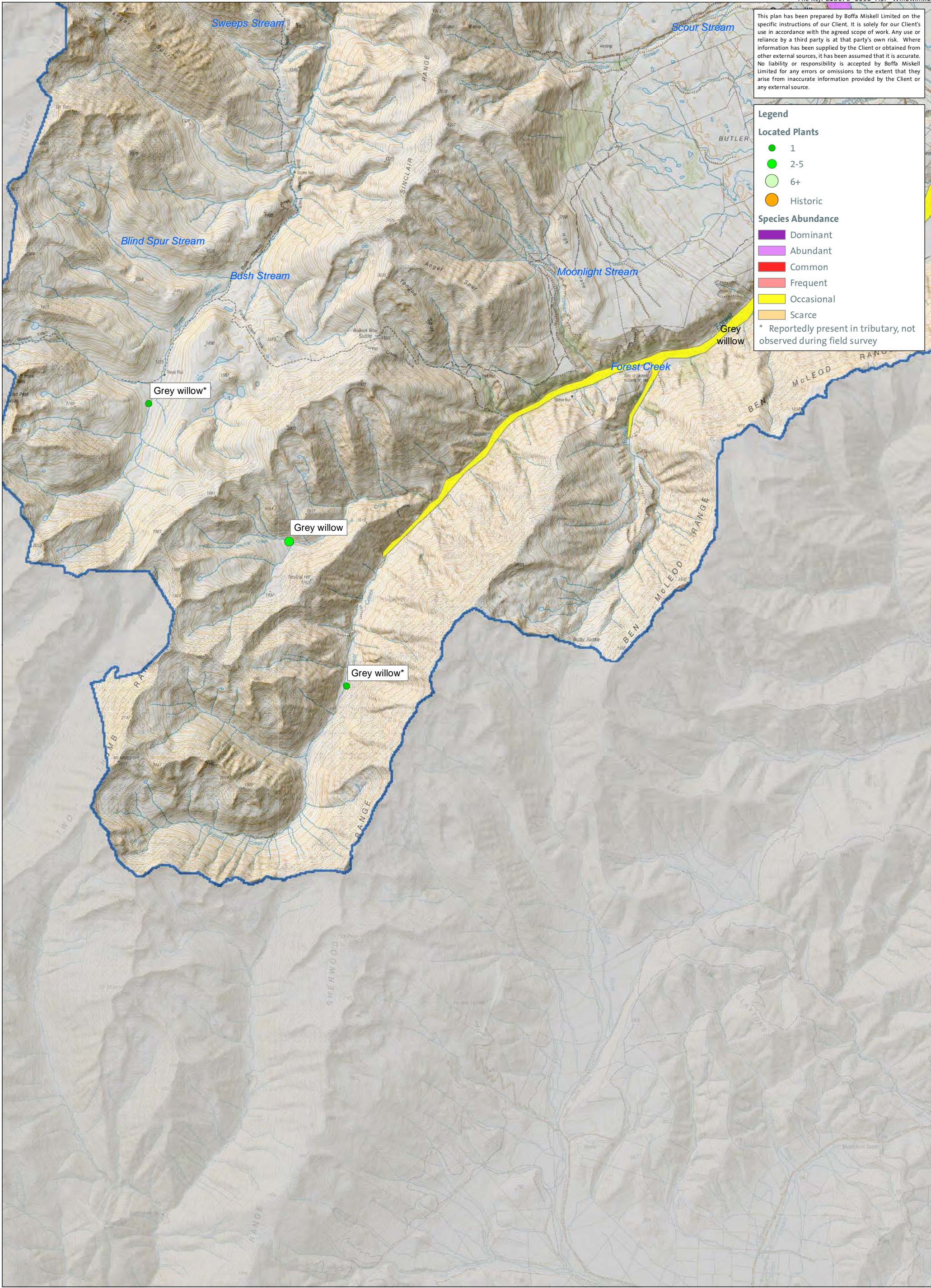
Species Abundance

- Dominant
- Abundant
- Common
- Frequent
- Occasional
- Scarce

* Reportedly present in tributary, not observed during field survey







This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Species Abundance

Dominant

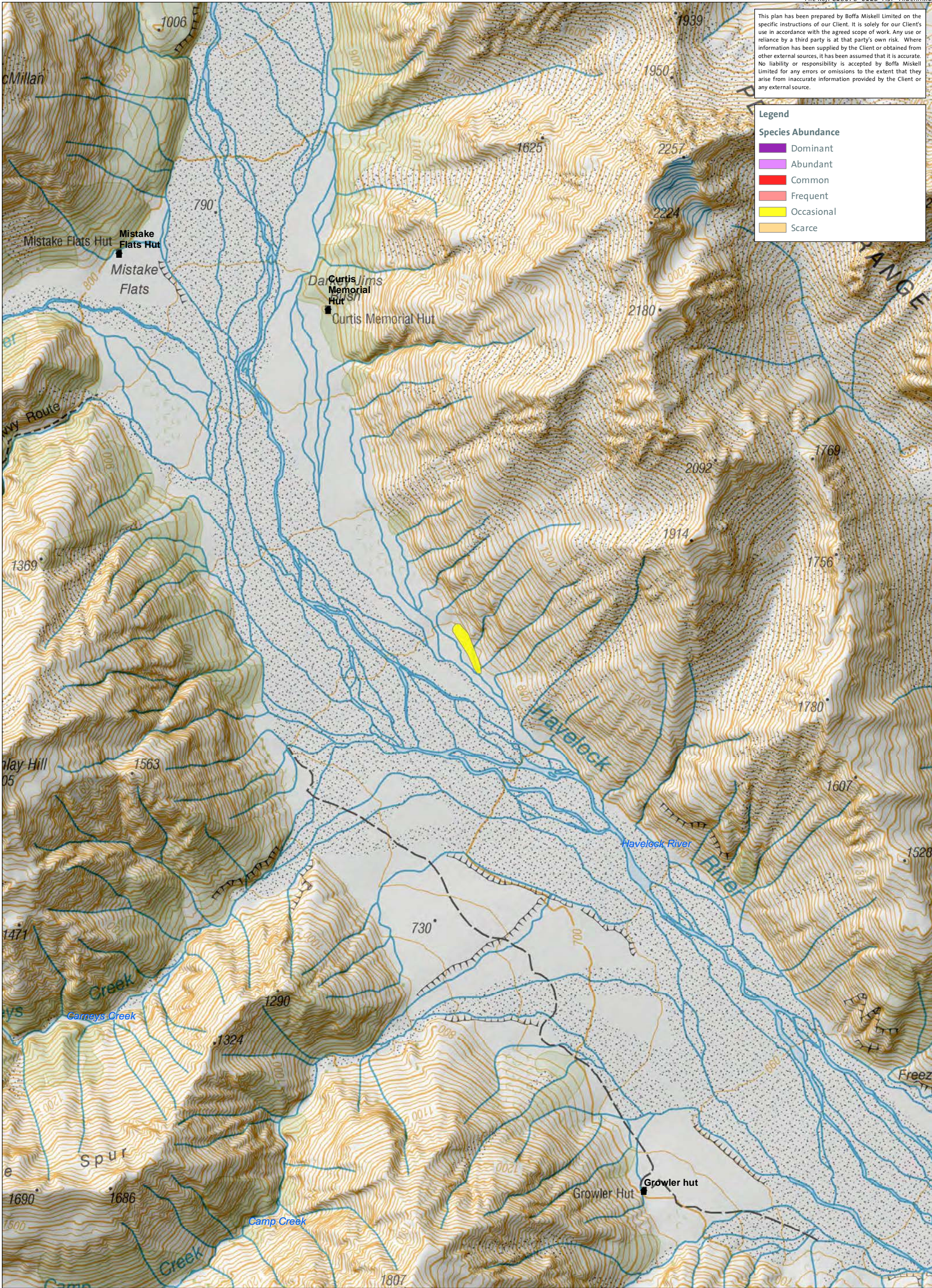
Abundant

Common

Frequent

Occasional

Scarce



