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The ecology and conservation of *Kunzea sinclairii* (Myrtaceae), a naturally rare plant of rhyolitic rock outcrops

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Abstract

Kunzea sinclairii is a local endemic on Great Barrier Island, northeastern New Zealand. While variously ranked as vulnerable and endangered in the past, we show that this species is naturally uncommon and under no threat of extinction. Previous assessments of its conservation status have been based on inadequate knowledge of its ecology. *K. sinclairii* is a rupestral species whose optimum habitat is low shrubland on rhyolitic rock outcrops and cliffs. Because of past logging and burning of forest adjacent to the habitat to which it is adapted, *K. sinclairii* expanded its range. However, in regeneration back to forest, *K. sinclairii* is being excluded as it is overtopped by other species. This has led to the impression that it is declining. Similarly, a suggestion that *K. sinclairii* could be threatened by hybridisation with the more abundant closely related *K.ericoides* is not supported as the hybrids are confined to the disturbed sites created by logging and fire. This case study highlights the importance of having a good understanding of the ecology of uncommon plant species before making decisions on their conservation. Natural rarity does not itself necessarily equate with increased extinction risk and these taxa should not be classified as threatened.

Keywords: *Kunzea sinclairii*; Rarity; Naturally uncommon species; Cliffs; Local endemic; Threatened species classification

1. Introduction

Rarity is a normal feature of all biological communities with most species assemblages comprising a few abundant species and many with only a few individuals (Rabinowitz et al., 1986; Gaston, 1994). However, the impact of humans on natural ecosystems has resulted in the formation of a new suite of rare species that were previously more abundant but are now rare because of human disturbances. In many rare species classifications, including the Red Book listings of the IUCN (Baillie and Groombridge, 1996; Walter and Gillett, 1998), these two types of rarity, natural and induced, are not always clearly distinguished (Rabinowitz et al., 1986; Gaston, 1994; de Lange and Norton, 1998). As a result, some species that are naturally rare are also ranked as threatened with extinction. While naturally rare species can be more vulnerable to extinction than common ones, rarity in itself is not synonymous with extinction threat (Gaston, 1994; Mace and Kershaw, 1997; de Lange and Norton, 1998). Understanding the difference between natural and induced rarity is important for focusing conservation efforts (Rabinowitz et al., 1986; de Lange and Norton, 1998).

One of the reasons why a plant species might be naturally rare is because its habitat is restricted (Gaston, 1994). An example of a naturally rare habitat are the rock outcrops, cliffs and pinnacles (inselbergs) that commonly occur as islands of suitable habitat within a matrix of unsuitable habitat such as forest (Larson et al., 2000; Porembski and Barthlott, 2000). Such habitats are of small extent within a region and present particular habitat limitations (e.g., exposure, water shortages, lack of soil; Szarzynski, 2000). They can also be important refugia for widespread species because cliff habitats often escape disturbances such as fire (Manders, 1986; Wiser, 2001). Due to this isolation and unique environment, cliffs provide habitat for local endemic and naturally rare plants (Wardle, 1991; Wyatt, 1997; Larson et al., 2000; Hopper, 2000; Wiser, 2001).

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An interesting feature of species from cliff communities is that they can often expand their range when the surrounding habitat has been disturbed. For example, some species normally confined to cliffs will expand into adjacent habitats after disturbances such as fire have removed the dominant vegetation (Larson et al., 2000). However, as the surrounding habitats regenerate towards their dominant vegetation (e.g., forest), cliff species are often excluded by competition. This phenomenon can give the impression that the cliff species are declining, when their decline is in fact an artifact of previous disturbance.

Kunzea sinclairii is endemic to Great Barrier Island off the east coast of northern New Zealand (Kirk, 1899) where it occurs on rhyolitic cliffs and related rocky sites and in the adjacent fire and logging-induced shrubland. Although first recognized and described in the late nineteenth century (Kirk, 1869, 1899), subsequent confusion with the related *Kunzea ericoides* (Cheeseman, 1906, 1914, 1925; Thompson, 1983), and occurrence of hybridism with that species (Harris et al., 1992; Dopson et al., 1999), have meant that the taxonomic status and ecological requirements of *K. sinclairii* have been uncertain (Dopson et al., 1999). As a result there has been confusion over its conservation status, which has vacillated from vulnerable and endangered (Given, 1990; Cameron et al., 1995) to insufficiently known (de Lange et al., 1999).

A preliminary survey of *Kunzea sinclairii* carried out during 1999 (P.J. de Lange unpubl. data) suggested that the habitats in which it is most common are rhyolitic cliffs, outcrops and pinnacles. While it is also present in shrubland adjacent to rock outcrops, it is being replaced by taller species as the forest regenerates after earlier logging and burning. Although very localized and apparently presently declining on some sites, the 1999 survey suggested the species was naturally rare and not threatened with extinction.

In this study we describe aspects of the ecology of *Kunzea sinclairii* as a basis for better understanding the conservation of endemic rock outcrop plants. We specifically address three questions:

1. What is the habitat of *K. sinclairii*?
2. What is the regeneration status of *K. sinclairii* populations?
3. What generalizations can be drawn from this study?

