

3.1 KALBARRI

Jakes Point, Red Bluff and Goat Gulch (Kalbarri National Park)

Regional setting of Kalbarri transects

Kalbarri has a climate classified as semi-arid (Gentilli 1972). It is situated in the Irwin Botanical District (Beard, 1980) *i.e.* the Geraldton Sandplains Biogeographical Region (IBRA, 2000). Mean annual rainfall is 369 mm (Australian Bureau of Meteorology, 2005) with the potential annual evaporation in excess of 1800mm (Hocking *et al.*, 1982). Winter rain is generally reliable with a growing season of about 4 months (Beard, 1976).

The coastal area at Kalbarri is part of the Perth-Carnarvon sedimentary basin bounded to the east by the Darling Fault and the Yilgarn Block (Hocking *et al.*, 1982). Apart from the dissected Proterozoic-aged horst in the Ajana area (part of the Northampton Block) and the Murchison River valley, most of the Kalbarri area south of the Murchison River is part of the Victoria Plateau. The latter landform is thought to have formed in the vicinity of the late Miocene era and comprises a gently-undulating, quartzose sandplain overlying the much older Tumblagooda Sandstone.

Landforms and sediments of the Kalbarri transects

The Kalbarri coastal area south of the mouth of the Murchison River mouth was included in this survey (Fig 8). This area is a plateau of Tumblagooda Sandstone truncated at the Indian Ocean by tall cliffs. The cliffs are composed of either exposed sandstone (such as the cliffs at Red Bluff) or sandstone capped with Tamala Limestone (such as the cliffs at Goat Gulch). From Jake's Point to Red Bluff there are also coastal dunes perched over the sandstone. The coastal dunes included a low foredune fronting the ocean and inland an irregular series of roughly shore-parallel low dunes. The rocky shore of Tumblagooda Sandstone of this area contains small exposures of relatively recently formed calcareous rocks known as the Chinaman's Rock formation. Between Jakes Point and Red Bluff there is a watercourse (Wittecarra Gully) draining the hinterland through the coastal dunes by intermittent breach of a sand bar at its mouth.

Surface sediments of the Kalbarri transects ranged from red –brown siliceous sands (with large fractions of quartz) to pink and cream-coloured quartz sand with a significant proportion of carbonate grains (being the skeletal remains of marine organisms) (Table 7).

The sands of the dunes between Jakes Point and Red Bluff were generally higher in calcareous content than the other sands encountered at Kalbarri in this study. They were light-coloured (cream to light brown), very low in organic matter and medium-to-fine in texture. The plateau at the top of the Red Bluff transect was overlaid by fine, light red-brown coloured siliceous sand (very low in carbonate materials), whilst the finer sediments collecting in rocky cliff crevices were dark red-brown siliceous muddy sands. The coarser siliceous sands forming low mounds at the base of the Red Bluff transect were relatively high in carbonate content and were cream-coloured to pink. The limestone pavement capping the plateau above Goat Gulch was overlaid by shallow, fine light-grey siliceous sand along with some calcareous gravel. Along the slope in the gulch there was a poorly-defined seasonal watercourse amongst limestone boulders with pockets of deeper, slightly humic grey siliceous sand. The steeper rocky slopes of the gulch were generally characterized by shallow, medium, light-grey, siliceous sand with gravel to boulder-sized limestone. Near the base of the transect, the Tumblagooda Sandstone was exposed down to sea level. In the jagged ledges of the sandstone above the splash zone there was shallow fine, red-brown siliceous (mainly quartz) muddy sand along with some calcareous gravel-sized particles.

Table 7: Kalbarri transect surface sediments.