This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Located Plants

1

2-5

6+

Historic

Species Abundance

Dominant

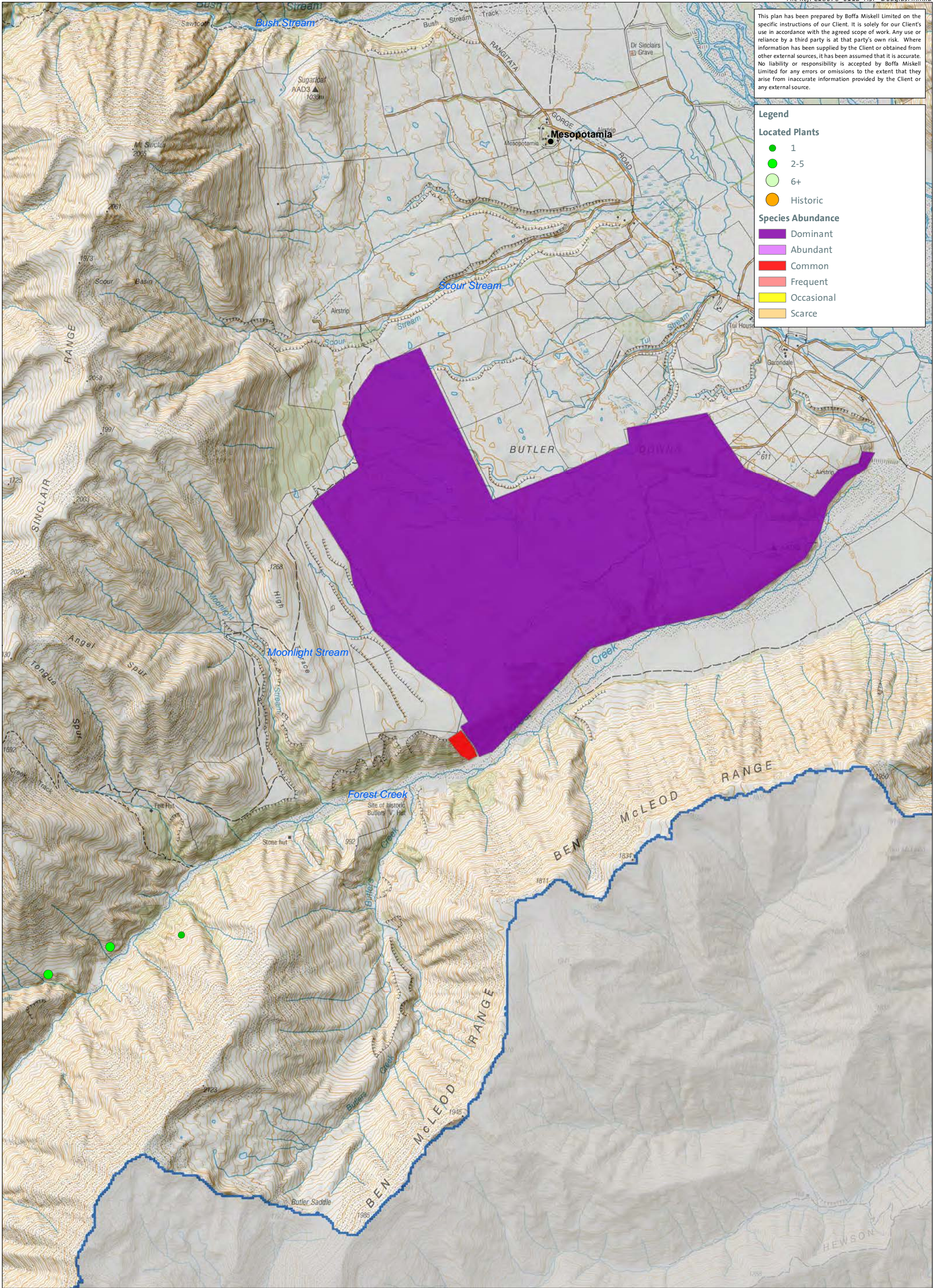
Abundant

Common

Frequent

Occasional

Scarce



This plan has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use in accordance with the agreed scope of work. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.