2. Methods

2.1. Study area

Great Barrier (Aotea) Island (Lat. 36° 11′ S Long. 175° 34′ E, c. 28 500 ha; Fig. 1) is located in the outer Hauraki Gulf, North Island, New Zealand. Our study area encompasses the central portion of the island wherein *Kunzea sinclairii* is endemic (Harris et al., 1992). This area is dominated by a series of 8–10 million year old rhyolitic lava flows which have been extensively eroded resulting in a topography typified by steep-sided gorges, cliffs, rock outcrops, and narrow rock pinnacles (Fig. 2). Soils of the area vary from the acidic recent soils of the rhyolitic rock outcrops through to organic soils under taller woody vegetation. Summary climate data (1951–1980 normals) is available from Port Fitzroy, central northwestern Great Barrier Island. The mean annual temperature is 15.6 °C with a February mean daily maximum of 23.8 °C and July mean daily minimum of 7.9 °C. Annual rainfall averages 1953 mm with a marked winter maximum. The climate of the island's interior, which reaches an altitude of 627 m, is likely to be cooler, cloudier and wetter than at Port Fitzroy.

The central portion of the island was formerly dominated by *Agathis australis* forest, with patches of conifer-angiosperm 'cloud' forest on the local high points. On the rhyolitic rock outcrops and pinnacles, there is a low shrubland in which two Great Barrier Island endemic shrubs *Kunzea sinclairii* and *Olearia allomii* are present (Kirk, 1869; Ogden, 2001). Since 1794 forest has been significantly reduced by logging and burning (Kirk, 1869; Sale, 1978; Sewell, 2001). As a result much of the island is vegetated today by dense secondary regrowth dominated by the small myrtaceous trees *Leptospermum scoparium* and *Kunzea ericoides* (Ogden, 2001).

2.2. Field methods

Kunzea sinclairii occurs in localized sites scattered across c. 8000 ha of rugged and heavily vegetated hill country (Fig. 1). Previous visits had identified rock outcrops as the most common habitat of *K. sinclairii*, but it is also present on slips and in regenerating shrubland on previously logged and burnt sites. We randomly located sample points across the habitats occupied by *K. sinclairii* as well as in adjacent areas of taller woody vegetation to quantify plant community composition. At each sample point we estimated visually the cover abundance of all vascular plant species in up to three strata, ground (0–0.5 m), shrub (0.5–2 m) and canopy (>2 m), using unbounded plots (Allen, 1992) of c. 25 m^2. The height range for each stratum was recorded for each plot. Cover abundance was measured using cover classes of <1, 1–5, 6–10, 11–25, 26–50, 51–75 and 76–100%. In addition altitude, slope, aspect and mean top height were recorded for each plot, and soil samples were collected from seven plots.

We made a number of additional measurements of population structure in a proportion of the plots representing the range of situations in which *Kunzea* *sinclairii* occurs. The crown dimensions of individual *K. sinclairii* were determined in ten plots where we measured the length of the longest horizontal axis of the crown and the axis perpendicular to this. We also measured the heights of *K. sinclairii* and other woody plant species at six plots.

2.3. Analytical methods

The computer program RECINT, run within PC-RECCE (Hall, 1992), was used to summarise the vegetation data so that there was one importance value per species per plot. This involved multiplying the cover for

