

SHORT COMMUNICATION

Cool Temperate Rainforest in the Pilot Wilderness Area, Kosciuszko National Park, New South Wales: Distribution, composition and impact of the 2003 fires

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Abstract: Although the distribution and composition of cool temperate rainforest in eastern Australia may be regarded as well documented, the recent discovery of cool temperate rainforest stands dominated by *Atherosperma moschatum* in the Pilot Wilderness area of Kosciuszko National Park shows that our knowledge is still incomplete. The additional discovery of 10 plant species previously unrecorded for the park including large specimens of *Elaeocarpus holopetalus* highlights the fact that although the flora and vegetation of the alpine and subalpine tracts of Kosciuszko National Park are relatively well studied, the remainder of the park is by comparison understudied and under sampled. Although not actively protected or managed, these cool temperate rainforest stands appear to have been little affected by the 2003 fires in the Australian Alps, with only 2 stands out of 25 showing any fire incursion. However, whether the direct effects of climate change or the indirect effects of human reaction to climate change poses the greatest threat to the continued existence of these stands is an open question. The aim of this short communication is to: a) examine the distribution and composition of these newly discovered stands of cool temperate rainforest and b) to briefly describe the impact of the 2003 fires on this restricted vegetation type.

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Introduction

Cool temperate rainforest in Australia is restricted to high rainfall, high elevation areas from south east Queensland, through New South Wales and Victoria and into Tasmania (Howard and Ashton, 1973, Australian Heritage Commission, 1987, Jarman et al., 1987, Cameron, 1987, Helman, 1987, Floyd, 1990a, Floyd, 1990b, Busby and Brown, 1994). Although the larger stands are dominated by *Nothofagus moorei* in the north and by *Nothofagus cunninghamii* to the south, stands in southern New South Wales lack *Nothofagus* and are dominated by *Atherosperma moschatum*, *Elaeocarpus holopetalus* and *Eucryphia moorei*, which occur in a 'Nothofagus gap' between these northern and southern occurrences of the type (Floyd, 1990a, Floyd, 1990b, Keith and Sanders, 1990). Although cool temperate rainforest stands tend to be small, the focus on rainforest protection in the 1980s and subsequent mapping of rainforest types over the past 30 years has meant that their distribution has been regarded as well documented.

However, during vegetation mapping for the Southern Comprehensive Regional Assessment in the mid 1990s (see Gellie, 2005), one of us (MDD) identified discrete stands of vegetation with a distinct LANDSAT TM false colour signature in the vicinity of the upper Pinch River and along the Suggan Buggan Range in Kosciuszko National Park. At the time, it was thought that these were likely to be stands of *Eucalyptus fastigata* with a mesic understorey, typically consisting of species such as *Bedfordia arborescens* and *Olearia argophylla*, with occasional *Hedycarya angustifolia*. Such moist eucalypt forest types are known from the Leatherbarrel Creek area to the west of Dead Horse Gap (Wimbush and Costin, 1973). Although creek line stands of *Atherosperma moschatum* are known from the Geehi area in Kosciuszko (Martin, 1986, Good, 1992) and from the Bogong Peaks area, there are no herbarium or survey records of *Atherosperma moschatum* from the south eastern side of Kosciuszko National Park (Australian Virtual Herbarium). Subsequently, in revising and updating a comprehensive plant species list for Kosciuszko National Park (Doherty,