Legend

Located Plants

1

2-5

6+

Historic

Species Abundance

Dominant

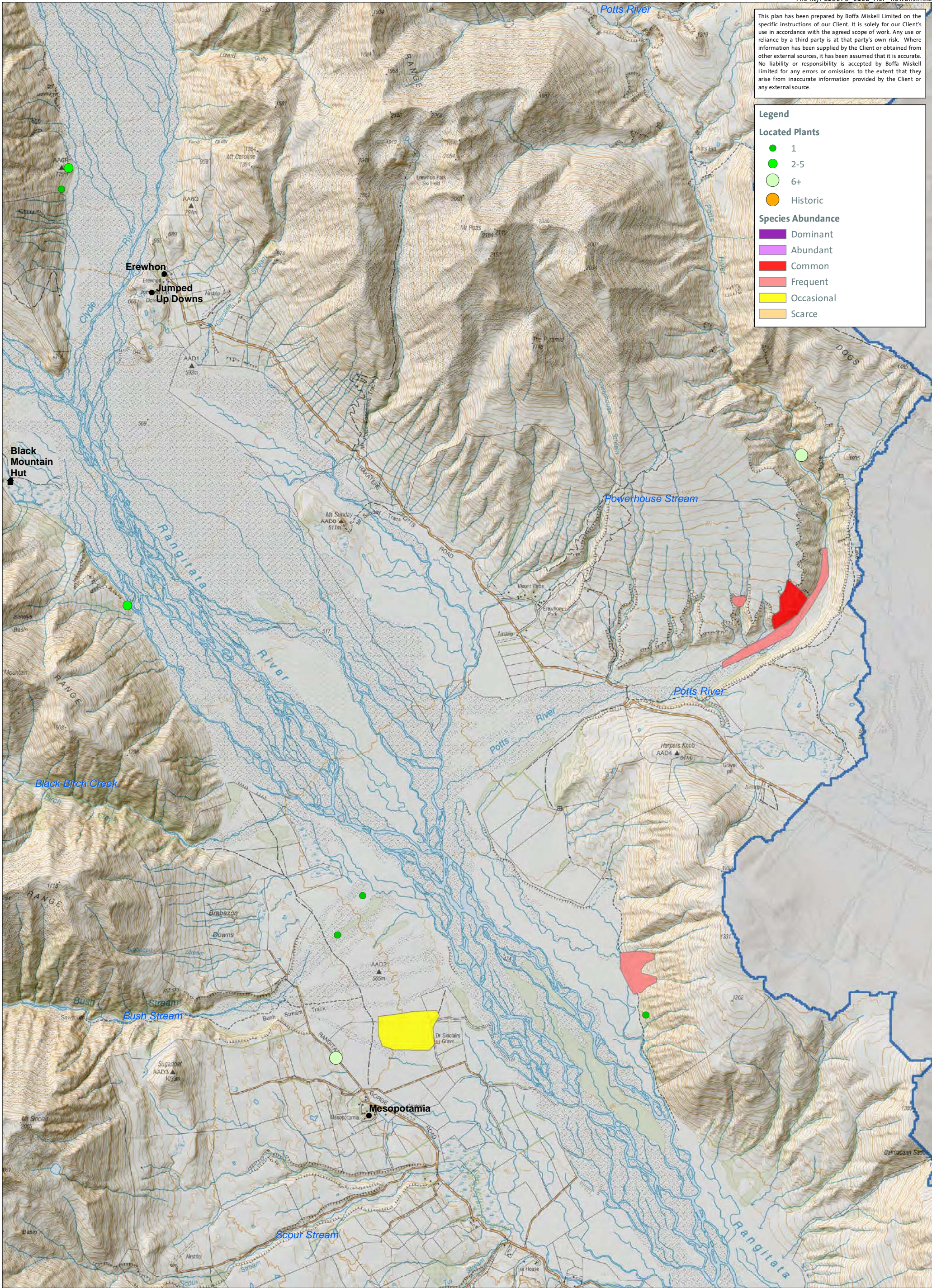
Abundant

Common

Frequent

Occasional

Scarce



Appendix 2: Weed Descriptions

The key and other weed species, their distributions and recommended control in the upper Rangitata River are described below (in alphabetical order). Their observed and expected distributions are mapped as polygons in Appendix 1: Maps.

Broom (*Cytisus scoparius*)

Broom is a leguminous shrub (able to fix its own nitrogen) which extensively covers river beds, indigenous and non-indigenous grasslands and disturbed habitat types. Broom produces many hard seeds which are dispersed by the explosive seed pods. Dispersal is also aided by animals, machinery, people and water. Seeds persist in the seed bank and can germinate even when buried 5 cm deep (Williams, 1981).

The distribution of broom throughout the upper Rangitata catchment is relatively sparse compared to many other catchments of this size. Broom is very lightly scattered in the upper Havelock River, from Murphy Stream down to Bush Stream, where there are some patches. The single broom plant near Murphy Stream was found beside a vehicle track, likely being carried there by a 4WD vehicle. There is a significant infestation of scattered plants on the hill face above Black Mountain Hut, at the Alma Stream and Rangitata River confluence. Infestations of broom on the hill faces on the true right of the Havelock River are present upstream as far as the Growler Hut (Matt Ford, pers. comm.).

Broom plants have historically been found and controlled south of Erewhon Station hut, at the confluence of the Clyde River and Lawrence River (Matt Ford, pers. comm.). A moderate infestation of broom is present on the hillside at the northern end of Jumped Up Downs, on the true left of lower Clyde River and is scattered within the riverbed downstream to Mt Sunday where there are higher densities and some mature plants. The lower hill country east of the Mt Sunday area has dense infestations of broom. There are scattered infestations within the Potts River above the bridge and along the hillside on the true left. Broom plants have been found and controlled several km up the Potts River above the gorge (Matt Ford, pers. comm.). There have been dense infestations below the bridge, which have been sprayed by DOC in the 2017/18 and 2018/19 seasons with good results. On the true left of the Rangitata River below Potts River confluence is an area of dense broom, with scattered infestations surrounding and on hillsides. This area of broom has reportedly been sprayed since the survey was carried out. Due to significant seed source in these areas, it is expected that broom may appear in any areas of riverbed downstream to the gorge. Scattered broom plants have been observed in Forest Creek, and consequently the “expected area” polygon (Appendix 1: Maps, Broom) extends up to Butler’s Creek. However, broom plants may be present above this point.

The map of expected area/scarce polygon (Appendix 1: Maps, Broom), shows the extent of observed and/or expected broom establishment given the seed source and general direction of dispersal, particularly through water movement.

Approximately 53 broom plants were controlled during the 2018 field survey.

Crack willow (*Salix fragilis*)

Crack willow is a large tree of up to 25 meters high with easily broken branches. It is found in wetlands, riverbanks, ponds and on lake edges where it grows quickly and abundantly. Only

male trees are found in New Zealand, and reproduction is by vegetative spread through movement of broken branches, generally spread via water and machinery, and subsequent sprouting.

The upstream extent of crack willow found during the survey is in the Havelock River, opposite Carneys Creek. Individual plants are lightly scattered until the area beside Black Mountain Hut. Scattered trees are found downstream until Black Birch Creek where higher densities of trees become common.

Mature willow trees are present on the true left of the lower Clyde River, downstream from Tank Gully. Scattered mature trees from this point downstream to Mt Sunday don't appear to be spreading significantly. Below Mt Sunday willow trees become scattered consistently along the river edge. Willow around the Ice Rink (true left, opposite Ben McLeod homestead) is spreading significantly, with numerous small trees establishing through the wetland area.