Soil sample site : Transect and landform	Dominant vegetation	Sediment description
Jakes Point foredune	<i>Spinifex longifolius</i> grassland with sparse shrubs	Medium to coarse, cream-coloured siliceous (mainly quartz) and carbonate sand.
Jakes Point to Red Bluff swale in leese of primary dune.	<i>Thryptomene baeckeacea</i> heath	Medium, light brown siliceous (mainly quartz) and carbonate sand.
Jakes point secondary dune crest	<i>Melaleuca cardiophylla-Thryptomene</i> spp. heath	Fine, cream-coloured, mainly carbonate sand.
Red Bluff shallow sand sheet over sandstone at base of transect.	Herbland inc. <i>Gunnipopsis septifraga</i> , <i>Pogonolepis stricta</i> , * <i>Cotula coronopifolia</i>	Coarse, cream-coloured to pink, siliceous (mainly quartz) and carbonate, muddy sand.
Red Bluff : small dune below cliff (close to start of RB transect).	<i>Thryptomene</i> sp. Kalbarri AG Gunness heath	Coarse cream-coloured to pink siliceous (mainly quartz) and carbonate sand.
Red Bluff crevices and ledges of cliff	Herbland inc. <i>Goodenia berardiana</i> , <i>Calandrinia remota</i> , Poaceae spp.	Medium to fine, red-brown, siliceous (mainly quartz) muddy sand (with very little carbonate).
Red Bluff plateau at end of transect	<i>Melaleuca longistaminea</i> – <i>Acacia andrewsii</i> open heath with grasses <i>Triodia bromioides</i> , <i>Austrostipa</i> spp., and herbs.	Fine, light red-brown coloured, siliceous (mainly quartz) sand (with very little carbonate).
Goat Gulch base of transect. Shallow soil in crevices of sandstone just above splash zone.	<i>Sarcocornia quinqueflora</i> <i>Wilsonia backhousei</i> and <i>Samolus repens</i> herbland.	Fine, red-brown siliceous (mainly quartz) muddy sand with some carbonate gravel-sized particles.
Goat Gulch mid slope. Shallow sand amongst limestone boulders.	<i>Frankenia pauciflora</i> – <i>Atriplex paludosa</i> - <i>Sclerolaena uniflora</i> low heath with herbs.	Medium to fine, cream – light grey coloured, siliceous (mainly quartz) and carbonate sand.
Goat Gulch mid slope. Deeper sand in a seasonal watercourse.	<i>Melaleuca lanceolata</i> open scrub over <i>Parietaria debilis</i> & <i>Zygophyllum fruticulosum</i>	Medium to fine, grey, humic, siliceous (mainly quartz) sand (with very little carbonate).
Goat Gulch : plateau with limestone pavement and shallow soils	Species- rich very low heath inc. <i>Melaleuca campanae</i> , <i>Grevillea argyrophylla</i> , <i>Beyeria cygnorum</i> with <i>Desmocladius asper</i> .	Fine, grey coloured, siliceous (mainly quartz) sand with some carbonate gravel sized particles.



Figure 8: Coastal vegetation Red Bluff to Jake's Point, Kalbarri

The floristics and vegetation of the Kalbarri transects

1. Jakes Point to Red Bluff

A total of 33 indigenous and 5 alien flora taxa were collected from the short transect through the foredune at Jakes Point and opportunistically from the dunes between Jakes Point and Red Bluff. (Appendix 2).

The low foredune of the Jakes Point transect (Figs 9 & 10) was sparsely vegetated with the rhizomatous grass *Spinifex longifolius* and the low open shrubs *Angianthus cunninghamii* and *Olearia axillaris* (Coastal Daisy Bush) generally less than 1m in height with the perennial herb *Lotus australis*. Also common on foredunes of this area were *Carpobrotus modestus* (Inland Pigface), *Euphorbia sharkoensis*, *Ptilotus villosiflorus*, *Rhagodia preissi* subsp. *obovata*, *Threlkeldia diffusa*, *Senecio pinnatifolius*, **Salsola tragus*, and *Scaevola crassifolia* (Thick-leafed Fanflower). Common alien taxa (particularly around the carpark at Jakes Point). included **Bromus diandrus*, **Centaurium melitensis* (Maltese Cockspur), **Ehrharta brevifolia* subsp. *cuspidata*, **Mesembryanthemum crystallinum* (Ice Plant), **Sonchus oleraceus* (Sow Thistle) and **Reichardia tingitana*. The swale on the leeside of the foredune hosted a heath to scrub assemblage including *Acacia rostellifera* (Summer Scented Wattle), *Austrostipa elegantissima*, *Pimelea microcephala*, *Santalum acuminatum* (Quandong), *Stylobasium spathulatum* (Pebble Bush) and *Zygophyllum fruticulosum*.

