FLORA OF THE QUINDALUP DUNES BETWEEN SWAN AND IRWIN RIVERS, WESTERN AUSTRALIA

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A. ABSTRACT

Five Sectors of the coast between Perth and Geraldton were recognised from a site based study of regional variation in the flora and vegetation of Holocene deposits. A number deficiencies in the conservation estate and the Register of the National Estate were identified. A list of flora is presented and aspects of the geology, geomorphology and soils of the Central Coast are described.

B. SUMMARY

A study designed to determine the variation in the composition of the vegetation on the coastal Holocene sand deposits between Perth and Geraldton is described. The study was based on 545 sites at which descriptions of the geology, landform, soil and vegetation and a complete list of flora were made.

The floristic composition of these sites varied considerably. Numerical classification showed some quite distinct communities and others which seemed part of a multidimensional continuum. Several factors appeared to be instrumental in the variation in composition. Landforms (incipient foredunes, dunes or plains) were a major factor. So too were proximity to the coast, age (time since colonisation), geology and soil types.

Relatively consistent regional variation in species composition was detected across a range of landforms and vegetation types. Based on this, five Sectors were recognised. The major influence on the Sectors appeared to be the variation in the Pleistocene deposits (Tamala Limestone and Cliff Head deposit) from which some of the Holocene sands were derived and over which some has been deposited.

It was concluded that a similar degree of regional variation in the composition of vegetation could be expected on the coast elsewhere in south-western Australia. The variation in the Pleistocene and older rock and sediment types could be used to predict the variation on the Holocene deposits.

While the vegetation of Holocene deposits are significantly poorer in species than the rich kwongan areas, over 300 native species were recognised in the Central Coast. A large proportion of these were confined to coastal areas. However, only a few species were endemic to the Central Coast, most being widespread in south-western or southern Australia.

There was a significant replacement of species from Sector to Sector as the Central Coast represented the end of the range (north or south) for over 100 of these coastal species. This turn over of species contributed to the regional variation in composition.

A large proportion of the variation in floristic composition occurs in the extensive conservation estate which covers much of the Central Coast. However, the significantly different vegetation in two of the Sectors, Greenough to Irwin River and south of Lancelin, was shown to be poorly represented. Opportunities were identified to ameliorate these deficiencies.

Contributions to the understanding of the geology, geomorphology and soils of the Central Coast were also made. A soft, possibly lagoonal sequence within the Tamala Limestone in the Cliff Head area has not been previously reported. This was referred to here as the Cliff Head deposit. It is speculated that this once extended both north and south along the coast. A model is proposed to describe how the presence of such a unit could have influenced the Holocene deposition in the Central Coast.

The processes involved in the accumulation and redistribution of the Holocene sands in the Central Coast are described.

While leaching was an important soil forming process on these carbonate soils, a model is proposed to explain the generally low carbonate mineral composition of older dunes compared to younger ones.

A number of opportunities for further research on the natural history of this area are outlined.

C. RECOMMENDATIONS

Many recommendations about specific areas are presented here under the five Sectors recognised and discussed in Appendix 18. Recommendations considered a priority for implementation are S5.3, S5.2, S1.1, S1.2, S4.4, S4.3, S4.5 and S4.6.

SPECIFIC LOCATIONS:

Sector V1. Greenough to Irwin River

S1.1 The purpose of Reserve 7276 should be amended to Conservation of Flora, Fauna and Recreation and remain vested in the Greenough Shire. A management plan should be prepared for this area as a matter of urgency.

S1.2 The Department of Conservation and Land Management should negotiate for acquisition of privately owned land south of Cape Burney with suitable diverse landscape which could be vested in the NP&NCA as a Nature Reserve.

S1.3 Reserve 25581 (or most thereof) should be added to Nature Reserve 23600. Any residue from Reserve 25581 should be added to reserve 39959.

Sector V2. Port Denison to Gum Tree Bay

S2.1 The northern part of the Northern Beekeepers Reserve (24496) and perhaps also the reserve for lime sand (23373) should have the purpose of Conservation of Flora and Fauna and be vested in the NP&NCA as a Nature Reserve, perhaps separate from the major part of the Northern Beekeepers Reserve.

S2.2 Consideration of applications to extract lime sand should recognise the high conservation values of the Northern Beekeepers Reserve. Should mining be allowed, the most sensitive approach would be to limit it to those mobile sand sheets close to Dongara.

S2.3 The majority of the Cliff Head deposit in Crown ownership with its *Eucalyptus obtusiflora* etc. should be part of the Nature Reserve recommended above which could be separate from the main part of the Northern Beekeepers Reserve.

S2.4 The coastal strip south of Cliff Head, i.e. that part west of the main road and as far south as Gum Tree Bay, should be separate reserves for Conservation of Flora and Recreation vested in the relevant local municipal authorities. Management plans should be prepared as a matter of urgency which would protect the conservation and scenic qualities of the area, particularly that south of Illawong.

S2.5 Consideration should be given to encouraging any expansion of residential development in the Cliff Head to Gum Tree Bay area on cleared privately owned land.

Sector V3. Gum Tree Bay to north of Jurien

S3.1 The majority of the Holocene plain between Coolimba and North Head, especially the lagoonal deposits, should be included in a Reserve for the Conservation of Flora and Fauna and vested in the NP&NCA as a Nature Reserve. This probably should be separate from the main part of the Northern Beekeepers Reserve but boundaries would need to be considered in association with any expanded Lesueur National Park.

S3.2 The portion of coastal reserve 42477 between Coolimba and Leeman should remain a recreation reserve vested in the Carnamah Shire. Except for that covered by Recommendation S2.4, the remainder should revert the Northern Beekeepers Reserve.

S3.3 The coastal reserve between Leeman and Green Head (22521) should remain vested in the Coorow Shire Council.

S3.4 The recreation reserve (40544), camping reserve (19759), the southern part of the Northern Beekeepers Reserve and the vacant Crown land between that and the Drovers Cave National Park should be added to the Lesueur National Park.

S3.5 Consideration should be given to the creation of a marine reserve extending from south of Green Head to North Head.

S3.6 The acquisition for conservation of the privately owned land at North Head, known as Pumpkin Hollow (cg 8836), would be a useful addition to the conservation estate but not as high a priority as acquisition of land in Sectors V1 or V5.

Sector V4. North of Jurien to Lancelin

S4.1 The existing Conservation Estate in this Sector should be retained but rationalised to acknowledge the recreational values and current usage of the coastal parts of the Nature Reserves.

S4.2 The northern part of the Jurien beach ridge plain should be protected in a reserve which would allow for the study of the Holocene depositional history. This might be added to the Drovers Cave National Park or an extended Lesueur National Park as recommended above.

S4.3 Most of reserve 19206 at Black Point should be added to reserve 36053. By way of compensation, part of 36053 should be excised so as to cater for the eastward expansion of Cervantes.

S4.4 The purpose of Lake Thetis (35819) should altered to Recreation and Conservation of Stromatolites and remain vested in the Dandaragan Shire. Its Class should be increased to A and a management plan prepared which would ensure the protection of the stromatolites.

S4.5 The town site of Grey should be cancelled and incorporated into the Nambung National Park on the proviso that a suitable camping area be provided within the National Park in the vicinity.

S4.6 Aquisition of sufficient private land should be made to ensure the protection of the Hill River mouth and its immediate surrounds.

S4.7 Consideration should be given to the aquisition of the enclave of private land (CG 2490) in the Nambung National Park for the conservation of the important Tuart woodlands and the Nambung River.

S4.8 Consideration should be given to aquiring a portion of Leased land 347 18175 east of the Nambung National Park where the Holocene dunes have over ridden the Bassendean system.

Sector V5. South of Lancelin

S5.1 The conservation values of reserves 31258, 28303 and 24408 should be investigated with a view to incorporating all or part in the conservation estate.

S5.2 The coastal portion of leased Crown land south of Seabird (lease 392 428) should be excised and declared a reserve for the Conservation of Flora and Fauna and vested in the NP&NCA as a Nature Reserve.

S5.3 The Crown owned locations 9755, 9756 and 9757 (Wilbinga) currently leased, should be added to the Caraban Management Priority Area which together should be declared a Conservation Park vested in the NP&NCA.

S5.4 The Public Recreation reserve at Mindarie (35890) should be enlarged to the east and south by the aquisition of privately owned land and be declared a reserve for the Conservation of Flora and Recreation and vested the Wanneroo City Council.

S5.5 Recreation reserve (16921) and the part of location 1911 (south of Bold Park) should be added to Bold Park and managed for the Conservation of Flora and Fauna.

GENERAL RECOMMENDATIONS:

G1. Planning processes should recognise the regional variation in the composition of vegetation growing on coastal Holocene sandy deposits and where opportunity arises secure representative areas throughout the south west of Western Australia for inclusion in the conservation estate.

G2. A study to identify deficiencies in the conservation estate on the coastline between Shark Bay and Israelite Bay should be initiated.

G3. Several areas should be added to the Register of the National Estate as a matter of priority. These are those covered by the above Recommendations S5.3, S5.2, S4.4, S4.3, and S1.2.

D. INTRODUCTION

The coast is amongst the most intensively used and disputed parts of Australia. Urban and recreational developments have been the major activities heightening conflicts. Prior to the 1970s developments took little recognition of the fragility of these areas. Since then most communities have recognised this and accommodated buffers in subdivision design. However, the buffers are there to maintain foredunes and protect the property to leeward from drifting sand. They are not a conservation tool and consequently do not represent the full assemblage of dune landforms at any place. More deliberate conservation measures are required to achieve the latter.

Assessments of potential development impacts have included descriptions of the natural biota. Unfortunately in Western Australia little regional information is available by which to assess the impact of development proposals. Studies such as those by Semeniuk *et al.* (1989) have begun to provide some regional background.

It is clear that there is an underlying perception that while this zone is fragile, it is relatively uniform and of limited biological significance.

The present study was initiated to provide some of the much needed regional background as well as a pilot study on which to base a broad scale study.

This paper examines the flora of the Quindalup Dunes between the Swan and Irwin Rivers in the Central Coast of Western Australia. Although the term Quindalup has been used to describe the Holocene dunes on this part of the coast, the term is not strictly appropriate. Quindalup Dunes is a soil unit described by McArthur and Bettany (1974) from a beach ridge sequence south of Busselton, a situation far from typical of the coastal Holocene dunes in south western Australia. Recent studies have begun to recognise this and have applied new names (e.g. Tille and Lantske 1990). In this report the broader term Holocene deposits will be used.

Study Area

The coast between Perth and Dongara was chosen for this Study for a number of reasons:

- it was substantially undisturbed
- much of this coast was already familiar to the author,
- it complemented other studies completed or planned in that region
- there were significant planning issues to be resolved.

It was a co-incidence that the Central Coast Planning Study was running concurrently. Contributions have been made to that study.

The coastal Holocene sandy deposits were chosen because of their relatively discrete and definable extent. They represent most of what is commonly considered as the coastal zone. Certain aspects of the juxtaposed and underlying Pleistocene deposits were also investigated to assist in interpretation.

Landforms

The study area (the Central Coast, Figure 1) was the western margin of the Swan Coastal Plain (McArthur and Bettenay 1974). These authors recognised three coast parallel dune systems (Bassendean, Spearwood and Quindalup) which made up the bulk of this plain.

The Quindalup Dunes is a narrow strip of mostly only a few kilometres wide. It is a complex of dunes and plains (see Gozzard 1985, and Gozzard and Hesp 1983). The dunes are perches on two distinct plains; an inland elevated one which equates to the undulating Spearwood Dune System and a coastal low flat one of younger Holocene deposits. The latter can be recognised from the "Deflation basins", "Relict foredune plains", "Lagoons" units of Gozzard (1985) and Gozzard and Hesp (1983). It is mainly 1 to 2 km wide and extends more or less continuously from Lancelin to Coolimba and then north of Cliff Head to Dongara.

The coastline is diverse (Tinley 1992) reflecting different lithologies and wave energies and sediment supplies.

Searle and Semeniuk (1985) and Semeniuk *et al.* (1989) provided a regional description of the landforms of the Quindalup Dunes. They recognised five sectors of the coast between Dongara and Busselton on the basis of associations of geomorphic units. They also provide terminologies for geomorphic units, however, these are not used in this report.

Gozzard (1985) and Gozzard and Hesp (1983) mapped much of the Central Coast from a land-use capability view point. McArthur and Bartle (1980) and Thomas *et al.* (1990) also mapped landforms of the Central Coast south of Wedge Island.

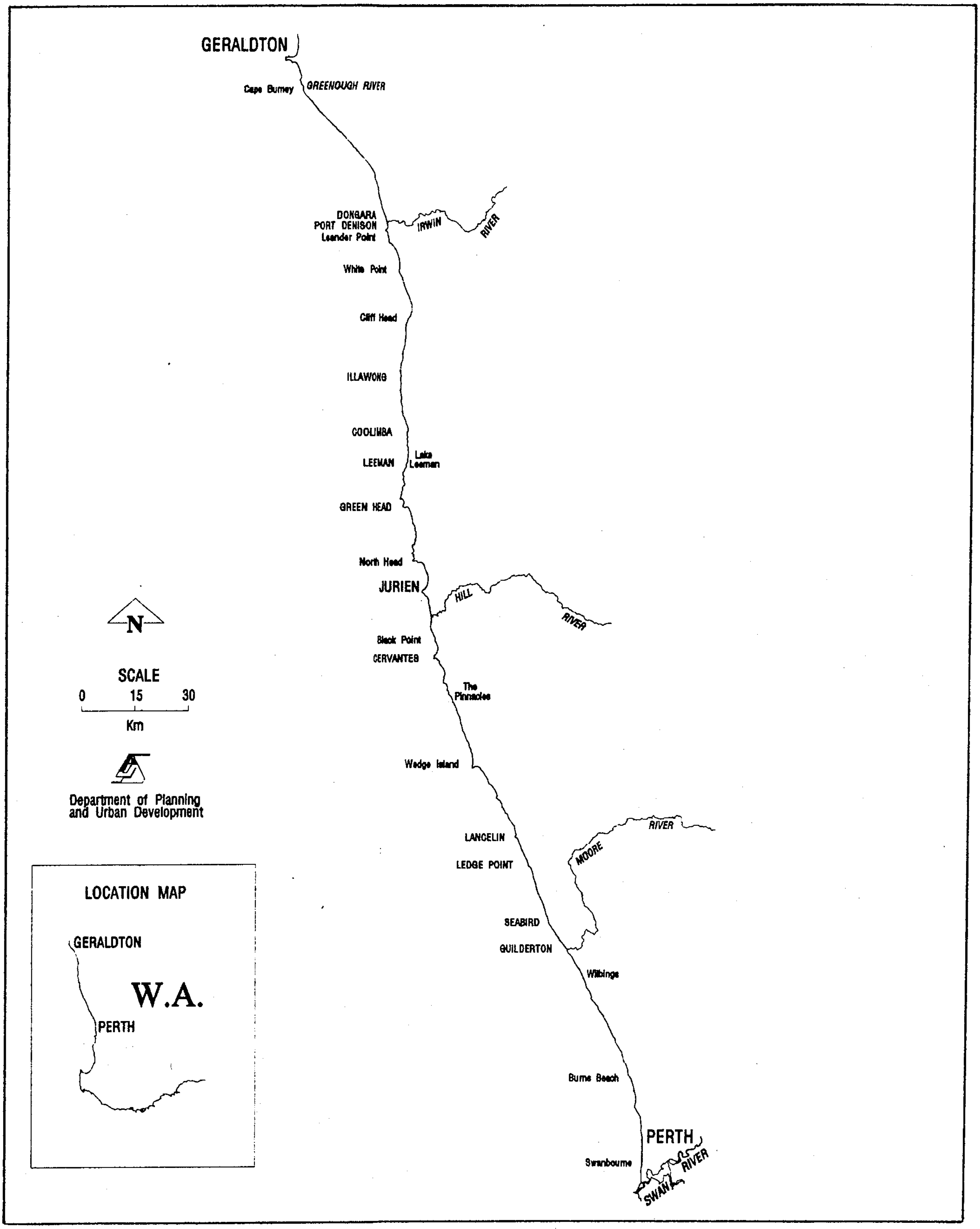


Figure 1 Central Coast

(All Locations mentioned in text)

Geology

The geology of the Central Coast has been mapped at the scale of 1:250,000 by Lowry (1974) and Wilde and Low (1978). The Dongara and Hill River 1:250,000 map sheets are being remapped at 1:100,000 by the Geological Survey of Western Australia (e.g. Mory and Iasky 1993).

Playford *et al.* (1976) described the Swan Coastal Plain as a Quaternary barrier system perched on Phanerozoic sediments which were truncated by marine inundation in the late Tertiary or early Pleistocene. A number of units have been recognised but the three most significant (Bassendean Sands, Tamala Limestone and Safety Bay Sands) are correlated with the above dune systems respectively. These represent progressively younger deposition events and, at least in part, overlie the older deposits. The Holocene sandy deposits (e.g. Safety Bay Sands) are the most relevant to this study. It is appropriate, however, that a brief description of the Pleistocene Tamala Limestone also be provided.

The Tamala Limestone is mostly aeolian calcarenite originally composed of calcareous and siliceous medium sands. It is reported to have been deposited in late Pleistocene (Playford *et al.* 1976). Although much of this was during a long period when sea levels were much lower than at present (Playford 1988), there is evidence that there were distinct phases of marine deposits near or above present sea levels (Seddon 1972, Kendrick *et al.* 1991). The coraline Rottnest Limestone apparently intercalated in older parts of the Tamala Limestone (Playford 1983) during a phase of higher sea levels.

The return of sea levels to much closer to that at present by the early Holocene appears to have involved some truncation of the Tamala Limestone. Subsequently there has been the formation of beach, aeolian and lagoonal deposits around the south-west coast of Australia.

There is a difference of opinions about the relative sea levels during deposition of these Holocene sands (see Playford 1988, Searle *et al.* 1985). The balance between eustatic and tectonic influences is still to be resolved.

Material to provide reliable ages has been at a premium in the Holocene. Semeniuk and Searle (1986) reported dates of over 7,800 years BP for the oldest parts of Holocene deposits in the Whitfords cusp. Shells in lagoonal shell beds in the White Point area have been dated at greater than 8,000 years BP (A. Mory pers comm.).

The Herschell Limestone, a subtidal to intertidal middle Holocene lagoonal shell bed, is one such unit. This formed during at least two phases, around 5,000 and 2,500 years ago (Playford 1988). These deposits were correlated with slightly elevated sea levels of about +2.5 m and +1 m. Other lagoonal shell beds known in the Central Coast might be correlated with this unit but this is still to be confirmed.

Ohmori and McArthur (1985) provide a variety of dates from about 5,000 years BP to a few hundred.

The majority of the coastal Holocene sandy deposits (Safety Bay Sands) are medium to fine grained calcareous sand (Lowry 1974). Semeniuk and Searle (1985), however, proposed the subdivision of this into a marine unit which they called the Becher Sands and retained the Safety Bay Sands for the aeolian deposits. This subdivision essentially reflected differences in deposition modes; nearshore and beach deposits, and dune deposits. No attempt was made to use this subdivision in the present study.

Searle and Semeniuk 1988 reported that in the Central Coast the Holocene beach sands were predominantly mollusc shell fragments but also included calcareous algae, forminifera, echinoids and lithoclasts. They noted a regional variation in the composition of these sands. For example silica was common in places, particularly south of Lancelin.

During the Holocene there have also been localised swamp, lagoonal and estuarine deposits. Arakel (1980) documented the sediments of Lake Leeman which were a mixture of calcareous, gypsiferous, saline and clastic deposits. Stromatolites have developed in a number of fresh to hypersaline coastal lakes during the Holocene; e.g. Lake Clifton (Moore *et al.* 1983), Lake Richmond at Rockingham (Kenneally *et al.* 1987), Lake Thetis at Cervantes (Gozzard 1985, Grey *et al.* 1990), and Government House Lake on Rottnest (Playford 1988).

Dune and Soil Development

The soils of the Holocene (Quindalup) Dunes in the Central Coast have only been described in general terms. Most of the information on them is derived from studies to the south. The area is being remapped by the Department of Agriculture (N. Schokneckt, pers comm.) mainly from a land capability point of view.

These soils are described as undifferentiated calcareous sands by Northcote *et al.* (1967). McArthur and Bettenay (1974) briefly described them as part of their treatment of the soils of the Swan Coastal Plain. They recognised variation in the degree of soil development and carbonate composition between coastal and inland Holocene dunes. This they attempted to correlate with the age of the dunes.

This theme was further developed by McArthur and Bartle (1980) who defined four different classes of Holocene dune which they attempted to correlate with age since deposition; Q1 (oldest) to Q4 (youngest). They defined them basically on the morphology of the dunes. The youngest were the tallest, steepest, often asymmetric and relatively crenulate in plan view and the oldest were lower and more symmetric and had more gentle slopes. Thomas *et al.* (1990) used this approach in mapping north of Lancelin.

Variations in the dune orientation have been noted by a number of authors (e.g. McArthur and Bartle 1980 and Semeniuk *et al.* 1989). The orientation has been related to a systematic change in the direction of the sea breeze from westerly south of Bunbury to almost southerly at Geraldton

(Searle and Semeniuk 1985). Ohmori and McArthur (1985) provide an interpretation of variation of dunes in the Lancelin area which they correlated to different phases of dune transgression. They concluded that this might reflect different wind regimes during the Holocene.

Woods (1983b) described the soil development of several beach ridge plains along the west coast. He described the leaching of carbonate minerals and accumulation of organic matter through the profile. His comparison of profiles of various ages up to 5,000 years BP led to conclusions about the soil development processes. Of note is that he reported that soil development was limited to the top 100 to 150 cm.

McArthur and Bartle (1980) provided data on the variation in the composition of the soil profile of their different age classes of dunes. They reported generally higher carbonate composition, higher organic matter composition and lower pH on the surface compared to the sub-surface. These differences were more pronounced in the soils of the older dunes. McArthur and Bettenay (1974) attributed this to longer periods of leaching.

Both McArthur and Bettenay (1974) and McArthur and Bartle (1980) reported the carbonate composition of the sub-soil of coastal (younger) dunes was much higher than the inland (older) dunes. It appears to be left to the reader to infer that this is due to the increased leaching of the older dunes. However, McArthur and Bartle (1980) noted a distinct yellow colour to some of the older dunes which they considered was the incorporation of Spearwood sand into the dune.

Secondary carbonate formation in soil profiles on the Holocene plain at Leeman were described by Arakel (1982). He reported pisoliths and oolith grainstones in the profiles. Although Milnes and Hutton (1983) described similar profiles in southern Australia, these appear not to have been reported by other workers in the Central Coast. Arakel's descriptions may be peculiar to the environment near lagoons.

Vegetation

There have been a number of publications describing the vegetation of parts of these dunes in the Central Coast. These include Speck (1952, 1958), Sauer (1965), Beard (1976a, 1976b, 1979a, 1979b, 1981), Beard and Burns (1976), Seddon (1972), Heddle *et al.* (1980), McMillan and Foulds (1980), Smith (1985), Creswell and Bridgewater (1985), Foulds and Mc Millan (1985), Pelham (1983), Burbidge and Boscacci (1989), Thomas *et al.* (1990) and a number of unpublished reports. A number of areas south of the Central Coast have also been described e.g. McArthur (1957), McArthur and Bartle (1981), Powell and Emberson (1981), Pen and Green (1983) and Trudgen (1984, 1991).

Most of these are brief descriptions of small areas. The studies of Speck and Beard were directed at defining vegetation systems and phytogeographic regions. Smith is a hand book to the flora of the beach and coast areas. Only Sauer attempted to analyse the regional variation in the flora of the coast but this was strictly for the beach areas and covers a much wider geographic range than the present study but with minimal detail. He did, however, recognise a geographic basis for variation in floristic composition.

Virtually all authors recognised that the beaches had distinctly different vegetation from the stabilised dunes. In the Central Coast the beaches have been recognised as having *Spinifex* plus *Cakile maritima* and a few other species. The dunes close to the coast were commonly defined as dominated by *Scaevola crassifolia, Myoporum insulare* and *Olearia axillaris.* Older dunes were said to have either scrub of *Acacia rostellifera* or low heath dominated by *Melaleuca acerosa* and *Acacia lasiocarpa.*

Pelham (1983) described the changes in vegetation during colonisation after the progress of parabolic dunes south of Dongara. She recognised several distinct phases following initial colonisation from sparse vegetation of perennial herbs (e.g. *Calocephalus brownii*) to a shrubland of *Allocasuarina lehmanniana* to a low heath of *Melaleuca acerosa.*

Climate

Virtually all of the Central Coast can be classed as Dry Mediterranean under the scheme of Bagnouls and Gaussen (1957). The rainfall in the Central Coast declines considerably from over 750 mm in the south to less than 500 in the north. Its reliability declines on the same gradient. Similarly the number of rainy months per year also declines from more than 6 to about 4. The temperature regimes follow an inverse pattern but only the summer maximum temperatures vary to any extent.

The maritime influence undoubtedly has a marked moderating effect on the climate of these coastal areas. This has much to do with the anticyclonic atmospheric circulation over the Indian Ocean which skirts the coast (J. Gentilli pers comm.). The sea breeze also contributes. The warm Leeuwin Current would also have a moderating effect on southern areas of the coast.

The surface winds exhibit both diurnal and a seasonal variation. Searle and Semeniuk (1985) provides a series of wind roses for coastal stations. These show the most consistently strong winds occur in the summer afternoons. These winds were principally the sea breeze effect originating from differential heating of the land. Its direction and strength appeared to vary with latitude. In the south it is from the west to south-west and in the north, around Geraldton, it is from the south-west to south. This direction change would appear to be influenced by the anti-cyclonic circulation over the Indian Ocean (J. Gentilli pers comm.). The wind is stronger in the north than the south (Jurien versus Busselton, Semeniuk *et al.* 1989). This difference would appear to be correlated to a greater thermal and pressure gradient across the coast in the north than in the south.

The normal winter wind are generally weaker and originate from a wide range of directions. Its significance to transporting sand is minor as this is the wet season of the year. On the other hand winter storm winds from the north-west to west can cause significant sand movement, even under damp conditions (I. J. Eliot pers comm.).

Land use

The Central Coast is principally Crown land of various types. The separate parcels of land are listed in Table 1. Figure 2

shows that these are unevenly distributed. In particular the portion of the Central Coast south of Lancelin has few

conservation reserves or areas of Crown land. Much of this southern portion is urban or for proposed urban development. Between the metropolitan region and Lancelin most of the land is privately owned. A large proportion of it has been cleared for agriculture.

On the other hand, between Lancelin and Dongara there are only small pockets of privately owned land. One discrete area is at the mouth of the Hill River between Cervantes and Jurien and another is between Illawong and Cliff Head. A number of small settlements, both developed town sites and unsanctioned squatter communities, are scattered along this portion. The squatter communities have proliferated in the last decade.

The majority of the land in this part is Crown reserves for the purposes of Conservation. Most reserves are vested in the National Parks and Nature Conservation Authority. There are a number of smaller unvested Crown reserves and some small areas of vacant Crown land. One area of vCl is leased by the Defence Department for training purposes. A number of areas of Crown land are leased by individuals and some of these are used for grazing.

The Environmental Protection Authority (1976) made recommendations for a working group to investigate the control and management of these lands. For all intent and purposes these recommendations have never been implemented and the fate of this land is still to be decided. It should be understood that following changes to the CALM Act, the Beekeepers reserves have recently been vested in the National Parks and Nature Conservation Authority since they have Conservation of Flora as a purpose.

Between Dongara and Geraldton there is very little Crown land. Although the majority of the land is privately owned, there is a significant proportion undeveloped.

The major land-uses in the Central Coast are Conservation, pastoral and urban. These follow the land ownership types mentioned above. It should be noted that Gozzard (1985) concluded that the majority of the Holocene sands in this area were unsuitable for residential or agricultural development because of erosion potential and instability.

Parts of the Central Coast have been considered as having mineral resource potential (Gozzard 1985, Gozzard and Hesp 1983). There are a number of Exploration and Prospecting Licences and a few Mining Leases through out the area. The majority appear to be for lime sand, limestone and gypsum. There has been some interest in exploration for coal. Exploration for oil and gas has been conducted in a number of places in the Central Coast as well as adjacent areas, both inland and off-shore.

A number of locations are on the Register of the National Estate. These are mainly the larger conservation reserves (Table 1). The Crown land at Hepburn Heights which is currently on the Interim List also contains some Holocene dunes.

Study Objectives

The principal goal of the study was to assess the adequacy of the conservation estate.

The study was designed to document the variation in floristic composition of vegetation growing on Holocene sandy deposits. It was also intended to document the composition across the obvious environmental gradients at specific sites and throughout the Central Coast. The analysis of this variation was to enable assessment to be made of the factors influencing the variation. It was also considered necessary to make contributions to the understanding of the geology of the area and the dynamics of the Central Coast, particularly dune development.

Table 1 Crown Reserves between Swan and Greenough Rivers

(Crown reserves with coastal Holocene deposits. Some minor recreation and foreshore reserves omitted.)

No.	N	Area	Purpose [Vesting] (Name)
			Greenough — Dongara
A7276		351	Parkland [Greenough]
37333		28	Rifle Range [unvested]
8613		33	Park [Greenough]
39959		54	Public Recreation [Irwin]
25581		173	Public Utility [unvested]
23600		52	Flora & Fauna [NP&NCA]
			Dongara — Leeman
36040		194	Landing Ground [Irwin]
23373		124	Lime sand [unvested]
137		377	Common [Irwin]
24496	*	65,123	Protection of Flora [NP&NCA] ("Northern Beekeepers Reserve")
42477		2,736	Parkland & Recreation etc. [Carnamah]
			Leeman — Jurien
22521		3,041	Parkland & Recreation etc. [Coorow]
40544		1,333	Parkland & Recreation [Coorow]
A42032	*	26,987	National Park [NP&NCA] (Lesueur NP)
19759		117	Camping [Dandaragan]
?		?	Stock Route [unvested]
A31302	*	2,681	National Park [NP&NCA] (Drovers Cave NP)
			Jurien — Cervantes
18865		1,846	Excepted from sale [unvested]
19206		789	Public Utility [Dandaragan]
36053		11,098	Apiculture and Conservation of Flora [NP&NCA] ("Southern Beekeepers")
			Cervantes — Lancelin
A24522	*	3,986	National Park [NP&NCA] (Nambung NP)
A28393	*	13,129	National Park [NP&NCA] (Nambung NP)
A29149	*	1,650	National Park [NP&NCA] (Nambung NP)
35819		38	Recreation [Dandaragan] (Lake Thetis)
31675	*	11,127	Conservation of Flora & Fauna [NP&NCA] (Wanagarren NR)
31781	*	5,519	Conservation of Flora & Fauna [NP&NCA] (Nilgen NR)
			Lancelin — Moore River
31258		476	Lime Sand [Gingin]
28303		199	Recreation et al. [Gingin]
24408		160	Public Utility [unvested]
36447		1,497	Electricity Power Station [SEC]
			Moore River — Swan River
35890		155	Public Recreation [Wanneroo]
20561		251	Recreation etc. [Wanneroo]
12992		83	Recreation [Stirling]
32559	*	122	Conservation of Dunes etc. [Stirling] (Trigg Open Space)
16921		54	Recreation [Perth]

Some reserves extend beyond the geographic range indicated, particularly 24496.

All reserves are Class C unless otherwise indicated.

Reserves with '*' are on the Register of the National Estate.

The Area should be taken as indicative. They are mostly that calculated by DPUD for the Central Coast Study. These were derived from polygons digitised from DOLA maps. There are minor discrepancies between these and that registered by DOLA. The greatest difference is for 24496 which has had significant boundary modification with the creation of the Lesueur National Park and reserve 42477.

[Vesting] — Local Government Authority, National Parks and Nature Conservation Authority, State Energy Commission

(NP) — National Park, (NR) — Nature Reserve

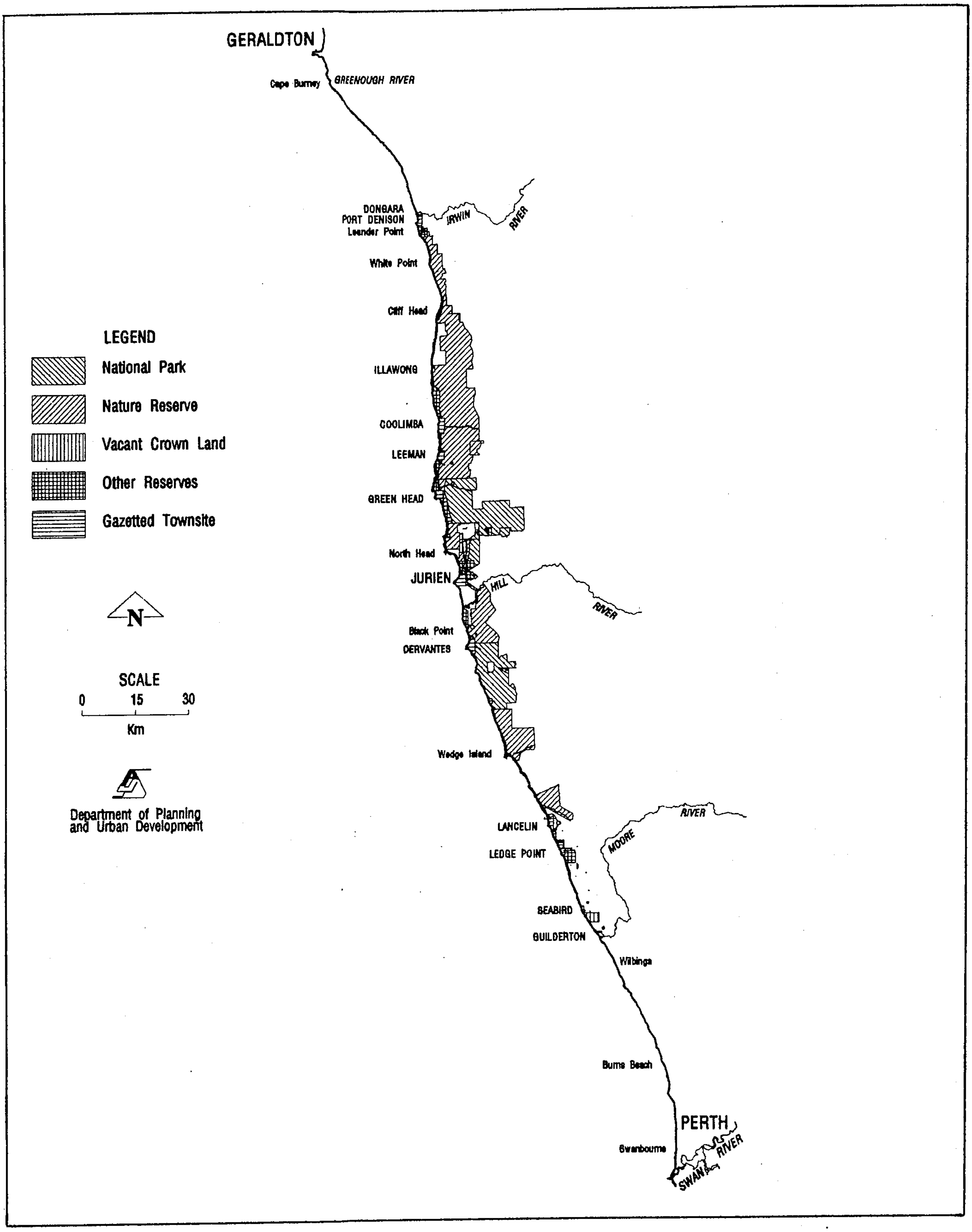


Figure 2 Central Coast Conservation Reserves

(Several small areas have been omitted.)

E. PHYSICAL ENVIRONMENT

While there is not a systematic attempt to describe the geology, geomorphology and soils of the Central Coast, a number of observations were made about these subjects during this study. These were principally to allow the sites sampled to be placed into a framework from which the variation in the vegetation and flora could be described.

It became clear during the field work and subsequent analysis that some of the observations did not fit the existing descriptions. It was decided to present the observations made and more importantly provide a discussion of a number of the issues of significance to this study.

Methods

Field Observations

Many of the accessible tracks in the Central Coast were traversed during the study. Casual notes were made about variations in geology and landform. The interpretation of aerial photographs (1990, colour, 1:20,000) was a prerequisite to allocating sampling sites. At 545 sites detailed descriptions were made of vegetation and flora plus general observations on geology, landform and soil (Field Sheet, Appendix 1).

Of major interest was the occurrences of the outcrops of particular geological formations, Tamala limestone, and various Holocene sandy deposits. The landforms and soils were described in the field and the sites placed into a classification scheme developed afterwards (Table 2). The slope and aspect were recorded for each site.

It was found difficult to confidently apply the dune age classification of McArthur and Bartle (1980). An alternate age scale was used (Table 3) to allow a rough discrimination between the youngest and oldest sites. The five levels are not meant to represent distinct phases of deposition as does that of McArthur and Bartle (1980).

Table 2 Landform / Soil units recognised in field (An elaboration of these units is provided in Appendix 4)

WB	Incipient foredune
WQ	Incipient foredune, quiet beach
WF	Foredunes, low
WF2 - WF5	Beach ridges (1st to 4th landward of foredune)
WS1 - WS5	Swales between Beach ridges
DBS	Dune - truncated tall foredune, seaward slope
DBC	Dune - truncated tall foredune, crest
DC	Dune - crest
DSL	Dune - slope leeward
DSW	Dune - slope windward
DT	Dune - toe
BL	Plain, Holocene - calcrete @ 0 - 15 cm
BLS	Plain, Holocene - calcrete @ 15 - 30+ cm
BS	Plain, Holocene - calcrete @ 30 - 100+ cm
BBL	Plain, Holocene - calcrete @ 0 - 15cm over beach deposits
BBS	Plain, Holocene - calcrete @ 15 - 100+ cm over beach deposits
BSW	Plain, Holocene - mix. of aeolian sands and lagoonal loam
BD	Plain, Holocene - sands, winter wet depression
TL	Plain, Tamala - limestone at surface no Holocene sand
TLH	Plain, Tamala - limestone at surface, thin Hol. sand
TLW	Plain, Tamala - limestone at surface, thin Hol. sand, sea cliff
TLS	Plain, Tamala - limestone at surface ,Tamala or Holocene sand 15 - 30 cm
THL	Plain, Tamala - limestone at surface ,mostly Holocene sand 30-50+ cm cover
THS	Plain, Tamala - Holocene 30-50+ cm / Tamala sand
TSH	Plain, Tamala - thin Holocene sand / Tamala sand
TS	Plain, Tamala - all Tamala sand
TIS	Plain, Undulating Cliff Head deposit *
TIH	Plain, Undulating Cliff Head deposit with Holocene sand

Notes: 1. no distinction has been made between beach ridges and relict foredunes

2. beach ridges over which a mobile sand sheet has passed are included under Holocene plains.

3. Cliff Head deposit is a tentative name for a unit with loamy soils and softer limestone than the Tamala Limestone. It is currently considered part of the Tamala Limestone.

At each of the 545 sites soil to a depth of 1 m (or to water table or a lithified or limestone layer if shallower) was described from samples extracted by soil auguring. This depth was likely to be adequate to cover the full extent of soil development for most sites (cf. Woods 1983b). Of principal focus was the Munsell soil value and Munsell soil chroma and a guesstimate of the relative importance of carbonate and silica minerals were recorded.

Munsell soil values were recorded as they have been shown to be correlated to soil organic carbon in similar soils (Figure 3). As much of the silica was derived from the yellow Tamala sand, the Munsell soil chromas were expected to indicate the relative importance of carbonate and silica minerals.

Depth intervals used for description were variable, with boundaries being a change in either the Munsell soil value and Munsell soil chroma, or a textural change. Samples were taken from a proportion of sites for laboratory analysis. Usually upper and lower intervals of the profile were taken from the selected sites. Samples from the swash zone on beaches opposite some foredune sites were also taken.

Signs of paleosols, usually indicated by an abrupt change to yellower or darker soils were noted. The grain size and type were also recorded. Care was taken to note any cemented layers. The proportion of the surface covered by plant litter and its depth were recorded.

Table 3 Qualitative description of deposition ages.

Inferred Age		Vegetation cover	Topography of Dunes
B	(bare)	more or less bare	
V	(very young)	sparsely vegetated	
Y	(young)	well vegetated	steep slope, crenulate
M	(moderate)	vegetated	moderate slope
O	(old)	vegetated	moderate slope, smooth

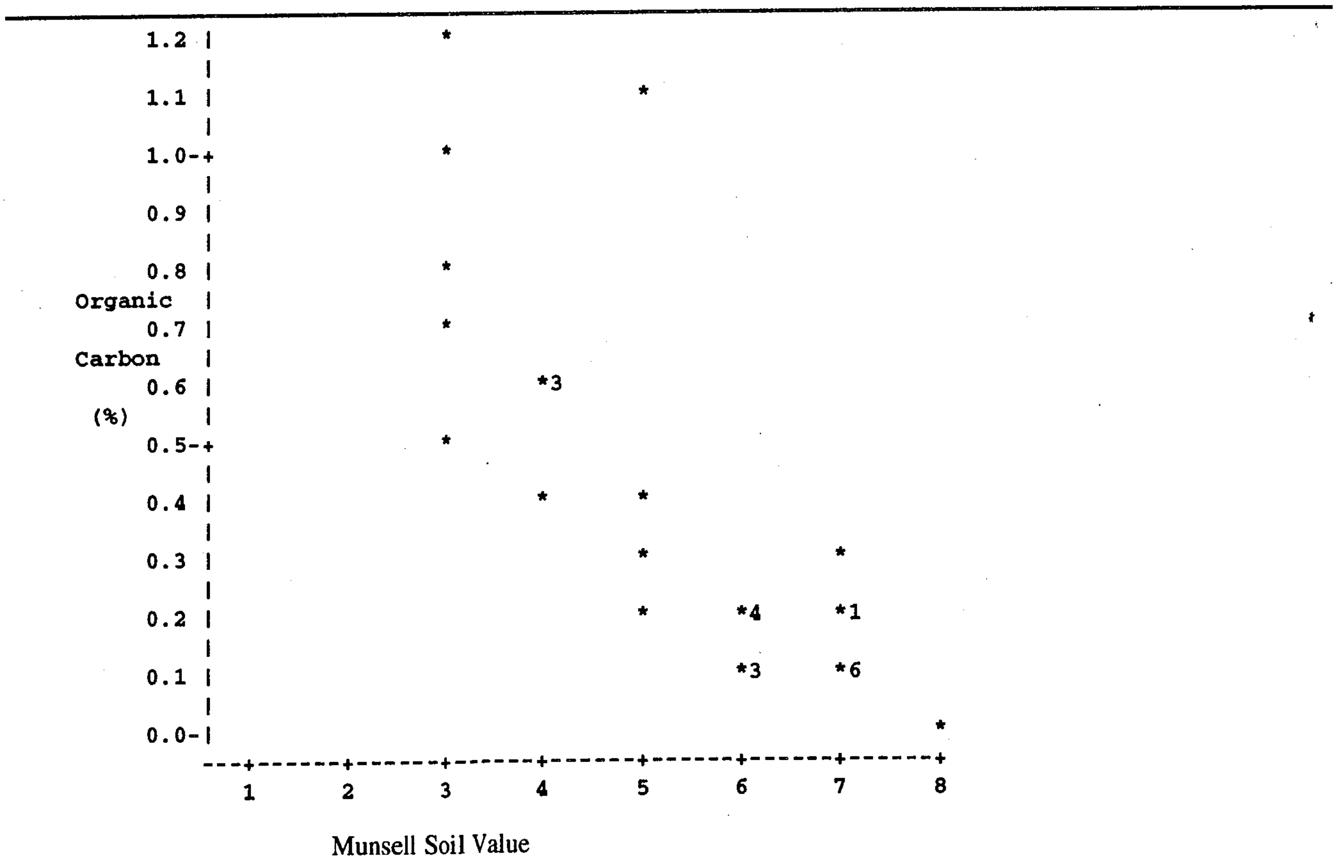


Figure 3 Soil organic carbon plotted against Munsell Values

(data from McArthur and Bartle 1980)

Laboratory

Samples taken were submitted for laboratory analysis. The main interest was the pH and carbonate level. Determination of the salt level of some surface samples were also undertaken. The gypsum content of a couple of samples were also obtained. The particle size distribution was determined in some samples.

The procedures used were:

- pH - 1 soil : 5 distilled water recorded by glass electrode
- carbonate - % digested in warm dilute HCl
- salt - calculated by determining Cl^- concentration (ppm)
- gypsum - calculated by determining SO_4^- (%)
- particle size - using sieves (1.0, 0.5, 0.3, 0.15 mm)

Results

This section presents more detailed descriptions of the physical environment of the Central Coast than is available in other sources. It also includes results of specific observations associated with the description of the sampling sites. Certain other information of an anecdotal nature are also presented.

Geology

The Central Coast was dominated by the Holocene Safety Bay Sand which was essentially as described in the Introduction. It included dunes, beach and lagoonal deposits. These were of varying thickness and in places the underlying Pleistocene Tamala Limestone was exposed. Frequently these exposures were accompanied by yellow sand. However, close to the coast between Lancelin and Dongara, there was usually no yellow sand. The one exception noted was a small patch east of North Head (AMG 66560 3084).

In the Cliff Head area there was a zone of what has been mapped by Lowry (1974) as Tamala Limestone which also has none of this yellow silica sand. Instead the soil was a loamy calcareous sand. Much of the limestone in this area was softer which in the railway cutting (AMG 67332 3070) showed up as broken rocks and gravel with a loamy matrix. Gypsum (as kopi) was a component in some of the soils in this zone (e.g. AMG 67312 3054). Patches of dense limestone were present within this zone. As it was so different from the typical Tamala Limestone, it was recognised for this study as a distinct unit. It appeared to be a coast parallel zone extending from Illawong to possibly south of Dongara. Because of its apparent difference from the bulk of the Tamala Limestone on the Central Coast, it will be referred to in this report as the Cliff Head deposit.

Not far inland, this was replaced by Tamala Limestone with accompanying yellow sand which was more typical of the Central Coast. On the coast side, the limestone was the more typical medium-grained dense Tamala Limestone.

Geomorphology

Platforms

As mentioned in the Introduction, the Central Coast was a band of Holocene, mainly sandy, deposits over a foundation of Pleistocene Tamala Limestone. The Tamala Limestone and associated yellow sands form a continuous elevated eastern platform on which ribbons of Holocene dunes were perched. The yellow sand was generally thickest in the east and thinnest in the west. This in part was because of the stripping of the Holocene mobile sand sheets. The limestone forms an undulating surface. The more eastern portions tended to have more pinnacle development which in places were exposed. The exposed limestone in the west tended to be large domes with numerous fractures.

The Pleistocene platform extends more or less to the coast between Cliff Head and Gum Tree Bay and also south of Lancelin. However, in the majority of the Central Coast it terminates at an elevated marine bench which has been cut into dense Tamala limestone. Truncated solution pipes (AMG 66827 3091) support the view that this was an erosion feature. This bench was at a relatively consistent AHD at least between Lancelin and Coolimba. No accurate elevations were available but it appears to be of the order of + 2 to + 5 m AHD based on DOLA 1:50,000 topographic maps.

This bench also defines the eastern limit of a lower Holocene plain made up largely of Holocene deposits. These appear to be primarily well sorted medium sands. It was interpreted that these were transported by mobile sand sheets and deposited in or over lagoons. Also included were localised in-shore marine, beach and lagoonal deposits. Much of the plain owes its existence to the repeated transgression of the mobile sand sheets and the presence of a lithified layer.

Parts of the Holocene plain on the Central Coast were studded with small hills of exposed Tamala limestone. Only a little of the presumably once overlying yellow sands remains associated with these outcrops (AMG 66560 3084). A band of Tamala Limestone outcrops form the majority of the coast between Cliff Head and North Head. The limestone islands and reefs off Jurien and Cervantes were approximately in alignment with this band.

No detailed mapping has been done in the course of this study. However, the boundaries of the plain can be readily inferred from the mapping of Gozzard (1985) and Gozzard and Hesp (1983) by combining their "Deflation basins", "Relict foredune plains", "Lagoons" and intervening "Parabolic and nested parabolic dunes" units. The plain was mainly 1 to 2 km wide and extends from Dongara to Cliff Head and then more or less continuously from north of Coolimba to just south of Lancelin.

The plain was relatively flat with a variable thickness of unconsolidated sand covering a weakly lithified layer. This layer was usually only 20 or 30 cm thick and much more porous and less competent than the Tamala Limestone of the area. It had the appearance of massive calcrete with a thin laminar surface layer. While superficially like calcrete developed at ground water level (cf. Semeniuk and Searle 1986), V. Semeniuk (pers comm.) suggested these were deposits with secondary carbonate cementation.

Beneath the lithified layer was sand with in places layers of clay or shells from beaches and lagoons. Investigations made at a few locations revealed thin weakly lithified layers distributed sporadically beneath the main surface layer.

In a number of places in the Central Coast there was a series of beach ridges which have developed and contributed to this Holocene plain. Many were just a few beach ridges while others were quite extensive.

The most extensive, at Jurien and Cervantes, were expansive cuspate plains. Both are currently slowly prograding on the north-west faces and eroding on south-west faces. Woods (1983a, b) documented the development of successive sets of ridges at Jurien. His study revealed a complex pattern of deposition and regression. The pattern also appears to be influenced by outcrops of Tamala limestone and includes at least two series of lagoons.

The cuspate plain at Cervantes takes a similar form and includes outcrops of Tamala limestone and a number of lagoons. Of particular note was the presence of Lake Thetis, a small permanent lake with living stromatolites. This apparently developed through the collapse of a doline (Grey *et al.* 1990).

The only other extensive beach ridge plain was at White Point, south of Dongara. This was sinusoidal or crescent shaped. It was not associated with the prominent islands and reefs which are off Jurien and Cervantes.

There were also a number places with only a few ridges. The most obvious were at Green Head, Kangaroo Point and Wedge Island. The small plain at Green Head has been disguised by subsequent aeolian processes and urban development but once was similar to that at Wedge Island, i.e. an island off-shore from a small cuspate plain.

In some places (e.g. White Point, AMG 67436 3032) the plain comprised two or even three distinct levels. These levels were separated by conspicuous small scarps of up to 1 m. The eastern and presumably older level was elevated compared to the more coastal level. It was the most strongly lithified position of the plain. A portion of the eastern level was a beach ridge sequence but the mode of deposition for the remainder was unclear.

The western portion was a recent beach ridge sequence over which mobile sand sheets had passed removing the unconsolidated aeolian material. Its very weak lithification appears to be consistent with observations on other beach ridge sequences (e.g. Woods 1983b, Gozzard 1985).

The most coastal portion of the plain in some places (e.g. at Wedge Island, Kangaroo Point, Cervantes, Gum Tree Bay and White Point) appeared to have no lithification at all. In these areas this was a narrow strip just inland from a relatively young foredune ridge. These strips were comparatively recent beach deposits over which a mobile sand sheet had passed. Frequently, these contain winter wet depressions, some with standing water.

Evidence can clearly be seen in aerial photographs of erosional events cutting into the plain, mainly beach ridge sets, in a number of places through out the Central Coast. The erosion might have been an elevated sea level at the time of cut, but it could have been long periods of increased storminess. At White Point for example this represents the low scarp mentioned above separating two levels of the Holocene plain. Woods (1983a, b) dates the sediments deposited after a cut at about 1,800 years BP.

Coastlines and Foredunes

The Holocene has been a period a nett deposition along much of the Central Coast. Some has been shore and marine deposits along prograding coastlines but there has also been much landward export of beach deposits, mainly from other coastline types.

The Tamala Limestone appears to be the foundation of and, in some areas, the controlling influence on both hard and soft coastlines. There were a number of rocky shorelines scattered throughout the Central Coast but particularly between Illawong and North Head. Some of these have cliffs of up to 20 m. Between these were normally small inset beaches. In a number of places there were cliffs separated from the ocean by a narrow strip of beach deposits and low dunes.

Most of the following description centres on sandy (or soft) coastlines because sediment accumulation along rocky coastlines was relatively insignificant. Sandy coastlines were principally backed by the Holocene plain described above.

The sandy coastlines of the Central Coast were mainly prograding or eroding, but very little was retreating (cf. definition of eroding and retreating, Tinley 1985, p202). The balance between eroding and prograding sandy coastlines appears to be controlled by the off-shore bathymetry, especially the presence of islands or reefs of Tamala limestone. Apparent differences in sediment loads were also involved in some areas. Wave energies and relative orientation have also been influential.

Figure 4 was a depiction of the characteristic features of the sandy coastlines north of Lancelin. This displays the product of deposition generally anchored between rocky outcrops or reefs. These outcrops may be obscured by dunes. The typical configuration includes parts which were either eroding or prograding coastlines with attendant characteristic foredune formations. Prograding coastlines apparently occur in low

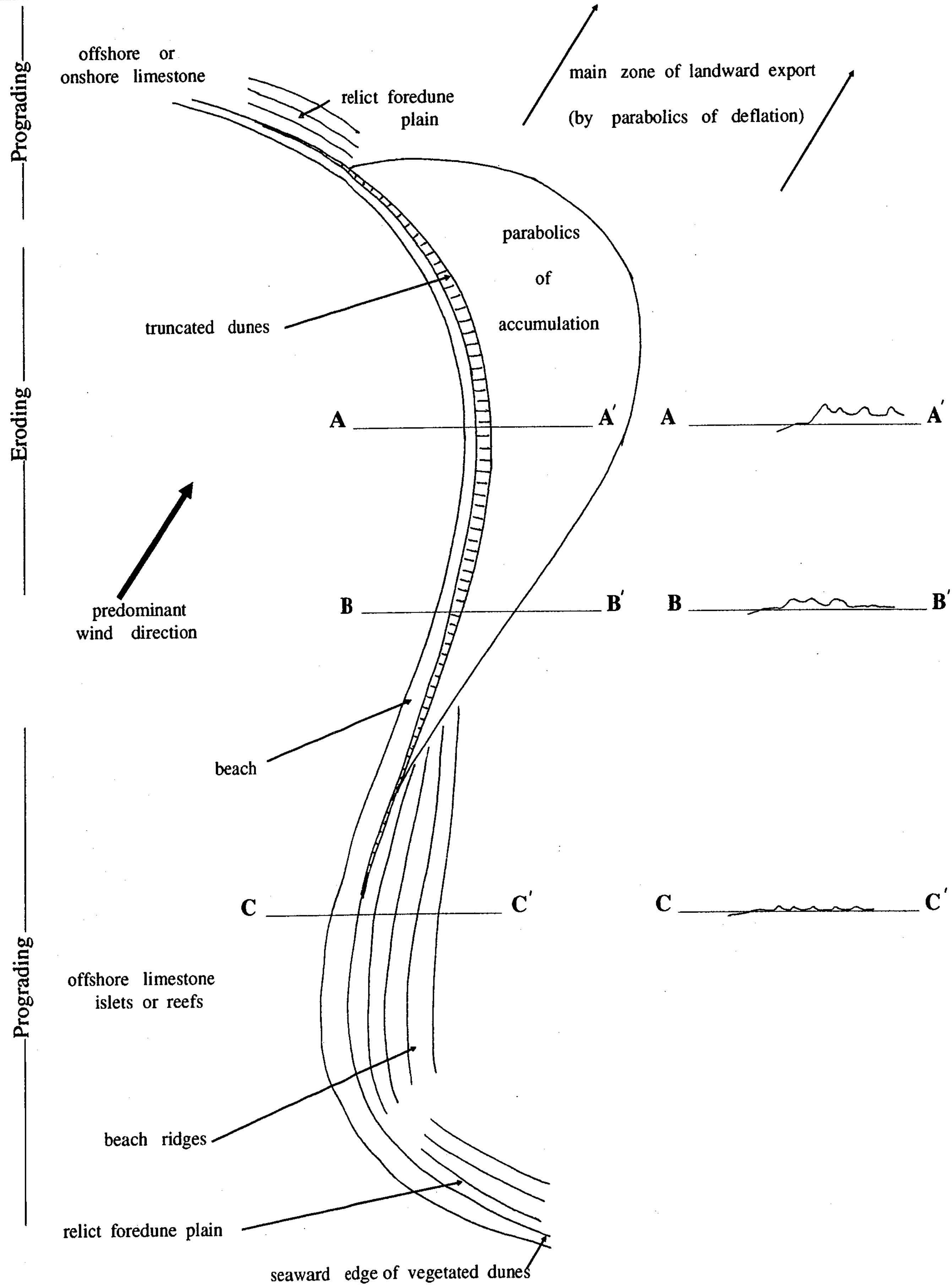


Figure 4 Typical coastlines (Showing zones and modes of deposition and export)

wave energy environments with moderate or high sediment loads. The higher energy coastlines were essentially stable although they were usually in a dynamic balance between seasonal differences in deposition and erosion.

The direction of the predominant winds modify the typical configuration. Where winds were more normal to the coast, as in the southern part of the Central Coast, the configuration tends to be symmetric. Winds oblique to the coast induces asymmetry.

As depicted in Figure 4, the nature of the foredunes can be tied into coastline configuration and the degree of coastline progradation. Prograding coastlines develop low beach ridges generally of less than 2 m tall. Sediments accumulate mostly in new ridges, rather than enlarging existing ones.

However, south facing ridges were generally taller than those facing west or north-west because of the additional influence of backshore accretion. These also appear to undergo a certain degree of truncation from storm serges. Relict foredunes is probably a better term for many of these sets.

Beach ridges commonly remain unmodified by subsequent aeolian processes. Relict foredunes, however, were likely to have at least minor blowouts altering them.

Moving northward from a prograding coastline there was a gradual change in the depositional environment to an eroding one. These moderate to high energy coastlines may be viewed as essentially static. This was due to the accumulation of sand in slight widened beaches in the summer followed by its removal by winter storms. The occasional undermining by these storm serges was largely responsible for the steep, truncated dunes which generally back this coastline type.

On eroding shorelines the sand blown off the beach and incipient foredune was ultimately deposited on the leeward slope of the foredune in the process of backshore accumulation. Aided by the stabilizing vegetation this results in the growth of the foredune. This growth in height may result in a slight seaward widening of the foredune. The windward (i.e. seaward) side of the foredune generally has quite a steep slope, up to 40°. Because of the considerable plant cover on most of these slopes it was concluded that this truncation was not a frequent event. On-shore winds also undoubtedly play a role in maintaining these slopes. In places sand was clearly winnowed from this face and deposited on the leeward side.

The rate at which the foredunes grow was not just a product of the sediment supply from the adjacent strip of beach. Along the majority of the Central Coast a significant amount of the sand deposited on west facing beaches was blown northward along the beach under the influence of the predominantly south and south-westerly winds. The slopes of the steep foredune enhance this movement by deflect the wind, and its load, northward along the dune face. This pool of beach sand was ultimately blown onto, and accumulates in, the foredunes of the more south-west facing beaches. Before the south facing beaches were reached, most of the sand moving on the beach has been blown onto the dunes. Because the wind was normal to the beach in this area, there was little export of sand along the beach. Most was deposited by backshore accretion onto the usually several relict foredunes typical of this area.

The net result under these generally south to south-westerly winds of the Central Coast was low foredunes on west facing beaches, the tallest dunes on south-west facing beaches and moderate ones on south facing beaches.

At a micro-scale, the growth of the foredunes on eroding coasts was uneven result and results in discrete ridges and gaps. These were more pronounced in higher dunes. The wind was funnelled through the gaps which become the loci of blowouts. Therefore, increased height was generally accompanied by an increased frequency of blowouts. The blowouts tend initially to be normal to the axis of the foredune rather than following the predominant wind direction.

Blowouts mainly serve to redistribute the sand locally, usually a few 10s of metres. In general they appear to be relatively short lived and were quickly stabilised by specialised coastal vegetation, and the accumulation of sand resumes. In this way a cluster of moderately tall dunes build up behind the foredune. These blowouts were essentially parabolics of accumulation. The result was an irregular dune field termed Chaots by Semeniuk *et al.* (1989).

As the dunefield increases in extent and height, blowouts appear to increase in frequency, size and distance travelled. These often form an irregular (or fretted) parabolic shape which appears to be the chaotic landscape's influence on both the wind direction and sand movement. Still these blowouts rarely travel far and just continue the local accumulation and redistribution.

Aeolian Transport

Much of the sand which accumulated in coastal dunes has been transported inland by aeolian processes, principally in mobile sand sheets. Several interesting points have emerged from the interpretation of aerial photography (this study) and satellite imagery (I. G. Eliot pers comm.).

Almost without exception, mobile sand sheets have been initiated from the foredune. In areas north of Lancelin these start predominantly on south-west facing eroding coastlines; just the areas described above with the tallest coastal dunes (parabolics of accumulation). These areas mark the start of discrete corridors along which most of the mobile sand sheets have followed (I. G. Eliot pers comm.). In obvious contrast, there has been little initiation from beach ridge plains and, in particular, west facing beaches.

When a mobile sand sheet was initiated it appears to have been the product of the coalescence of several blowouts. In this case all of the unstable dunes in the vicinity and most of the unconsolidated soil in the overwhelmed areas were exported.

It is hypothesized that a pulse of sand will not break free until enough of the accumulated sand can be mobilised. This is required for two reasons:

- to continually overwhelm the stabilising vegetation, and
- to ride over the downwind landscape without loosing too much sand to deep hollows.

It also seems that the deflation basin might have to reach a critical size to maintain adequate wind speed and a consistent direction. From this point on, the mobile sand sheets can be equated to parabolics of deflation.

The basins created were deflated down to beach level, or at least to a resistant layer should one exist. Thus a sizable gap forms in the foredunes. Rebuilding of the foredune begins almost immediately and the basin soon becomes closed off from the coast by an incipient foredune. The gap closes from the south being fed by sand blown northwards along the beach.

These mobile sand sheets have passed over much of the Holocene plain and some of the adjacent Tamala platform. There are a few aspects of the progress of these dunes which warrant comment.

The deflation basins were scoured until layers resistant to the wind's influence were exposed. Most commonly these were lithified layers including Tamala limestone. Significant also were fossil soils, clastic deposits, shell beds common in beach ridges and even moist sand. Shells and gravel winnowed from the dune may concentrate on the surface in some basins and armour it from further deflation.

Sand was lost to the trailing arms but as the mobile sand sheet overwhelms unconsolidated sediments in its path additional material may be added. The rate of forward movement of the sand sheet was influenced by factors such as wind speed and consistent direction, aspects of the mobile sand sheet (e.g. particle size, moisture content, volume of sand), aspects of land over which the dune passes (e.g. surface roughness, slope, relief, vegetation type) and presumably other things.

Table 4 Progress of several mobile sand sheets

Average distances which advancing face of several mobile sand masses have travelled (m/year).

Mobile Sand Mass	Travel (m/year)	Dist. from Source (km)	Position
1. E of Green Head	2 to 7	10	inland
2. SE of Green Head	11	0.3	coastal
3. S of 2.	9.5 to 15	1.5	coastal
4. Pinnacles	0 to 7	30	inland
5. Grey	3.5 to 21	20	coastal
6. Horseshoe	3.5 to 7	12	inland
7. N of Wedge	7 to 14	5	coastal

observation interval: 1. - 3. 1944 - 1990. (Mapping scale 1:20,000).
4. - 7. June 1982 - December 1989. (Mapping scale 1:50,000).

Table 5 Velocity of sea breeze in Perth metropolitan area.

(Data from Bureau of Meteorology from 7.1.1989 to 31.1.1989 for hourly events where Sea Breeze became established over most of the gradient.)

Wind Speed (km/hr)	Rottnest	Frequency of event at various recording stations: Ocean Beach	Swanbourne	Jandakot Airport	Perth Airport
0	0	0	0	0	*2
1 - 4	0	1	1	3	*9
5 - 8	0	0	1	8	4
9 - 12	1	4	6	18	17
13 - 16	7	8	19	22	18
17 - 20	25	18	24	0	1
21 - 24	14	16	1	0	0
25 - 28	4	4	0	0	0

* these were Land Breezes

The current rate of progress of the mobile sand sheets have not been systematically assessed. There was a small amount of information to suggest that rates of greater than 10 m per year are possible (Pelham 1983, Thomas *et al.* 1990). Pelham (1983) showed considerable differences in rates but did not offer an explanation. Table 4 indicates a considerable variation in rate of advance of mobile sand sheets, both within and between. The faster moving of those mentioned in Table 4 were close to the coast, but it was clear that a number of the factors mentioned above are involved in the progress of sand sheets.

Table 5 shows that there was a significant decline in the speed of the sea breeze after it crosses the coast.

Most of these mobile sand sheets were far from the classical parabola. Blowouts tended to either fan out from the source if they were amongst Chaots, or become long and narrow while they remained between existing dunes. Narrow mobile sand sheets were essentially simple parabolics of deflation with a hairpin shape (also called attenuated parabolics by Semeniuk *et al.* 1989).

Mobile sand sheets start on a broader front than do small blowouts. Most of those north of Lancelin may fan out slightly to a width which remained fairly constant throughout their passage. The constant width may be because they were partially confined by the arms of previous dunes travelling in the same corridor. Consistent wind direction undoubtedly plays a major part.

There was a suggestion from one dune east of North Head that, where there are no confining dunes, the mobile sand sheet would fan out significantly in response to the variations in wind direction alone.

Larger mobile sand sheets were made up of several or even many transverse or even barchanoid dunes more or less parallel to the advancing front. They moved in phase like the ocean swell. This movement has been documented in a digital terrain model for Southgate dune south of Geraldton (I.G. Eliot pers comm.). Each dune in a set appears to have similar amplitude and wavelength. On the other hand there were large differences between dune sets. Transverse or barchanoid dunes which were large with a deflated surface exposed between apparently indicated a system in which sand supply was becoming depleted (K. L. Tinley pers comm.).

The fronts were often compound, either the result of dunes which had coalesced or a single one partitioned by variation in the topography of the platform. Partitioning was quite likely where mobile sand sheets were composed of barchanoid dunes. The front of the mobile sand sheet was rarely a smooth line or curve and its progress rarely steady. A common feature was a low tongue of sand protruding from a tall wall. This tongue was eventually over run by the main sheet front.

The trailing dunes layed down on the flank of the mobile sand sheet varied considerably in height and profile, both between areas and with time since deposition. Depending on the type of vegetation fringing the dune, the rate of stabilizing these dunes has varied considerably. *Acacia rostellifera* for example coped well with sand inundation. It grew through the growing dune and partially stabilizing. This resulted in the dune height and slope increasing.

There were some differences between the slopes of these dunes which Figure 5 attempts to portray. This example was taken from an area where *Acacia rostellifera, Melaleuca cardiophylla* and *M. huegelii* were important components of the stabilizing vegetation. The inner slopes are the most dynamic. As the sand sheet was blown away from the trailing dune, these slopes are gradually exposed. By that time the vegetation on the outer slope had usually grown to the top. The roots of these plants were exposed on the inner slopes as the sand was blown away. The root suckering propensity of species such as *Acacia rostellifera* partially stabilized these slopes, often at an angle steeper than the angle of repose.

Continued undermining and consequent slumping lead to the death of many of the trees and larger shrubs which had been keeping the top of the dune stable. This death was probably due to moisture deficit. Subsequently the dunes' profile changed as the sand was transported from the top to the toe. Thompson and Bowman (1984) recognised that water erosion including surface wash and raindrop splash was the major modifying force, particularly on soils with water repellent surfaces.

Table 6 shows considerable moderation in the slope of vegetated dunes with age. The change would mostly have been due to redistribution, slumping and erosion. Some may have resulted from leaching of the carbonates.

It was often noted in the field that leeward slopes of the dunes were steeper than windward slopes. Table 6 suggests that this was not the case for the youngest dunes which was apparently in conflict with the observations of McArthur and Bartle (1980a). The relative symmetry of these younger, mainly trailing arm dunes can, in part, be explained in Figure 5.

The slightly older dunes had more distinctly steeper windward slopes than leeward slopes (Table 6). This suggests the wind contributed significantly to the moderation of the dune slopes for a long time after it being first layed down. The oldest of dunes appeared to be also relatively symmetric.

Table 6 Average slopes of portions of dunes of different ages

(Values are average slope in degrees)

		Inferred Age * (youngest)				(oldest)
		B	V	Y	M	O
Crest	(DC)	22	4	5	4	4
Windward Slope	(DSW)	-	35	23	12	15
Leeward Slope	(DSL)	40	37	29	18	12
Toe	(DT)	-	-	5	15	2

* see Table 3 for explanation

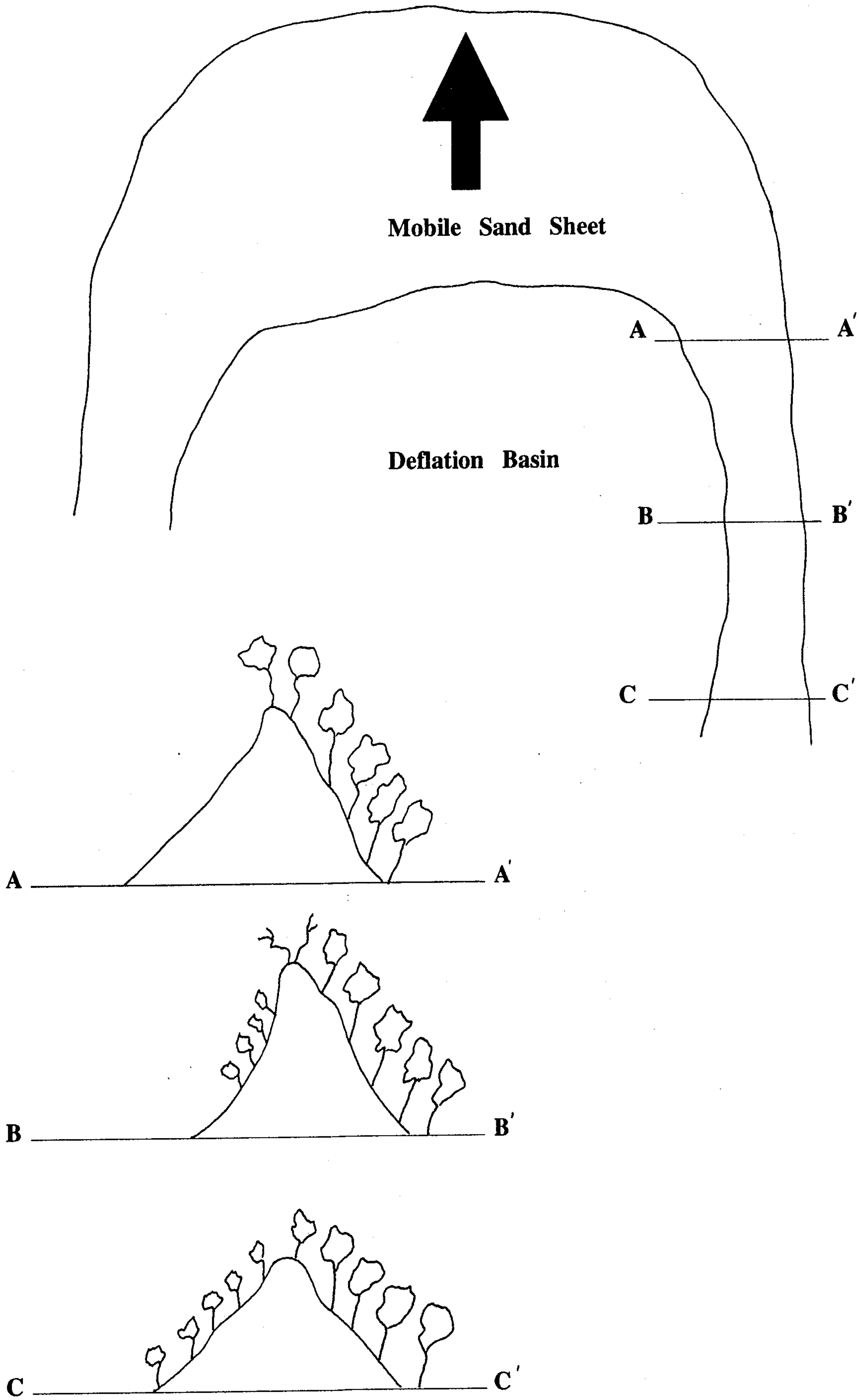


Figure 5 Profile changes of trailing dunes (Immediately after passing of mobile sand sheet)

Not all mobile sand sheets layed down trailing dunes on both flanks. No stable dunes were layed down on the western flanks of many of the dunes in the Wedge Island to Nambung area. This was probably an interaction between variation in wind direction and topography of the deflated surface.