Willows on the true right from Black Birch Creek downstream are scattered with areas of dense trees in some areas. The map from Potts River/Black Birch Creek downstream shows scattered crack and grey willow trees together, as they are present in the same general areas. Additionally, in areas surveyed by helicopter it can be difficult to distinguish between young crack and grey willows. Throughout this area there are countless small clusters of trees, which are not practical to show separately on the map.

Crack willow control should continue where there is obvious spread occurring, particularly in wetland areas, such as around the Ice Rink. Any young willows found within the upper Rangitata catchment should be controlled as a priority. Mature trees with no signs of reproduction nearby may be left in the medium term ("crack willow exceptions"), such as those around the lower Clyde River. If mature willow trees are for flood protection, discussions should be started with Environment Canterbury and adjacent landholders on how these could be replaced with non-weed species long-term.

Regrowth of previously controlled willows was observed in the wetland between Scour Stream and Tui Stream. Follow-up control will be required at this area in the near future to prevent these willows reverting to previous densities. This is not a high priority activity for the general weed control programme. However, separate funding should be sought to efficiently keep this area from again increasing in willow abundance.

False tamarisk (*Myricaria germanica*)

False tamarisk is a shrub up to 1.5 meters tall, occurring on stony ground within braided river beds (Heenan et al., 2010). It has vigorous re-sprouting after browsing and disturbance, and produces large numbers of small seeds which are wind-dispersed and have a short viability (Sambrook Smith, Best, Bristow, & Petts, 2006).

The upstream extent of false tamarisk in the Havelock riverbed was found at the confluence with The Growler. Occasional plants were found downstream until above the confluence with Black Birch Creek. Downstream from this area, patches were found in some areas. It is expected that plants will continue to be spread, particularly downstream, until the seed source is removed. No false tamarisk was detected on the true left of the Rangitata River. However, it is expected that false tamarisk will be present, as it has been previously controlled in this area. Being a wind-dispersed species, false tamarisk can more easily establish plants across the river from a seeding individual.

The neighbouring Rakaia River catchment has seen a significant increase in false tamarisk abundance in recent years (Harding, 2018). The relatively low abundance of false tamarisk in

the upper Rangitata and its ability to spread quickly and in any direction makes it a key species for control and should be targeted for total control (all identified plants) each year.

The map of “expected area” polygon (Appendix 1: Maps, false tamarisk), shows the extent of false tamarisk establishment given the seed source and general dispersal, particularly through water movement. However, due to its wind-spread seed, false tamarisk may establish in areas far from its seed source.

Approximately 30 false tamarisk plants were treated during the 2018 field survey.

Gorse (*Ulex europaeus*)

Gorse is a very prickly woody shrub which can grow taller than 2 metres. It thrives throughout New Zealand in pasture, river beds, scrubland, forest margins and wasteland. It produces masses of seeds which are dispersed by the explosive seed pods propelling the seed away from the parent plant. Seed can be viable in the seed bank for more than 20 years (Hill, Gourlay, & Barker, 2001) which makes gorse a difficult weed to eradicate.

The upstream extent of gorse within the Havelock River was found at The Growler confluence. Gorse was found near Black Mountain Hut, and above Black Birch Creek confluence. Downstream from this point small patches and scattered gorse plants were found on the true right. Control appears to be very effective in the lower section of riverbed, between the gorge and Ben McLeod Station on the true right.

There have been gorse plants located near Erewhon Station Hut, at the confluence of Lawrence River and Clyde River. Gorse was not detected at these sites during this survey, as only helicopter survey was carried out here. Controlling gorse in the Clyde River before seeding is a key priority to prevent further spread in this area of low incidence weeds. Gorse becomes more prevalent downstream from the Rangitata River and Potts River confluence, including one patch of more densely scattered plants directly beside the confluence. Scattered gorse plants are present in the lower riverbed, above the gorge, particularly above and below the ice rink. Due to the seed source from the Potts River and Black Birch Creek, it is expected that gorse may appear in any areas of riverbed downstream to the gorge. Scattered gorse plants have been observed in Forest Creek, and the mapped “expected area” polygon (Appendix 1: Maps, Gorse) extends up to Butlers Creek as an indication of presence. However, plants may also be present above this point.

The map of “expected area” polygon (Appendix 1: Maps, Gorse), shows the extent of observed and expected consistent gorse establishment given the seed source and general direction of dispersal, particularly through water movement. Scattered plants were observed throughout this area where searched.

Approximately 25 gorse plants were controlled during the 2018 field survey.

Grey willow (*Salix cinerea*)

Grey willow is a small tree up to 7 meters tall and forms large dense thickets. It prefers swampy, wet areas and river banks (Roy et al., 2004) and threatens many wetland and riparian sites throughout New Zealand. Grey willow reproduces light seed prolifically with wide wind dispersal, and can hybridise with several other species of willow (Harman, 2004).

A single grey willow has been recorded and controlled up the Lawrence River, upstream from the Lawrence Hut and has been found as far up as Winifred Stream in the Havelock River (Matt Ford, pers. comm.). Grey willow trees are scattered throughout the true right tributaries of the Havelock and Rangitata Rivers, including Murphy Stream (Matt Ford, pers. comm.) down to the

upper reaches of Forest Creek. There are dense infestations of grey willow within Forest Creek around the confluence with Butlers Creek. The mapped grey willow points in these tributaries indicate general presence in this tributary, and do not show an upstream extent, except for the point in Neutral Creek (Forest Creek tributary). The upstream extent of grey willow detected during this survey was downstream of The Growler in the Havelock River and approximately 3km up the Clyde River from the Havelock River confluence. There were only occasional grey willows found until approximately 1km upstream of Black Birch Creek. Below Black Birch Creek there are numerous areas of grey willow within the riverbed and on adjoining land on both sides of the Rangitata riverbed. Grey willow has been found in the Potts River gorge above the bridge (Matt Ford, pers. comm.) but it is not common in this area. Total control of grey willow upstream from Black Birch Creek/Potts River confluence should be a priority due to the relatively low incidence in this area. Although grey willow seed is wind-dispersed, and can travel up-valley, the seed dispersal and subsequent growth of seedlings will be more manageable if plants are not given the opportunity to grow and seed prolifically in this area.

The “expected area” polygon (Appendix 1: Maps, Willow) shows scattered crack and grey willow trees within the main riverbed together, as they are present in the same area in the lower riverbed. Additionally, in areas surveyed by helicopter it is difficult to distinguish between young crack and grey willows.

Approximately 20 grey willow plants were controlled during the 2018 field survey.