The secondary dune was inhabited by a more species-rich open heath less than 0.5m in height often dominated by *Thryptomene* sp. Red Bluff and *Beyeria cygnorum* and associated with *Acanthocarpus preissii*, *Acacia rostellifera* (Summer Scented Wattle), *Austrostipa elegantissima*, *Brachyscome iberidifolia*, **Bromus diandrus*, *Calandrinia remota*, *Carpobrotus modestus*, **Ehrharta brevifolia* subsp. *cuspidata*, *Lomandra maritima*, *Melaleuca cardiophylla*, *Olearia axillaris*, *Pimelea microcephala*, *Rhagodia preissi* subsp. *obovata*, *Santalum acuminatum* (Quandong), *Scaevola crassifolia*, *Senecio pinnatifolius* (Coastal Groundsel), *Sporobolus virginicus*, *Stylobasium spathulatum*, *Threlkeldia diffusa* and *Zygophyllum fruticulosum*.

The dunes inland from the above were dominated by a heath less than about 0.5m in height of *Melaleuca cardiophylla* with *Beyeria cygnorum*, *Eremophila glabra* subsp. *tomentosa*, *Thryptomene baeckeacea* and *Desmocladius asper*. Associated with this were *Acacia idiomorpha*, *Alyxia buxifolia*, *Austrodanthonia caespitosa*, *Austrostipa crinita*, *Austrostipa macalpinei*, *Calothamnus kalbarriensis*, *Diplolaena mollis*, *Diplopeltis intermedia* subsp. *intermedia*, *Euphorbia tannensis* subsp. *eremophila*, *Halgania littoralis*,

Melaleuca longistaminea, *Phyllanthus calycinus*, *Phyllanthus scaber*, *Pimelea microcephala*, *Ptilotus gaudichaudii*, *Stackhousia dielsii*, *Triodia bromioides* and *Waitzia podolepis* *Scaevola crassifolia* (Thick-leafed Fanflower) and *Melaleuca cardiophylla* with a sparse understorey of *Desmocladius asper* were prominent on the crests of the dunes within this zone with occasional clumps of prostrate mallee *Eucalyptus oraria* less than 1.2 m in height and 4m or more in diameter. *Melaleuca cardiophylla* closed heath to closed scrub was the dominant vegetation of the dunes adjacent to the highway on the eastern border of the coastal reserve.

The lagoon formed by the waters of Wittecarra Gully (that is usually dammed by a sandbar at its mouth) was fringed in places by a patchy closed heath dominated by *Halosarcia indica* subsp. *bidens* and *Atriplex cinerea* with *Sporobolus virginicus* and *Cyperus gymnocaulis*. Closer to the highway there was a low closed forest of *Casuarina obesa* (Saltwater Sheoak) with *Sarcocornia quinqueflora* and *Frankenia pauciflora* fringing the lagoon..