The ultimate fate of the mobile sand sheet also deserves some comment.

The first point is the shape of stabilised dunes. There was no evidence in the Central Coast that a mobile sand sheet has stabilized with the blunt, advancing front intact. Commonly, these end points have taken the form of parabolics of deflation giving the classic configuration of V-shaped converging trailing arms. These were often nested suggesting a common origin.

However, south-east of Dongara the stabilised mobile sand sheet were more like parabolics of accumulation. They tended to be taller and more rounded, just like most south of Lancelin and on the southern coast of Western Australia.

The second point is why they stop where they do. Factors mentioned above which influence the rate of progress of mobile sand sheets are clearly involved in stopping it. Table 5 showed that the velocity of the sea breeze declined rapidly after it crossed the coast. The potential for reversal of sand under continental winds probably increases as the sand sheet penetrates further inland.

If the velocity of the sea breeze was the principal influence on the penetration of the sand sheets, their distance of travel would be correlated with its strength and/or duration. Tinley (1992) reported that the velocity of the sea breeze in the Central Coast decreased from north to south. However, Table 7 shows that the penetration by the dunes was not correlated with this gradient. This suggests that wind speed may be only of secondary importance in determining how far dunes penetrate.

Table 7 Penetration of mobile sand sheets onto land

Starting Point	Maximum Distance Travelled (km)
North of Dongara	4
South of Denison	8
White Point	11
Coolimba	10
South of Green Head	15
Grey	25
Wedge Island	23
South of Wedge	20
Lancelin	20
Moore River	6
Mullaloo	5

Other factors are clearly significant. In some areas it appeared to be that the encountering of thick vegetation (e.g. south of Dongara, and perhaps in the Swanbourne area) was important. Many cases of declining sand supply (e.g. north-east of Cervantes) can be found. Changing topography of the Tamala surface (e.g. east of Pinnacles) may also be of importance.

Dune Composition

The sands of the beach swash zones were quite coarse, but variable; usually between 20 and 80% coarser than 0.5 mm. However, in some places it was quite fine with very little coarser than 0.3 mm (e.g. DD08 shown on Figure 6). There was a suggestion in the data of a positive correlation between the energy of the beaches (and beach slope) and the size of the sand in the swash zone. In most cases the sand of the adjacent dunes were finer (Figure 6). This conforms with the wind having selectively transported the finer fractions.

The particle size of the dune sand also varies considerably. Figure 6 provides a graphical representation of the proportion of different size fractions in samples collected from dunes, beaches and some deflation basins. While most dunes had less than 10% of their particles coarser than 0.5 mm, there was a wide range of sizes finer than 0.5 mm. South of Ledge Point most dunes had less than 70% of particles finer than 0.3 mm. North of Ledge Point most dunes were more than 70% finer than 0.3 mm. In this northern area 10 to 40% was finer than 0.15 mm. Very fine fractions (finer than 0.05 mm) were mostly absent from all dunes.

The data also suggest a complex relationship between particle size and the carbonate mineral composition. Most of the finer dune sands were high to very high in carbonates. However, some dunes, generally the most inland, were quite low in carbonates. The more coarse sands were generally in the swash zone and commonly had a relatively low carbonate content. A number of swash zones and beaches had high proportions of coarse shell fragments.

The composition of the Holocene sands also showed a significant regional pattern. Appendix 3 was a series of maps showing the percentage of carbonate minerals in a selection of samples from dunes and beaches.

Most of the beaches and coastal dunes were very high in carbonates. The few exceptions were in the very south of the Central Coast (e.g. Trigg and Swanbourne) and just north of Dongara. These data accord in general terms with Searle and Semeniuk (1988) who noted high silica contents in present day beach deposits south of Lancelin and low proportions north of Lancelin. The data of Sanderson (1992) conform also with this.

The more inland of dunes south of North Head had moderate to high proportions of carbonate minerals. Between these and the coast there was something of a gradient of increasing carbonate composition. The majority of the inland dunes north of North Head were very high in carbonate. It should be appreciated that in this area none of the Holocene sand sheets have passed over the high silica Tamala Limestone.

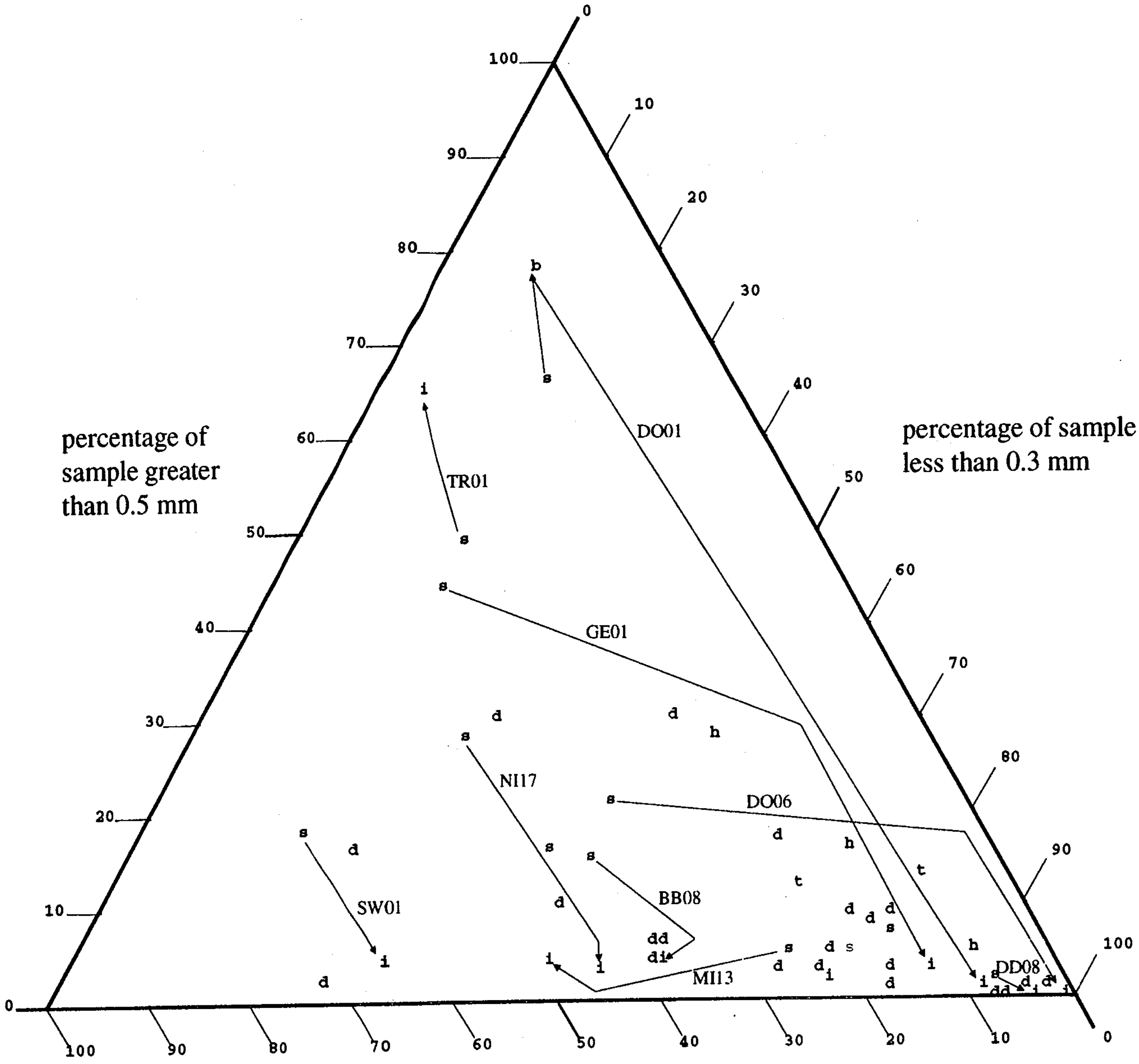


Figure 6 Three-dimentional particle size relationship of selected Holocene sand samples

(s - swash zone, b - beach, i - incipient foredune, d - dune, h - sand on Holocene plain, t - sand on Tamala plain or (paleosol))

Arrows indicate sites (DO01) where samples taken from both swash zone and incipient foredune.

Some have passed over the Cliff Head deposit which was low in silica.

The data showed that the composition of the sand deposited (in the arms and eventually the stabilised advancing face) has varied over the life of the mobile sand sheet. Prime examples were mobile sand sheets in the Cervantes area (AMG 66322 3192) which are now 70 - 80% silica but probably started at the coast with negligible silica. Given the low rate of leaching reported by Woods (1983b) it was unlikely that this process could account for the gross difference in composition. McArthur and Bartle (1980a), who reported moderate levels of silica in their older (Q1) and more inland dunes, noted that some of the yellow sand from the Tamala limestone platform over which they passed had been incorporated into them.

There was some evidence of weak lithification of the sand in older dunes in the Central Coast. McArthur and Bartle (1980a) suggested this was a feature of older dunes. Only rarely, however, did the soil auger sampling in this study (to 1 m) reveal such lithification. However, cemented lamina were conspicuous in a number of places where a mobile sand sheet had reworked an older dune. The best examples were in Nilgen Nature Reserve, the Defence Department land and also in parts of Nambung National Park. Some has been also been observed in a mobile sand sheet at Cape Burney at the mouth of the Greenough River (McMillan and Foulds 1980).

The limited observations suggested that the lithification of these dunes was more advanced in the southern parts of the Central Coast than in the north. Some differences in the ages of dunes between the south and north may, however, have biased these observations.

Some rhizoliths were noted, mainly in the reworking of young to moderate aged dunes.

Soils

These were as expected alkaline soils with pH values recorded mainly between 7.5 and 9.0. This was within the range of McMillan and Foulds (1980), Woods (1983b) and Tille and Lantzke (1990) but at variance with McArthur and Bartle (1980a) who reported values of 8.6 to 9.5. The difference might be in the methodology.

The majority of the soils in the Central Coast showed minimal development except for the accumulation of variable amounts of organic matter. Most was Uc1.11 with a little Uc1.14 (Northcote 1979). Some with the yellow sands from the Tamala limestone was Uc1.12. The depth of unconsolidated sand over the lithified layer or Tamala limestone was a soil parameter of significance not included in this classification.

A description of the major landforms and associated soils was provided in Appendix 4. A classification scheme based on landform and inferred age (Table 2) was used to distinguish different situations. This basically discriminated on depth of unconsolidated sand and the inferred age. This grouped beach deposits with dunes. The deflation surfaces, either the Holocene plain or Tamala limestone, had shallow soils. The distinctly different, often loamy, soils of the Cliff Head deposit should be noted.

The accumulation of organic matter was the principal pedogenic process which has occurred to these Holocene sands. The variation in the proportion of carbonate minerals and silica have contributed to differences between soils. A certain amount of leaching of the carbonate from the surface soils was inferred from some of the data.

The numerical data collected were summarised in an attempt to show establish relationships between the major soil parameters which were contributing to the differences between soils. While there were a number of consistent relationships within a profile, it was not possible to establish any significant relationship for the pooled data. The relevant data summaries are provided mainly to demonstrate the complexity of the chemistry of these soils.

There was a wide range of carbonate composition in the soils of all inferred ages (Table 8). This suggested a very poor relationship between carbonate composition and the age of deposit. The younger coastal dunes were generally very high in carbonate. So were some young inland dunes e.g. east of White Point, but others, e.g. at Nambung, were quite low in carbonate.

In some areas the carbonate composition of the dunes can be correlated to dune age on the local scale. For example at Breton Bay, the older dunes (and inland) were 10 to 15% carbonates while the younger (more coastal) were 50 to 80%. This accords with the results of McArthur and Bartle (1980a) for the Yanchep area. As far north as North Head, the carbonate of inland dunes was lower than that of coastal ones. However, many of the inland ones were quite young, even currently mobile. Therefore, one must conclude that the remoteness from the coast was more important than dune age in determining carbonate composition.

Table 8 Carbonate composition of different aged soils

Inferred Age *	Number of Samples	Carbonates (% Acid Soluble) Range	Mean
(youngest)			
B	4	0.2 - 22.9	8.7
V	2	91.2 - 93.6	92.4
Y	43	0.7 - 97.1	56.6
M	100	0.5 - 98.7	69.8
O	28	2.8 - 97.3	65.7
(oldest)			

* see Table 3 for explanation

In many dunes the surface soil, usually the top 10 to 40 cm, was lower in carbonates than the soil beneath. This was noted for dunes with a wide range of carbonate composition. However, most showed virtually no change. Table 9 shows that, on average, the difference appeared to be only a few percent. It appeared that older dunes had a more consistent increase in carbonate composition with depth than did younger dunes.

While an increase in carbonates down the profile was not always consistent, there was more consistent increase in both the pH and the Munsell soil value. The increase in pH was between 0.2 to 0.5 of a pH unit. The younger dunes tended to have slightly higher pH for both surface and sub soil. There appeared to be a similar increase in pH with depth for dunes of all ages but the younger dunes showed this trend less consistently.

There was a marked decrease in the organic matter content of the dune soil with depth (increase in Munsell soil value). The greatest change was for the older dunes which had comparatively darker surface soils. It was noticeable, however, that before 1 m all dunes had approximately the same Munsell soil value.

Woods (1983b) indicated that the build-up of organic matter on the surface released organic acids which lead to the reduction of pH and the leaching of the carbonate minerals of these soils. A certain degree of correlation between pH, carbonate composition and Munsell soil value was suggested by the above data. A number of attempts were made to demonstrate a relationship between these parameters.

Table 9 Differences between surface and sub-soils of dunes

(Crests and slopes only. Samples from the toe was omitted as they were frequently smallow soil over a paleosol.)

Inferred Age	No of Samples	Munsell Value S*1	Munsell Value SS*2	pH S	pH SS	% Acid Soluble S	% Acid Soluble SS
Y	7	6.8	7.9	8.15	8.47	61.5	65.7
M	25	5.5	7.7	8.12	8.47	63.9	65.6
O	5	5.4	7.6	8.08	8.32	60.6	63.7

S*1 - Surface Soil SS*2 - Sub surface Soil

However, the pooled data from all sites did not support a simple relationship. Even when the carbonate content of the soil was included in the comparison there appeared to be only a poor overall relationship between these parameters (Figure 7). Lines drawn on this figure are examples of profiles representative of the differences in soil chemistry between surface and sub surface. This demonstrates the relatively consistent increase in pH and the less consistent increase in carbonate composition with depth mentioned above.

Even when the pH differences were expressed as $[H^+]$ gradient, there was no clear relation to proportion of carbonate minerals in the parent soil, nor to the carbonate gradient (Figure 8), nor to the organic matter accumulation (Figure 9).

Figure 8 shows that those sites with the greatest soil profile carbonate gradient tended to be in the more southern parts of the Central Coast, mostly located south of Lancelin. This conforms with the observations of Woods (1983b) who showed data on the leaching of carbonate decreasing as rainfall declined from Busselton to Jurien. However, this simple interpretation was confounded by other factors; the southern areas had lower parent soil carbonate levels, a higher proportion of older soil profiles and a higher rainfall.

Figure 10 emphasises the regional nature of variation in carbonate (and silica) composition of the Holocene sand deposits already mentioned earlier (Appendix 3). The southern areas were generally low in carbonate and the northern very high.

Very low carbonate samples from the central part of the coast were mainly deflated surfaces or paleosols of Tamala yellow sand.

Also to be noted was the variation in Munsell soil chroma (Figure 11). The most intense yellow colours (high Munsell chroma) were recorded for the Pleistocene yellow sand over the Tamala limestone. This Tamala sand was exposed in a number of deflation basins and beneath some Holocene sand. Moderate or even bright yellow sands were encountered in a number of places in some Holocene dunes. This sand was most probably reworked Pleistocene yellow sand.

Figure 11 also shows the yellowest soils were relatively low in carbonate, as were most yellow sands over the Tamala Limestone. On the other hand many soils low in carbonate had a Munsell chroma indistinguishable from those high in carbonate. Most of these were surface soils. It was therefore assumed this lower intensity yellow was caused by:

- the removal of the iron coating from the surface of the silica grains by several mechanisms including abrasion in the ocean, leaching and perhaps bleaching, and
- the addition of masking dark organic coatings.

Paleosols were encountered commonly, particularly in recently deflated areas on the Holocene plain and occasionally in coastal dunes. They were recognised as clearly darker (lower Munsell soil value) or with an abrupt increase in the yellow

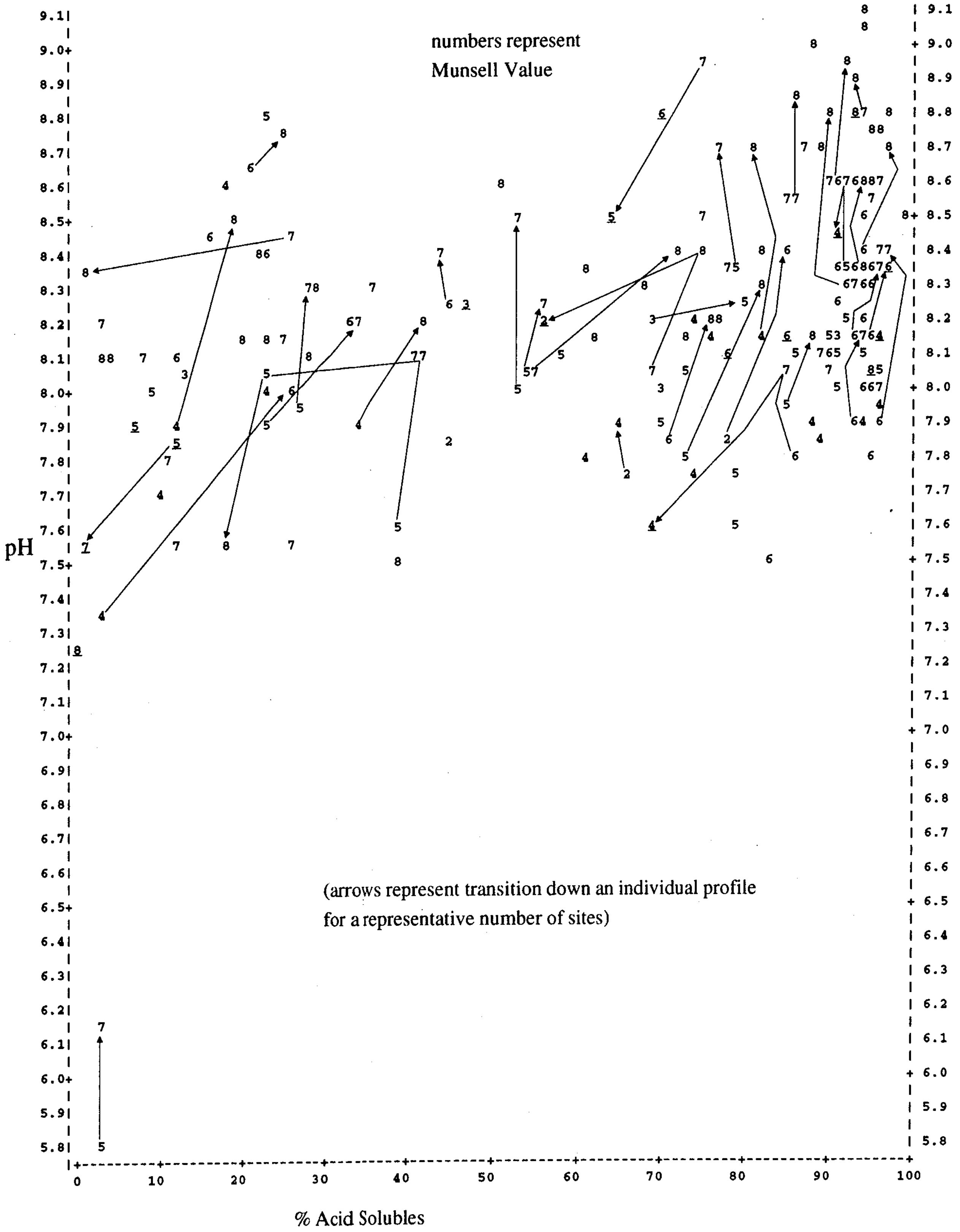


Figure 7 Relationship between pH, carbonate content and Munsell Value of soils.

(All samples, paleosols underlined)

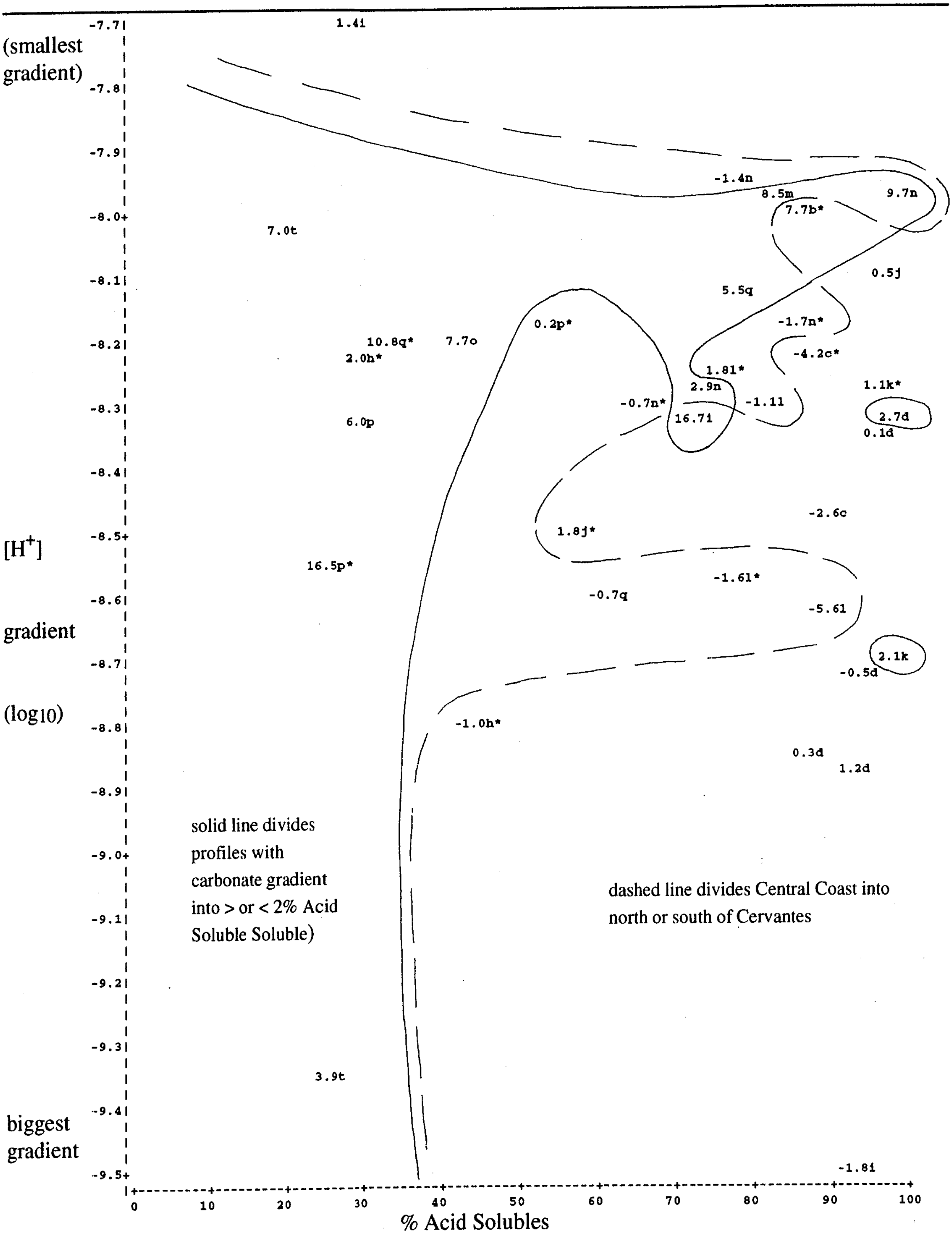


Figure 8 Carbonate gradient and $[H^+]$ gradient down soil profile plotted on carbonate content of subsoil.

(Data from 40 dunes where pH gradient increased, 6 profiles on dunes where measured pH gradient decreased were omitted, - numbers are carbonate gradient (sub surface minus surface expressed as % Acid Soluble), - all profiles except those marked with '*' had Munsell value of 8 by 1 m below surface and were probably parent soils. It could be inferred that both the $[H^+]$ and the carbonate gradients for profiles with '*' would be slightly greater than those indicated

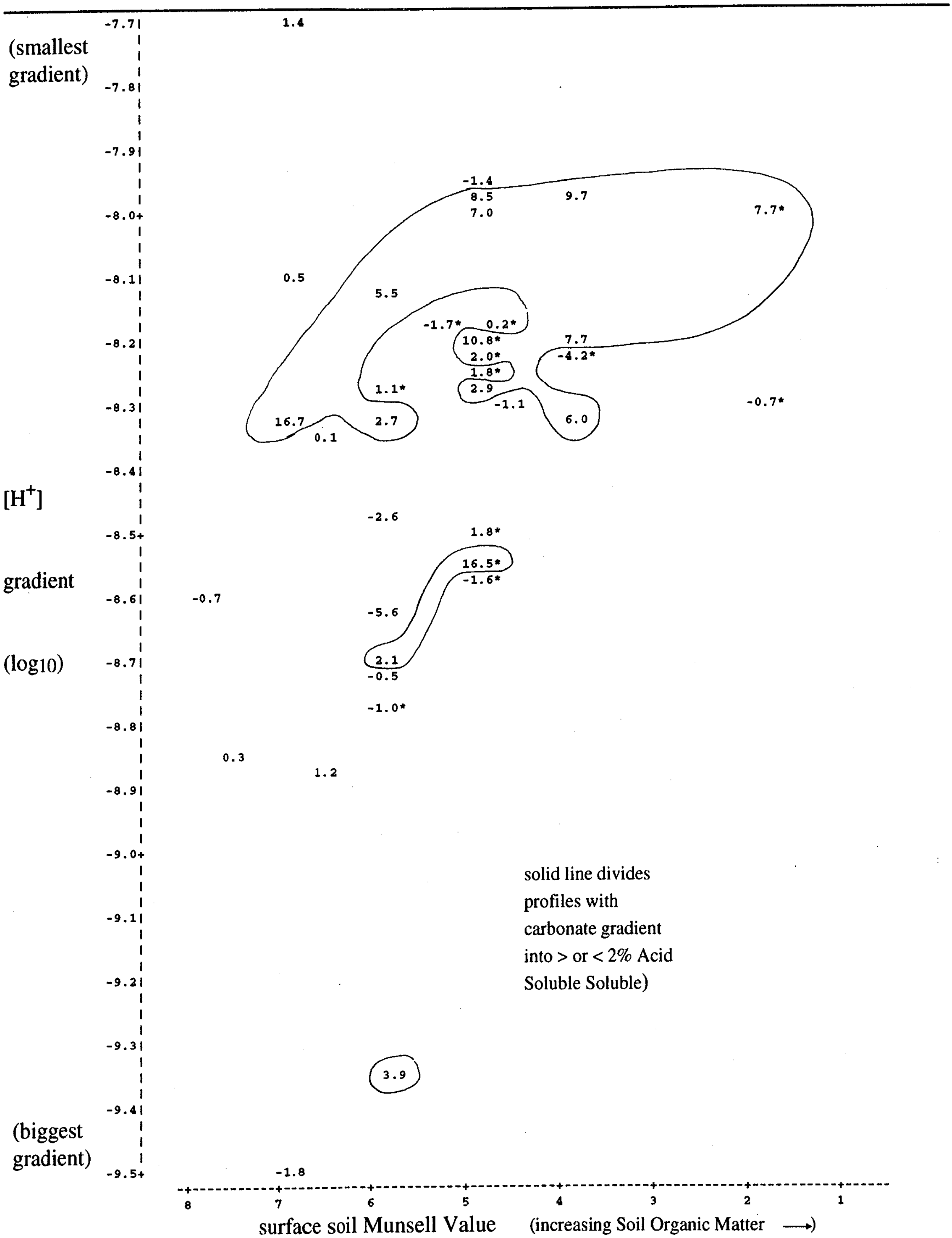


Figure 9 Carbonate gradient and [H+] gradient down soil profile plotted against surface Munsell Value.

(Data from 40 dunes where pH gradient increased, 6 profiles on dunes where measured pH gradient decreased were omitted, - numbers are carbonate gradient (sub surface minus surface expressed as % Acid Soluble), - all profiles except those marked with '*' had Munsell value of 8 by 1 m below surface and were probably parent soils. It could be inferred that both the [H+] and the carbonate gradients for profiles with '*' would be slightly greater than those indicated.

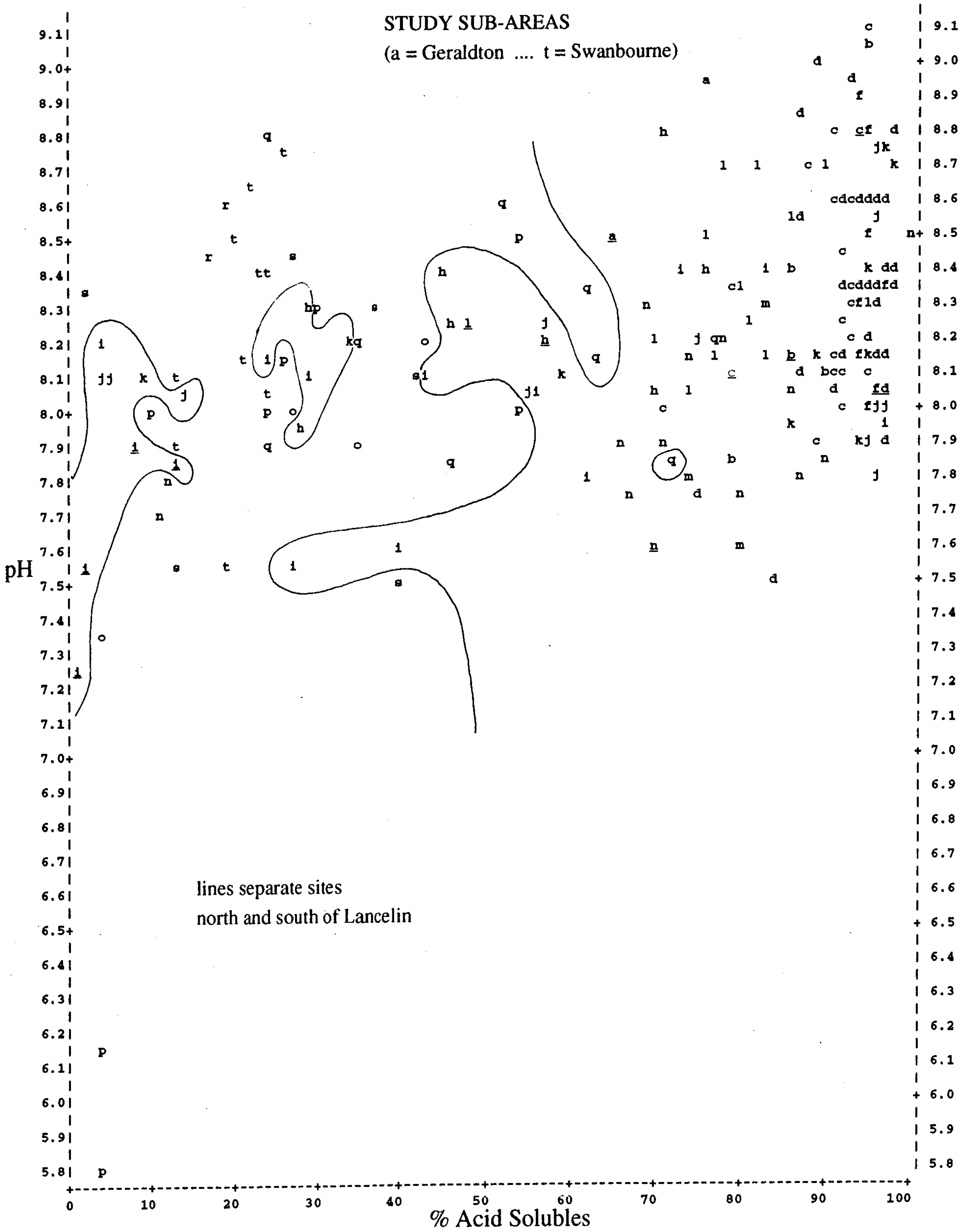


Figure 10 Relationship between pH, carbonate content of soils for different parts of the Central Coast.

(All samples, paleosols underlined)

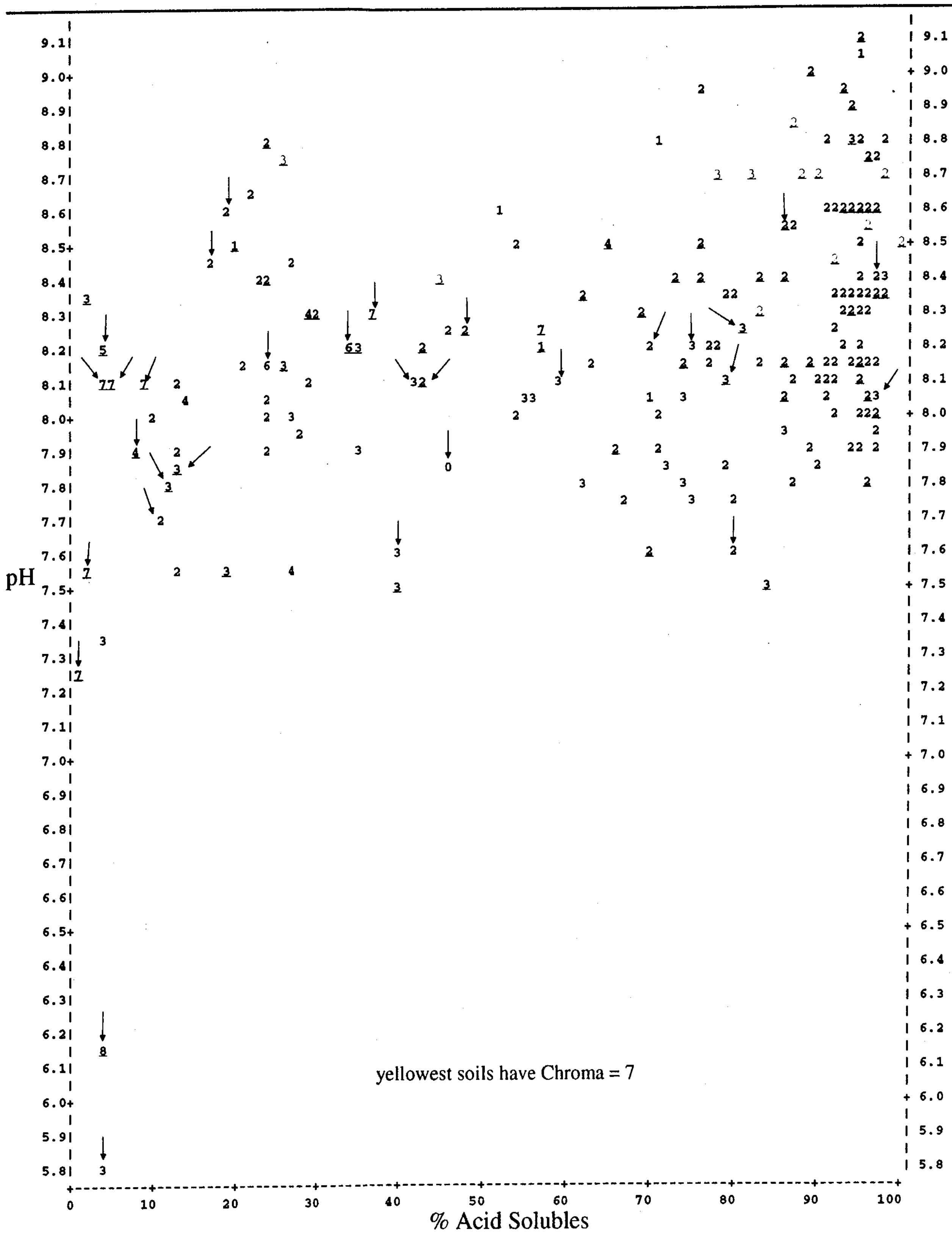


Figure 11 Relationship between pH, carbonate content and Munsell Chroma of soils.

(All samples, values represent Munsell Chroma, sub surface soils underlined, Tamala surfaces indicated by ↓)

colour (higher Munsell chroma). Their presence was verified by the chemical analyses conducted. In most cases paleosols were lower in pH and carbonate than the younger layer immediately above.

The Munsell soil value of paleosols varied considerably irrespective of the inferred surface age. On average the Munsell soil values were roughly the same. However, paleosols were more commonly noted on younger Holocene surfaces than older ones (Table 10). The paleosols noted in older soils tended to be deeper than those found in younger soils. (The data from Tamala surfaces was in agreement with this.) This suggests that the paleosols might be being gradually broken down by bioturbation and oxidation. The paleosols closer to the surface might be broken down more quickly.

Table 10 Incidence of paleosols on Holocene plains

Inferred Age *	Total # of relevés	Paleosol present #	(%)	Paleosol Munsell value
B	18	8	(44)	5.2
V	30	8	(27)	5.3
Y	43	15	(35)	5.4
M	51	7	(14)	4.8
O	1	0	(0)	-

* See Table 3 for explanation

Seventeen surface soil samples were analysed for [Cl⁻]. These were from dunes of a range of ages and wide geographic spread across the Central Coast. Results presented in Figure 12 shows a declining trend in [Cl⁻] inland from the coast.

This supports expectations as the major source of sodium chloride was aerosols from the ocean and empirical data of Semeniuk *et al.* (1989). It should be noted that:

- there was considerable variation in [Cl⁻] between areas close to the coast,
- the values for most samples taken from within 3 km of the coast were slightly lower than those reported by Semeniuk *et al.* (1989) taken from the same part of the coast. The differences may reflect their summer sampling compared to spring sampling of this study.
- there was no recognisable north - south gradient within the Central Coast as suggested by Semeniuk *et al.* (1989). Their data from Whitfords and Dongara fail to support their own conclusions,
- the amount of NaCl in the top 5 cm of coastal soil approximates the annual sea-salt fall-out for the coastal town Leeman of 153 kg ha^{-1} (15.3 gm^{-2}) (Arakel 1980), and
- the data were insufficient to test whether accumulation continued in the surface soils as the dune aged. While the assertion by Semeniuk *et al.* (1989) that salt content increases with humus content can not be addresses with any conviction, the samples with the lowest [Cl⁻] had the highest organic build up (Munsell soil values of 4 to 5).

Classification of Central Coast

By recognising the presence of various geology, geomorphic and soil units the Central Coast has been classified into several sectors. This was not a classification of the coastline but of the suite of Holocene deposits backing it. These are described in sequence and an attempt has been made to provide a hierarchy (Appendix 5).

This analysis provides significantly more sectors than earlier studies (Semeniuk *et al.* 1979, and Tinley 1992, Sanderson 1992). Semeniuk *et al.* (1979)'s Dongara to Lancelin Sector was here divided into six. Some have obvious broad similarities (e.g. possession of a Holocene plain) which they probably considered grounds for combining into a single unit. These more similar sectors were separated by quite different ones. Tinley (1992) recognised many of these areas. Sanderson (1992) divided the coast between Moore River and Cliff Head into five sectors according to variation in the composition of the sand of the swash zone.

Regional variation will be discussed further under the Vegetation section.

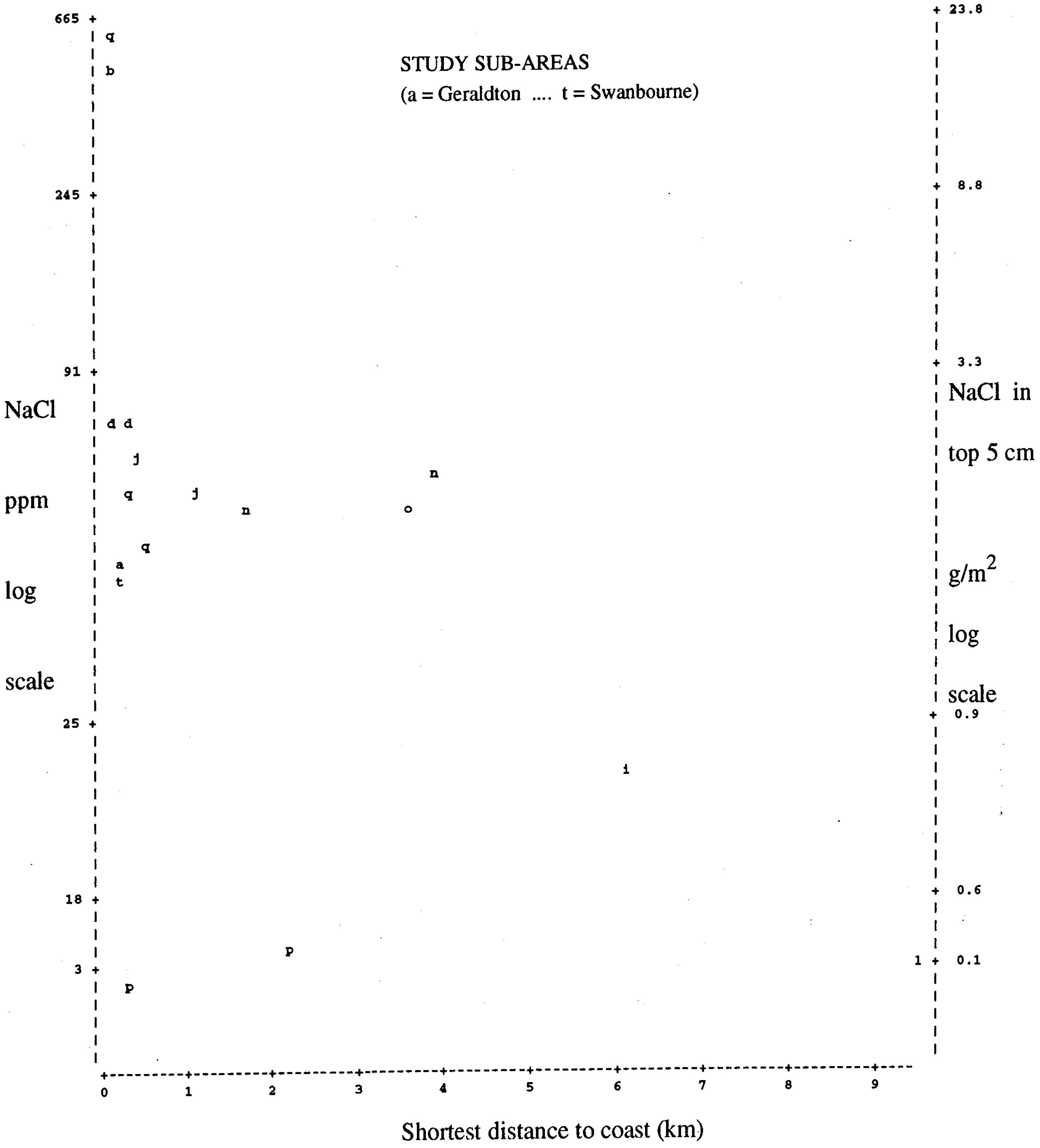


Figure 12 Sodium chloride concentration of surface soils plotted against distance from coast.

(Study Sub-areas indicated by alpha characters)

Discussion

While this study did not set out to examine the geology, geomorphology and soils of the Central Coast, a number of useful data have been assembled. The following discussion on these points should not be considered definitive as they have been prepared principally to stimulate discussion and investigation by specialists.

Cliff Head Deposit

A part of what has to date been mapped as Tamala Limestone in the Cliff Head area has been shown to have a composition and structure different from the bulk of the Tamala Limestone in the Central Coast. Soil mapping (N. Schokneckt, pers comm.) have distinguished loamy calcareous soils rather than yellow silica sands. The log of a drill core from a hydrological survey (Nidagal 1992) reported the limestone in this area was less competent than the typical Tamala Limestone.

This combination suggests that there is a case for considering the Cliff Head deposit as a unit of some kind distinct from the Tamala Limestone.

It is speculated that this could have been in part a coastal Pleistocene lagoonal deposit. These could have readily weathered to form the loamy, calcareous and gypsiferous soils now in the area. If lagoonal shell beds or corals could be found within the Cliff Head deposit it would assist greatly in ascertaining its origin.

Further speculation leads to the hypothesis that this unit could have extended further north and south, perhaps for several hundred kilometres. As it was softer than the Tamala Limestone most of it was removed during the early Holocene marine incursion.

Encouragement for this speculation comes from a number of areas, principally the alignment of several features in the residual Tamala Limestone.

Firstly, the eastern margin of the Cliff Head deposit was essentially the northerly projection of the eastern margin of the early Holocene marine bench.

Secondly, the residual limestone which forms the shoreline in the Cliff Head area can be projected southwards to include headlands, islands and reefs at least as far south as Cervantes.

Thirdly, the nature of the low limestone hills within the Cliff Head deposit was similar to the limestone which was exposed in places throughout the Holocene plain. All these were low domed rises with narrow fissures.

The final point comes from a comparison of the composition of the oldest beach deposits following the early Holocene marine incursion. This event clearly mobilised substantial volumes of material presumably from the Tamala limestone along the west coast. This probably formed the bulk of the sands redeposited along the coast in the early Holocene.

South of Perth (e.g. Rockingham and Busselton) the gradual exhaustion of this source as it was incorporated into coastal deposits was reflected in the dilution of silica and lithoclasts in younger sediments by skeletal fragments (Woods 1983b).

In marked contrast, Woods (1983b) found that all sediments at Jurien were low in silica and there had been little change in the proportion of silica, calcium, magnesium or strontium in beach ridges since early Holocene. This was in spite of the residual Tamala Limestone east of Jurien including considerable silica. So what was eroded in this part of the Central Coast? Apparently not the typical Tamala limestone with its mantle of yellow sand, perhaps the weaker Cliff Head deposit which was low in silica.

A close examination of the cores of the Cervantes hydrogeology survey would probably assist in clarifying this speculation.

Geological Deposition Events

This section indicates progress towards a description of the development of Holocene deposits in the Central Coast based on observations during this study.

The starting point for this account is taken at late Pleistocene or early Holocene, at the end of a marine incursion. There is some debate about the possible timing of this event. Searle *et al.* (1988) reported a sea level high at about 8,000 years BP in the Rockingham area. Playford (1988) does not support this suggesting instead an interval of between 6,000 and 5,000 years BP for a high at Rottnest Island.

Nevertheless a period of transgression cut into the Tamala up to 3 km inland from the present coastline. It is argued here that this represents the eastern limit of the Cliff Head deposit, a softer unit which was more or less removed by the Holocene transgression. It trended roughly north-south and appears to have been confined on the west by a ridge of Tamala Limestone. Remnants of this ridge the rocky coastline elements from North Head to Coolimba and the islands off Jurien etc.

The work of Arakel (1980) is here interpreted to support this theory. His stratigraphic sections of Leeman Lagoon show a trough of up to 5 m deep having developed in the Tamala limestone by early Holocene.

At the end of the Pleistocene (or early Holocene) the hypothetical trough would have been completely open to the sea between just north of Cliff Head and Dongara, partially open between Coolimba and North Head and more or less completely open further south. This structure dominated the subsequent Holocene deposition along this part of the coast. It determined the location of lagoonal deposits and beach plains alike.

At around early Holocene (prior to about 5,000 years BP) there was a gradual build-up of beach deposits adjacent to the eastern bench. This was apparently during a period of higher (+ 2 to + 5 m above present) and perhaps falling sea levels. Several lagoonal shell beds have been found along this shoreline between White Point and Cervantes. These may correspond to the Vincent Member of the Herschell Limestone which, according to Playford (1977), was deposited at sea levels of + 2.4 m at Rottnest between 6,000 and 5,000 years BP. This fits in with dates of about 6,000 years BP obtained from shells (clam and turbo) cemented in the Holocene plain at Lancelin (Ohmori and McArthur 1985).

It should be noted that, unlike most other sections of the Central Coast, there was little Holocene deposition on the Tamala platform east of the bench between North Head and Gum Tree Bay. This suggests that there were only minor aeolian deposits on this sheltered coastline and a well developed barrier island chain was probably in place in this area by the early Holocene. The limestone outcrops west of the early Holocene shoreline were islands at that time. On those between North Head and Gum Tree Bay, sediment accumulated, initially as beach deposits, to form a barrier complex with, occasional lagoons behind.

The continued accumulation of sediment in dunes on these barriers island was eventually transported landward by blowouts and mobile sand sheets to gradually fill some of these lagoons and form the plain. Arakel (1980) reported that the remaining lagoons were eventually filled with evaporites.

While much of the plain has been built up of sands initially deposited in coastal dunes, beach deposits have been locally significant. Additionally they provide valuable information about the environment during this time.

There has been an expanding literature on this subject in Western Australia over the last decade. The most immediately relevant is the work of Woods (1983a, b) who dated beach deposits and identified beach ridges sets and shorelines of varying ages in the Jurien area. A number of interpretations are possible for this data, however, it seems likely that sea levels have varied only slightly over the last 5,000 years. A chain of lagoons on otherwise open coasts may be explained in terms of a reasonably rapid lowering of sea levels at some point in mid-Holocene. On the other hand the truncation of beach ridge sets is distinct evidence for periods of elevated sea levels.

There is not a lot of point in attempting further to explain the variations in these beach ridge plains given the paucity of dates available. However, there were several similar events which warrants mention.

Evidence can clearly be seen in aerial photographs of erosional events cutting into older deposits, mainly beach ridge sets, in a number of places through out the Central Coast. The erosion might have been an elevated sea level at the time of cut, but it could have been long periods of increased storminess. At White Point for example this represents the low scarp mentioned earlier separating two levels of the Holocene plain. Woods (1983a, b) dates the sediments deposited after a cut at Jurien at about 1,800 years BP but provides a different interpretation for the preceding period than that just mentioned.

Variation in Dune Composition

Erosion and soil development processes have modified dunes to different degrees. A number of workers have reported the correlation of the degree of soil development, especially the leaching of carbonate from the surface, with the age of Holocene sandy deposits.

Prolonged leaching of the Pleistocene carbonate rich Tamala Limestone has been commonly invoked (e.g. Lowry 1974) to explain its yellow silica sand covering. It is in this context that the differences in carbonate composition of the Holocene dunes is liable for misinterpretation.

McArthur and Bartle (1980a) recognised four different phases of dune deposition within the Holocene. They distinguished each based on gradational differences in dune shape and soil profile development including the degrees of organic matter accumulation, the leaching of carbonate from the surface and its precipitation further down the profile.

The differences in carbonate composition of the dunes which they reported can be inversely correlated with the apparent dune age, implying significant post depositional leaching. However, while leaching was greatest in older dunes, this was only the surface soils, not the whole dune mass. Woods (1983a), for example, showed that after even 5,000 years or more, leaching and soil development had modified no more than the top 1 to 1.5 m of deposits.

In the southern part of the Central Coast, which was the focus of McArthur and Bartle's 1980a study, the oldest dunes extended furthermost inland and the youngest only a little distance from the coast. Although a similar situation occurred throughout much of the Central Coast, it did not hold over all of it.

The most relevant observation is that most inland dunes were lowest in carbonate (and highest in silica) irrespective of dune age (Appendix 3). This is the clue to explaining part of the differences in the composition of dunes.

A simple mechanism is proposed. It need have nothing to do with variation in sediment supply or variations in the climate although both probable occurred to some degree. It is mostly to do with the amount of unconsolidated sand available for incorporation into the mobile sand sheets.

At the beginning of the Holocene the Tamala Limestone was covered by unconsolidated yellow siliceous sand, just as most of the Tamala Limestone which has not had Holocene dunes pass over them is now. This sand would have been incorporated into the earliest Holocene mobile sand sheets making it possible for them to penetrate a significant distance inland before they ran out of sand.

This first sand sheets would have effectively swept most of the unconsolidated sand off the coastal Tamala Limestone. Little, therefore, remained for following dunes to mobilise. This would have resulted in two points of particular interest: the silica content of following sand sheets would be lower and the they would have stopped short of the earlier ones. Younger dunes could only be high in silica if they were able to advance further inland than the previous dunes, or were fed from a high silica ocean source. The latter is unusual on the west coast of Western Australia in the late Holocene and the data of Woods (1983a) from Becher Point show the proportion of silica in the beach deposits has declined since early Holocene.

The most recent sand sheets have travelled only a short distance in the south of the Central Coast thus remaining high in carbonates. On the other hand in the central part, many have advanced as far inland as the oldest Holocene dunes and captured all of their sand and becoming high in silica (in some instances).

The obvious question remaining on this subject is whether there were distinct phases of Holocene dunes deposition such as those recognised by McArthur and Bartle (1980a)? Ohmori and McArthur (1985) reinforce this by postulating that there were distinct periods of mobility and stability. Implicit in such arguments is that these periods of mobility and stability might be universal on the Central Coast.

There is only a handful of dune surfaces dated and it is much too early to come to any such conclusions. It is safe only to conclude that old dunes can be distinguished from young ones by their shape, and to a lesser degree by the organic matter accumulation, pH gradient and carbonate gradient. It is unwise to equate for example the oldest dunes in one area to the oldest in another. Attempts to apply the Q1, Q2, Q3, and Q4 units will be plagued with difficulties, especially in regional scale mapping.

Soil Development

It is apparent that the soil development process has resulted in parallel variation in a number of parameters (i.e. pH, carbonate gradient and organic matter accumulation) in a particular profile. However, a number of attempts made in this report to demonstrate an overall relationship between these parameters have proven unsatisfactory.

There have been suggestions that other factors such as climate and parental carbonate composition were also involved. Woods (1983b) proposed a multi-linear regression model of Time Since Deposition on Carbonate Loss and Parental Carbonate Composition. A close examination of his expression shows it was only meaningful for a narrow range of his own data. It does not describe the range of data collected in this study, not the range possible. Clearly it does not describe the mechanism by which profile change through time.

Unfortunately this study has not provided any new data to assist in clarifying this issue. It is somewhat perplexing and warrants further examination.

Mobile Sand Sheet Advance

It was indicated that the current rate of advance of mobile sand sheets was quite variable between zero to over 20 meters per year (Table 4). It appears that the rate in the early, near coastal, part of the life of these sand sheets is significantly greater than it is during the latter, inland part of their life. In some cases this represents the a response to increased resistance from taller vegetation. However, in most cases on the Central Coast this probably reflects the decline in wind speed inland and the gradual loss of sand to trailing dunes.

It is interesting to speculate just how long the presently mobile sand sheets have been on the move. Take one example, at the Pinnacles. This sand sheet is approaching the end of its path. Before it stops it will probably over run a complex of stabilised hairpin dunes from an earlier mobile sand sheet.

These stabilised dunes were still significantly crenulated which suggests that they were not the oldest Holocene dunes on the Central Coast which Ohmori and McArthur (1985) might be around 5,000 to 6,000 years BP. The crenulation suggests that they be perhaps 2,000 years BP but probably no more than 3,000 years BP.

The current mobile sand sheet at the Pinnacles originated in the Wedge Island area. The southern most portion of its eastern trailing arm (AMG 65885 3307) was recognised by Thomas *et al.* (1990) as a Q2 dune. So this sand sheet was probably initiated no more than 2000 years BP.

What does this mean for its rate of advance? The 25 km would have been travelled at an average of 10 to 25 m / year. This is an average rate equal to the fastest currently mobile sand sheets. However, it is presently almost stopped and would have been advancing at more like 5 to 10 m per year for much of its life. It must be concluded that in its early phase this mobile sand sheet advanced faster than 10 to 25 m / year, perhaps twice that speed. If so, this is greater than the speed of the present day mobile sand sheets close to the coast (cf. Table 4).

Does this mean that conditions were windier at about 2,000 years BP, were they more arid or was there more sediment coming ashore then? Could this correspond to one of the cut in the beach ridge plains at several sites along the Central Coast. Data from Woods (1983a) suggests that there might have been one of these events just prior to 1,800 years BP. There are a lot of questions but not much data.

F. VEGETATION STUDIES

As mentioned above this study covered the range of Holocene sandy deposits in the Central Coast, not just the dunes. This approach was adopted as there were many species in common across these deposits except the lagoonal deposits. The latter deposits were excluded.

Methods

Selection of Locations for Sampling

The location of the 545 sampling sites were selected, mainly from aerial photographs, to give as wide a range as possible of vegetation types, deposition types and age from throughout the Central Coast. It was not intended to document gradational changes in the vegetation of parts of the dunes in detail.

Sampling of the Central Coast was divided into 20 Sub-areas between Geraldton and Swanbourne more for convenience than any prior expectations. Numbering of the sites includes characters to indicate this. The location of these sites was shown in Appendix 6. These were from 7 conservation reserves, 12 other reserves and 1 privately owned remnant.

Preference was given to areas which were in existing Conservation Reserves rather than private property or road reserves. Recently burnt areas were not considered suitable and, in general, the areas selected had not been burnt for more than 10 years. Vegetation in good condition was preferred but some areas with significant weed invasion were included when there was no suitable alternative.

Field Observations

This study was based on intensive sampling of the different vegetation types in small representative patches. Detailed studies over the last decade have recognised that the appropriate sample size for this type of ecological study in the Northern Kwongan was about 100 m^2 (Griffin and Hopkins 1985). This has been used as a standard for several studies in the area (Griffin *et. al.* 1983, Mattiski and Burbidge 1991). However, insufficient time prevented the establishment and thorough examination of permanent quadrats at each site. An alternative relevé (plant list) method was adopted with a sample size of about 100 m^2 which ensured a reasonable compatibility of data collected previously in the northern sand plains. The relevés were sampled once between the months of July and December 1991.

The data collected included information on species and the site being sampled. A sample of the recording sheet was included in Appendix 1. At each relevé, all species present were recorded and an estimate of the Canopy Cover using the DominKranjina CoverAbundance scale (MuellerDombois and Ellenberg 1974) was made for each species. Voucher specimens were lodged in the Western Australian Herbarium.

Information on geology, landform, soils, and litter for each site was collected. In addition, a description was made of the vegetation structure using the classification scheme of Muir (1977) (Appendix 2).

Data Collation

A considerable number of plant species were recorded or collected during the study. To a list compiled for the Central Coast, species which had been recorded to occur in the Central Coast from other sources were included.

Additional records were extracted from the computer records of the Western Australian Herbarium (to June 1991 which included mainly Priority Flora, grasses, orchids, eucalypts, melaleucas, acacias, daisies, Rhamnaceae and Rutaceae). Secondly, information from several unpublished reports (M.E. Trudgen and G.J. Keighery) were included. Finally, flora treatments such as Marchant *et. al.* (1987), and various volumes of Blackall and Grieve and the Flora of Australia were scanned for distribution information.

Information on the conservation status of the plant taxa which were recorded in the Central Coast was obtained principally from the Department of Conservation and Land Management (Atkins 1991). This indicated species which were:

- Declared Endangered under the Wildlife Conservation Act,
- regionally endemic with small geographic ranges, and
- poorly known and were therefore considered in need of further study.

In addition, the distribution of each species was assessed from various sources including the collections of the Western Australian Herbarium. This was undertaken principally to ascertain whether the populations occurring in the Central Coast were of special significance. The principal criterion used in this assessment was whether the northern or southern limit to species' distribution was within the Central Coast. It also helped to ascertain the geographic range of each taxa.

Summaries were done on the basis of the conservation and distribution categories and also on major taxonomic groupings e.g. plant families and genera. Summaries were also made in relation to plant lifeforms based on categories in Appendix 7.

Numerical Analysis of Floristic Data

All data collected were incorporated into a computer database. This facilitated data validation, preparation for analysis and summarising of results. The principal analyses were performed with the aid of a package of computer programs called PATN (Belbin 1987). Included in this were a variety of programs which were used to analyse and summarise the data.

For the analysis, a matrix of species by relevés was prepared. The purpose of the computer analysis was to provide a simplified means of representing what was a very complex species data set. In general, the programs used were attempting to perform three basic functions. Firstly, they provided a means of producing groups of relevés according to similarities in their species composition. This was to define Floristic Types. Secondly, the programs enabled the differences between vegetation types to be identified and possible reasons for these differences to be hypothesized and tested. Finally, it provided a means of displaying the results simply.

The principal programs used were:

- ASO - This was a program which produces a similarity measure between each row (e.g. relevés) of the data matrix and each other row. A variety of formulas were available. In this case the Bray and Curtis coefficient was used. The similarity measures were presented as an Association Matrix of the original row by row (e.g. relevé by relevé).
- FUSE - This was a classification program which combines the rows into groups. Again there were a number of different ways the fusion could occur. In this case the group average method was used. This ultimately produces one group made up of all rows.
- DEND - This displays the history of fusion from FUSE (and other similar programs).
- MST - This was an alternate way of displaying the similarity between the rows. By definition it combines all rows into a tree (or network diagram) so that each row was joined to the row to which it was most similar but without forming a loop.

Although there was only one data set, two different forms were analysed. The first form used the percentage cover of the species at each relevé (Cover Data). The other simplified the data to presence or absence of the species in the relevé (Presence / Absence Data). For each of these data sets all of the above analyses were performed with relevés as the rows and the species as the columns.

No attempt was made to submit the data to an ordination program. Ordination proved of little extra value in understanding or describing diverse data sets with many relevés which have few species in common (Griffin 1990, Griffin 1992).

Results

Flora

Richness

A total of 377 flowering plant taxa (species, subspecies and varieties) recorded from the Central Coast including 320 taxa which were found in this study (Appendix 8). It was considered unlikely that substantial additions will result from further studies on Holocene sands in this area. However, 42 species on this list (see Appendix 8) were typical more of the Tamala sand and limestone than of the Holocene sands. These were recorded where there was little or no calcareous Holocene sand over Tamala yellow sand.

The Holocene sands have a relatively low species richness considering the Central Coast was perhaps 1000 to 2000 km^2. For comparison, 821 taxa have been reported from the very rich Lesueur National Park which was only about 275 km^2 (Griffin *et. al.* 1990). Individual relevés also had a low richness with most between 1 and 47 native species in about 100 m^2 compared to anything between 40 and 120 in kwongan. There were up to 13 alien species in some relevés.

A reflection of the low richness of these areas was the low level of sympatry (co-occurence of taxa) of the same genus. While it was common for there to be two taxa of, perhaps, several genera (e.g. *Melaleuca, Cassytha, Acacia* and *Leucopogon*) in a relevé, it was rare to find three or more. Griffin and Keighery (1989) reported much higher levels of sympatry in kwongan.

The total represents 226 genera from 75 families. Only 7 taxa were apparently undescribed (*Stylidium 'maritimum', Angianthus* sp. aff. *milnei, Diplolaena* sp. (Kalbarri), *Eucalyptus 'zopherophloia', E. 'petrensis', E. foecunda* (Coolimba) and *Diplolaena* sp. (Lancelin)).

The families Poaceae (31 taxa), Asteraceae (38), Myrtaceae (20) and Papilionaceae (17) were the best represented overall (Table 11). Alien species were represented by 64 species (56 genera in 19 families). Poaceae (17 taxa), Asteraceae (8) and Brassicaceae (5) were the most important of these. The remaining 313 native species were from 177 genera and 70 families of which Asteraceae and Myrtaceae were the most important.

Discounting alien plant species, the family tallies were Asteraceae (30), Myrtaceae (20), Cyperaceae (15) Poaceae (31), Proteaceae (14), and Papilionaceae (14). This was in marked contrast with studies of areas of kwongan where Myrtaceae, Proteaceae, Papilionaceae and Mimosaceae were the richest families (cf. Griffin *et. al.* 1990). The contrast was even more pronounced when it was considered that most of the species from Proteaceae and some from the Papilionaceae and Myrtaceae found in this study were essentially from

Table 11 Numbers of Taxa in major plant families.

	NUMBER OF SPECIES			MAIN LIFEFORMS *1
FAMILY	Total	Natives	Aliens	(no of taxa)
POACEAE	31	14	17	(AG – 9, GT – 9)
CYPERACEAE	15	15		(GT-11)
LILIACEAE *2	14	12	2	(BG-7)
ORCHIDACEAE	12	12		(BG-12)
PROTEACEAE	14	14		(SMSR-7)
SANTALACEAE	8	8		(SSEC-5)
CHENOPODIACEAE	13	13		(SXP-11)
BRASSICACEAE	10	5	5	(AH-5, SXE-5)
MIMOSACEAE	11	11		(SMSR-6, SSEI-3)
PAPILIONACEAE	17	14	3	(SMSR-6, SSEI-4, AH-4)
EUPHORBIACEAE	8	7	1	(SXE-5)
MYRTACEAE	20	20		(SMSR-9, M-5)
APIACEAE	8	8		(AH-8)
GOODENIACEAE	9	9		(SMSR-5)
ASTERACEAE	38	30	8	(AH-29)
TOTAL	377	313	64	

*1 - See Appendix 7 for explanation of lifeform codes

*2 - For purposes of comparison with other studies, LILIACEAE includes families 54C (DASYPOGONACEAE) to 54J (COLCHICACEAE).

Tamala sands not Holocene sands. The genera represented by the greatest number of taxa were *Acacia* (11), *Crassula* (7), *Scaevola* (6), *Eucalyptus* (6), *Melaleuca* (6), *Rhagodia* (5), *Caladenia* (5), *Conostylis* (5) and *Schoenus* (5). Again this was a contrast with the most numerous genera of the kwongan.

Lifeforms and Trophic Types

Indicated in Appendix 8 was the lifeform for each taxon. Table 12 shows that a wide range of lifeforms were represented on the Holocene sands. Shrubs and annuals were most common but sub-shrubs, chamaephytes and geophytes were also significant. Alien species were predominantly annuals. The importance of annuals was reflected in the importance of Poaceae and Asteraceae. In contrast kwongan was relatively poor in these families and also poor in annuals.

While 377 taxa are reported here from the Central Coast and 320 found in this study, most were found in only few of the 545 relevés. For example 161 species were recorded from 6 or fewer relevés (1% of the total). Only 23 species were found in more than 25% of the relevés (in order of decreasing frequency):

Trachymene pilosa, Melaleuca acerosa, Senecio lautus ssp. *dissectifolius, Conostylis candicans* ssp. *calcicola, Stipa flavescens, Acacia lasiocarpa* var. *lasiocarpa, Cassytha racemosa, Spyridium globulosum, Olearia axillaris, Rhagodia baccata* ssp. *baccata, Acacia rostellifera, Acanthocarpus preissii, Loxocarya flexuosa, Leucopogon parviflorus, Lepidosperma angustatum, Isotoma hypocrateriformis, Poa poiformis, Opercularia vaginata, Scaevola crassifolia, Hemiandra pungens, *Dischisma arenarium, Danthonia caespitosa* and *Crassula colorata* ssp. *colorata*.

Most of these were either shrubs or chamaephytes with just a few annuals and only one alien species.

The spectrum of modes of nutrition of the taxa recorded from this study reflects that reported for kwongan (Pate *et al.* 1984). Most were probably autotrophs, many were probably nitrogen-fixing (especially *Acacia*, Papilionaceae and Casuarinaceae), quite a few were hemiparasites (on roots - Santalaceae and stems - *Cassytha* and *Amyema*) but carnivorous (*Drosera*) were rare. It appears likely that at least some of the apparent autotrophs had a mycorrhizal association (e.g. *Spyridium globulosum* and some Epacridaceae, K.W. Dixon pers. comm.)

It was notable in some communities on Holocene sands that Santalaceae and *Cassytha* were particularly important. While these taxa are present in the kwongan, they are rarely important. These hemiparasites appeared to be most important where nitrogen-fixing species, especially *Allocasuarina lehmanniana*, were important or even dominant. This was particularly so in the early to middle stages of succession on a deflation plain after the progress of a mobile sand sheet. Both hemiparasites and nitrogen fixing species decline markedly in importance in climax communities.

In some communities on the Holocene sands taxa with fleshy fruit were quite important (e.g. Santalaceae, *Cassytha*,

Table 12 Major lifeform types and plant families

(Summary of lifeform types for all taxa in Species List - Appendix 8.)

Life-form*1	TA*2	Major plant families in each Lifeform
		Annuals
AG	25(16)	(Poaceae 19 taxa)
AH	85(32)	(Asteraceae 29, Apiaceae 8, Crassulaceae 7, Brassicaceae 5, Caryophyllaceae 5)
	110(48)	
		Geophytes
BG	23 (4)	(Orchidaceae 12, Liliaceae 7)
	23 (4)	
		Chamaephyte
GC	11	(Poaceae 3, Cyperaceae 3, Liliaceae 3)
GT	32 (2)	(Cyperaceae 11, Poaceae 9, Haemodoraceae 7)
	43 (2)	
		Arborescent Monocot
MA	1	(Liliaceae 1)
	1	
		Sub-shrubs
SXE	22 (2)	(Brassicaceae 5, Euphorbiaceae 5)
SXP	28 (5)	(Chenopodiaceae 11, Aizoaceae 4, Zygophyllaceae 3)
SXPS	1	
SXR	4	(Stylidiaceae 3)
	55 (7)	

Life-form*1	TA*2	Major plant families in each Lifeform
		Parasites
PS	2	(Loranthaceae 2)
PT	5	(Lauraceae 4)
	7	
		Shrubs
SMSC	8	
SMSE	10	
SMSR	55 (1)	(Myrtaceae 9, Proteaceae 7, Mimosaceae 6, Papilionaceae 6)
SMSS	3	
SSEC	19	(Santalaceae 5, Solanaceae 3)
SSEI	24	(Papilionaceae 4, Mimosaceae 3, Santalaceae 3)
SSES	2	
SSS	3	
	124 (1)	
		Mallees
M	5	(Myrtaceae 5)
	5	
		Trees
TS	7 (1)	
	7 (1)	
TOTAL	377(64)	

*1 – See Appendix 7 for explanation of lifeform codes *2 – Total species (alien species)

Acrotriche, *Leucopogon* and Chenopodiaceae). Many of these species were associated with areas where apparent nitrogen-fixing species were also important. Again such genera are not uncommon in kwongan but they are rarely important.

Alien Species

Sixty four alien species have been noted in this Study (Appendix 8). This represent 17% of the flora of the Central Coast. The species most frequently encountered were **Dischisma arenarium*, **Tetragonia decumbens*, **Bromus diandrus*, **Crassula glomerata*, **Vulpia myuros*, **Heliophila pusilla* and **Ehrharta brevifolia* (Appendix 8). Annuals were the predominant lifeform although there were a few sub-shrubs (Table 12).

Alien species dominated the many small disturbed areas in the Central Coast. However, the importance of aliens in the relevés varied considerably, even though the vegetation which they sampled was essentially undisturbed. In some areas they even dominated.

A total of 11 species were noted as having a cover of greater than 10% in at least one of the relevés. The most significant species in this regard were **Tetragonia decumbens*, **Cakile maritima*, **Pelargonium capitatum* and **Ehrharta brevifolia*. **Casuarina equisetifolia* dominated one relevé in the Southgate dunes (north of the Greenough River). This was the first record of a naturalised occurrence of this species in Western Australia.

The alien status of some species was in doubt. **Cakile maritima* was one of the most important (and sometimes only) species growing on incipient foredunes. It appears to be a cosmopolitan species and its presence in Western Australia might be entirely natural. The alien status of **Tetragonia decumbens* may also be in doubt since the Western Australian plants recognised as **Tetragonia decumbens* appears to not match the specimens in South Africa where **Tetragonia decumbens* occurs naturally (Marchant *et al.* 1987). This species was widespread along the incipient foredunes and foredunes of the Central Coast, even in remote and apparently undisturbed areas.