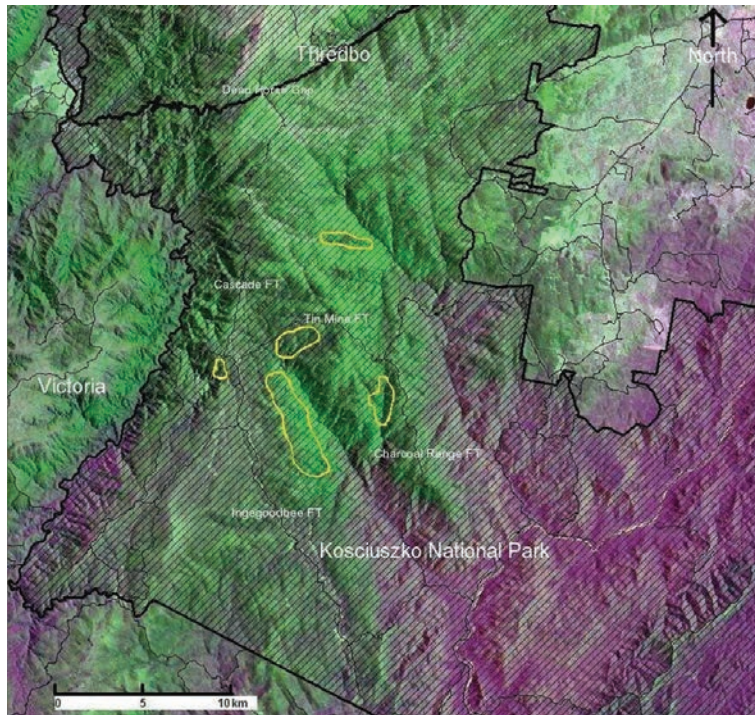


Fig. 1. Location of cool temperate rainforest in the Pilot Wilderness Area: areas within which discrete but non-contiguous stands occur are outlined in yellow; FT refers to Fire Trail. (False colour LANDSAT TM image, June 1999)

Wright and Duncan in prep.) the opportunity was taken to investigate these areas along the Suggan Buggan Range, particularly as independent field investigations by one of us (DC) after the 2003 wildfires had located creek line stands of *Atherosperma moschatum* in south eastern Kosciuszko National Park in the Charcoal Range area and in the upper Pinch River. Initial attempts by DC to access the largest stand proved unsuccessful, so a detailed inspection of the stands was undertaken in April 2010.

As the stands are small and restricted and embedded within more flammable eucalypt forest vegetation types, it is important to be able to accurately document their distribution, detail their composition and to assess any impact from the 2003 fires that may affect their viability. The aim of this short communication is to: a) examine the distribution and composition of newly discovered stands of cool temperate rainforest in Kosciuszko National Park and b) to briefly describe the impact of the 2003 fires on this restricted vegetation type.



Fig. 2. Canopy types in the larger cool temperate rainforest stand. Oblique aerial image.

Methods

Initial inspection of false colour LANDSAT TM imagery (image: June 1999) in the target area of the upper Pinch River and Suggan Buggan Range in Kosciuszko National Park identified areas of high productivity vegetation, which characteristically show a bright green rather than dark green (moist vegetation types) or purple (dry vegetation types) canopy signature (Figure 1). Candidate stands of cool temperate rainforest vegetation were then identified within these areas using finer resolution imagery available via Google Earth (image: June 2004) and the altitude and grid reference, taken as the upper and lower extent of the stand, can be found in Appendix 1. A subsequent helicopter inspection was undertaken of the area and confirmed that most occurrences are narrow creek line stands of *Atherosperma moschatum*, generally only one or two trees in width. However, one stand was identified for further on-ground field investigation because it was significantly larger than the creek line stands and had crown types other than *Atherosperma moschatum* (Figure 2). The stand was sampled in April 2010, with a reconnaissance survey of its floristic composition and the completion of a permanent 20 m x 20 m reference plot. All vascular plant species encountered

in the stand were recorded and on the reference plot, species cover was estimated using a modified Braun-Blanquet 1–6 cover scale and the DBH of a sub-sample of *Atherosperma moschatum* was measured. Mosses and liverworts were recorded opportunistically.

Results

The cool temperate rainforest stands in the Pilot Wilderness area are located in steep, narrow south or southeast facing drainage lines, ranging in elevation from 975–1405 m, with most stands occurring above 1200 m. The majority of stands in the area occur in the upper Pinch River catchment, bounded to the west by the Ingegoodbee and Cascade Fire Trails, to the north by the Tin Mine Fire Trail and to the east by the Charcoal Range Fire Trail, with one outlier stand in Tin Mine Creek and one stand in the upper Jacobs River catchment (Figure 1). All occurrences are on Mowamba Granodiorite, a unit which extends across a large area of southern Kosciuszko. The largest cool temperate rainforest stand is approximately 8 ha in area but as is typical for cool temperate rainforest, does not exhibit high plant species richness (18 species in



Fig. 3. Interior of stand with *Atherosperma moschatum* and *Dicksonia antarctica*.