Russell lupin (*Lupinus polyphyllus*)

Russell lupin is a perennial herb, producing an erect flowerhead with colourful flowers. It spreads seed through explosive seed pods and through water and soil movement. Russell lupin has spread significantly throughout numerous South Island braided rivers, with significant costs associated with annual control. Lupins can create a dense monoculture, excluding indigenous plants species and providing suitable habitat for mammalian predators. Within some Canterbury rivers lupins have become so abundant that control has ceased from those areas of riverbed, despite the impact on biodiversity values.

Russell lupin was found at several sites within the upper Rangitata River. The upper extent was in the Forbes River, from Forbes Bivouac to Mistake Flats Hut. It is likely that scattered individuals will establish downstream from this area through dispersal of seeds by water. The ground control methods in this area appear to be sufficient and covers the area where several historic braids of the Forbes River diverge and converge further downstream. The “expected area” polygon (Appendix 1: Maps, Russell lupin) shows the area where lupin may establish over time through seed dispersed by water. Due to the reduction in lupins establishing with increased distance, it is not expected significant populations will establish unless individuals are allowed to establish and seed outside the current extent.

The upper extent of Russell lupins in the Clyde River was observed at the upstream end of the Jumped Up Downs, with dense infestations along the hillside down to the southern end of the Jumped Up Downs. This infestation was found to be down to the riverbed in many areas, and will undoubtedly add seed into the river at high flows. The land manager for this land has advised that lupins near the riverbed can be controlled as part of the control programme. This agreement should be formalised with agreed control distances before control begins in this area. Russell lupin is scattered from this area to downstream of Mt Sunday. The expected area polygon shows the area where lupin has been found and/or will likely establish over time through seed dispersed by water, down the true left of the river. No lupins were found in the Potts River during the survey but have been recorded here previously. Lupins are not generally found downstream of the Potts River until around the Ice Rink (Matt Ford, pers. comm.). Lupins will likely establish outside the expected area at times, particularly if the river channels move

towards the true right of the Rangitata River. However, this will be at a much lower frequency than spread inside this polygon. The area between the Potts River and the Ice Rink should be controlled for lupins when gorse and broom surveillance/control is being carried out.

Approximately 32 Russell lupins were controlled during the 2018 field survey.

Tree Lupin (*Lupinus arboreous*)

Tree lupin is a short-lived, leguminous shrub which grows in tussockland, riverbeds, coastal sandy and well-drained areas. It grows up to 3 meters tall, matures quickly and produces many long-lived seeds. Seeds are spread by its explosive seed pods and are also carried by water and soil movement (Roy et al., 2004).

Tree lupin is a problem species in many South Island braided river systems. It can quickly form a dense monoculture, removing braided river bird habitat, and providing suitable habitat for predators. It has a long-lived seed, generally spreading downstream via water. There is currently no significant infestation in the upper Rangitata River, and therefore it is a priority to ensure all individual plants found are destroyed as soon as practicable.

Tree lupin was not observed during surveys of the upper Rangitata catchment. Plants have previously been found and controlled in the lower riverbed, particularly between Forest Creek and the Rangitata Gorge, and often around the Ice Rink section of riverbed. When found, this species should be targeted for complete control. It is important to record where this is found and return for follow-up control. This will reduce the likelihood that some individuals are missed, or survive, and are then able to set seed.

Other Weed Species

Alder (*Alnus glutinosa*)

Alder is a perennial tree up to 15 meters tall. It favours moist ground near freshwater bodies such as rivers, ponds and lakes, but also grows in drier locations and on the edges of bush. It produces winged seeds which are readily dispersed via wind and water. Alders are a significant weed species in some New Zealand riverbed systems, quickly spreading and colonising areas with thick seedlings. Alders are present in the upper Havelock River, opposite Carneys Creek confluence. Alder seedlings spreading along a small tributary from the mature trees were controlled during the survey. Alders are also present around the Mesopotamia homestead. Seedlings can be seen nearby, and over time will spread towards the riverbed through water movement. It is vital to control all alders as soon as possible before they spread into the main river system, significantly increasing costs of search and control. Any other alders found in the upper Rangitata River should be controlled and recorded for follow-up surveillance.

Cotoneaster (*Cotoneaster* spp.)

Cotoneaster is an evergreen small tree or shrub, producing red or orange berries. Seeds within the berries are consumed by birds and dispersed widely. During the weed survey cotoneaster was recorded on the true left hillside of the Clyde River, upstream from Jumped Up Downs. A prostrate form of cotoneaster (most likely *Cotoneaster horizontalis*) was observed on the true right of Bush Stream below the gorge, forming a dense ground cover in some areas. It is possible these species would colonise stable riverbed islands over time, providing cover for mammalian predators. They also threaten indigenous forest, where they can dominate the understorey and restrict regeneration of forest tree species, shrubland and tussock grasslands. Although not a priority species for control with general riverbed weed control budgets, these

infestations should be removed as separate projects. Infestations are still relatively restricted, making eradication/comprehensive control more cost-effective. In particular, a control programme targeting the Bush Stream cotoneaster should be implemented as soon as possible to ensure this species does not continue to be dispersed further throughout the catchment.

Douglas fir (*Pseudotsuga menziesii*)

Douglas fir is a large gymnosperm tree which grows up to sub-alpine zones, and in scrub, forest margins and tussockland. It produces seeds which are dispersed by wind at a rate of up to 20,000 seeds per tree annually. Seeds can remain viable for many years, but require light to germinate so seedlings rarely occur in areas of dense vegetation cover (Timmins & MacKenzie, 1995). However, Douglas fir seedlings are tolerant to partial shade, allowing them to establish in more open forest or scrubland common to New Zealand.

Wilding Douglas firs are recorded as a separate group from wilding conifers within the upper Rangitata River, due to the significant seed source at Forest Creek and the expected spread arising from this species in the future. Whereas other invasive species are prioritised for control when in dense infestations, Douglas fir forestry is at present permitted, and thus mature trees are a source for seed supply to neighbouring areas. The resource consent conditions for this plantation require the control of Douglas fir seedlings for 2km around the Douglas fir forest. The map (Appendix 1: Maps, Douglas fir) shows the area of forestry, dense spread adjacent, and trees spreading further up Forest Creek over the 2km control threshold. Some wilding Douglas fir trees may be from older Douglas fir plantings that have seeded over a longer period. However, this highlights the increased risk of spread when the forestry Douglas fir begin to seed more prolifically. There are seedlings spreading around the forestry area that have not been mapped, as they are controlled regularly. The control is carried out in line with a wilding tree management plan, produced by the forestry manager, which targets wilding trees far greater than 2km from the forest edge and far more frequently than that required under the resource consent conditions. The wilding tree management plan is continually updated with new information on wilding tree presence. Regular communication between the forestry manager, URGLG and agencies will help provide updates to wilding tree dispersal, particularly through discussions at the URGLG meetings. The long-term threat posed by this forestry plantation is serious, as it will provide an increasing seed-rain onto surrounding land, including braided riverbed areas. Discussions should continue with the forestry manager to ensure trees dispersing beyond the 2km control threshold are detected and added to the wilding tree management plan. The early removal of the Douglas fir forest would prevent increasing seed dispersal establishing wilding Douglas fir trees throughout the catchment and is an option that should be considered in the short-term. Failing this, significant and frequent wilding tree control will be required long-term throughout the area.