On the other hand there were other clearly alien species which had a distribution apparently influenced by proximity to urban disturbed areas. The shrub **Pelargonium capitatum* and the geophyte *Trachy*andra divaricata* were classics in this regard. They were found in a number of landforms but virtually only in relevés close to the Perth Metropolitan Area. **Pelargonium capitatum*'s ability to proliferate on developing foredunes in the Mindarie area indicates it has a potential distribution in Western Australia far greater than it currently exploits.

Table 13 shows that the alien species were concentrated in the southern part of the Central Coast where there was on average about five in each relevé. The bulk of the Central Coast had on average one or less.

Table 13 Distribution of Alien Species

Total number of Alien species recorded in relevés in Study sub-areas and average per relevé.
Study sub-areas ordered from north to south.

Sub-area	# of Relevés	Species - Total #	Species - Average
Geraldton (GE)	12	12	1.8
Dongara (DO)	32	9	0.6
White Point (WP)	73	7	0.4
Cliff Head (CL)	36	7	0.5
Gum Tree Bay (GT)	7	8	1.9
Leeman (LE)	26	9	0.8
Green Head (GH)	26	8	1.0
North Head (NH)	26	15	1.0
Cervantes (CE)	44	14	1.4
Nambung National Park (NA)	56	12	0.7
Wanagarran Nature Reserve (WG)	39	8	0.6
vacant Crown land (VC)	8	3	0.9
Defence Department (DD)	15	8	1.0
Nilgen N. Reserve (NI)	50	18	1.6
Ledge Point (LP)	4	2	1.3
Breton Bay (BB)	32	20	2.6
Mindare (MI)	23	28	5.3
Burns Beach (BU)	4	14	5.0
Trigg (TR)	8	16	4.5
Swanbourne (SW)	11	24	7.6

Rare and Restricted

Only a few species reported in this study were either rare or presumed rare (Table 14). Until 1990 *Chorizema varium* was thought to be extinct. It was now considered rare and in need of special protection as it appears to have less than a thousand plants on vacant Crown land (leased for grazing) and some private land in the Seabird area.

Several species were considered rare but less under threat. A total of 14 species encountered were thought to be confined to the Central Coast (or the adjacent Tamala limestone). Of these, only five species (*Angianthus* sp. aff. *milnei*, *Conostylis pauciflora* ssp. *euryrhipis* and *Stylidium 'maritima'* and possibly *Conostylis bracteata* and *Haloragis foliosa)* appear to be actually be confined to Holocene dunes of the Central Coast.

Table 14 Endangered, Rare and Geographically Restricted Taxa

C*	E	G	S	T	Taxon
1	R	1	x	T	*Chorizema varium*
1	1	2	x		*Haloragis foliosa*
3	3	2	x	T	*Eucalyptus foecunda* (Coolimba)
4	4	1	x		*Eucalyptus 'zopherophloia'*
4	4	1	x	T	*Grevillea olivacea*
.	3	2	x		*Phyllanthus maitlandianus*
.	.	1	x		*Conostylis aculeata* ssp. *cygnorum*
.	.	1	x		*Conostylis bracteata*
.	.	2	x		*Angianthus* sp. aff. *milnei*
.	.	2	x		*Conostylis pauciflora* ssp *euryrhipis*
.	.	.	x	T	*Diplolaena angustifolia*
.	.	.	x	T	*Diplolaena* sp. (Lancelin)
.	.	.	x		*Stylidium 'maritimum'*

* C — Declared Rare and Priority codes from Department of CALM (Atkins 1991)
R = Declared Rare
1 = Poorly known, under threat
3 = Poorly known, not under threat
4 = Rare, not under threat

E — Declared Rare and Priority codes recommendations from this Study, codes as above

G — Geographic range
1 = less than 50 km
2 = 50 to 160 km

S — Apparently confined to Central Coast

T — Apparently confined to Tamala Limestone

(See Appendix 8 for distribution range of each taxon.)

Distributions

This study extended the previously reported range of more than 40 taxa, mostly in a northerly direction. Examples of northerly extensions include *Leucopogon parviflorus* (from Nambung to Dongara), *Trymalium albicans* (Lancelin to North Head), *Spinifex hirsutus* (Wanneroo to Gum Tree Bay) and *Stylidium 'maritimum'* (Nambung to Cliff Head). Examples of southerly extensions include *Anthobolus foveolatus* (Cliff Head to North Head) and *Rhagodia latifolia* ssp. *recta* (Port Denison to Leeman).

It should be noted that these range extensions are a reflection of the lack of comprehensive surveys in this area. Recent studies of the Shark Bay area have also provided many range extensions over previously recorded information (M. E. Trudgen pers comm.).

Although few (%) of the native taxa encountered were restricted to the Central Coast (Table 14), almost half of the natives can be considered confined to the coastal or near coastal areas of Australia (Appendix 8). These were recorded according to habitat type:

- strictly on the incipient foredune (e.g. *Cakile maritima*),
- most commonly on the vegetated foredunes (e.g. *Olearia axillaris* and *Scaevola crassifolia*),
- on deflation plains (e.g. *Allocasuarina lehmanniana*), and
- on the Tamala limestone and its associated sands (e.g. *Diplolaena* sp. (Lancelin)).

It was difficult to summarise the distribution ranges simply but it was clear that the Central Coast was one with many overlapping distributions. Many taxa ranged from the Pilbara and Shark Bay area to as far south as:

- the Greenough River mouth (e.g. *Stylobasium spathulatum*),
- the Mt Lesueur area (e.g. *Olearia dampieri* ssp *dampieri*),
- Perth (e.g. *Lepidium lyratogynum*),
- Augusta (e.g. *Melaleuca huegelii*),
- Israelite Bay (e.g. *Guichenotia ledifolia*), and
- further east (e.g. *Gahnia lanigera*).

These were mostly also confined to the coastal areas. Fourteen species have also been found in the Goldfields but not in the south west except on the west coast (e.g. *Zygophyllum simile*, *Pimelea microcephala* and *Santalum acuminatum*). Quite a few taxa extended from Shark Bay to the south west (e.g. *Calothamnus quadrifidus* and *Opercularia vaginata*) and beyond (e.g. *Podolepis canescens*).

Similarly a large number of taxa extended from Murchison River, Kalbarri or Geraldton to various place to the south between Geraldton to the Eastern States. Only a couple of these taxa have also been recorded from inland of the wheatbelt (these were *Lycium australe* and *Cuscuta australis*).

About 90 taxa extended no further north than Dongara and were commonly confined to near coastal areas. About a third of these were restricted to between Dongara and Augusta (e.g. *Grevillea crithmifolia*, *Acacia truncata*, *Diplolaena angustifolia*, *Eucalpytus gomphocephala*, and *Rhagodia baccata* ssp. *dioica*). The rest extend further east again mainly along the coast (e.g. *Agonis flexuosa*, *Pimelea ferruginea* and *Leptorhynchos scabrus*) including to the Eastern States (e.g. *Acrotriche cordata* and *Actites megalocarpa*).

About 180 of the taxa (nearly half) recorded in the Central Coast have also been reported from other States of Australia (Appendix 8). Virtually all of these were from along the southern coastal areas. About one third of these were alien species. Actually only a handful of aliens recorded in the Central Coast have not been recorded from other States.

Eight of the native species (*Bromus arenarius*, *Spinifex longifolius*, *Sporobolus virginicus*, *Isolepis marginata*, *Isolepis nodosa*, *Parietaria debilis*, *Crassula colorata and Crassula peduncularis*) were reported to occur naturally in other countries (Marchant *et al.* 1987).

It can be seen in Appendix 9 that for about 100 taxa either the northern or southern limit to their distribution occurs in the Central Coast. From this data alone it would appear likely that the composition of communities would vary considerably from north to south. While their overall distribution sets the limit to their occurrence in this study, there were clearly other factors determining the local patterns for many species.

Vegetation

Structure

The vegetation of the Central Coast was dominated by shrub communities. These were represented by quite a range of formations although some only occurred in small pockets.

Trees of any stature were uncommon on the Holocene sands. Table 12 showed that just seven species in the area were normally trees. Two other species (*Melaleuca cardiophylla* and *M. huegelii*) also occurred as trees in some parts, even though they were mostly tall shrubs. The trees in the occasional patch were mostly less than 5 m tall but Tuart may exceed this height.

The trees formed Low Forest B or Low woodland B (sensu Muir 1977, see Appendix 2). These mainly occurred on younger dunes. These patches were usually dominated by a single taxon from the following group: Tuart (*Eucalyptus gomphocephala*), *Melaleuca lanceolata*, *M. cardiophylla*, *M. huegelii*, *Callitris preissii*, *Acacia rostellifera*, *Casuarina equisetifolia* and *Banksia attenuata*. The understorey was generally sparse except when the tree cover was lower than 30%.

Several mallees were present (*Eucalyptus obtusiflora*, *E. foecunda* (Coolimba), *E. 'petrensis'*, *E. 'zopherophloia'* and

E. oraria) but only *E. obtusiflora* formed patches of Shrub Mallee of significant area. Mostly these were growing on the Cliff Head deposit. In these patches tall shrubs of *Melaleuca cardiophylla* and *M. huegelii* were often also present. Beneath these there were several sparse strata, generally of shrubs or sedges.

There was a very wide range of structure in shrub dominated communities. Dominant species showed considerable plasticity which makes the strict application of Muir scheme difficult.

Taxa important amongst taller (1.5 m) shrub dominated communities were mainly *Acacia rostellifera, Melaleuca cardiophylla, Allocasuarina lehmanniana* and occasionally *Melaleuca huegelii, Spyridium globulosum, Chamelaucium uncinatum* and *Atriplex isatidea. A. rostellifera* and *M. cardiophylla* commonly formed a Dense Thicket, Dense Heath A or Dense Heath B. These usually had a very sparse understorey, often with only a few scattered herbs. *Acacia rostellifera* also formed more open communities (Thicket Heath A or Heath B), as did *Allocasuarina lehmanniana, Chamelaucium uncinatum, Spyridium globulosum* and *Atriplex isatidea*. Most of these often had a significant stratum of sedges beneath.

The tallest (2 m) shrubs were mainly on young to medium aged dunes. Shrubs between 1 and 2 m were on a range of landforms. Taller shrubs tended to be on the younger land surfaces.

The low (between 0.5 and 1.0 m tall) shrub dominated communities mainly included *Olearia axillaris, Melaleuca acerosa* and *Spyridium globulosum*. These commonly had an emergent tall shrub stratum including taxa such as *A. rostellifera* or *M. huegelii*.

Communities where very low (0.5 m) shrubs formed the principal stratum included a range of dominant taxa. These were usually one to three of the following: *Melaleuca acerosa, M. huegelii, Scaevola crassifolia, *Tetragona decumbens, Thryptomene baeckeacea, Acacia lasiocarpa, Acrotriche cordata, Nemcia reticulata,* and *Frankenia pauciflora*. A Low Sedges or Dense Low Sedges layer was usually present.

These low shrub communities grew on a range of landforms but most prominently in areas of old, medium or even young ages on dunes and Tamala surfaces but on younger areas on beach ridges and Holocene plains.

Although a low sedge stratum was commonly present it was usually subordinate to shrub strata. The most important taxa were *Loxocarya flexuosa, Lomandra maritima, Acanthocarpus preissii*, and to a lesser extent *Lepidosperma angustatum, Conostylis candicans* ssp. *calcicola* and *Gahnia lanigera*. These were more important on older areas on a range of surfaces.

The taller sedge *Lepidosperma gladiatum* dominated several patches near the coast and formed a Sedge or Dense Sedge stratum. This was mostly on younger dunes and beach ridges. A few small winter wet depressions were generally dominated by a combination of taller sedges (*Juncus acutus, Baumea juncea, Leptocarpus aristatus* and *Gahnia trifida*) and the lower sedge *Schoenus nitens*.

The rhizomatus grasses *Spinifex longifolia* and *S. hirsutus* formed a distinct stratum on such areas as the incipient foredune. They were mid-dense and perhaps should be called a Tall Grass as they would probably be classified by Muir (1977) as bunch grasses. (This does not appear entirely satisfactory as their lifeform differs little from many sedges).

Annual herbs were a common occurrence and often formed a mid-dense or dense stratum. These were mainly on young to medium aged surfaces and slightly more common on dunes than other surfaces. These rarely existed in the absence of a shrub stratum.

Again there was difficulty in assigning sub-shrubs (sensu Appendix 7) to the Muir scheme. Probably some such as *Cakile maritima, Opercularia vaginata* and *Calocephalus brownii* should be called herbs when it come to classifying strata, but species such as **Tetragona decumbens* function more as shrubs and have been included accordingly in that treatment. The only significant occurrences where a herb stratum existed alone (except for disturbed areas) was on parts of a deflation plain where *Opercularia vaginata* and *Calocephalus brownii* were the most important species forming Very Open Herbs to Open Herbs. *Cakile maritima* also dominated a stratum on the incipient foredune.

Mosses were recorded at nearly half of the sites. These were most important in areas of low light, usually beneath *Melaleuca cardiophylla, M. huegelii* and/or *Acacia rostellifera*. Mosses were neither collected nor identified.

Communities

The classification resulting from numerical analyses provided some basis for describing the relationships between the vegetation. (There was great difficulty in defining discrete Vegetation Types, see Appendix 14.) However, the geographic patterns were elucidated subjectively. The regions described include more or less unique combinations of groups of relevés based on the present/absence data with a high intra-regional consistency.

Classification

Appendix 10 and Appendix 11 presents the fusion history of the groups of relevés from the present/absence and cover data sets respectively. Also shown for each was a tabulation of the number of relevés from each study Sub-area in each group.

For the purpose of discussion, 134 groups of relevés were recognised from the classification of the presence / absence data and 51 groups and many sub-groups from the classification of the cover data.

Similar but not identical results were produced by the two classifications (Appendix 12). Also shown was a summary of the landforms and formation ages for the groups of relevés

from the present / absence data set. There were a number of consistent groupings of relevés by both classifications. These are described briefly in Table 15.

An attempt to summarise the major influences controlling the floristic composition follows.

Neither classifications was considered entirely satisfactory. For example, the classification based on cover grouped relevés with very high cover of a particular taxon irrespective of what taxa accompanied it. This produced groups variable in floristic composition. On the other hand the presence / absence data produced groups more consistent in floristic composition but, on occasions, with quite different taxa dominating. Appendix 13 provides a tabulated summary of the occurrence of the most common and significant species for most of the 134 Groups derived from the presence / absence data.

There were a number of distinct variables influencing the vegetation in different ways. This, combined with the relatively uniform substrate (calcareous sand), explains the difficulties encountered in defining distinct Vegetation Types.

It was significant that these variables were essentially recognisable in the analyses from both data sets. That from the cover set, however, provided less emphasis on regional variation than did that from presence / absence data. It was considered that the data from the analyses of the presence / absence data was the most relevant. What is presented here will be mostly from that source.

It proved too complex to define specific vegetation types in the traditional sense. The important species and landforms etc. for each of the Groups from the analysis of the presence / absence data are listed in Appendix 14. An attempt was also made to amalgamate these into broader groups which made sense ecologically. These broader groups did not directly reflect the groupings in Table 15.

Figure 13 was the minimum spanning tree from the presence / absence data optimised manually to place the most similar relevés as near as possible to each other without changing any linkages.

The groups from presence / absence data are depicted in Figure 14 which was based on the minimum spanning tree. This figure shows that most of the relevés from the 134 groups and many from the higher level fused groups were adjacent to each other, if not directly connected by the minimum spanning tree as most were.

Table 15 Broad Groupings of Relevés

Broad groupings of relevés consistent between presence / absence and cover data sets.

1. INCIPIENT FOREDUNES, mainly on very young land surfaces, usually dominated by *Spinifex longifolia* and **Tetragona decumbens*, but also in places *Spinifex hirsutus, Atriplex isatidea* or *A. cinerea.*

2. FOREDUNES AND YOUNG BEACH RIDGE PLAINS, mainly on very young to young land surfaces, commonly dominated by *Olearia axillaris* and *Scaevola crassifolia* but also important in some were *Myoporum insularis, Rhagodia baccata* and *Acanthocarpus preissii,*

3. PLAINS, variable depending on age and land surface:

   3a. more or less bare, important species were variable but included one or several of the following: *Calocephalus brownii, Opercularia vaginata, Hibbertia racemosa* and *Scaevola crassifolia,*

   3b. very young, dominance generally was low but main species usually were *Allocasuarina lehmanniana, Spyridium globulosum, Nemcia capitata* or *Dryandra sessilis,*

   3c. young, similar species to 3b. (above), usually quite dominant but also important were *Acrotriche cordata* or *Acacia truncata,*

   3d. older, tended to be dominated by *Melaleuca acerosa* and *M. huegelii* or *M. cardiophylla* or *Thryptomene baeckeacea* or *Dryandra sessilis,*

4. INLAND DUNES, variable depending partly on age:

   4a. younger, tending to be dominated by *Acacia rostellifera* and in some cases *Melaleuca, huegelii* or *M. cardiophylla* tall shrublands, with *Acanthocarpus preissii,* and

   4b. older, with much less *Acacia rostellifera* but with *Melaleuca acerosa* usually dominant with combinations of *Loxocarya flexuosa* and *Lomandra maritima.*

Note: beach ridges over which a mobile sand sheet has passed are included under plains.

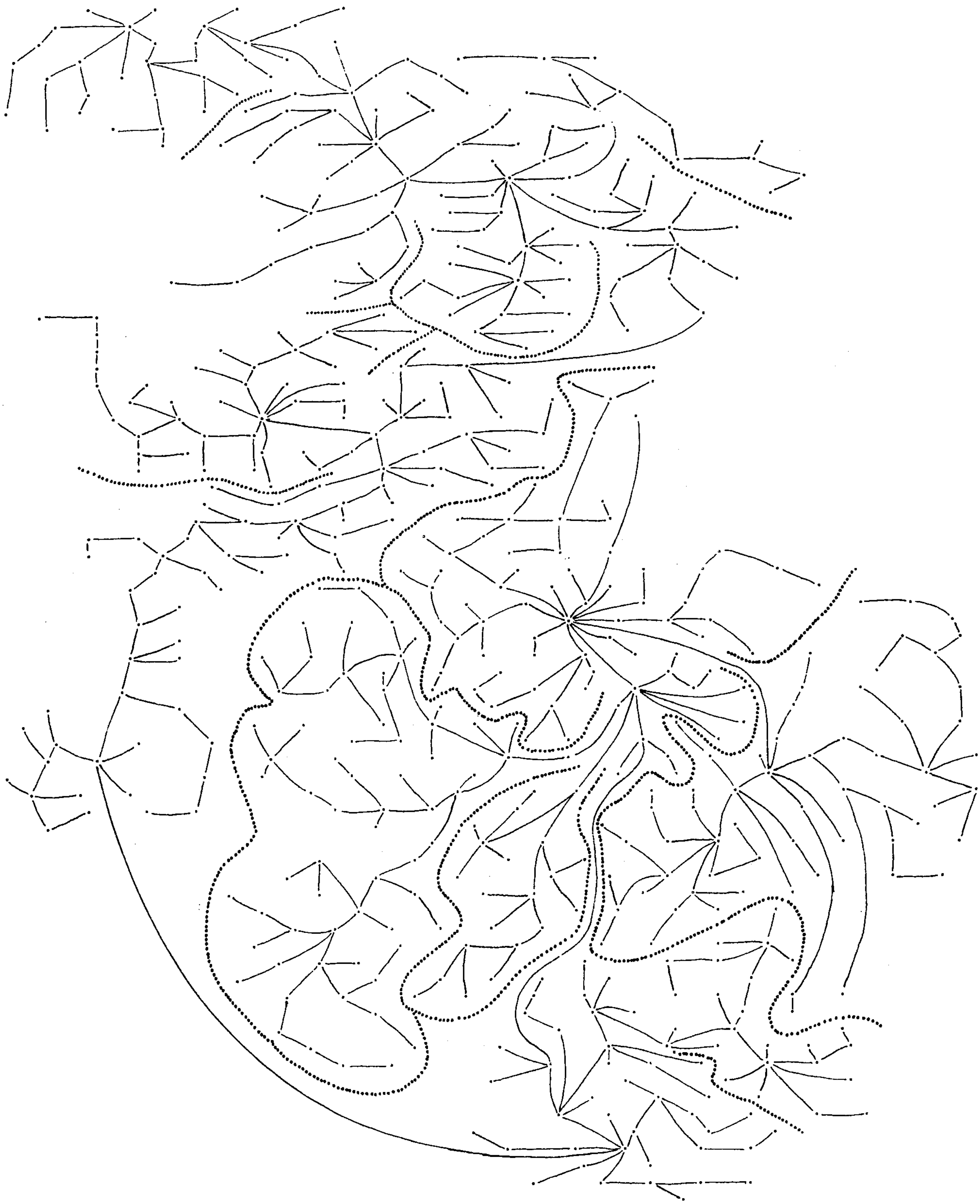


Figure 13 Minimum Spanning Tree from Presence/absence Data

(Relevés joined to most similar other relevé)

(cf. Appendix 15 for plots of important species on this figure)

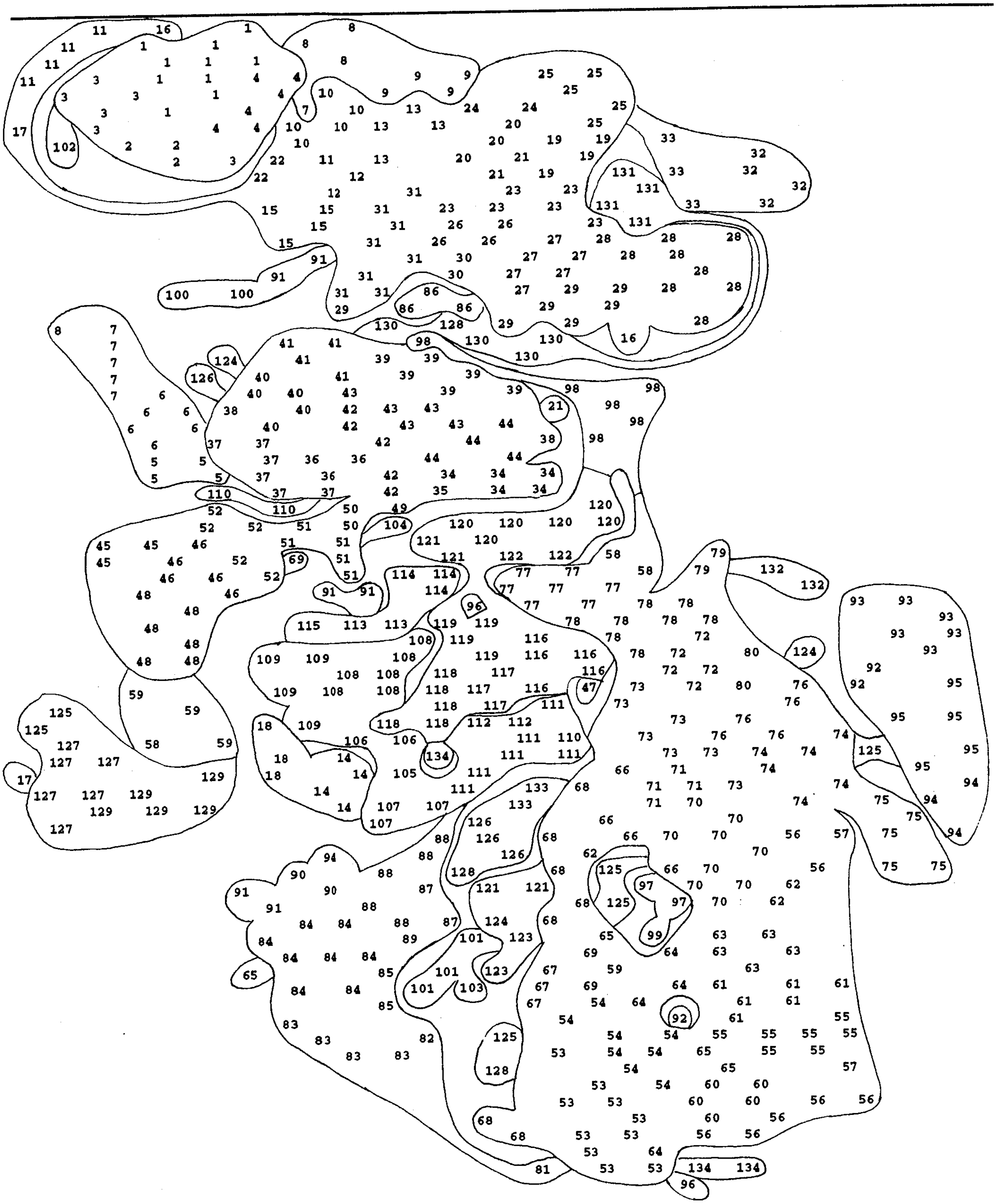


Figure 14 Presence/Absence Groups on Minimum Spanning Tree

(Lines indicate groups of relevés according to fusion shown in Appendix 10)

An indication of the complexity of the floristic patterns can be seen in Appendix 15 which was a series of plots on the minimum spanning tree each showing the cover of one of the more important or common species.

Landform, distance from coast, age since stabilizing and regional variation appear all to have had some influence on the composition of the vegetation.

Figure 15 shows considerable clustering of relevés based on landforms. For example most of the incipient foredunes (WB & WQ) were tightly clustered in this figure. Other landforms were divided into several clusters. Landforms appear, therefore, to be the primary discriminator for only some vegetation types.

Figure 16 shows the distance from the coast of the relevés. By comparison with Figure 15 it can be seen that the beach ridge plain deposits and truncated foredunes were clustered together with other coastal dunes. These near coastal dunes were clustered adjacent to the incipient foredunes.

Figure 17, which shows the inferred age of relevés, indicates clustering, especially of the older ones. A comparison with Figure 15 indicates significant interaction between landforms and age.

Figure 18 shows that relevés with minimal organic matter accumulation (as indicated by Munsell Value) were generally clustered together. There was no clustering of ones with higher levels of organic matter accumulation.

Organic matter accumulation was minimal in the youngest areas. On the other hand, relevés with substantial organic matter accumulation were not necessarily the oldest sites. Commonly these were interdunal areas in particular parts of the Central Coast.

Other parameters investigated, including proportion of carbonate in the soil, slope of dunes, Holocene or Tamala limestone and litter seemed to be not at all important at this level of segregation.

Superimposed on, and possibly dominant to, at least some of the factors indicated above appears to be regional variation. Appendix 10 shows the subdivision of the Central Coast into five Sectors. These were defined subjectively by minimising the occurrence of presence / absence groups in more than one Sector. The Sectors defined were:

- V1. Greenough to Irwin River,
- V2. Port Denison to Gum Tree Bay,
- V3. Gum Tree Bay to north of Jurien,
- V4. North of Jurien to Lancelin, and
- V5. South of Lancelin.

It seemed possible to divide at least some of these further, but the distinction would necessarily have been less clear. Additional divisions may be possible at Cliff Head and somewhere around Trigg.

Figure 19 shows the 20 Study Sub-areas grouped into the five Sectors on the minimum spanning tree. There was strong clustering both of Sub-areas and Sectors. A number of the lines dividing the Sectors coincided with the lines separating the groups of relevés (cf. Figure 14). This co-incidence was strongest for the non-coastal areas and least for coastal areas.

This indicates that the floristic composition of vegetation on the coast was relatively uniform while, even a little inland, the composition was regionally influenced. Appendix 16 provides a series of maps of the Central Coast on which the five Sectors and the 134 presence / absence Groups for each relevé indicated. A comparison with Appendix 10 will assist in appreciating the limited distribution of many of these Groups.

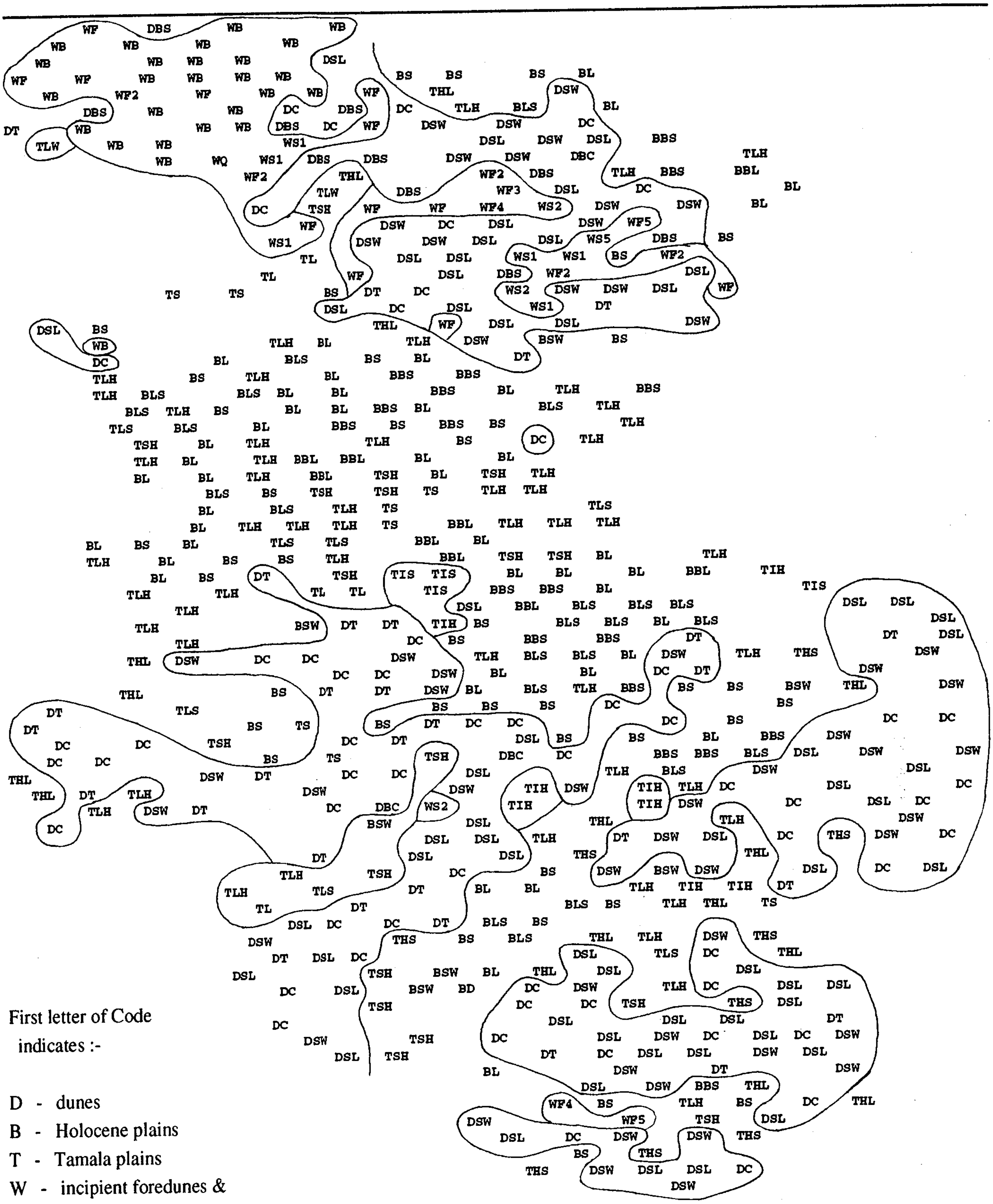
Description of Vegetation

While it was mentioned above that the landforms were not the principal determinants of floristic composition, it was clear that significant aspects of the variation could be explained in terms of them. Four main groups of landforms (incipient foredunes, frontal dunes, plains and dunes) which controlled the vegetation were recognised. The following was a description of the vegetation and main species of these including a perceived progress through time for each. Appendix 13 will assist in following this description. Reference was made to 'typical' presence / absence Groups which are described in Appendix 14.

In each of the main landform types, distinct vegetation successions were noted. The particular successions varied also according to differences in the soil types and regionally. An attempt has been made to define the major successions in each of the Sectors identified in terms of the presence / absence Groups. Since there were few places where a complete succession was present (or accessible) following a particular disturbance, the successions in each Sector were reconstructions using the data from separate disturbances. Care was also necessary in interpreting a succession as many of the mobile sand sheets pass over several soil types during its life.

Each of the successions appeared to follow a similar pattern. First there was a sparse cover which relatively rapidly increased in biomass, cover and height. With the onset of a mature stage the each of these appeared to slightly decline. The species richness appears to gradually increase to a plateau in the mature stage.

Table 16 provides an ordering of presence / absence Groups which were encountered in the different successions on beach ridges, inland dunes and plains for each Sector. It was more difficult to interpret the successions for the coastal dunes in these terms as they were more chaotic in form and difficult to place in an implied sequence. The descriptions below drew heavily from these successions.



First letter of Code indicates :-

D - dunes
B - Holocene plains
T - Tamala plains
W - incipient foredunes & beach ridges

Figure 15 Landforms on Minimum Spanning Tree

(see Table 2 and Appendix 3 for expla nation of codes)

Figure 16 Distance from Coast on Minimum Spanning Tree

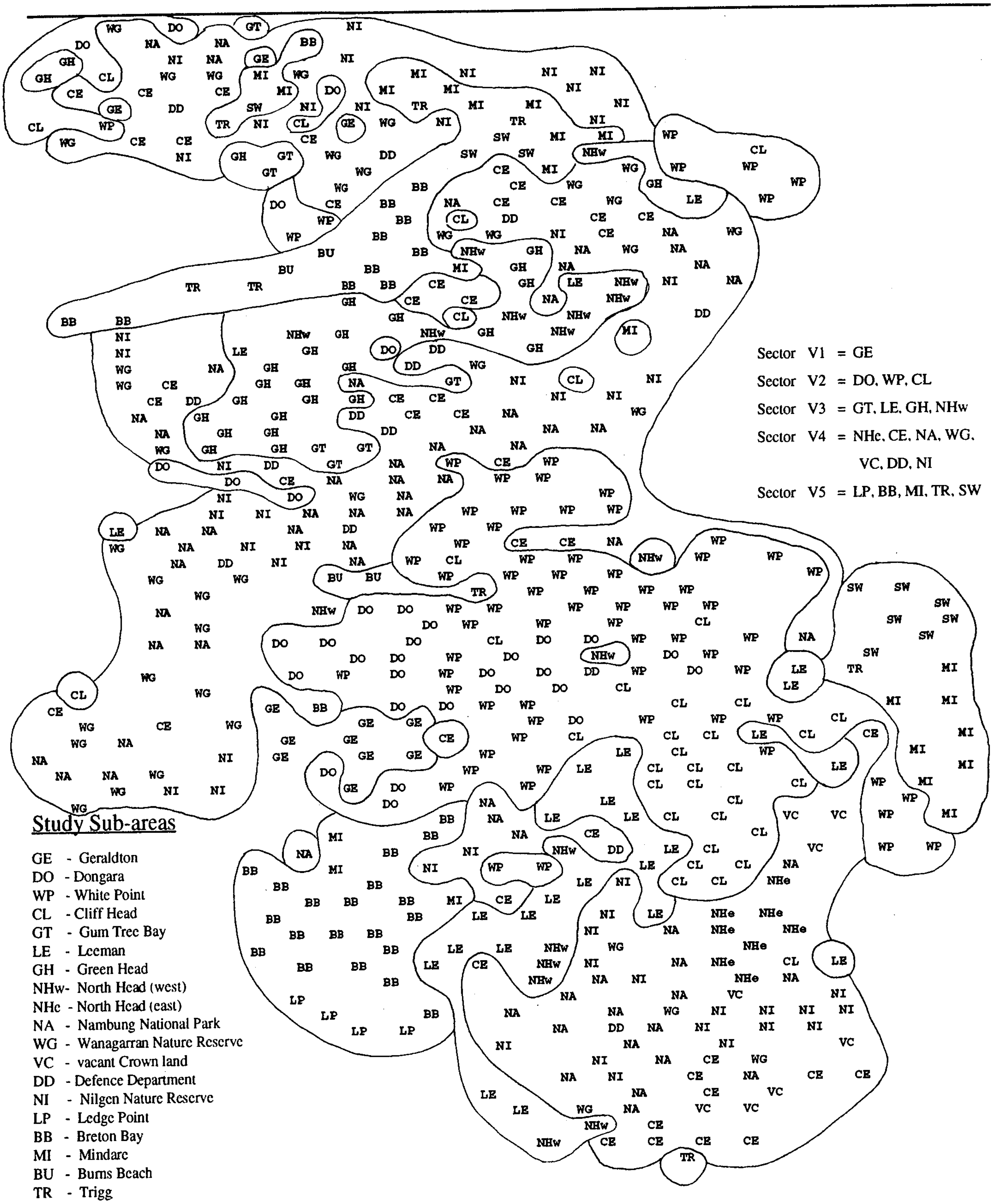
(numbers are coded; 1 - closest .... 8 - most remote)

Figure 17 Inferred Age on Minimum Spanning Tree

(B, V, Y, M, O indicate youngest to oldest, see Table 3)

Figure 18 Munsell Soil Value in Topsoil on Minimum Spanning Tree

(high numbers indicate no or very low organic matter accumulation)



Sector V1 = GE
Sector V2 = DO, WP, CL
Sector V3 = GT, LE, GH, NHw
Sector V4 = NHe, CE, NA, WG, VC, DD, NI
Sector V5 = LP, BB, MI, TR, SW

Study Sub-areas

GE - Geraldton
DO - Dongara
WP - White Point
CL - Cliff Head
GT - Gum Tree Bay
LE - Leeman
GH - Green Head
NHw - North Head (west)
NHe - North Head (east)
NA - Nambung National Park
WG - Wanagarran Nature Reserve
VC - vacant Crown land
DD - Defence Department
NI - Nilgen Nature Reserve
LP - Ledge Point
BB - Breton Bay
MI - Mindarie
BU - Burns Beach
TR - Trigg
SW - Swanbourne

Figure 19 Sectors and Study sub-areas on Minimum Spanning Tree

(letters are Study sub-areas, lines circumscribe Sectors)

Table 16 Vegetation Successions

The successions recognised for the major landforms are presented in terms of the presence / absence Groups. A description of these Groups is provided in Appendix 14. Separate successions were identified for each Sector. It was not possible to place every Group along a one dimensional succession. Some were alternates for different parts of the same Sector, while others represent variation due to differences in the substrate.

The vertical alignment indicates progression over time with early stages of the successions on the left and late stages on the right. Groups at approximately the same stage in each succession are bracketed.

Beach Ridge Plains

Sector

V2:	(3) -> (15) -> (107) ->
V3:	(1) -> (11) -> (22, 27) ->
V4:	(1, 2, 3) -> (10) -> (21, 23, 27, 28) -> (131) -> (53)

Inland Dunes

Sector

V1:	(14) -> (105 to 109) ->
V2:	(14, 16, 17) -> (26) -> (107, 108) -> (111, 112, 113, 118) -> (72 to 75, 70)
V3:	(19) -> (29,30) -> (68, 67) -> (53)
V4:	(17, 26, 28, 29) -> (86, 87) -> (126 to 129, 125, 131, 134) -> (65, 69) -> (54, 53, 55, 56, 57) -> (63, 61)
V5:	(16, 19, 20, 30, 31) -> (87, 88) -> (92 to 96) -> (83, 84)

Plains

Sector

V1:	-> (18) ->
V2:	(5) -> (32, 33, 34) -> 110 -> (120, 121) -> (117, 116, 119) -> (71, 76 to 80)
V3:	(5, 6) -> (36 to 39) -> (40, 41) -> (45) -> (123, 124) -> (66)
V4:	(104, 5, 6, 7) -> (12, 15) -> (25, 34, 35) -> (37, 38, 39) -> (42, 43, 44) -> (49 to 52) -> (48, 45, 46, 47) -> (58 to 64)
V5:	(9) -> (24) -> .... -> (82, 85, 89, 90, 91)

Sectors:

V1.	Greenough to Irwin River,
V2.	Port Denison to Gum Tree Bay,
V3.	Gum Tree Bay to north of Jurien,
V4.	North of Jurien to Lancelin, and
V5.	South of Lancelin.

Note: beach ridges over which a mobile sand mass has passed are included under Plains.

Pelham (1983), who produced the only readily comparable, data defined four stages of succession on the Holocene plains following the progress of a mobile sand sheet:

- 1. *Calocephalus brownii,*
- 2. *Scaevola crassifolia,*
- 3. *Allocasuarina lehmanniana - Acacia lasiocarpa,* and
- 4. *Melaleuca acerosa.*

These stages were relatively consistent for the Holocene plain throughout the Central Coast. There were, however, areas with substrates different from the Holocene plain which did not fit this model.

The following are descriptions of the vegetation on the major landforms

a. Incipient foredunes

The earliest plant species to colonise the incipient foredunes was **Cakile maritima* (Group 2). In such areas the incipient foredune was only slightly raised above the beach. Most commonly also these occurred on quieter (prograding or homeostatic) beaches. In southern Sectors *Cakile* was accompanied occasionally by **Arctotheca populifolia.*

Invading in the same situations were **Tetragona decumbens* and *Spinifex longifolius* throughout and *Spinifex hirsutus* in the south and occasionally *Atriplex isatidea* mostly north of Wedge Island (Groups 1 & 4).

The presence of plants, *Spinifex* in particular, served to accumulate sand blown from the beach. Generally the greater the sand accumulation the higher the proportion of either of the *Spinifex* species which were well adapted to trap and grow through sand. Maze and Whalley (1992) considered that vigorous growth of *Spinifex sericeus* in eastern Australia was stimulated by sand deposition. *Atriplex isatidea* appears also well adapted to these situations.

It was common for these growing incipient foredunes to be truncated presumably by winter storm serges.

Quiet coasts, usually those protected by continuous reefs, commonly had substantial accumulations of seaweed. The vegetation at the landward edge of these seaweed banks were dominated by **Tetragona decumbens* with *Spinifex longifolius, Atriplex cinerea* and to a lesser extent *Atriplex isatidea* (Group 3).

The incipient foredunes were species poor, but most of those species present were more or less confined to it (e.g. **Cakile maritima, *Arctotheca populifolia, Spinifex hirsutus* and *Atriplex isatidea*). *Spinifex longifolius* and **Tetragona decumbens* were often in frontal dunes or mobile sand sheets. *Atriplex cinerea* also grew in some saline environments.

Species more typical of frontal dunes (e.g. *Scaevola crassifolia* and *Olearia axillaris*) seem to have invaded the older incipient foredunes creating floristically transitional areas (Group 10).

b. Frontal dunes and swales

Included in this description are foredunes, both low and high, and the 'young' beach plain ridge and swale sequences. The vegetation on these was variable but it did not seem possible to relate much of this directly to different landform types. Some species (e.g. *Myoporum insularis* and *Spyridium globulosum* (Group 29)) were, however, more common in more sheltered parts of these landforms.

The most significant factor other than age which these areas appeared to have in common was the proximity to the coast. There was also some distinct variation due to different ages of the vegetation which will be described briefly below.

These shrub dominated areas had more species than the incipient foredunes. Dominant species were *Scaevola crassifolia* and *Olearia axillaris* (Groups 10-31). As mentioned above there were areas which were distinct transitions between the vegetation on these landforms and that on the incipient foredunes (Group 10).

Younger areas had only a few species growing on them (*Calocephalus brownii, *Crassula glomerata, Senecio lautus* and *Isolepis nodosus*), (Group 8). Other species which apparently invaded early include *Carpobrotus virescens, Enchylaena tomentosa, Rhagodia baccata* and *Myoporum insularis.*

Older areas were richer with the addition of *Spyridium globulosum, Acanthocarpus preissii, Hardenbergia comptoniana, Conostylis candicans* ssp. *calcicola, *Dischisma arenarium* and **Bromus diandrus* (Groups 26-29) and less consistently species like *Acacia cyclops* and *Lepidosperma gladiatum* (Groups 19-21). The last two were more common in the southern portions of the Central Coast.

Some of these herb and shrub species were more or less confined to the frontal dunes (e.g. *Myoporum insularis, Acacia cyclops* and *Lepidosperma gladiatum*). However, some were also present at their earliest stages of regeneration of the deflation plains (e.g. *Calocephalus brownii, Scaevola crassifolia, Isolepis nodosus, Olearia axillaris, Senecio lautus, Acacia cyclops* and *Spyridium globulosum*). Others were also present on young inland dunes (e.g. *Scaevola crassifolia* and *Acanthocarpus preissii*).

Of interest also was the invasion by species mentioned above of coastal stands of vegetation typical of older landforms (Group 91). *Olearia axillaris* in particular and others such as *Senecio lautus, Hardenbergia comptoniana* and *Rhagodia baccata* are specific examples.

There were a number of species in common with young dunes away from the coast. However, *Acacia rostellifera, Melaleuca huegelii* and *M. cardiophylla* which dominated young dunes inland were not important on most parts of the coast. The absence of these large species on the coast appear to have allowed the shrub species, particularly *Scaevola crassifolia* and *Olearia axillaris,* to dominate.

c. Inland Dunes

This description also covers older beach ridges. As implied above there were differences between the composition of younger and older inland dunes.

The younger dunes had some of the species present on the frontal dunes (e.g. *Acanthocarpus preissii*, *Spyridium globulosum*, *Scaevola crassifolia* and *Senecio lautus*) (Groups 28, 88 & 111). These dunes were mostly dominated by *Acacia rostellifera*, *Melaleuca huegelii* and/or *M. cardiophylla* (Groups 108 & 109) as tall shrublands or even low woodlands but were quite variable in floristic composition. So variable that these stands on younger dunes were more similar to nearby older dunes than they were to each other.

Other dominant species in some areas were *Melaleuca acerosa*, *Allocasuarina lehmanniana* (Group 129) and *Thryptomene baeckeacea*. Species more common on younger dunes than older were *Acanthocarpus preissii*, *Spyridium globulosum*, *Scaevola crassifolia* and *Senecio lautus* as mentioned above plus *Acacia rostellifera* and *Melaleuca cardiophylla*.

The older dunes had much less *Acacia rostellifera* and *Melaleuca cardiophylla* and were mainly dominated by the low shrub *Melaleuca acerosa* with the sedges *Loxocarya flexuosa* and less consistently *Lomandra maritima* (e.g. Groups 61, 75, 84). The other species most commonly present were *Trachymene pilosa*, *Acacia lasiocarpa ssp. lasiocarpa*, *Conostylis candicans* ssp. *calcicola* and *Stipa flavescens*. There was a wide range of accompanying species depending on the Sector of the Central Coast.

Older dunes were richer with the following examples of species more commonly found on older dunes than on younger ones: *Melaleuca acerosa*, *Loxocarya flexuosa*, *Lepidosperma angustatum* and *Lomandra maritima*. On some dunes these species were accompanied by *Calothamnus quadrifidus*, *Chamelaucium uncinatum*, *Podotheca gracilis*, *Podotheca canescens*, *Leptorhynchos scabrus*, *Poa drummondii*, *Danthonia caespitosa*, *Phyllanthus calycinus* or *Gahnia lanigera*. Most of these species were present in only some Sectors of the Central Coast and grew on some plains and young dunes. This resulted in the older stands being floristically more similar to nearby younger stands on dunes or even the vegetation of the plains than to stands on older dunes elsewhere.

Although there were differences in composition which could be related to the age of the dunes, this was not just a simple transition. Of particular note was the apparent differentiation within the same dunes. Figure 5 indicates that *Acacia rostellifera* might cover young dunes but it declines or disappears more quickly from the crest of the dunes than from the toe. This phenomenon was also noted for *Melaleuca cardiophylla* and *M. huegelii*. It was common for 'medium' aged dunes to have a narrow strip of these species growing along the base of the dunes trailing the mobile sand sheet, particularly south of Port Denison. It was suggested, therefore, that the top of these dunes provide inadequate moisture to support these taller shrubs (or small trees), but this may be only part of the story.

For several species the upper windward slope seemed to be the only part of the dune on which they grew. It was noted earlier (Table 6) that windward slopes were less steep than leeward slopes. The summary in Table 17 confirms the apparent preference of a number of species (*Acrotriche cordata*, *Lysinema ciliatum*, *Pimelea ferruginea*, *Nemcia reticulata*, *Santalum acuminatum*, *Opercularia vaginata*, *Isotoma hypocrateriformis*, *Leucopogon parviflorus* and *Acacia truncata*) for the windward slopes. What drew attention to them in the first place was the apparent preference of some of them for growing on plains (see Table 19 below).

On the other hand one species especially preferring younger ages of plains, *Allocasuarina lehmanniana*, showed no such preference for the windward side of dunes. It only occurred on dunes in the south of the Central Coast.

The fewer species which appeared to show preference for the leeward slopes and toes (*Acanthocarpus preissii*, *Spyridium globulosum*, and *Acacia rostellifera*) were generally ones which grew more commonly on younger dunes. This accords with the description above regarding the differential changes in composition of dunes with time.

d. Plains

Included here are relatively flat areas which remained after the progress of the mobile sand sheets. These were mostly shallow calcareous sands over a lithified layer of calcareous Holocene sands, or very shallow calcareous sand over Tamala limestone, or yellow siliceous (with traces of carbonate) sand over Tamala limestone. Descriptions of several, distinctive communities (wetlands and mallees) growing on these plains are provided at the end of this section.

The vegetation of these plains was generally distinct from that of dunes (frontal or inland), particularly for the areas of 'young' to 'medium' ages. There was a clear succession of vegetation from the earliest colonisation to a climax vegetation. Typically the climax vegetation was dominated by *Melaleuca acerosa* and *M. huegelii*. While the succession was not identical throughout the Central Coast or even within a Sector, there were some fundamental similarities.

The earliest colonising species included *Opercularia vaginata*, *Calocephalus brownii*, *Senecio lautus*, *Hibbertia racemosa*, and *Isolepis nodosus* (Groups 5, 6, 7, 8, 24, 104) but generally not all of them at one location. These were followed by *Scaevola crassifolia*, *Isotoma hypocrateriformis*, *Spyridium globulosum*, *Conostylis candicans* ssp. *calcicola* and *Allocasuarina lehmanniana* (Groups 32 - 38). *Calocephalus brownii* and *Isolepis nodosus* occurred in the relatively young stands only and more often where some loose sand had endured. The others remained longer, even until the climax (*Isotoma hypocrateriformis*, *Senecio lautus* and *Conostylis candicans* ssp. *calcicola*), while the rest increased in importance before declining before the climax. Within this latter group *Allocasuarina lehmanniana* was the classic as it dominated the communities apparently for some time but was virtually absent in the climax vegetation.

These early species appeared to be progressively joined by a large range of others. Amongst the next to invade were:

- *Cassytha racemosa, C. aurea, Leptomeria preissiana* and *Acacia cyclops* (Groups 36- 38) which declined in importance before climax was reached,
- *Acrotriche cordata, Acacia truncata, Dryandra sessilis, Leucopogon parviflorus, L. insularis* and *Nemcia reticulata* (Groups 39-44) which remained throughout followed by,
- *Acacia lasiocarpa, Melaleuca acerosa, M. huegelii, M. cardiophylla, Stylidium junceum, Leptorhynchos scabrus, Loxocarya flexuosa, Pimelea ferruginea* and *Lysinema ciliatum* (Groups 45-52),
- followed lastly by such as *Santalum acuminatum, Schoenus lanatus, Thomasia cognata, Dodonaea aptra, Gahnia lanigera, Opercularia spermacoea,Lepidosperma angustatum* and *Leptomeria spinescens* (Groups 58-64, 76-80, 85).

Table 18 indicates the probable changes through time in the importance of examples of the above species.

Some of the earliest colonising species were ones which were typical of beach or frontal dunes (*Calocephalus brownii, Scaevola crassifolia* and *Isolepis nodosus*). *Spyridium globulosum, Conostylis candicans* ssp. *calcicola* and *Senecio lautus* were species present commonly on dunes. Most of the other early species were generally restricted to the plains (Table 19).

Table 17 Examples of differential occurrence of species on dunes

Separate Table for each species;
Values are number of relevés for particular combination (below) where species was present -
Horizontal - Inferred Age (B = youngest, O = oldest)
Vertical - parts of the dunes (DC - crest, DSW - windward slope, DSL - leeward slope, DT - toe)

Species organised to emphasise different apparent preferences for the Windward Slope, for neither slope, and then for the Leeward Slope.

Number of sites

	B	V	Y	M	O	
DC	2	4	21	26	5	58
DSW	0	5	21	26	2	54
DSL	2	6	23	27	2	60
DT	0	0	13	15	1	29

Acrotriche cordata

	B	V	Y	M	O	
DC	0	0	1	1	0	2
DSW	0	0	2	3	1	6
DSL	0	0	0	0	0	0
DT	0	0	1	0	0	1

Lysinema ciliatum

	B	V	Y	M	O	
DC	0	0	0	2	0	2
DSW	0	0	1	3	0	4
DSL	0	0	0	0	0	0
DT	0	0	1	0	0	1

Pimelea ferruginea

	B	V	Y	M	O	
DC	0	0	1	5	0	6
DSW	0	0	4	6	1	11
DSL	0	0	2	2	0	4
DT	0	0	1	0	0	1

Nemcia reticulata

	B	V	Y	M	O	
DC	0	0	1	4	1	6
DSW	0	2	11	6	0	19
DSL	0	0	1	3	1	5
DT	0	0	1	0	0	1

Santalum acuminatum

	B	V	Y	M	O	
DC	0	0	5	3	0	8
DSW	0	0	7	8	0	15
DSL	0	0	3	5	0	8
DT	0	0	2	0	0	2

Opercularia vaginata

	B	V	Y	M	O	
DC	0	0	3	10	3	16
DSW	0	0	9	10	0	19
DSL	0	1	4	6	0	11
DT	0	0	0	1	0	1

Isotoma hypocrateriformis

	B	V	Y	M	O	
DC	0	0	1	9	1	11
DSW	0	0	3	7	2	12
DSL	0	0	1	3	1	5
DT	0	0	2	3	1	6

Leucopogon parviflorus

	B	V	Y	M	O	
DC	0	0	4	9	1	14
DSW	0	1	12	9	0	22
DSL	0	1	5	7	0	13
DT	0	0	5	2	0	7

Allocasuarina lehmanniana

	B	V	Y	M	O	
DC	0	0	5	1	0	6
DSW	0	0	3	1	0	4
DSL	0	1	2	2	0	5
DT	0	0	2	1	0	3

Hibbertia racemos

	B	V	Y	M	O	
DC	0	0	3	6	1	10
DSW	0	0	5	14	0	19
DSL	0	0	6	12	1	19
DT	0	0	1	3	0	4

Melaleuca acerosa

	B	V	Y	M	O	
DC	0	0	10	24	5	39
DSW	0	0	10	23	2	35
DSL	0	0	12	26	2	40
DT	0	0	5	12	1	18

Acanthocarpus preissii

	B	V	Y	M	O	
DC	0	1	19	14	4	38
DSW	0	4	14	15	2	35
DSL	0	4	20	15	1	40
DT	0	0	10	8	0	18

Spyridium globulosum

	B	V	Y	M	O	
DC	0	1	9	8	0	18
DSW	0	1	10	3	0	14
DSL	0	4	11	7	1	23
DT	0	0	7	9	0	16

Acacia rostellifera

	B	V	Y	M	O	
DC	0	3	12	16	1	32
DSW	0	4	3	12	2	21
DSL	0	3	9	15	1	28
DT	0	0	7	11	1	19

Table 18 Examples of changes in importance of species on Deflation plains

Separate Table for each species;
Values are number of relevés for particular combination (below) where species was present -
Horizontal Axis - Cover Abundance Scale (1 = < 1%, 7+ = 33%)
Vertical Axis - 'Apparent Age' (B = youngest, O = oldest)

Some data will reflect differences in the number of relevés of different Ages
(B - 32, V - 44, Y - 78, M - 96 and O -22).

Species ordered to emphasise different rates of 'colonisation'.

Calocephalus brownii

	1	2	3	4	5	6	7+
B	3	3	3	7	3	.	.
V	2	.	1	.	.	.	1
Y	.	.	.	1	.	.	.
M	.	.	.	.	.	.	.
O	.	.	.	.	.	.	.

Isolepis nodosus

	1	2	3	4	5	6	7+
B	8	6	3	4	2	.	.
V	8	3	3	1	.	.	.
Y	4	1	.	.	.	.	.
M	.	2	.	.	.	.	.
O	1	.	.	.	.	.	.

Scaevola crassifolia

	1	2	3	4	5	6	7+
B	1	4	5	6	1	.	.
V	2	11	8	2	.	.	1
Y	2	4	4	1	1	1	1
M	.	.	1	.	.	.	.
O	.	.	2	.	.	.	.

Allocasuarina lehmanniana

	1	2	3	4	5	6	7+
B	.	3	1	1	.	1	1
V	.	9	9	8	6	1	1
Y	1	8	12	9	8	8	4
M	2	2	6	2	2	.	.
O	.	.	.	.	.	.	.

Leptomeria preissiana

	1	2	3	4	5	6	7+
B	4	1	.	.	.	.	.
V	3	14	7	1	1	.	.
Y	.	13	2	1	.	.	.
M	1	7	1	1	.	.	.
O	.	.	1	.	.	.	.

Acrotriche cordata

	1	2	3	4	5	6	7+
B	2	1	.	.	.	.	.
V	1	10	9	2	.	.	.
Y	1	9	8	9	6	.	.
M	.	5	.	2	.	.	.
O	.	1	1	.	.	.	.

Leucopogon insularis

	1	2	3	4	5	6	7+
B	.	1	.	.	.	.	.
V	2	11	4	.	.	.	.
Y	2	23	8	4	.	.	.
M	1	20	11	.	.	.	.
O	.	3	4	.	.	.	.

Acacia lasiocarpa

	1	2	3	4	5	6	7+
B	.	.	.	.	1	.	.
V	.	8	9	3	2	.	.
Y	1	7	19	8	7	.	1
M	1	15	29	16	3	.	1
O	.	1	6	5	.	.	.

Nemcia reticulata

	1	2	3	4	5	6	7+
B	.	2	2	1	1	.	.
V	1	4	3	1	1	2	1
Y	2	11	9	3	1	.	.
M	.	8	3	1	.	.	.
O	1	6	1	.	.	.	.

Loxocarya flexuosa

	1	2	3	4	5	6	7+
B	.	.	.	.	.	.	.
V	1	2	1	3	2	1	.
Y	.	3	7	1	4	.	.
M	1	5	19	19	15	7	3
O	.	3	3	1	2	.	3

Melaleuca acerosa

	1	2	3	4	5	6	7+
B	.	.	.	.	.	.	.
V	.	5	7	2	1	1	.
Y	.	12	5	7	12	6	3
M	1	4	14	7	14	22	22
O	.	1	3	.	3	4	2

Melaleuca huegelii

	1	2	3	4	5	6	7+
B	.	.	.	.	.	.	.
V	1	1	1	1	.	.	1
Y	1	3	9	5	.	3	9
M	.	3	10	7	5	9	12
O	.	4	2	.	.	1	2

Lepidosperma angustatum

	1	2	3	4	5	6	7+
B	.	.	.	.	.	.	.
V	.	1	.	.	.	.	.
Y	.	2	4	4	1	1	.
M	.	7	18	15	11	6	5
O	.	1	3	3	1	1	.

Dodonaea aptra

	1	2	3	4	5	6	7+
B	.	.	.	.	.	.	.
V	.	1	.	.	.	.	.
Y	.	.	.	.	.	.	.
M	1	3	5	.	2	2	.
O	.	1	.	.	2	.	.

Gahnia lanigera

	1	2	3	4	5	6	7+
B	.	.	.	.	.	.	.
V	.	.	.	.	.	.	.
Y	.	.	.	.	.	.	.
M	1	3	1	.	.	1	5
O	.	.	1	1	3	2	.

Table 19 Species fidelity for Deflation plains

(Species relatively common on plains, both Tamala and Holocene; ones with greatest fidelity mentioned first)

	P*/T*	%
Dryandra sessilis	19/19	1.00
Thomasia cognata	15/16	0.94
Schoenus pleistemoneus	28/30	0.93
Acrotriche cordata	67/76	0.88
Leptomeria spinescens	20/23	0.87
Allocasuarina lehmanniana	105/123	0.85
Melaleuca huegelii	90/107	0.84
Lysinema ciliata	29/36	0.81
Acacia truncata	61/76	0.80
Isotoma hypocrateriformis	136/171	0.80
Leptomeria preissiana	58/74	0.78
Stylidium junceum	35/46	0.76
Dodonaea aptra	14/19	0.74
Leucopogon insularis	94/129	0.73
Cassytha aurea	34/47	0.72
Gahnia lanigera	18/25	0.72
Melaleuca cardiophylla	59/82	0.72
Schoenus lanatus	26/36	0.72
Leucopogon parviflorus	123/182	0.68
Pimelea ferruginea	42/64	0.66
Nemcia reticulata	65/103	0.63
Opercularia vaginata	97/153	0.63
Santalum acuminatum	59/93	0.63
Thryptomene baeckeacea	18/29	0.62
Spyridium globulosum	133/223	0.60
Leptorhynchos scabrus	44/76	0.58
Acacia lasiocarpa	143/256	0.56
Hibbertia racemosa	68/124	0.55
Loxocarya flexuosa	106/197	0.54
Melaleuca acerosa	158/296	0.53
Isolepis nodosus	46/89	0.52
Acacia cyclops	21/41	0.51
Opercularia spermacoea	53/106	0.50
Lepidosperma angustatum	84/172	0.49
Conostylis candicans ssp. *calcicola*	127/263	0.48
Senecio lautus	116/266	0.44
Scaevola crassifolia	58/150	0.39
Calocephalus brownii	13/48	0.27

P*/T* - Number of relevés on plains / Total for each species mentioned

Total Number of relevés on plains / Total Number of relevés (263/565) = 0.47

Although many of the later invading species were found most commonly on plains, there was a significant group of species which were typical also of the climax dune vegetation (e.g. *Melaleuca acerosa, Loxocarya flexuosa* and *Lepidosperma angustatum*). This explains why the classification of the floristic composition of the relevés indicated a convergence of floristic composition of the older vegetation on plains and dunes.

Both Tamala and Holocene surfaces were represented in many of the vegetation units typical of these plains. It could be concluded that, at this level of investigation, differences in the underlying substrate did not appear to be much use in segregating the vegetation. This may be because most of the Tamala limestone sampled had no yellow sand but essentially the same calcareous soil between its fissures as was above the lithified Holocene layers.

Apparently supporting this, there were only a few of the 37 most commonly occurring species investigated which showed any preference for plains of either Tamala or Holocene substrates. Clearly *Dryandra sessilis* preferred Tamala surfaces as apparently did *Dodonaea aptra* and *Pimelea ferruginea*. *Acacia cyclops* seemed possibly to prefer Holocene surfaces. *Nemcia reticulata* was relatively more common on Holocene surfaces, particularly on plains developed on weakly lithified beach deposits close to the present coast.

There were a number of species found only a couple of times in this study which appeared to showed a distinct preference for Tamala surfaces (*Grevillea olivacea, Beyeria viscosa, Grevillea thelemanniana* ssp. *preissii, Eucalyptus obtusiflora, Lasiopetalum oppositifolium, Allocasuarina humilis, Dryandra nivea, Banksia attenuata, Tetraria octandra, Hibbertia hypericoides, Hakea lissocarpha, Bossiaea eriocarpa, Jacksonia* sp. aff. *spinosa, Labichea cassioides, Logania* ? *vaginata, Mesomelaena pseudostygia, Conospermum stoechadis, Acacia spathulifolia, Hibbertia spicata* ssp. *leptotheca, Banksia leptophylla, Petrophile serruriae* and *Hakea trifurcata*) (Groups 81, 82). As indicated in the species list (Appendix 8), most of these were more typical of the Tamala limestone than of the Holocene sands.

Most of those were found along the eastern margins of the Central Coast. Although most were found clearly in an areas over which Holocene dunes had passed, the soil was usually yellow Tamala silica sand but with pH slightly more alkaline. This was clearly the residual of truncated Pleistocene soils.

Of particular note were areas of mallee vegetation (*Eucalyptus obtusiflora*) (Groups 114, 132 & 133). These were growing on brown loamy soils of the Cliff Head deposit, sometimes with a veneer of Holocene sand. The climax form of this community was the only age observed. The absence of most species mentioned earlier as typical of plains makes this floristically distinct from most other parts of the plain. There were several species restricted to these areas (e.g. *Eucalyptus obtusiflora* and *Lasiopetalum oppositifolium*). *Melaleuca* *cardiophylla* and *M. huegelii* were usually an important part of this community.

Just a few species showed preference for Holocene plains (*Melaleuca brevifolia, M. viminea, Baumea juncea, Leptocarpus aristatus, Gahnia trifida, *Juncus acutus* and *Schoenus nitens*). These were almost entirely associated with winter wet depressions within the Holocene plain.

Also of note are wetlands which formed (or reformed) in the wake of mobile sand sheets. These also were quite distinct from the other areas. One group formed close to the coast, usually on beach deposits just inland from trailing dune left by mobile sand sheets. These areas had negligible lithification and were very close to, if not below the winter watertable. Several sedges (e.g. *Baumea juncea, *Juncus acutus* and *Schoenus nitens*) (Group 103) appear to quickly invade these wet areas. They have few species in common with the descriptions above.

Another group of communities occurred where mobile sand sheets had passed over pre-existing saline lakes. Sedges also appear to quickly invade these areas. Although these were given only a cursory examination during this study they appeared quite different. Where deep sand appears to have been deposited over these salt lakes, a suite of species (*Melaleuca brevifolia, M. viminea, M. lanceolata, Baumea juncea, Leptocarpus aristatus* and *Gahnia trifida*) (Group 101) were commonly present. Sometimes these were quite distinct communities e.g. dominated by the melaleucas, or just present with many species typical of the plains.

Description of Regional Variation

It was mentioned above that much of the variation in the composition of the vegetation in the Central Coast had a significant regional pattern. Appendix 9 provides an indication that many species were found in only part of the Central Coast. Appendix 17 provides a brief description of the variation in the vegetation types in each Sector.

Some of the variation appears to be due to the overlap in distribution of many species, especially those which terminate somewhere in the Central Coast. Most obvious were species like *Spinifex hirsutus, *Pelargonium capitatum, Agonis flexuosa,* and *Conostylis pauciflora* ssp. *euryrhipis* which occurred only in the south of the Central Coast and *Angianthus* aff. *milnei, Anthobolus foveolatus, Diplolaena* sp. (Kalbarri), which occurred only in the north.

Part of the variation was clearly related to the uneven distribution of substrates within the Central Coast, e.g. saline lakes with such as *Melaleuca brevifolia, Leptocarpus aristatus* and *Gahnia trifida* and the loamy soil of the Cliff Head deposit which supports *Eucalyptus obtusiflora* and others.

Some distributions appeared more related to other factors. *Acacia rostellifera* and a number of the weeds were more important in both the south and the north of the Central Coast than in the centre. This may relate to these areas disturbance history, e.g. having been settled and grazed longer. On the other hand, this may be related to differences in soil type, perhaps higher silica composition (cf. Appendix 3). However, silica per se, being inert, probably has little influence.

The distribution of *Gahnia lanigera* was of interest. It occurs as far south as Esperance but in the Central Coast was found only between Port Denison and Illawong. Its distribution here appeared to parallel the distribution of *Eucalyptus obtusiflora* while mostly growing in Holocene sand, but not in the Cliff Head deposit. The major occurrences of *Thryptomene baeckeacea* was also parallel the distribution of *Eucalyptus obtusiflora,* but grew in sand or Tamala limestone.

A comparison with other studies supports the conclusion of significant regional variation. The vegetation of the more inland (and generally older) Holocene dunes south of Perth (e.g. the Mandurah coast, Trudgen 1991) seemed quite different even though a number of the dominant species (*Melaleuca acerosa, Lomandra maritima, Acacia rostellifera*) were shared.

A number of species important on these older Holocene dunes at Mandurah were absent from the Central Coast (*Diplolaena dampieri*) or only in the most southern Sector (V5) (*Acacia cochlearis, Diplolaena dampieri, Acacia saligna* and *Agonis flexuosa*).

On the other hand the vegetation of the beach and foredunes of the Central Coast were relatively similar to those at Mandurah.

Discussion

While there were as few as twenty or thirty species ubiquitous on Holocene sandy deposits between Perth and Geraldton, this study has demonstrated that there was considerable variation in the composition of this vegetation. In essence this was a complex interaction between landforms, seral time stage following deposition, distance from coast, moisture status and certain regional aspects.

The study examined these factors and a few warrant further discussion.

Classification of Regional Variation

On the basis of vegetation and flora, this study has divided the vegetation of Holocene sandy deposits of the Central Coast into five Sectors (Appendix 17). Undoubtedly the geomorphology has influenced the interpretation of these Sectors. The classification of the Central Coast on the basis of geomorphology alone (Appendix 5) provided 8 sectors. These seemed to accord quite well with the boundaries for the Sectors from the floristic units (see Appendix 10).

Other Studies

Most earlier studies recognised fewer units on the Central Coast (Table 20); the number of units and their features differ from study to study.

Sauer (1965) divided his study of the west coast between Port Headland and east of Albany into 5 sectors. Although this was probably reasonable for the level of that study, his division was based not on analysis of species distributions but an intuitive combination of things including climate and landforms. The boundaries between his sectors should not be taken literally. Of significance, however, to the present study is his suggestion that the vegetation in the Geraldton area was different from that further south.

Each of the four other studies (Table 20) appear to have recognised only part of the variation. Their boundaries appear to be reasonably supported by the present study, however, a number of their units appeared heterogeneous.

An interesting point is the degree of similarity between the sectors produced on the basis of composition of swash zone sands (Sanderson 1992) and those from terrestrial geomorphology and vegetation parameters. This accord would be based on the nature of the sands in the swash zone.

A correlation would be particularly significant where the swash zone contained substantial reworked terrestrial material. A terrestrial character can be maintained for a substantial time after the most recent shoreline erosion. This relates to the differential residence time in the swash zone of different sized particles. Inferring from the discussion of Figure 6 it is concluded that coarse particles (> 0.5 mm) such as silica sand can have a long residence time in the swash. Hence the presence or absence of such sand in the reworked terrestrial material would be reflected in the composition of the swash for some time.

Keighery and Alford (in prep.) considered that the islands between Dongara and Lancelin showed no geographic trends in floristic composition.

Description

It is concluded that the regional variation in the composition of vegetation was determined in part by changes in the geology and geomorphology of the Central Coast. The Greenough to Port Denison Sector (V1) was influenced by the sediment discharges from the Greenough and Irwin rivers. These are relatively fertile as indicated by the agronomic desirability of the Greenough flood plain. By inference, the Holocene sands in this Sector are probably more fertile than the sands further south. This has allowed species such as *Acacia rostellifera* to flourish on both young and old dunes. This in turn has almost certainly been the reason why parabolics of accumulation have been the predominate landform in this Sector.

The Port Denison to Gum Tree Bay Sector (V2) can be related to the Cliff Head deposit. This area supports the unique occurrence along the west coast of the mallee vegetation dominated by *Eucalyptus obtusiflora*. Where the Holocene sand sheets have passed over these areas some of the Cliff Head deposit soil has been incorporated. The subsequent vegetation has been influenced by this and the truncated Cliff Head deposit soil profile below.

It in not currently possible to offer an explanation why the vegetation on the Holocene plain in this Sector would follow the same regional pattern. Clearly there would have been very little direct influence from the adjacent Cliff Head deposit and its soils. The calcareous sands on this plain have undoubtedly come via the sea from areas further south.

It is reasoned, therefore, that two local factors have influenced the composition of the vegetation on the Holocene plain in Sector V2. Firstly some species have invaded from the adjacent Cliff Head deposit. Secondly, the block of Cliff Head deposit south of Cliff Head which reaches almost to the coast and which was virtually free of Holocene sand has formed something of a barrier to the migration of species along the coast. Appendix 9 indicates that a significant group of species extend no further north than Green Head or Leeman.