Fig. 4. Multi-stemmed specimen of *Atherosperma moschatum*.

total, Appendix 2). However, of the species so far recorded in the stand, ten are new records for Kosciuszko National Park. These species include *Blechnum patersonii*, *Blechnum chambersii*, *Uncinia tenella* and *Parsonsia brownii*, all of which are found in cool temperate rainforest stands further to the south and east. Of particular interest is the presence of large specimens of *Elaeocarpus holopetalus*, a species whose nearest known occurrences in New South Wales are 100 km to the east on the coastal escarpment and for which there were no known occurrences in the Park previously. Structurally, the canopy of the larger stand is dominated by *Atherosperma moschatum* to a height of 18 metres, with a diffuse sub canopy of *Elaeocarpus holopetalus*, a mid layer of *Dicksonia antarctica* and a ground layer of *Blechnum patersonii* and *Polystichum proliferum*.

The stand contained seedlings of both *Atherosperma moschatum* and *Elaeocarpus holopetalus* and also a range of saplings and adults, indicating ongoing recruitment. Diameter at breast height measurements for a sample of *Atherosperma moschatum* ranged from 15–46 cm (mean 27 cm) and heights from 12–18 m (mean 14 m). While most *Atherosperma moschatum* trees were single-stemmed (Figure 3) there

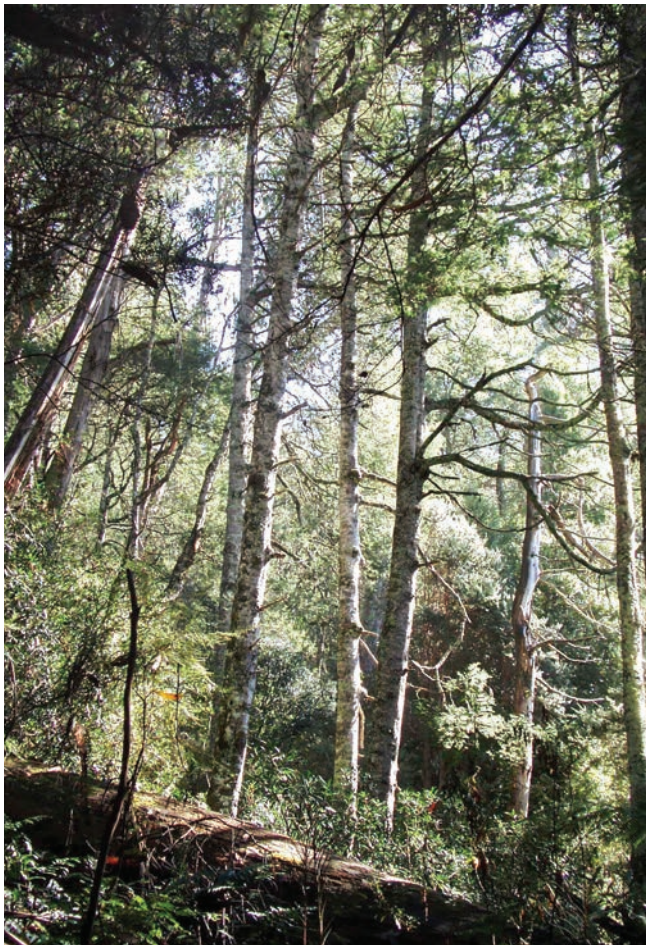


Fig. 5. *Acacia dealbata* subsp. *dealbata* on edge of cool temperate rainforest stand

were some multi-stemmed individuals (Figure 4) and while these may have been a result of coppicing from a past fire event, there was no evidence of fire or charcoal in the stand, despite the 2003 fires having burnt above and around the stand with high intensity. Johnston and Lacey (1983) note that multi-stemmed basal sprouting can occur in specimens of *Doryphora sassafras* and *Eucryphia moorei*, unassociated with disturbance by fire.