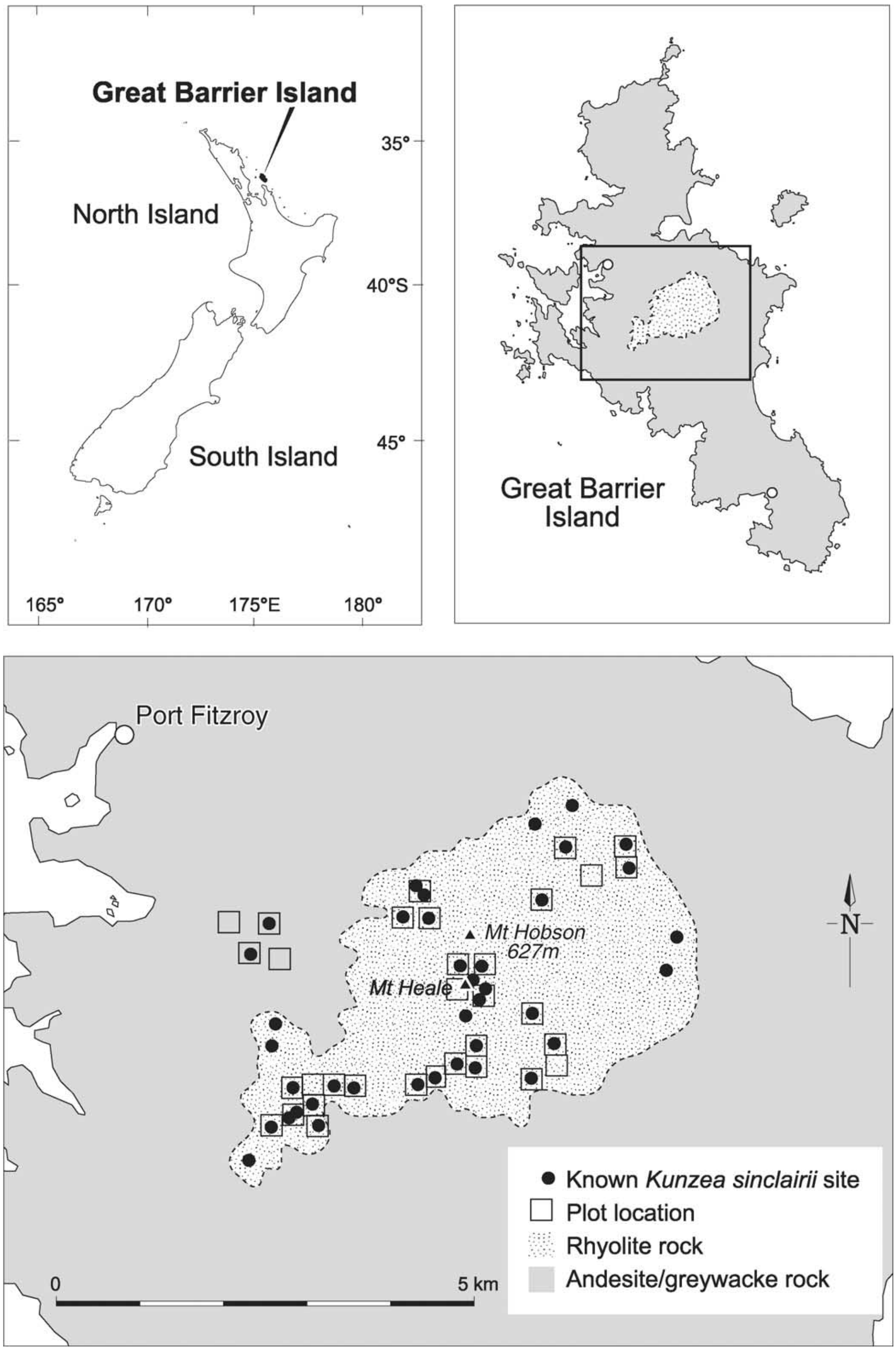

Fig. 1. Location of study area and distribution of *Kunzea sinclairii*, Great Barrier Island, New Zealand.

each species in each stratum by $\log_{10}$ of stratum height $+1$, and then summing these values for each species across the strata. Simultaneous classification of plots and species was performed using the polythetic divisive technique of indicator species analysis (ISA; Hill et al., 1975) as implemented in TWINSPAN. After examining the divisions, the second level was used for classification yielding four groups (communities). The PC-RECCE module RECSUM was then used to derive summary data of species frequency and cover abundance by strata, and environmental data, for each of the four classification groups.

Species richness per plot, elevation, slope, aspect, mean top height and ground cover were independently compared between the four ISA community groups using a simple ANOVA as implemented using SAS version 8. *A posteriori* least squares means tests were used to test for significant differences between individual community means. Elevation described the altitudinal difference between a plot and the local topographical high point, with plots with the greatest elevation occurring furthest down-slope from the local high point. The measures of aspect were initially corrected for magnetic declination and then expressed on a scale of 0–180 such that east and west both scored 90. Proportional data were arc-sine(sqrt) transformed prior to analysis. Means are presented ± 1 standard error.

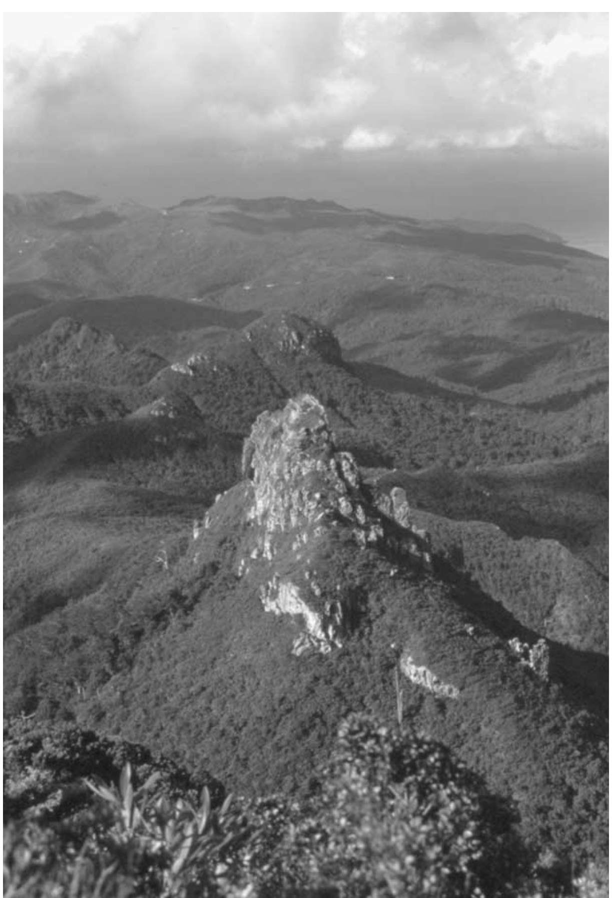

Fig. 2. The rhyolitic pinnacle of Mt Heale (510 m), providing *Kunzea sinclairii* habitat on the exposed rock areas.

Kunzea sinclairii crown areas were determined using crown diameter (based on the average of the two measured axes) to calculate the area of a circle. These measurements were then summed for four area size classes, <0.01, 0.01–0.09, 0.1–0.9 and >1 m^2 representing seedlings, establishing plants, and two size-classes of mature plants respectively. Plant height data were summarised using 1 m height classes.

Soil samples were sieved (<2 mm) and dried prior to analysis for Olsen phosphorus (P), total carbon (C), total nitrogen (N) and pH (water soluble). Analyses were undertaken using the methods described by Blakemore et al. (1987). Data from low and tall shrubland sites were compared using single factor ANOVA. Proportional data were arc-sine(sqrt) transformed prior to analysis. Means are presented ± 1 standard error.