The Gum Tree Bay to north of Jurien Sector (V3) appears to also be influenced by the Cliff Head deposit. This was despite most of it having being removed by the marine incursion in early Holocene. The Tamala limestone residues forming the majority of the coastline in this Sector supports vegetation which was virtually absent further south (e.g. *Thryptomene baeckeacea*). The extensive lagoonal (including salt lake) deposits in this Sector may have also contributed to the particular local composition of the vegetation.

There has clearly been migration of species onto the Holocene plain in this Sector from areas to the South (Appendix 9). The lack of areas with calcareous Holocene sand over Tamala yellow sand in this Sector may have contributed to distinctive nature of this Sector.

The Sector from north of Jurien to Lancelin (V4) was dominated by a Holocene plain backed by areas of Tamala yellow sand and limestone much overridden by calcareous Holocene sand sheets. There was no evidence of the Cliff Head deposit present in the more northern Sectors. However, as it was argued earlier in this document, it may have once been present in this Sector and its eastern limit approximated the eastern boundary of the Holocene plain.

Some vegetation types were restricted to this plain and, therefore, extend no further to the south. However, a reason for the regional patterns within the areas underlain by Tamala yellow sand is less clear. The Holocene dunes perched on Tamala Limestone were more or less continuous from the Swan River to north of Jurien.

As indicated above, the Sector south of Lancelin (V5) has no Holocene plain and much of the coast was outcropping Tamala limestone. Most of the older and some of the younger dunes were high in silica. Many of the dunes in this Sector are best described as parabolics of accumulation, where as all but the coastal dunes in the Sector north of Lancelin are parabolics of

Table 20 Divisions of the Coast

Comparison of various attempts to divide the Central Coast into 'homogeneous' parts.

LOCATION	VEGETATION STUDIES: Sauer	Beard	present	GEOMORPHOLOGY STUDIES: present	Semeniuk	Sanderson	Tinley
Greenough River		*Greenough*	===	===			
			V1	G1			
Port Denison			---------	---------	===		===

	Central West		V2	G2			
Cliff Head				---------		===	---------
				G3			
Gum Tree Bay		*Cliff Head*	---------	---------			
			V3	G4	*Wedge Island - Dongara*	---------	
Green Head		---------					
N of Jurien			---------	---------			---------
				G5		---------	
Cervantes							
Grey				---------			
			V4	G6			
N of Wedge Island				---------		---------	
				G7			
	---------	*Guilderton*					
Lancelin			---------	---------	---------		
	South West		V5	G8	*Whitfords - Lancelin*		
Ledge Point						---------	
Moore River						===	
Whitfords					---------		===
Swan River		---------	===	===	*Cape Bouvard - Trigg*		
		Rockingham					

--------- indicates division between sectors; === indicates limit of particular study

Names are those provided by respective authors.

Sources (Vegetation Studies):

Sauer (Sauer 1965);
Beard (Beard 1976a, 1976b, 1979a, 1979b, 1981; and Beard and Burns 1976;
present (Appendix 10, 17)

Sources (Geomorphology Studies):

present (Appendix 5)
Semeniuk (Semeniuk *et al.* 1979);
Sanderson (Sanderson 1992)
Tinley (Tinley 1992)

deflation. Ones in the south were generally taller and extended a relatively short distance inland compared to those to the north.

Within this Sector (V5) there was significant variation in composition of the vegetation suggesting further subdivision might be reasonable. There were a number of species at their northern limit in this Sector (Appendix 9). Most obvious were *Callitris preissii* and *Agonis flexuosa*. Such large species may have been limited to this Sector by a combination of depth of dunes and declining rainfall. Some, but not all, of the distinctive nature of the composition of vegetation in this Sector would come from the relatively higher importance of alien species.

It was concluded that there was recognisable regional variation in the composition of the vegetation growing on the Holocene deposits. The older and more inland areas were the most distinct from each other. The vegetation of the beach and incipient foredunes while being relatively uniform still often retained a regional character.

It must be emphasised that this study showed that setting aside a narrow strip of coastal dunes for the protection of landforms and property does not serve to protect the regional variation in the vegetation. When planning a conservation area which would be regionally representative, it is important that it include the older and inland Holocene deposits not just the beach and foredunes.

Vegetation Mapping

McArthur and Bartle (1980a) reported differences between dunes of different ages and the vegetation they support. While their study covered only the southern part of the Central Coast, the thrust of their findings was supported by this Study.

It was not always possible to demonstrate more than three broad age groups in all areas. Nor was it possible to suggest whether the different relative ages were consistent throughout. Several other points were clear. Age was not the primary determinant of vegetation or flora of an area. The location, whether it be coastal or more inland, or which Sector was more important.

Extrapolation of vegetation types from landforms based on inferred ages (i.e. dune morphology) is not reliable. On the one hand young inland dunes (Q4) will be quite different from young coastal dunes even within the same Sector. Older inland dunes (Q1 and Q2) are likely to be different in different Sectors. But young coastal dunes (Q4 and even Q3) might well be quite similar across a range of Sectors.

While deflation plains were readily distinguishable from the dunes, the vegetation they support varied considerably. It is reasonable to recognise different age related (e.g. young, medium and climax) vegetation types within a plain subtended by an active sand sheet. As for dunes, the grouping according to age across different Sectors of the coast is unsafe.

It was not always possible to discriminate different communities according to the presence or absence of Tamala limestone in a plain. On the other hand, plains with residual yellow sand (and limestone) are probably distinct from other Holocene plains. They are probably not the same as that growing on Tamala which has not had a Holocene dune pass over.

Older vegetation from dunes and plains of the same Sector tend to converge in composition.

Trophic Types

The role of the nitrogen fixing species in early colonization, particularly of deflation plains warrants some consideration. For all intent and purpose the soil has changed little with the passing of the dune.

Are these species better able to exploit new spaces than non-fixing species? Are they (or their mycorrhiza) poor competitors for them to decline in importance in climax vegetation?

Nitrogen-fixers are presumably an attractive host for parasites (and hemi-parasites) which have a high demand for nutrients (B.B. Lamont pers comm.). This is probably the simplest explanation for the association of these groups in early colonisation of deflation plains.

The seeds of both groups were found in emu faeces. They may thus be co-dispersed, each contributing towards a balanced diet for the emu.

The decline in the nitrogen fixers with age is somewhat more difficult to explain. These also apparently have a relatively high demand for nutrients (B.B. Lamont pers comm.). There may be a change in availability of nutrients as standing and woody biomass accumulates. If so, the nitrogen fixers may not be able to compete with the autotrophs adapted to low nutrient conditions.

The paleosol may be an additional factor worth considering. When the sand sheet covers an area, some of the nutrients in the biomass was retained in the A horizon of the overwhelmed soil. In areas with shallow soils over an indurated carbonate pan (Holocene plain or Tamala Limestone) this generally remains intact as a paleosol.

After the passing of the sand sheet, the nutrients once locked up in biomass, may be readily available for plant growth. The frequency of occurrence of paleosols at older successional stages on both Holocene and Tamala plains suggests that the shallower paleosols were broken down by soil processes and probably utilised by the plants.

The data of Pelham (1983) who sampled the Holocene plain south of Dongara do not reveal any consistent change in soil nutrients (e.g. N, P, K) with inferred time after the sand sheet had passed. This could be a sampling problem as much as anything, particularly if it is the paleosol and not the surface sand which is the important component.

The situation on the deflated plains on Tamala yellow sand was a somewhat different situation. In these areas the paleosol was generally the B horizon of the soil overwhelmed. The slightly loamier nature of these may have a slightly higher nutrient status than the more leached surface soil.

Vegetation Sere

It was clear that following the massive disturbance caused by sand inundation, there was a clear succession of vegetation on the Holocene landforms. This study has demonstrated a number of different successions on a range of landforms in different Sectors of the Central Coast. The successions involve changes in both structure and floristic composition.

A variety of factors appear to be contributing to the changes in the vegetation structure and the floristic composition. It is unclear what the important factors are. The processes for dunes and plains may well be different.

Changes in pH, organic matter content and carbonate content appear unlikely to be the major factors. For both dunes and plains, the surface soil pH was clearly in climax vegetation than in younger vegetation. However, the wide variation in the pH of different climax communities and the considerable overlap of ages (Table 9) suggests that species were not discriminating on the basis of pH. Similar arguments can readily be invoked in relation to organic matter content and carbonate content.

Changes in nutrients seem to be the most likely factor for the plains. Differential colonisation and changes in competitive advantage may be important. These may also be important for the dunes but other possibilities have come under notice.

Figure 5 suggested a process by which the profile of trailing dunes might naturally be modified. The decline of the stabilising *Acacia rostellifera* and *Melaleuca cardiophylla* was presumed to partly reflect a moisture deficit. However, it seems contradictory that moisture is more available in narrow steep dunes than in broader low dunes. In both situations it is likely that the plants were relying on vadose water, not groundwater.) The story is, therefore, probably more complex than meets the eye. Two potential factors seem relevant: water repellant soils and the other soil compaction.

It is clear that the sand of the older dune is more water repellant than that of younger dunes. This is caused by the build-up of an organic coating on the sand particles of the surface soil on older dunes. Thus run-off is promoted in older dunes lowering infiltration.

Well sorted sands (as most of these Holocene dunes are) are probably not expected to compact much. Perhaps this is why there has been no known systematic attempt to determine differences in the compaction of these soils. However, soil sampling (this study and W.M. McArthur pers comm.) has suggested that there was an increase in compaction with age.

Two factors might be important in promoting compaction. Firstly, the relatively flat shell fragments would tend to compact more than rounded quartz. Secondly, the slightly more dense carbonate pans which develop through precipitation of carbonate leached from the surface are relatively common generally in older dunes and absent in young ones.

A secondary observation comes from the differential occurrence of *Acrotriche cordata* and others (Table 17) on some dunes. These species appear to prefer the deflation plains (Table 19) with dense carbonate pan close to the surface. Their occurrence on the upper windward slopes of some older dunes suggests an increase in compaction of this portion the dunes.

Just how much influence these would have on the plants is debatable. It should be noted that *Acacia rostellifera* is promoted in areas which the soil has been disturbed by ripping etc.

Proximity to coast

It was clear that there was a coastal element in the vegetation of the Central Coast. The incipient foredunes are distinct. The frontal dunes were also quite different from the inland dunes and plains. One obvious issue is how much is this due to the presence of saline adaptated or tolerant species?

Two groups are probably saline adapted. The first was a group restricted to the incipient foredunes (*Cakile maritima, *Tetragona decumbens, Spinifex hirsutus, *Arctotheca populifolia* and *Atriplex isatidea*).

The other group of species (*Frankenia pauciflora, Atriplex cinerea, Wilsonia backhousia* and *Sarcocornia quinquinervia*) grow on a few cliffs fronting the sea which get sprayed by salt-water. This group commonly grow around saline lakes in this area.

These make up only a small portion of the species growing on the coast. Obviously many other species must have some tolerance for the salt spray. The majority of these are not restricted to the coast and are commonly on inland sites (e.g. on mobile sand sheets.)

A number must, therefore, be tolerant to at least some salt spray (e.g. *Spinifex longifolia, Scaevola crassifolia* and *Olearia axillaris*). These three grow as vigorously on the foredunes as they do on inland sites. Others (e.g. *Acacia rostellifera, Melaleuca cardiophylla* and *Chamelauceum uncinatum*) are distinctly smaller when growing in exposed coastal areas than on inland sites. It is assumed that this indicated salt and/or wind pruning in coastal areas.

Young dunes shared many species in common. However, young inland dunes tend to be more similar to the older inland dunes than they were to the frontal dunes. This suggests that age (and degree of soil development) is not the only issue. So what is?

One factor which might contribute is scarcely obvious. This is the more continuous sand precipitation which coastal dunes receive. This process of backshore accretion is successful as a dune building process because of the adaptation of the plants to inundation by sand. This continuous inundation clearly maintains the vegetation of coastal dunes at a relatively young successional stage. However, the vegetation on young inland dunes which, once stabilised, is unlikely to be subject to same degree of inundation and is allowed to develop towards a climax community.

Isolation also appears to be involved. The young inland dunes were surrounded by older dunes and flats from which species such as *Acacia rostellifera, Melaleuca cardiophylla* and *M. huegelii* invade. *A. rostellifera* with its root suckering is particularly suited to this situation. There is probably a limit to the species which can succeed in the dense shrublands and dense litter which they generate.

In contrast the frontal dunes were a continuous band which seems to have maintained the opportunity for a wide suite disturbance adapted species to occur throughout. In addition neither *Acacia rostellifera* nor *Melaleuca cardiophylla* nor *M. huegelii* dominate as they appear to be limited in stature by the salt winds. The shorter lived large shrub *Acacia cyclops* which is restricted to the coast and quite important in some areas never dominated like those just mentioned. The low dominance by these taller species has apparently allowed other shrubs to perpetuate themselves in this labile environment.

Thus it is concluded that the coastal element is the combination of a significant number with adaptation to sand inundation, many with a certain degree of saline tolerance and a limited proportion of distinctly saline adapted species.

Distributions

A large number of species recorded in this study are restricted (endemic) to coastal areas, particularly of southern Australia. This conforms with the observations of Sauer (1965). On the other hand there were very few of the species growing on the Holocene dunes which were endemic to the Central Coast. Earlier Sauer (1965) noted few of the coastal species of Western Australia had restricted distributions. Most of these coastal species appear to have ranges of several hundred to several thousand kilometres. The distributions were mostly overlapping rather than co-incident, thus the difficulty in defining discrete communities.

Therefore, the species present in a particular area or Sector of the coast have a range of distributions. In the Central Coast there were coastal species extending from the Shark Bay area, species from the west coast, species from the south coast and even some from south-eastern Australia.

It is clear, however, that there is a significant number of species which are not endemic to the coastal areas. Some have invaded from nearby Pleistocene land surfaces (e.g. *Calothamnus quadrifidus* and *Chamelauceum uncinatum*). However, virtually none has invaded from the adjacent northern kwongan with its many endemic species (Griffin *et al.* 1990).

Many of the others are widespread in south-western Australia (e.g. *Poa drummondiana, Daucus glochidiatus, Podolepis gracilis, Clematis microphylla, Opercularia vaginata and Isotropis cuneifolia*). A high proportion of these are sub-shrubs or annual herbs.

An interesting group are species which also grow in the Eremaean (Goldfields area or further inland) (e.g. *Zygophyllum simile, Lycium australe, Pimelea microcephala* and *Santalum acuminatum*). These occurrences are mainly connected through the Murchison and Gasgoyne areas.

It is interesting to speculate the origin of the species on these Holocene deposits. Some are clearly part of cosmopolitan coastal genera. Many obviously evolved in different parts of the Australian coast and spread laterally along it at various rates. They may have evolved in early Holocene. They may also have been residuals of the flora growing on now-drowned Pleistocene coasts.

Why there appears to have been a limited invasion from south-western Australia on to the coast is an interesting point. The principal invaders were not the woody perennial shrubs but herbs and sub-shrubs. Most are ubiquitous in the south-west. The woody perennials which have invaded are mostly from the Eremaean not the rich kwongan flora of the south-west.

Soil factors may be involved, however, there appears to be no simple explanation. The rich kwongan flora occur on mainly acid (and neutral) sands while the Holocene sands are mainly alkaline. The soils in the Eremean are a mixture of alkaline and neutral soils (H.M. Churchward pers comm.). This may help to explain why some of them grow on the coast and in the Eremean.

On the other hand the Holocene sands may have a nutrient status equivalent to some of the Eremean soils. Slightly elevated potassium levels on the coast and inland compared to the south-west have been reported by Milewski (1982) and Milewski *et al.* (in prep). They also associated this with an elevated proportion of fleshy fruited species, something noted in this study.

Alien Species

It is clear that alien species are an important part of the flora of the southern part of the Central Coast. Their presence in relatively undisturbed areas was, however, generally insignificant.

There appear to be a couple of exceptions. *Pelarg_onium capitatum_ and *Trachy_andra divaricata_ are perennial species which appear to be very well adapted to disturbed situations and moderate to good competitors with the perennial native species. They are mostly confined to south of Lancelin but there are spot occurrences throughout the Central Coast.

*_Pelargonium capitatum_ has readily established on the young foredunes (e.g. at Mindarie) in quasi-naturally disturbed areas. This must be concerning for the remainder of the Central Coast for it has the potential to spread into natural areas even without significant human intervention. Nothing is really known about its persistence in the face of competition from native perennials. In situations such as foredunes where disturbance is a natural phenomenon it is likely to remain significant.

*_Ehrharta villosa_ (pypgrass) and *_Thinopyrum distichum_ (sea wheat) which have been used for dune stabilization are also of concern for the vegetation of the incipient foredunes. The latter of these occupies the same niche as _Spinifex_ spp. and could displace them (G.J. Keighery pers comm.).

*_Lycium ferocissimum_ is a dense shrub with rigid thorns which is a serious weed of some islands of the Central Coast. It has the potential to spread along rocky shorelines of the mainland.

G. CONSERVATION

This section deals with the adequacy of the existing Conservation Estate in representing the range of landscape features, geomorphic units and vegetation units recognised in this study of the Central Coast.

Adequacy of Conservation Estate

This Study identified significant regional variation in the geomorphology of, and vegetation growing on the coastal Holocene deposits. Five Sectors were identified each with recognisably distinct floristic composition.

The variation in floristic composition was incompletely represented in the existing Conservation Reserves. Appendix 18 provides a summary of the features of conservation significance in each of the Sectors of the coast determined from the vegetation studies. It also indicates areas which should be added to the conservation estate, or similarly protected.

The majority of the features of the Central Coast are well represented in the existing conservation estate. However, there are significant deficiencies in two Sectors; Greenough to Irwin River and Lancelin to Swan River.

In the former Sector, the inclusion of several small, existing reserves (which have other purposes) into the conservation estate would protect most of its natural values. There are significant management problems with reserve 7276 at Cape Burney and it might be more appropriate to acquire suitable privately owned land for a Nature Reserve.

South of Lancelin, however, the situation was quite different. There are no conservation reserves in that Sector (Table 1) and the opportunities to incorporate other areas of Crown land are limited. A few existing recreation reserves (e.g. at Mindarie) would be a valuable contribution. The conservation needs for this Sector is still great, given that there appears to be significant variation within the Sector (from north to south) in the vegetation.

Two areas of leased Crown land appear to be the best opportunity. Three locations at Wilbinga (just north of Two Rocks) and one south of Seabird should be included in the Conservation Estate. The former three would be added to the Caraban Management Priority Area and so become part of a very significant conservation reserve. The latter would be a reserve essentially for the protection of the rare *Chorizema varium* in an area where Tamala Limestone is exposed on the coast.

Elsewhere in the Central Coast there are several small areas in the other Sectors worthy of special protection, possibly by inclusion in the conservation estate (e.g. Lake Thetis, Black Point and the mouth of the Hill River).

The status of parts of the Beekeepers Reserve (24496) currently the subject of review in the Central Coast Planning Study warrant special consideration. The values for the conservation estate of certain portions of it should be emphasised: the portion between Dongara and Cliff Head, the coast from Cliff Head to north of Gum Tree Bay, the salt lake system east of Leeman, the coast between Green Head and North Head and the salt lake system east of North Head. It might be appropriate to have these distinct from the Beekeepers Reserve.

Several geological deposits are significant areas for the understanding of the Holocene history of this area. Efforts should be made to preserve representative portions of the various marl deposits which are likely to be the early Holocene Vincent Member of the Hershell limestone.

The beach ridge plains are another of these geological resources. White Point is the last remaining significant one of these along the west coast of southern Australia which is in near pristine condition. To complement this, the northern parts of the beach ridge plain at both Jurien and Cervantes should also be protected.

Register of the National Estate

Table 1 indicates that majority of the existing conservation estate (both in terms of numbers of reserves and area) are on the Register of the National Estate. This Study has shown that their vegetation varies considerably in composition and therefore complement rather than duplicate each other.

Several areas should be added to the Register. The most important is the Wilbinga area which together with the contiguous Caraban Management Priority Area should be added to the Register. This would provide an excellent example of both the Holocene and Pleistocene dunes in Sector V5.

There are several small areas which should be placed on the Register, either by amalgamation with places currently on the Register or as separate listings. Lake Thetis with its stromatolites should be a priority. One is at Black Point, another is south of Seabird and a third at Mindarie. A suitable area in Sector V1 should also be identified for inclusion on the Register. The values of these areas are described in Appendix 18.

H. RESEARCH OPPORTUNITIES

The neglect by the scientific community of the natural history of the Holocene coastal deposits appears to be one based on a widely held misconception of the low diversity of this system.

Sure, most of the communities are less rich in species and lacking in large numbers of species with very restricted distribution compared to kwongan. However, this need not make it an uninteresting. It is one of the few in Western Australia where there are clear examples of succession and this aspect has been hardly recognised let alone described and understood.

The lack of past interest is undoubtedly the reason why the single geological (Safety Bay Sands) or soil (Quindalup Dunes) units are generally applied to it. Its diversity of sometimes subtle variation in landform and geology hold many topics to be unravelled.

There are many aspects yet to be adequately documented which have significant management implications. The coast is a very high impact zone and it warrants considerable research attention because of the need for quality planning and management.

There are significant research opportunities which could readily shed light on the various interacting processes fundamental to this coastal environment. Those outlined cover aspects of botany, soils, geomorphology and geology other study areas including fauna and water.

Some could lead to a better understanding of the Holocene history of south-western Australia. Some require a significant commitment but others need few resources to undertake.

Botany and Ecology

A study of succession has potential to cast light on a whole range of dynamic aspects of Australian plant communities. This might concentrate on the nutritional and ecophysiological processes and functional characteristics of the plants. There is a significant potential that models developed in this system applicable to other areas

clarifying the plant community succession for the dunes and plains.

A study defining the response of these communities to fire, particularly the interaction with successional stages of the various plant communities, is especially relevant as these areas have a high incidence of human initiated fires and a significant landuse conflict.

A study of the significance of the alien species in these coastal communities, particularly in the Perth metropolitan area, would provide much needed guidelines for management of these species.

A study extending along the coast between (at least) Shark Bay and the Nullabor to define the regional variation of the vegetation and landforms would extremely useful for assessing planning options.

Soils

An integrated study of the soil units of coastal Holocene deposits in south-western Australia would clarify the confusion in applying the term Quindalup Dunes. This would greatly improve the framework for planning processes.

A study into the relationships between the principal soil parameters (e.g. pH, carbonate content, organic matter etc.) would clarify the development processes in these soils.

A study of soil development in association with plant succession would provide much needed basic information on reconstruction of artificially disturbed areas.

Geomorphology

Determining the current rate of movement of mobile sand masses would assist in planning and management issues and in understanding the processes involved. This aspect can be readily investigated from the series of aerial photographs available over the last 50 years.

A study of the dynamics of the barchanoid dunes in the mobile sand sheets could assist in determining their rate of movement.

A study of the rate of build-up of sand in foredunes reestablished in the throat of deflated basins will assist in understanding the sediment supply and movement along the coast.

A study designed to document the decline in the speed of the sea breeze after crossing the coast would assist in understanding the movement of mobile sand sheets. This should be integrated with a study of the actual movement of sand under different wind and moisture conditions.

A study of the stability of the scarped foredunes would provide an ideal baseline for monitoring of any effects of possible sea level rises.

Geology

A study to define the age of the Holocene dunes and document their orientation would aid in understanding the Holocene climate history. This would assist in understanding potential impacts from currently predicted climatic changes. It would also be fundamental to understanding the soil development processes.

A study focusing on the age of shell deposits on the Holocene plain would complement the study on dune age.

Should a study validate of the Cliff Head deposit indicated here as distinct from the Tamala Limestone the Holocene history of the Central Coast might be better understood.

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My understanding of my family during the Study made this possible.

K. APPENDICES

APPENDIX 1 Field recording sheet

QUINDALUP DUNES STUDY
(Perth to Geraldton)
Vegetation Assessment Sheet **(E.A. Griffin & Associates - 361 0373)**

Property:... Date:../../91

Code:........ Sample Type:.. Map Zone:....... AMG:........... .... Reserve No:......

Slope:.. Aspect:... Fire Age:...yrs Condition:........ Veg type:..........................

Bare:..% Patchiness:....... Litter:..% Weeds:..% Drainage:.. Wet:.. Geol:..................

Surface / Sub Soil: (see over for more detail) ....

....

Landscape:...

Muir Struct (1 - 70-100%, 2 - 30-70%, 3 - 10-30%, 4 - 2-10%, 5 - patches, 2%)
T1:.. T2:.. MT:.. MS:.. S:.. SA:.. SB:.. SC:.. SD:.. MP:.. B:.. H:.. ST:.. SL:..

Cover Codes + - sol insig, 1 - few insig, 2 - %, 3 - 1-5%, 4 - 5-10%,
5 - 10-25%, 6 - 25-33%, 7 - 33-50%, 8 - 50-75%, 9 - 75%

.. A cochle	.. Chamelau	.. Hib spic	.. Pim sulp	.. ..
.. A cyclop	.. Clemat m	.. Hyban ca	.. Pitho pu	.. ..
.. A huegel	.. Conosp s	.. ..	.. Pit phyl	.. ..
.. A idiomo	.. Cono cal	.. Isolep n	.. Podot gn	.. ..
.. A lasi l	.. Cono can	.. Jack fur	.. Rhagodia	.. ..
.. A pul gl	.. CONO PAU	.. Jack str	.. ..	.. ..
.. A ROSTEL	.. Comesper	.. Ken pros	.. Salsola	.. ..
.. A trunca	.. Cra coll	.. ..	.. Santalum	.. ..
.. A xanthi	.. Cra pedi	.. Lech lin	.. Sarco qu	.. ..
.. ..	.. CARPO ED	.. Lepid fo	.. SCA CRAS	.. ..
.. ACAN PRE	.. Crypt gl	.. Lepid ro	.. Sca niti	.. ..
.. Acrotric	.. ..	.. Lepido a	.. Sca palu	.. Marram ....
.. Actites	.. Damp lin	.. Lepido g	.. Sca thes	.. Anagal a ....
.. Allo hum	.. Daucus g	.. Leptomer	.. Scho gra	.. Arct pop ....
.. ALLO LEH	.. Dianella	.. Leu insu	.. SENEC LA	.. Briza ma ....
.. Alyxia b	.. Diplo da	.. Leu parv	.. Spi hirs	.. Carpo ed ....
.. Angi cun	.. Dip hueg	.. Leu prop	.. SPI LONG	.. Cera glo ....
.. Anigo ma	.. Dros mac	.. Loma mar	.. Sporob v	.. Cras glo ....
.. ..	.. Dry nive	.. Loma pre	.. Spyrid g	.. Disch ar ....
.. Antho il	.. Dry sess	.. Lox flex	.. Steno ro	.. Heliophi ....
.. Antho li	.. ..	.. MEL ACER	.. Stipa fl	.. Hypo gla ....
.. Atrip is	.. Emp grac	.. MEL HUEG	.. Stipa va	.. Laguris ....
.. Beyer vi	.. ENCH TOM	.. MEL CARD	.. Sty mari	.. Oenoth d ....
.. Boss eri	.. Eremo gl	.. ..	.. ..	.. Pelargon ....
.. Brachy i	.. Erod cic	.. Myop ins	.. TET DECU	.. Pet velu ....
.. ..	.. Exocarpo	.. Nem capi	.. Thys are	.. Polycarp ....
.. Cakile m	.. Frankeni	.. Nitr bil	.. Thys pat	.. Silene g ....
.. Calad la	.. Gomp tom	.. Olax ben	.. Tra coer	.. Tetragon ....
.. CALAND C	.. Grev the	.. OLEAR AX	.. Tra pilo	.. Trachy d ....
.. Caland l	.. ..	.. Olear ru	.. Trym alb	.. Vulpia m ....
.. Callitri	.. Hakea li	.. Oper vag	.. Waitz ci	.. Sonch ol.....
.. Caloce a	.. Hakea pr	.. ..	.. West dam	.. Paren le.....
.. Caloce b	.. Hardenbe	.. Parietar	.. Zyg bill	.. ..
.. Calo qua	.. Heli cor	.. Phyl cal	.. ZYG FRUT	.. ..
.. Cassy gl	.. Hemiandr	.. Pim ferr	.. Trigl ca.....	.. ..
.. Cassy ra	.. Hib race	.. Pim gilg	.. Waitz au.....	.. Moss.........

Appendix 1 (Continued)

Quindalup Dunes Study Site Code:.......
SOIL

Samp	Interval (m)	Colour (Munsell)	Comments (e.g. horizon, organic matter, cemented?, etc.)
....	.... -	..../.	....
....	.... -	..../.	....
....	.... -	..../.	....
....	.... -	..../.	....
....	.... -	..../.	....

Chemical Analysis

Samp	Insol %	Cl- ppm	pH	
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

Particle Sizing (%)

Samp	+1.0	+0.5	+0.3	+0.15	-0.15	
....	....	....	....	....	....	....
....	....	....	....	....	....	....
....	....	....	....	....	....	....
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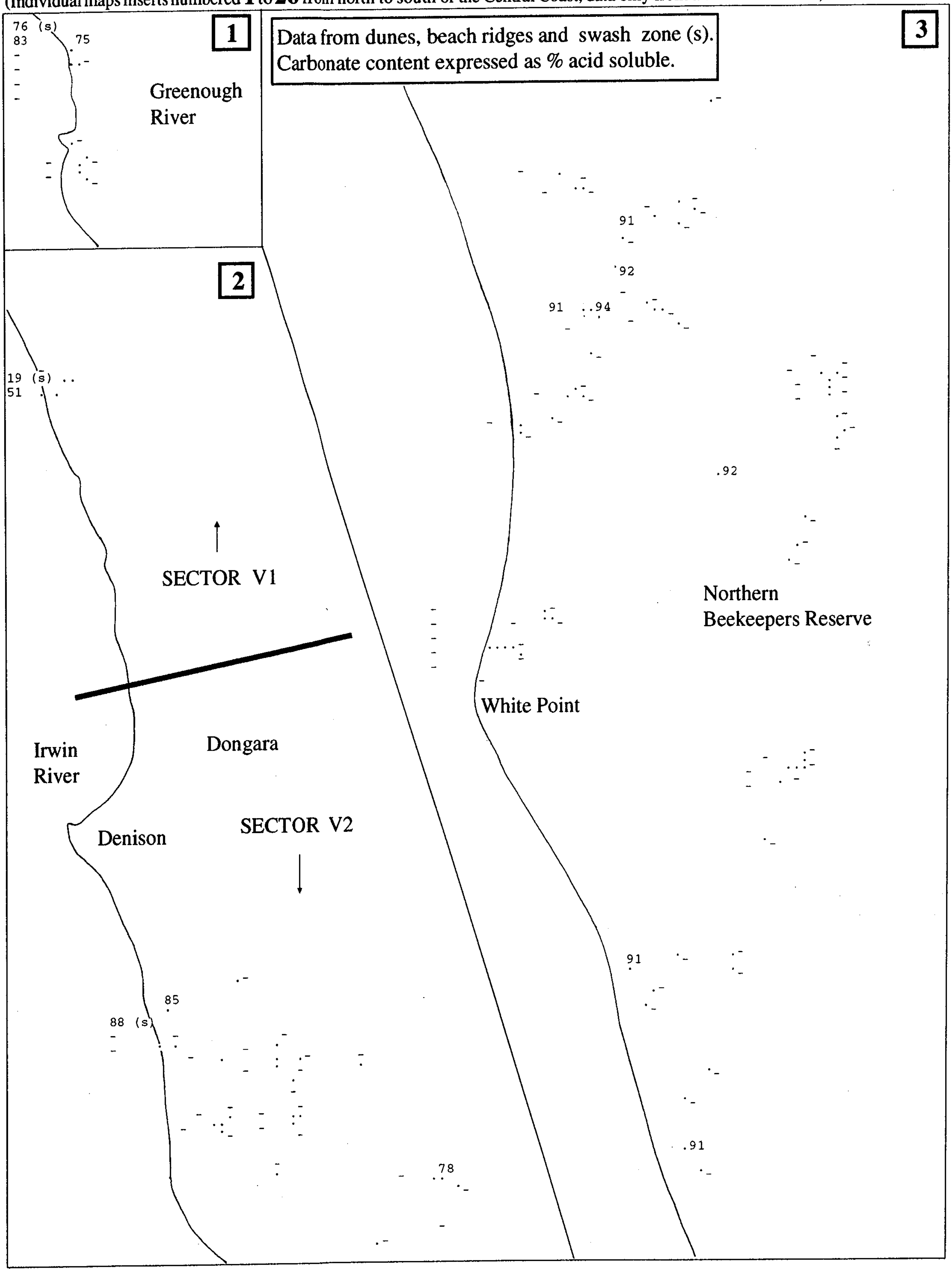
APPENDIX 2 Muir vegetation classification scheme

Structural scheme used in this Study (from Muir 1977).

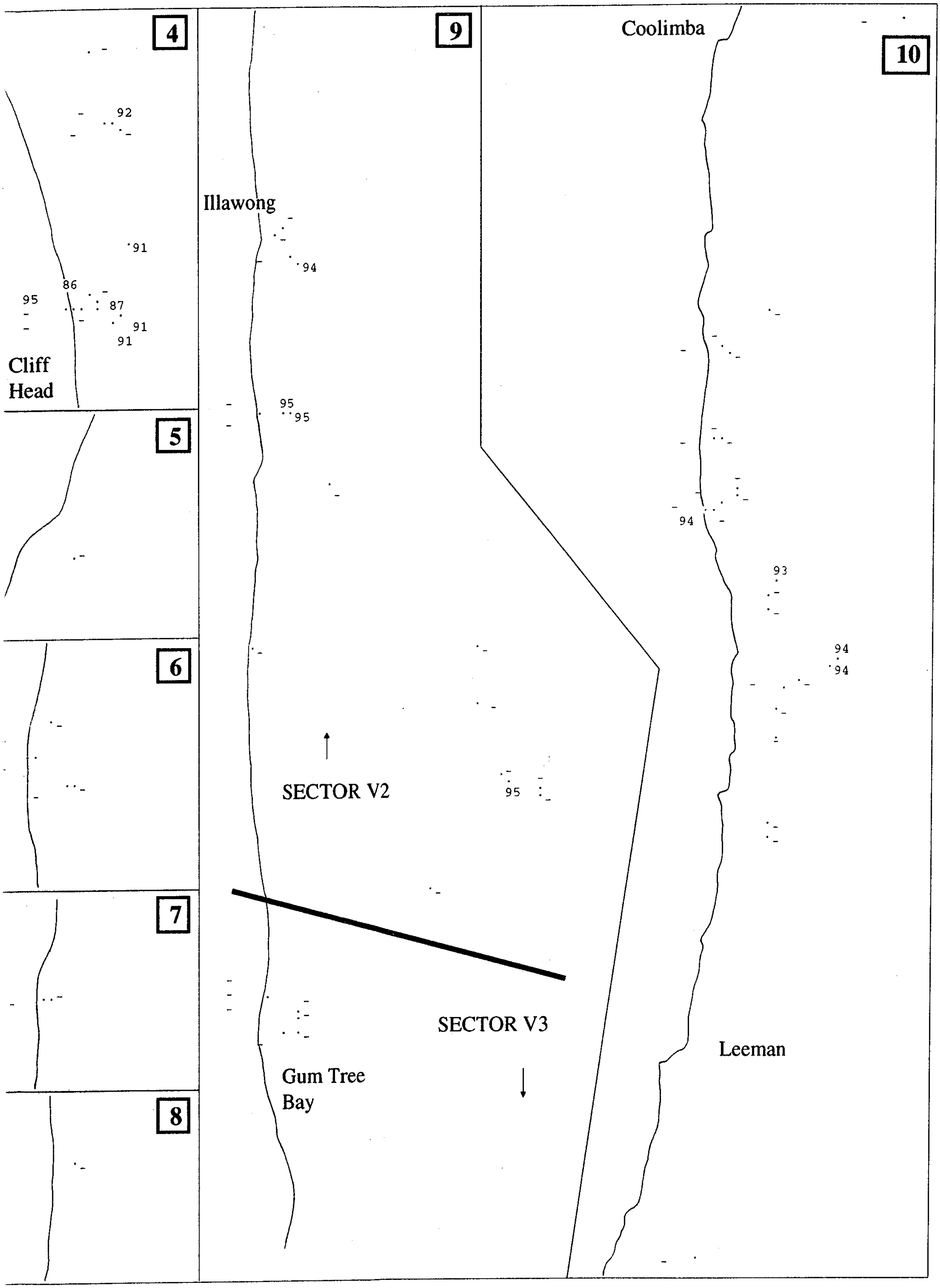
LIFE FORM/HEIGHT CLASS	CANOPY COVER			
	DENSE d 70-100%	MID-DENSE c 30-70%	SPARSE i 10-30%	VERY SPARSE r 2-10%
T Trees >30m M Trees 15-30m LA Trees 5-15m LB Trees <5m	Dense Tall Forest Dense Forest Dense Low Forest A Dense Low Forest B	Tall Forest Forest Low Forest A Low Forest B	Tall Woodland Woodland Low Woodland A Low Woodland B	Open Tall Woodland Open Woodland Open Low Woodland A Open Low Woodland B
KT Mallee tree form KS Mallee shrub form	Dense Tree Mallee Dense Shrub Mallee	Tree Mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee
S Shrubs >2m SA Shrubs 1.5-2.0m SB Shrubs 1 0-1.5m SC Shrubs 0.5-1.0m SD Shrubs 0.0-0.5m	Dense Thicket Dense Heath A Dense Heath B Dense Low Heath C Dense Low Heath D	Thicket Heath A Heath B Low Heath C Low Heath D	Scrub Low Scrub A Low Scrub B Dwarf Scrub C Dwarf Scrub D	Open Scrub Open Low Scrub A Open Low Scrub B Open Dwarf Scrub C Open Dwarf Scrub D
P Mat plants H Hummock Grass	Dense Mat Plants Dense Hummock Grass	Mat Plants Mid-Dense Hummock Grass	Open Mat Plants Hummock Grass	Very Open Mat Plants Open Hummock Grass
GT Bunch grass >0.5m GL Bunch grass <0.5m J Herbaceous spp.	Dense Tall Grass Dense Low Grass Dense Herbs	Tall Grass Low Grass Herbs	Open Tall Grass Open Low Grass Open Herbs	Very Open Tall Grass Very Open Low Grass Very Open Herbs
VT Sedges >0.5m VL Sedges <0.5m	Dense Tall Sedges Dense Low Sedges	Tall Sedges Low Sedges	Open Tall Sedges Open Low Sedges	Very Open Tall Sedges Very Open Low Sedges
X Ferns Mosses, liverwort	Dense Ferns Dense Mosses	Ferns Mosses	Open Ferns Open Mosses	Very Open Ferns Very Open Mosses

APPENDIX 3 Map with carbonate in topsoil of dunes

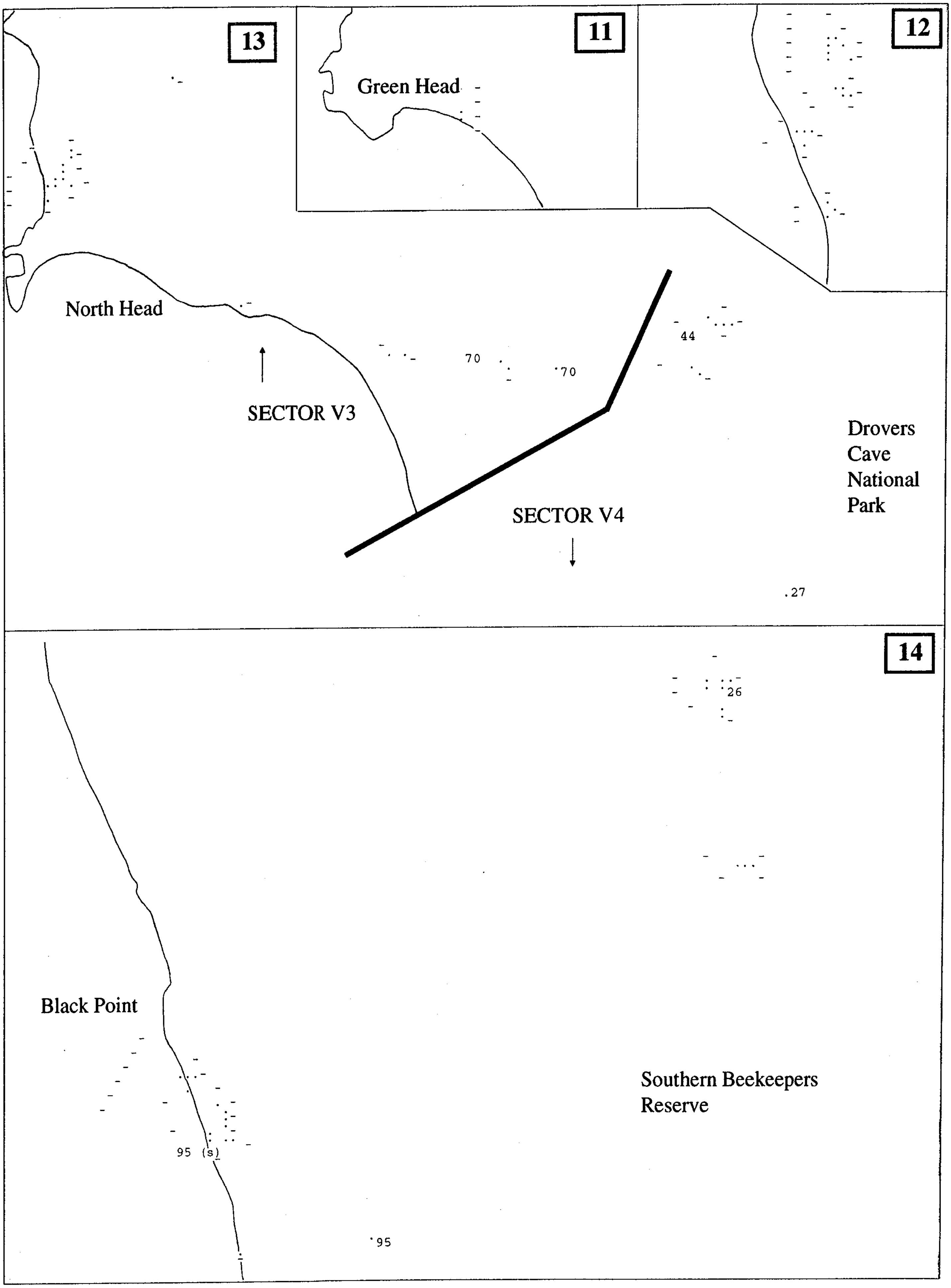
(Individual maps inserts numbered **1** to **26** from north to south of the Central Coast, data only from a selection of sites)



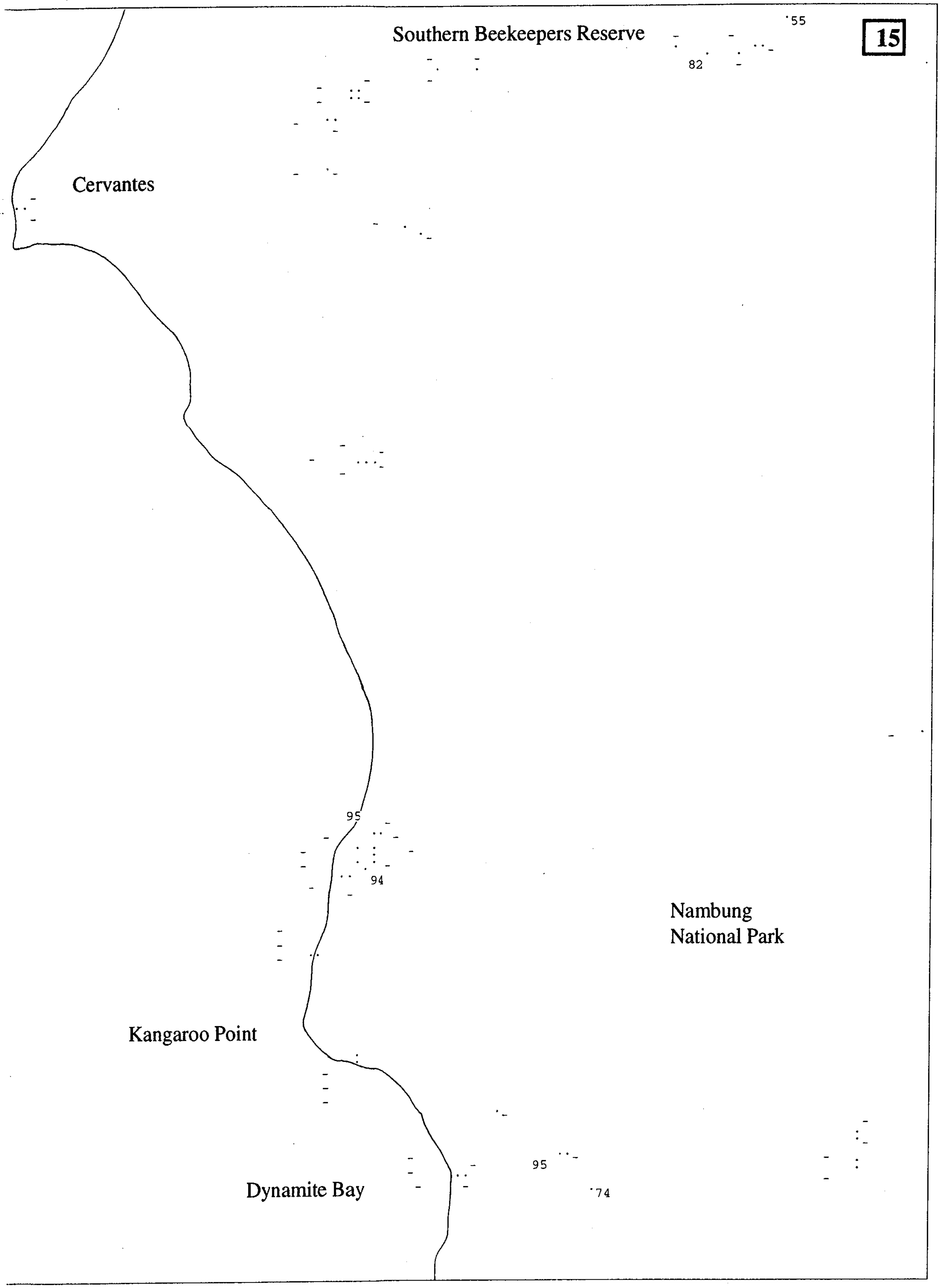
Appendix 3 (Continued)



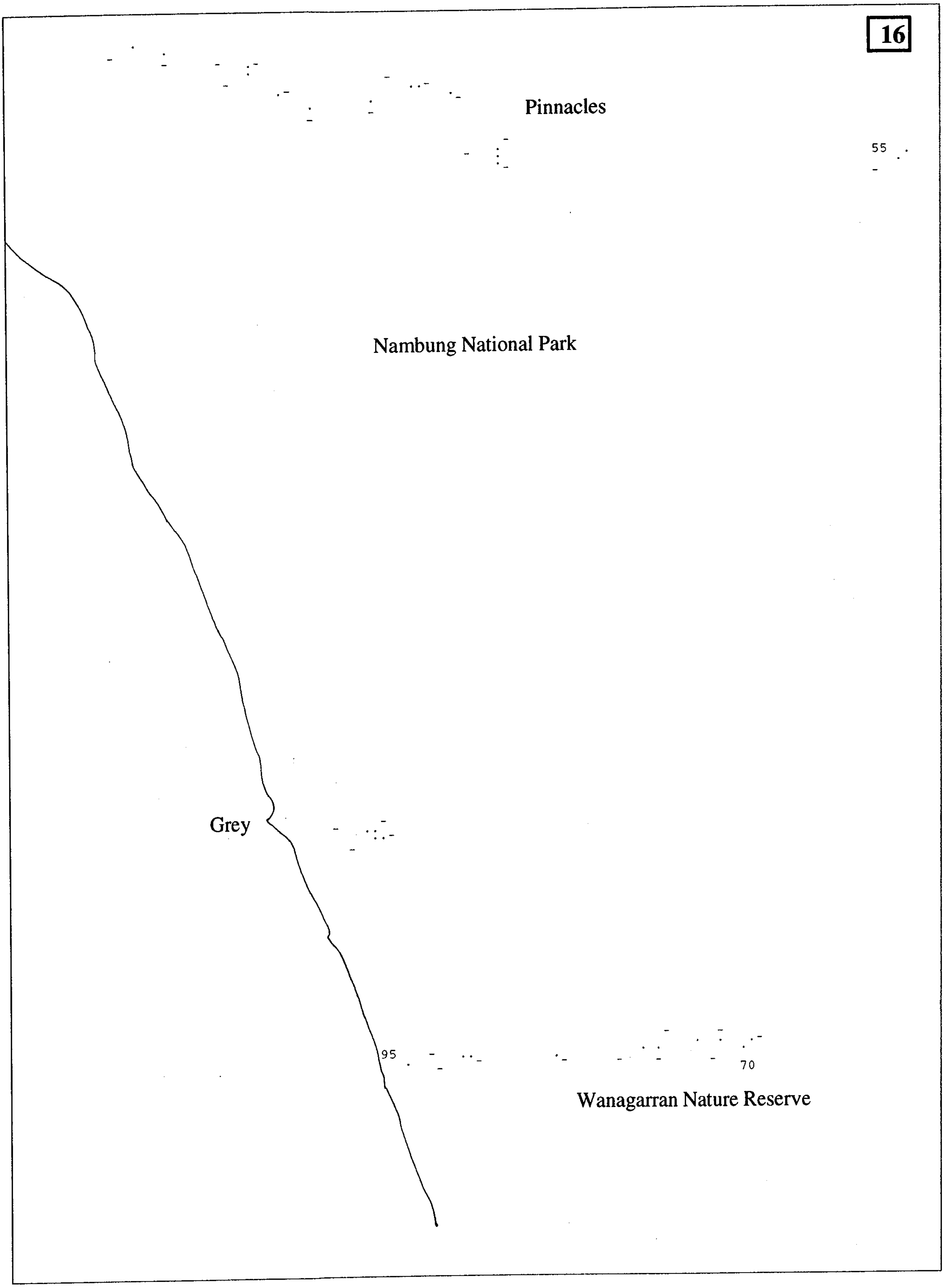
Appendix 3 (Continued)



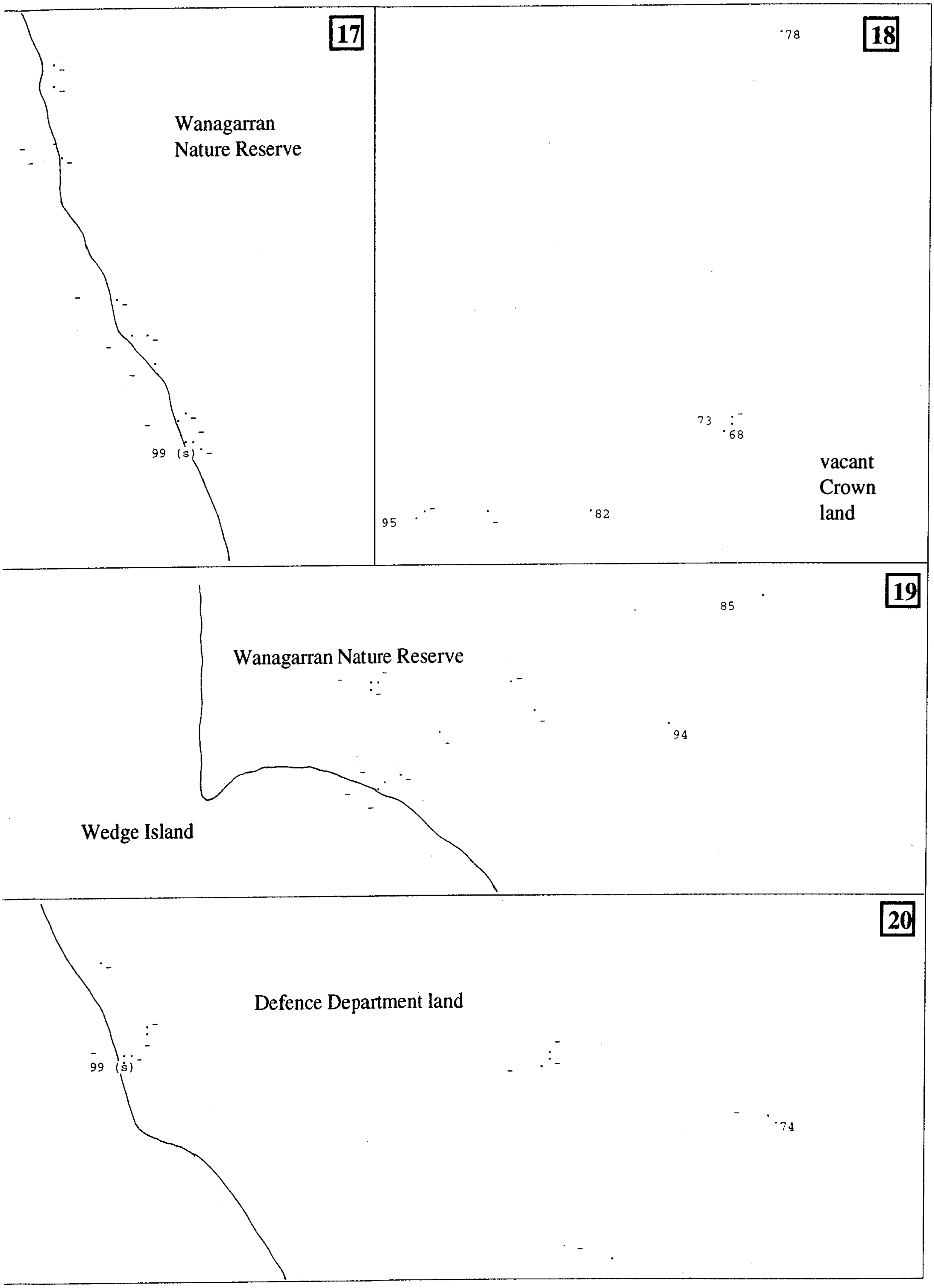
Appendix 3 (Continued)



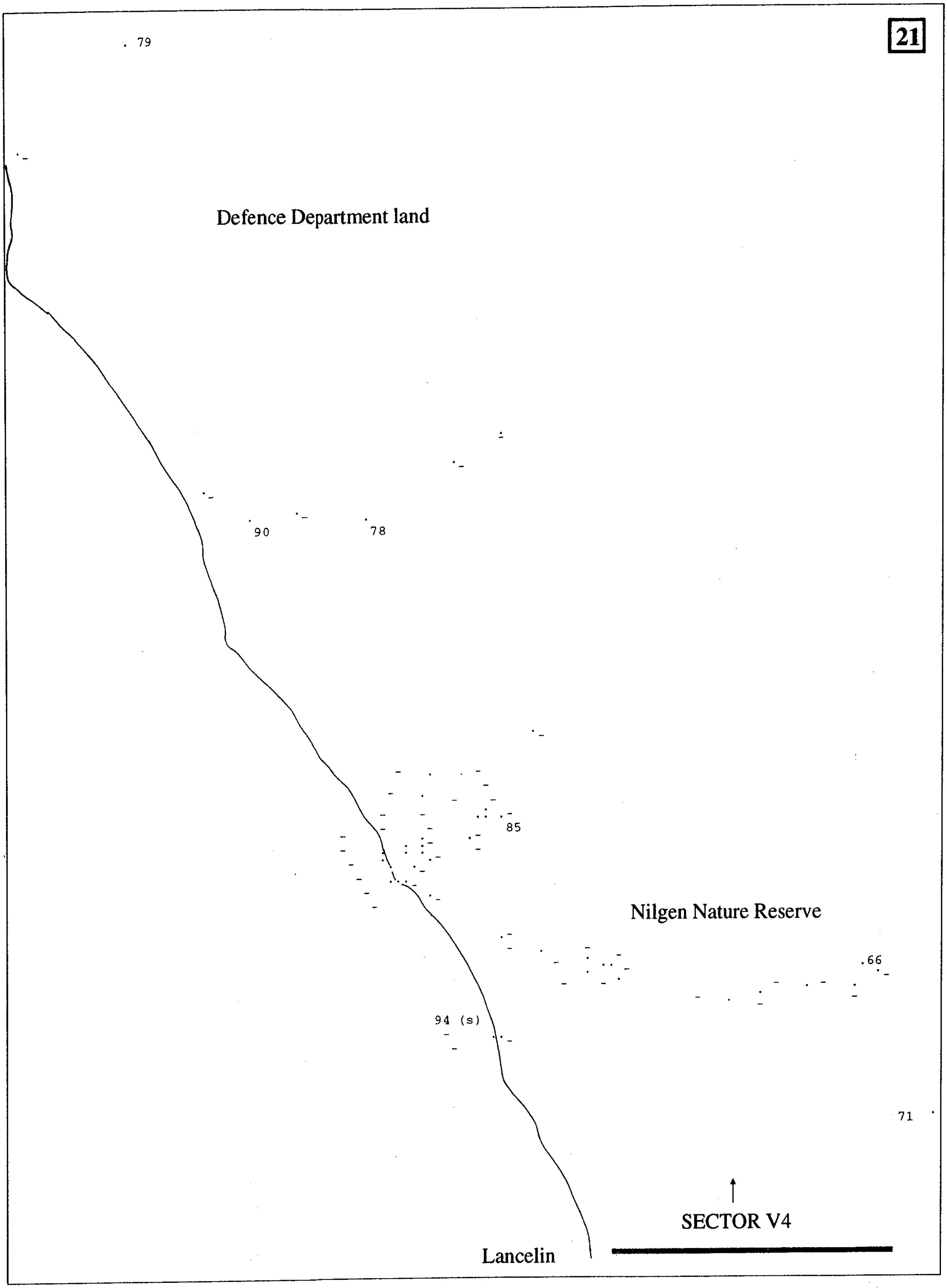
Appendix 3 (Continued)



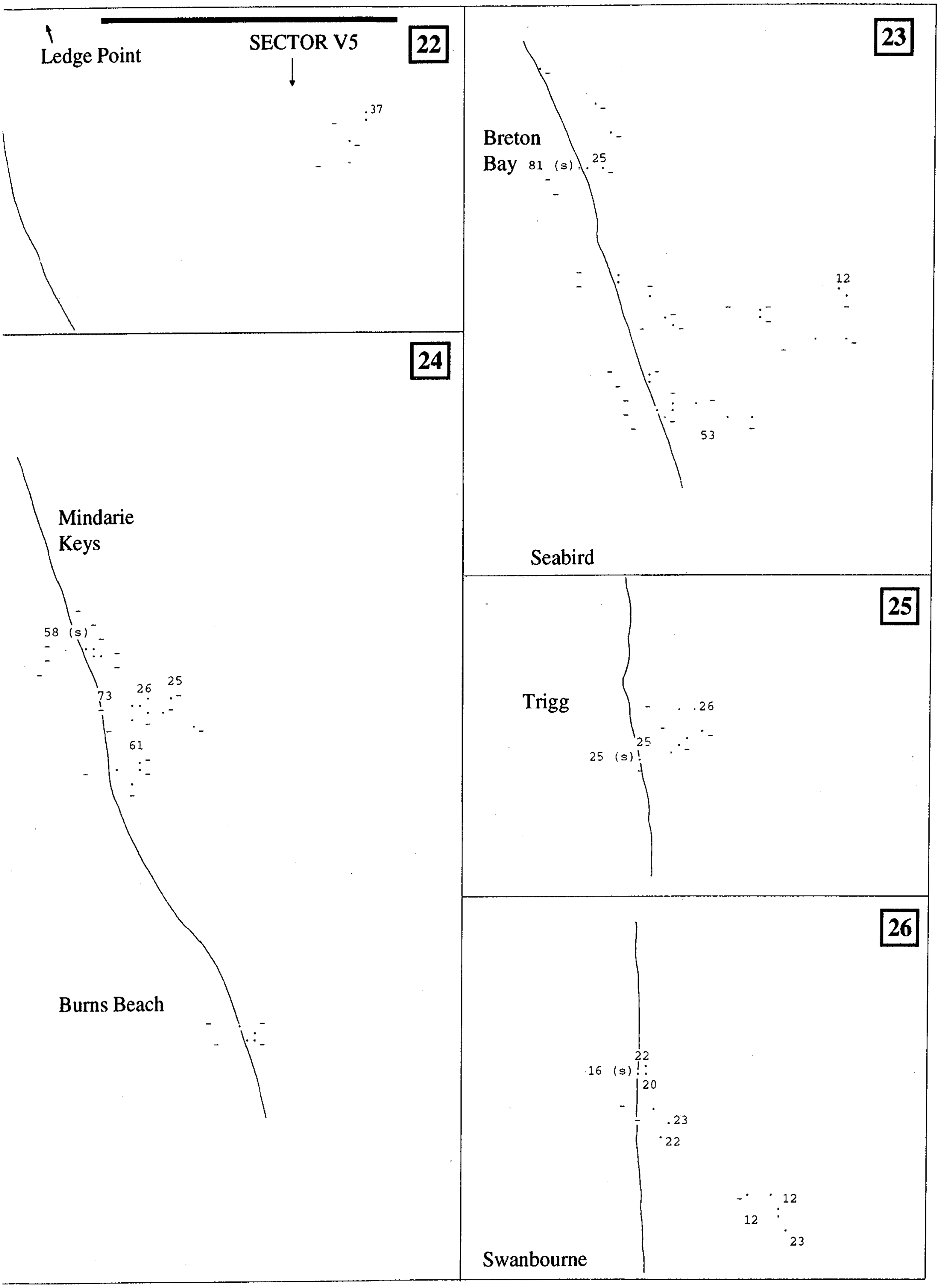
Appendix 3 (Continued)



Appendix 3 (Continued)



Appendix 3 (Continued)



APPENDIX 4 Soil and landform descriptions

(See Table 2 for a brief summary of these landform units used in this Study)

The major descriminators used here are firstly dunes and plains and then the type of dunes or plains. Dunes are partitioned into crests, slopes and toes. For the plains the amount of sand covering is also used.

A. DUNES and BEACH RIDGES

A1. BEACH PLAINS

Aeolian sand, 20 – 95% carbonate minerals, structureless. Beach deposits below including beds of medium to coarse, shells may be within 1 m of surface. (Notes: no distinction has been made herre between beach ridges and relict foredunes; beach ridges over which a mobile sand mass has passed are included under B. DEFLATED SURFACES.)

Incipient Foredune (WB), quite small at less than 1.5 m tall, may be slope up to 30°, taller dunes usually truncated by the sea. Virtually no soil development, and the only organic matter accumulated on surface is seaweed. Mainly 10YR8/1 sand, pH >9.0. Some quiet beaches (WQ) can have minimal dune developed but with up to 100% cover of deep seaweed.

Low foredunes (WF) and **Beach Ridges** (WF2 – WF5), generally less than 2 m tall with slope up to 20°. Minor soil development with minor organic matter accumulation increasing with age accompanying light litter on surface covering up to 50%. Surface mainly 10YR8/1 (younger) to 10YR6/2 (older) sand, pH 9.0 (younger) to 8.5 (older).

Swales (WS1 – WS5) like Low Foredunes but slightly more litter on surface and minimal slope.

A2. TALLER DUNES

Dunes are fine to medium aeolian sand, generally well sorted, 20 – 95% carbonate minerals, structureless, except perhaps where very high organic matter has accumulated on surface and broken down.

Truncated Foredune (DBS), seaward face of foredune ridge 5 – 10 m (or even 15) tall with slope up to 45°. Very little soil development with light litter on surface with up to 20% cover. Mainly 10YR8/1 (younger) to 10YR7/1 (older) sand, pH about 9.0.

Young Dunes

crest (DC, DBC), of dunes of variable height, slope of crest up to 8°. Minor organic matter accumulation in younger dunes although litter cover highly variable. Mainly less than 5 cm of 10YR7/2, pH 7.5 to 8.5 over 10YR8/2, pH 8.0 to 9.0. Some variation in pH and Munsell Chroma is correlated with silica content.

slope (windward (DSW) and leeward (DSL)), of variable heighted dunes, slope up to 50°. (Windward slopes tend to be slightly less steep.) Minor organic matter accumulation although litter cover highly variable. Mainly less than 5 cm of 10YR7/2, pH 7.5 to 8.5 over 10YR8/2, pH 8.0 to 9.0.

toe (DT), with slope less than 10°. Moderate organic matter accumulation in soil and profile development may exceed 1m. This is presumably through accumuluation of surface soil from the slope of the dunes. Often with litter up to 2 cm thick over 10 to 100% of surface. May have a distinct A0 horizon. Up to 10 to 30 cm of 10YR2/2 to 10YR5/2, pH about 8.0 over 10YR4/2 to 10YR8/2, pH 7.5 to 8.5. Grades into 10YR8/3 where over Tamala sand.

Older Dunes

crest (DC), between 0° and 10°slope. Moderate organic matter accumulation although litter cover highly variable but may be up to 90%. Mainly 5 to 30 cm of 10YR5/2 to 10YR6/2, pH 7.5 to 8.5 over 10YR8/2, pH 8.0 to 9.0.

slope (windward (DSW) and leeward (DSL)), between 10° and 40° slope. (Windward slopes tend to be slightly less steep.) Moderate organic matter accumulation although litter cover highly variable but may be up to 80%. Mainly 5 to 30 cm of 10YR5/2 to 10YR6/2, pH 8.0 to 8.5 over 10YR8/2, pH 8.0 to 9.0.

toe (DT), with slope less than 10°. Moderate to high organic matter accumulation in soil and profile development may exceed 1 m (see Young Dunes above.). Often with litter up to 3 cm thick over 10 to 100% of surface. May have a distinct A0 horizon. Mainly 15 to 50 cm of 10YR3/2 to 10YR5/2, pH 7.8 to 8.3 over 10YR8/2, pH 8.0 to 9.0.

Appendix 4 (Continued)

B. DEFLATED SURFACES

thin (<30 cm) to very thin (<2 cm) layer of calcareous aeolian sand over a resistant surface, usually a lithified layer or Tamala Limestone.

B1. HOLOCENE PLAIN

Shallow but variable depth of calcareous aeolian sands (usually 50 – 95% carbonate minerals) over a layer resistant to the wind.

Resistant surface principally weakly to poorly cemented calcareous (?)aeolian sands which occasionally include shells of beach deposits. Relatively hard cemented layer 10 to 20 or perhaps 30 cm thick. Gozzard (1985) reported cementation up to 5.5 m thick. The upper centimetre of this cemented deposit was distinctly harder with a film of pale carbonate cement (laminar calcrete) on the upper surface.

Clayey pans from saline and gypsiferous lakes are also resistant layers in some areas. The moisture from ground water may also act to limit stripping where other resistant layer are absent.

(BL) Lithified layer either exposed (up to 90% of surface) or covered by very shallow sand generally less than 15 cm deep. Commonly a thin paleosol covering lithified layer 0 to 1 cm thick, or 3 cm in pockets (10YR4/2 or 10YR5/2, pH 7.9 – 8.4). Surface sands 10YR8/2 (younger) to 10YR6/2 or even 10YR5/2 (older), pH 9.0 (younger) to 8.0 (older). Thin litter covered up to 60% of surface over a range of ages.

(BLS) Only a little o f lithified layer is exposed. Surface is covered by shallow sand 15 – 30 cm deep. Paleosol as for BL covering lithified layer. Surface sands up to 10 cm thick as for BL grading to 10YR8/2 (younger) or 10YR7/2 (older) with depth. Litter cover tended to increase with age, generally in the range of 10 to 40%.

(BS) Surface covered by shallow sand 30 – 100 cm or more deep. Again an occasional paleosol as for BL and BLS. Surface sands as for BLS but obviously deeper. Litter as for BLS, occasionally to 90% cover with distinct A0 horizon 1 to 2 cm thick.

(BBL) Similar to BL but lithified layer was much weaker, up to 70% exposed. Beach shells may be on the surface, and certainly prominent beneath lithified layer. Noted occurring over beach plains but uncertain whether this is typical of these areas. Litter covering 10 to 30% of surface. Surface sand as for BL but no paleosol noted.

(BBS) Similar to BSL but as for BBL above.

(BSW) Only two sites were examined and both had layers of sand and loamy sand to at least 1 m depth. Litter cover varies with age and there may be an A0 horizon to 1 cm thick. Minimal development observed with top 5 – 10 cm 10YR6/2 to 10YR7/2 over 10YR 7/2 to 10YR8/2, pH 8.0 – 8.5, loamy layers 10YR6/2. A gravelly layer was noted at water table (95 cm) with pH 9.7 in one profile.

(BD) Calcareous sands but no lithified layer noted. Water table within 0.5 m of surface and some areas it is above the surface in winter. Thin organic layer on surface beneath up to 100% litter cover with minimal soil development, generally 10YR 7/2 to 10YR8/2.

B2. TAMALA PLATFORM and OUTCROPS

There were three different situations involving Pleistocene deposits in the Central Coast. Firstly, there was the classical variable depth of Pleistocene yellow sand over Tamala limestone on the eastern platform.

Secondly, there were areas within the Holocene plain where Tamala limestone occurred as outcrops without any residual Pleistocene yellow sand (if it ever existed there). It is assumed that these areas have been stripped mainly by an early Holocene marine transgression.

Finally, there were parts of the eastern platform, obviously a Pleistocene deposit, which has no yellow sand and the limestone was not dense aeolianite. The limestone here is softer often pisolitic and is tentatively referred to as the Cliff Head deposit.

(TLH) The calcareous sands of these areas were mainly between gaps in shallow undulating (0 to 8 slope) Tamala limestone (up to 80% exposed). These were between 0 and 10 cm or rarely 25 cm deep occupying cracks. A paleosol (10YR3/2 to 10YR5/2, pH about 8) was usually present in the deeper crevices. The surface sand of usually less than 5 cm depth varied with age from 10YR8/2 to 10YR6/2 and pH 8.5 to 7.5. Litter cover varied up to 50% cover, with very young areas much less.

(TLW) Some of the sea cliffs of Tamala limestone have similar soil to TLH. These generally have less soil and paleosols are not obvious. Seaweed is a dominant litter covering in some areas testifying to periodic high wave intensity.

Appendix 4 (Continued)

(TLS) Generally these areas are similar to TLH except for the depth of calcareous sand cover which is greater than 15 cm and less than 30 cm. These may also include some yellow sand usually a truncated Pleistocene soil. There was up to 30% limestone exposed often as small pinnacles. The build-up of organic matter in the surface soil (10YR3/2) can be substantial in areas where *Melaleuca cardiophylla* dominates. Litter varied up to 90% cover.

(THL) The greater depth of sand (perhaps over 50 cm) is the main difference between this and TLS or TLH. Litter varied up to 70% cover.

(TL) Some areas sampled had no obvious Holocene calcareous sand on the surface. In this case there was minimal soil of any kind over the Tamala limestone. The pockets of siliceous sand were up to 20 cm deep with up to 70% limestone exposed. They were 10YR3/2 over 10YR6/2. The pH of two sites close to the coast was 8.5 suggesting some calcareous material present in the soil. Litter covered 20 – 30 % of the surface.

(TS) Several sites where the mobile sand mass had exposed a deflated surface of yellow Pleistocene sand (mostly less than 10% carbonate minerals). There were often pinnacles of Tamala Limestone at the surface or emergent from it (up to 10% of surface). The development of soils showed a progressive increase in the accumulation of organic matter. The soils varied from 10YR8/7 (younger) to between 10YR2/0 and 10YR4/3 over 10YR7/6 (older). The pH of the surface was about 8.0 and may decrease to less than 7.0 with depth. Litter varied from 0 to 90% and occasionally with an A0 horizon of up to 2 cm thick.

(TSH) There were occasions where a distinct thin layer of calcareous sand (less than 10 cm) overlay the yellow sand. These showed a similar development with time as TLH and THS.

(THS) This defined areas with deeper calcareous sand (up to 50 cm or more). There was a similar development of soil to that described in TLH and TSH.

B3. CLIFF HEAD deposit (a tentative new geological unit)

In the Cliff Head to Dongara area much of the Pleistocene Limestone has no yellow sand and the limestone was not dense aeolianite. The soils developed on these appear to be significantly different from most other Tamala areas. Some has a covering of Holocene aeolian sand.