Discussion

Floristic Affinities and Biogeography

The structure and floristic composition of the stand conforms to that of cool temperate rainforest (Cameron, 1987, Helman, 1987, Floyd, 1990a, Floyd, 1990b). Gellie (2005) notes cool temperate rainforest occurring in the Geehi catchment of Kosciuszko National Park although, the floristic composition of these stands is not detailed, other than their dominance by *Atherosperma moschatum*. Gellie describes this unit as VG 172: Kosciuszko Western Escarpment Cool Temperate Rainforest, which is a western outlier of VG 164: Coastal Escarpment Cool Temperate Rainforest, but does not contain *Eucryphia moorei* and up until the current survey, was also presumed not to contain *Elaeocarpus holopetalus*. Although Gellie estimated that 105 ha of VG 172 occurred in Kosciuszko National Park, the stands in the Pilot area and the Bogong Peaks area were not included in this estimation. However, as the recently discovered stands are generally confined to creek lines and the largest stand in the Pilot area is only 8 hectares, a total area of 120–150 ha may now be a reasonable estimation for the extent of this vegetation type in the Park. Communities with a co-dominance of *Atherosperma moschatum* and *Elaeocarpus holopetalus* occur further to the east and north on the high parts of the coastal escarpment in Mount Imlay National Park, Nalbaugh National Park and South East Forests National Park (Community 3, *Elaeocarpus holopetalus* / *Dicksonia antarctica* Closed-forest (Keith and Sanders, 1990); Suballiance 56: *Elaeocarpus holopetalus*-*Atherosperma* of (Floyd, 1990a, Floyd, 1990b)). Keith and Sanders note that *Eucryphia moorei* begins to occur as a dominant or co-dominant with *Atherosperma moschatum* and *Elaeocarpus holopetalus* on the coastal escarpment on more fertile soils. Areas such as Monga National Park contain communities where all three species co-occur (Floyd, 1990a, Floyd, 1990b).

The Pilot stands are transitional in relation to the overall composition of cool temperate rainforest in SE NSW. While *Atherosperma moschatum* occurs much further to the west in Victoria, *Elaeocarpus holopetalus* has its western limit only slightly further west of Kosciuszko on the Nunniong Plateau in Victoria (Peel, 1999). As *Elaeocarpus holopetalus* drops out, *Atherosperma moschatum* persists in very small isolated stands, including as isolated individuals in creek lines in western Kosciuszko National Park and at high altitudes

on Mt. Buffalo in Victoria (Doherty, 2008). It has been noted that *Atherosperma moschatum* has greater long term drought resistance as compared to *Nothofagus cunninghamii* (Sommerville and Read, 2008) and this capacity may permit a greater westerly range than other cool temperate rainforest species in SE Australia. Although Olesen (1997) suggests that in mixed stands on the Errinundra Plateau *Atherosperma moschatum* will eventually outcompete *Elaeocarpus holopetalus* due to the former's greater shade tolerance, evidence from the Pilot stands suggest that *Elaeocarpus holopetalus* is able to recruit in these mixed stands. The larger stand in the Pilot area is floristically similar in composition to stands of Cool Temperate Rainforest found to the south-east on the Errinundra Plateau in Victoria (Cameron, 1987, Peel, 1999) where *Atherosperma moschatum* and *Elaeocarpus holopetalus* are co-dominant. The Pilot stand is essentially the same as Community 7, Sub-community 1, Cool Temperate Rainforest of Forbes et al. (1982), which is also equivalent to EVC 31: Cool Temperate Rainforest of Woodgate et al. (1994). However, at 1000–1400 m elevation, the Kosciuszko stands are generally higher than the stands found on the Errinundra Plateau, which occur between 800–900 m elevation.