2.4. *Extent of* Kunzea sinclairii *habitat*

The extent of potential and known *Kunzea sinclairii* rock outcrop habitat was obtained by first overlaying the locations of herbarium vouchers (AK!, AKU!, CHR!, WELT!) on an aerial photograph of Great Barrier Island (scale 1:18 000), and then determining the area of each of the rock outcrop habitats surrounding that specimen using a Tamaya Digital Planix 7 Planometer. In this way c. 80% of the total potential habitat was determined. The remaining areas of rock outcrop were then assumed to also carry this species.

3. Results

3.1. *Community types*

Classification of the 38 vegetation plots using two-way indicator species analysis resulted in the identification of four plant communities (Table 1): rocky stream bank; low shrubland; tall shrubland; and regenerating forest.

3.1.1. *Rocky stream bank*

This unusual community was sampled by two plots along the sides of a stream bed scoured by the passage of *Agathis australis* logs during logging that had removed the vegetated stream banks leaving exposed unweathered rhyolitic bedrock (>50% area) with minimal soil. The habitat is characterised by flash flooding, that together with exposed bedrock has resulted in a sparse vegetation cover dominated by prostrate *Leptospermum scoparium* and *Kunzea sinclairii*, patches of *Lycopodiella cernua*, and *Blechnum novae-zelandiae* in seepages. Other stream banks were observed to support similar vegetation, but were not sampled.

3.1.2. Low shrubland

This community is typical of exposed, and often steeply sloping (mean slope 19.4 ± 3.8°) rhyolite outcrops, pinnacles and cliff faces (Fig. 2) and occurs widely throughout the study area (19 plots). Vegetation is typically patchy with rock occupying a substantial proportion of the total area (34.2 ± 6.4%) and minimal soil development. The vegetation comprises a sparse upper stratum of shrubs 1–1.5 m tall, mostly *Leptospermum scoparium*. The main vegetation cover is prostrate *Kunzea sinclairii* and *L. scoparium*, with lesser amounts of *Phormium cookianum* and *Olearia allomii*. A large number of vascular plants were also recorded, but individual species were often present only in one to a few plots. A distinctive feature of several of the plots is the very high cover of lichens and bryophytes (particularly *Cladia retipora* and *Ptychomnion aciculare*).

3.1.3. Tall shrubland

This community, down-slope from the exposed rhyolite outcrops is developed on colluvial slopes with variable soil depths depending on the nature of the underlying rhyolite. Typically this community has a dense canopy dominated by *Leptospermum scoparium* (3.4 ± 0.8 m), with a few individuals of several potential forest dominants. The shrub layer, although sparse, is species rich and includes senescent *Kunzea sinclairii*. The ground layer is dominated by ferns and clubmosses (*Gleichenia dicarpa*, *Blechnum novae-zelandiae* and *Lycopodium deuterodensum*) and etiolated sedges (especially *Schoenus tendo*).

3.1.4. Regenerating forest

This community also occurs down-slope from the rhyolite outcrops but was best developed in valley heads less affected by fire and in pockets of deep colluvium. Although structurally similar to tall shrubland, it is characterized by a much higher abundance of forest species in the canopy (4.4 ± 1.0 m top height) including *Weinmannia silvicola*, *Pseudopanax discolor* and *Agathis australis*. Although still common, *Leptospermum scoparium* is frequently senescent. The forest fern *Blechnum novae-zelandiae* is by far the most abundant ground cover species, whilst other ferns typical of mature *A. australis* forest (e.g. *Loxsoma cunninghamii*) are also present. *Kunzea sinclairii* was not recorded from regenerating forest plots.

3.1.5. Floristic and environmental comparisons

One hundred and nine vascular plant species were recorded in the study plots, with significantly more species recorded per plot from the tall shrubland and regenerating forest communities than from the rocky stream bank and low shrubland communities (Table 2). The rocky stream bank, tall shrubland and regenerating forest communities were significantly further down slope from local high points than the low shrubland. There was no significant difference in aspect or slope of the four communities. Mean top height of the vegetation was, however, significantly greater in the tall shrubland and regenerating forest communities than in the rocky stream bank and low shrubland communities (Table 2). There was no significant difference in vascular

Table 1
Percentage cover for those species present in = 66% in any one community. + Species with = 1% cover. * naturalized species

Species	Rocky stream bank	Low shrubland	Tall shrubland	Regenerating forest
**Rytidosperma racemosum*	+			
Lycopodiella cernua	18.5	+		
Kunzea sinclairii	10.8	36.9	6.7	
Leptospermum scoparium	18.5	22.2	59.4	25.3
Blechnum novae-zelandiae	4.3	+	11.4	39.6
Phormium cookianum subsp. *hookeri*		4.6	+	+
Olearia allomii		3.3	+	+
Gleichenia dicarpa	+	+	33.5	+
Schoenus tendo	+		13.0	
Lycopodium deuterodensum		+	12.2	+
Leucopogon fasciculatus	+	+	4.7	3.7
Kunzea ericioides × *K. sinclairii*	+	+	4.6	+
Morelotia affinis	+	+	+	+
Weinmannia silvicola	+	+	9.6	51.3
Pseudopanax discolor		+	3.9	29.4
Geniostoma ligustrifolium			5.6	+
Agathis australis		+	+	3.2
Astelia trinervia			+	2.6
Dianella nigra	+	+	+	1.9
Hebe macrocarpa var. *latisepala*		+	+	1.9
Coprosma dodonaeifolia		+	+	+
Myrsine australis			+	+
Brachyglottis kirkii var. *angustior*		+	+	+

plant or bryophyte ground cover between communities, but there were significant differences in the ground cover of litter and rocks, with the former significantly higher and the latter significantly lower in the tall shrubland and regenerating forest communities compared to the rocky stream bank and low shrubland communities (Table 2).