(TIS) Fine calcareous loam or gravelly loam (10 to 60 cm, 10YR3/2 to 10YR4/2, about 75% carbonate minerals, pH about 8.0) over sandy gravel 10YR6/2. Gravel has red mottles (5YR4/4). Apparently grades into weak limestone. Usually dense litter up to 3 cm deep and 80 to 90% cover. Patches of gypsum (kopi)have been found in some sites.

(TIH) Similar to TIS but with distinct calcareous (95% carbonate minerals) Holocene sand covering up to 50cm.

APPENDIX 5 Definition of Sectors based on geomorphology

These Sectors were recognised through the presence of specific combinations of landforms most of which are of Holocene age or have been modified during the Holocene. These Sectors are a little different from those recognised from the distribution of vegetation. Table 19 provides a comparison of these two analyses and also the attempts by other authors to divide the coast.

Sector G1. Greenough to Irwin River

This Sector has only been briefly inspected as it was essentially outside the Study. The coast is mostly sandy with occasional Tamala limestone outcrops.

The majority of this Sector is dunes (parabolics of accumulation). These appear to be mostly perched on Tamala limestone. They have moved only a few kilometres inland, presumably limited by the thick vegetation and the Greenough River. The dune sand is variable in its silica content.

There are no wetlands in this Sector within the Holocene deposits.

Sector G2. Port Denison to North of Cliff Head

From south of Leander Point (Port Denison) the coast is boarded by a crescentic Holocene plain. This extends to just north of Cliff Head. This Sector appears to have low to moderate sea energy and moderate sediment supply. Very few patches of Tamala Limestone are exposed above the plain.

White Point, about half way along this Sector, is a major beach ridge plain. Its shape is more sinusoidal than cuspate and thus differs from the other major beach plains at Jurien and Cervantes. The oldest beach ridges at Jurien display a similar form (see Woods 1983a). In this respect White Point is like the Whitfords Cusp documented by Semeniuk and Searle (1986).

Mobile sand masses and the trailing arms of parabolics of deflation are perched on this plain.

Unlike Sectors to the south, the eastern margin of this plain is poorly defined. This may have something to do with the loamy soils and the less competent nature of the Cliff Head deposit in this area. Also unlike most other Sectors, the run of the mobile dunes appears to be limited by the vegetation. Hence the stabilised eastern dunes are mostly parabolics of accumulation.

Except for small soaks and attendant sedgelands behind some foredunes, no wetlands are present in this Sector.

Sector G3. North of Cliff Head to Gum Tree Bay

From just north of Cliff Head to south of Illawong the Tamala limestone dominates the coast. This is not to say that rocky shorelines predominate, but just that the Holocene sands are only a minor part of the Sector.

There is, however, a narrow coastal strip of Holocene beach ridges. These are mostly quite old and demonstrate the low energy and low sediment load of the neighbouring sea. A few stabilised dunes (mainly parabolics of accumulation) are present, mainly intruding from the south.

The limestone and soils indicate that the Pleistocene deposits in this Sector is quite variable. At least three distinct coast parallel units were recognised within it:

- a coastal dense limestone, possibly stripped of attendant sands,
- Cliff Head deposit, and
- more typical Tamala Limestone with yellow sand covering.

A feature of the narrow coastal Holocene sandy deposits is the presence of soaks and ground water outfalls to which the vegetation has responded. This is exhibited as the presence of certain trees rather than sedge dominated wetlands which are absent from this Sector.

Sector G4. Gum Tree Bay to North of Jurien

From north of Coolimba to about North Head there is a discontinuous line of outcropping dense Tamala limestone on or close to the coast. The islands off Cervantes and Jurien are a southward projection of these outcrops. The coastal limestone unit mentioned in Sector G3 is a northward projection. The outcrops in this Sector are extensive and have acted to trap a more or less continuous sand sheet. Thus developed a relatively broad plain backed by, and partially covering, a lagoonal plain.

The Tamala Limestone east of the plain is covered by varying depths of yellow sand but not modified by the passage of Holocene sand masses.

Moderate heighted dunes line parts of this coast. Mobile sand masses have developed from these in just a small proportion of the Sector. These have mostly terminated as parabolics of deflation on the plain with very little perched on the Pleistocene deposits except for just east of Gum Tree Bay. In this case the Pleistocene deposit is the Cliff Head deposit.

Appendix 5 (Continued)

Except for occasional soaks near some dunes on the coast, the saline and gypsiferous wetlands of the lagoonal deposits are the only wetlands of the Sector. The lagoonal deposits are more or less continuous for the southern three quarters of the Sector. These are diverse having been covered to varying degrees by mobile sand masses.

Sector G5. North of Jurien to Grey

This Sector has a coastal plain of up to perhaps two kilometres wide. Like the Lancelin Sector (below) it is backed by Tamala Limestone over which mobile sand masses are active or have passed. These dunes mainly originate in the Wedge Island – Lancelin Sector, not this Sector. Mobile dunes originating in this Sector have travelled sub-parallel to the coast, usually remaining on the Holocene plain.

Tamala Limestone is uncommonly exposed either on the coast or in the plain. On the other hand this Sector has substantially more Tamala limestone islands than others. These islands have probably contributed significantly to the lower energy of this coast line and the formation of the cuspate foreland beach plains on which Cervantes and Jurien are sited. Moderate heighted coastal dunes are present in parts of this Sector.

While not characteristic of this Sector there are several small wetlands of note. Most obvious are Lake Thetis and the Hill River mouth. Lake Thetis is saline with a highly significant occurrence of stromatolites.

The Hill River is perennial fresh water. South of the present mouth of the Hill River are shallow but well defined old drainage channels containing brackish or even fresh water. These may have once been part of the Hill River. The seasonally free water is undoubtedly an expression of ground water en route to the coast.

There are also several small wetlands on the coast south of Cervantes. These typically are just inland of the first coast parallel dune. Dingo Swamp is another wetland area in this Sector. It is within an area of marl deposits. Similar depressions are also present east of Jurien.

Sector G6. Grey to North of Wedge Island

This is a Sector dominated by Tamala Limestone, many areas with sea cliffs. Depending on the height of these cliffs, the limestone is variably overlain by Holocene dunes. There may be some very small inset beaches and accompanying foredunes. The bowl exposed by the small parabolic dunes is generally Tamala limestone.

Inland the Tamala limestone has been stripped of the bulk of the yellow silica sand by the progress of numerous long run mobile sand masses. These originated from the Wedge Island to Lancelin Sector.

No wetlands are present in this Sector.

Sector G7. North of Wedge Island to South of Lancelin

This Sector has a narrow Holocene plain coastward of the Tamala limestone. Virtually no limestone is exposed on the sea shore. Small and narrow beach plain deposits are present in some places on the seashore e.g. Lancelin and to a lesser degree Wedge Island.

While a number of currently mobile dunes originated from this Sector, the coastal part of this Sector is in a period of generally low activity. The sediment deposited on the beach is being accumulated in coastal moderately tall dunes.

The backing Tamala Limestone has been covered by a number of sequences of Holocene dunes with accompanying variation in the silica/carbonate ratio. This Sector has been the major source for Holocene mobile sand masses which travelled as far north as Nambung.

Only minor wetlands occur in some soaks which formed landward of some foredunes, e.g. at Wedge Island.

Sector G8. South of Lancelin to Swan River

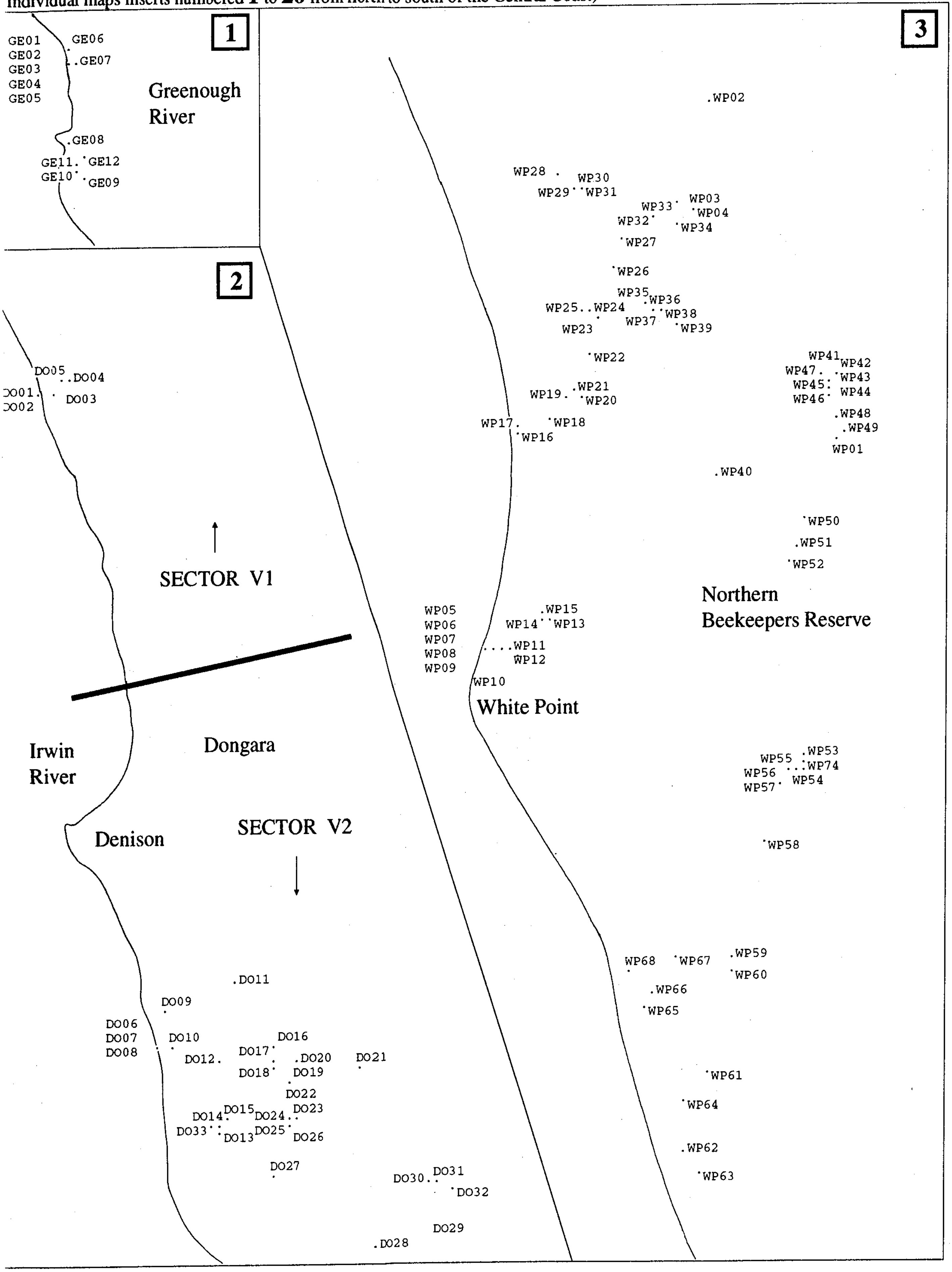
The southern boundary of this Sector is uncertain. It may be appropriate to terminate it at Whitfords as does Seminiuk and Searl (1985). This area has a skeleton of Tamala Limestone over which there are Holocene dunes with variable ratio of silica to carbonate. Limestone is patchily exposed as headlands between which are moderately tall dunes (parabolics of accumulation). There are rare narrow foredunes backing inset beaches.

The parabolic dunes in this Sector only extend a few kilometres inland and have a more easterly aspect to their orientation than those in the northern Sectors. Much of the sand of these dunes are silica, probably redistributed yellow sand associated with the Tamala limestone and a little from the discharge of the Swan River.

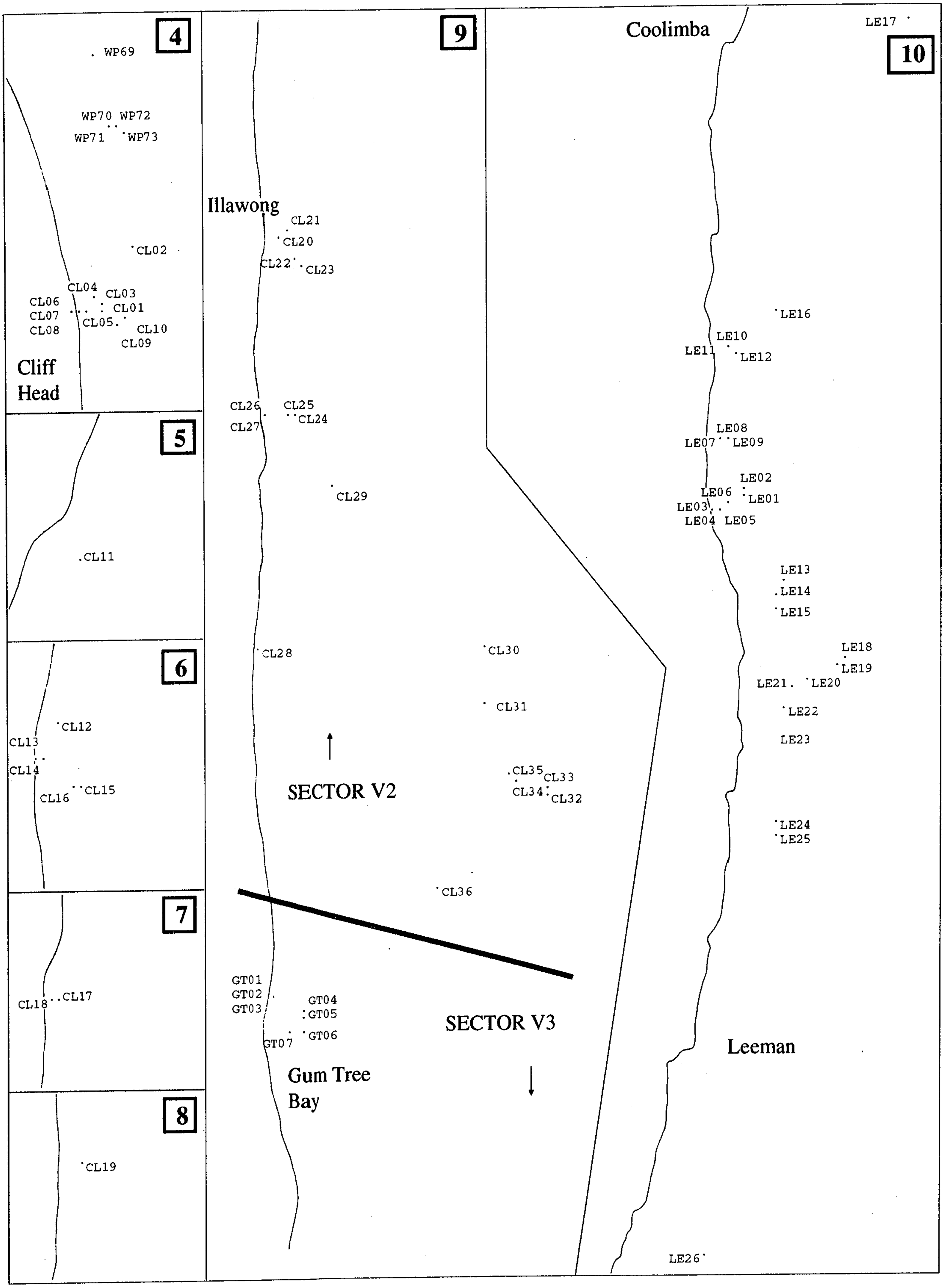
No wetlands occur in this Sector except for the Moore River estuary.

APPENDIX 6 Study Sub-areas and relevés

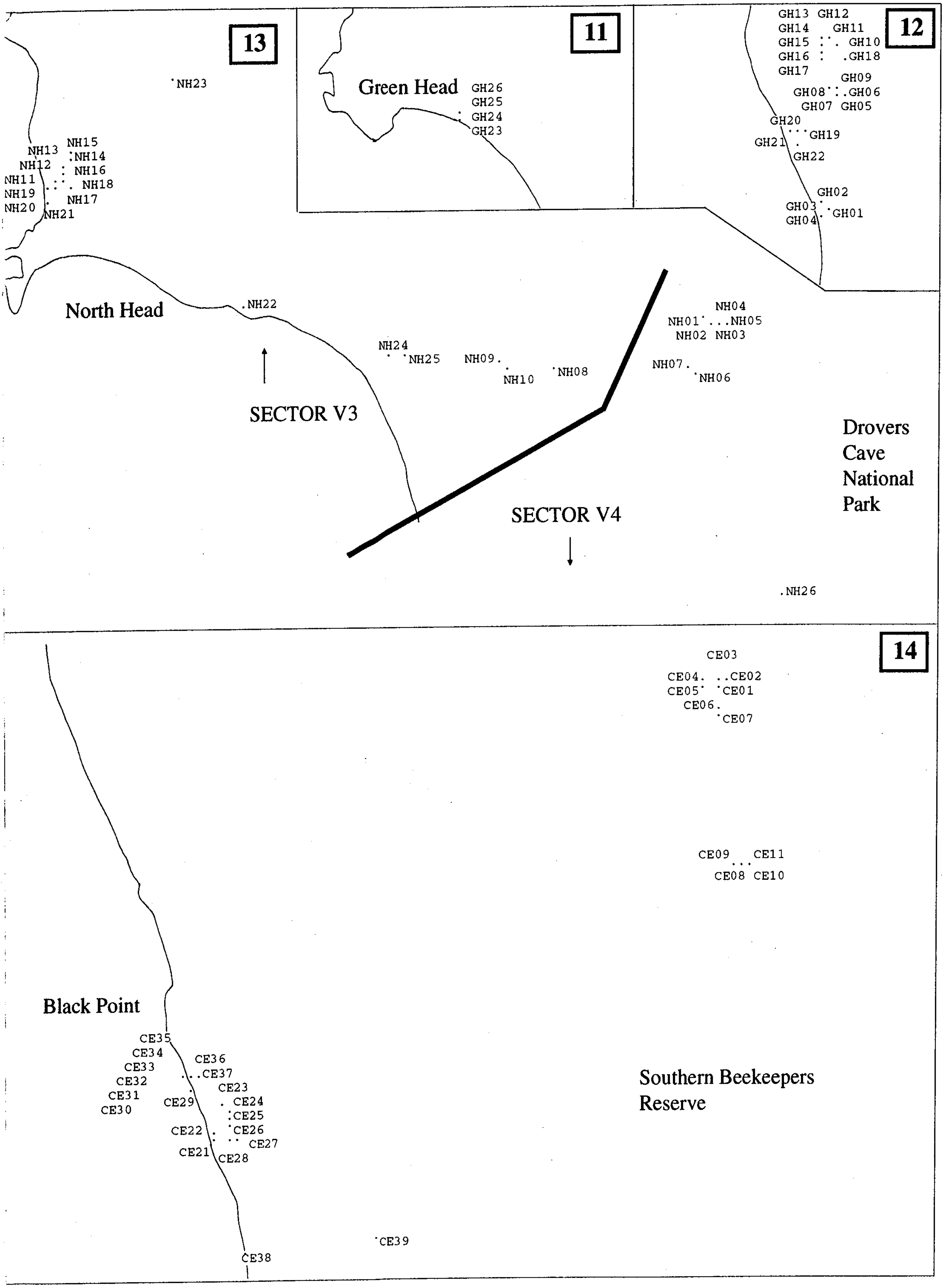
Individual maps inserts numbered **1** to **26** from north to south of the Central Coast)



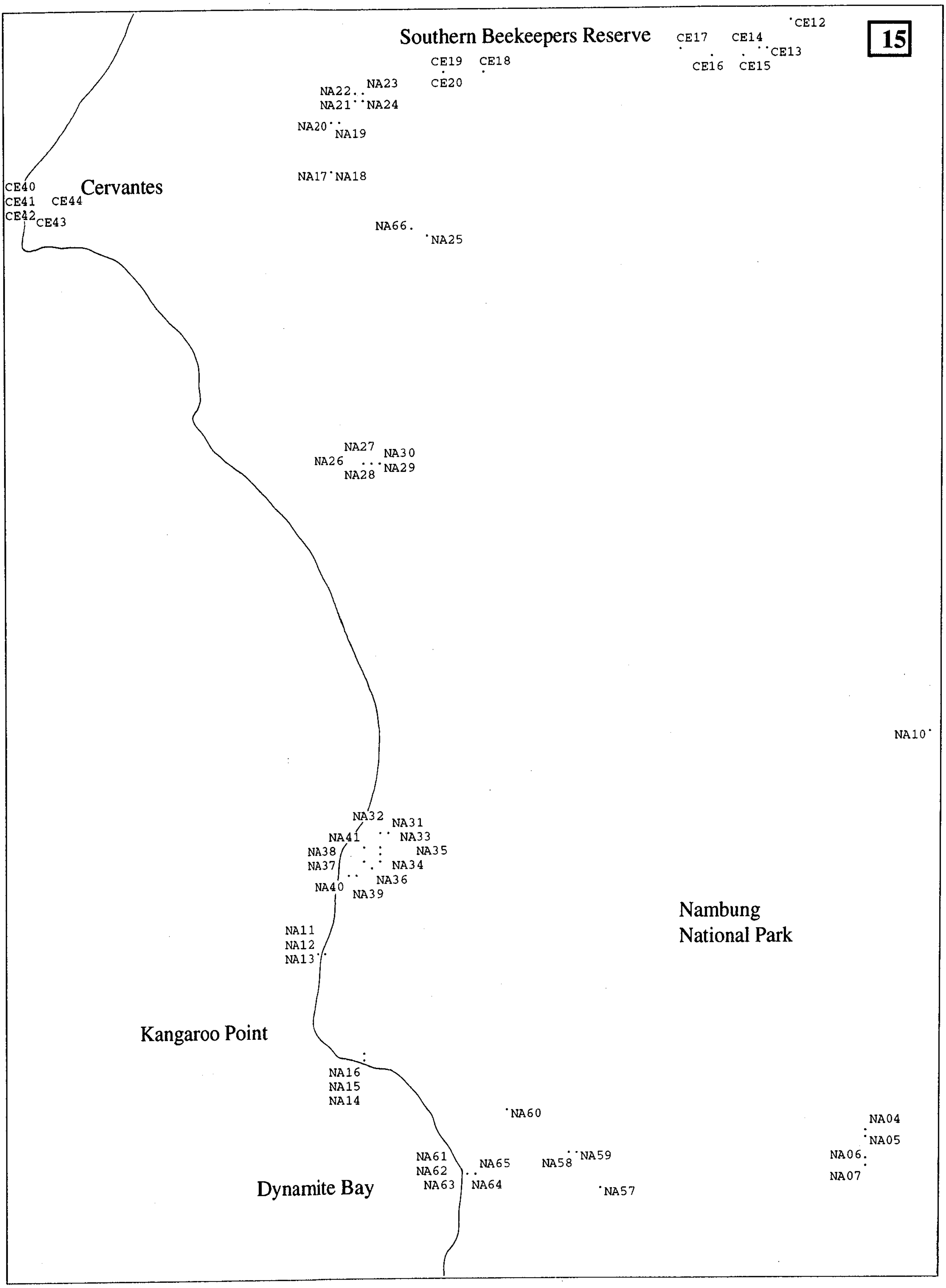
Appendix 6 (Continued)



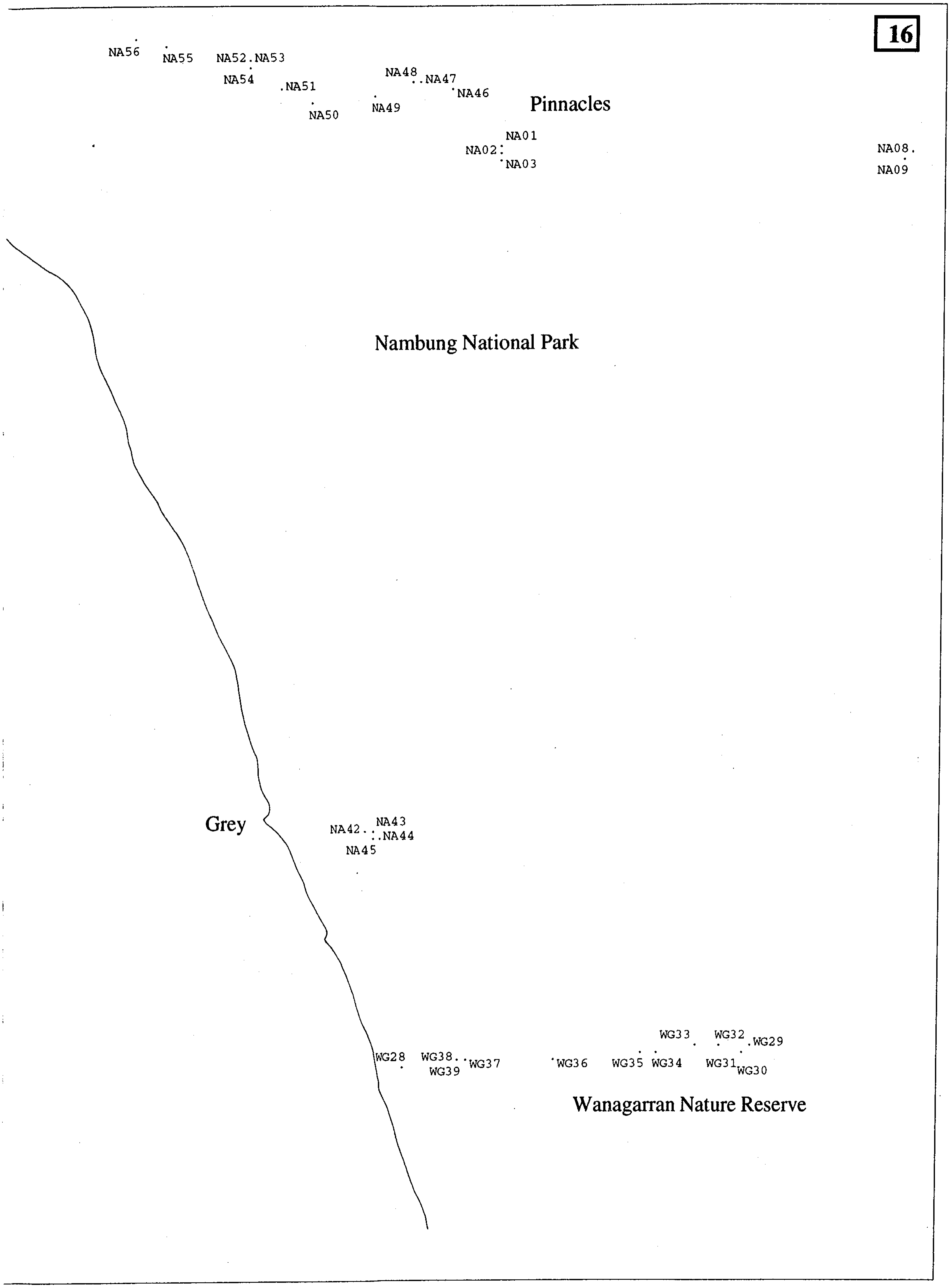
Appendix 6 (Continued)



Appendix 6 (Continued)



Appendix 6 (Continued)



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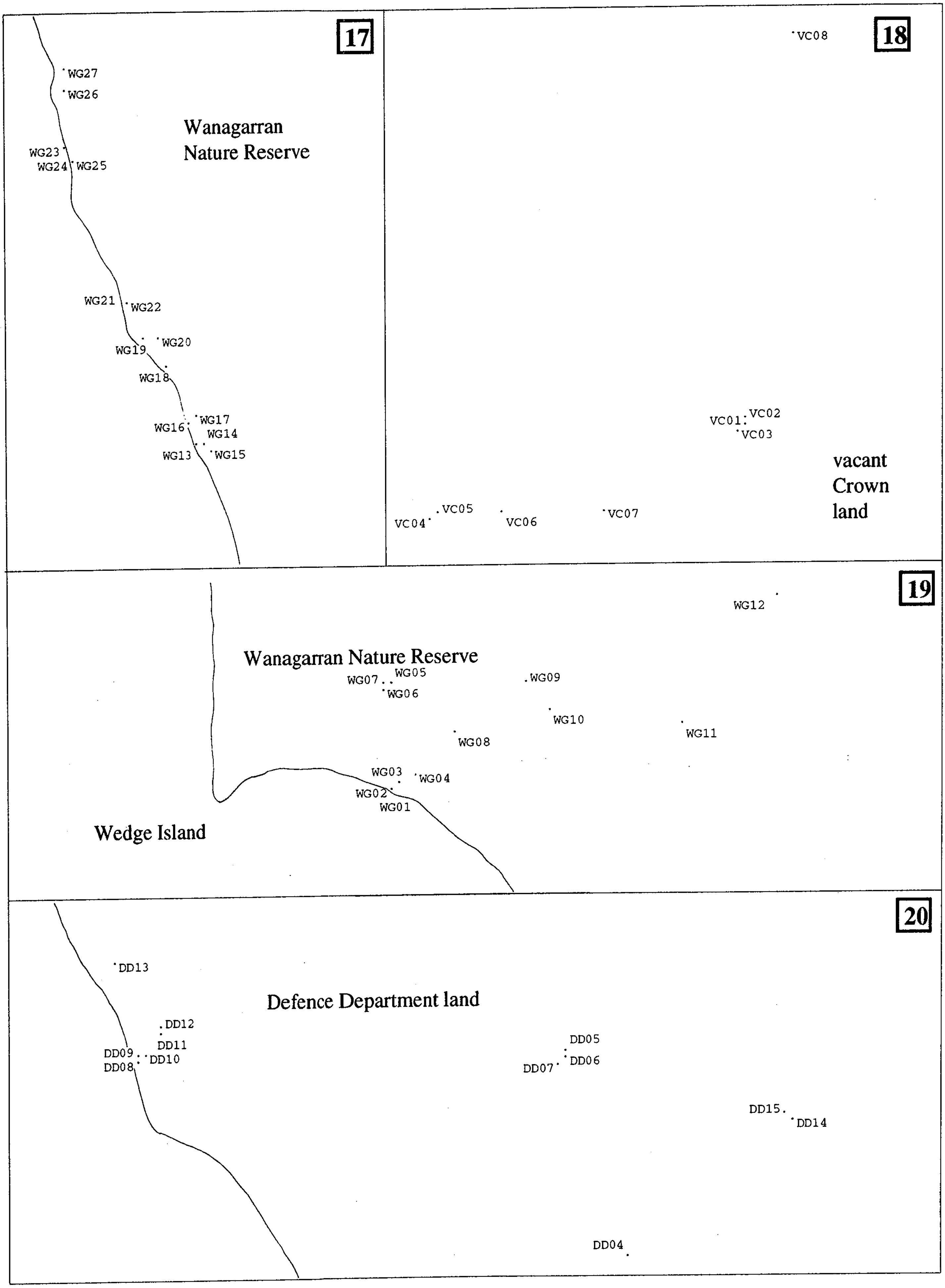

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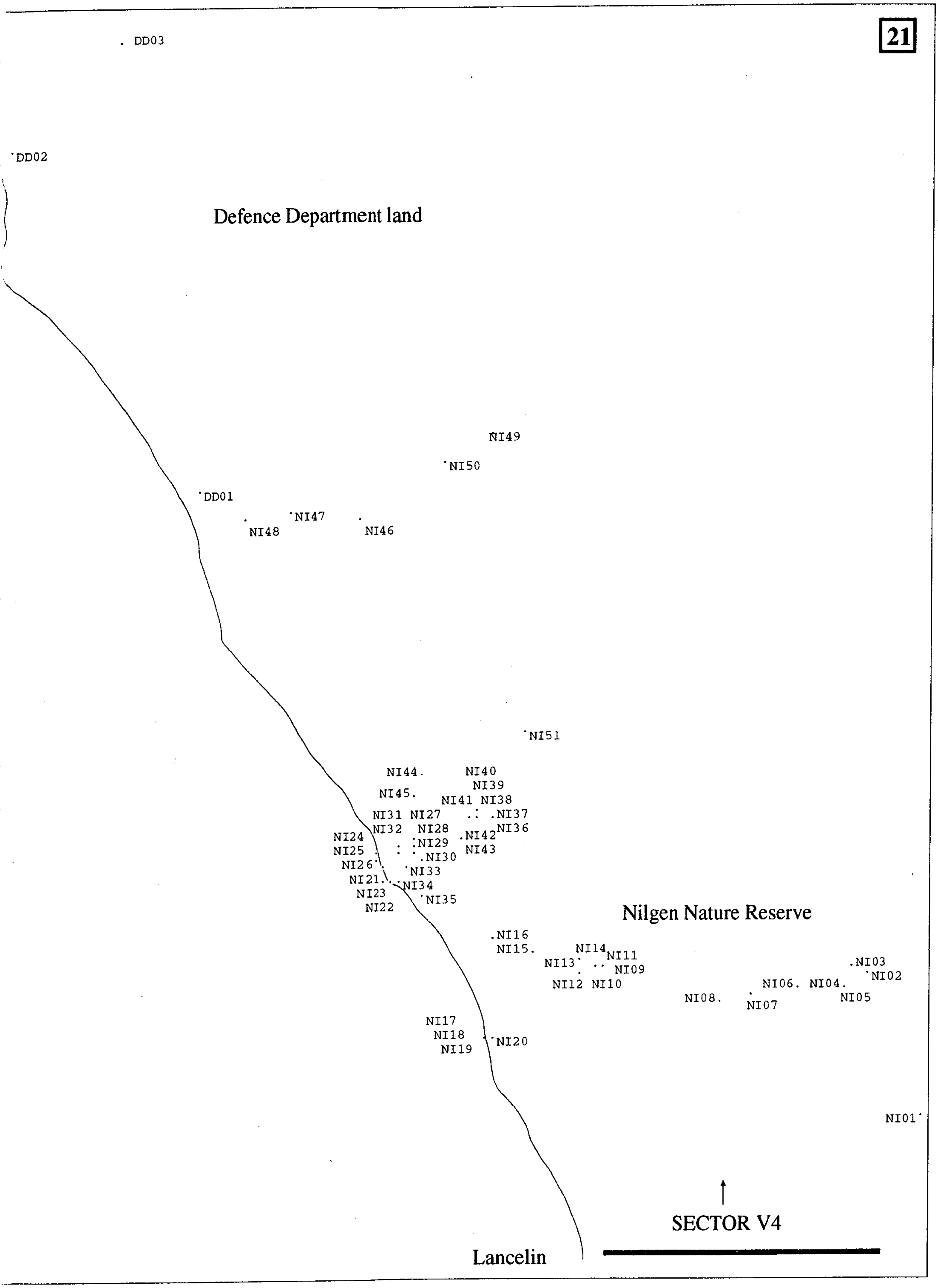

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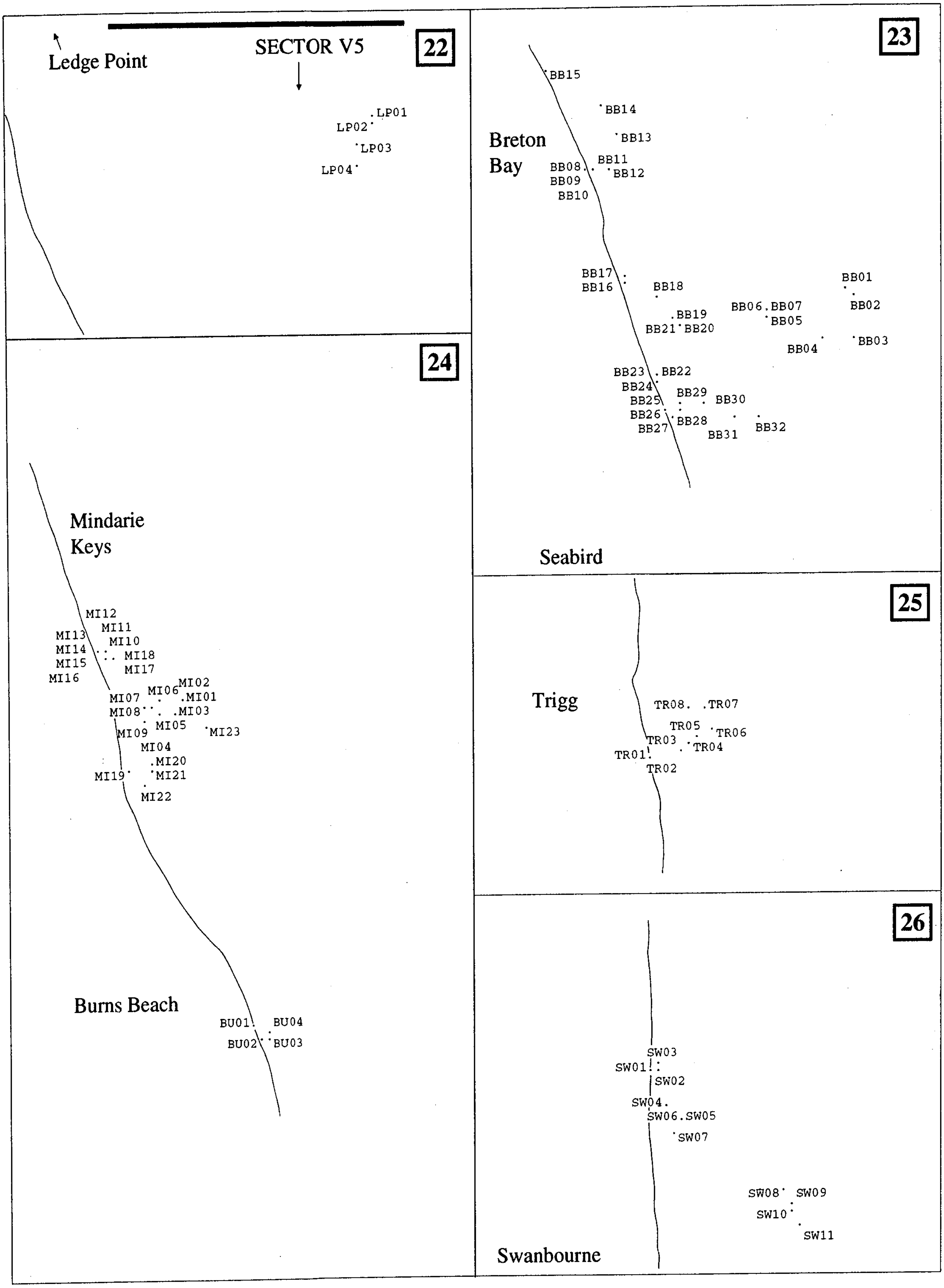

APPENDIX 7 Plant lifeform types

(from unpublished preliminary scheme of E.A. Griffin & A.J.M. Hopkins)

CODE	DESCRIPTION
AG	Annual Graminoids
AH	Annual Herbs
BG	Bulbous Geophytes
BGC	Bulbous Geophytes, Clamberer
BGT	Bulbous Geophytes, Twiner
GC	Chaemophyte, below ground growing point
GT	Chaemophyte, above ground growing point
GTS	Chaemophyte, above ground growing point , Stilted
M	Mallee
MA	Arborescent Monocot
PS	Parasitic Shrub
PSE	Parasitic Shrub, Epiphytic
PSR	Parasitic Shrub, Root
PT	Parasitic Twiner

CODE	DESCRIPTION
SMSC	Shrub, Multi-stemmed, Surface branching, Creeper
SMSE	Shrub, Multi-stemmed, Surface branching, Erect
SMSR	Shrub, Multi-stemmed, Surface branching, Recumbent
SMSS	Shrub, Multi-stemmed, Surface branching, Spralling
SMU	Shrub, Multi-stemmed, Underground branching
SSEC	Shrub, Single-stemmed, Erect, Cone shaped
SSEI	Shrub, Single-stemmed, Erect, Inverted cone
SSES	Shrub, Single-stemmed, Erect, Spindle
SSS	Shrub, Single-stemmed, Surface branching
SXE	Sub-Shrub, Erect
SXP	Sub-Shrub, Prostrate
SXPS	Sub-Shrub, Prostrate, Stilted
SXR	Sub-Shrub, Rosette
SXRS	Sub-Shrub, Rosette, Stilted
TM	Tree, Multi-stemmed
TS	Tree, Single-stemmed

APPENDIX 8 Species list

List of vascular plant species reported from the Central Coast, mostly on Holocene deposits. This includes data from this Study, data from Keighery and Alford (in prep.) and records of the Western Australian Herbarium. Species are organised in plant families following the order of Green (1985). Nomenclature follows Green, but takes into account recent revisions provided in supplements and recent literature.

Some manuscript names in use in the Western Australian Herbarium are shown in this report in parenthesis. These include ones foreshadowed in Brooker and Kleinig (1990) and Hoffman and Brown (1992). For some other apparently undescribed taxa phrase names in brackets are used. Where appropriate voucher specimens lodged at the Western Australian Herbarium are cited.

Certain other information is provided.

L – (Lifeform) from Griffin and Hopkins unpublished (Appendix 7)

E – (Endemics) Taxa apparently endemic to Coastal Holocene deposits (C) or near coastal, generally Tamala (s) areas

T – (Tamala) Taxa found on Tamala surfaces in this study or ones more typical of Tamala surfaces (from Herbarium records and Keighery, (1990).

#R – (Number) Number of relevés of the present study in which this taxa was recorded.

Alien taxa are indicated by '*' in front of the name.

The distributions indicated are based on several sources: specimens at the Western Australian Herbarium, Marchant et. al. (1987), several volumes of Flora of Australia, Hnatiuk (1990), Hoffman and Brown (1992), unpublished data from Shark Bay (M.E. Trudgen pers comm.) and This Study. SW = south-western Australia, ES = eastern States of Australia, OS = overseas (for native Australian species only).

Life-form	E	T	#R	TAXON	RANGE
				Monocotlyedons	
				** 18 **CUPRESSACEAE**	
TS			2	*Callitris preissii* Miq. ssp. *preissii*	Perth & SW
				** 26 **JUNCAGINACEAE**	
AG			73	*Triglochin calcitrapa* Hook.	Shark Bay - SW - Nullabor & ES
AG			1	*Triglochin mucronata* R.Br.	Shark Bay - SW - Balladonia & ES
AG	C		.	*Triglochin trichophora* Nees ex.Endl.	Shark Bay - Yalgorup & ES
				** 31 **POACEAE**	
GT			3	*Amphipogon debilis* R.Br.	Jurien - SW
AG			6	**Avena barbata* Link	Shark Bay - SW & ES
AG			4	**Briza maxima* L.	SW & ES
AG			1	**Briza minor* L.	Shark Bay - SW & ES
AG	C		41	*Bromus arenarius* Labill.	Carnarvon - Nullabor & ES & OS
AG	C		59	**Bromus diandrus* Roth.	Shark Bay - Perth & ES
AG			.	**Bromus madritensis* L.	Perth - SW & ES
GT			141	*Danthonia caespitosa* Gaudich.	Shark Bay SW & ES
AG	s		10	**Desmazeria rigida* (L.)Tutin	Yanchep - Busselton
AG			42	**Ehrharta brevifolia* Schrader	Shark Bay - Perth
AG	C		.	**Ehrharta villosa* J.H.Schultes ex Schultes & J.H.Schultes	Guilderton - Margaret River & ES
AG			.	**Hordeum leporinum* Link	Shark Bay - Nullabor & SW & ES
AG			16	**Laguris ovatus* L.	Cervantes - SW & ES
AG			18	**Lolium rigidum* Gaudin	Shark Bay - SW - Esperance & ES
GT			1	*Neurachne alopecuroides* R.Br.	SW & ES
GT			2	**Parapholis invurva* (L.)C.E.Hubb.	Shark Bay - SW - Nullabor & ES

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				POACEAE (Continued)	
AG			3	**Pentaschistis airoides* (Nees)Stapf	Geraldton - SW & ES
AG			.	**Phalaris minor* Retz.	Geraldton - Esperance
AG			.	**Poa annua* L.	Shark Bay - Cape Naturalist & ES
GT			64	*Poa drummondiana* Nees	Shark Bay - SW - Nullabor & ES
GT	C		161	*Poa poiformis* (Labill.)Druce	Geraldton - Recherche & ES
AG	s		3	*Polypogon tenellus* R.Br.	Shark Bay - Albany
GC	C		11	*Spinifex hirsutus* Labill.	N of Leeman - Eucla & ES
GC	C		11	*Spinifex hirsutus* Labill.	N of Leeman - Eucla & ES
GC	C		59	*Spinifex longifolius* R.Br.	N Australia - Albany & ES & OS
GC	?		8	*Sporobolus virginicus* (L.)Kunth	SW & ES & OS
GT			9	*Stipa elegantissima* Labill.	Shark Bay - SW - Nullabor & ES
GT	s		259	*Stipa flavescens* Labill.	Geraldton - SW & ES
AG			1	*Stipa macalpinei* Reader	Geraldton - SW - Albany
AG			4	**Trisetaria cristata* (L.)Kerguelen	Shark Bay - S & ES
AG			51	**Vulpia myuros* (L.)C.Gmelin var. *hirsuta* Hack.	SW & ES
				** 32 **CYPERACEAE**	
GC	s		9	*Baumea juncea* (R.Br.)Palla	Dongara - Recherche & ES
GC	C		13	*Carex preissii* Nees	Dongara - Cape Le Grande
GT	s		25	*Gahnia lanigera* (R.Br.)Benth.	Shark Bay - Nullabor & ES
GT	C		7	*Gahnia trifida* Labill.	Kalbarri - Cape Arid & ES
AG	s		17	*Isolepis marginata* (Thunb.)A.Dietr.	Abrohlos - Israelite Bay & ES & OS
GC	C		89	*Isolepis nodosa* (Rottb.)R.Br.	Geraldton - Recherche & ES & OS
GT			172	*Lepidosperma angustatum* R.Br.	Dongara - Collie
GT	C		49	*Lepidosperma gladiatum* Labill.	Cliff Head - Cape Arid & ES
GT		T	1	*Mesomelaena pseudostygia* (Kuek.)K.L.Wilson	Shark Bay - Pinjarra
GT	s		6	*Schoenus caespititius* W.Fitzg.	Jurien Bay - SW - Albany
GT	s		28	*Schoenus grandiflorus* (Nees)F.Muell.	Geraldton - Fitzgerald River
GT	s		30	*Schoenus lanatus* Labill.	Cliff Head - Cocklebiddy
GT	s		1	*Schoenus nitens* (R.Br.)Poiret	Cervantes - Albany - Nullabor
GT	s		30	*Schoenus pleistemoneus* F.Muell.	Kalbarri - Yanchep
GT	s	T	1	*Tetraria octandra* (Nees)Kuek.	Eneabba - Albany
				** 39 **RESTIONACEAE**	
GC	s		3	*Leptocarpus aristatus* R.Br.	Leeman - Bremer Bay
GC			197	*Loxocarya flexuosa* (R.Br.)Benth.	Shark Bay - SW - Nullabor
				** 40 **CENTROLEPIDACEAE**	
AG			2	*Centrolepis drummondiana* (Nees)Walp.	Kalbarri - Esperance & ES
AG			2	*Centrolepis glabra* (F.Muell.ex Sonder) Hieron	Geraldton - Recherche & ES
				** 52 **JUNCACEAE**	
GT	s		2	**Juncus acutus* L.	Cervantes - Wheatbelt Esperance & ES
				** 54C **DASYPOGONACEAE**	
GC	C		197	*Acanthocarpus preissii* Lehm.	Exmouth - ?Bunbury & Scarp
GT	C		135	*Lomandra maritima* T.S.Choo	Shark Bay - Bunbury
				** 54D **XANTHORRHOEACEAE**	
MA			3	*Xanthorrhoea preissii* Endl.	SW
				** 54E **PHORMIACEAE**	
GT			12	*Dianella revoluta* R.Br. var. *divaricata* (R.Br.)R.Henderson	Shark Bay - SW & ES

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				** 54F **ANTHERICACEAE**	
GC	s	T	.	*Corynotheca micrantha* (Lindley) J.F.Macbr. var. *acanthoclada* (F.Muell.)R.Henderson	Geraldton - Perth
GC	s		2	*Corynotheca micrantha* (Lindley) J.F.Macbr. var. *micrantha*	Pilbara - Cape Leeuwin
BG			1	*Thysanotus arbuscula* Baker	Jurien - southern forest
BG	C		28	*Thysanotus arenarius* Brittan	Shark Bay - south coast
BG			45	*Thysanotus patersonii* R.Br.	Shark Bay - SW & ES
BG		T	1	*Thysanotus thyrsoideus* Baker	Eneabba - SW - Cape Riche
GT			11	*Tricoryne elatior* R.Br.	Shark Bay - SW - Nullabor & ES
				** 54G **ASPHODELACEAE**	
BG			.	**Asphodelus fistulosus* L.	Gasgoyne - Nullabor & ES
BG	C		16	**Trachyandra divaricata* (Jacq.)Kunth	N of Jurien - Walpole & ES
				** 54J **COLCHICACEAE**	
BG			10	*Wurmbea monantha* (Endl.)T.D.MacFarlane	Shark Bay - south coast
				** 55 **HAEMORODACEAE**	
GT		T	3	*Anigozanthos humilis* Lindley ssp. *humilis*	Kalbarri - Hopetoun
GT	s		1	*Anigozanthos manglesii* D.Don ssp. *quadrans* Hopper	Shark Bay - Jurien
GT	s		1	*Conostylis aculeata* R.Br. ssp. *cygnorum* Hopper	Burns Beach - Leederville
GT	s		.	*Conostylis bracteata* Lindley	Lancelin - Perth
GT	C		263	*Conostylis candicans* Endl. ssp. *calcicola* Hopper	Geraldton - Bunbury & Scott River
GT	s		18	*Conostylis candicans* Endl. ssp. *candicans*	Mingenew - Yalgorup
GT	C		41	*Conostylis pauciflora* Hopper ssp. *euryrhipis* Hopper	Cervantes - Yanchep
				** 59 **DIOSCOREACEAE**	
SMSC	s	T	1	*Dioscorea hastifolia* Endl.	Shark Bay - s of Perth
				** 60 **IRIDACEAE**	
GT		T	2	*Patersonia occidentalis* R.Br.	Murchison River - SW & ES
BG			4	**Romulea rosea* (L.)Ecklon var. *australis* (Ewart)De Vos	SW & ES
				** 66 **ORCHIDACEAE**	
BG	s		1	*Caladenia bicalliata* R.Rogers	Kalbarri - Leeuwin - Denmark & SE
BG			1	*Caladenia flava* R.Br. ssp. *flava*	Kalbarri - SW
BG	s		3	*Caladenia latifolia* R.Br.	Kalbarri - Israelite Bay & ES
BG	s		2	*Caladenia longicauda* Lindley ssp. '*calcigena*' Hopper & A.P.Brown	Lancelin - Bunbury
BG			.	*'Cyanicula' (Caladenia) deformis* (R.Br.)Hopper & A.P.Brown	Kalbarri - SW & ES
BG	s		.	*Cyrtostylis huegelii* Endl.	Gingin - Albany
BG	s		1	*Eriochilus dilatatus* Lindley ssp. *dilatatus*	Geraldton - Recherche
BG	s		4	*Microtis media* R.Br. ssp. *media*	Leeman - Mindarie
BG	s		2	*Prasophyllum calcicola* R.Bates	Kalbarri - Dongara
BG	s		6	*Prasophyllum giganteum* Lindley	Northhampton - Scarp - Bunbury
BG			.	*Pterostylis sanguinea* D.Jones	Kalbarri - Wheatbelt - Israelite Bay

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				Dicotoledons	
				** 70 **CASUARINEACEAE**	
SMSR		T	5	*Allocasuarina humilis* (Otto & Dietr.) L.Johnson	Geraldton & SW - E of Israelite Bay
SSEC	s		123	*Allocasuarina lehmanniana* (Miq.)L.Johnson ssp. *lehmanniana*	Murchison River - Israelite Bay
TS			1	**Casuarina equisetifolia* L.	Geraldton
				** 88 **URTICACEAE**	
AH			49	*Parietaria debilis* G.Forster	North West Cape & SW - Nullabor
AH			.	**Urtica urens* L.	Geraldton - SW & ES
				** 90 **PROTEACEAE**	
TS		T	1	*Banksia attenuata* R.Br.	Murchison River - Bremer Bay
SSS	s	T	2	*Banksia leptophylla* George	Murchison River - Perth
TS			1	*Banksia prionotes* Lindley	Shark Bay - Perth
SMSR	?	T	1	*Conospermum stoechadis* Endl.	Shark Bay - SW
SMSR		T	8	*Dryandra nivea* (Labill.)R.Br.	Dongara - SW
SSEI		T	19	*Dryandra sessilis* (Knight)Domin	Kalbarri - SW
SMSR	s		1	*Grevillea crithmifolia* R.Br.	Dongara - Waneroo - Yalgorup
SSS	s	T	2	*Grevillea olivacea* George	Cliff Head - Jurien
SMSR	s	T	7	*Grevillea thelemanniana* Huegel ex Endl. ssp. *preissii* (Meissner)McGillivray	Leeman - Yalgorup
SMSR		T	5	*Hakea lissocarpha* R.Br.	Kalbarri - Israelite Bay SW
SMSR		T	6	*Hakea prostrata* R.Br.	Eneabba - SW
SSEI		T	6	*Hakea trifurcata* (Smith)R.Br.	Geraldton - Esperance
SMSR		T	1	*Petrophile brevifolia* Lindley	Murchison River - SW
SSES		T	5	*Petrophile serruriae* R.Br.	Geraldton - Esperance SW
				** 92 **SANTALACEAE**	
SSEC	C		9	*Anthobolus foveolatus* F.Muell.	Shark Bay - n of Jurien
SSEC			25	*Exocarpos aphyllus* R.Br.	Carnarvon - Perth
SSEI	C		.	*Exocarpos sparteus* R.Br.	Exmouth - SW - Nullabor & ES
SSEI	s		2	*Leptomeria empetriformis* Miq.	Eneabba - Yalgorup
SSEC	C		74	*Leptomeria preissiana* (Miq.)A.DC.	Shark Bay - Mandurah Frank Hann & ES
SSEI	s		23	*Leptomeria spinosa* (Miq.)A.DC.	Shark Bay - Esperance
SSEC	C		93	*Santalum acuminatum* (R.Br.)A.DC.	Carnarvon - Nullabour & inland & ES
				** 95 **OLACACEAE**	
SSEI	s		9	*Olax benthamiana* Miq.	Northhampton - Israelite Bay
				** 97 **LORANTHACEAE**	
PS			3	*Amyema miraculosum* (Miq.)Tieghem ssp. *miraculosum*	WA & ES
PS			3	*Amyema preissii* (Miq.)Tieghem	Shark Bay - Dongara - Wheatbelt
TS	s		.	*Nuytsia floribunda* (Labill.)R.Br.ex Fenzel	Kalbarri - SW
				** 103 **POLYGONACEAE**	
SMSC	s		3	*Muehlenbeckia adpressa* (Labill.)Meissner	Shark Bay - Israelite Bay & ES

Appendix 8 (Continued)

Life-form	E T	#R	TAXON	RANGE
			** 105 **CHENOPODIACEAE**	
SXP	C	11	*Atriplex cinerea* Poiret	Shark Bay - Nullabor & ES
SSEI	C	26	*Atriplex isatidea* Moq.	Dampier - Twilight Cove
SXP		81	*Enchylaena tomentosa* R.Br. ssp. *tomentosa*	WA & ES
SXP	C	.	*Rhagodia baccata* (Labill.)Moq. ssp. *dioica* (Nees)Paul G.Wilson	Lancelin - Geographe Bay
SXP	C	2	*Rhagodia latifolia* (Benth.)Paul G.Wilson ssp. *recta* Paul G.Wilson	Kalbarri - Leeman
SXP	C	.	*Rhagodia preissii* Moq. ssp. *obovata* (Moq.)Paul G.Wilson	Roebourne - Dongara
SXP		.	*Rhagodia preissii* Moq. ssp. *preissii*	Coolamia - SW - Nullabor & ES
SXE		7	*Salsola kali* L.	WA & ES
SXP		.	*Sarcocornia blackiana* (Ulbr.)A.J.Scott	Carnarvon - Caiguna & ES
SXP		1	*Sarcocornia quinqueflora* (Bunge ex Ung.-Sternb.)A.J.Scott	Carnarvon - SW & ES
SXP	s	.	*Suadea australis* (R.Br.)Moq.	Abrolhos - Cape Arid & ES
SXP	C	1	*Threlkeldia diffusa* R.Br.	Broome - SW & ES
			** 106 **AMARANTHACEAE**	
SXP		2	*Ptilotus divaricatus* (Gaudich.) F.Muell. var. *divaricatus*	Carnarvon - Cliff Head n Wheatbelt (& Pinjarra)
AH		2	*Ptilotus gaudichaudii* (Steudel)J.Black var. *parviflorus* (Benth.)Benl.	Carnarvon - Geraldton - Cundeelee (Cottesloe) & ES
SXP		21	*Ptilotus stirlingii* (Lindley) F.Muell. var. *stirlingii*	Kalbarri - SW
			** 108 **GYROSTEMONACEAE**	
SXP	s	3	*Tersoonia cyathiflora* (Fenzl)George	Kalbarri - Yalgorup
			** 110 **AIZOACEAE**	
SXP	C	.	**Carpobrotus edulis* (L.)L.Bolus	Perth - ES
SXP	C	111	*Carpobrotus virescens* (Haw.)Schwantes	Murchison River - Nullabor
SXP	C	.	**Mesembryanthemum crystallinum* L.	Shark Bay - ES
SXP	C	61	**Tetragonia decumbens* Miller	Geraldton - Cape Riche & ES
			** 111 **PORTULACACEAE**	
AH		.	*Calandrinia calyptrata* J.D.Hook.	Shark Bay - SW - Nullabor & ES
AH		85	*Calandrinia corrigioloides* F.Muell.ex Benth.	Shark Bay - SW & ES
AH	?	36	*Calandrinia liniflora* Fenzl	Kalbarri - Cape Naturaliste
			** 113 **CARYOPHYLLACEAE**	
AH		7	**Cerastium glomeratum* Thuill.	Shark Bay - SW & ES
AH		8	**Petrorhagia velutina* (Guss.)P.Ball & Heyw.	Northhampton - SW & ES
AH		.	**Polycarpon tetraphyllum* (L.)L.	Shark Bay - SW & ES
AH		1	**Silene gallica* L. var. *gallica*	Shark Bay - SW & ES
AH		.	**Spergularia salina* J.S.Presl & C.Presl	Shark Bay - SW & ES
AH?		.	**Vaccaria hispanica* (Miller)Rauschert	Dongara - Mt Barker & ES
			** 119 **RANUNCULACEAE**	
SMSC		85	*Clematis microphylla* DC.	Shark Bay - SW & ES

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				** 131 **LAURACEAE**	
PT	C		47	*Cassytha aurea* J.Z.Weber var. *hirta* J.Z.Weber	Kalbarri - Perth
PT			69	*Cassytha flava* Nees	Geraldton - SW - Esperance
PT			19	*Cassytha glabella* R.Br.	Geraldton - SW
PT				*Cassytha glabella* R.Br. forma *dispar* (Schltdt.)J.Z.Weber	Geraldton - SW
PT	s		253	*Cassytha racemosa* Nees	Cape Range - SW
				** 138 **BRASSICACEAE**	
SXE	C		31	**Cakile maritima* Scop.	Shark Bay - Esperance
AH	C		.	**Diplotaxis muralis* (L.)DC.	Shark Bay - Augusta & ES
AH	s		49	**Heliophila pusilla* L.f.	Jurien - Cape Naturaliste
	C		.	**Hymenolobus procumbens* (L.)Nutt.ex Schinz & Thell.	Dirk Hartog - Nullabor & ES
SXE	C		8	*Lepidium foliosum* Desv.	Green Head - Nullabor & ES
SXE	C		4	*Lepidium linifolium* (Desv.)Steudel	Dampier - Kalbarri - Lancelin
SXE	C		3	*Lepidium lyratogynum* H.J.Hewson	Carnarvon - Perth
SXE			6	*Lepidium rotundum* (Desv.)DC.	Carnarvon - SW & ES
AH			8	**Raphanus raphanistrum* L.	SW & ES
AH	C		17	*Stenopetalum robustum* Endl.	Shark Bay - Walpole
				** 139 **RESEDACEAE**	
SXE?	C		.	**Resida alba* L.	Geraldton - Rottnest & ES
				** 143 **DROSERACEAE**	
BG		T	1	*Drosera macrantha* Endl. ssp. *macrantha*	Geraldton - SW
BG			2	*Drosera stolonifera* Endl. ssp. *humilis* (Planchon)N.Marchant	Shark Bay - Mogumber
				** 149 **CRASSULACEAE**	
AH			140	*Crassula colorata* (Nees)Ostenf. var. *colorata*	Shark Bay - SW & ES & OS
AH			.	*Crassula colorata* (Nees)Ostenf. var. *tuberculata* Tolken	Shark Bay - SA border
AH			.	*Crassula decumbens* Thunb. var. *decumbens*	Kalbarri - SW & ES
AH			.	*Crassula exerta* (Reader)Ostenf.	Abrohlos - SW & ES
AH	C		52	**Crassula glomerata* P.Bergius	N of Jurien - Albany & Sydney
AH			3	*Crassula pedicellosa* (F.Muell.)Ostenf.	SW & ES
AH			.	*Crassula peduncularis* (Smith)Meigen	Kalbarri - SW & ES & OS
				** 152 **PITTOSPORACEAE**	
SMSC		T	1	*Billardiera bicolor* (Putterl.) E.M.Bennett var. *lineata* (Benth.)E.M.Bennett	Kalbarri - Cockleshell Gully
SSEC	C		3	*Pittosporum phylliraeoides* DC. var. *phylliraeoides*	Shark Bay - Perth
				** 155 **CUNONIACEAE**	
SMSC	s	T	1	*Aphanopetalum clematideum* (J.Drumm.ex Harvey)Domin	Shark Bay - Stock Yard Gully
				** 160 **SURIANACEAE**	
SSEC			1	*Stylobasium spathulatum* Desf.	N Australia - Geraldton

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				** 163 **MIMOSACEAE**	
SMSR	C		17	*Acacia cochlearis* (Labill.)H.L.Wendl.	Leeman - Madura
SSS	C		41	*Acacia cyclops* Cunn. ex Don	Leeman - Nullabor & ES
SMSR	s		.	*Acacia huegelii* Benth.	Moore River - Yallingup
SMSR	C		6	*Acacia idiomorpha* Cunn.ex Benth.	Shark Bay - Wedge Island
SSEI	s		256	*Acacia lasiocarpa* Benth. var. *lasiocarpa*	Murchison River - Bunbury
SSEI			13	*Acacia pulchella* R.Br. var. *glaberrima* Meissner	Coorow - SW
SMSR	s		201	*Acacia rostellifera* Benth.	Shark Bay - Cape Arid
SSEC			2	*Acacia saligna* (Labill.)H.L.Wendl.	Murchison River - SW & ES
SMSR	s	T	1	*Acacia spathulifolia* Maslin	NW Cape - Lancelin
SSEI	s		76	*Acacia truncata* (Burm.f.)Hort.ex.Hoffsgg.	Leeman - Bunbury
SMSR	s		15	*Acacia xanthina* Benth.	Shark Bay - Perth
				** 164 **CAESALPINIACEAE**	
SMSS	s	T	1	*Labichea cassioides* Gaudich.	NW Cape - Cockleshell Gully
				** 165 **PAPILIONACEAE**	
SSEI		T	2	*Bossiaea eriocarpa* Benth.	Kalbarri - SW
SMSR	C	T	1	*Chorizema varium* Benth.	Seabird (& extinct at Fremantle)
SMSR	s	T	2	*Daviesia divaricata* Benth.	Murchison River - Walpole
SSEI			55	*Gompholobium tomentosum* Labill.	Shark Bay - SW
SMSC	C		104	*Hardenbergia comptoniana* (Andrews)Benth.	Dongara - Albany
SXE			24	*Isotropis cuneifolia* (Smith)Benth.ex B.D.Jackson	Geraldton - SW
SSEI			.	*Jacksonia furcellata* (Bonpl.)DC.	Geraldton - Esperance SW
SMSR	s	T	3	*Jacksonia* sp. aff. *spinosa* (Labill.)R.Br. (R.Pullen 9659)	Eneabba - Yanchep
SMSC			12	*Kennedia prostrata* R.Br.	Shark Bay - SW & ES
AH			2	*Lotus australis* Andrews	Gasgoyne - Geraldton & ES
AH			1	**Medicago polymorpha* L. ssp. *polymorpha*	Shark Bay - Esperance SW & ES
AH			3	**Melilotus indica* (L.)All.	Shark Bay - Esperance SW & ES
SMSR	s		103	*Nemcia reticulata* (Meissner)Dom	Northhampton - Mandurah
SMSR			5	*Sphaerolobium macranthum* Meissner var. *macranthum*	Geraldton - SW
SMSR			.	*Sphaerolobium medium* R.Br.	Cockleshell Gully - Stirling Range
SSEI	C		61	*Templetonia retusa* (Vent.)R.Br.	Shark Bay - Israelite Bay & ES
AH			2	**Trifolium campestre* Schreber	Kalbarri & SW & ES
				** 167 **GERANIACEAE**	
AH			6	**Erodium cicutarium* (L.)L'Her.	Shark Bay & SW - Nullabor & ES
SMSR	C		29	**Pelargonium capitatum* (L.)L'Her.	Moore River - Esperance & ES
SXP			2	*Pelargonium littorale* Huegel	Shark Bay - SW - Cape Arid & ES
				** 173 **ZYGOPHYLLACEAE**	
SMSR	C		4	*Nitraria billardierei* DC.	Carnarvon - SA border & ES & inland
SXP	C		13	*Zygophyllum billardierei* DC.	Shark Bay - Esperance & ES
SXP			42	*Zygophyllum fruticulosum* DC.	Carnarvon - SW - W Nullabor
SXP	C		.	*Zygophyllum simile* Hj.Eichler	Carnarvon - Recherche
				** 175 **RUTACEAE**	
SMSR	s		.	*Boronia alata* Smith	Perth - Esperance
SMSR			3	*Boronia crenulata* Smith	Shark Bay - Esperance
SMSR	s	T	.	*Diplolaena angustifolia* Hook.	Leeman - Yanchep
SMSR	s		12	*Diplolaena* sp. Kalbarri	Shark Bay - n of Jurien
SMSR	s	T	1	*Diplolaena* sp. Lancelin	Eneabba - Breton Bay
SMSE		T	1	*Eriostemon spicatus* A.Rich.	Three Springs & SW

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				** 183 **POLYGALACEAE**	
SXE	s		47	*Comesperma confertum* Labill.	Geraldton - Israelite Bay
SMSC			39	*Comesperma integerrimum* Endl.	Shark Bay - SW & ES
SXE			4	*Comesperma scoparium* Steetz	Shark Bay - south coast
				** 185 **EUPHORBIACEAE**	
SXE	s		1	*Adriana quadripartita* (Labill.)Gaudich.	Dongara - Esperance - Nullabor & ES
SXE	C		19	*Beyeria cinerea* Airy Shaw	Exmouth - Mandurah
SXE	s		1	*Beyeria viscosa* (Labill.)Miq.	Geraldton - Esperance & ES
SXE			3	*Euphorbia boophthona* C.Gardner	Pilbara - Gasgoyne - Leeman & ES
AH			3	**Euphorbia peplus* L.	Dongara - Perth - Cape Naturaliste
SSEI			101	*Phyllanthus calycinus* Labill.	Shark Bay - Israelite Bay & ES
SXE	C		6	*Phyllanthus maitlandianus* Diels	Greenough River - N of Leeman
AH			18	*Poranthera microphylla* Brong.	Shark Bay - SW - Nullabor & ES
				** 202 **STACKHOUSIACEAE**	
SXE			5	*Stackhousia monogyna* Labill.	Shark Bay - SW - Nullabor & ES
				** 207 **SAPINDACEAE**	
SMSR	s		1	*Diplopeltis huegelii* Endl. var.*huegelii*	Three Springs - Yalgorup
SMSR	s		.	*Diplopeltis huegelii* Endl. var. *subintegra* George	Shark Bay - ?? Arrowsmith River
SMSR	s		.	*Diplopeltis petiolaris* F.Muell.ex Benth.	Kalbarri - Dongara
SSEI	s		19	*Dodonaea aptera* Miq.	Shark Bay - Yallingup
				** 215 **RHAMNACEAE**	
SSEI	s		56	*Cryptandra mutila* Nees	Shark Bay - Yallingup
SSEI	C		223	*Spyridium globulosum* (Labill.)Benth.	Geraldton - Nullabor
SMSS			22	*Stenanthemum tridentatum* Benth.	Kalbarri - SW & ES
SSEC	s		4	*Trymalium albicans* (Steudel)Reissek	N of Jurien - Yalgorup
				** 221 **MALVACEAE**	
SSEC			.	*Alyogyne hakeifolia* (Giord.)Alef.	NW Cape - Jurien - Wheatbelt - Nullabor & ES
SSEC			6	*Alyogyne huegelii* (Endl.)Fryx. var. *huegelii*	Shark Bay - SW & ES
				** 223 **STERCULIACEAE**	
SMSR	C		13	*Guichenotia ledifolia* Gay	Shark Bay - Israelite Bay
SMSR	C		4	*Lasiopetalum oppositifolium* F.Muell.	Shark Bay - Perth
SMSR	C		4	*Rulingia malvifolia* Steetz var. *borealis* E.Pritzel	Shark Bay - Recherche
SMSR	C		16	*Thomasia cognata* Steudel	Murchison River - Cape Arid
SMSR	s		.	*Thomasia triphylla* (Labill.)Gay	Nambung - Esperance
				** 226 **DILLENIACEAE**	
SMSE		T	1	*Hibbertia hypericoides* (DC.)Benth.	Northhampton - Augusta
SSEI	s		124	*Hibbertia racemosa* (Endl.)Gilg	Shark Bay - Esperance
SMSE	s		10	*Hibbertia spicata* F.Muell. ssp. *leptotheca* J.R.Wheeler	Wedge Island - Yalgorup
				** 236 **FRANKENIACEAE**	
SMSR			4	*Frankenia pauciflora* DC. ssp. *pauciflora*	WA & ES
				** 243 **VIOLACEAE**	
SMSR			8	*Hybanthus calycinus* (DC.ex Ging.)F.Muell.	Kalbarri - SW