Recent vegetation survey work in the Bogong Peaks area in tributaries of the Goobaragandra River (N. Taws, pers. comm.) has also detailed previously known occurrences of *Atherosperma moschatum* in the northern parts of Kosciuszko National Park and has found additional previously unrecorded species for the park including the ferns *Grammitis billardieri* and *Todea barbara*, as well as locating new populations of the ferns *Gleichenia dicarpa* and *Gleichenia microphylla*. These latter species have only been recorded sporadically in the park, often adjacent to stands of *Atherosperma moschatum*. Stands in the Geehi area also contain disjunct populations of ferns, in the latter case *Gleichenia microphylla* and *Sticherus urceolatus* (J. Miles pers. comm.).

The disjunct nature of the populations of both the stands and the species that occur within them reflect the fact that the stands are climatic relicts, occurring only in small climatically suitable refuges where the species have been able to persist as Australia has moved northward since the breakup of Gondwana (Hill, 1994). For example, while *Nothofagus cunninghamii* is not present north of the Central Highlands of Victoria (Howard and Ashton, 1973), a stump of *Nothofagus*, probably *Nothofagus cunninghamii*, has been recorded from beneath a blockstream in the Toolong Range in Kosciuszko National Park, dated at approximately 35,000 years BP (Caine and Jennings, 1968).

Fire Ecology and Fire Management:

As is the case with mixed forests in the Victorian Central Highlands (Simkin and Baker, 2008), infrequent high intensity crown fires are the major disturbance agent in the *Eucalyptus delegatensis* subsp. *delegatensis* forest surrounding the

cool temperate rainforest stands. Fire penetrating into the rainforest stands from surrounding eucalypt forest is therefore a major factor influencing the persistence of the rainforest stands. All stands of cool temperate rainforest identified in the study area occur in gullies or steep valleys with easterly aspects, providing protection from wildfires which generally run from the west or north west. There are no recorded fires in or immediately adjacent to the largest stand (in the upper Pinch River gorge) since at least 1939 (Office of Environment and Heritage GIS) and despite high intensity fire in 2003 in the surrounding eucalypt forest, only 2 of the 25 rainforest stands identified (Stand 2 and Stand 9) showed any evidence of fire penetration. The presence of *Acacia dealbata* subsp. *dealbata* adjacent to cool temperate rainforest stands is thought to indicate previous fire incursions (Peel, 1999) and this species was noted around the edges of the Pilot cool temperate rainforest stands (Figure 5). In particular, the presence of large specimens of *Acacia dealbata* subsp. *dealbata* and the absence of *Atherosperma moschatum* between Stand 9 and Stand 10 (Figure 5) may indicate a previous fire incursion that broke the connectivity of what may have been a continuous stand. However, the diameter at breast height of individuals of both *Acacia dealbata* subsp. *dealbata* and *Eucalyptus delegatensis* subsp. *delegatensis* on the margin of the largest stand (>50 cm and 1.9 m diameter respectively) suggests that it may be a century or more since a wildfire resulted in canopy death in or around the stand. Additionally, young individuals of *Atherosperma moschatum* downstream of Stand 10 indicate ongoing stand expansion in suitable areas.

Given the lack of fire penetration into the stands under even extreme conditions, this vegetation type appears to burn very infrequently and even when fire does penetrate the edges of a stand, there is still some ability for recovery. Some individuals of *Atherosperma moschatum* in the Geehi Valley in Kosciuszko National Park were noted to resprout after the 2003 fires (D. Woods, pers. comm.), but there was also some tree death. Such attrition at the edges of stands may reduce their extent over the longer term, but the time between fire events will be critical, as a long interval between fire events may allow full recovery. Although generally classed as 'fire sensitive' communities, there is clearly some resilience in cool temperate rainforest communities in relation to particular fire events, as evidenced by the response of large individuals of *Nothofagus cunninghamii* which were observed resprouting after the 2009 Victorian fires (Lindenmayer et al., 2010). In Tasmania, *Atherosperma moschatum* can resprout vigorously from rootstocks after logging (Hickey and Wilkinson, 1999), 1999) and there is evidence of resprouting and seedlings after wildfire (Hickey, 1994), but Hill and Read (1984) noted almost 100% mortality of *Atherosperma moschatum* in a low to moderate intensity surface fire in western Tasmania.