3.2. Population structures

The combined population size class distribution for *Kunzea sinclairii* from the two rocky stream bank plots showed evidence of episodic recruitment (Fig. 3). The *K. sinclairii* size-class distributions from the five low shrubland plots all showed a reverse J-shaped curve with abundant small plants and relatively few large plants suggesting continuous recruitment. Three of the four tall shrubland *K. sinclairii* size-class distributions showed highly skewed distributions with a complete lack of small plants. In contrast the fourth tall shrubland size-class distribution had a size-class distribution similar to that in the low shrubland.

Height class distribution for *Kunzea sinclairii* and other woody species (primarily *Leptospermum scoparium*, *Kunzea ericoides*, *K. ericoides*×*K. sinclairii* and *Weinmannia silvicola*) show a marked difference between low shrubland and tall shrubland plots (Fig. 4). In the former, *K. sinclairii* is abundant in the uppermost vegetation layer while in the latter *K. sinclairii* typically occurs in the lower layers of the vegetation, with other woody species above it. It is evident from two of the tall shrubland plots (Fig. 5) that hybrid *K. ericoides*×*K. sinclairii* plants are present in the same layer as *K. ericoides*, overtopping the *K. sinclairii* plants.

3.3. Extent of Kunzea sinclairii habitat

The rock outcrop habitats in which *Kunzea sinclairii* is most abundant is covered by the low shrubland vegetation type and comprises 90.5 ha (0.3% of the area) of Great Barrier Island. The extent of the tall shrubland and rocky stream bed communities also known to support *K. sinclairii* was not determined. The tall shrubland (and regenerating forest) habitats are transitory extensions of the range of the rock outcrop favoring *K. sinclairii* (see below) and it was not possible to map a maximum distribution area in which *K. sinclairii* might occur. It was also not possible to delineate the narrow rocky stream beds at the mapping scale used.

3.4. Soil chemistry

Soil C ranged from 4.1–21.1%, with a mean of 15.0±2.1%, and N from 0.19–0.88%, with a mean of 0.53±0.09%. Olsen P ranged from 1.0—13.9 mg kg^{-1}, with a mean of 4.8±1.6 mg kg^{-1}. pH ranged from 4.0–5.6 pH units with a mean of 4.6±0.2 pH units. There was no significant difference ($P<0.05$) between the values for any of these soil variables from the low and tall shrubland samples.

4. Discussion

Kunzea sinclairii is a rock outcrop or cliff species (sensu Larson et al., 2000), being most abundant and almost completely confined to the rhyolitic outcrops of central Great Barrier Island. While many rock outcrop plants are also common in adjacent vegetation (e.g., epiphytic ferns), *K. sinclairii* is one of a smaller group of species, including another Great Barrier Island endemic *Olearia allomii*, whose optimum habitat appears to be rock outcrops. While there are few rupestral woody species in the New Zealand flora, these species typically have limited geographical distributions (Wardle, 1991) and many are classified as rare (Wiser, 2001).

Rock outcrops provide a unique environment for plant growth (Larson et al., 2000; Szarzynski, 2000).

Table 2
Species and environmental attributes of vegetation communities. Means in the same row followed by the same letter are not significantly different at $P<0.05$

	Rocky stream bank	Low shrubland	Tall shrubland	Regenerating forest	ANOVA *P*
No. plots	2	19	9	8	
Total no. species	19	73	60	64	
Species per plot	13.0±4.2a	16.1±0.9a	24.2±1.8b	22.3±1.5b	<0.001
Elevation (m)[a]	170.0±0.0a	19.5±5.9b	127.2±24.4a	97.1±30.4a	<0.001
Aspect (°)	72±0.0	93.9±13.0	103.1±19.8	88.1±22.1	0.897
Slope (°)	15.0±0.0	19.4±3.8	11.0±5.1	12.5±5.4	0.554
Top height (m)	0.5±0.0a	0.4±0.1a	3.4±0.8b	4.4±1.0b	<0.001
Vascular%	42.5±12.5	45.5±5.7	64.4±7.3	55.0±9.6	0.279
Bryophyte/lichen%	5.0±0	13.9±4.0	0.0±0.0	10.0±6.5	0.071
Litter%	0.0±0.0 a	6.3±3.4a	28.9±7.5b	35.0±6.0b	<0.001
Rock%	52.5±12.5a	34.2±6.4a	6.7±6.7b	0.0±0.0b	<0.001

[a] Vertical height below the local topographical high point.