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				** 263 **THYMELAEACEAE**	
SSES			1	*Pimelea argentea* R.Br.	Murchison River - SW - Israelite Bay
SMSE	C		64	*Pimelea ferruginea* Labill.	Dongara - west Nullabor
SSEI	s		1	*Pimelea gilgiana* E.Pritzel	Shark Bay - Wilbinga
SMSE			1	*Pimelea microcephala* R.Br. ssp. *microcephala*	Pilbara - Geraldton Goldfields & ES
				** 273 **MYRTACEAE**	
SMSR	s		2	*Agonis flexuosa* (Sprengel)Schauer	Perth - Bremer Bay
SMSR			39	*Calothamnus quadrifidus* R.Br.	Shark Bay - SW
SMSR		T	1	*Calothamnus sanguineus* Labill.	Kalbarri - SW
SSEI	s		20	*Chamelaucium uncinatum* Schauer	Kalbarri - Perth
TS	s		3	*Eucalpytus gomphocephala* DC.	Jurien - Ludlow
M	s		.	*Eucalyptus 'petrensis'* Brooker & Hopper	N of Jurien - Yalgorup
M	s		.	*Eucalyptus 'zopherophloia'* Brooker & Hopper	Dongara - Illawong
M	s	T	1	*Eucalyptus foecunda* Schauer (Coolimba) (MIH Brooker 9556)	Coolimba - N of Jurien
M			8	*Eucalyptus obtusiflora* DC.	Shark Bay - N of Jurien
M	s		.	*Eucalyptus oraria* L.Johnson	Shark Bay - Cliff Head
SMSR	s		296	*Melaleuca acerosa* Schauer	Geraldton - Walpole
SMSR	s		3	*Melaleuca brevifolia* Turcz.	Leeman - Israelite Bay
SMSR	s		82	*Melaleuca cardiophylla* F.Muell.	Exmouth - Mullalloo
SMSE	s		107	*Melaleuca huegelii* Endl. ssp. *huegelii*	Shark Bay - Augusta
TS			7	*Melaleuca lanceolata* Otto	Shark Bay - SW - SA border & ES
SMSE			1	*Melaleuca viminea* Lindley ssp. *viminea*	Kalbarri - SW - Mt Barker
SMSR	s	T	1	*Scholtzia umbellifera* F.Muell.	Kalbarri - Jurien
SMSR	s		28	*Thryptomene baeckeacea* F.Muell.	Cape Range - Lancelin
SMSR			3	*Thryptomene hyporhytis* Turcz.	Geraldton - Badgingarra
SMSR			.	*Thryptomene prolifera* Turcz.	Murchison River - Mogumber
				** 275 **ONAGRACEAE**	
SXP	C		1	**Oenothera drummondii* Hook.	Perth - Mandurah & ES
				** 276 **HALORAGACEAE**	
SXE	s		9	*Halorogis foliosa* Benth.	Dongara - Cervantes
				** 281 **APIACEAE**	
AH			115	*Daucus glochidiatus* (Labill.) Fischer, C.Meyer & Ave-Lall.	Cape Range - SW - Nullabor & ES
AH	C		1	*Hydrocotyle blepharocarpa* F.Muell.	Dongara - Albany
AH			20	*Hydrocotyle callicarpa* Bunge	Dongara - SW - Nullabor & ES
AH			1	*Hydrocotyle diantha* DC.	n of Perth - Esperance & ES
AH			2	*Hydrocotyle pilifera* Turcz. ssp. *glabrata* Benth.	SW & Goldfields & ES
AH	s		1	*Trachymene coerulea* R.A.Graham var. *coerulea*	Yanchep - Augusta
AH	s	T	1	*Trachymene coerulea* R.A.Graham var. *leucopetala* Benth.	Kalbarri - Eneabba
AH			322	*Trachymene pilosa* Smith	Shark Bay - SW & ES
				** 288 **EPACRIDACEAE**	
SMSE	C		76	*Acrotriche cordata* (Labill.)R.Br.	Dongara - Cocklebiddy & ES
SMSE	C		129	*Leucopogon insularis* Cunn.ex DC.	Geraldton - Perth
SMSE	C		182	*Leucopogon parviflorus* (Andrews)Lindley	Dongara - Israelite Bay & ES
SSEI			36	*Lysinema ciliatum* R.Br.	Kalbarri - SW - Nullabor

Appendix 8 (Continued)

Life-form	E T	#R	TAXON	RANGE
			** 293 **PRIMULACEAE**	
AH		28	**Anagallis arvensis* L. var. *caerulea* Gouan	Shark Bay - SW & ES
SXE		.	*Samolus junceus* R.Br.	Shark Bay - Cape Arid
SXP	s	6	*Samolus repens* (Forster & G.Forster)Pers. ssp. *floribundus* Benth.	Millstream - Israelite Bay
			** 302 **LOGANIACEAE**	
SMSR	s	7	*Logania vaginalis* (Labill.)F.Muell.	Cape Range - Recherche
AH		26	*Mitrasacme paradoxa* R.Br.	Dongara - SW & ES
			** 303 **GENTIANACEAE**	
AH		1	**Centaurium erythraea* Rafn	Shark Bay - SW - Nullabor & ES
AH	C	4	**Centaurium spicatum* (L.)Fritsch ex Janchen	Karratha - Bunbury - Recherche & ES
			** 304 **APOCYNACEAE**	
SSEC		5	*Alyxia buxifolia* R.Br.	Shark Bay - Goldfields - Nullabor
			** 307 **CONVOLVULACEAE**	
SXP		1	*Wilsonia backhousei* J.D.Hook.	Shark Bay - SW & ES
			** 307A **CUSCUTACEAE**	
PT		6	*Cuscuta australis* R.Br.	Shark Bay - SW - Goldfields & ES
			** 310 **BORAGINACEAE**	
AH		.	**Buglossoides arvensis* (L.)I.M.Johnston	Geraldton - Busselton Goldfields & ES
			** 313 **LAMIACEAE**	
SSEI		147	*Hemiandra pungens* R.Br.	Kalbarri - SW
SMSR	C	14	*Westringia dampieri* R.Br.	Shark Bay - Nullabor & ES
			** 315 **SOLANACEAE**	
SSEC		1	*Anthocercis ilicifolia* Labill. ssp. *ilicifolia*	Shark Bay - Mandurah & Northam
SSEC	C	13	*Anthocercis littorea* Labill.	Carnarvon - Israelite Bay
SSEC		6	*Lycium australe* F.Muell.	Shark Bay - Fremantle & ES
SSEC		.	**Lycium ferocissimum* Miers	? Shark Bay - Goldfields Nullabor & ES
AH	C	3	*Nicotinia occidentalis* Wheller ssp. *hesperis* (N.Burb.)P.Horton	Carnarvon - Jurien
AH		1	**Solanum nigrum* L.	WA & ES
			** 316 **SCROPHULARIACEAE**	
AH	C	141	**Dischisma arenarium* E.Meyer	Shark Bay - Cape Le Grande & ES
AH		15	**Parentucellia latifolia* (L.)Caruel	Geraldton - SW & ES
AH		1	**Zaluzianskya divaricata* (Thunb.)Walp.	Northhampton - Wheatbelt & ES
			** 320 **OROBRANCHACEAE**	
BG		11	**Orobanche minor* Smith	Shark Bay - SW
			** 326 **MYOPORACEAE**	
SXP		12	*Eremophila glabra* (R.Br.)Ostenf.	Exmouth - SW & ES
SMSR	s	.	*Myoporum caprarioides* Benth.	Dongara - Busselton
SSEC	C	62	*Myoporum insulare* R.Br.	Shark Bay - Nullabor & ES
			** 329 **PLANTAGINACEAE**	
AH		2	*Plantago drummondii* Decne.	Carnarvon - Geraldton - Goldfields & ES

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				** 331 **RUBIACEAE**	
AH	c		.	*Galium migrans* Ehrendorfer & McGillivray	Jurien - Nullabor & ES
AH			1	**Galium murale* (L.)All.	Perth - SW - Nullabor & ES
SXE			106	*Opercularia spermacocea* Labill.	Shark Bay - Wheatbelt - s coast
SXE			153	*Opercularia vaginata* Labill.	Shark Bay - SW
				** 339 **CAMPANULACEAE**	
AH			2	*Wahlenbergia preissii* Vreise	Geraldton - SW & ES
				** 340 **LOBELIACEAE**	
AH			171	*Isotoma hypocrateriformis* (R.Br.)Druce	Kalbarri - SW
AH			25	*Lobelia heterophylla* Labill.	Hamersley Range - SW & ES
				** 341 **GOODENIACEAE**	
AH			2	*Goodenia filiformis* R.Br.	Geraldton - SW
SMSR	s		8	*Lechenaultia linarioides* DC.	Shark Bay - Perth
SMSS		T	1	*Scaevola canescens* Benth.	Kalbarri - S Coast
SMSR	C		150	*Scaevola crassifolia* Labill.	Shark Bay - Nullabor & ES
SSEC	C		12	*Scaevola nitida* R.Br.	Dongara - ES
SMSR			1	*Scaevola paludosa* R.Br.	Shark Bay - Williams
SMSR			1	*Scaevola spinescens* R.Br.	N Australia - Eneabba - Wheatbelt
SMSR	C		53	*Scaevola thesioides* Benth. ssp. *thesioides*	Kalbarri - Yalgorup
SXE			6	*Velleia trinervis* Labill.	Dongara - SW
				** 343 **STYLIDIACEAE**	
SXR	s		24	*Stylidium 'maritimum'* D.Coates	Cliff Head - Yalgorup
SXR		T	1	*Stylidium brunonianum* Benth. ssp. *brunonianum*	Kalbarri - Nannup
SXR			46	*Stylidium junceum* R.Br.	Cliff Head - SW
SXPS			1	*Stylidium repens* R.Br.	Kalbarri - SW - Israelite Bay
				** 345 **ASTERACEAE**	
AH	C		1	*Actinobole condensatum* (A.Gray)P.S.Short	Shark Bay - Abrohlos - Watheroo
SXE			3	*Actites megalocarpa* (J.D.Hook.)N.S.Lander	Lancelin - SW - Esperance & ES
AH	C		.	*Angianthus cunninghamii* (DC.)Benth.	Onslow - Perth
AH	C		22	*Angianthus* sp. aff. *milnei* Benth. (GJ Keighery 2579)	Dongara - Jurien
AH			1	**Arctotheca calendula* (L.)Levyns	Shark Bay - SW - Nullabor & ES
SXP	C		6	**Arctotheca populifolia* (P.Bergius)Norlindh	Geraldton - Esperance & ES
AH	s		3	*Asteridea pulverulenta* Lindley	Eneabba - Esperance
AH			68	*Brachycome iberidifolia* Benth.	Carnarvon - SW & ES
SXE	C		48	*Calocephalus brownii* (Cass.)F.Muell.	Shark Bay - SW & ES
AH			2	*Cotula cotuloides* (Steetz)Druce	Shark Bay - SW
AH	C		6	*Erymophyllum ramosum* (A.Gray)Paul G.Wilson ssp. *involucratum* (F.Muell.)Paul G.Wilson	Carnarvon - Wedge Island
AH			3	*Erymophyllum tenellum* (Turcz.) Paul G.Wilson	S of Dongara - Wheatbelt - Nullabor
AH	C		.	*Gnaphalium indutum* J.D.Hook.	Abrohlos - Israelite Bay & ES
SXP	C		25	*Helichrysum cordatum* DC.	Green Head - Albany
AH			6	*Hyalosperma cotula* (Benth.) Paul G.Wilson	Kalbarri - SW & ES
AH			8	**Hypochoeris glabra* L.	Shark Bay - SW & ES
SXR		T	1	*Lagenifera huegelii* Benth.	Jurien - SW & ES
AH	C		76	*Leptorhynchos scabrus* (Benth.)Haegi	Dongara - Esperance
AH			15	*Millotia myosotidifolia* (Benth.)Steetz	Carnarvon - SW & ES
SSEI	C		206	*Olearia axillaris* (DC.)F.Muell.ex Benth.	Shark Bay - SW & ES
SSEC	s		12	*Olearia dampieri* (DC.)N.S.Lander com nov. ssp. *dampieri*	Dampier - Lesueur
SMSR			2	*Olearia rudis* (Benth.)F.Muell.ex Benth.	Cliff Head - SW & ES

Appendix 8 (Continued)

Life-form	E	T	#R	TAXON	RANGE
				ASTERACEAE (Continued)	
AH			62	*Podolepis canescens* Cunn.ex DC.	Shark Bay - SW & ES
AH			1	*Podolepis capillaris* (Steetz)Diels	Shark Bay - SW & ES
AH			52	*Podolepis gracilis* (Lehm.)R.A.Graham	Dongara - SW
AH			116	*Podotheca angustifolia* (Labill.)Less.	Shark Bay - SW & ES
AH		T	1	*Podotheca gnaphalioides* R.A.Graham	Shark Bay - Mandurah
AH			4	*Pogonolepis stricta* Steetz	Shark Bay - southern WA
AH	C		4	**Reichardia tingitana* (L.)Roth	Shark Bay - Cliff Head & ES
AH			99	*Rhodanthe citrina* (Benth.) Paul G.Wilson	SW & ES
AH	s		.	*Rhodanthe corymbosa* (A.Gray) Paul G.Wilson	Northhampton - Cape Naturaliste
AH		T	1	*Rhodanthe oppositifolia* (S.Moore)Paul G.Wilson ssp. *oppositifolia*	Shark Bay - Lesueur - Goldfields & ES
SXE			266	*Senecio lautus* G.Forster ex Willd. ssp. *dissectifolius* Ali	Hamersley Range - SW & ES
AH			24	**Sonchus oleraceus* L.	WA & ES
AH			1	**Taraxacum officinale* Wigg.	Perth - SW & ES
AH			.	**Urospermum picroides* (L.)Scop.ex F.W.Schmidt	Carnarvon - Wongan Hills - Perth ES
AH		T	1	**Ursinia anthemoides* (L.)Poiret	SW
AH			17	*Waitzia suaveolens* (Benth.)Druce var. *suaveolens*	Kalbarri - SW

APPENDIX 9 Occurrence of selected taxa in Study Sub-areas

Taxa included are those whose northern or southern limit to their overall distribution occurs within the Central Coast.

Study Sub-areas are ordered north to south from left to right.
Vertical lines indicate divisions between Sectors defined in Appendix 10.
Values indicate numbers of relevés in each Segment in which taxa was recorded.
'.' indicates within known distribution.
Approximate northern and southern limits are indicated by 'N' and 'S' respectively.

GE	DO	WP	CL	GT	LE	GH	NH	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Taxon
1S																				*Stylobasium spathulatum*
1S																				*Pimelea microcephala ssp. microcephala*
1	1S																			*Ptilotus divaricatus var. divaricatus*
.	2S																			*Prasophyllum calcicola*
.	.	.	1S																	*Billardiera bicolor* var. *lineata*
.	.	2	4S																	*Phyllanthus maitlandianus*
.	.	.	2	2S																**Reichardia tingitana*
1	.	.	1	.	1S															*Euphorbia boophthona*
.	.	1	.	.	1S															*Rhagodia latifolia* ssp. *recta*
.	.	1	.	.	.S															*Trachymene coerulea* var. *leucopetala*
.	.	.	.	.	1	.S														*Aphanopetalum clematideum*
.	.	7	3	.	1	.	1S													*Olearia dampieri* ssp. *dampieri*
.	.	.	.	.	.	.	1S													*Labichea cassioides*
.	.	7	1	.	.	.	.S													*Eucalyptus obtusiflora*
.	2	4	2	.	.	.	1S													*Anthobolus foveolatus*
1	3	5	2	.	.	.	1S													*Diplolaena* sp. (Kalbarri)
3	.	.	.	.	.	.	.S													*Nicotinia occidentalis* ssp. *hesperis*
3	.	.	.	.	.	.	.S													*Thryptomene hyporhytis*
.	.	.	.	.	.	.	.	.	.	.	.	.	4S							*Lepidium linifolium*
.	.	.	.	.	.	.	.	.	.	.	.	.	1S							*Anigozanthos manglesii* ssp. *quadrans*
.	.	.	.	.	.	.	1	.	.	.	.	.	.S							*Acacia spathulifolia*
.	.	.	8	.	8	4	3	.	.	.	.	.	5S							*Thryptomene baeckeacea*
.	.	4	.	.	.	.	.	.	2	.	.	.	.S							*Erymophyllum ramosum ssp. involucratum*
.	.	.	1	.	.	.	.	.	.	2	.	.	.	3S						*Acacia idiomorpha*
.	.	.	.	.	.	.	2	.	.	.	.	.	.	.S						*Drosera stolonifera* ssp. *humilis*
.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.S					*Banksia leptophylla*
.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.S				*Pimelea gilgiana*
	N.	1	12	3	6S															*Angianthus* sp. aff. *milnei*
	N.	.	1	.	.	.	.	4	3	.	1S									*Halorogis foliosa*
	N.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	*Grevillea crithmifolia*
	N2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	**Euphorbia peplus*
	N5	34	19	.	15	.	11	12	19	6	7	3	15	3	10	5	.	2	6	*Lepidosperma angustatum*
	N1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*Hydrocotyle blepharocarpa*
	N.	7	2	.	4	7	9	13	11	3	.	2	7	1	19	7	4	3	5	*Hardenbergia comptoniana*
	N.	2	.	.	1	.	1	.	.	1	.	.	1	.	.	.	.	.	.	*Velleia trinervis*
	N.	.	.	.	.	.	1	.	.	.	.	.	1	1	4	.	1	.	.	*Dryandra nivea*
	N1	.	.	.	.	3	8	8	9	8	2	2	10	.	.	.	.	1	.	*Podolepis gracilis*
	N7	2	.	.	.	3	4	.	.	.	.	.	.	.	4	.	.	.	.	*Hydrocotyle callicarpa*
	N1	.	.	.	.	10	10	4	17	7	.	7	15	.	2	3	.	.	.	*Leptorhynchos scabrus*
	N.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*Adriana quadripartita*
	N.	17	6	2	5	8	3	16	12	7	2	4	14	3	23	13	1	3	2	**Dischisma arenarium*
	N.	.	11	.	4	3	4	1	11	10	2	5	9	1	1	2	.	.	.	*Pimelea ferruginea*
	N3	39	19	.	17	6	17	10	18	8	6	1	16	4	16	8	2	1	6	*Loxocarya flexuosa*
	N7	25	3	2	8	15	8	16	39	13	6	5	16	2	3	4	4	2	4	*Leucopogon parviflorus*
	N.	1	.	.	.	.	1	.	3	2	.	1	2	.	2	.	1	.	.	*Carex preissii*
	N1	1	.	.	.	.	.	.	1	1	.	.	4	.	.	3	.	1	.	*Scaevola nitida*
	N.	10	2	.	2	1	3	1	1	1	.	1	3	.	1	.	.	.	.	*Mitrasacme paradoxa*
	N2	9	2	1	2	10	1	5	19	6	1	7	8	.	.	1	1	1	.	*Acrotriche cordata*
	N.	.	.	.	5	.	.	3	1	.	.	.	.	.	.	.	.	.	.	*Baumea juncea*
		N.	.	.	.	.	.	6	1	.	.	.	.	.	.	.	.	3	8	*Conostylis candicans* ssp. *candicans*
		N2	2	.	1	.	1	3	13	5	1	2	.	.	.	.	.	.	.	*Schoenus lanatus*
		N2	8	.	.	.	9	6	9	5	2	3	11	1	8	.	.	.	.	*Poa drummondiana*
		N2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	*Erymophyllum tenellum*
			N1	.	1S															*Grevillea olivacea*
			N.	.	.	.	1S													*Eucalyptus foecunda* (Coolimba)
			N.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	*Wilsonia backhousei*
			N1	1	1	.	1	4	4	3	1	3	7	.	10	7	1	1	4	*Lepidosperma gladiatum*
			N8	.	.	.	5	.	.	1	.	.	6	2	.	2	.	.	.	*Stylidium 'maritimum'*
			N3	.	6	6	1	1	13	1	1	5	7	.	.	2	.	.	.	*Stylidium junceum*

Continued ...

Appendix 9 (Continued)

GE	DO	WP	CL	GT	LE	GH	NH	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Taxon
			N.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	*Olearia rudis*
				N.	1	.	.	1	.	1	.	.	.	.	.	1	.	.	.	*Microtis media*
				N.	.	.	.	.	.	.	.	.	.	.	5	.	2	.	.	*Grevillea thelemanniana* ssp. *preissii*
				N.	2	11	4	5	20	10	.	8	13	1	1	.	1	.	.	*Acacia truncata*
				N1	.	.	.	2	1	.	.	1	3	.	2	1	.	.	.	**Orobanche minor*
				N.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*Leptocarpus aristatus*
				N.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*Melaleuca brevifolia*
				N1	.	.	.	2	.	1	.	.	2	.	.	2	.	2	1	*Spinifex hirsutus*
				N2	.	1	.	8	5	2	.	3	11	.	4	1	1	2	1	*Acacia cyclops*
						N.	.	.	.	.	.	.	.	.	1S					*Diplolaena* sp. (Lancelin)
						N.	1	1	.	.	.	.	.	.	1S					*Jacksonia* **aff.** *spinosa*
						N.	.	.	.	.	.	.	.	.	.	.	.	.	1	*Diplopeltis huegelii* var. *huegelii*
						N.	1	.	1	.	.	.	.	.	.	.	.	.	.	*Leptomeria empetriformis*
						N.	.	.	.	.	.	.	.	.	1	.	.	.	.	*Tetraria octandra*
						N.	.	.	.	.	.	.	.	.	1	.	.	.	.	*Eriostemon spicatus*
						N.	1	.	.	.	.	.	.	.	.	.	.	.	.	*Scaevola paludosa*
						N.	.	.	1	.	.	.	1	2	2	.	.	.	.	*Hakea prostrata*
						N.	2	.	.	.	.	.	.	4	7	.	.	.	.	*Acacia pulchella* var. *glaberrima*
						N.	.	.	.	.	.	.	.	.	1	.	.	.	.	*Thysanotus thyrsoideus*
						N.	.	1	1	.	.	1	.	.	.	.	.	.	.	*Asteridea pulverulenta*
						N.	1	.	1	.	.	.	2	.	.	.	.	.	.	*Trymalium albicans*
						N.	1	.	.	.	.	.	1	.	1	7	.	3	3	**Trachyandra divaricata*
						N.	1	.	.	3	.	3	20	.	4	13	2	5	1	**Crassula glomerata*
						N1	.	3	1	.	.	.	1	.	8	7	.	2	2	*Helichrysum cordatum*
						N1	3	1	.	.	.	.	.	.	3	.	.	.	.	*Lepidium foliosum*
							N1	1	6	3	3	2	10	2	8	9	.	.	4	**Heliophila pusilla*
								N2	.	.	.	.	.	.	.	.	.	1	.	*Eucalpytus gomphocephala*
								N.	.	.	.	.	.	.	.	.	.	.	1	**Centaurium erythraea*
								N.	.	.	.	1	3	.	2	.	.	.	.	*Schoenus caespititius*
								N.	.	.	.	.	.	.	1	.	.	.	.	*Lagenifera huegelii*
								N1	.	.	.	.	.	.	.	.	1	5	9	**Laguris ovatus*
								N1	1	.	.	.	.	.	.	.	.	.	.	**Juncus acutus*
								N1	.	.	.	.	.	.	.	.	.	.	.	*Schoenus nitens*
									N.	1	.	.	1	4	22	10	.	1	.	*Conostylis pauciflora* ssp. *euryrhipis*
										N.	.	.	.	.	2	.	.	.	.	*Caladenia longicauda* ssp. *calcigena*
										N1	.	1	3	.	2	1	2	.	.	*Hibbertia spicata* ssp. *leptotheca*
										N.	.	.	1	.	.	2	.	.	.	*Actites megalocarpa*
										N2	5	2	.	2	5	.	1	.	.	*Acacia cochlearis*
														N.	.	.	.	.	.	*Trachymene coerulea* var. *coerulea*
															N1	.	.	.	.	*Chorizema varium*
															N.	5	2	.	2	**Catapodium rigidum*
															N1	17	1	3	7	**Pelargonium capitatum*
															N.	1	.	.	.	**Taraxacum officinale*
																N1	.	.	.	**Galium murale*
																	N1	.	.	*Conostylis aculeata* ssp. *cygnorum*
																	N.	1	.	**Oenothera drummondii*
																		N2	.	*Callitris preissii* ssp. *preissii*
																			N2	*Agonis flexuosa*
Geraldton	Dongara	White Point	Cliff Head	Gum Tree Bay	Leeman	Green Head	North Head	Cervantes	Nambung	Wanagarran	Vacant Crown Land	Defence Department	Nilgen	Ledge Point	Breton Bay	Mindarie	Burns Beach	Trigg	Swanbourne	(Study sub areas) (Read vertically)

APPENDIX 10 Dendrogram describing fusion of Presence / Absence Groups

Number of Relevés in each Group from each Study Sub-area
(Vertical lines indicate divisions between Sectors which are described in Appendix 17)

DENDROGRAM DESCRIBING THE FUSION OF GROUPS
(based on Presence / Absence data)

GE	DO	WP	CL	GT	LE	GH	NHw	NHe	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Group No.
1	.	.	.	1	.	.	.	.	1	3	2	.	1	1	.	.	.	.	.	.	1
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1	1	.	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	10
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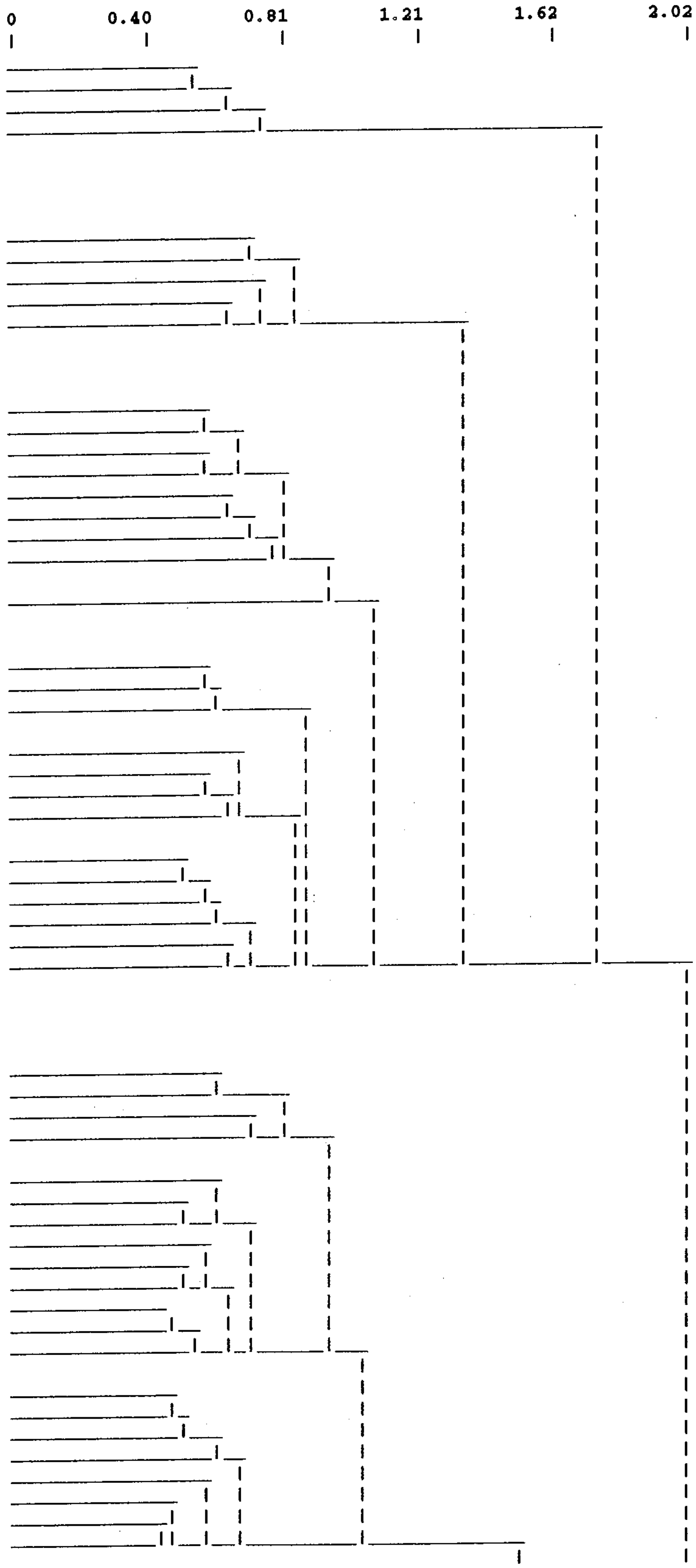

Continued ...

Appendix 10 (Continued)

GE	DO	WP	CL	GT	LE	GH	NHw	NHe	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Group No.
.	.	.	.	.	.	.	1	.	2	4	1	.	.	2	.	.	.	.	.	.	53
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.	.	.	.	.	.	.	.	.	3	1	1	.	.	.	.	.	.	.	.	.	60
.	.	.	1	.	1	.	.	2	.	1	.	1	.	.	.	.	.	.	.	.	61
.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	62
.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	63
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.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	66
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.	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	72
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.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	95
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.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	97
.	.	.	1	.	.	.	1	.	.	1	1	.	.	2	.	.	.	.	.	.	98
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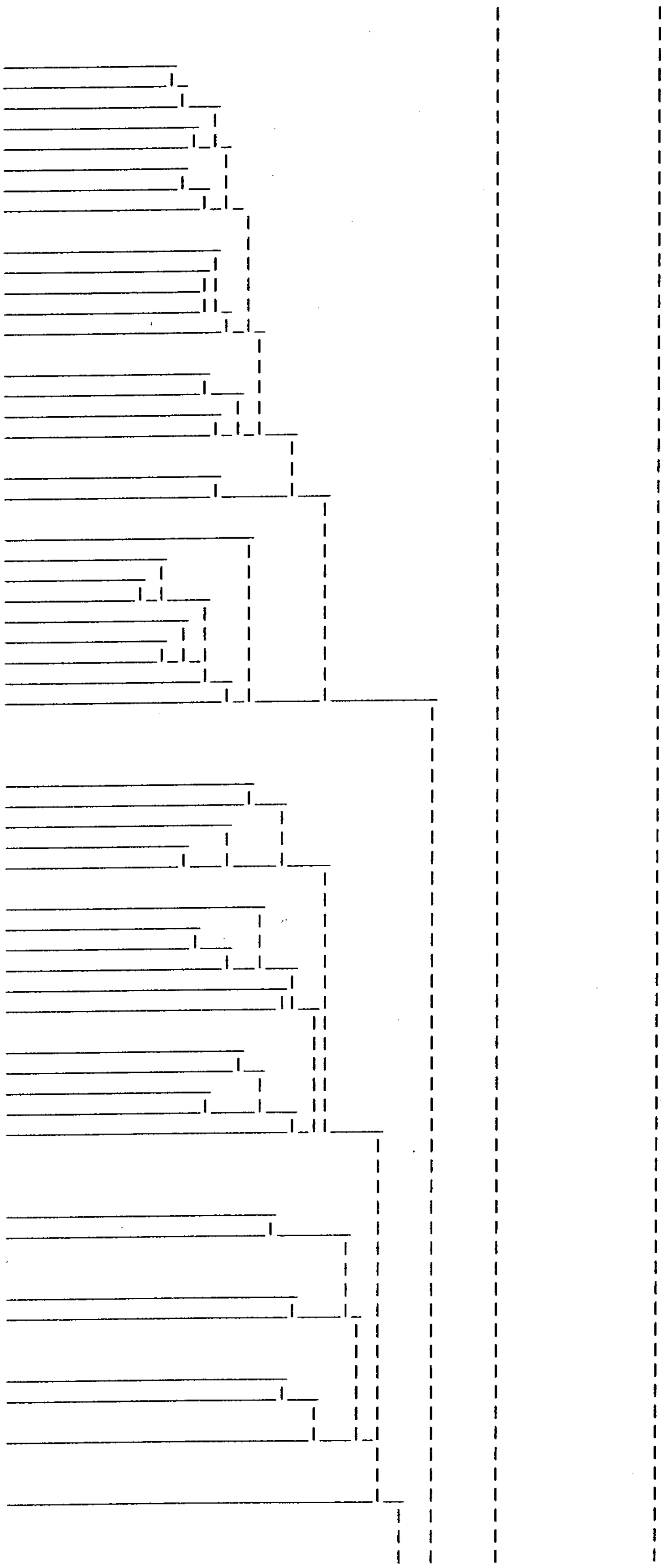
.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	104



Continued ...

Appendix 10 (Continued)

GE	DO	WP	CL	GT	LE	GH	NHw	NHe	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Group No.
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	105
2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	106
.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	107
.	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	108
.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	109
.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	110
.	1	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	111
.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	112
.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	113
.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	114
.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	115
.	3	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	116
.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	117
.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	118
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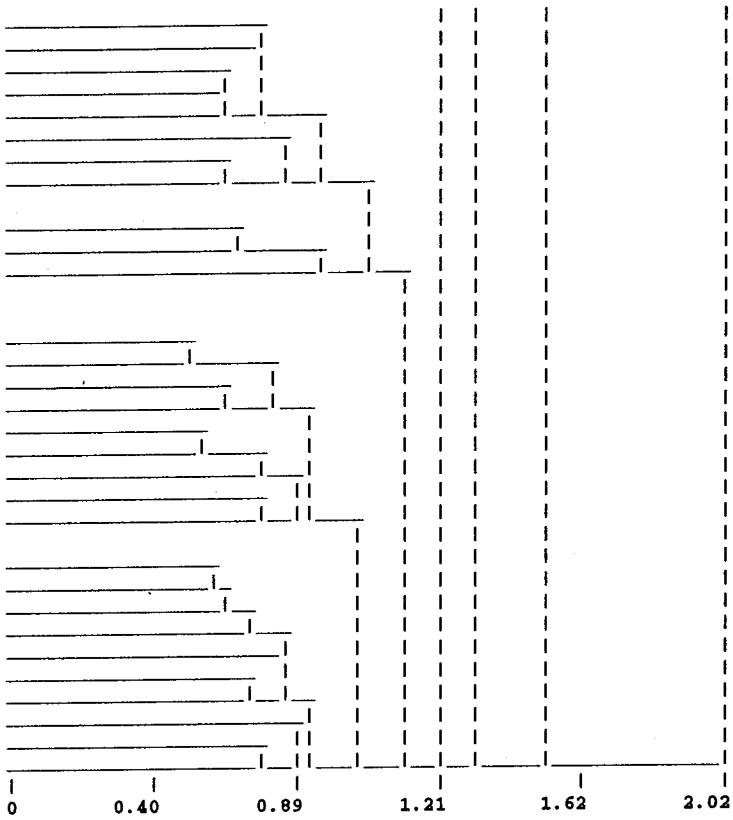
.	.	.	1	.	.	.	.	.	2	1	.	.	1	1	.	.	.	.	.	.	125
.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	126
.	.	.	.	.	.	.	.	.	.	3	3	.	.	.	.	.	.	.	.	.	127
.	.	.	1	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	128
.	.	.	.	.	.	.	.	.	.	.	2	.	.	3	.	.	.	.	.	.	129
.	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	130
.	.	.	.	.	.	1	.	.	1	.	2	.	.	.	.	.	.	.	.	.	131
.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	132
.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	133
.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	134
GE	DO	WP	CL	GT	LE	GH	NHw	NHe	CE	NN	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	



NH (North Head) split into two, west and east.

APPENDIX 11 Dendrogram describing Fusion of Cover Groups

Number of Relevés in each Group from each Study Sub-area

(Vertical lines indicate divisions between Sectors which are described in Appendix 17)

GE	DO	WP	CL	GT	LE	GH	NHw	NHe	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Group No.
1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	2	.	.	.	1a
.	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.	.	1b
1	.	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	1c
.	1	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	.	.	1d
.	.	.	1	1	.	.	.	.	2	3	2	.	.	.	.	.	1	.	.	.	2a
.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2b
1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3a
.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	3b
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	4
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
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.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	14c
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.	1	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	16a
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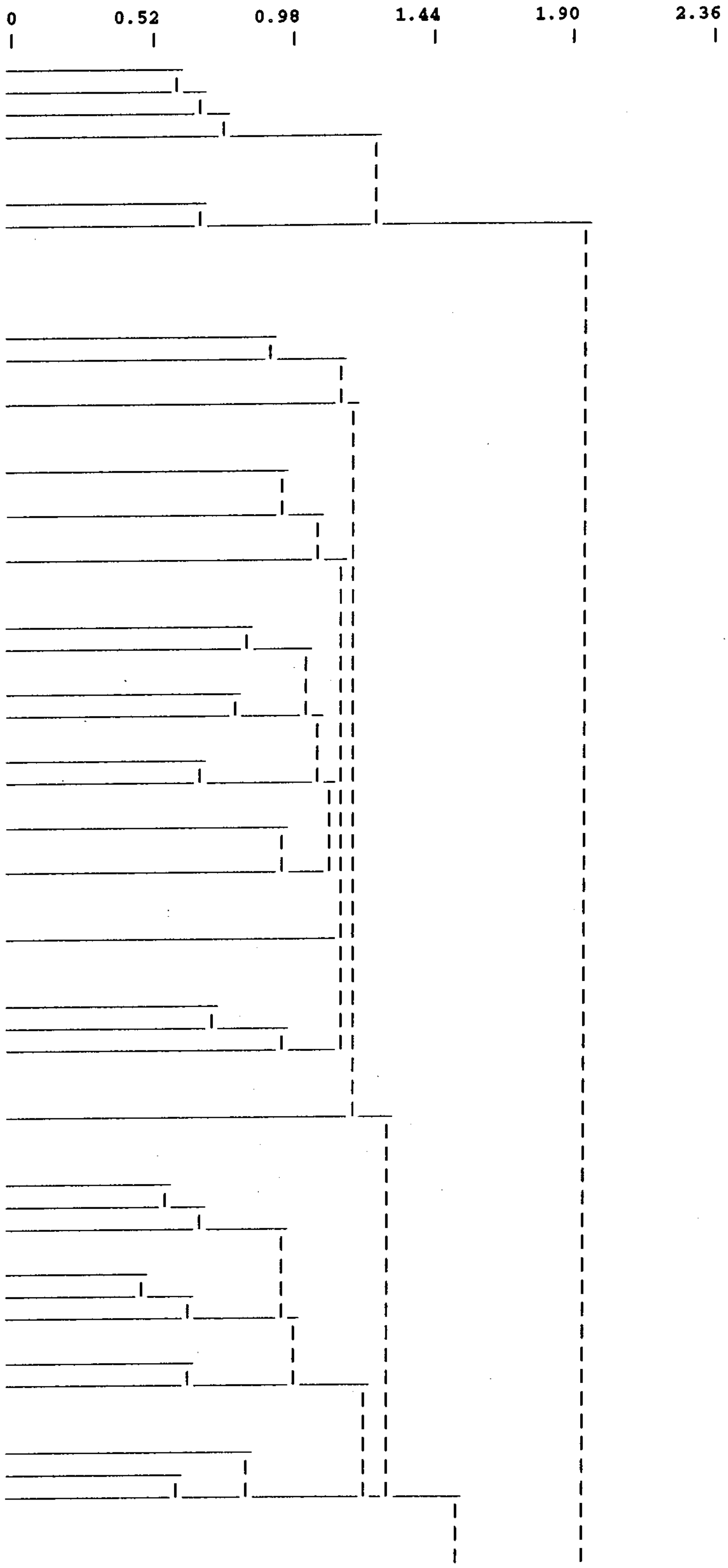
DENDROGRAM DESCRIBING THE FUSION OF GROUPS
(based on Cover data)



Continued ...

Appendix 11 (Continued)

GE	DO	WP	CL	GT	LE	GH	NHw	NHe	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Group No.
.	2	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	20a
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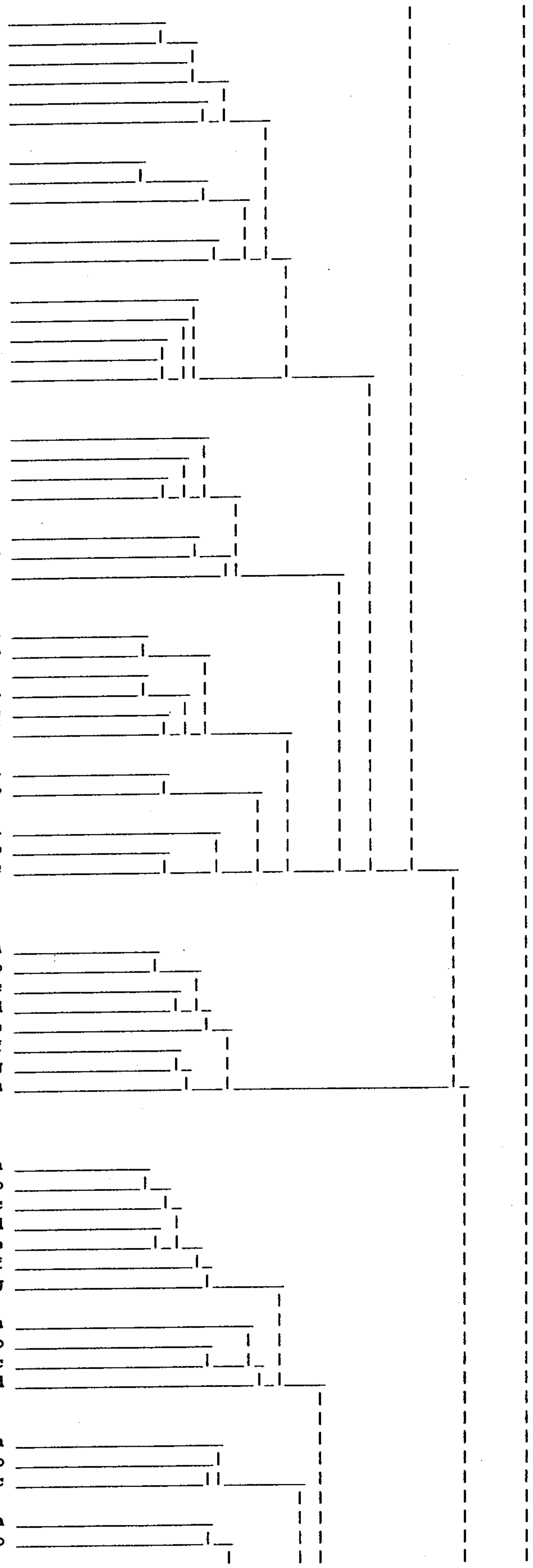

Continued ...

Appendix 11 (Continued)

G E	D O	W P	C L	G T	L E	G H	N H w	N H e	C E	N A	W G	V C	D D	N I	L P	B B	M I	B U	T R	S W	Group No.
.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	34a
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.	1	1	1	.	1	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	44a
.	.	3	.	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.	.	.	44b
.	1	.	4	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	44c
.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	44d
.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	44e
.	.	3	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	44f
.	.	1	.	.	2	.	.	1	.	1	.	.	.	1	.	.	.	.	.	.	44g
.	.	1	1	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.	1	44h
.	.	3	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	44i
.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	44j
.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	44k
.	.	1	1	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	45a
.	.	.	1	.	.	.	.	.	.	.	.	2	.	1	.	1	.	.	.	.	45b
.	.	.	1	.	.	.	.	3	.	.	.	.	.	1	.	.	.	.	.	.	45c
.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	45d
.	.	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46a
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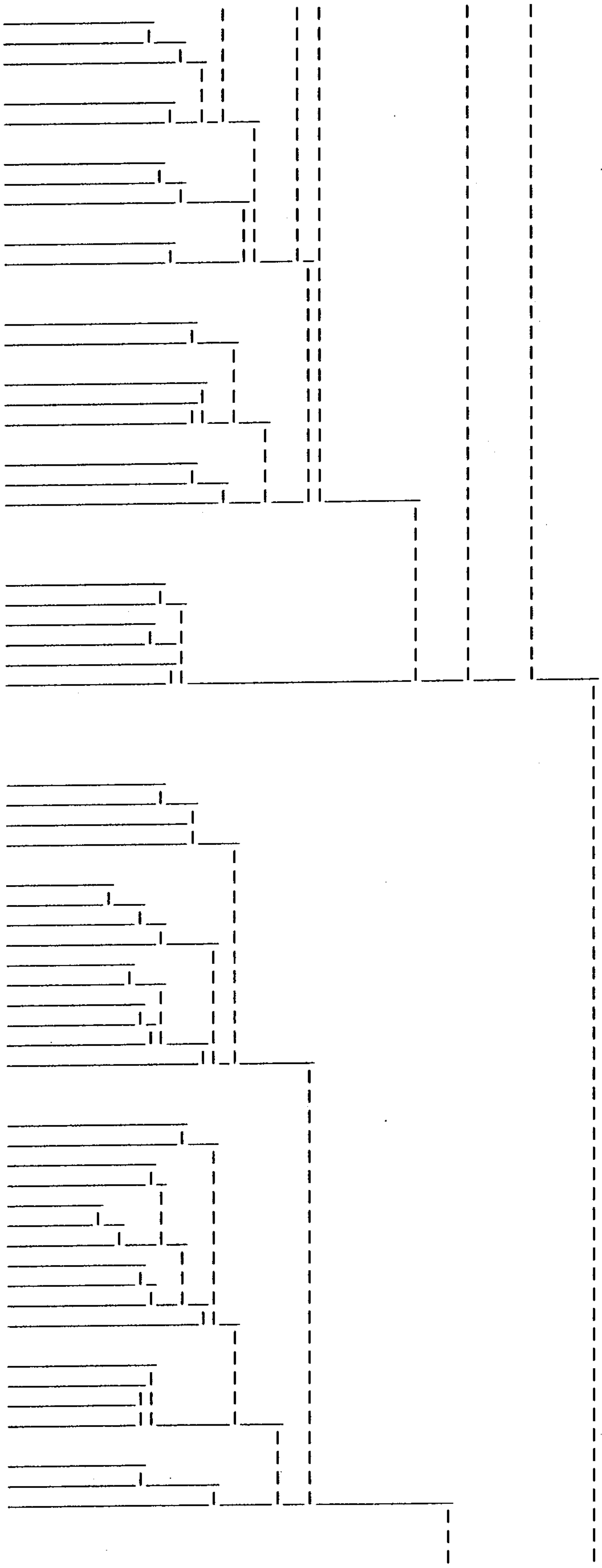
.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46c



Continued ...

Appendix 11 (Continued)

GE	DO	WP	CL	GT	LE	GH	NHw	NHe	CE	NA	WG	VC	DD	NI	LP	BB	MI	BU	TR	SW	Group No.
.	2	3	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	47a
.	.	4	.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	47b
.	.	4	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	47c
.	1	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	47d
.	2	2	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	1	.	.	48a
.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	48b
.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	48c
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	48d
.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49a
.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49b
.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49c
.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49d
.	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50a
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.	2	2	.	.	1	.	.	.	2	1	.	.	.	1	.	.	1	1	.	.	51a
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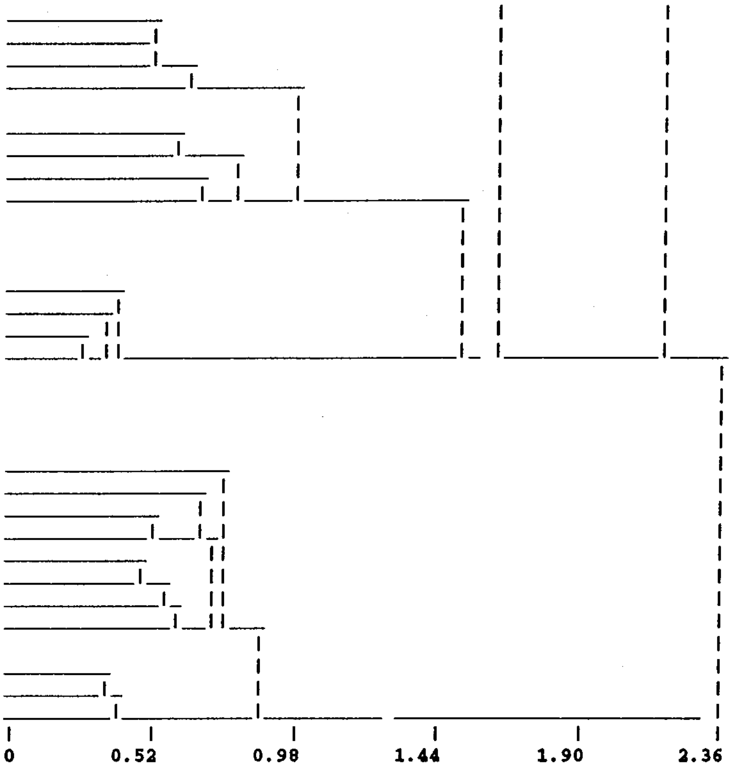

G |D W C |G L G N |N C N W V D N |L B M B T S|Group
E |O P L |T E H H |H E A G C D I |P B I U R W| No.
w |e

NH (North Head) divided into two, west and east.

APPENDIX 12 Tabulation of Presence / Absence Groups versus Cover Groups

Numbers in each cell represent number of relevés in respective combination.

The width of horizontal and vertical divisions follows the respective dentrograms (Appendix 7 and 8).

The species mentioned are those most consistently important in each Cover group.

PRESENCE/ABSENCE GROUP NUMBERS --

COVER GROUP	1234	56789	10–17	18	19–21	22–25	26–31	32–35	36–44	45–52	53–60	61–65	66–69	70–71	72–80	81–85	86–91	92–96	97–98	99–100	101–102	103	104	105–112	113–115	116–124	125–134	COVER GROUP / SUPER GROUPS (See Appendix 14)
	AAAA	BBBBB	CCCCCCCC	C	CCC	CCCC	CCCCCC	DDDD	DDDDDDDDD	DDDDDDDD	EEEEEEEE	EEEEE	EEEE	EE	EEEEEEEEE	FFFFF	FFFFFF	FFFFF	GG	GG	GG	G	G	HHHHHHHH	III	JJJJJJJJJ	KKKKKKKKKK	
1a	2..2	..1..	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	1a
1b	1.1.	...1.	.1......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	1b
1c	....	.....	2....1..	.	..1	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	1c *Spinifex longifolius*
1d	11.1	..1..	1.......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	1d
2a	6.21	.....	....	.	1..	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	2a
2b	..2.	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	2b *Tetragonia decumbens*
3a	..1.	.....	.1......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	3a
3b	.2..	.....	.1......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	3b *Atriplex cinerea*
4	...2	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	4 *Spinifex hirsutus*
5	....	.....	....	1	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	5 *Casuarina equisetifolia*
6	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	2.....	.....	..	..	..	.	.	....	...	....	....	6 Tuart
7	....	.....	....1...	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	1.......	...	....	....	7 *Thryptomene hyporhytis*
8a	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	.....1..	...	....	....	8a *Acacia lasiocarpa - Allocasuarina lehmanniana*
8b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	.....1..	...	....	....	8b
9a	....	.....	..2.....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	9a
9b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	.1	.	.	....	...	....	....	9b *Frankenia pauciflora*
10a	....	1	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	10a
10b	....	.....	....	.	...	..2.	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	10b *Pelargonium capitatum*
11	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	1.	.	.	....	...	....	....	11 *Melaleuca brevifolia*
12	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	1	.	....	...	....	....	12 *Schoenus nitens*
13	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	.2	..	.	.	....	...	....	....	13 *Callitris preissii*
14a	....	.....	....	.	...	....	......	..1.	.1.......	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	14a
14b	....	.....	....	.	...	....	......	...1	......1..	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	14b *Dryandra sessilis*
14c	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	1	....	...	....	....	14c
15	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	..1.....	..1	....	....	15 *Melaleuca lanceolata*
16a	....	2....	....	.	...	....	......	....	.1.......	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	16a
16b	....	.....	....1...	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	16b *Scaevola crassifolia*
16c	....	.....	....	.	...	...2	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	16c
17a	....	.....	....	.	...	....	......	....	1........	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	17a
17b	....	.....	....	.	...	....	......	....	.2.......	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	17b *Opercularia vaginata*
17c	....	2....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	17c
18a	....	.....	.....1..	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	18a
18b	....	.2...	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	18b *Hibbertia racemosa*
19a	....	.33..	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	19a
19b	....	.1..2	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	19b *Calocephalus brownii*
19c	....	..1.1	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	19c
20a	....	...1.	.....2..	.	...	2...	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	..1.....	...	....	....	20a
20b	....	.....	.1.1....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	20b
20c	....	.....	....	.	...	...2	......	....	.1.......	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	20c *Olearia axillaris* *Scaevola crassifolia*
20d	....	...2.	1.......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	20d
20e	....	.....	....	.	1..	...1	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	.......1..	20e
20f	....	.....	....	.	...	.2..	1	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	20f
21a	....	.....	...1....	.	...	....	....1.	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	21a
21b	....	.....	....	.	.1.	....	..1...	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	21b *Myoporum insulare*
21c	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	21c
22a	....	.....	.1..1...	.	...	....	....1.	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	22a
22b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	.2......	...	....	....	22b *Rhagodia baccata*

Continued ...

Appendix 12 (Continued)

```
COVER        PRESENCE/ABSENCE GROUP NUMBERS --
GROUP               11111111 1 122 2222 222233 3333 333344444 44444555 55555556 66666 6666 77 777777778 88888 888899 99999 99  1 11 1 1 11111111 111 111111111 1111111111 COVER
  |   1234   56789  01234567 8 901 2345 678901 2345 678901234 56789012 34567890 12345 6789 01 234567890 12345 678901 23456 78 90 00 0 0 00000111 111 111122222 2222233333 GROUP
  |                                                                                                                         90 12 3 4 56789012 345 678901234 5678901234   |
      AAAA   BBBBB  CCCCCCCC C CCCCCCCCCCCCC   DDDD DDDDDDDDD DDDDDDDD EEEEEEEE EEEEE EEEE EE EEEEEEEEE FFFFF FFFFFF FFFFF GG GG GG G G HHHHHHHH III JJJJJJJJJ KKKKKKKKKK   |   SUPER GROUPS
                                                                                                                                                                               (See Appendix 14)
 23a  ....   .....  ...21.1. . 21. .2.. 111... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... ...1...... 23a
 23b  ....   .....  1.....1. . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 23b
 23c  ....   .....  ........ . .1. .... 2.2..2 .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......1.. 23c Scaevola crassifolia - Olearia axillaris
 23d  ....   .....  ........ . ... .2.. .2...1 .... ...1..... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 23d
 23e  ....   .....  ........ . ... .... 11.2.1 .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 23e

 24a  ....   .....  ........ . .1. .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ......11 ... ......... .......... 24a
 24b  ....   .....  ........ . ... .... ...1.. .... ......... ........ ........ 1.... .... .. ......1.. ..... ...... 1.... .. .. .. . . ........ ... ......... .......1.. 24b
 24c  ....   .....  ........ . ... .... ...1.. .... ......... ........ ........ ..... .... .. ......... ..... ..1... ..... .. .. .. . . ........ ... ......... .......1.. 24c Acanthocarpus preissii
 24d  ....   .....  ........ . ... .... .1.11. .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 24d

 25a  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... 2......... 25a
 25b  ....   .....  ........ . ... .... ..4... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 25b Acacia lasiocarpa
 25c  ....   .....  ........ . ... .... .....1 .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... ..1....... 25c

 26a  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ..1... ..... .. .. .. . . ........ ... ......1.. .......... 26a
 26b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...1.. ..... .. .. .. . . ........ ... ......... .......... 26b
 26c  ....   .....  ........ . ... .... ...... 11.. ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 26c Spyridium globulosum
 26d  ....   .....  ........ . ... .... ...... .... .......1. ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 26d
 26e  ....   .....  ........ . ... .... ..1..2 .... ........1 ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 26e
 26f  ....   .....  ........ . ..1 .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 26f

 27a  ....   .....  ........ . ... .... ..1... 1... .......1. ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 27a
 27b  ....   .....  ........ . ... .... ...... .1.. ...1...1. ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 27b Nemcia reticulata

 28a  ....   .....  ........ . ... .... ...... 1... 1..1....1 ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 28a
 28b  ....   .....  ........ . ... .... ...... .... ...1.2... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 28b Spyridium globulosum - Acrotriche cordata
 28c  ....   .....  ........ . ... .... ...... .... ...1....2 ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 28c

 29a  ....   .....  ........ 2 ... .... ...1.. .... ......... ........ ........ ..... .... .. ......... ..... 1..... ....1 .. .. .. . . ...1.... ... ......... .3........ 29a
 29b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... 11... .. .. .. . . ........ ... ......... 2......... 29b
 29c  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... .1.... ..... .. .. .. . . ..1..... ... ......... .......... 29c
 29d  ....   .....  .......1 . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... .1.... ....1 .. .. .. . . ......1. ... ......... 1......... 29d Acacia rostellifera
 29e  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ....1 .... .. ......... ..... ..2... ..11. .. .. .. . . ........ ... ......... .......... 29e
 29f  ....   .....  ........ . ... .... ...... .... .1....... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ...11.1. ... ......... .......... 29f
 29g  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... ......2... 29g
 29h  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ........1 .......... 29h

 30a  ....   .....  ........ . ... .... ...... ..2. ..1...1.. ....1... ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 30a
 30b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......1.. .......... 30b
 30c  ....   .....  ........ . ... .... ...... .... 1........ ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 30c
 30d  ....   .....  ........ . ... .... ...... .... ......... ......12 ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .1........ 30d Allocasuarina lehmanniana
 30e  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... ...1 .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 30e
 30f  ....   .....  ........ . ... .... ...... .... ......... ...1.... ......1. .1... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 30f
 30g  ....   .....  ........ . ... .... ...... .... ......... ...1.... ........ ..... .... .. ......... ..... ...... .1... .. .. .. . . ........ ... ...1..... ..1.1..... 30g

 31a  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ......1. ... ......... .......... 31a
 31b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... .1..1.... .......... 31b
 31c  ....   .....  ........ . ... .... ...... ..1. ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 31c Allocasuarina lehmanniana
 31d  ....   .....  ........ . ... .... ...... 1.1. ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ...1..... .......... 31d

 32a  ....   .....  ........ . ... .... ...... .... ...1..... ........ 1....... ....1 .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 32a
 32b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ...11.... .......... 32b Acacia lasiocarpa
 32c  ....   .....  ........ . ... .... ...... .... ......... ........ ........ 1.... .... 1. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 32c

 33a  ....   .....  ........ . ... .... ...... .... ......... .1.....2 ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 33a
 33b  ....   .....  ........ . ... .... ...... .... ...1.1... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 33b Acrotriche cordata

 34a  ....   .....  ........ . ... .... ...... .... ....1.1.. ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 34a
 34b  ....   .....  ........ . ... .... ...... .... .....1... .......1 ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 34b Acacia truncata - Allocasuarina lehmanniana
 34c  ....   .....  ........ . ... .... ...... .... ......... .......1 ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 34c

 35a  ....   .....  ........ . ... .... ...... .... ....1.11. ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 35a
 35b  ....   .....  ........ . ... .... ...... .... ....1.... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 35b Acacia truncata

 36a  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... .1...1... .......... 36a
 36b  ....   .....  ........ . ... .... ...... .... ......... ..2...1. ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ....1.... .......... 36b Melaleuca acerosa - Allocasuarina lehmanniana
 36c  ....   .....  ........ . ... .... ...... .... ......... ......11 ........ ..... ..1. .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 36c

 37a  ....   .....  ........ . ... .... ...... .... ......... ....3..1 ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 37a
 37b  ....   .....  ........ . ... .... ...... .... ......... .....1.1 ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 37b Lysinema ciliatum

 38a  ....   .....  ........ . ... .... ...... .... ......1.. ........ ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ....1.... .......... 38a
 38b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... .1 .. .. . . ........ ... ......... .......... 38b Loxocarya flexuosa

 39a  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... 1.... ...... ..... .. .. .. . . ........ ... ......... .......... 39a
 39b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ....2 ...... ..... .. .. .. . . ........ ... ......... .......... 39b Allocasuarina humilis
 39c  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... .1... ...... ..... .. .. .. . . ........ ... ......... .......... 39c

 40a  ....   .....  ........ . ... .... ...... .... ......... ....1... ........ ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 40a
 40b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... ...1 .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 40b Acacia truncata  Nemcia reticulata
 40c  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... .1.1. .. .. .. . . ........ ... ......... .......... 40c

 41a  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... 3... .. .1....... ..... ...... ..... 1. .. .. . . ........ ... ......... .......... 41a
 41b  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .2.. .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 41b
 41c  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... ..1. 3. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 41c Thryptomene baeckeacea
 41d  ....   .....  ........ . ... .... ...... .... ......3.. ........ .1...... ..... .... .. ......... ..... ...... ..... .. .. .. . . ........ ... ......... .......... 41d
 41e  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... .... .. ......... ..... ...... ..... 1. .. .. . . ........ ... ......... .......... 41e
 41f  ....   .....  ........ . ... .... ...... .... ......... ........ ........ ..... 1... .. ......... ..... ...... ..... .2 .. .. . . ........ ... ......... .......... 41f
```

Continued .

Appendix 12 (Continued)

PRESENCE/ABSENCE GROUP NUMBERS --

COVER GROUP	1234 AAAA	56789 BBBBB	11111111 01234567 CCCCCCCC	1 8 C	122 901 CCC	2222 2345 CCCC	222233 678901 CCCCCC	3333 2345 DDDD	333344444 678901234 DDDDDDDDD	44444555 56789012 DDDDDDDD	55555556 34567890 EEEEEEEE	66666 12345 EEEEE	6666 6789 EEEE	77 01 EE	777777778 234567890 EEEEEEEEE	88888 12345 FFFFF	888899 678901 FFFFFF	99999 23456 FFFFF	99 78 GG	1 90 90 GG	11 00 12 GG	1 0 3 G	1 0 4 G	11111111 00000111 56789012 HHHHHHHH	111 111 345 III	111111111 111122222 678901234 JJJJJJJJJ	1111111111 2222233333 5678901234 KKKKKKKKKK	COVER GROUP	SUPER GROUPS (See Appendix 14)
42a	....	.....	....	.	...	....	......	....	....	....	41......	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	42a	
42b	....	.....	....	.	...	....	......	....	....	....	13......	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	42b	*Lomandra maritima* - *Melaleuca acerosa*
42c	....	.....	....	.	...	....	......	....	....	....	1.1.....	.....	....	..	....	.....	......	.1...	..	..	..	.	.	....	...	....	....	42c	
42d	....	.....	....	.	...	....	......	....	....	....	..2.....	.....	....	..	....	..1..	......	...1.	..	..	..	.	.	....	...	....	....	42d	
43a	....	.....	....	.	...	....	......	....	....	....	...1.1.2	1	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	43a	
43b	....	.....	....	.	...	....	......	....	....	....	11.1...1	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	43b	
43c	....	.....	....	.	...	....	......	....	....	....	.....1..	1	....	..	....	.....	......	1.31.	..	..	..	.	.	....	...	....	....	43c	
43d	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	..3..	......	.....	..	..	..	.	.	....	...	....	....	43d	
43e	....	.....	....	.	...	....	......	....	....	....	11.1...1	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	43e	*Lomandra maritima*
43f	....	.....	....	.	...	....	......	....	....	....	...2....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	43f	
43g	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	...5.	......	.....	..	..	..	.	.	....	...	....	....	43g	
43h	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	...1.	......	.....	..	..	..	.	.	....	...	....	....	43h	
43i	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	...1.	......	.....	..	..	..	.	.	....	...	....	....	43i	
43j	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	..1...	...1.	..	..	..	.	.	....	...	....	....	43j	
44a	....	.....	....	.	...	....	......	....	....	..1.....	.....1..	...1.	..1.	1.	..1......	.....	......	.....	..	..	..	.	.	....	...	1........	....	44a	
44b	....	.....	....	.	...	....	......	....	....	....	1	...1.	....	..	..11....1	.....	......	.....	..	..	..	.	.	....	...	....	...1......	44b	
44c	....	.....	....	.	...	....	......	....	....	1.......	....	.....	..2.	..	1....12..	.....	......	.....	..	..	..	.	.	......1.	...	....	....	44c	
44d	....	.....	....	.	...	....	......	....	....	....	...1..3.	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	44d	
44e	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	...3.11..	.....	......	.....	..	..	..	.	.	....	...	....	....	44e	
44f	....	.....	....	.	...	....	......	....	....	....	....	.1...	....	..	.....111.	.....	......	.....	..	..	..	.	.	....	...	....	....	44f	*Melaleuca acerosa*
44g	....	.....	....	.	...	....	......	....	....	....	.11.....	..1..	..1.	..	......11.	.....	......	.....	..	..	..	.	.	....	...	....	....	44g	
44h	....	.....	....	.	...	....	......	....	....	....	..1.....	...1.	....	..	.....1...	.....	......	.1...	..	..	..	.	.	1	...	....	..1.......	44h	
44i	....	.....	....	.	...	....	......	....	....	....	....	2....	....	..	1......2.	.....	......	.....	..	..	..	.	.	....	...	....	...1......	44i	
44j	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	..1..1...	.....	1	.1...	..	..	..	.	.	....	...	....	....	44j	
44k	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	1........	.....	......	.....	..	..	..	.	.	....	...	....	....	44k	
45a	....	.....	....	.	...	....	......	....	....	....	....	2.2..	....	..	.1...1...	.....	......	.....	..	..	..	.	.	....	...	....	....	45a	
45b	....	.....	....	.	...	....	......	....	....	....	..111...	.....	....	..	.....1...	...1.	......	.....	..	..	..	.	.	....	...	....	....	45b	
45c	....	.....	....	.	...	....	......	....	....	....	....	.12..	....	..	.1.......	.....	......	.....	..	..	..	.	.	....	...	....	1.........	45c	*Loxocarya flexuosa*
45d	....	.....	....	.	...	....	......	....	....	....	1.......	.....	.1..	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	45d	
46a	....	.....	....	.	...	....	......	....	....	....	....	.....	....	.1	...4....1	.....	......	.....	..	..	..	.	.	....	...	....	....	46a	
46b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	12	....	.....	......	.....	..	..	..	.	.	....	...	....	....	46b	*Gahnia lanigera* *Melaleuca acerosa*
46c	....	.....	....	.	...	....	......	....	....	....	....	.....	....	3.	....	.....	......	.....	..	..	..	.	.	....	...	....	....	46c	
47a	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	..1.2....	.....	......	.....	..	..	..	.	.	....	...	2.......1	....	47a	
47b	....	.....	....	.	...	....	......	....	....	....	.....1..	.....	..1.	..	.1.......	.....	......	.....	..	..	..	.	.	....	...	1...11.1.	....	47b	*Melaleuca huegelii* *Melaleuca acerosa*
47c	....	.....	....	.	...	....	......	....	....	1.......	....	.....	....	..	.21......	.....	......	.....	..	..	..	.	.	....	...	1	....	47c	
47d	....	.....	....	.	...	....	......	....	....	.1......	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	11.....1.	....	47d	
48a	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	2	.....	..	..	..	.	.	...11...	...	..11.....	.....1....	48a	
48b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	.....1..	...	..11.....	....	48b	
48c	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	...1....	...	....	....	48c	*Melaleuca huegelii*
48d	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....1...	...	....	....	48d	
49a	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	.......1..	49a	
49b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	.1.	....	........1.	49b	
49c	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	.......1..	49c	*Eucalyptus obtusiflora*
49d	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	.1.	....	........1.	49d	
50a	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....1...	11.	..31.....	....	50a	
50b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	.1	....	.....	......	.....	..	..	..	.	.	....	...	....	....	50b	
50c	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	1	50c	
50d	....	.....	....	.	...	....	......	....	....	1.......	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	..2.1.....	50d	
50e	....	.....	1	.	...	....	......	....	....	....	....	...1.	....	..	....	.....	1	.....	.1	1.	..	.	.	....	...	....	....	50e	*Melaleuca cardiophylla*
50f	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	.1	..	..	.	.	....	...	....	....2.....	50f	
50g	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	1	.....	..	..	..	.	.	....	...	....	....	50g	
50h	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	.1	..	..	.	.	....	...	....	....	50h	
51a	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	1........	.....	11	.....	..	..	1.	.	.	...2....	1..	....	..1.1....2	51a	
51b	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	....1.	.....	..	..	..	.	.	....	...	....	....	51b	*Melaleuca cardiophylla*
51c	....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	.....1....	51c	
	1234 AAAA	56789 BBBBB	11111111 01234567 CCCCCCCC	1 8 C	122 901 CCC	2222 2345 CCCC	222233 678901 CCCCCC	3333 2345 DDDD	333344444 678901234 DDDDDDDDD	44444555 56789012 DDDDDDDD	55555556 34567890 EEEEEEEE	66666 12345 EEEEE	6666 6789 EEEE	77 01 EE	777777778 234567890 EEEEEEEEE	88888 12345 FFFFF	888899 678901 FFFFFF	99999 23456 FFFFF	99 78 GG	1 90 90 GG	11 00 12 GG	1 0 3 G	1 0 4 G	11111111 00000111 56789012 HHHHHHHH	111 111 345 III	111111111 111122222 678901234 JJJJJJJJJ	1111111111 2222233333 5678901234 KKKKKKKKKK		SUPER GROUPS (See Appendix 14)

PRESENCE/ABSENCE GROOUP NUMBERS

APPENDIX 13 Fidelity of major species for Presence / Absence Groups

All species listed occurred in more than 60% of relevés in at least one Group.

Value 5 represents occurrence of >80% of relevés   Value 4 represents occurrence of >60% and <80% of relevés in a Group

Value 0 represents presence in Group which has only one relevé

Ordering of species is to highlight differences between Groups. Species mentioned first were those occurring most commonly.

Vertical separation of Groups follow Appendix 10 and reflect the fusion dendrogram in that appendix.

Shown also are summaries by AGE and LANDFORM of numbers of relevés in each Group (See Tables 2 and 3 for explanation of AGE and LANDFORM categories.)