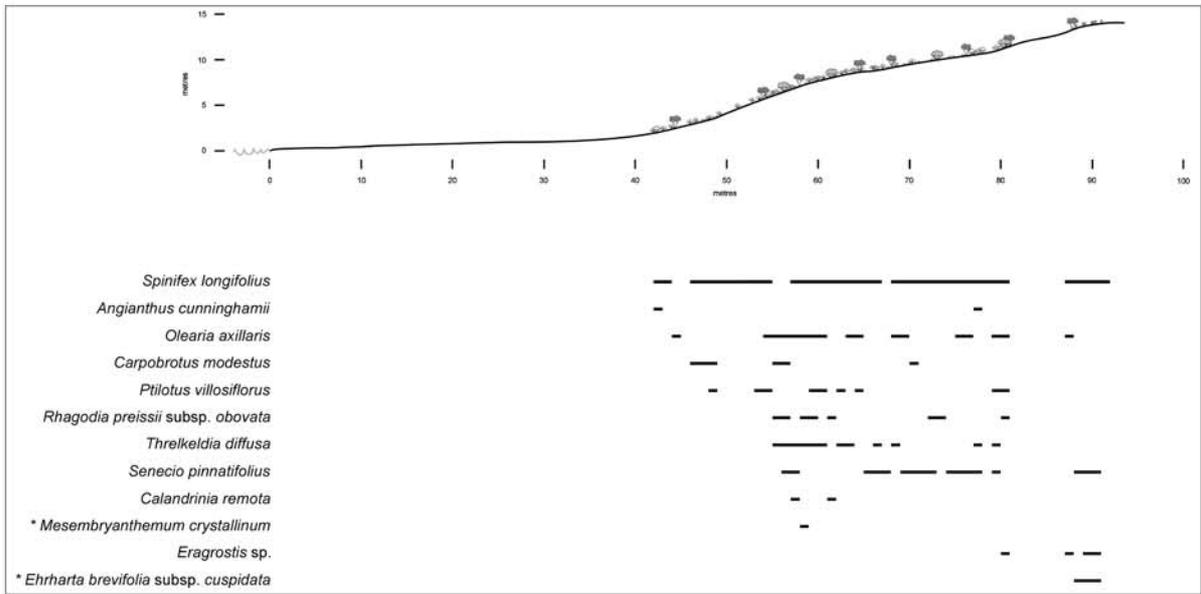


Figure 9: Jake's Point Transect, Kalbarri.



Figure 10: Tumblogooda Sandstone rocky shore with Holocene dunes at Jake's Point, Kalbarri.

2. Red Bluff

The transect at Red Bluff spanned a bare rocky shore of Tumblagooda sandstone, a zone of shallow sand overlying the sandstone, a small sandstone cliff and a moderate slope up to the plateau with a sand sheet over the sandstone (Figs 11,12 &13). The study area was located adjacent to private property and a caravan park. The rocky shore at the base of the transect was used as an informal car park.

A total of 71 indigenous and 10 alien flora taxa were collected from the Red Bluff transect and adjacent vegetation.

The gentle slope overlaid by shallow white sand at the base of the transect was vegetated by an open heath less than 1m in height of *Thryptomene* sp. Red Bluff (A.G. Gunness 2358) over a species-rich assemblage of herbs including *Brachyscome iberidifolia*, *Calandrinia remota*, *Carpobrotus modestus* (Inland Pigface), *Centrolepis eremica*, *Eragrostis dielsii*, *Euphorbia sharkoensis*, *Gunniopsis septifraga*, *Pogonolepis stricta*, *Ptilotus villosiflorus*, *Senecio pinnatifolius* (Coastal Groundsel), *Trachymene ceratocarpa* and *Triglochin mucronata*. Alien taxa include * *Cotula coronopifolia*, **Ehrharta brevifolia* subsp. *cuspidata*, **Polycarpon tetraphyllum* and **Rostraria cristata*.