They are usually open sites with limited competitive interactions and often escape disturbances such as fire. At the same time the attributes of the site such as high light, low moisture, limited soil, wind exposure, and gravity can limit plant growth. The rocky sites and associated soils that *Kunzea sinclairii* grows on are also characterized by very low fertility levels. Harris et al. (1992) observed that the soils on which *K. sinclairii*

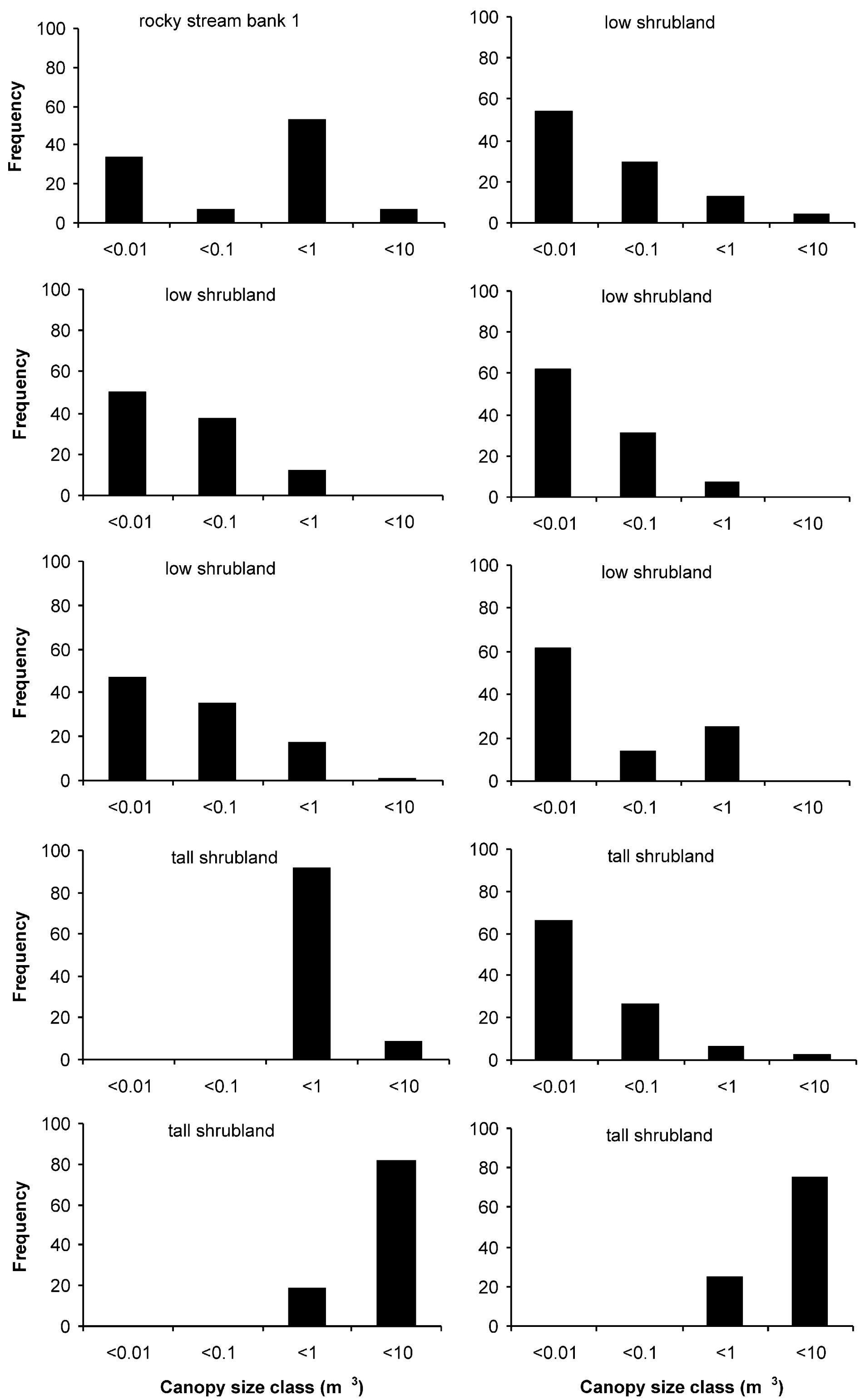

Fig. 3. Canopy size-class distributions for 10 *Kunzea sinclairii* populations. Community types are indicated, but with no data from the regenerating forest type as *K. sinclairii* was absent from this type.

occurs have been mapped as naturally of low fertility, and the nutrient levels recorded in the present study are very low compared with typical New Zealand agricultural soils (Blakemore et al., 1987). Reflecting the environmental limitations of rock outcrops, a distinctive feature of the rock outcrop flora sampled here, and of other rock outcrop floras (Porembski et al., 1997; Larson et al., 2000), is the high lichen and bryophytes cover.

The Great Barrier Island rock outcrops have never been affected by glacial conditions and have been surrounded by tall forest at least since the end of the last glaciation and possibly for much longer (Bartlett and Gardner, 1983; Moore, 2001). Rock outcrops can take on a similar ecological role to nunataks in glaciated regions (Larson et al., 2000), acting both as refugia for plants that were previously widespread under different climatic conditions (Wiser, 1994) and as sites for