Conclusion

As this work was undertaken as an initial reconnaissance, a systematic study of the occurrence and size of the stands in Kosciuszko National Park would be a logical next step, concentrating on the five largest stands initially (Appendix 1). Although considerable research and monitoring has been undertaken in the alpine and subalpine tracts of the Kosciuszko National Park over many years (McLuckie and Petrie, 1927, Costin, 1957, Costin et al., 1969, Wimbush and Costin, 1979a, Wimbush and Costin, 1979b, Wimbush and Costin, 1979c, Clarke and Martin, 1999, McDougall and Walsh, 2002, Walsh and McDougall, 2004, McDougall and Wright, 2004, Bear et al., 2006) few published studies exist outside these areas, exceptions being the lower Snowy River (Pulsford et al., 1993) and Byadbo areas (Clayton-Greene and Wimbush, 1988).

Given the large size (690,425 ha) and altitudinal variation (200–2228 m a.s.l.) of Kosciuszko National Park and the paucity of detailed survey work outside the alpine and subalpine tracts, the potential for unrecorded plant species and communities still remains significant, as evidenced by the number of new species records obtained for Kosciuszko National park during this survey.

The lack of fire penetration into the stands from the 2003 fires is encouraging and indicates a high degree of topographic protection from fire. However, as these relictual Kosciuszko cool temperate rainforest stands are small in overall extent and are often found as ribbon like threads only two or three trees wide along creek lines, projected climate and fire regime changes may result in an increase in the frequency with which fire burns around or into the stands and drier conditions may allow a greater depth of fire penetration into the stands in extreme weather situations, as experienced in 2003, or in 2009 in Victoria.

In the longer term, research on stand dynamics would be beneficial, particularly as regards the effects of predicted future changes in temperature and rainfall in SE NSW (PMSEIC Independent Working Group, 2007), and the possibility of an increase in the frequency of high intensity fire in SE Australia (Williams et al., 2001, Cary, 2002, Hennessy et al., 2005, Lucas et al., 2007). Such climate driven changes to fire regimes (Gill, 1975) i.e. the cumulative impact of fire events over time, may accelerate the climate-fire interactions that have already caused the extent of the communities to contract over many thousands of years.

Whether the direct effects of a possible increase in unplanned fire frequency and intensity prove more a threat to the existence of the stands than proposed increases in planned fire frequency and extent, as humans respond to climate change, remains to be seen.

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Appendix 1: Grid references for Cool Temperate Rainforest stands in the Pilot Wilderness