9336	..12.	12......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	LANDFORMS WB & WQ (Beach Ridges)
1.1.	1	.2.1.1..	.	...	.1..	..1..2	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	...1......	WF
..1.	.....	....	.	..1	12..	.11...	....	....	....	2.......	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	WF (other)
....	.....	1...1...	.	...	11..	.311..	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	..1.....	...	....	....	WS (all)
..1.	.....	21.1..1.	.	2..	....	.11..1	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	..1...1.	...	....	....	DB (all)
....	..22.	1..231.1	1	231	.2.2	413624	.1..	....1....	...1...1	6875111.	513.3	1232	4.	4355.....	..38.	324...	26452	..	..	..	.	.	12.62.42	2..	..3......	5351322..2	DC, DSL, DSW, DT (Dunes)
....	.....	....	.	...	....	......	12..	3..3..12.	....	1	.....	....	..	..3..1311	.....	......	.....	.1	..	..	.	.	....	...	1...12...	....	BB (Holocene Plains)
....	33...	....	.	..1	..12	......	2.1.	243.1.122	13.....2	.....2..	.....	..1.	.1	..1.147..	.....	......	.....	..	..	..	.	.	....2...	...	42..12.22	...1......	BL & BLS
....	..1.2	......1.	2	...	...1	..2..1	....	1...11.12	11.....1	2......1	.....	..21	..	11..2...1	.....	......	.....	..	..	1.	.	.	....111.	...	.122.....	11........	BS
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	1	.	....	...	....	....	BD
....	.....	....	.	...	....	......	....	....	....	....	.....	1...	..	....1....	.....	......	.....	..	..	2.	.	.	..1.....	..1	....	......1...	BSW
....	.....	..1.....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	.1	.	.	....	...	....	....	TLW (Tamala Plains)
....	112.1	..1....1	.	...	..1.	......	1.3.	.11.3.1..	1115.221	...1..12	..111	211.	31	11	.....	16	1....	25	1.	..	.	.	....	...	...13....	..1.211...	THL, TLH, TL
....	.2...	....11..	.	...	....	......	..11	....1.2..	....1.3.	...11.21	1213.	....	..	....	111.2	..111.	.....	..	.2	..	.	1	....1...	...	....1.2.1	1	THS, TLS, TS, TSH
....	.....	....	.	...	....	......	....	....	....	....	.....	....	22	....	.....	......	.....	..	..	..	.	.	....	.3.	...1.....	........22.	TIH & TIS
.1..	46512	.....1..	.	1..	..12	......	313.	23.......	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	1	....	...	....	....	B
6212	...21	33..2.1.	.	1.1	.211	.11212	1121	131254142	.....1..	....	.....	....	..	....	.....	1.....	.....	.1	..	..	1	.	...121..	...	...1312..	......1...	V
4.54	..111	22241312	3	232	24.2	448515	.1..	..14..412	33.61135	13....4.	.1.1.	2.51	..	.13......	.....	2.1.1.	.4.3.	..	2	.1	.	.	.1341141	1.1	131233.2.	.361323..3	Y AGE
....	.....	....1...	.	...	....	.1...1	....	....	.21...2.	956723.4	42334	2222	22	463557822	1.461	.241.2	32322	15	1.	3.	.	.	11.22.11	1..	4.41....3	61.221112.	M
....	.....	....	.	...	....	......	....	....	....	..1....1	2.2..	.1..	72	1........	.1.21	14	..1..	1.	..	..	.	.	....	.3.	....	.......1..	O
AAAA	BBBBB	CCCCCCCC	C	CCC	CCCC	CCCCCC	DDDD	DDDDDDDDD	DDDDDDDD	EEEEEEEE	EEEEE	EEEE	EE	EEEEEEEEE	FFFFF	FFFFFF	FFFFF	GG	GG	GG	G	G	HHHHHHHH	III	JJJJJJJJJ	KKKKKKKKKK	SUPER GROUPS (See Appendix 14)
1234	56789	11111111 01234567	1 8	122 901	2222 2345	222233 678901	3333 2345	333344444 678901234	44444555 56789012	55555556 34567890	66666 12345	6666 6789	77 01	777777778 234567890	88888 12345	888899 678901	99999 23456	99 78	1 90 90	11 00 12	1 0 3	1 0 4	11111111 00000111 56789012	111 111 345	111111111 111122222 678901234	1111111111 2222233333 5678901234	PRESENCE / ABSENCE GROUPS
55.4	.....	.4......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Cakile maritima
544.	.....	.4......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	Atriplex isatidea
5544	..5..	54......	.	4..	.4..	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	Spinifex longifolius
5454	...5.	54.5....	.	544	.4..	4	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Tetragonia decumbens
5.4.	.....	455..5..	.	..5	5..4	5.4...	..4.	....	....	....	.....	45..	..	....	5	......	.....	..	..	..	.	.	..5.....	...	....	....	Carpobrotus virescens
..5.	.....	55544..5	4	.4.	....	5.4...	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	40	.	.	055.5.4.	...	....	....	Enchylaena tomentosa
....	55555	4.......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	.....4..	...	....	....	Calocephalus brownii
....	44455	4.......	5	454	5454	4	5.4.	.5.......	....	....	.....	....	..	....	.....	5.....	.....	..	..	..	.	.	....	...	....	....	Isolepis nodosa
....	...54	55555555	4	545	55.4	5555.4	.4..	.4555....	....	.4......	.....	....	..	....	.....	5....5	.4.4.	..	..	..	.	.	.5......	...	....4....	...5......	Olearia axillaris
....	44...	4.55545.	.	554	5555	5555.5	.4.0	455.4.4.4	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	.....4.5	...	....	.......5..	Scaevola crassifolia
....	.5..5	.5.555.5	.	4..	55.5	5444.5	45..	55..4..4.	......4.	.4.4....	4...4	.5.4	..	4544445..	.0.55	..40..	.....	..	..	..	.	.	0554555.	.4.	..5......	..44.45.5.	Senecio lautus
....	.....	..555...	4	.5.	....	554455	.4..	...4.4...	....	55......	.....	...5	..	5..54....	0..55	5550.5	.....	..	..	..	.	.	.5545.4.	5.0	......4..	.54......4	Rhagodia baccata ssp. baccata
....	.....	.4...4..	.	...	55.5	5454.5	.4..	5	....	....	.....	....	..	..4......	..45.	4.5...	..45.	..	.5	4.	.	.	......4.	...	......5..	....	*Dischisma arenarium
....	.....	..54....	.	.5.	5...	55445.	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	Myoporum insulare
....	.....	5	.	...	....	554.55	....	....	....	....	.....	....	..	....	...55	555.5.	..5..	..	..	..	.	.	....	...	....	..445.4..4	Daucus glochidiatus
....	.....	....	5	...	....	.4.4..	....	....	....	....	4	....	..	....5....	.....	454.5.	.....	..	..	..	.	.	....4...	...	....	5.54.....4	Clematis microphylla
....	.....	....	.	555	.4..	...455	....	....	....	....	.....	.4..	..	....	.....	4.50.5	4....	..	..	..	.	.	....	...	.......5.	.4...55...	Hardenbergia comptoniana
....	.....	....	.	554	5...	.4.4.4	....	....	....	....	.....	....	..	....	.....	5..0..	..5..	..	..	..	.	.	....	...	....	....	*Bromus diandrus
....	.....	....	.	454	....	555555	....	....	....	....	4....	.4.4	4.	..44.....	.....	455...	5554.	..	..	..	.	.	.5454.45	...	..4......	.554445.55	Acanthocarpus preissii
....	.....	5	.	..5	.455	.454.5	5550	555555545	4...0545	.....4..	.....	....	..	....54...	...4.	5540..	..44.	..	.5	..	.	.	....4.4.	...	4..4.45.5	5544...55.	Spyridium globulosum
....	.....	....	.	...	...5	......	.4..	44545.444	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	.....45..	......4...	Leptomeria preissiana
....	.....	....	.	...	....	..4...	45..	...5...4.	.40....4	...4....	.....	....	.4	....	.0.4.	......	...4.	..	..	..	.	.	5	...	45..45...	.......4..	Nemcia reticulata
....	.5...	....	.	...	....	......	..4.	.55.4.445	.4...554	.44.....	.....	...5	..	....	..4..	4.....	54...	..	..	..	.	.	....	...	...54.5..	.4........	Hibbertia racemosa
....	.....	....	.	...	....	......	..50	4.5.55554	54040555	....	.4...	....	..	....	.....	......	.....	..	..	..	.	.	.....5..	...	55.45555.	..4.4.....	Allocasuarina lehmanniana
....	.....	....	.	...	....	......	...0	...44555.	5405.554	....	.....	...5	..	....	.....	......	.....	..	..	..	.	.	....	...	....	.....44...	Acacia truncata
....	.....	....	.	...	....	......	....	...455555	.5.50545	....	.....	...4	..	....	.....	......	.....	..	..	..	.	.	....	...	....45..4	....	Acrotriche cordata
....	.....	....	.	...	....	......	....	....454..	5.050544	.....45.	.....	445.	5.	.....4...	..4..	......	.....	54	..	..	.	.	.....4..	...	44..5...4	....4.....	Leucopogon insularis
....	.....	....	.	...	....	......	....	.4.445...	.40....4	.54..4..	...5.	.5..	..	....	.....	......	.....	.4	..	..	.	.	....	...	....	....	Leptorhynchos scabrus
....	.....	....	.	...	.4..	.454..	....	.....5.4.	45.....4	544.....	...4.	4545	..	.44.4....	.....	......	..44.	..	..	..	.	.	....	...	....	45.5.45..4	Poa poiformis
....	.....	....	.	...	....	..5...	....	5..4..4..	55	44......	.....	.444	4.	..44.....	..4..	......	.5.4.	..	..	..	.	.	.....5..	...	.....4...	.4.5......	Hemiandra pungens
....	.....	....	.	...	....	......	..4.	..5555555	44.50544	4..45454	..44.	..55	..	....	.....	5	4..4.	..	..	..	.	.	....	4..	...554..4	.54.44.5..	Leucopogon parviflorus
....	5....	....	.	...	.555	.4545.	.5.0	455454555	5505....	55545.55	54544	5545	5.	.4554....	0....	......	.....	..	..	..	.	.	545	...	....	455445....	Conostylis candicans ssp. calcicola
....	.....	....	.	...	....	......	..4.	......4..	.4..0544	4545.4..	4....	..55	54	.444.44.5	.....	......	.....	4.	..	..	.	.	....	...	....545..	....	Danthonia caespitosa
....	.....	....	.	...	....	......	55..	55.545555	.40.0544	..4.545.	.....	....	4.	.4.4455..	.....	......	.....	.5	..	4.	.	.	....	...	.4..55...	....45....	Isotoma hypocrateriformis
....	5....	....	.	...	5...	..5...	....	....	55050554	4444.545	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....4.....	Opercularia vaginata
....	.....	....	.	...	....	..44..	444.	...4.54.5	550405.5	55445544	45555	.545	54	55555555.	00.55	5.50..	..44.	.4	..	5.	.	.	...55455	5.0	5555545.4	5454554..4	Trachymene pilosa
....	.....	455	.	...	.4..	4	....	...455...	5504....	545..55.	4554.	554.	4.	45445455.	00.4.	4	.4...	..	..	..	.	.	0.......	.4.	5545....5	545.454..4	Cassytha racemosa
....	.....	....	.	...	....	......	.5..	..5.45...	5504....	5554.555	4545.	5554	54	.5454454.	0..5.	......	.5.4.	..	..	..	.	.	....4...	...	55..45.54	45554545.4	Acacia lasiocarpa
....	.....	....	.	...	....	......	....	.....4...	5505054.	55555555	55555	5454	55	455555555	00555	.550..	45555	.4	..	..	.	.	.5....45	...	554555.55	54554..5.5	Melaleuca acerosa
....	.....	...55...	5	...	....	....5.	55..	....	....	....	..4.5	....	..	44445.555	.....	5550..	5.545	5.	..	..	.	.	05445.55	54.	..44..5..	44...4.5.5	Acacia rostellifera
....	.....	....	.	...	....	......	....	.....5...	54...5..	55555544	55545	5444	54	4555455.5	0.55.	..40.5	55.5.	.4	..	4.	.	.	......4.	...	5...45...	4.4...5.54	Stipa flavescens
....	.....	....	.	...	....	......	....	.....5...	5.......	44545444	44554	544.	4.	545455555	00555	...0..	5454.	54	..	..	.	.	....	...	....44..4	....	Loxocarya flexuosa
....	.....	....	.	...	....	......	....	....	4..405.4	.4445544	.44..	5...	45	44455	00...	5	444..	54	0.	5.	.	.	0.......	..0	4445...54	....44....	moss
....	.....	....	.	...	....	......	....	....	..0.....	4545.545	45454	..45	45	44455445.	..44.	......	54.4.	..	..	..	.	.	....	...	5.......4	...4...5..	Lepidosperma angustatum
....	.....	....	.	...	....	......	....	....	....	55555..5	5.554	....	54	.445.....	00555	..4...	..55.	..	..	..	.	.	....	...	....	....	Lomandra maritima
....	.....	....	.	...	....	......	....	....	54	..445...	4....	.5..	..	....	00555	......	.....	..	..	..	.	.	....	...	....	....	Brachycome iberidifolia
....	.....	....	.	...	....	...4..	....	....	....	..4.....	4.4.4	55..	5.	.4454.555	..5..	......	.....	..	..	..	.	.	....	...	....	....	Opercularia spermacocea
....	.....	....	.	...	....	......	....	....	....	544....4	4..44	....	..	....	.....	...05.	..54.	..	..	..	.	.	.5......	...	..4......	4...4.....	Phyllanthus calycinus
....	.....	....	.	...	....	......	....	....	....	.44....5	..55.	....	..	....	0...5	......	.....	..	..	..	.	.	....	...	....	....	Poa drummondiana
....	.....	....	.	...	....	......	....	....	550.....	....	...4.	....	..	....44.5.	.....	5	.....	..	..	4.	.	.	...44...	55.	55554..55	...4....5.	Melaleuca huegelii
....	.....	....	.	...	....	......	....	....	..0.....	....	.....	....	..	....	.....	54	.....	55	0.	5.	.	.	...4....	54.	.544....4	....5..55	Melaleuca cardiophylla
....	.....	....	.	...	....	......	....	....	...50.44	....	.45..	..55	..	..4444...	.....	...0..	.....	..	.5	..	.	.	....	...	4....4.54	....4.5...	Santalum acuminatum

Continued

Appendix 13 (Continued)

1234	56789	11111111 01234567	1 8	122 901	2222 2345	222233 678901	3333 2345	333344444 678901234	44444555 56789012	55555556 34567890	66666 12345	6666 6789	77 01	777777778 234567890	88888 12345	888899 678901	99999 23456	99 78	1 90 90	11 00 12	1 0 3	1 0 4	11111111 00000111 56789012	111 111 345	111111111 111122222 678901234	1111111111 2222233333 5678901234	PRESENCE / ABSENCE GROUPS
....	.....	....	.	...	....	5	....	....	....	....	.44..	....	..	....	..4.5	.5.0..	.....	..	..	..	.	.	0.44..4.	...	..4...5.4	4	*Calandrinia corrigioloides*
....	.....	....4...	.	...	.4..	...45.	....	....	..0..5..	....	.....	...4	..	44..4.45.	0...5	4	.....	..	0.	4.	.	.	0..4.4..	...	4.4......	...445....	*Crassula colorata*
....	.....	....	.	...	....	......	....	....	4.......	.....4..	5....	....	..	...4444..	.0...	......	.....	..	..	..	.	.	545	...	554......	..4.......	*Podotheca angustifolia*
....	.....	....	.	...	....	......	....	....	....	....5...	.....	....	4.	.455.55.5	.....	......	.....	..	..	..	.	.	....	...	....	....	*Podolepis canescens*
....	.....	....	.	...	....	......	....	....	.40..5..	..4..5..	.....	....	..	5..44.5..	.0...	......	.....	.4	..	..	.	.	.....4..	...	45.......	..5.......	*Rhodanthe citrina*
....	.....	....	.	...	....	......	....	....	4.......	....	.....	....	..	..4......	.....	......	.....	..	..	..	.	.	445	...	..4......	....	*Triglochin calcitrapa*
....	.....	....	.	...	....	......	....	....	5..5.55.	..4.....	.....	....	..	.4..444..	.....	......	.....	..	..	..	.	.	....	...	.....5.5.	....	*Cassytha flava*
...5	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Spinifex hirsutus*
.5..	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	**Arctotheca populifolia*
..4.	.....	..5.....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Atriplex cinerea*
....	5	....	.	...	..55	......	....	....	....	....	.....	...5	..	....	.....	......	...4.	..	.5	..	.	.	....	...	....	....	**Crassula glomerata*
....	.....	4.......	.	.4.	....	....5.	....	....	....	....	.....	....	..	....	.....	5.....	.4...	..	0.	..	.	.	..4.....	...	....	....	**Ehrharta brevifolia*
....	.....	..5.....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	.0	.	.	....	...	....	....	*Frankenia pauciflora*
....	.....	..5.....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Westringia dampieri*
....	.....	....	.	454	....	5	....	....	....	....	.....	...5	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Lepidosperma gladiatum*
....	.....	....	.	45.	....	......	....	...4...4.	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	**Trachyandra divaricata*
....	.....	....	.	.5.	....	......	....	....	....	....	.....	....	..	....	.....	......	.5...	..	..	..	.	.	....	...	....	5	*Conostylis candicans* ssp. *candicans*
....	.....	....	.	.5.	....	......	....	....	....	....	.....	....	..	....	.....	......	.5...	..	.5	..	.	.	....	...	....	....	**Lagurus ovatus*
....	.....	....	.	.5.	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	**Raphanus raphanistrum*
....	.....	....	.	.45	....	......	....	5......5.	....	....	.....	....	..	....	.....	......	.....	..	..	..	0	.	....	...	......4..	....	*Cassytha aurea* var. *hirta*
....	.....	....	.	.4.	....	4	....	....	....	....	.....	....	..	....	.....	4.....	...5.	..	..	..	.	.	....	...	....	....	*Helichrysum cordatum*
....	.....	....	.	.4.	....	......	....	....	5.......	....	...4.	.4..	.4	....	.....	4	.4...	5.	0.	..	.	.	....	...	4	...4......	*Templetonia retusa*
....	.....	....	.	.4.	....	......	....	....	....	....	.....	....	..	....	.....	4.....	.....	..	..	..	.	.	.5......	...	....	....	**Sonchus oleraceus*
....	.....	....	.	..5	...5	......	....	.4.4.....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Acacia cyclops*
....	.....	....	.	..4	.45.	......	....	....	....	....	.....	....	..	....4....	.0...	4.....	.....	..	..	4.	.	.	....	...	.......5.	....	**Vulpia myuros*
....	.....	....	.	...	5...	......	....	....	....	....	.....	....	..	....	.....	......	.4...	..	..	..	.	.	....	...	....	....	**Lolium rigidum*
....	.....	....	.	...	5...	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Isolepis marginata*
....	.....	....	.	...	5...	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	**Reichardia tingitana*
....	.....	....	.	...	.4..	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Exocarpos aphyllus*
....	4	....	.	45.	..5.	......	....	....	....	....	.....	....	..	....	.....	......	.444.	..	..	..	.	.	....	...	....	....	**Pelargonium capitatum*
....	.....	....	.	...	..5.	......	....	....	....	..4.....	.....	....	..	....	...45	......	.444.	.4	..	..	.	.	....	...	....	....	**Heliophila pusilla*
....	.....	....	.	...	....	......	4...	....	....	....	.....	....	..	.....4...	.....	......	.....	..	..	..	.	.	....	...	....	....	*Mitrasacme paradoxa*
....	.....	....	.	...	....	......	.4..	....	....	....	.....	....	..	....	.....	5.....	.....	..	..	5.	.	.	....44..	.5.	....	........5.	*Comesperma integerrimum*
....	.....	....	.	...	....	......	...0	......4..	....05..	....	.....	....	..	....	00...	...0..	.....	..	..	..	.	0	....	...	....	....	*Dryandra sessilis*
....	.....	....	.	...	....	......	....	5........	....	....	.....	....	.4	....	.....	......	.....	..	..	4.	.	.	....	...	....	....	*Angianthus* sp. aff. *milnei*
....	.....	....	.	...	....	......	....	4........	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Pogonolepis stricta*
....	.....	....	.	...	....	......	....	....5....	44....55	....	.....	...4	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Stylidium junceum*
....	.....	....	.	...	....	......	....	.....5...	....	....	.....	54..	4.	....	.....	......	.....	5.	..	..	.	.	....	...	....	....	*Thryptomene baeckeacea*
....	.....	....	.	...	....	......	....	.....5...	....	....	.....	.5..	..	....	0..5.	..4...	.....	..	..	..	.	.	....	...	....	....	*Calandrinia liniflora*
....	.....	....	.	...	....	......	....	.....4...	540....5	......4.	.....	....	44	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Pimelea ferruginea*
....	.....	....	.	...	....	......	....	.....4...	....	....	.....	....	..	....	.....	..4...	.....	..	..	..	.	.	....	...	.4.......	....	*Hydrocotyle callicarpa*
....	.....	....	.	...	....	......	....	....	44....4.	.....4..	.....	....	.4	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Comesperma confertum*
....	.....	....	.	...	....	......	....	....	4.......	..4.....	4	.5..	..	....	.....	......	.....	4.	..	..	.	.	....	...	....	....	*Cryptandra mutila*
....	.....	....	.	...	....	......	....	....	4.......	....	.....	....	..	....	0....	......	.4.4.	..	..	..	.	.	....	...	4....4...	....	*Gompholobium tomentosum*
....	.....	....	.	...	....	......	....	....	4..4.545	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	.......5.	....	*Schoenus pleistemoneus*
....	.....	....	.	...	....	......	....	....4....	.504.545	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Lysinema ciliatum*
....	.....	....	.	...	....	......	....	....	.4..0.45	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Leptomeria spinosa*
....	.....	....	.	...	....	......	....	....	.4....5.	4	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Schoenus lanatus*
....	.....	....	.	...	....	......	....	....	..0.....	....	.....	....	..	....	.....	4	.....	..	..	..	.	.	....	...	4	....	*Thomasia cognata*
....	.....	....	.	...	....	......	....	....	..0.....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Hibbertia spicata* ssp. *leptotheca*
....	.....	....	.	...	....	......	....	....	....0...	....	.....	....	..	....	00...	......	.....	..	..	..	.	.	....	...	....	....	*Hakea trifurcata*
....	.....	....	.	...	....	......	....	....	....0...	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Petrophile serruriae*
....	.....	....	.	...	....	......	....	....	....	.4.....5	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Ptilotus stirlingii*
....	.....	....	.	...	....	......	....	....	....	.4......	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Stenopetalum robustum*
....	.....	....	.	...	....	......	....	....	....	..4...4.	4....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Isotropis cuneifolia*
....	.....	....	.	...	....	......	....	....	.4......	..4..444	..4..	...4	..	....	.....	......	4....	..	..	..	.	.	....	...	....	....	*Podolepis gracilis*
....	.....	....	.	...	....	......	....	....	....	...4....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Acacia cochlearis*
....	.....	....	.	...	....	......	....	....	....	....5...	.....	....	..	....	.....	......	.....	..	..	..	.	.	0.......	...	.4.......	....	**Parentucellia latifolia*
....	.....	....	.	...	....	......	....	....	....	.....5..	.....	....	..	....	.....	......	.....	..	..	..	.	.	....4...	...	..4......	....	*Thysanotus patersonii*
....	.....	....	.	...	....	......	....	....	....	4	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Halorogis foliosa*
....	.....	....	.	...	....	......	....	....	....	....	4....	....	..	....	.....	......	5	..	..	..	.	.	....	...	....	....	*Anthocercis littorea*
....	.....	....	.	...	....	......	....	....	....	....	454..	....	..	....	.....	......	...4.	..	..	..	.	.	....	...	....	....	*Thysanotus arenarius*
....	.....	....	.	...	....	......	....	....	....	....	..5..	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Beyeria cinerea*
....	.....	....	.	...	....	......	....	....	....	....	..4..	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Lepidium foliosum*
....	.....	....	.	...	....	......	....	....	....	....	..5..	.5..	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Stenanthemum tridentatum*
....	.....	....	.	...	....	......	....	....	....	....	4	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Lepidium linifolium*
....	.....	....	.	...	....	......	....	....	....	....	.....	...4	..	....	.....	....5.	.....	..	..	..	.	.	....	...	....	....	*Scaevola nitida*
....	.....	....	.	...	....	......	....	....	....	....	.....	...4	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Trymalium albicans*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	5.	....	.....	......	.....	..	..	..	.	.	....	...	....	....	*Stylidium* 'maritimum'
....	.....	....	.	...	....	......	....	....	....	....	.....	....	45	....	.....	......	.....	..	..	..	.	.	....	...	....	...4......	*Cassytha glabella*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	55	......4..	.....	......	.....	..	..	..	.	.	....	...	....	....	*Gahnia lanigera*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	.4	....	..5..	......	...4.	..	..	..	.	.	....	...	....	....	*Scaevola thesioides*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	4..5.....	.....	......	.....	..	..	..	.	.	....	.4.	....	....	*Waitzia suaveolens*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	...4.....	.....	......	.....	..	..	..	.	.	....	...	4	....	*Lobelia heterophylla*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	.......5.	.....	......	.....	..	..	..	.	.	....	...	....	....	*Logania vaginalis*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	4	0....	......	.....	..	..	..	.	.	....	...	....	....	*Olearia dampieri*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	0....	......	.....	..	..	..	.	.	....	...	....	....	*Acacia spathulifolia*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	0....	......	.....	..	..	..	.	.	....	...	....	....	*Conospermum stoechadis*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	0....	......	.....	..	..	..	.	.	....	...	....	....	*Banksia leptophylla*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	0....	......	.....	..	..	..	.	.	....	...	....	....	*Eucalyptus foecunda* (Coolimba)
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	0....	......	.....	..	..	..	.	.	....	...	....	....	*Mesomelaena pseudostygia*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	0....	......	.....	..	..	..	.	.	....	...	....	....	*Labichea cassioides*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	00...	......	.....	..	..	..	.	.	....	...	....	....	*Hakea lissocarpha*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	00...	......	.....	..	..	..	.	.	....	...	....	....	*Jacksonia* aff. *spinosa*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	..5..	......	.....	..	..	..	.	.	....	...	....	....	*Acacia pulchella* var. *glaberrima*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	..4..	......	.....	4.	..	..	.	.	....	...	....	....	*Acacia xanthina*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	..4..	......	.....	..	..	..	.	.	....	...	....	....	*Acacia idiomorpha*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0...	......	.....	..	..	..	.	.	....	...	....	....	**Pentaschistis airoides*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0...	......	.....	..	..	..	.	.	....	...	....	....	*Bossiaea eriocarpa*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0...	......	.....	..	..	..	.	.	....	...	....	....	*Calothamnus sanguineus*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0...	......	.....	..	..	..	.	.	....	...	....	....	*Hibbertia hypericoides*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0...	......	.....	..	..	..	.	.	....	...	....	....	*Tetraria octandra*
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....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	00..5	......	.....	..	..	..	.	.	....	...	....	....	*Allocasuarina humilis*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0..5	......	.....	..	..	..	.	.	....	...	....	....	*Grevillea thelemanniana* ssp. *preissii*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0555	..40..	..45.	..	..	..	.	.	....	...	....	....	*Conostylis pauciflora* ssp. *euryrhipis*
....	.....	....	.	...	....	......	....	....	....	....	.5...	....	..	....	..4.5	......	.4..5	..	..	..	.	.	....	...	....	....	*Schoenus grandiflorus*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	5	......	.....	..	..	..	.	.	....	...	....	....	*Hybanthus calycinus*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	5	......	.....	..	..	..	.	.	....	...	....	....	*Millotia myosotidifolia*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	5.....	.....	..	..	..	.	.	....	...	....	....	*Stipa elegantissima*

Continued ...

Appendix 13 (Continued)

1234	56789	11111111 01234567	1 8	122 901	2222 2345	222233 678901	3333 2345	333344444 678901234	44444555 56789012	55555556 34567890	66666 12345	6666 6789	77 01	777777778 234567890	88888 12345	888899 678901	99999 23456	99 78	1 90 90	11 00 12	1 0 3	1 0 4	11111111 00000111 56789012	111 111 345	111111111 111122222 678901234	1111111111 2222233333 5678901234	PRESENCE / ABSENCE GROUPS
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....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	4.....	.....	..	..	..	.	.	....	...	....	....	*Eucalyptus gomphocephala*
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....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	..4..	..	..	..	.	.	....	...	....	....	**Catapodium rigidum*
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....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	.5......	...	....	....	*Pittosporum phylliraeoides*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	.4.	....	....	*Lasiopetalum oppositifolium*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	..+.....	.40	....	....	*Melaleuca lanceolata*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	.4.......	....	*Amphipogon debilis*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	.......5.	....	*Leptocarpus aristatus*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	0	.	....	...	.......5.	....	*Baumea juncea*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	0.	..	.	.	....	...	....	....	*Grevillea olivacea*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	.5	..	.	.	....	...	....	....	**Cerastium glomeratum*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	.5	..	.	.	....	...	....	....	*Callitris preissii*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	0.	..	.	.	....	...	....	....	*Beyeria viscosa*
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....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	0	.	....	...	....	....	**Juncus acutus*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	0	.	....	...	....	....	*Schoenus nitens*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.0...	......	.....	..	..	..	.	.	....	...	....	...4......	*Schoenus caespititius*
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....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	.5.	....	55	*Eucalyptus obtusiflora*
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	5	*Guichenotia ledifolia*
1234	56789	11111111 01234567	1 8	122 901	2222 2345	222233 678901	3333 2345	333344444 678901234	44444555 56789012	55555556 34567890	66666 12345	6666 6789	77 01	777777778 234567890	88888 12345	888899 678901	99999 23456	99 78	1 90 90	11 00 12	1 0 3	1 0 4	11111111 00000111 56789012	111 111 345	111111111 111122222 678901234	1111111111 2222233333 5678901234	PRESENCE / ABSENCE GROUPS
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.1..	46512	....1...	.	1..	..12	......	313.	23.......	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	1	....	...	....	....	B (AGE)
6212	...21	33..2.1.	.	1.1	.211	.11212	1121	131254142	......1.	....	.....	....	..	....	.....	1.....	.....	.1	..	..	1	.	...121..	...	...1312..	......1...	V (AGE)
4.54	..111	22241312	3	232	24.2	448515	.1..	..14..412	33.61135	13....4.	.1.1.	2.51	..	..13.....	.....	2.1.1.	.4.3.	..	.2	.1	.	.	.1341141	1.1	131233.2.	.361323..3	Y (AGE)
....	.....	....1...	.	...	....	.1...1	....	....	.21...2.	956723.4	42334	2222	22	463557822	1.461	.241.2	32322	15	1.	3.	.	.	11.22.11	1..	4.41....3	61.221112.	M (AGE)
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																											LANDFORMS
9336	..12.	12......	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	WB & WQ (Beach Ridges)
1.1.	1	.2.1.1..	.	...	.1..	..1..2	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....1.....	WE
..1.	.....	....	.	..1	12..	.11...	....	....	....	2.......	.....	....	..	....	.....	......	.....	..	..	..	.	.	....	...	....	....	WE (other)
....	.....	1....1..	.	...	11..	.311..	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	..1.....	...	....	....	WS (all)
..1.	.....	21.1..1.	.	2..	....	..11.1	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	.	.	..1...1.	...	....	....	DB (all) (Dunes)
....	..22.	1..231.1	1	231	.2.2	413624	.1..	.....1...	....1..1	6875111.	513.3	1232	4.	4355.....	..38.	324...	26452	..	..	..	.	.	12.62.42	2..	..3......	5351322..2	DC, DSL, DSW, DT
....	.....	....	.	...	....	......	12..	3..3..12.	....	1	.....	....	..	.3..1311.	.....	......	.....	.1	..	..	.	.	....	...	1...12...	....	BB (Holocene Plains)
....	33...	....	.	..1	..12	......	2.1.	243.1.122	13.....2	....2...	.....	..1.	.1	..1.147..	.....	......	.....	..	..	..	.	.	....2...	...	42..12.22	....1.....	BL & BLS
....	..1.2	......1.	2	...	...1	..2..1	....	1...11.12	11.....1	2......1	.....	..21	..	11..2...1	.....	......	.....	..	..	1.	.	.	....111.	...	.122.....	11........	BS
....	.....	....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	..	1	.	....	...	....	....	BD
....	.....	....	.	...	....	......	....	....	....	....	.....	1...	..	....1....	.....	......	.....	..	..	2.	.	.	..1.....	..1	....	.......1..	BSW
....	.....	..1.....	.	...	....	......	....	....	....	....	.....	....	..	....	.....	......	.....	..	..	.1	.	.	....	...	....	....	TLW (Tamala Plains)
....	112.1	..1....1	.	...	..1.	......	1.3.	.11.3.1..	1115.221	...1..12	..111	211.	31	11	.....	16	1....	25	1.	..	.	.	....	...	...13....	..1.211...	THL, TLH, TL
....	.2...	....11..	.	...	....	......	..11	....1.2..	....1.3.	...11.21	1213.	....	..	....	111.2	..111.	.....	..	.2	..	.	1	....1...	...	...1.2.1.	1	THS, TLS, TS, TSH
....	.....	....	.	...	....	......	....	....	....	....	.....	....	22	....	.....	......	.....	..	..	..	.	.	....	.3.	...1.....	22	THT & TIS

Appendix 14 Description of Vegetation

It was hoped to be able to define discrete Vegetation Types, typify them and provide a relatively descriptive short name. This proved extremely difficult for a number of reasons. The main one appears to be the wide range of habitats in which a few species grow (e.g. *Melaleuca acerosa, M. huegelii, Acacia rostellifera, Loxocarya flexuosa* etc.). The other significant one appears to be the gradients in floristic composition in both a regional sense and a successional sense. Hence it is probable that a significant number of the relevés sampled transitional communities. In this context, deciding the typical vegetation for each region and for each stage of a number of different successions proved beyond the current resources.

In leu of this typification of the 134 Groups recognised from the presence / absence data was considered appropriate. In addition brief descriptions of higher order grouping (Super Groups) are provided. The significance of some Super Groups is debatable as a few were obviously heterogeneous. Relationships between Groups are provided in Appendix 10 and Figures 13 and 14.

To determine the species likely to be present at a particular site first determine Sector, landform and relative age and then select likely Groups from Table 16.

Structure: Strata usually present (see Appendix 2, Muir 1977), (Strata in brackets ( ) were only in some relevés)

Dominant Species: species with greatest cover, ranges of Cover Codes indicated (3 = 1 – 5% ... 9 = 75%, see Appendix 1 for detailed explaination of codes)

Constant Species: usually present in most relevés in Group (5 = 80%, 4 = 60 – 80% of relevés, 0 = presence in Group which has only one relevé)

Landform: First letters (W, D, B, T) indicate Incipient Foredunes, Dunes, Holocene Plain, Tamala Plain. (see Table 2 and Appendix 4 for detailed explaination of codes) (Landforms in brackets ( ) were in a minority of relevés)

Age: B, V, Y, M, O indicate youngest to oldest, see Table 3 (Age in brackets ( ) was that for a minority of relevés)

Sectors: (from analysis of distribution of Presence / Absence Groups - see Appendix 10) V1. - Greenough to Irwin River, V2. - Denison to Gum Tree Bay, V3. - Gum Tree Bay to north of Jurien, V4. - North of Jurien to Lancelin, V5. - South of Lancelin (Sector in brackets ( ) was that for a minority of relevés)

Super Group: A Incipient Foredunes

Virtually all in this Super Group are very young to young incipient foredunes (landforms WB, WQ and WF). *Spinifex longifolius*, **Tetragonia decumbens* and **Cakile maritima* were the most consistently occurring species. All Sectors were represented in this Super Group. The composition of the Groups showed some regional patterns with for example *Atriplex isatidea* being mostly north of Wedge Island (Sectors V1 - V4) and *Spinifex hirsutus* south of Wedge Island (Sector V5).

Group: 1 (10 relevés)

Structure: (Low Scrub B), Low Heath D, Open Low Sedges

Dominant Species: *Spinifex longifolius* 3-9, **Tetragonia decumbens* 4-8, *Atriplex isatidea* 0-7
Constant Species: *Carpobrotus virescens* 5, *Spinifex longifolius* 5, **Cakile maritima* 5, **Tetragonia decumbens* 5

Landform: WB (WF) **Age:** V, Y **Sectors:** V4, (V1, V3)

Group: 2 (3 relevés)

Structure: Dwarf Scrub D

Dominant Species: *Spinifex longifolius* 1-8, **Cakile maritima* 3-5, **Arctotheca populifolia* 3, *Atriplex isatidea* 0-4, **Tetragonia decumbens* 0-4
Constant Species: *Atriplex isatidea* 4, *Spinifex longifolius* 5, **Arctotheca populifolia* 5, **Cakile maritima* 5, **Tetragonia decumbens* 4

Landform: WB **Age:** V (B) **Sector:** V4

Appendix 14 (Continued)

Group: 3 (6 relevés)

Structure: (Low Scrub B), Low Heath D, Open Low Sedges

Dominant Species: **Tetragonia decumbens* 2-8, *Atriplex cinerea* 0-7, *Spinifex longifolius* 0-6, *Atriplex isatidea* 3-8
Constant Species: *Atriplex cinerea* 4, *A. isatidea* 4, *Carpobrotus virescens* 4, *Enchylaena tomentosa* 5, *Spinifex longifolius* 4, **Tetragonia decumbens* 5

Landform: WB, WF (WQ, DBS) **Age:** Y (V)
Sectors: V4, V2 (V1, V3)

Group: 4 (6 relevés)

Structure: (Low Scrub B), Low Sedges

Dominant Species: *Spinifex hirsutus* 2-8, *Spinifex longifolius* 0-9, **Tetragonia decumbens* 0-8
Constant Species: *Spinifex hirsutus* 5, *S. longifolius* 4, **Cakile maritima* 4, **Tetragonia decumbens* 4

Landform: WB **Age:** Y, V **Sectors:** V5 (V4)

Super Group: B Very Young Deflation Plains

This grouping involved relevés from throughout the Central Coast which were the youngest successional stage on most of the deflation plains. Most were close to the coast. Some were actually incipient foredunes. Generally there was a thin loose layer of calcareous sand covering either Holocene or Tamala limestone. The species present in most of these relevés were *Calocephalus brownii, Senecio lautus* and *Isolepis nodosa.* The composition of groups reflected some regional variation. They also tended to reflect different amounts of loose sand cover.

Group: 5 (4 relevés)

Structure: Open Dwarf Scrub D

Dominant Species: *Opercularia vaginata* 2-4, *Calocephalus brownii* 1-4, *Scaevola crassifolia* 0-4
Constant Species: *Calocephalus brownii* 5, *Conostylis candicans* ssp. *calcicola* 5, *Isolepis nodosa* 4, *Opercularia vaginata* 5, *Scaevola crassifolia* 4

Landform: BL (BTL) **Age:** B **Sectors:** V4 (V2, V3)

Group: 6 (6 relevés)

Structure: Open Dwarf Scrub D

Dominant Species: *Calocephalus brownii* 1-5, *Hibbertia racemosa* 1-4, *Senecio lautus* 1-3
Constant Species: *Calocephalus brownii* 5, *Hibbertia racemosa* 5, *Isolepis nodosa, Scaevola crassifolia, Senecio lautus* 5

Landform: BLS (BLH, TLH, TLS) **Age:** B
Sectors: V4 (V3)

Group: 7 (6 relevés)

Structure: (Open Dwarf Scrub D), Open Low Sedges

Dominant Species: *Spinifex longifolius* 2-9, *Calocephalus brownii* 2-7
Constant Species: *Calocephalus brownii* 5, *Isolepis nodosa* 4, *Spinifex longifolius* 5

Landform: TLH, DC (DC, WB) **Age:** B (Y) **Sector:** V4

Group: 8 (4 relevés)

Structure: Dwarf Scrub C, Dwarf Scrub D

Dominant Species: *Olearia axillaris* 4-8, **Tetragonia decumbens* 4-6
Constant Species: *Calocephalus brownii* 5, *Isolepis nodosa* 5, *Olearia axillaris* 5, **Tetragonia decumbens* 5

Landform: WB, DSL **Age:** V (B, Y) **Sectors:** V4, V5

Group: 9 (4 relevés)

Structure: Dwarf Scrub D, Open Low Sedges

Dominant Species: *Calocephalus brownii* 4-7, *Isolepis nodosa* 3-5, **Pelargonium capitatum* 0-7
Constant Species: *Calocephalus brownii* 5, *Isolepis nodosa* 5, *Olearia axillaris* 4, *Senecio lautus* 5, **Crassula glomerata* 5, **Pelargonium capitatum* 4

Landform: BS (WF, TLH) **Age:** B (V, Y)
Sectors: V5 (V4)

Appendix 14 (Continued)

Super Group: C Coastal Dunes

These were mostly dunes (beach ridge plains and foredunes) very close to the coast. They were very young to young. The species most consistently present were *Scaevola crassifolia, Olearia axillaris, Senecio lautus* and *Carpobrotus virescens*. All Sectors were represented although there was some regional patterns were reflected in the composition of the Groups. Differences in age and proximity to coast also influenced the Groups.

Groups 10 - 13 were generally transitional between incipient foredunes and stabilised foredunes with *Scaevola crassifolia, Olearia axillaris, *Tetragonia decumbens* and in some *Spinifex longifolius*.

Group: 10 (5 relevés)

Structure: Dwarf Scrub C, Low Heath D, Open Low Sedges

Dominant Species: *Spinifex longifolius* 3-8, *Olearia axillaris* 3-6, **Tetragonia decumbens* 2-5, *Scaevola crassifolia* 0-6
Constant Species: *Calocephalus brownii* 4, *Carpobrotus virescens* 4, *Enchylaena tomentosa* 5, *Isolepis nodosa* 4, *Olearia axillaris* 5, *Scaevola crassifolia* 4, *Spinifex longifolius* 4, **Ehrharta brevifolia* 4, **Tetragonia decumbens* 5

Landform: DBS (WB, WS1, DC) **Age:** V, Y
Sectors: V1, V4 (V2)

Group: 11 (5 relevés)

Structure: (Open Low Scrub B) Low Heath D

Dominant Species: *Olearia axillaris* 2-6, **Tetragonia decumbens* 0-6, *Enchylaena tomentosa* 2-5, *Carpobrotus virescens* 2-4, *Senecio lautus* 2-4
Constant Species: *Atriplex isatidea* 4, *Carpobrotus virescens* 5, *Enchylaena tomentosa* 5, *Olearia axillaris* 5, *Senecio lautus* 5, *Spinifex longifolius* 4, **Cakile maritima* 4, **Dischisma arenarium* 4, **Tetragonia decumbens* 4

Landform: WB, WF (DBS) **Age:** V, Y
Sectors: V3, V4 (V2)

Group: 12 (2 relevés)

Structure: Heath B

Dominant Species: *Frankenia pauciflora* 4, *Myoporum insulare* 3-4, *Olearia axillaris* 2-4, *Rhagodia baccata* ssp. *baccata* 3, *Carpobrotus virescens* 3
Constant Species: *Atriplex cinerea* 5, *Carpobrotus virescens* 5, *Enchylaena tomentosa* 5, *Frankenia pauciflora* 5, *Myoporum insulare* 5, *Olearia axillaris* 5, *Rhagodia baccata* ssp. *baccata* 5, *Scaevola crassifolia* 5, *Westringia dampieri* 5

Landform: THL, TLW **Age:** Y **Sector:** V4

Group: 13 (4 relevés)

Structure: (Dwarf Scrub C) Low Heath D (Open Herbs) (Low Sedges)

Dominant Species: *Scaevola crassifolia* 2-8, *Olearia axillaris* 3-6, *Myoporum insulare* 0-8, **Tetragonia decumbens* 2-4, *Rhagodia baccata* ssp. *baccata* 2-4
Constant Species: *Enchylaena tomentosa* 4, *Myoporum insulare* 4, *Olearia axillaris* 5, *Rhagodia baccata* ssp. *baccata* 5, *Scaevola crassifolia* 5, *Senecio lautus* 5, **Tetragonia decumbens* 5

Landform: WF, DBS, DSW, DC **Age:** Y
Sectors: V4 (V5)

Groups 14 - 18 were depauperate foredunes with *Acacia rostellifera* joining *Scaevola crassifolia* and *Olearia axillaris*. These were mostly in Sectors V1 and V2.

Group: 14 (4 relevés)

Structure: Dwarf Scrub C, Low Heath D

Dominant Species: *Scaevola crassifolia* 3-8, *Rhagodia baccata* ssp. *baccata* 1-6, *Olearia axillaris* 2-5, *Acacia rostellifera* 3-4, *Senecio lautus* 1-4
Constant Species: *Acacia rostellifera* 5, *Enchylaena tomentosa* 4, *Olearia axillaris* 5, *Rhagodia baccata* ssp. *baccata* 5, *Scaevola crassifolia* 5, *Senecio lautus* 5

Landform: DC (DSW, TS) **Age:** Y (V, M) **Sectors:** V1 (V2)

Group: 15 (4 relevés)

Structure: Dwarf Scrub C, Low Heath D, Very Open Herbs

Dominant Species: *Olearia axillaris* 1-6, *Scaevola crassifolia* 0-4, *Acacia rostellifera* 3-6, *Senecio lautus* 2-4, **Dischisma arenarium* 0-4
Constant Species: *Acacia rostellifera* 5, *Carpobrotus virescens* 5, *Cassytha racemosa* 4, *Crassula colorata* 4, *Olearia axillaris* 5, *Scaevola crassifolia* 4, *Senecio lautus* 5, **Dischisma arenarium* 4

Landform: WF, WS1, DC, TSH **Age:** Y (B)
Sectors: V2 (V4)

Appendix 14 (Continued)

Group: 16 (2 relevés)

Structure: Low Heath C

Dominant Species: *Scaevola crassifolia* 6-8, *Olearia axillaris* 3-4, *Carpobrotus virescens* 0-5, *Lepidosperma gladiatum* 0-5
Constant Species: *Cassytha racemosa* 5, *Olearia axillaris* 5, *Scaevola crassifolia* 5

Landform: DBS, BS **Age:** V, Y **Sectors:** V2, V5

Group: 17 (2 relevés)

Structure: Heath A, Low Scrub B, Open Low Sedges

Dominant Species: *Daucus glochidiatus* 3-5, *Cassytha racemosa* 3-4, *Olearia axillaris* 2-4, *Acacia rostellifera* 0-7, *Melaleuca cardiophylla* 0-8
Constant Species: *Cassytha racemosa* 5, *Daucus glochidiatus* 5, *Enchylaena tomentosa* 5, *Olearia axillaris* 5, *Senecio lautus* 5, *Spyridium globulosum* 5

Landform: DT, THL **Age:** Y **Sectors:** V2, V4

Group: 18 (3 relevés)

Structure: Low Scrub A, Heath B

Dominant Species: *Acacia rostellifera* 5-8, *Olearia axillaris* 0-4, *Casuarina equisetifolia* 0-8
Constant Species: *Acacia rostellifera* 5, *Clematis microphylla* 5, *Enchylaena tomentosa* 4, *Isolepis nodosa* 5, *Olearia axillaris* 4, *Rhagodia baccata* ssp. *baccata* 4

Landform: BS (DT) **Age:** Y **Sector:** V1

The remainder in this Super Group were richer with the most consistent species being *Scaevola crassifolia, Olearia axillaris, Acanthocarpus preissii, Spyridium globulosum, Hardenbergia comptoniana Senecio lautus, Myoporum insulare* and *Rhagodia baccata* ssp. *baccata.*

Groups 19 - 21 were mostly in Sector V5 with *Lepidosperma gladiatum, *Pelargonium capitatum, Isolepis nodosa* and *Acacia cyclops* also important.

Group: 19 (4 relevés)

Structure: Dwarf Scrub C, Low Heath D, Open Low Sedges

Dominant Species: *Scaevola crassifolia* 2-8, *Olearia axillaris* 4-5, **Tetragonia decumbens* 3-8, *Hardenbergia comptoniana* 3-4, *Spinifex longifolius* 0-5, **Pelargonium capitatum* 0-4, *Lepidosperma gladiatum* 0-4, *Acanthocarpus preissii* 0-4
Constant Species: *Acanthocarpus preissii* 4, *Hardenbergia comptoniana* 5, *Isolepis nodosa* 4, *Lepidosperma gladiatum* 4, *Olearia axillaris* 5, *Scaevola crassifolia* 5, *Senecio lautus* 4, *Spinifex longifolius* 4, **Bromus diandrus* 5, **Pelargonium capitatum* 4, **Tetragonia decumbens* 5, **Trachyandra divaricata* 4

Landform: DB, DS **Age:** Y (V, B) **Sectors:** V5 (V3)

Group: 20 (3 relevés)

Structure: Dwarf Scrub C, Low Heath D, Very Open Herbs, Very Open Low Sedges

Dominant Species: *Scaevola crassifolia* 4-8, *Acanthocarpus preissii* 2-5, **Pelargonium capitatum* 2-4
Constant Species: *Acanthocarpus preissii* 5, *Cassytha aurea* forma *hirta* 4, *Conostylis candicans* ssp. *candicans* 5, *Enchylaena tomentosa* 4, *Hardenbergia comptoniana* 5, *Helichrysum cordatum* 4, *Isolepis nodosa* 5, *Lepidosperma gladiatum* 5, *Myoporum insulare* 5, *Olearia axillaris* 4, *Rhagodia baccata* ssp. *baccata* 5, *Scaevola crassifolia* 5, *Templetonia retusa* 4, **Bromus diandrus* 5, **Ehrharta brevifolia* 4, **Laguris ovatus* 5, **Pelargonium capitatum* 5, **Raphanus raphanistrum* 5, **Sonchus oleraceus* 4, **Tetragonia decumbens* 4, **Trachyandra divaricata* 5

Landform: DS **Age:** Y **Sector:** V5

Group: 21 (3 relevés)

Structure: Open Low Scrub B, Dwarf Scrub C, Open Tall Sedges

Dominant Species: *Spyridium globulosum* 3-7, *Acacia cyclops* 2-7, *Cassytha aurea* forma *hirta* 2-5, *Olearia axillaris* 3-4, *Hardenbergia comptoniana* 3-4, *Carpobrotus virescens* 2-4, *Lepidosperma gladiatum* 0-4
Constant Species: *Acacia cyclops* 5, *Acanthocarpus preissii* 4, *Carpobrotus virescens* 5, *Cassytha aurea* forma *hirta* 5, *Hardenbergia comptoniana* 5, *Isolepis nodosa* 5, *Lepidosperma gladiatum* 4, *Olearia axillaris* 5, *Scaevola crassifolia* 4, *Spyridium globulosum* 5, *Tetragonia decumbens* 4, **Bromus diandrus* 4, **Vulpia myuros* 4

Landform: WF, BLS, DS **Age:** Y (V) **Sectors:** V4 (V5)

Appendix 14 (Continued)

Groups 22 - 25 were mostly from Sector V4. *Conostylis candicans* ssp. *calcicola, Isolepis nodosa* and *Acacia cyclops* were additional species common in most relevés.

Group: 22 (2 relevés)

Structure: Open Low Scrub A, Dwarf Scrub C, Open Herbs, Very Open Low Sedges

Dominant Species: *Olearia axillaris* 6, *Scaevola crassifolia* 4-5, *Isolepis marginata* 4-5, *Spyridium globulosum* 0-5, *Spinifex hirsutus* 0-5
Constant Species: *Carpobrotus virescens* 5, *Isolepis marginata* 5, *I. nodosa* 5, *Myoporum insulare* 5, *Olearia axillaris* 5, *Opercularia vaginata* 5, *Scaevola crassifolia* 5, *Senecio lautus* 5, **Bromus diandrus* 5, **Dischisma arenarium* 5, **Lolium rigidum* 5, **Reichardia tingitana* 5

Landform: WF, WS **Age:** Y **Sector:** V3

Group: 23 (6 relevés)

Structure: (Low Scrub B), Dwarf Scrub C, (Dwarf Scrub D), Very Open Herbs, Very Open Low Sedges

Dominant Species: *Scaevola crassifolia* 4-8, *Olearia axillaris* 4-6, *Hardenbergia comptoniana* 0-6, *Conostylis candicans* ssp. *calcicola* 2-4, *Spyridium globulosum* 0-5
Constant Species: **Vulpia myuros* 4, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Crassula colorata* 4, *Dischisma arenarium* 5, *Exocarpos aphyllus* 4, *Hardenbergia comptoniana* 4, *Isolepis nodosa* 4, *Olearia axillaris* 5, *Poa poiformis* 4, *Scaevola crassifolia* 5, *Senecio lautus* 5, *Spinifex longifolius* 4, *Spyridium globulosum* 4, *Tetragonia decumbens* 4

Landform: WF, DS (WS) **Age:** V,Y **Sector:** V4

Group: 24 (2 relevés)

Structure: Dwarf Scrub D, (Open Low Sedges)

Dominant Species: **Pelargonium capitatum* 5-7, *Isolepis nodosa* 1-5, *Acacia cyclops* 0-6
Constant Species: *Conostylis candicans* ssp. *calcicola* 5, *Isolepis nodosa* 5, *Scaevola crassifolia* 5, *Spyridium globulosum* 5, **Crassula glomerata* 5, **Heliophila pusilla* 5, **Pelargonium capitatum* 5, **Vulpia myuros* 5

Landform: TLH, BLS **Age:** B, V **Sector:** V5

Group: 25 (5 relevés)

Structure: (Dwarf Scrub C), Dwarf Scrub D, Open Low Sedges

Dominant Species: *Scaevola crassifolia* 3-5, *Acacia cyclops* 3-5, *Conostylis candicans* ssp. *calcicola* 2-4, *Olearia axillaris* 0-5, **Crassula glomerata* 1-4, *Isolepis nodosa* 0-4
Constant Species: *Acacia cyclops* 5, *Carpobrotus virescens* 4, *Conostylis candicans* ssp. *calcicola* 5, *Isolepis nodosa* 4, *Leptomeria preissiana* 5, *Olearia axillaris* 4, *Scaevola crassifolia* 5, *Senecio lautus* 5, *Spyridium globulosum* 5, **Crassula glomerata* 5, **Dischisma arenarium* 5

Landform: BL (BS, DC, DS) **Age:** B, Y (V) **Sector:** V4

Groups 26 - 29 were again mainly from Sector V4 but appeared to be slightly older or more protected sites. *Acanthocarpus preissii* was very important in these Groups. *Conostylis candicans* ssp. *calcicola, Daucus glochidiatus* and *Poa poiformis* were the main additional species.

Group: 26 (4 relevés)

Structure: Low Heath C, (Low Heath D), (Very Open Herbs), (Open Low Sedges)

Dominant Species: *Scaevola crassifolia* 7-8, *Olearia axillaris* 3-6, *Acanthocarpus preissii* 2-5, *Rhagodia baccata* ssp. *baccata* 2-5, *Westringia dampieri* 0-5
Constant Species: *Acanthocarpus preissii* 5, *Carpobrotus virescens* 5, *Daucus glochidiatus* 5, *Enchylaena tomentosa* 5, *Myoporum insulare* 5, *Olearia axillaris* 5, *Rhagodia baccata* ssp. *baccata* 5, *Scaevola crassifolia* 5, *Senecio lautus* 5, *Zygophyllum fruticulosum* 4, **Dischisma arenarium* 5

Landform: DS (DC) **Age:** Y **Sectors:** V4 (V2)

Group: 27 (6 relevés)

Structure: (Open Low Scrub B), Dwarf Scrub C, (Low Heath D), Very Open Herbs, Open Low Sedges

Dominant Species: *Olearia axillaris* 3-8, *Myoporum insulare* 4-7, *Acanthocarpus preissii* 2-7, *Spyridium globulosum* 0-6, *Daucus glochidiatus* 3-5, *Olearia axillaris* 1-5, *Conostylis candicans* ssp. *calcicola* 0-4
Constant Species: *Acanthocarpus preissii* 5, *Clematis microphylla* 4, *Conostylis candicans* ssp. *calcicola* 4, *Daucus glochidiatus* 5, *Myoporum insulare* 5, *Olearia axillaris* 5, *Poa poiformis* 4, *Rhagodia baccata* ssp. *baccata* 5, *Scaevola crassifolia* 5, *Senecio lautus* 4, *Spyridium globulosum* 4, **Bromus diandrus* 4, **Dischisma arenarium* 4

Landform: WS (WF, DB, DS) **Age:** Y (V, M)
Sectors: V3, V4

Appendix 14 (Continued)

Group: 28 (9 relevés)

Structure: (Open Low Scrub B), (Open Dwarf Scrub C), Low Heath D, Open Low Sedges

Dominant Species: *Scaevola crassifolia* 3-8, *Conostylis candicans* ssp. *calcicola* 3-5, *Acanthocarpus preissii* 2-5, *Olearia axillaris* 3-5, *Spyridium globulosum* 2-6
Constant Species: *Acanthocarpus preissii* 5, *Carpobrotus virescens* 4, *Conostylis candicans* ssp. *calcicola* 5, *Daucus glochidiatus* 4, *Enchylaena tomentosa* 4, *Hemiandra pungens* 5, *Myoporum insulare* 4, *Nemcia reticulata* 4, *Olearia axillaris* 5, *Opercularia vaginata* 5, *Poa poiformis* 5, *Rhagodia baccata* ssp. *baccata* 4, *Scaevola crassifolia* 5, *Senecio lautus* 4, *Spyridium globulosum* 5, *Trachymene pilosa* 4

Landform: DS, WF (DB, WS, BS) **Age:** Y (V) **Sector:** V4

Group: 29 (7 relevés)

Structure: Open Low Scrub B, Dwarf Scrub C, (Open Herbs), Low Sedges

Dominant Species: *Scaevola crassifolia* 3-8, *Acanthocarpus preissii* 3-7, *Conostylis candicans* ssp. *calcicola* 0-6, *Spyridium globulosum* 0-7, *Olearia axillaris* 2-5, *Myoporum insulare* 0-8
Constant Species: *Acanthocarpus preissii* 5, *Clematis microphylla* 4, *Conostylis candicans* ssp. *calcicola* 4, *Crassula colorata* 4, *Hardenbergia comptoniana* 4, *Myoporum insulare* 4, *Olearia axillaris* 5, *Opercularia spermacocea* 4, *Poa poiformis* 4, *Rhagodia baccata* ssp. *baccata* 4, *Scaevola crassifolia* 5, *Senecio lautus* 4, *Spyridium globulosum* 4, *Trachymene pilosa* 4, **Bromus diandrus* 4, **Dischisma arenarium* 4

Landform: DS (DT, WS) **Age:** Y (V) **Sectors:** V3 (V4)

Groups 30 and 31 were mainly from Sector V5 but otherwise similar to the previous Groups. *Acanthocarpus preissii* was very important in these Groups. *Lepidosperma gladiatum*, *Daucus glochidiatus* and *Helichrysum cordatum* were the main additional species.

Group: 30 (2 relevés)

Structure: Low Scrub B, Dwarf Scrub C, Open Herbs, Open Low Sedges

Dominant Species: *Acacia rostellifera* 4-6, *Acanthocarpus preissii* 3-7, *Myoporum insulare* 3-5, *Rhagodia baccata* ssp. *baccata* 3-5
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 5, *Conostylis candicans* ssp. *calcicola* 5, *Crassula colorata* 5, *Daucus glochidiatus* 5, *Hardenbergia comptoniana* 5, *Myoporum insulare* 5, *Rhagodia baccata* ssp. *baccata* 5, **Ehrharta brevifolia* 5

Landform: DS **Age:** V, Y **Sectors:** V3, V5

Group: 31 (8 relevés)

Structure: Open Low Scrub B, Dwarf Scrub C, Dwarf Scrub D, Open Herbs, (Very Open Low Sedges)

Dominant Species: *Scaevola crassifolia* 3-7, *Spyridium globulosum* 0-7, *Lepidosperma gladiatum* 1-6, *Acanthocarpus preissii* 2-5, *Olearia axillaris* 0-5, *Daucus glochidiatus* 2-5
Constant Species: *Acanthocarpus preissii* 5, *Calandrinia corrigioloides* 5, *Cassytha racemosa* 4, *Daucus glochidiatus* 5, *Hardenbergia comptoniana* 5, *Helichrysum cordatum* 4, *Isolepis nodosa* 4, *Lepidosperma gladiatum* 5, *Olearia axillaris* 4, *Rhagodia baccata* ssp. *baccata* 5, *Scaevola crassifolia* 5, *Senecio lautus* 5, *Spyridium globulosum* 5, **Bromus diandrus* 4, **Dischisma arenarium* 5, **Tetragonia decumbens* 4

Landform: DS (DT, DB, WF, BS) **Age:** Y (V, M)
Sector: V5

Appendix 14 (Continued)

Super Group: D Young Deflation Plains

This included most relevés which were young to medium successional stages of vegetation on deflation plains, both over Holocene and Tamala surfaces. However, some were significantly in other Groups e.g. 120 - 122. There was a considerable turnover of species largely representing the increasing age of relevés. Only a few species were represented in a majority of relevés (*Spyridium globulosum, Allocasuarina lehmanniana, Conostylis candicans* ssp. *calcicola, Opercularia vaginata* and *Isotoma hypocrateriformis*).

Sectors V2, V3 and V4 were represented in this Super Group. Division of it involved an interaction between age and regional factors. Most were on the Holocene plain close to the coast. Although a number were on Tamala limestone, these patches were mostly small rises within the Holocene plain.

Groups 32 - 35 were almost bare and were dominated by *Spyridium globulosum* and in some *Allocasuarina lehmanniana, Acacia rostellifera* and *Nemcia reticulata.* They were mostly from Sector V2. Variation in substrate (Holocene or Tamala) appears to distinguish the Groups.

Group: 32 Group: (4 relevés)

Structure: Dwarf Scrub D

Dominant Species: *Spyridium globulosum* 3-6, *Nemcia reticulata* 0-5, *Acacia rostellifera* 2-4
Constant Species: *Acacia rostellifera* 5, *Isolepis nodosa* 5, *Isotoma hypocrateriformis* 5, *Mitrasacme paradoxa* 4, *Nemcia reticulata* 4, *Senecio lautus* 4, *Spyridium globulosum* 5, *Trachymene pilosa* 4

Landform: BL (BBL, TLH) **Age:** B (V) **Sector:** V2

Group: 33 (3 relevés)

Structure: (Dwarf Scrub C), Low Heath D

Dominant Species: *Spyridium globulosum* 3-6, *Nemcia reticulata* 2-6, *Acacia lasiocarpa* 2-5
Constant Species: *Acacia lasiocarpa* 5, *A. rostellifera* 5, *Conostylis candicans* ssp. *calcicola* 5, *Isotoma hypocrateriformis* 5, *Leptomeria preissiana* 4, *Nemcia reticulata* 5, *Olearia axillaris* 4, *Rhagodia baccata* ssp. *baccata* 4, *Scaevola crassifolia* 4, *Senecio lautus* 5, *Spyridium globulosum* 5, *Trachymene pilosa* 4, **Dischisma arenarium* 4

Landform: BBS (DSW) **Age:** B, V, Y **Sectors:** V2 (V3)

Group: 34 (5 relevés)

Structure: Open Low Scrub B, (Dwarf Scrub D)

Dominant Species: *Allocasuarina lehmanniana* 3-7, *Spyridium globulosum* 2-4, *Hibbertia racemosa* 0-5
Constant Species: *Allocasuarina lehmanniana* 5, *Carpobrotus virescens* 4, *Comesperma integerrimum* 4, *Danthonia caespitosa* 4, *Hibbertia racemosa* 4, *Isolepis nodosa* 4, *Leucopogon parviflorus* 4, *Spyridium globulosum* 5, *Trachymene pilosa* 4

Landform: TLH (TSH, BL) **Age:** B, V **Sectors:** V2 (V4)

Group: 35 (1 relevé)

Structure: Open Low Scrub B, Low Heath D

Dominant Species: *Acacia truncata* 6, *Dryandra sessilis* 5, *Spyridium globulosum* 3

Landform: TS **Age:** V **Sector:** V4

Groups 36 - 38 were also virtually bare. They were dominated by *Scaevola crassifolia* and *Opercularia vaginata* with *Conostylis candicans* ssp. *calcicola, Olearia axillaris, Hibbertia racemosa* and *Isotoma hypocrateriformis.* Virtually all were from Sector V3. Again variation in substrate appears important in the discrimination between Groups.

Group: 36 (3 relevés)

Structure: Dwarf Scrub D

Dominant Species: *Opercularia vaginata* 1-5, *Spyridium globulosum* 1-4, *Allocasuarina lehmanniana* 0-5
Constant Species: *Allocasuarina lehmanniana* 4, *Angianthus* sp. aff. *milnei* 5, *Cassytha aurea* forma *hirta* 5, *Conostylis candicans* ssp. *calcicola* 4, *Hemiandra pungens* 5, *Isotoma hypocrateriformis* 5, *Leptomeria preissiana* 4, *Opercularia vaginata* 5, *Pogonolepis stricta* 4, *Scaevola crassifolia* 4, *Senecio lautus* 5, *Spyridium globulosum* 5

Landform: BBL **Age:** B (V) **Sector:** V3

Appendix 14 (Continued)

Group: 37 (6 relevés)

Structure: (Open Low Scrub B), Dwarf Scrub D, (Open Low Sedges)

Dominant Species: *Scaevola crassifolia* 2-4, *Opercularia vaginata* 2-5, *Isolepis nodosa* 1-4, *Olearia axillaris* 0-5
Constant Species: *Conostylis candicans* ssp. *calcicola* 5, *cyclops* 4, *Hibbertia racemosa* 5, *Isolepis nodosa* 5, *Isotoma hypocrateriformis* 5, *Leptomeria preissiana* 4, *Leptorhynchos scabrus* 4, *Olearia axillaris* 4, *Opercularia vaginata* 5, *Scaevola crassifolia* 5, *Senecio lautus* 5, *Spyridium globulosum* 5

Landform: TLH (BS, BL) **Age:** B, V **Sectors:** V3, V4

Group: 38 (2 relevés)

Structure: Open Low Scrub B, Dwarf Scrub D, Open Low Sedges

Dominant Species: *Allocasuarina lehmanniana* 3-7, *Spyridium globulosum* 3-4, *Conostylis candicans* ssp. *calcicola* 3-4, *Acacia lasiocarpa* 3-4, *Olearia axillaris* 3-4, *Scaevola crassifolia* 3-4
Constant Species: *Acacia lasiocarpa* 5, *Allocasuarina lehmanniana* 5, *Conostylis candicans* ssp. *calcicola* 5, *Hibbertia racemosa* 5, *Leptomeria preissiana* 5, *Leucopogon parviflorus* 5, *Olearia axillaris* 5, *Scaevola crassifolia* 5, *Spyridium globulosum* 5

Landform: BS, DC **Age:** V, Y **Sectors:** V3, V4

Groups 39 - 44 have considerable vegetation cover but are still very young. These were dominated by *Allocasuarina lehmanniana, Acacia truncata* and *Spyridium globulosum* with *Leucopogon parviflorus, Conostylis candicans* ssp. *calcicola, Opercularia vaginata, Isotoma hypocrateriformis, Leptomeria preissiana* and *Acrotriche cordata* usually present. These were mostly in Sectors V3 and V4 close to the coast on the Holocene plain. Some were on patches of Tamala limestone emergent from the plain and this appeared to influence the Groups.

Group: 39 (6 relevés)

Structure: (Dwarf Scrub C), Dwarf Scrub D

Dominant Species: *Spyridium globulosum* 2-5, *Nemcia reticulata* 2-7, *Olearia axillaris* 1-5, *Leptomeria preissiana* 0-5, *Acrotriche cordata* 0-5
Constant Species: *Acacia cyclops* 4, *A. truncata* 4, *Acrotriche cordata* 4, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 4, *Hemiandra pungens* 4, *Isotoma hypocrateriformis* 5, *Lepidosperma gladiatum* 4, *Leptomeria preissiana* 4, *Leptorhynchos scabrus* 4, *Leucopogon parviflorus* 5, *Nemcia reticulata* 5, *Olearia axillaris* 5, *Opercularia vaginata* 4, *Rhagodia baccata* ssp. *baccata* 4, *Spyridium globulosum* 5, *Trachymene pilosa* 4

Landform: BBS, BL (BS) **Age:** Y (V) **Sectors:** V4 (V2, V3)

Group: 40 (5 relevés)

Structure: (Dwarf Scrub C), Low Heath D, Open Low Sedges

Dominant Species: *Allocasuarina lehmanniana* 2-5, *Acacia truncata* 0-6, *Opercularia vaginata* 3-4, *Conostylis candicans* ssp. *calcicola* 2-4, *Acacia lasiocarpa* 0-5
Constant Species: *Acacia lasiocarpa* 4, *A. truncata* 4, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 5, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Hibbertia racemosa* 4, *Isotoma hypocrateriformis* 4, *Leptomeria preissiana* 5, *Leptorhynchos scabrus* 4, *Leucopogon insularis* 4, *L. parviflorus* 5, *Lysinema ciliatum* 4, *Olearia axillaris* 5, *Opercularia vaginata* 5, *Scaevola crassifolia* 4, *Senecio lautus* 4, *Spyridium globulosum* 5, *Stylidium junceum* 5

Landform: BL (BLS, TLH) **Age:** V **Sector:** V3

Group: 41 (4 relevés)

Structure: Open Low Scrub B, Low Heath D, Open Herbs, Open Low Sedges

Dominant Species: *Thryptomene baeckeacea* 3-7, *Allocasuarina lehmanniana* 2-6, *Loxocarya flexuosa* 4-5, *Acacia truncata* 2-4
Constant Species: *Acacia lasiocarpa* 5, *A. truncata* 5, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 5, *Calandrinia liniflora* 5, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 4, *Hydrocotyle callicarpa* 4, *Isotoma hypocrateriformis* 5, *Leptorhynchos scabrus* 5, *Leucopogon insularis* 5, *L. parviflorus* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 4, *Opercularia vaginata* 4, *Pimelea ferruginea* 4, *Poa poiformis* 5, *Rhagodia baccata* ssp. *baccata* 4, *Spyridium globulosum* 5, *Stipa flavescens* 5, *Thryptomene baeckeacea* 5, *Trachymene pilosa* 5

Landform: BL (BLS, TLH) **Age:** V **Sector:** V3

Appendix 14 (Continued)

Group: 42 (5 relevés)

Structure: (Heath B), (Open Dwarf Scrub C), Dwarf Scrub D

Dominant Species: *Acacia truncata* 3-7, *Allocasuarina lehmanniana* 2-5, *Acrotriche cordata* 2-5, *Opercularia vaginata* 2-4, *Dryandra sessilis* 0-7
Constant Species: *Acacia truncata* 5, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 5, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 4, *Dryandra sessilis* 4, *Hemiandra pungens* 4, *Hibbertia racemosa* 4, *Isotoma hypocrateriformis* 5, *Leptomeria preissiana* 4, *Leucopogon insularis* 4, *L. parviflorus* 5, *Opercularia vaginata* 5, *Scaevola crassifolia* 4, *Spyridium globulosum* 5, *Trachymene pilosa* 4

Landform: TSH (TLH, BL, BBS) **Age:** Y, (V)
Sectors: V4 (V3)

Group: 43 (5 relevés)

Structure: Open Low Scrub B, Low Heath D

Dominant Species: *Allocasuarina lehmanniana* 3-6, *Acacia truncata* 2-5, *Conostylis candicans* ssp. *calcicola* 2-4, *Nemcia reticulata* 0-6, *Spyridium globulosum* 0-6
Constant Species: *Acacia truncata* 5, *Allocasuarina lehmanniana* 5, *Cassytha aurea* forma *hirta* 5, *Conostylis candicans* ssp. *calcicola* 5, *Hibbertia racemosa* 4, *Isotoma hypocrateriformis* 5, *Lepidosperma gladiatum* 4, *Leptomeria preissiana* 4, *Leucopogon parviflorus* 5, *Nemcia reticulata* 4, *Poa poiformis* 4, *Senecio lautus* 4, *Spyridium globulosum* 4

Landform: BL, BBS (BS) **Age:** V (Y) **Sector:** V4

Group: 44 (4 relevés)

Structure: (Open Low Scrub A), (Dwarf Scrub C), Dwarf Scrub D, (Open Low Sedges)

Dominant Species: *Spyridium globulosum* 4-7, *Conostylis candicans* ssp. *calcicola* 2-4, *Leptomeria preissiana* 0-4
Constant Species: *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 4, *Conostylis candicans* ssp. *calcicola* 5, *Hibbertia racemosa* 5, *Isotoma hypocrateriformis* 5, *Leptomeria preissiana* 4, *Leucopogon parviflorus* 5, *Rhodanthe citrina* 4, *Scaevola crassifolia* 4, *Spyridium globulosum* 5, *Trachymene pilosa* 5, **Dischisma arenarium* 5

Landform: BL, BS **Age:** V, Y **Sector:** V4

Groups 45 - 52 were clearly older successional stages. *Allocasuarina lehmanniana* generally still dominated but *Acacia truncata* and *Spyridium globulosum* were less important. *Conostylis candicans* ssp. *calcicola*, *Leucopogon parviflorus*, *Opercularia vaginata* and *Acrotriche cordata* were still consistently present but *Leptomeria preissiana* had declined. *Melaleuca acerosa* was present in most and important in many. *Lysinema ciliatum* and *Schoenus pleistemoneus* were common in many. Most of the relevés were from the Tamala plain so these Groups are not a strict progression from the previous ones. All but one relevé was from Sector V4. Some of the variation appears, however, to be regionally influenced. Some appears related to the depth of calcareous sand present.