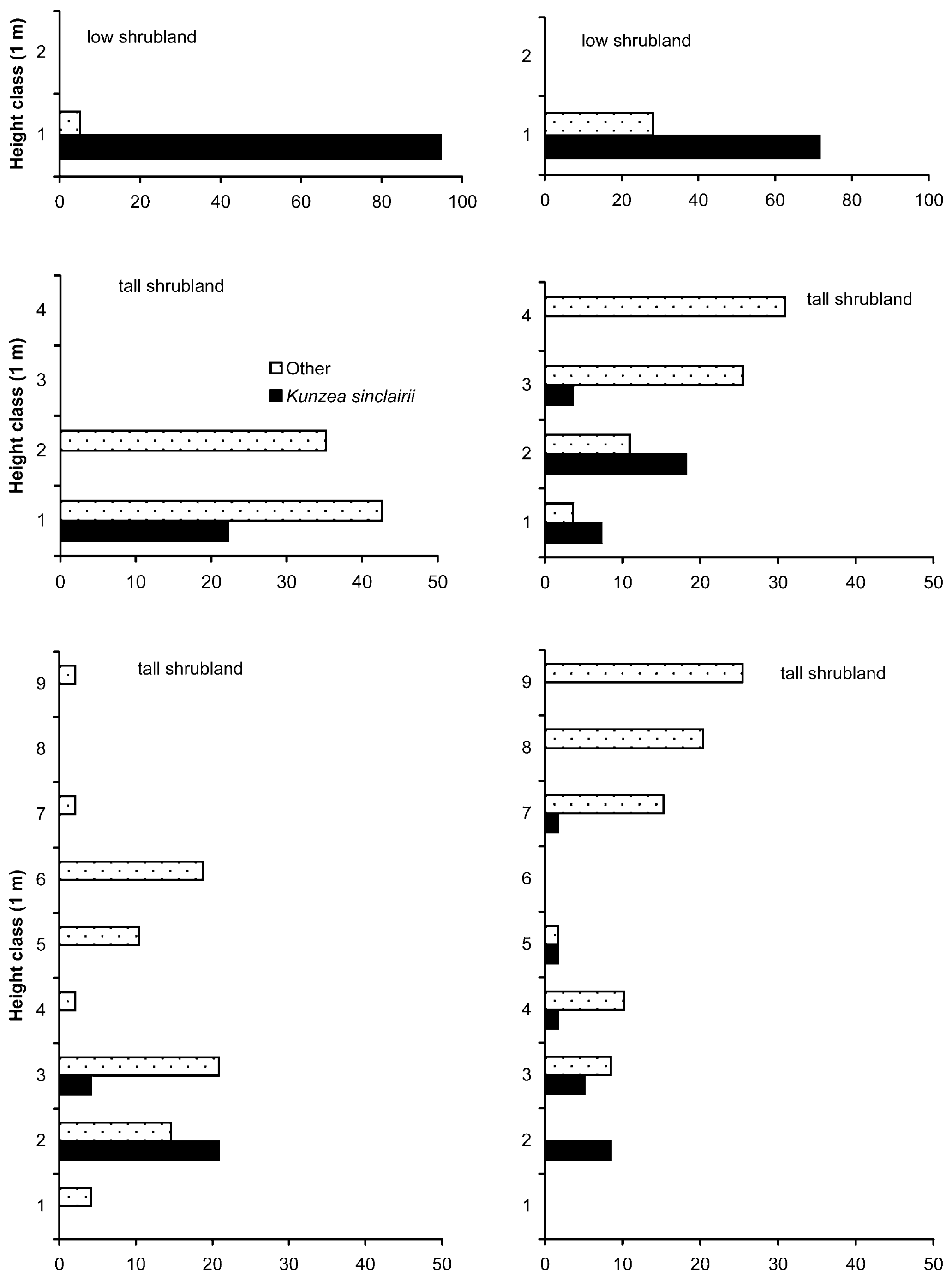

Fig. 4. Height class distributions for *Kunzea sinclairii* and other woody species for six *K. sinclairii* populations. Community types are indicated.

speciation as plants respond to the unique conditions present (Snogerup, 1971; Wyatt, 1997; Hopper, 2000). Certainly the presence of the local rock outcrop endemics, *Kunzea sinclairii* and *Olearia allomii*, suggests that this has been the case on the Great Barrier Island rhyolitic outcrops. In New Zealand, two thirds of plant species that have narrow geographical ranges are restricted to steep rocky sites (Wardle, 1991), highlighting the role that these sites play in speciation.

Earlier assessments of the conservation status of *Kunzea sinclairii* resulted in 'endangered' (Cameron et al., 1995) or 'vulnerable' (Given, 1990) rankings reflecting the apparent failure of *K. sinclairii* populations to regenerate. However, our data show that this is only the case for populations in tall shrubland, although even here regeneration occurs on the bare surfaces of recent slips. In contrast, regeneration of *K. sinclairii* is abundant in the low shrubland communities on the rhyolitic outcrops suggesting that the long-term future of this species is secure in these sites.

As *Kunzea sinclairii* is primarily a rock outcrop species it would seem reasonable to hypothesise that it expanded from these sites into the open habitats created by logging and especially fire. However, because *K. sinclairii* is a slow growing species with a typically decumbent growth habit, it is now being overtopped by taller and faster growing regenerating forest species including *Leptospermum scoparium*, *Kunzea ericoides* and *Weinmannia silvicola* (cf. Harris et al., 1992). There is no regeneration of *K. sinclairii* in the regenerating forest