Elder/Elderberry (*Sambucus nigra*)

Elder is a shrub or small tree up to 6 meters high, lives up to 100 years and grows in scrub, forest margins and modified habitats (Timmins & MacKenzie, 1995). Elder require sun and is intolerant of heavy shade. Seeding is prolific, and readily dispersed by birds (Williams, 1983). Viability of seed is high, but seed does not persist in the seed bank (New Zealand Plant Conservation Network, 2019).

Individual and scattered elder plants were found during the survey, but no significant infestations were observed. Elder trees should be included in the control programme as and when they are detected during control of key species.

Marram grass (*Ammophila arenaria*)

Marram grass was introduced in New Zealand and is generally a sand-dune species. Marram grass produces low numbers of seed which are wind dispersed, have low viability and has no seed bank (Hilton et al., 2019). Reproduction is almost exclusively through vegetative growth via fragmentation of the rhizomes. It is highly tolerant to drought and unpalatable to browsers (Hilton et al., 2005).

Marram grass is known to be present near the Mesopotamia homestead. This species does not pose a significant threat compared to other weed species present in the upper Rangitata River as it is well outside its normal habitat. However, it is worthwhile to remove this species while the infestation extent is limited.

Rowan (*Sorbus aucuparia*)

Rowan is a small tree of up to eight meters and produces many red/orange berries which last through winter and are eaten and dispersed by birds (Nielsen, Whigham, Frew, Callaway, & Dickinson, 2015). Rowan trees can become dense and widespread throughout hill country, with significant costs of control associated. They have become a significant pest in other areas of Canterbury, including on the Ben Ohau Range.

Rowan found during the upper Rangitata survey were generally individual trees, or lightly scattered through an area. Rowan trees are relatively dense on the true right above the Potts River bridge. This poses a significant seed source for dispersal by birds. This infestation illustrates how rowan trees spread and become dense within an area.

Control is important in the medium term to prevent this dense infestation from continuing to spread further up- and downstream along these slopes and into the riverbed.

St John's wort (*Hypericum perforatum*)

St. John's wort is a perennial plant which is relatively long-lived and tolerant of a wide range of weather conditions (Weedbusters, 2019). It reproduces from seeds and rhizomes; seeds are dispersed via wind and animal vectors, and rhizomes are dispersed via soil and water movement (New Zealand Plant Conservation Network, 2019). St John's wort is widespread throughout the Rangitata catchment and surrounding areas. Widespread control of this species in the Rangitata catchment is not practical with current budgets. However, areas of low incidence plants could be controlled when undertaking adjacent control of other species.

Stonecrop (*Sedum acre*)

Stonecrop is a low-growing herbaceous plant up to 10 cm high which grows on loose gravel and rocky habitat. It can be found on coastal cliffs, walls, banks, roadsides, riverbeds, railway tracks and in wastelands by human disturbance. Stonecrop forms a mat with creeping stems rooting at nodes, with short flowering stems rising erectly, and reproducing by wind-dispersed seed (New Zealand Plant Conservation Network, 2019) and stem and leaf fragments.

Stonecrop was not recorded during the field survey, but has been found within the upper Rangitata riverbed near the confluence with Forest Creek. Due to its low-growing habit, detection is difficult within widely braided rivers. Where small populations of stonecrop are detected it should be controlled alongside other weed species.

Sweet briar (*Rosa rubiginosa*)

Sweet briar is a prickly, woody, deciduous, perennial shrub up to 3 meters tall, commonly found in the South Island in tussockland, river beds, banks and roadsides. It self-fertilises and produces rosehips containing many seeds (Roy et al., 2004), which are dispersed by birds and stock. It is also able to regrow from stem suckers (New Zealand Plant Conservation Network, 2019). This means a single plant can successfully re-colonise an area from which it has been cleared.

Sweet briar is scattered throughout much of the upper Rangitata catchment. Individual plants were controlled in the Havelock River to below Camp Creek as they were found during the 2018 survey, but downstream become too common for practical control with the tools carried.

Sweet briar is uncommon in the Clyde River adjacent to northern end of Jumped Up Downs, becoming thickly scattered at the southern end of Jumped Up Downs within the riverbed. Sweet briar should be controlled within the Clyde and Lawrence rivers whenever found. Within the Havelock River, it is worthwhile controlling all individuals found upstream of Camp Creek, and controlling individuals below this when controlling key weed species adjacent.

Thistle species

Numerous thistle species are spread throughout the upper Rangitata catchment, including in upper tributaries. Thistles are not considered worthwhile specifically targeting under the current programme. However, when control is being carried out for key weed species, thistles should be controlled when found in low densities, particularly in upper tributaries. A good example of efficient control would be to control scotch thistle (*Cirsium vulgare*) found in the Forbes River, while carrying out Russell lupin control.

Vipers bugloss (*Echium vulgare*)

Vipers bugloss is an annual or biennial which prefers hot sunny exposed conditions and tolerates dry windy conditions, physical damage and poor soil quality. It is often found in wasteland, pasture, roadside and unstable disturbed habitats. It reproduces numerous long-lived seeds which disperse by wind or water (New Zealand Plant Conservation Network, 2019). Vipers bugloss is widespread throughout the Rangitata catchment and surrounding areas. Widespread control of this species in the Rangitata catchment is not practical with current budgets. However, areas of low incidence plants could be controlled when undertaking adjacent control of other species.

Wilding conifers (*Pinus spp.*)

Wilding conifers (henceforth, “wildings”) are able to establish and form dense stands within a range of environments, including stable riverbed areas. Once established they often displace other plant species, due predominantly to shading. Pines produce cones with winged seeds which disperse in the wind (New Zealand Plant Conservation Network, 2019), enabling wildings to spread considerable distance. The National Wilding Conifer Programme has funded wilding control over vast areas of land, including the upper Rangitata River area. There is currently no guarantee that government-funded follow-up control will be undertaken in subsequent seasons.