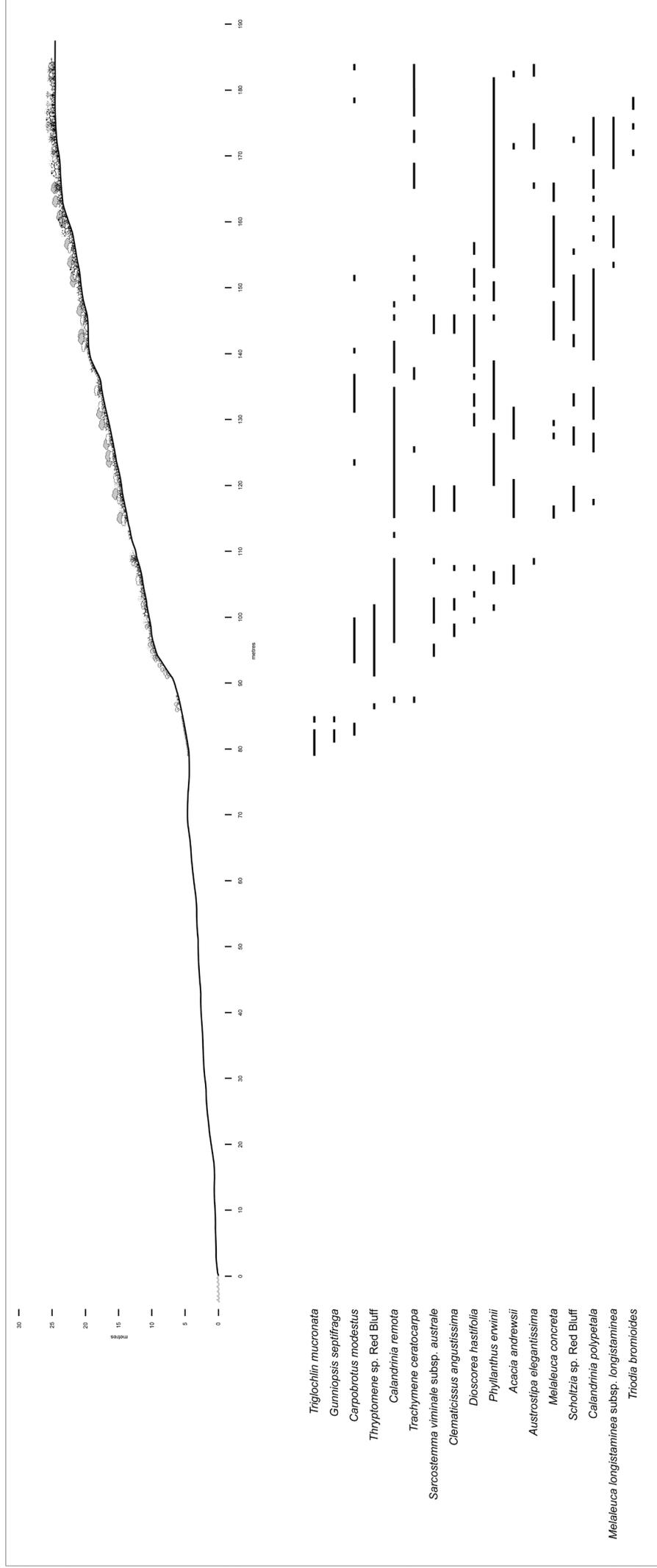


Figure 11: Red Bluff Transect, Kalbarri.

The rocky cliff above the sandy area at the base of the red Bluff transect was largely bare except for annuals and grasses (in shallow soil in crevices) that included *Calandrinia remota*, **Ehrharta brevifolia* subsp. *cuspidata*, *Eragrostis dielsii*, **Euphorbia sharkoensis*, *Goodenia berardiana*, *Nicotiana rotundifolia*, *Phyllanthus erwinii* and **Reichardia tingitana*.