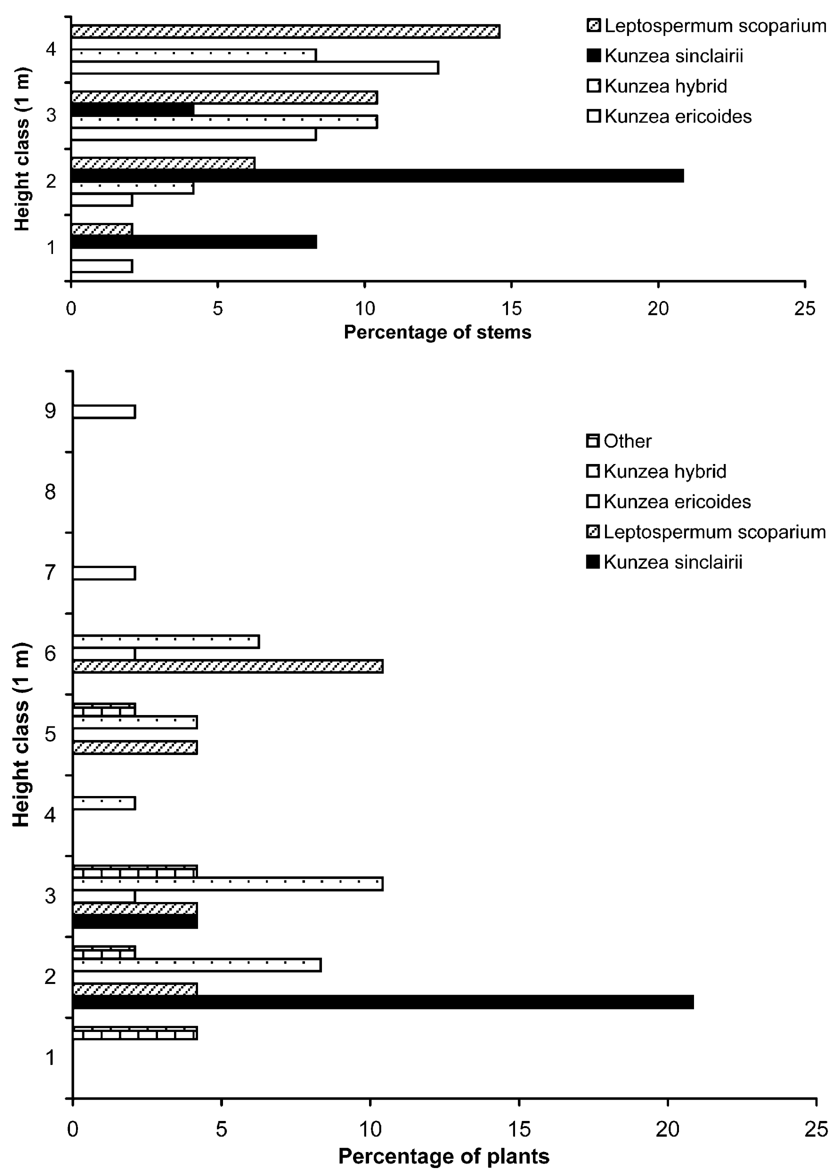

Fig. 5. Height class distributions for *Kunzea sinclairii*, *K. ericoides*, *K. ericoides*×*sinclairii*, *Leptospermum scoparium* and other woody species from two plots.

community because forest floor conditions, especially low light levels, are unsuitable. In fact the absence of *K. sinclairii* in the more structurally complex regenerating forest community in our study suggests that this is a more advanced stage of forest regeneration from which *K. sinclairii* has already been lost. The lack of *K. sinclairii* regeneration in the tall shrubland community does not mean that the species is threatened with extinction, it simply highlights the fact that these habitats are at the edge of the range of this species.

A further factor that contributed to earlier assessments of *Kunzea sinclairii* as a threatened species was the observation that it was hybridizing with the related *K. ericoides* (Harris et al., 1992; Dopson et al., 1999). Hybrids are generally confined to the tall shrubland communities adjacent to rock outcrops. A consequence of deforestation has been expansion of the range of *K. ericoides* (Ogden, 2001), which is normally a species of forest margins and gaps especially at lower altitudes. Deforestation has brought the two *Kunzea* species into close contact and resulted in some hybridisation. However, no hybrids were found on the rhyolitic outcrops that are the preferred habitat for *K. sinclairii* and it seems unlikely that hybridisation represents a long-term threat to this species.

The information presented here shows that *Kunzea sinclairii* is naturally uncommon being largely confined to rocky rhyolitic outcrops that are a conspicuous, but local, feature of central Great Barrier Island. Using the New Zealand Threatened Species Classification System (Molloy et al., 2002), *K. sinclairii* should be classified as 'range restricted'. If *K. sinclairii* was classified using the IUCN red list system it would most probably be ranked as 'vulnerable' on the grounds that the "Population [is] very small or restricted in the form of ... very restricted area of occupancy (typically less than 20 km^2)" (IUCN, 2001). This difference in classification highlights the problem of how best to deal with naturally uncommon species in threatened species classifications (de Lange and Norton, 1998), and is one of the reasons why New Zealand, which has a large number of naturally uncommon species, has chosen to develop its own threatened species classification system distinct from that used by the IUCN (Molloy et al., 2002).

This case study highlights the importance of having a good understanding of the ecology of uncommon plant species as a basis for making decisions regarding their conservation. Many species are uncommon simply because their habitat is restricted, but this condition does not necessarily equate with increased extinction risk (Rabinowitz et al., 1986; Gaston, 1994; de Lange and Norton, 1998). Nonetheless, naturally uncommon species are potentially more susceptible to extinction because they are less abundant (Mace and Kershaw, 1997). Given that all land surrounding the outcrop habitat of *Kunzea sinclairii* is part of the public conservation estate, and that the unstable, highly weathered nature of the rhyolite rock where it grows is unsuitable for rock climbing or other use (cf. McMillan and Larson, 2002), it seems unlikely that this species will become susceptible to human-induced extinction in the foreseeable future.

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