Wilding conifers, including *Pinus radiata* (radiata pine), *P. nigra* (Corsican pine) and *P. ponderosa* (ponderosa pine) are present in the upper Rangitata River catchment (Douglas fir is discussed separately above). Although these are not the most vigorously spreading species, they are capable of spreading in some environments, ultimately producing stands of wilding trees with little biodiversity or agricultural values beneath. A shelter belt of ponderosa pine on

the lower, true-left of the Potts River is producing numerous seedlings around the parent trees. Radiata pine is also spreading from mature trees north of Mesopotamia homestead. These should be targeted if they begin spreading within the riverbed but are currently not considered a significant threat to braided river biodiversity. These trees may be included as part of the National Wilding Conifer Control Programme (NWCCP) if future NWCCP funding is acquired.

Wilding conifer presence is not significant in areas of riverbed surveyed. However, if wilding tree infestations establish in areas immediately adjacent to riverbeds, these can harbour mammalian pest species which threaten braided river bird species. Limiting the establishment of such infestations should be a priority going forward.

Wild thyme (*Thymus vulgaris*)

Wild thyme is a scrubby herb of approximately 15-30 cm tall which forms dense patches of scrub in cold dry areas (Nielsen et al., 2015). It reproduces by producing numerous seeds which are spread by people and soil movement (New Zealand Plant Conservation Network, 2019). Wild thyme has become widespread throughout many areas of Central Otago, displacing indigenous species.

The wild thyme infestation within the upper Rangitata is restricted to an area around Forest Creek Bridge. Environment Canterbury manages this infestation through a regular control programme. Within the RPMP this species is listed under the “site-led” programme to protect values (Canterbury Regional Pest Management Plan 2018-2038).

Woolly mullein (*Verbascum thapsus*)

Woolly mullein is a biennial herb which produces a rosette growth form in the first year and produces seed in its second year before dying. Small seeds are produced in large numbers of approximately 180,000 seeds per plant which have a viability of over 40 years (Gross & Werner, 1978). Seeds readily germinate with only light and water required (Semenza, Young, & Evans, 1978). Woolly mullein does not generally create dense infestations, and is not commonly considered a serious threat to biodiversity or agriculture.

Woolly mullein is scattered throughout the upper Rangitata, and is not a priority for control. It can be efficiently controlled when single or sparsely scattered plants are found nearby other species being controlled. However, it is not suggested that significant priority should be placed on control of this species.

Further tree weed species

Numerous weed tree species are situated in the catchment outside and within the riverbed area. These trees are frequently found around buildings and shelterbelts, and include fruit trees, larch (*Larix decidua*), poplar (*Populus* spp.) and sycamore (*Acer pseudoplatanus*). Sycamore is a significant weed in forest and shrubland ecosystems and has also been reportedly controlled in the upper Havelock River between Murphy Stream and Carneys Creek, but was not observed here during the field survey. Poplars are spreading in some areas, including at Tui Stream, and within the Rangitata River, spreading downstream of the Ice Rink. A long-term plan to replace invasive trees with non-spreading species will be required to reduce ongoing control in surrounding areas. Where present on adjoining properties, these tree species could be added to long-term farm weed plans.

Appendix 3: Alignment with Plans and Strategies

It is important that weed management plans align with relevant regional and local strategies and plans, ensuring the direction of weed control in the upper Rangitata River is consistent with higher-level coordination. The summaries and excerpts below are from Canterbury documents relevant to weed control and monitoring. The Upper Rangitata 10 Year Weed Plan seeks to align with these goals and objectives to ensure correct prioritisation of control and to guarantee best chances of continued and increased future funding for monitoring and control activities.

Canterbury Regional Pest Management Plan 2018-2038 (CRPMP)

The CRPMP establishes the regulatory basis for pest management in Canterbury. This document defines which species are considered pests, and which rules (if any) are applied to those species. The purpose of the plan is to:

- Minimise the actual or potential adverse or unintended effects associated with harmful organisms; and
- Maximise the effectiveness of individual actions in managing pests through a regionally coordinated approach.

The CRPMP includes pest species listed within the following programmes: Exclusion, Eradication, Progressive Containment, Sustained Control or Site-led. The National Policy Direction for Pest Management 2015 (NPD) states that management outcomes must align with one of these 5 programmes.

Most of the weed species found in the upper Rangitata River are listed as “Pests” or “Organisms of Interest” within the region. Of the key weed species addressed within this Weed Plan, gorse, broom and Russell lupin have rules requiring land managers to undertake control in some situations. Grey and crack willow, tree lupin, and false tamarisk have no rules associated with their control.

The Implementation Strategy for the Braided River Flagship Project

The aim of the Implementation Strategy for the Braided River Flagship Project (for the upper Rangitata River) is to, “contain (stop spread) and, where possible, progressively eradicate weeds that affect freshwater biodiversity values.” Three key outcomes are sought:

1. Prevent establishment of new invasive weed species that could spread into or impact braided river beds, wetlands, springs, spring-fed tributaries, or other key freshwater ecosystems or freshwater related indigenous vegetation.
2. Keep clear areas clear – i.e. maintain areas which are currently clear of existing weed species clear of those weeds.
3. Progressively clear areas of key environmental weeds, normally beginning at the tops of the catchments and moving downwards.

The three outcomes above align closely with the Canterbury Regional Pest Management Plan programmes, 1. Exclusion, 2. Eradication and 3. Progressive Containment. These outcomes do not include the “Sustained Control” programme as an option for control in this area. It is, therefore, fundamental that sufficient budget is allocated to managing environmental weeds to

ensure these outcomes are achieved over time. Currently, some areas are not achieving these outcomes, particularly areas of weeds within the wider riverbed (including on private land) that are not being progressively contained, and those key weed species producing wind-dispersed seed.

Canterbury Water Management Strategy (CWMS)

The relevant key outcome from the CWMS, “*ecosystems, habitats and landscapes will be protected and progressively restored, and indigenous biodiversity will show significant improvement,*” reinforces the focus of protecting and restoring areas (from weed species), which will in turn improve indigenous biodiversity. Controlling weed species is a key example of restoring an area, while minimising the spread of weeds protects further areas from weed establishment.

The relevant goals within the CWMS are to achieve:

By 2020:

- Protected significant habitat for a full range of indigenous braided river flora and fauna
- Protected and enhanced habitats in riparian wetlands, springs and the lagoons associated with braided rivers

By 2040:

- Canterbury’s braided rivers show the dynamic, braided nature typical of such rivers
- All indigenous braided river-dependent species are showing positive trends in abundance and health
- Increased habitat area usable by all species of braided river indigenous birds.

With adequate/increased funding, the upper Rangitata River catchment is on track to achieve these goals. Continued vigilance from landholders and agencies toward scattered infestations and establishing weed species will ensure the riverbed remains clear of significant infestations. Continued control of the last remaining areas of higher density weeds will ensure there is no significant seed source to reinvade clear areas. Protecting areas of braided riverbed habitat will benefit braided river-dependent species. However, positive trends in abundance and health (by 2040, goal 2) is also dependent on other variables, including predator control.