CTRF Stand Number	Altitude	Easting	Northing	Comments
CTRF Stand 1 Upper	1405 m	617920	5948354	Outlying stand
CTRF Stand 1 Lower	1225 m	618720	5948193	Outlying stand
CTRF Stand 2 Upper	1260 m	613904	5942584	
CTRF Stand 2 Lower	1235 m	613824	5942427	
CTRF Stand 3 Upper	1285 m	614330	5942539	
CTRF Stand 3 Lower	1250 m	614253	5942358	
CTRF Stand 4 Upper	1240 m	614222	5942290	
CTRF Stand 4 Lower	1210 m	614129	5942094	
CTRF Stand 5 Upper	1265 m	615105	5942227	
CTRF Stand 5 Lower	1160 m	614713	5941610	
CTRF Stand 6 Upper	1320 m	613439	5939811	
CTRF Stand 6 Lower	1140 m	614209	5940343	
CTRF Stand 7 Upper	1305 m	614176	5939064	Fifth largest stand
CTRF Stand 7 Branch	1305 m	614205	5939148	Fifth largest stand
CTRF Stand 7 Lower	1265 m	614381	5939223	Fifth largest stand
CTRF Stand 8 Upper	1320 m	614226	5938789	
CTRF Stand 8 Lower	1300 m	614280	5938981	
CTRF Stand 9 Upper	1230 m	614565	5938083	Largest stand
CTRF Stand 9 Centre	1120 m	614835	5938188	Largest stand
CTRF Stand 9 Lower	1065 m	615012	5938185	Largest stand
CTRF Stand 10 Upper	1330 m	614247	5937829	
CTRF Stand 10 Lower	1300 m	614357	5937906	
CTRF Stand 11 Upper	1350 m	614369	5936588	Second largest stand
CTRF Stand 11 Centre	1320 m	614484	5936593	Second largest stand
CTRF Stand 11 Lower	1310 m	614560	5936661	Second largest stand
CTRF Stand 12 Upper	1180 m	615308	5936962	
CTRF Stand 12 Lower	1150 m	615459	5936963	
CTRF Stand 13 Upper	1295 m	615548	5935926	Fourth largest stand
CTRF Stand 13 Lower	1250 m	615707	5935821	Fourth largest stand
CTRF Stand 14 Upper	1330 m	615079	5935361	
CTRF Stand 14 Lower	1275 m	615227	5935190	
CTRF Stand 15 Upper	1280 m	615180	5935095	Third largest stand
CTRF Stand 15 Branch	1270 m	615411	5935292	Third largest stand
CTRF Stand 15 Lower	1210 m	615723	5935097	Third largest stand
CTRF Stand 16 Upper	1245 m	615218	5934696	
CTRF Stand 16 Lower	1110 m	615707	5934363	
CTRF Stand 17 Upper	1280 m	614639	5934453	
CTRF Stand 17 Lower	1255 m	614611	5934319	
CTRF Stand 18 Upper	1040 m	616014	5934409	
CTRF Stand 18 Branch	1040 m	616130	5934671	
CTRF Stand 18 Lower	975 m	616359	5934503	
CTRF Stand 19 Upper	1340 m	619099	5939770	
CTRF Stand 19 Branch	1355 m	619061	5939556	
CTRF Stand 19 Lower	1045 m	619974	5938570	
CTRF Stand 20 Upper	1330 m	620308	5940736	
CTRF Stand 20 Lower	1065 m	620216	5938792	
CTRF Stand 21 Upper	1345 m	615066	5942734	
CTRF Stand 21 Lower	1255 m	615213	5942245	
CTRF Stand 22 Upper	1385 m	615812	5942986	
CTRF Stand 22 Lower	1350 m	615768	5942684	
CTRF Stand 23 Upper	1100 m	613929	5941462	
CTRF Stand 23 Lower	1095 m	613999	5941506	
CTRF Stand 24 Upper	1235 m	614577	5941908	
CTRF Stand 24 Lower	1065 m	614274	5941480	
CTRF Stand 25 Upper	1255 m	610410	5940926	
CTRF Stand 25 Lower	1000 m	610214	5940153	

Appendix 2: Plant species recorded in and immediately adjacent to the larger Cool Temperate Rainforest stand in the Pilot Wilderness Area

Species recorded in the reference plot in the core of the stand

Liverworts:

Hymenophyton flabellatum: new record for Kosciuszko NP

Mosses:

Cyathophorum bulbosum: new record for Kosciuszko NP

Hypnodendron vittense: new record for Kosciuszko NP

Ferns:

Asplenium bulbiferum: new record for Kosciuszko NP

Asplenium flabellifolium

Blechnum chambersii: new record for Kosciuszko NP

Blechnum patersonii: new record for Kosciuszko NP

Dicksonia antarctica

Histiopteris incisa: new record for Kosciuszko NP

Polystichum proliferum

Herbs:

Viola hederacea hederacea

Shrubs:

Coprosma quadrifida

Pittosporum bicolor

Tasmannia lanceolata

Trees:

Atherosperma moschatum

Elaeocarpus holopetalus: new record for Kosciuszko NP

Climbers:

Parsonsia brownii: new record for Kosciuszko NP

Sedges:

Uncinia tenella: new record for Kosciuszko NP

Common species immediately adjacent to the stand

Acacia dealbata subsp. *dealbata* (Silver Wattle)

Bedfordia arborescens (Blanket Bush)

Cassinia aculeata (Dolly Bush)

Eucalyptus delegatensis subsp. *delegatensis* (Alpine Ash)

Eucalyptus fastigata (Brown Barrel)

Olearia argophylla (Musk Daisy Bush)

Poa sieberiana subsp. *sieberiana* (Snow Grass)

Urtica incisa (Stinging Nettle)