The vegetation of the moderate slope above the cliff differed to that of the sandy zone at the base of the transect. It was a heath less than 1m in height that included *Scholtzia* sp. Red Bluff (A.G. Gunness 2373) and *Melaleuca concreta* with a species-rich seasonal herb and geophyte layer. Common associates in this zone were *Acacia andrewsii*, *Calandrinia polypetala*, *Calandrinia remota*, *Calocephalus francisii*, *Centrolepis cephaliformis* subsp. *murrayi*, *Clematicissimus angustissima* (Native Grapevine), *Conostylis prolifera*, *Dioscorea hastilifolia* (Native Yam), *Grevillea pinaster*, *Phyllanthus erwinii*, *Rhodanthe oppositifolia* subsp. *oppositifolia*, *Sarcostemma viminale* subsp. *australe* (Caustic Bush), *Setaria dielsii*, *Trachymene ceratocarpa* and *Trachymene pilosa*.

As the slope graded into the deeper sands of the plateau the heath assemblage varied to include *Austrostipa elegantissima*, *Conospermum stoechadis* (Smoke Bush), *Ecdeiocolea monostachya*, *Hibbertia potentilliflora*, *Melaleuca campanae*, *Melaleuca cardiophylla*, *Melaleuca longistaminea* subsp. *longistaminea* and *Triodia bromioides*.



Figure 12: Volunteers at Kalbarri, surveying Red Bluff Transect.



Figure 13: Volunteers at Kalbarri, preparing field herbarium for Red Bluff Transect

3. Goats Gulch

The transect at Goats Gulch extended from the Tamala Limestone capped plateau, down the centre of a steep gully that drained the plateau to the exposed Tumblagooda Sandstone near sea level (Figs 14, 15 & 16). The base of the Goats Gulch transect, just above the splash zone where there was shallow moist soil in crevices and ledges, was host to sparse prostrate halophytes including *Sarcocornia quinqueflora*, *Samolus repens*, *Wilsonia backhousei* and *Frankenia pauciflora*.

Further up the slope, in shallow sand with limestone cobbles, there was a more species-rich low open heath, less than 50cm in height that included *Atriplex paludosa* subsp. *moquiniana*, *Enchylaena tomentosa*, *Eremophila glabra* subsp. *tomentosa*, *Frankenia pauciflora*, *Rhagodia latifolia* subsp. *recta*, *Sclerolaena uniflora* and *Threlkeldia diffusa*. These species (with the addition of *Zygophyllum fruticulosum*, *Parietaria debilis* and *Diplolaena grandiflora*) were also present amongst limestone boulders further up the transect. *Melaleuca lanceolata* open scrub inhabited a poorly defined channel and rock crevices with deeper sand about half way up the gulch. The steeper upper slope was a low heath dominated by *Frankenia pauciflora*, *Phyllanthus scaber*, *Sclerolaena uniflora* and the annuals *Calandrinia* aff. *remota*, **Centaurea melitensis*, **Emex australis*, *Lotus australis*, *Nicotiana occidentalis*, *Oxalis perennans*, **Rostraria pumila* and *Senecio pinnatifolius*.

The plateau vegetation was a species-rich, very low, wind-pruned open heath over *Desmocladus asper*. Common shrub species less than 20cm in height on the plateau were *Beyeria cygnorum*, *Bossiaea spinescens*, *Grevillea argyrophylla*, *Hibbertia spicata* subsp. *spicata*, *Melaleuca campanae*, *Melaleuca longistaminea* subsp. *longistaminea*, *Scaevola crassifolia* and *Scholtzia* sp. Red Bluff (A.G. Gunness 2373). In contrast to the low heath along the slope and on the plateau, some of the same species (*Grevillea argyrophylla*, *Melaleuca cardiophylla* and *Acacia rostellifera*) formed a closed scrub of about 3m in height in the more sheltered channel of Goat Gulch on the plateau.