Canterbury Biodiversity Strategy

The Canterbury Biodiversity Strategy’s six goals are listed below:

- Goal 1 Protect and maintain the health of all significant habitats and ecosystems.
- Goal 2 Restore the natural character of degraded indigenous habitats and ecosystems.
- Goal 3 Increase the integration and sustainable use of indigenous species in modified environments (e.g. farm, urban, lifestyle blocks).
- Goal 4 Enhance public awareness, understanding and support of biodiversity.
- Goal 5 Encourage, celebrate and support action by landowners and communities to protect, maintain and restore biodiversity.
- Goal 6 Improve the range and quality of knowledge and information about Canterbury’s biodiversity for its sustainable management.

The management of the upper Rangitata River is currently fulfilling the six goals of the Canterbury Biodiversity Strategy to various degrees. All six goals are currently being achieved through the information sharing through regular Upper Rangitata Gorge Landcare Group meetings and the collaborative approach to weed management between landholders and multiple agencies. This Weed Plan seeks to ensure these goals continue to be achieved through the priorities and objectives for weed management, outlined in the Weed Control Strategy section of this Plan. Goal 4 will be further achieved through the Recreational Users Tool, which explains, in simple terms, the importance and range of biodiversity values, and how detecting and recording weed species helps to protect these values.

All four key documents are consistent in seeking improvements in management of weed species, protection of areas and achievement of priorities for better outcomes and this Weed Plan will assist in supporting this ongoing work. Continued and increased funding is essential to meet these goals.

Appendix 4: Photos

Photos are ordered by geographic area, from upper tributaries downstream to Rangitata riverbed.



Figure 1 : Forbes River, Aciphylla spp. (indigenous speargrass)



Figure 2 : Mount Cook buttercup (indigenous), Forbes River



Figure 3 : Russell lupins, Forbes River, true right



Figure 4 : Upper Havelock River, true left, looking upstream



Figure 5 : Upper Havelock River, looking downstream



Figure 6: Alders and willows, true left Havelock River



Figure 7 : Havelock River, looking upstream toward Forbes River confluence



Figure 8 : Havelock River, stable island



Figure 9 : Upper Lawrence River, true right



Figure 10 : Upper Lawrence River, looking upstream



Figure 11 : Lower Lawrence River, looking downstream



Figure 12 : Upper Clyde River



Figure 13 : Clyde riverbed, true right, looking upstream



Figure 14 : Clyde riverbed, looking downstream



Figure 15 : Russell lupins, Erewhon Station, adjoining Clyde riverbed



Figure 16 : Grey willow, Rangitata River, upstream of Black Birch Creek confluence



Figure 17 : Individual false tamarisk, Rangitata River and Black Birch Creek confluence



Figure 18 : Scattered false tamarisk, Rangitata River and Black Birch Creek confluence



Figure 19 : Broom seeding, Bush Stream



Figure 20 : Gorse, Rangitata River and Bush Stream confluence



Figure 21 : Upper Potts River, looking upstream



Figure 22 : Patches of broom in flower, Mt Potts Station



Figure 23 : Broom in flower, Potts River, below bridge



Figure 24 : Broom (sprayed), Potts River



Figure 25 : Flowering and controlled broom, Rangitata River, true left below Potts River confluence



Figure 26 : Rangitata riverbed, true left, looking upstream toward Potts River confluence



Figure 27 : Seeding gorse in the Rangitata riverbed, true right, adjacent to Mesopotamia homestead



Figure 28 : Rangitata riverbed, true right, looking downstream

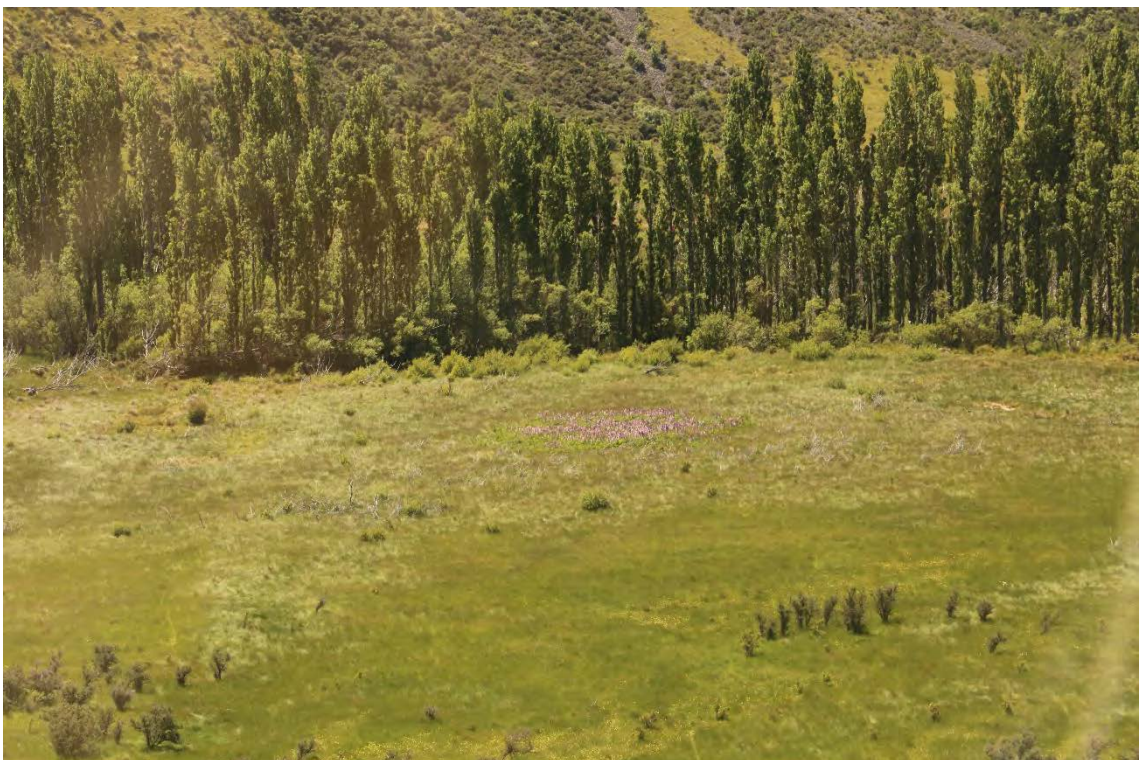


Figure 29 : Russell lupin and willow spreading near the Ice Rink