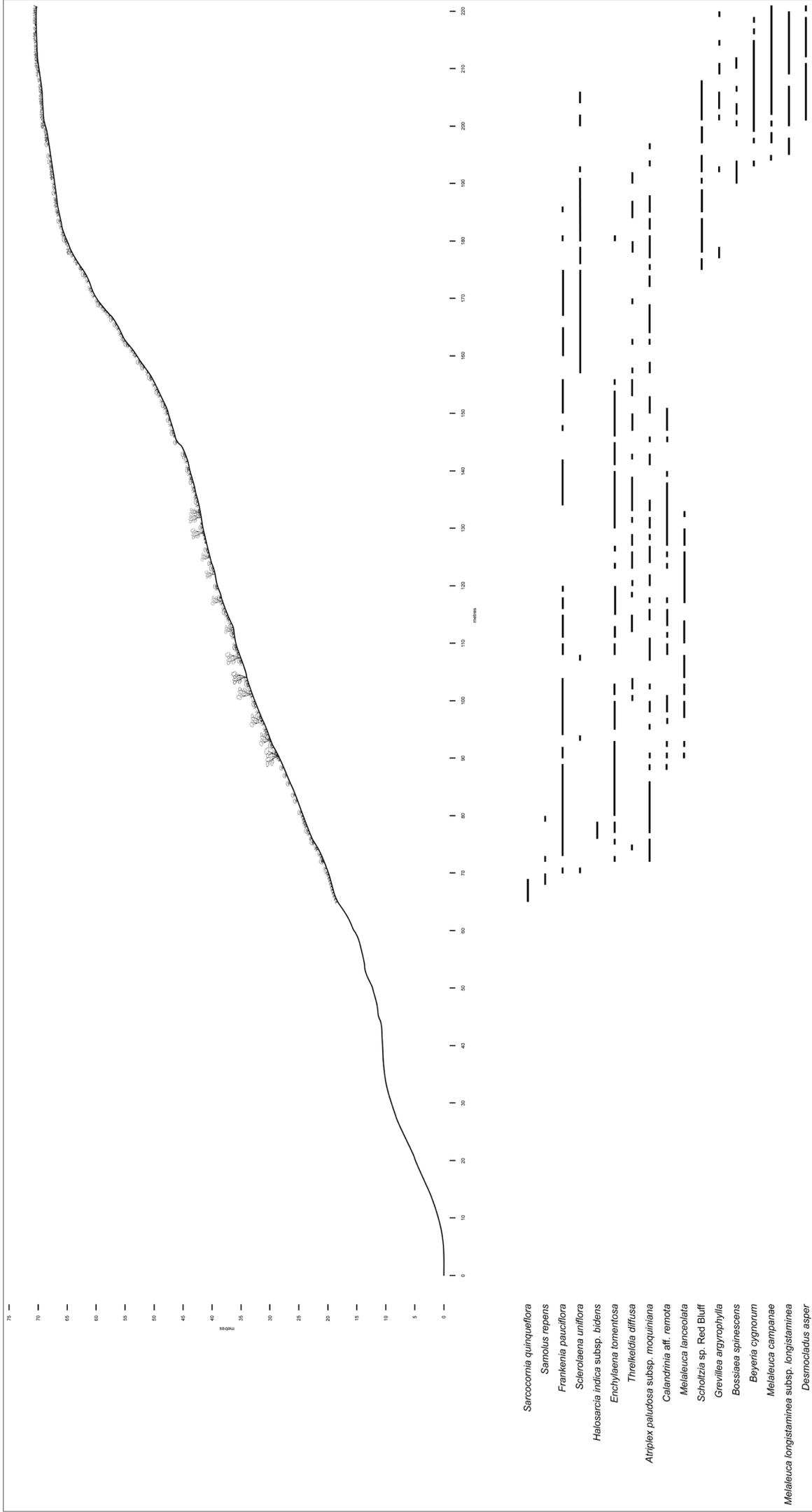


Figure 14: Goat Gulch Transect, Kalbarri



Figure 15: Volunteers at the base of Goat Gulch Transect, Kalbarri.



Figure 16: Goat Gulch Transect overview.