Group: 45 (3 relevés)

Structure: Low Scrub B, Dwarf Scrub C, Low Heath D, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 4-7, *M. huegelii* 3-7, *Loxocarya flexuosa* 3-5, *Allocasuarina lehmanniana* 2-5
Constant Species: *Acacia lasiocarpa* 5, *A. truncata* 5, *Allocasuarina lehmanniana* 5, *Cassytha flava* 5, *C. racemosa* 5, *Comesperma confertum* 4, *Conostylis candicans* ssp. *calcicola* 5, *Cryptandra mutila* 4, *Gompholobium tomentosum* 4, *Leucopogon insularis* 5, *L. parviflorus* 4, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *M. huegelii* 5, moss 4, *Opercularia vaginata* 5, *Pimelea ferruginea* 5, *Poa poiformis* 4, *Podotheca angustifolia* 4, *Schoenus pleistemoneus* 4, *Spyridium globulosum* 4, *Stipa flavescens* 5, *Stylidium junceum* 4, *Templetonia retusa* 5, *Trachymene pilosa* 5, *Triglochin calcitrapa* 4

Landform: BL, BS, TLH **Age:** Y **Sectors:** V4 (V3)

Group: 46 (5 relevés)

Structure: Open Dwarf Scrub C, Low Heath D, (Low Sedges)

Dominant Species: *Melaleuca huegelii* 2-6, *M. acerosa* 2-5, *Acrotriche cordata* 2-5, *Acacia lasiocarpa* 2-4, *Lysinema ciliatum* 2-4
Constant Species: *Acacia lasiocarpa* 5, *A. truncata* 4, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 4, *Cassytha racemosa* 5, *Comesperma confertum* 4, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 4, *Hibbertia racemosa* 4, *Isotoma hypocrateriformis* 4, *Leptomeria spinosa* 4, *Leptorhynchos scabrus* 4, *Leucopogon parviflorus* 4, *Lysinema ciliatum* 5, *Melaleuca acerosa* 5, *M. huegelii* 5, *Nemcia reticulata* 4, *Opercularia vaginata* 5, *Pimelea ferruginea* 4, *Poa poiformis* 5, *Podolepis gracilis* 4, *Rhodanthe citrina* 4, *Schoenus lanatus* 4, *Stipa flavescens* 4, *Stylidium junceum* 4, *Trachymene pilosa* 5

Landform: BL (BS, TLH) **Age:** Y, M **Sector:** V4

Appendix 14 (Continued)

Group: 47 (1 relevé)

Structure: Dwarf Scrub C, Low Heath D

Dominant Species: *Melaleuca acerosa* 5, *M. cardiophylla* 5, *Lepidosperma angustatum* 5, *Acacia lasiocarpa*, *Hibbertia spicata* ssp. *leptotheca* 4, *Lysinema ciliatum* 4, *Melaleuca huegelii* 4, *Pimelea ferruginea* 4

Landform: TLH **Age:** M **Sector:** V4

Group: 48 (6 relevés)

Structure: Low Scrub B, Low Heath D, (Very Open Low Sedges)

Dominant Species: *Allocasuarina lehmanniana* 0-8, *Melaleuca acerosa* 2-5, *Acacia lasiocarpa* 0-5, *Lysinema ciliatum* 0-6
Constant Species: *Acacia lasiocarpa* 4, *A. truncata* 5, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 4, *Cassytha flava* 5, *C. racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Leucopogon insularis* 5, *L. parviflorus* 5, *Lysinema ciliatum* 4, *Melaleuca acerosa* 5, moss 4, *Opercularia vaginata* 5, *Santalum acuminatum* 5, *Schoenus pleistemoneus* 4, *Trachymene pilosa* 4

Landform: TLH (THL, DSW) **Age:** Y **Sector:** V4

Group: 49 (1 relevé)

Structure: Heath A, Dwarf Scrub D

Dominant Species: *Allocasuarina lehmanniana* 7, moss 7, *Dryandra sessilis* 5

Landform: TS **Age:** Y **Sector:** V4

Group: 50 (2 relevés)

Structure: Open Low Scrub B, Low Heath D

Dominant Species: *Melaleuca acerosa* 5-6, *Allocasuarina lehmanniana* 3-4, *Dryandra sessilis* 3-4, moss 3-4, *Acrotriche cordata* 2-4
Constant Species: *Acacia truncata* 5, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 5, *Cassytha flava* 5, *Crassula colorata* 5, *Danthonia caespitosa* 5, *Dryandra sessilis* 5, *Hibbertia racemosa* 5, *Isotoma hypocrateriformis* 5, *Leucopogon insularis* 5, *L. parviflorus* 5, *Lysinema ciliatum* 5, *Melaleuca acerosa* 5, moss 5, *Opercularia vaginata* 5, *Rhodanthe citrina* 5, *Schoenus pleistemoneus* 5, *Spyridium globulosum* 5, *Stipa flavescens* 5, *Trachymene pilosa* 5

Landform: TLH **Age:** V, Y **Sector:** V4

Group: 51 (5 relevés)

Structure: Low Scrub B, Low Heath D

Dominant Species: *Allocasuarina lehmanniana* 3-7, *Schoenus pleistemoneus* 0-4, *Lysinema ciliatum* 0-5, *Acrotriche cordata* 0-4, *Opercularia vaginata* 3
Constant Species: *Acacia truncata* 5, *Acrotriche cordata* 4, *Allocasuarina lehmanniana* 5, *Brachycome iberidifolia* 5, *Cassytha flava* 5, *Comesperma confertum* 4, *Danthonia caespitosa* 4, *Hemiandra pungens* 5, *Hibbertia racemosa* 5, *Isotoma hypocrateriformis* 4, *Leptomeria spinosa* 4, *Leucopogon insularis* 4, *L. parviflorus* 4, *Lysinema ciliatum* 4, *Melaleuca acerosa* 4, *Opercularia vaginata* 5, *Santalum acuminatum* 4, *Schoenus lanatus* 5, *S. pleistemoneus* 4, *Spyridium globulosum* 4, *Stylidium junceum* 5

Landform: TLH, TLS (TSH) **Age:** Y, M **Sector:** V4

Group: 52 (5 relevés)

Structure: (Open Dwarf Scrub D), (Dwarf Scrub C), Low Heath D, Open Low Sedges

Dominant Species: *Allocasuarina lehmanniana* 2-6, *Lysinema ciliatum* 2-7, *Schoenus pleistemoneus* 3-5, *Acrotriche cordata* 3-5
Constant Species: *Acacia truncata* 4, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 5, *Brachycome iberidifolia* 4, *Danthonia caespitosa* 4, *Hemiandra pungens* 5, *Hibbertia racemosa* 4, *Isotoma hypocrateriformis* 4, *Leptomeria spinosa* 5, *Leptorhynchos scabrus* 4, *Leucopogon insularis* 4, *L. parviflorus* 4, *Lysinema ciliatum* 5, moss 4, *Nemcia reticulata* 4, *Opercularia vaginata* 4, *Pimelea ferruginea* 5, *Poa poiformis* 4, *Santalum acuminatum* 4, *Schoenus pleistemoneus* 5, *Spyridium globulosum* 5, *Stylidium junceum* 5, *Trachymene pilosa* 5

Landform: BL, BS, TLH, DT **Age:** Y **Sector:** V4

Appendix 14 (Continued)

Super Group: E Older (Inland) Dunes and Plains

These were a mixture of dunes and plains although most were relatively old stages of the successions. Most of the plains had a significant calcareous sand cover, either over Holocene or Tamala limestone. The species most usually present and generally the dominant also were *Melaleuca acerosa, Acacia lasiocarpa, Loxocarya flexuosa, Lepidosperma angustatum, Conostylis candicans* ssp. *calcicola, Stipa flavescens, Cassytha racemosa, Trachymene pilosa* and to a lesser extent *Lomandra maritima.*

While there were relevés from each of Sectors V2, V3 and V4, the regional variation showed up strongly in the differences between Groups. Differences in landforms (dunes or plains) also were reflected in the Groups.

Groups 53 - 65 were mainly from Sector V4 with some Sector V3. The major species were as described above although *Opercularia vaginata* was commonly present mainly on the dunes. The presence of small numbers of species distinguished the Groups from each other. Most Groups were, therefore, local variants.

Group: 53 (10 relevés)

Structure: (Open Low Scrub B), Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 3-6, *Lomandra maritima* 2-7, *Acacia lasiocarpa* 3-7, *Conostylis candicans* ssp. *calcicola* 0-5, *Loxocarya flexuosa* 0-6
Constant Species: *Acacia lasiocarpa* 5, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 4, *Hemiandra pungens* 4, *Lepidosperma angustatum* 4, *Leucopogon parviflorus* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Opercularia vaginata* 4, *Phyllanthus calycinus* 5, *Poa poiformis* 5, *Rhagodia baccata* ssp. *baccata* 5, *Stipa flavescens* 5, *Trachymene pilosa* 5

Landform: DS (BS, WF, DT, DC) **Age:** M **Sectors:** V4 (V3)

Group: 54 (8 relevés)

Structure: (Dwarf Scrub C), Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 3-7, *Lomandra maritima* 3-7, *Conostylis candicans* ssp. *calcicola* 3-5, *Loxocarya flexuosa* 0-5, *Acacia lasiocarpa* 0-4
Constant Species: *Acacia lasiocarpa* 5, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 5, *Hemiandra pungens* 4, *Hibbertia racemosa* 4, *Lepidosperma angustatum* 5, *Leptorhynchos scabrus* 5, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 4, *Olearia axillaris* 4, *Opercularia vaginata* 4, *Phyllanthus calycinus* 4, *Poa poiformis* 4, *Ptilotus stirlingii* 4, *Rhagodia baccata* ssp. *baccata* 5, *Senecio lautus* 4, *Stenopetalum robustum* 4, *Stipa flavescens* 5, *Trachymene pilosa* 5

Landform: DS (DC) **Age:** M, Y **Sector:** V4

Group: 55 (7 relevès)

Structure: (Dwarf Scrub C), Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 3-7, *Loxocarya flexuosa* 2-5, *Lomandra maritima* 0-6, *Conostylis candicans* ssp. *calcicola* 3-4, *Calothamnus quadrifidus* 0-5
Constant Species: *Acacia lasiocarpa* 5, *Brachycome iberidifolia* 4, *Calothamnus quadrifidus* 4, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Cryptandra mutila* 4, *Danthonia caespitosa* 4, *Hibbertia racemosa* 4, *Isotoma hypocrateriformis* 4, *Isotropis cuneifolia* 4, *Lepidosperma angustatum* 4, *Leptorhynchos scabrus* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, moss 4, *Opercularia spermacocea* 4, *O. vaginata* 4, *Phyllanthus calycinus* 4, *Poa drummondiana* 4, *P. poiformis* 4, *Podolepis gracilis* 4, *Rhodanthe citrina* 4, *Stipa flavescens* 5, *Trachymene pilosa* 4, **Heliophila pusilla* 4

Landform: DS (DC, DT) **Age:** M (O) **Sector:** V4

Group: 56 (7 relevés)

Structure: (Dwarf Scrub C), Low Heath D, Low Sedges

Dominant Species: *Lomandra maritima* 4-8, *Melaleuca acerosa* 4-6, *Lepidosperma angustatum* 3-5, *Conostylis candicans* ssp. *calcicola* 0-5, *Acacia lasiocarpa* 0-7, *Loxocarya flexuosa* 0-6
Constant Species: *Acacia cochlearis* 4, *A. lasiocarpa* 4, *Brachycome iberidifolia* 4, *Cassytha flava* 4, *Conostylis candicans* ssp. *calcicola* 4, *Danthonia caespitosa* 5, *Lepidosperma angustatum* 5, *Leucopogon parviflorus* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 4, *Nemcia reticulata* 4, *Opercularia vaginata* 4, *Senecio lautus* 4, *Stipa flavescens* 5, *Trachymene pilosa* 4

Landform: DS, DC (THL, THS) **Age:** M **Sector:** V4

Appendix 14 (Continued)

Group: 57 (2 relevés)

Structure: (Dwarf Scrub C), Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 6-7, *Lomandra maritima* 6, *Loxocarya flexuosa* 4-6, moss 4-5, *Conostylis candicans* ssp. *calcicola* 3-5
Constant Species: *Brachycome iberidifolia* 5, *Conostylis candicans* ssp. *calcicola* 5, *Isotoma hypocrateriformis* 5, *Leucopogon parviflorus* 5, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, moss 5, *Podolepis canescens* 5, *Stipa flavescens* 5, *Trachymene pilosa* 5, **Parentucellia latifolia* 5

Landform: DSW, THS **Age:** M **Sector:** V4

Group: 58 (3 relevés)

Structure: (Low Heath C), Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 5-8, *Lepidosperma angustatum* 4-5, *Acacia lasiocarpa* 3-5, moss 3-5
Constant Species: *Acacia lasiocarpa* 5, *Cassytha racemosa* 5, *Comesperma confertum* 4, *Danthonia caespitosa* 4, *Isotoma hypocrateriformis* 4, *Lepidosperma angustatum* 5, *Leptorhynchos scabrus* 4, *Leucopogon insularis* 4, *L. parviflorus* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 5, *Opercularia vaginata* 5, *Podolepis gracilis* 4, *Podotheca angustifolia* 5, *Rhodanthe citrina* 4, *Spyridium globulosum* 4, *Stipa flavescens* 5, *Thysanotus patersonii* 5, *Trachymene pilosa* 5

Landform: BL (DC) **Age:** M **Sectors:** V4 (V3)

Group: 59 (4 relevés)

Structure: (Heath A), Dwarf Scrub C, (Low Heath D), Open Low Sedges

Dominant Species: *Melaleuca acerosa* 5-6, *Acacia lasiocarpa* 5, *Conostylis candicans* ssp. *calcicola* 2-4, *Lepidosperma angustatum* 0-4
Constant Species: *Acacia lasiocarpa* 5, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Isotoma hypocrateriformis* 5, *Isotropis cuneifolia* 4, *Lepidosperma angustatum* 4, *Leptorhynchos scabrus* 4, *Leucopogon insularis* 5, *L. parviflorus* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 4, *Opercularia vaginata* 4, *Pimelea ferruginea* 4, *Podolepis gracilis* 4, *Stipa flavescens* 4, *Trachymene pilosa* 4

Landform: TLS, THL, DS **Age:** Y **Sector:** V4

Group: 60 (5 relevés)

Structure: Low Heath D, Low Sedges

Dominant Species: *Lomandra maritima* 4-7, *Melaleuca acerosa* 3-8, *Lepidosperma angustatum* 3-6, *Loxocarya flexuosa* 0-5, *Acacia lasiocarpa* 3-4, moss 0-5, *Schoenus lanatus* 0-5
Constant Species: *Acacia lasiocarpa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Halorogis foliosa* 4, *Lepidosperma angustatum* 5, *Leucopogon parviflorus* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 4, *Opercularia vaginata* 5, *Phyllanthus calycinus* 4, *Poa drummondiana* 5, *Podolepis gracilis* 4, *Ptilotus stirlingii* 5, *Schoenus lanatus* 4, *Stipa flavescens* 4, *Trachymene pilosa* 4

Group: 61 (6 relevés)

Structure: (Dwarf Scrub C), Low Heath D, Open Herbs, Low Sedges

Dominant Species: *Melaleuca acerosa* 3-7, *Conostylis candicans* ssp. *calcicola* 2-5, *Loxocarya flexuosa* 0-8, *Lomandra maritima* 2-4, *Acanthocarpus preissii* 0-6
Constant Species: *Acacia lasiocarpa* 4, *Acanthocarpus preissii* 4, *Anthocercis littorea* 4, *Brachycome iberidifolia* 4, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 4, *Isotropis cuneifolia* 4, *Lepidosperma angustatum* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Opercularia spermacocea* 4, *Phyllanthus calycinus* 4, *Podotheca angustifolia* 5, *Senecio lautus* 4, *Stipa flavescens* 5, *Thysanotus arenarius* 4, *Trachymene pilosa* 4

Landform: DS (DC, THS) **Age:** M (O) **Sectors:** V4 (V2)

Group: 62 (3 relevés)

Structure: (Scrub), (Low Scrub B), Low Heath C, Low Sedges

Dominant Species: *Melaleuca acerosa* 5-7, *Lepidosperma angustatum* 4, *Allocasuarina lehmanniana* 0-6, *Loxocarya flexuosa* 0-6, *Acacia lasiocarpa* 2-5
Constant Species: *Acacia lasiocarpa* 5, *Allocasuarina lehmanniana* 4, *Calandrinia corrigioloides* 4, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 4, *Lepidosperma angustatum* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 4, *Santalum acuminatum* 4, *Schoenus grandiflorus* 5, *Stipa flavescens* 5, *Thysanotus arenarius* 5, *Trachymene pilosa* 5

Landform: TS, THS, DT **Age:** M, Y **Sectors:** V4, V3

Appendix 14 (Continued)

Group: 63 (5 relevés)

Structure: (Open Low Scrub B), Low Heath D, Open Herbs, Low Sedges

Dominant Species: *Loxocarya flexuosa* 5-8, *Melaleuca acerosa* 5-7, *Lomandra maritima* 3-5, *Lepidosperma angustatum* 0-5, *Conostylis candicans* ssp. *calcicola* 3-4, *Beyeria cinerea* 2-5, *Santalum acuminatum* 2-4, *Acacia lasiocarpa* 0-4, *Trachymene pilosa* 2-5
Constant Species: *Acacia lasiocarpa* 4, *A. rostellifera* 4, *Beyeria cinerea* 5, *Calandrinia corrigioloides* 4, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Lepidium foliosum* 4, *Lepidosperma angustatum* 4, *Leucopogon parviflorus* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, moss 4, *Opercularia spermacocea* 4, *Poa drummondiana* 5, *Podolepis gracilis* 4, *Santalum acuminatum* 5, *Stenamthemum tridentatum* 5, *Stipa flavescens* 5, *Thysanotus arenarius* 4, *Trachymene pilosa* 5

Landform: DS, DC, THS, THL **Age:** M, O **Sector:** V4

Group: 64 (4 relevés)

Structure: (Heath B), Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 2-7, *Lepidosperma angustatum* 4-7, *Acacia lasiocarpa* 2-4, *Melaleuca huegelii* 0-4

Constant Species: *Acacia lasiocarpa* 5, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 4, *Lepidosperma angustatum* 5, *Leptorhynchos scabrus* 5, *Leucopogon parviflorus* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *M. huegelii* 4, *Phyllanthus calycinus* 4, *Poa drummondiana* 5, *P. poiformis* 4, *Stipa flavescens* 4, *Templetonia retusa* 4, *Trachymene pilosa* 5

Landform: TSH, THS, TLH, TLS **Age:** M **Sector:** V4

Group: 65 (4 relevés)

Structure: Open Low Scrub B, Low Heath D, Open Herbs, Low Sedges

Dominant Species: *Melaleuca acerosa* 4-7, *Acacia rostellifera* 2-7, *Lomandra maritima* 0-7, *Trachymene pilosa* 2-5, *Loxocarya flexuosa* 0-5, *Lepidosperma angustatum* 0-5, *Stipa flavescens* 1-5
Constant Species: *Acacia rostellifera* 5, *Clematis microphylla* 4, *Conostylis candicans* ssp. *calcicola* 4, *Cryptandra mutila* 4, *Lepidium linifolium* 4, *Lepidosperma angustatum* 4, *Lomandra maritima* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Opercularia spermacocea* 4, *Phyllanthus calycinus* 4, *Senecio lautus* 4, *Stipa flavescens* 5, *Trachymene pilosa* 5

Landform: DS, DT, THL **Age:** M **Sectors:** V4 (V5)

Groups 66 - 69 were mostly from Sector V3 and many of the relevés were younger than most other Groups. They had all but *Lomandra maritima* of those mentioned above for this Super Group. *Opercularia spermacocea* appeared to have replaced *O. vaginata* in most relevés. *Thryptomene baeckeacea* and less consistently *Santalum acuminatum* distinguish these Groups from the others in this Super Group.

Group: 66 (4 relevés)

Structure: Low Scrub B, Low Heath D, Very Open Low Sedges

Dominant Species: *Thryptomene baeckeacea* 7-8, moss 3-5, *Loxocarya flexuosa* 3-4, *Acacia lasiocarpa* 2-5
Constant Species: *Acacia lasiocarpa* 5, *Carpobrotus virescens* 4, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Leucopogon insularis* 4, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, moss 5, *Opercularia spermacocea* 5, *Poa poiformis* 4, *Stipa flavescens* 5, *Thryptomene baeckeacea* 5

Landform: TLH, THL, DT, BSW **Age:** Y, M **Sector:** V3

Group: 67 (3 relevés)

Structure: Low Heath D, Open Herbs, Low Sedges

Dominant Species: *Thryptomene baeckeacea* 0-8, *Cryptandra mutila* 4-5, *Conostylis candicans* ssp. *calcicola* 3-5, *Loxocarya flexuosa* 0-6, *Brachycome iberidifolia* 4
Constant Species: *Acacia lasiocarpa* 5, *Acanthocarpus preissii* 4, *Brachycome iberidifolia* 5, *Calandrinia liniflora* 5, *Carpobrotus virescens* 5, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Cryptandra mutila* 5, *Hardenbergia comptoniana* 4, *Hemiandra pungens* 4, *Leptorhynchos scabrus* 5, *Leucopogon insularis* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 4, *Opercularia spermacocea* 5, *Poa poiformis* 5, *Senecio lautus* 5, *Stenamthemum tridentatum* 5, *Stipa flavescens* 4, *Templetonia retusa* 4, *Thryptomene baeckeacea* 4, *Trachymene pilosa* 5

Landform: DC, THL **Age:** M, O **Sector:** V3

Appendix 14 (Continued)

Group: 68 (7 relevés)

Structure: Low Heath D, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 4-7, *Lepidosperma angustatum* 3-5, *Conostylis candicans* ssp. *calcicola* 0-5, *Loxocarya flexuosa* 0-5, *Acacia lasiocarpa* 3-4, *Santalum acuminatum* 2-4
Constant Species: *Acacia lasiocarpa* 5, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 4, *Danthonia caespitosa* 5, *Hemiandra pungens* 4, *Lepidosperma angustatum* 4, *Leucopogon insularis* 5, *L. parviflorus* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Poa poiformis* 4, *Santalum acuminatum* 5, *Stipa flavescens* 4, *Trachymene pilosa* 4

Landform: DS (BS, BLS, TLH) **Age:** Y, M **Sector:** V3

Group: 69 (3 relevés)

Structure: Dwarf Scrub C, Low Heath D, Very Open Herbs, Open Low Sedges

Dominant Species: *Acacia truncata* 3-5, *Santalum acuminatum* 2-4, *Melaleuca acerosa* 0-4, *Calothamnus quadrifidus* 0-4
Constant Species: *Acacia lasiocarpa* 4, *A. truncata* 5, *Acanthocarpus preissii* 4, *Acrotriche cordata* 4, *Calothamnus quadrifidus* 4, *Conostylis candicans* ssp. *calcicola* 5, *Crassula colorata* 4, *Danthonia caespitosa* 5, *Hemiandra pungens* 4, *Hibbertia racemosa* 5, *Lepidosperma angustatum* 5, *Lepidosperma gladiatum* 5, *Leucopogon parviflorus* 5, *Melaleuca acerosa* 4, *Poa poiformis* 5, *Podolepis gracilis* 4, *Rhagodia baccata* ssp. *baccata* 5, *Santalum acuminatum* 5, *Scaevola nitida* 4, *Senecio lautus* 4, *Stipa flavescens* 4, *Stylidium junceum* 4, *Trachymene pilosa* 5, *Trymalium albicans* 4, **Crassula glomerata* 5

Landform: DS, BS **Age:** M, Y **Sector:** V4

Groups 70 - 71 were from Sector V3 in the Cliff Head area. These were a mixture of both dunes and plains. All were relatively old successional stages. The major species mentioned for the Super Group were present. *Gahnia lanigera*, and to a lesser extent *Cassytha glabella*, *Pimelea ferruginea*, *Thryptomene baeckeacea* and *Leucopogon insularis* were distinguishing species. *Opercularia spermacocea* appeared to have replaced *O. vaginata* in most relevés.

Group: 70 (9 relevés)

Structure: Low Heath D, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 2-7, *Gahnia lanigera* 2-5, *Thryptomene baeckeacea* 0-7, *Leucopogon insularis* 2-4, *Opercularia spermacocea* 1-5, *Acacia lasiocarpa* 0-5, *Lepidosperma angustatum* 0-5
Constant Species: *Acacia lasiocarpa* 5, *Acanthocarpus preissii* 4, *Cassytha glabella* 4, *C. racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 5, *Gahnia lanigera* 5, *Hemiandra pungens* 4, *Isotoma hypocrateriformis* 4, *Lepidosperma angustatum* 4, *Leucopogon insularis* 5, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 4, *Opercularia spermacocea* 5, *Pimelea ferruginea* 4, *Podolepis canescens* 4, *Stipa flavescens* 5, *Stylidium 'maritimum'* 5, *Thryptomene baeckeacea* 4, *Trachymene pilosa* 5

Landform: DS (TIH, THL, TLH) **Age:** O (M)
Sector: V2

Group: 71 (4 relevés)

Structure: Dwarf Scrub C, Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 2-7, *Gahnia lanigera* 2-7, moss 3-5, *Acacia lasiocarpa* 0-5
Constant Species: *Acacia lasiocarpa* 4, *Angianthus* sp. aff. *milnei* 4, *Cassytha glabella* 4, *Comesperma confertum* 4, *Danthonia caespitosa* 4, *Gahnia lanigera* 5, *Lepidosperma angustatum* 5, *Lomandra maritima* 4, *Melaleuca acerosa* 5, moss 5, *Nemcia reticulata* 4, *Pimelea ferruginea* 4, *Scaevola thesioides* 4, *Stipa flavescens* 4, *Templetonia retusa* 4, *Trachymene pilosa* 4

Landform: TIH, TLH, BLS **Age:** M, O **Sector:** V2

Groups 72 - 80 were again groups of relevés from both dunes and plains. All were moderately old successional stages and virtually all were from Sector V2. The major species mentioned for the Super Group were all present although *Conostylis candicans* ssp. *calcicola* and *Lomandra maritima* were less consistently present. *Opercularia spermacocea* appeared to have replaced *O. vaginata* in most relevés. *Acacia rostellifera* was the most notable addition although it was not usually a dominant species. *Melaleuca huegelii* was present on most Holocene plains (Groups 76 - 79).

Appendix 14 (Continued)

Group: 72 (5 relevés)

Structure: Heath B, Low Heath D, Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 0-7, *Trachymene pilosa* 2-5, *Loxocarya flexuosa* 2-4, *Waitzia suaveolens* 0-5, *Lepidosperma angustatum* 0-4
Constant Species: *Acacia rostellifera* 4, *Cassytha racemosa* 4, *Crassula colorata* 4, *Lepidosperma angustatum* 4, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 4, *Rhagodia baccata* ssp. *baccata* 5, *Rhodanthe citrina* 5, *Senecio lautus* 4, *Stipa flavescens* 4, *Trachymene pilosa* 5, *Waitzia suaveolens* 4

Landform: DT, DS, DC, BS **Age:** M (O) **Sector:** V2

Group: 73 (7 relevés)

Structure: (Open Low Scrub B), Low Heath D, Very Open Herbs, Low Sedges

Dominant Species: *Melaleuca acerosa* 6-8, *Loxocarya flexuosa* 0-7, *Acacia lasiocarpa* 2-5
Constant Species: *Acacia lasiocarpa* 5, *A. rostellifera* 4, *Cassytha flava* 4, *C. racemosa* 5, *Conostylis candicans* ssp. *calcicola* 4, *Crassula colorata* 4, *Danthonia caespitosa* 4, *Isotoma hypocrateriformis* 4, *Lepidosperma angustatum* 4, *Lomandra maritima* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Opercularia spermacocea* 4, *Poa poiformis* 4, *Podolepis canescens* 4, *Rhodanthe citrina* 5, *Senecio lautus* 5, *Stipa flavescens* 5, *Trachymene pilosa* 5

Landform: DC, BBS (BS) **Age:** M (Y) **Sector:** V2

Group: 74 (6 relevés)

Structure: (Open Dwarf Scrub C), Low Heath D, Very Open Herbs, Low Sedges

Dominant Species: *Melaleuca acerosa* 3-6, *Loxocarya flexuosa* 4-5, *Acanthocarpus preissii* 0-6, *Conostylis candicans* ssp. *calcicola* 3-4, *Acacia lasiocarpa* 0-4, *Loxocarya flexuosa* 0-4,
Constant Species: *Acacia lasiocarpa* 4, *A. rostellifera* 4, *Acanthocarpus preissii* 4, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 4, *Hemiandra pungens* 4, *Lepidosperma angustatum* 4, *Lomandra maritima* 4, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *Opercularia spermacocea* 4, *Poa poiformis* 4, *Podolepis canescens* 5, *Santalum acuminatum* 4, *Senecio lautus* 4, *Stipa flavescens* 5, *Trachymene pilosa* 5, *Triglochin calcitrapa* 4, **Dischisma arenarium* 4

Landform: DS (DC, BLS) **Age:** Y, M **Sectors:** V2, V3

Group: 75 (5 relevés)

Structure: (Heath B), Low Heath D, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 5-7, *Loxocarya flexuosa* 0-5, *Conostylis candicans* ssp. *calcicola* 1-4, *Acanthocarpus preissii* 0-5,
Constant Species: *Acacia lasiocarpa* 5, *A. rostellifera* 4, *Acanthocarpus preissii* 4, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Danthonia caespitosa* 4, *Hemiandra pungens* 4, *Isotoma hypocrateriformis* 4, *Lepidosperma angustatum* 5, *Lobelia heterophylla* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Opercularia spermacocea* 5, *Podolepis canescens* 5, *Podotheca angustifolia* 4, *Rhagodia baccata* ssp. *baccata* 5, *Rhodanthe citrina* 4, *Santalum acuminatum* 4, *Senecio lautus* 4, *Stipa flavescens* 5, *Trachymene pilosa* 5, *Waitzia suaveolens* 5

Landform: DS (DC) **Age:** M **Sector:** V2

Group: 76 (5 relevés)

Structure: Low Scrub B, Low Heath D, Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 5-8, *Loxocarya flexuosa* 3-7, *Trachymene pilosa* 2-5, *Lepidosperma angustatum* 2-5, *Melaleuca huegelii* 0-7, moss 0-5,
Constant Species: *Acacia lasiocarpa* 4, *A. rostellifera* 5, *Cassytha flava* 4, *C. racemosa* 5, *Clematis microphylla* 5, *Conostylis candicans* ssp. *calcicola* 4, *Crassula colorata* 4, *Isotoma hypocrateriformis* 4, *Lepidosperma angustatum* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *M. huegelii* 4, moss 4, *Opercularia spermacocea* 4, *Poa poiformis* 4, *Podotheca angustifolia* 4, *Rhagodia baccata* ssp. *baccata* 4, *Rhodanthe citrina* 4, *Santalum acuminatum* 4, *Senecio lautus* 4, *Spyridium globulosum* 5, *Stipa flavescens* 4, *Trachymene pilosa* 5, **Vulpia myuros* 4

Landform: BS, BSW, BBS, BL **Age:** M **Sectors:** V2, V3

Group: 77 (7 relevés)

Structure: Low Scrub B, (Dwarf Scrub C), Low Heath D, Very Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 6-7, *Lepidosperma angustatum* 0-6, *Loxocarya flexuosa* 3-5, moss 3-5, *Melaleuca huegelii* 0-7,
Constant Species: *Acacia lasiocarpa* 4, *Cassytha flava* 4, *C. racemosa* 4, *Danthonia caespitosa* 4, *Isotoma hypocrateriformis* 5, *Lepidosperma angustatum* 4, *Leucopogon insularis* 4, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *M. huegelii* 4, *Mitrasacme paradoxa* 4, moss 4, *Podolepis canescens* 5, *Podotheca angustifolia* 4, *Santalum acuminatum* 4, *Senecio lautus* 4, *Spyridium globulosum* 4, *Stipa flavescens* 5, *Trachymene pilosa* 5

Appendix 14 (Continued)

Landform: BL (BBS, BBL, BLS) **Age:** M **Sector:** V2

Group: 78 (8 relevés)

Structure: Open Low Scrub B, Low Heath D, Very Open Herbs, Low Sedges

Dominant Species: *Melaleuca acerosa* 5-7, *Loxocarya flexuosa* 0-5, *Gahnia lanigera* 0-8, *Lepidosperma angustatum* 0-7, *Podolepis canescens* 1-4,
Constant Species: *Acacia lasiocarpa* 5, *A. rostellifera* 5, *Cassytha flava* 4, *C. racemosa* 5, *Crassula colorata* 4, *Danthonia caespitosa* 4, *Gahnia lanigera* 4, *Isotoma hypocrateriformis* 5, *Lepidosperma angustatum* 4, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, moss 4, *Opercularia spermacocea* 5, *Podolepis canescens* 5, *Podotheca angustifolia* 4, *Rhodanthe citrina* 5, *Senecio lautus* 5, *Stipa flavescens* 5, *Trachymene pilosa* 5

Landform: BLS (BL, BBS) **Age:** M **Sector:** V2

Group: 79 (2 relevés)

Structure: Open Low Scrub B, Open Dwarf Scrub C, Low Heath D, Low Sedges

Dominant Species: *Lepidosperma angustatum* 6-7, *Melaleuca acerosa* 5-6, *M. huegelii* 5-6, moss 3-5, *Loxocarya flexuosa* 3-4,
Constant Species: *Acacia lasiocarpa* 4, *A. rostellifera* 5, *Cassytha racemosa* 5, *Crassula colorata* 5, *Lepidosperma angustatum* 5, *Logania vaginalis* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *M. huegelii* 5, moss 5, *Opercularia spermacocea* 5, *Trachymene pilosa* 5

Landform: BBL, TLH **Age:** M **Sector:** V2

Group: 80 (2 relevés)

Structure: (Open Low Scrub A), Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 7, *Loxocarya flexuosa* 3-4, moss 3-4, *Lepidosperma angustatum* 0-7, *Gahnia lanigera* 0-7,
Constant Species: *Acacia rostellifera* 5, *Danthonia caespitosa* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, moss 5, *Olearia dampieri* 4, *Opercularia spermacocea* 5, *Podolepis canescens* 5, *Stipa flavescens* 5

Landform: BS, TLH **Age:** M **Sector:** V2

Super Group: F Southern Older Dunes

This was a diverse group (cf. Appendix 10) essentially from Sector V5. They were mostly dunes (and some Tamala plains) which were relatively old successional stages. The main species they shared in common were *Melaleuca acerosa*, *Loxocarya flexuosa* and *Stipa flavescens* and to a lesser extent *Lomandra maritima*, *Acacia rostellifera*, *Lepidosperma angustatum* and *Acanthocarpus preissii.*

Groups 81 - 85 were mostly in the Seabird to Ledge Point area. The major distinguishing species were *Calothamnus quadrifidus*, *Chamelaucium uncinatum* and *Conostylis pauciflora* ssp. *euryrhipis*. Landform differences contributed to the distinction of individual Groups.

Group: 81 (1 relevé)

Structure: Dwarf Scrub C, Low Heath D, Very Open Herbs, Low Sedges

Dominant Species: *Loxocarya flexuosa* 5, moss 5, *Melaleuca acerosa* 4, *Acacia lasiocarpa* 4, *Chamelaucium uncinatum* 4, *Allocasuarina humilis* 3, *Calothamnus quadrifidus* 3, *Crassula colorata* 3, *Conostylis candicans* ssp. *calcicola* 3, *Diplolaena* sp. (Kalbarri) 3, *Lomandra maritima* 3, *Trachymene pilosa* 3

Landform: THS **Age:** M **Sector:** V3

Group: 82 (1 relevé)

Structure: Open Low Scrub B, Dwarf Scrub C, Low Heath D, Open Herbs, Low Sedges

Dominant Species: *Dryandra sessilis* 5, *Melaleuca acerosa* 5, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Brachycome iberidifolia* 3, *Calothamnus quadrifidus* 3, *Conostylis pauciflora* ssp. *euryrhipis* 3, *Dryandra nivea* 3, moss 3, *Podotheca angustifolia* 3, *Rhodanthe citrina* 3

Landform: TSH **Age:** O **Sector:** V5

Appendix 14 (Continued)

Group: 83 (4 relevés)

Structure: Low Scrub B, Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 5-7, *Lomandra maritima* 5-7, *Acacia xanthina* 0-7, *Loxocarya flexuosa* 3-4, *Conostylis pauciflora* ssp. *euryrhipis* 3-4,
Constant Species: *Acacia idiomorpha* 4, *A. pulchella* var. *glaberrima* 5, *A. xanthina* 4, *Brachycome iberidifolia* 5, *Calandrinia corrigioloides* 4, *Calothamnus quadrifidus* 5, *Chamelaucium uncinatum* 4, *Conostylis pauciflora* ssp. *euryrhipis* 5, *Hemiandra pungens* 4, *Hibbertia racemosa* 4, *Lepidosperma angustatum* 4, *Leucopogon insularis* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *Opercularia spermacocea* 5, *Scaevola thesioides* 5, *Schoenus grandiflorus* 4, *Stipa flavescens* 5, **Dischisma arenarium* 4

Landform: DS, DC, TSH **Age:** M **Sector:** V5

Group: 84 (8 relevés)

Structure: (Open Low Scrub B), Dwarf Scrub C, Dwarf Scrub D, Open Herbs, Low Sedges

Dominant Species: *Lomandra maritima* 3-9, *Loxocarya flexuosa* 3-6, *Melaleuca acerosa* 2-5, *Conostylis pauciflora* ssp. *euryrhipis* 3-4, *Calothamnus quadrifidus* 0-5, *Chamelaucium uncinatum* 2-4, *Acacia lasiocarpa* 2-4, *Brachycome iberidifolia* 1-4, *Acacia rostellifera* 0-6,
Constant Species: *Acacia lasiocarpa* 5, *Brachycome iberidifolia* 5, *Calandrinia liniflora* 5, *Calothamnus quadrifidus* 5, *Cassytha racemosa* 4, *Chamelaucium uncinatum* 5, *Conostylis pauciflora* ssp. *euryrhipis* 5, *Daucus glochidiatus* 5, *Lepidosperma angustatum* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *Nemcia reticulata* 4, *Rhagodia baccata* ssp. *baccata* 5, *Senecio lautus* 5, *Spyridium globulosum* 4, *Stipa flavescens* 5, *Trachymene pilosa* 5, **Dischisma arenarium* 5, **Heliophila pusilla* 4

Landform: DS, DC (DT) **Age:** M (O) **Sector:** V5

Group: 85 (2 relevés)

Structure: (Open Low Scrub A), Low Heath D, Open Herbs, Low Sedges

Dominant Species: *Allocasuarina humilis* 6-7, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Conostylis pauciflora* ssp. *euryrhipis* 3-4, *Trachymene pilosa* 3-4,
Constant Species: *Allocasuarina humilis* 5, *Brachycome iberidifolia* 5, *Calandrinia corrigioloides* 5, *Conostylis pauciflora* ssp. *euryrhipis* 5, *Crassula colorata* 5, *Daucus glochidiatus* 5, *Dryandra nivea* 5, *Grevillea thelemanniana* ssp. *preissii* 5, *Hybanthus calycinus* 5, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, *Millotia myosotidifolia* 5, *Poa drummondiana* 5, *Rhagodia baccata* ssp. *baccata* 5, *Schoenus grandiflorus* 5, *Senecio lautus* 5, *Trachymene pilosa* 5, **Heliophila pusilla* 5

Landform: TSH **Age:** M, O **Sector:** V5

Groups 86 - 89 are made up of relevés from mainly older areas on dunes in Sectors V4 and V5. *Acacia rostellifera, Spyridium globulosum, Rhagodia baccata* ssp. *baccata, Acanthocarpus preissii, Daucus glochidiatus* and **Dischisma arenarium* were the most consistently present species. Group 86 had Tuart (*Eucalpytus gomphocephala*) while Groups 87 - 89 had *Melaleuca acerosa* and a few others.

Group: 86 (3 relevés)

Structure: Low Forest B, Low Scrub B, Open Herbs, Open Low Sedges

Dominant Species: *Acacia rostellifera* 4-8, *Eucalpytus gomphocephala* 0-7, *Daucus glochidiatus* 3-6, *Spyridium globulosum* 3-5, *Stipa elegantissima* 3-5,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 4, *Bromus arenarius* 4, *Clematis microphylla* 4, *Comesperma integerrimum* 5, *Daucus glochidiatus* 5, *Dianella revoluta* 4, *Eucalpytus gomphocephala* 4, *Hardenbergia comptoniana* 4, *Helichrysum cordatum* 4, *Hibbertia racemosa* 4, *Isolepis nodosa* 5, *Olearia axillaris* 5, *Rhagodia baccata* ssp. *baccata* 5, *Spyridium globulosum* 5, *Stipa elegantissima* 5, *Trachymene pilosa* 5, **Dischisma arenarium* 4, **Bromus diandrus* 5, **Ehrharta brevifolia* 5, **Sonchus oleraceus* 4, **Vulpia myuros* 4

Landform: DC, DS **Age:** Y, V **Sector:** V4

Group: 87 (2 relevés)

Structure: Heath A, Dwarf Scrub C, Open Herbs, Open Low Sedges

Dominant Species: *Acacia rostellifera* 7-8, *Clematis microphylla* 5, *Spyridium globulosum* 4-5, *Rhagodia baccata* ssp. *baccata* 3-5,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 5, *Calandrinia corrigioloides* 5, *Clematis microphylla* 5, *Daucus glochidiatus* 5, *Rhagodia baccata* ssp. *baccata* 5, *Spyridium globulosum* 5, **Erodium cicutarium* 5

Landform: DT **Age:** M **Sectors:** V4, V5

Appendix 14 (Continued)

Group: 88 (5 relevés)

Structure: (Heath A), Dwarf Scrub C, Dwarf Scrub D, Herbs, Open Low Sedges

Dominant Species: *Acacia rostellifera* 2-7, *Daucus glochidiatus* 3-7, *Acanthocarpus preissii* 2-7, *Melaleuca acerosa* 3-5, *Trachymene pilosa* 3-5, *Lomandra maritima* 0-6, *Rhagodia baccata* ssp. *baccata* 3-4, *Hardenbergia comptoniana* 3-4,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 5, *Calandrinia liniflora* 4, *Chamelaucium uncinatum* 4, *Clematis microphylla* 4, *Conostylis pauciflora* ssp. *euryrhipis* 4, *Daucus glochidiatus* 5, *Hardenbergia comptoniana* 5, *Hydrocotyle callicarpa* 4, *Lomandra maritima* 4, *Melaleuca acerosa* 5, *Parietaria debilis* 4, *Rhagodia baccata* ssp. *baccata* 5, *Senecio lautus* 4, *Spyridium globulosum* 4, *Stipa flavescens* 4, *Trachymene pilosa* 5, **Dischisma arenarium* 5

Landform: DS, DT, DC, TSH **Age:** M (Y) **Sector:** V5

Group: 89 (1 relevé)

Structure: Low Scrub A, Dwarf Scrub C, Herbs

Dominant Species: *Spyridium globulosum* 7, *Rhagodia baccata* ssp. *baccata* 5, *Calandrinia corrigioloides* 5, *Dryandra sessilis* 4, *Calothamnus quadrifidus* 4, *Acacia rostellifera* 3, *Grevillea thelemanniana* ssp. *preissii* 3, *Hardenbergia comptoniana* 3, *Melaleuca acerosa* 3, *Parietaria debilis* 3, *Santalum acuminatum* 3, *Trachymene pilosa* 3

Landform: THS **Age:** M **Sector:** V5

Groups 90 - 91 were relevés on old sites and included all those dominated by *Melaleuca cardiophylla* in Sector V5. Most of these were in coastal areas on Tamala limestone bluffs exposed to the sea spray. *Melaleuca huegelii* was usually present. Other consistently present species were *Thomasia cognata* plus ones which were common on the coast (*Olearia axillaris, Hardenbergia comptoniana, Rhagodia baccata* ssp. *baccata* and *Templetonia retusa*.

Group: 90 (2 relevés)

Structure: Dense Heath A, Open Herbs

Dominant Species: *Melaleuca cardiophylla* 9, *Daucus glochidiatus* 3-6,
Constant Species: *Clematis microphylla* 5, *Daucus glochidiatus* 5, *Melaleuca cardiophylla* 5, *Phyllanthus calycinus* 5, *Scaevola nitida* 5

Landform: TLS, TLH **Age:** Y, O **Sectors:** V4, V5

Group: 91 (6 relevés)

Structure: (Dwarf Scrub C), Low Heath D, Very Open Herbs

Dominant Species: *Melaleuca cardiophylla* 0-9, *M. huegelii* 0-8, moss 3-5, *Olearia axillaris* 0-4,
Constant Species: *Cassytha racemosa* 4, *Crassula colorata* 4, *Hardenbergia comptoniana* 5, *Leucopogon parviflorus* 5, *Melaleuca cardiophylla* 5, *M. huegelii* 5, moss 5, *Olearia axillaris* 5, *Rhagodia baccata* ssp. *baccata* 5, *Stipa flavescens* 4, *Templetonia retusa* 4, *Thomasia cognata* 4, **Anagallis arvensis* 4

Landform: TL (TLH) **Age:** O **Sector:** V5

Groups 92 - 96 were again a heterogeneous group of Groups almost entirely from Sector V5. They were generally dominated by *Acacia rostellifera* with *Melaleuca acerosa, Acanthocarpus preissii, Loxocarya flexuosa, Stipa flavescens, Lepidosperma angustatum, *Pelargonium capitatum, *Heliophila pusilla* and *Lomandra maritima*. The abundance of *Acacia rostellifera* and the virtual absence of *Calothamnus quadrifidus* and *Chamelaucium uncinatum* distinguishes these from Groups 81 - 84.

Group: 92 (3 relevés)

Structure: Low Scrub A, Dwarf Scrub D, Low Sedges

Dominant Species: *Acacia rostellifera* 2-9, *Acanthocarpus preissii* 3-7, *Melaleuca acerosa* 0-6, *Loxocarya flexuosa* 3-4, *Lepidosperma angustatum* 2-5,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 5, *Hardenbergia comptoniana* 4, *Hibbertia racemosa* 5, *Lepidosperma angustatum* 5, *Leucopogon parviflorus* 4, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 4, moss 4, *Podolepis gracilis* 4, *Stipa flavescens* 5, **Anagallis arvensis* 4

Landform: DS, THL **Age:** M **Sectors:** V5, V4

Appendix 14 (Continued)

Group: 93 (6 relevés)

Structure: (Low Scrub A), Dwarf Scrub C, Low Heath D, Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 4-8, *Acanthocarpus preissii* 3-4, moss 0-6, *Hemiandra pungens* 1-5,
Constant Species: *Acacia lasiocarpa* 5, *Acanthocarpus preissii* 5, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *candicans* 5, *Gompholobium tomentosum* 4, *Hemiandra pungens* 5, *Hibbertia racemosa* 5, *Lepidosperma angustatum* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, moss 4, *Olearia axillaris* 4, *Schoenus grandiflorus* 4, *Stipa flavescens* 5, *Templetonia retusa* 4, **Anagallis arvensis* 5, **Ehrharta brevifolia* 4, **Heliophila pusilla* 4, **Laguris ovatus* 5, **Lolium rigidum* 4, **Pelargonium capitatum* 4, **Petrorhagia velutina* 5

Landform: DS (DC) **Age:** Y (M) **Sector:** V5

Group: 95 (5 relevés)

Structure: (Low Scrub B), Dwarf Scrub C, Low Heath D, Very Open Herbs, Low Sedges

Dominant Species: *Lomandra maritima* 4-6, *Melaleuca acerosa* 3-5, *Acacia rostellifera* 0-7, *Hemiandra pungens* 0-5, *Conostylis pauciflora* ssp. *euryrhipis* 2-4,
Constant Species: *Acacia lasiocarpa* 4, *A. rostellifera* 4, *Acanthocarpus preissii* 4, *Conostylis pauciflora* ssp. *euryrhipis* 5, *Dischisma arenarium* 5, *Gompholobium tomentosum* 4, *Helichrysum cordatum* 5, *Hemiandra pungens* 4, *Lepidosperma angustatum* 4, *Leucopogon parviflorus* 4, *Lomandra maritima* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Nemcia reticulata* 4, *Olearia axillaris* 4, *Phyllanthus calycinus* 4, *Poa poiformis* 4, *Scaevola thesioides* 4, *Spyridium globulosum* 4, *Stipa flavescens* 5, *Thysanotus arenarius* 4, *Trachymene pilosa* 4, **Crassula glomerata* 4, **Heliophila pusilla* 4, **Pelargonium capitatum* 4

Landform: DS, DC **Age:** Y, M **Sector:** V5

Group: 94 (4 relevés)

Structure: Low Scrub A, Low Heath D, Open Herbs, Low Sedges

Dominant Species: *Melaleuca acerosa* 6-7, *Lomandra maritima* 6-7, *Acacia rostellifera* 2-7, *Acanthocarpus preissii* 3-4, *Loxocarya flexuosa* 3-4,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 5, *Conostylis pauciflora* ssp. *euryrhipis* 4, *Daucus glochidiatus* 5, *Lomandra maritima* 5, *Loxocarya flexuosa* 5, *Melaleuca acerosa* 5, moss 4, *Olax benthamiana* 4, *Phyllanthus calycinus* 5, *Poa poiformis* 4, *Spyridium globulosum* 4, *Trachymene pilosa* 4, **Anagallis arvensis* 5, **Bromus diandrus* 5, **Catapodium rigidum* 4, **Dischisma arenarium* 4, **Heliophila pusilla* 4, **Pelargonium capitatum* 4

Landform: DC (DT) **Age:** M (O) **Sector:** V5

Group: 96 (2 relevés)

Structure: Low Scrub B, Dwarf Scrub D, Open Low Sedges

Dominant Species: *Acacia rostellifera* 7-8, *Melaleuca acerosa* 2-3,
Constant Species: *Acacia rostellifera* 5, *Anthocercis littorea* 5, *Melaleuca acerosa* 5, *Schoenus grandiflorus* 5

Landform: DS **Age:** M **Sector:** V5

Super Group: G Miscellaneous

This is a number of Groups with little in common with most other Groups. Their inclusion together here should not be inferred as an indication that they have much in common with each other.

Groups 97 - 98 were coastal relevés in Sectors V2, V3 and V4 which had *Melaleuca cardiophylla* growing on Tamala limestone sometimes with *Thryptomene baeckeacea*. *Dodonaea aptera* and *Loxocarya flexuosa* were almost always present.

Group: 97 (2 relevés)

Structure: Low Heath C, Open Low Sedges

Dominant Species: *Thryptomene baeckeacea* 7-8, moss 4-5, *Melaleuca cardiophylla* 3-5,
Constant Species: *Acacia rostellifera* 5, *A. xanthina*, *Cryptandra mutila*, *Danthonia caespitosa*, *Dodonaea aptera* 5, *Leucopogon insularis* 5, *Loxocarya flexuosa* 5, *Melaleuca cardiophylla* 5, moss 5, *Templetonia retusa* 5, *Thryptomene baeckeacea* 5

Landform: TLH **Age:** M, O **Sectors:** V2, V3

Appendix 14 (Continued)

Group: 98 (6 relevés)

Structure: (Heath B), Low Heath D, Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca cardiophylla* 0-8, moss 0-7, *Loxocarya flexuosa* 0-7, *Dodonaea aptera* 0-6, *Melaleuca acerosa* 0-5,
Constant Species: *Dodonaea aptera* 4, *Isotoma hypocrateriformis* 5, *Leptorhynchos scabrus* 4, *Leucopogon insularis* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 4, *M. cardiophylla* 4, moss 4, *Rhodanthe citrina* 4, *Stipa flavescens* 4, *Trachymene pilosa* 4, **Heliophila pusilla* 4

Landform: TLH (BBS) **Age:** M **Sectors:** V4 (V2, V3)

Groups 99 - 104 were all very different from each other. Group 99 was on Tamala limestone near the salt lake Lake Leeman. Group 100 was dominated by *Callitris preissii* on calcareous sand over Tamala yellow sand at Trigg. Group 101 was relevés near Leeman where calcareous sand had covered lagoonal deposits. Group 102 was a relevé perched on the edge of a cliff Tamala limestone onto which salt water was occasionally splashed. This was typical of this situation throughout the Central Coast. Group 103 was a sedgeland typical of those which form just east of a foredune in a plain evacuated by a mobile sandmass. These were observed from Sector V2 to Sector V4. Group 104 was a plain of Tamala yellow sand at the Pinnacles almost bare of vegetation, the earliest phase of succession.

Group: 99 (1 relevé)

Structure: Heath B, Herbs

Dominant Species: *Melaleuca cardiophylla* 8, moss 7, **Ehrharta brevifolia* 5, *Rhodanthe oppositifolium* 4, *Beyeria viscosa* 4, *Grevillea olivacea* 3

Landform: TLH **Age:** M **Sector:** V3

Group: 100 (2 relevés)

Structure: (Low Forest B), (Thicket), Dwarf Scrub D

Dominant Species: *Callitris preissii* 7-8, *Spyridium globulosum* 3,
Constant Species: *Callitris preissii* 5, *Santalum acuminatum* 5, *Spyridium globulosum* 5, **Cerastium glomeratum* 5, **Crassula glomerata* 5, **Dischisma arenarium* 5, **Laguris ovatus* 5

Landform: TS **Age:** Y **Sector:** V5

Group: 101 (3 relevés)

Structure: Heath B, Dwarf Scrub C, Open Low Sedges

Dominant Species: *Melaleuca cardiophylla* 4-9, moss 5-6, *Melaleuca huegelii* 0-6, *M. brevifolia* 0-6, *Gahnia trifida* 0-5,
Constant Species: *Angianthus* sp. aff. *milnei* 4, *Comesperma integerrimum* 5, *Crassula colorata* 4, *Enchylaena tomentosa* 4, *Gahnia trifida* 4, *Isotoma hypocrateriformis* 4, *Melaleuca brevifolia* 4, *M. cardiophylla* 5, *M. huegelii* 4, moss 5, *Samolus repens* 5, *Stipa flavescens* 4, *Trachymene pilosa* 5, **Dischisma arenarium* 4, **Vulpia myuros* 4

Landform: BSW, BS **Age:** M **Sector:** V3

Group: 102 (1 relevé)

Structure: Low Heath D

Dominant Species: *Frankenia pauciflora* 6, *Wilsonia backhousei* 6, *Samolus repens* 4, *Sarcocornia quinqueflora* 4, *Carpobrotus virescens* 3, *Enchylaena tomentosa* 3

Landform: TLW **Age:** Y **Sector:** V4

Group: 103 (1 relevé)

Structure: Dense Tall Sedges

Dominant Species: *Schoenus nitens* 8, *Baumea juncea* 5, **Juncus acutus* 4, *Samolus repens* 3

Landform: BD **Age:** V **Sector:** V4

Group: 104 (1 relevé)

Structure: Open Dwarf Scrub D

Dominant Species: *Dryandra sessilis* 3

Landform: TS **Age:** B **Sector:** V4

Appendix 14 (Continued)

Super Group: H Northern Younger Dunes

These were mostly dunes of young to moderate ages from Sectors V1 and V2. *Acacia rostellifera* was present in most and sometimes dominating. Other consistently occurring species were *Zygophyllum fruticulosum, Acanthocarpus preissii, Senecio lautus, Calandrinia corrigioloides* and *Trachymene pilosa.*

Groups 105 - 109 had in addition *Parietaria debilis*. Some were quite close to the coast. Two Groups were dominated by *Melaleuca cardiophylla, M. huegelii.*

Group: 105 (1 relevé)

Structure: Open Dwarf Scrub C, Low Heath D, Very Open Herbs

Dominant Species: *Thryptomene hyporhytis* 8, *Crassula colorata* 4, **Parentucellia latifolia* 4, *Acacia rostellifera* 3, *Calandrinia corrigioloides* 3, *Cassytha racemosa* 3, *Senecio lautus* 3, *Zygophyllum fruticulosum* 3

Landform: DC **Age:** M **Sector:** V1

Group: 106 (2 relevés)

Structure: Open Low Scrub B, Dwarf Scrub C, Low Heath D, Open Low Sedges

Dominant Species: *Acanthocarpus preissii* 4-7, *Senecio lautus* 5-6, *Acacia rostellifera* 3-4, *Rhagodia baccata* ssp. *baccata* 2-5, *Olearia axillaris* 3-4,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 5, *Enchylaena tomentosa* 5, *Melaleuca acerosa* 5, *Nicotinia occidentalis* ssp. *hesperis* 5, *Olearia axillaris* 5, *Parietaria debilis* 5, *Phyllanthus calycinus* 5, *Pittosporum phylliraeoides* 5, *Rhagodia baccata* ssp. *baccata* 5, *Senecio lautus* 5, **Sonchus oleraceus* 5

Landform: DC, DT **Age:** Y, M **Sector:** V1

Group: 107 (3 relevés)

Structure: (Dense Low Forest B), Open Low Scrub B, Dwarf Scrub C, Open Herbs

Dominant Species: *Acacia rostellifera* 0-7, *Parietaria debilis* 4, *Rhagodia baccata* ssp. *baccata* 2-5, *Enchylaena tomentosa* 2-4, *Zygophyllum fruticulosum* 2-4, *Melaleuca lanceolata* 0-9,
Constant Species: *Acacia rostellifera* 4, *Acanthocarpus preissii* 4, *Calandrinia corrigioloides* 4, *Carpobrotus virescens* 5, *Enchylaena tomentosa* 5, *Parietaria debilis* 5, *Rhagodia baccata* ssp. *baccata* 5, *Senecio lautus* 5, *Zygophyllum fruticulosum* 5, **Ehrharta brevifolia* 4

Landform: DBC, BSW, WS **Age:** Y **Sectors:** V1, V2

Group: 108 (6 relevés)

Structure: (Dense Low Forest B), Heath B, Dwarf Scrub C, Herbs, (Very Open Low Sedges)

Dominant Species: *Melaleuca cardiophylla* 0-9, *M. huegelii* 0-9, *Acacia rostellifera* 0-8, *Parietaria debilis* 3-8, *Trachymene pilosa* 3-5, *Zygophyllum fruticulosum* 2-5,
Constant Species: *Acacia rostellifera* 4, *Acanthocarpus preissii* 5, *Calandrinia corrigioloides* 4, *Crassula colorata* 4, *Melaleuca cardiophylla* 4, *M. huegelii* 4, *Parietaria debilis* 5, *Rhagodia baccata* ssp. *baccata* 4, *Senecio lautus* 4, *Trachymene pilosa* 5, *Zygophyllum fruticulosum* 5

Landform: DC, DT (DS) **Age:** Y (M) **Sectors:** V1, V2

Group: 109 (4 relevés)

Structure: (Low Woodland B), (Dense Thicket), (Open Low Scrub B), Open Dwarf Scrub C, Herbs

Dominant Species: *Melaleuca huegelii* 0-9, *Acacia rostellifera* 3-6, *Parietaria debilis* 3-4, *Trachymene pilosa* 1-7,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 4, *Clematis microphylla* 4, *Comesperma integerrimum* 4, *Enchylaena tomentosa* 5, *Melaleuca huegelii* 4, *Parietaria debilis* 5, *Rhagodia baccata* ssp. *baccata* 5, *Senecio lautus* 5, *Spyridium globulosum* 4, *Thysanotus patersonii* 4, *Trachymene pilosa* 5, *Zygophyllum fruticulosum* 4

Landform: DC, BS, TS **Age:** M, V, Y **Sectors:** V1, V5

Appendix 14 (Continued)

Groups 110 - 112 were a little further south though overlapping with Groups 105 - 109. *Podotheca angustifolia* and *Conostylis candicans* ssp. *calcicola* appears to be present instead of *Parietaria debilis*. They were on the Holocene plain between Denison and Cliff Head in Sector V2, mostly on dunes perched on it.

Group: 110 (3 relevés)

Structure: Low Scrub B, Dwarf Scrub D, Open Herbs

Dominant Species: *Allocasuarina lehmanniana* 2-6, *Conostylis candicans* ssp. *calcicola* 2-3, *Hemiandra pungens* 2-3,
Constant Species: *Acacia lasiocarpa* 4, *Allocasuarina lehmanniana* 5, *Calocephalus brownii* 4, *Comesperma integerrimum* 4, *Conostylis candicans* ssp. *calcicola* 5, *Crassula colorata* 4, *Hemiandra pungens* 5, *Leucopogon insularis* 4, *Podotheca angustifolia* 5, *Rhodanthe citrina* 4, *Scaevola crassifolia* 4, *Senecio lautus* 5, *Trachymene pilosa* 4, *Triglochin calcitrapa* 4

Landform: BLS, BS **Age:** V, Y **Sector:** V2

Group: 111 (6 relevés)

Structure: Low Scrub A, Dwarf Scrub C, (Dwarf Scrub D), Open Herbs, Open Low Sedges

Dominant Species: *Acacia rostellifera* 3-7, *Podotheca angustifolia* 1-5, *Trachymene pilosa* 3-5, *Melaleuca acerosa* 0-6, *Acanthocarpus preissii* 0-5, *Spyridium globulosum* 2-4, *Scaevola crassifolia* 0-5, *Conostylis candicans* ssp. *calcicola* 0-5,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 4, *Calandrinia corrigioloides* 4, *Conostylis candicans* ssp. *calcicola* 4, *Enchylaena tomentosa* 4, *Melaleuca acerosa* 4, *Podotheca angustifolia* 4, *Rhagodia baccata* ssp. *baccata* 4, *Senecio lautus* 5, *Spyridium globulosum* 4, *Stipa flavescens* 4, *Trachymene pilosa* 5, *Triglochin calcitrapa* 4, *Zygophyllum fruticulosum* 4, **Dischisma arenarium* 4

Landform: DS (DC, DBC, BS) **Age:** Y (M) **Sector:** V2

Group: 112 (2 relevés)

Structure: Dwarf Scrub D, Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 2-7, *Acanthocarpus preissii* 5, *Acacia rostellifera* 2-4, *Conostylis candicans* ssp. *calcicola* 3-4,
Constant Species: *Acacia rostellifera* 5, *Acanthocarpus preissii* 5, *Conostylis candicans* ssp. *calcicola* 5, *Melaleuca acerosa* 5, *Nemcia reticulata* 5, *Podotheca angustifolia* 5, *Scaevola crassifolia* 5, *Trachymene pilosa* 5, *Triglochin calcitrapa* 5

Landform: DC **Age:** Y, M **Sector:** V2

Super Group: I *Melaleuca cardiophylla* and *Eucalyptus obtusiflora* variants

This was mostly relevés which were in dense vegetation dominated by *Melaleuca cardiophylla* and *M. huegelii*. There were few other species present consistently except *Acacia rostellifera Trachymene pilosa* and *Rhagodia baccata* ssp. *baccata*. This low richness is why the three relatively different Groups have been clustered together. Group 113 was dominated by the above species on Holocene dunes south east of Denison. Group 114 was dominated by the Mallee *Eucalyptus obtusiflora* with significant contributions from the melaleucas. This was growing on the loamy soil over the local variant of Tamala limestone in the Cliff Head area. Group 115 was a single relevé dominated by *Melaleuca lanceolata* in the North Head area.

Group: 113 (2 relevés)

Structure: Dense Heath A, (Very Open Herbs)

Dominant Species: *Melaleuca cardiophylla* 8-9, *M. huegelii* 4-7, *Acacia rostellifera* 3-4, *Trachymene pilosa* 3,
Constant Species: *Acacia rostellifera* 5, *Leucopogon parviflorus* 4, *Melaleuca cardiophylla* 5, *M. huegelii* 5, *Rhagodia baccata* ssp. *baccata* 5, *Trachymene pilosa* 5

Landform: DT **Age:** Y, M **Sector:** V2

Group: 114 (3 relevés)

Structure: Open Shrub Mallee, Open Low Scrub A

Dominant Species: *Eucalyptus obtusiflora* 4-8, *Melaleuca huegelii* 3-7, *M. cardiophylla* 0-7, *Dodonaea aptera* 0-5, *Acacia rostellifera* 0-4,
Constant Species: *Acacia rostellifera* 4, *Cassytha racemosa* 4, *Comesperma integerrimum* 5, *Dodonaea aptera* 4, *Eucalyptus obtusiflora* 5, *Lasiopetalum oppositifolium* 4, *Melaleuca cardiophylla* 4, *M. huegelii* 5, *M. lanceolata* 4, *Senecio lautus* 4, *Waitzia suaveolens* 4

Landform: TIS **Age:** O **Sector:** V2

Appendix 14 (Continued)

Group: 115 (1 relevé)

Structure: Dense Low Forest B

Dominant Species: *Melaleuca lanceolata* 9, moss 8

Landform: BSW **Age:** Y **Sector:** V3

Super Group: J Northern Plains

These were mostly Holocene plains of varying ages from Sectors V2 and V3. The most common species were *Melaleuca acerosa*, *M. huegelii*, *Allocasuarina lehmanniana*, *Acacia lasiocarpa*, *Cassytha racemosa* and *Trachymene pilosa*. *Acacia rostellifera* was present in many of these.

Groups 116 - 119 were the comparatively older relevés. *Melaleuca acerosa* and *M. huegelii* with in some *M. cardiophylla* dominated. *Allocasuarina lehmanniana* was relatively low abundance. Few other species were consistently present.

Group: 116 (5 relevés)

Structure: Open Low Scrub B, Low Heath D, Very Open Herbs, Low Sedges

Dominant Species: *Melaleuca huegelii* 3-7, *Lepidosperma angustatum* 4-6, *Melaleuca acerosa* 3-6, *Acacia lasiocarpa* 3-4, *Allocasuarina lehmanniana* 3-4,
Constant Species: *Acacia lasiocarpa* 5, *Allocasuarina lehmanniana* 5, *Cassytha racemosa* 5, *Crassula colorata* 4, *Gompholobium tomentosum* 4, *Lepidosperma angustatum* 5, *Leucopogon insularis* 4, *Melaleuca acerosa* 5, *M. huegelii* 5, moss 4, *Nemcia reticulata* 4, *Podotheca angustifolia* 5, *Rhodanthe citrina* 4, *Santalum acuminatum* 4, *Spyridium globulosum* 4, *Stipa flavescens* 5, *Trachymene pilosa* 5

Landform: BLS (BL, BBS) **Age:** M (Y) **Sectors:** V2 (V3)

Group: 117 (3 relevés)

Structure: Open Dwarf Scrub C, Low Heath D, Open Herbs

Dominant Species: *Melaleuca acerosa* 3-5, *M. huegelii* 3-6, *M. cardiophylla* 3, *Acacia lasiocarpa* 1-4, *Allocasuarina lehmanniana* 3-4,
Constant Species: *Acacia lasiocarpa* 5, *Allocasuarina lehmanniana* 5, *Amphipogon debilis* 4, *Cassytha racemosa* 5, *Hydrocotyle callicarpa* 4, *Isotoma hypocrateriformis* 4, *Leucopogon insularis* 4, *Melaleuca acerosa* 5, *M. cardiophylla* 5, *M. huegelii* 5, *Nemcia reticulata* 5, *Podotheca angustifolia* 5, *Rhodanthe citrina* 5, *Trachymene pilosa* 5, **Parentucellia latifolia* 4

Landform: BL, BS **Age:** Y **Sector:** V2

Group: 118 (5 relevés)

Structure: Thicket, Heath B, Open Herbs

Dominant Species: *Melaleuca huegelii* 5-8, *M. cardiophylla* 0-8, *Acacia rostellifera* 0-4, *Trachymene pilosa* 2-4,
Constant Species: *Acacia rostellifera* 4, *Acanthocarpus preissii* 4, *Calandrinia corrigioloides* 4, *Cassytha racemosa* 4, *Crassula colorata* 4, *Melaleuca acerosa* 4, *M. cardiophylla* 4, *M. huegelii* 5, moss 4, *Phyllanthus calycinus* 4, *Podotheca angustifolia* 4, *Senecio lautus* 5, *Thysanotus patersonii* 4, *Trachymene pilosa* 5, *Triglochin calcitrapa* 4

Landform: BS, DS, DT **Age:** M (Y) **Sector:** V2

Group: 119 (4 relevés)

Structure: (Low Forest B), (Dense Heath B), Dwarf Scrub C, (Dwarf Scrub D)

Dominant Species: *Melaleuca huegelii* 7-8, *M. cardiophylla* 0-8, moss 4-5, *M. acerosa* 2-7, *Hibbertia racemosa* 1-4,
Constant Species: *Acacia rostellifera* 4, *Allocasuarina lehmanniana* 4, *Cassytha racemosa* 5, *Hibbertia racemosa* 5, *Leucopogon parviflorus* 5, *Melaleuca acerosa* 5, *M. cardiophylla* 4, *M. huegelii* 5, moss 5, *Spyridium globulosum* 4, *Trachymene pilosa* 5

Landform: BS, TLH, TIH **Age:** Y, V, M **Sector:** V2

Appendix 14 (Continued)

Groups 120 - 124 were younger successional stages. They were predominantly from Sector V2 with some from V3 and V4. *Allocasuarina lehmanniana* dominated and *Melaleuca huegelii* was less important than the Groups above. Other species typical of younger successional stages were *Spyridium globulosum Leucopogon insularis, L. parviflorus* and *Acrotriche cordata*. Age and regional factors appear to contribute to the differences between Groups.

Group: 120 (6 relevés)

Structure: Low Scrub B, Dwarf Scrub D, Open Low Sedges

Dominant Species: *Allocasuarina lehmanniana* 2-8, *Melaleuca acerosa* 2-5, *M. huegelii* 0-7, *Hibbertia racemosa* 0-6, *Loxocarya flexuosa* 0-5,
Constant Species: *Acacia lasiocarpa* 4, *Acrotriche cordata* 4, *Allocasuarina lehmanniana* 5, *Danthonia caespitosa* 5, *Hibbertia racemosa* 4, *Isotoma hypocrateriformis* 5, *Leucopogon insularis* 5, *L. parviflorus* 5, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *M. huegelii* 4, *Nemcia reticulata* 4, *Trachymene pilosa* 5

Landform: TLH (TLS, BL, BBL) **Age:** V, Y **Sector:** V2

Group: 121 (4 relevés)

Structure: Dwarf Scrub C, Low Heath D

Dominant Species: *Allocasuarina lehmanniana* 4, *Melaleuca acerosa* 2-6, *Acacia lasiocarpa* 3-5,
Constant Species: *Acacia lasiocarpa* 5, *Acrotriche cordata* 5, *Allocasuarina lehmanniana* 5, *Cassytha flava* 5, *Danthonia caespitosa* 4, *Gompholobium tomentosum* 4, *Hemiandra pungens* 4, *Isotoma hypocrateriformis* 5, *Leptomeria preissiana* 4, *Leucopogon parviflorus* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *Nemcia reticulata* 5, *Olearia axillaris* 4, *Santalum acuminatum* 4, *Spyridium globulosum* 4, *Stipa flavescens* 4, *Trachymene pilosa* 4

Landform: BL, BBL **Age:** Y (V) **Sector:** V2

Group: 122 (2 relevés)

Structure: Low Scrub A, Dwarf Scrub C, Open Herbs

Dominant Species: *Acacia rostellifera* 3-5, *Allocasuarina lehmanniana* 2-7, *Spyridium globulosum* 4-6, *Calandrinia corrigioloides* 2-6, *Trachymene pilosa* 3-4,
Constant Species: *Acacia rostellifera* 5, *Allocasuarina lehmanniana* 5, *Calandrinia corrigioloides* 5, *Cassytha aurea* forma *hirta* 4, *Danthonia caespitosa* 5, *Hardenbergia comptoniana* 5, *Hibbertia racemosa* 5, *Leptomeria preissiana* 5, *Rhagodia baccata baccata* 5, *Spyridium globulosum* 5, *Stipa flavescens* 5, *Trachymene pilosa* 5, **Dischisma arenarium* 5

Landform: TSH **Age:** V **Sector:** V4

Group: 123 (2 relevés)

Structure: Dwarf Scrub C, Low Heath D, Low Sedges

Dominant Species: *Melaleuca huegelii* 6-7, *M. acerosa* 5, *Allocasuarina lehmanniana* 3-5, *Schoenus pleistemoneus* 4-6, moss 3-4, **Vulpia myuros* 3-4,
Constant Species: *Acacia lasiocarpa* 5, *Allocasuarina lehmanniana* 5, *Baumea juncea* 5, *Cassytha flava* 5, *Leptocarpus aristatus* 5, *Melaleuca acerosa* 5, *M. huegelii* 5, moss 5, *Santalum acuminatum* 5, *Schoenus pleistemoneus* 5

Landform: BL, BLS **Age:** Y **Sector:** V3

Group: 124 (3 relevés)

Structure: Open Low Scrub A, Heath B, Low Heath C, Open Low Sedges

Dominant Species: *Melaleuca huegelii* 5-7, *M. acerosa* 3-7, *Lepidosperma angustatum* 0-6, moss 0-6, *Templetonia retusa* 0-5, *Dodonaea aptera* 0-5,
Constant Species: *Acacia lasiocarpa* 4, *Acrotriche cordata* 4, *Calandrinia corrigioloides* 4, *Cassytha racemosa* 5, *Dodonaea aptera* 4, *Gahnia trifida* 5, *Lepidosperma angustatum* 4, *Leucopogon insularis* 4, *L. parviflorus* 4, *Lobelia heterophylla* 4, *Loxocarya flexuosa* 4, *Melaleuca acerosa* 5, *M. cardiophylla* 4, *M. huegelii* 5, moss 4, *Santalum acuminatum* 4, *Spyridium globulosum* 5, *Templetonia retusa* 4, *Thomasia cognata* 4, *Trachymene pilosa* 4

Landform: BL, BLS, THS **Age:** M **Sectors:** V4, V3

Appendix 14 (Continued)

Super Group: K Younger Dunes

These were mostly from Sector V4 and were dunes of young to moderate age. Important species were *Melaleuca acerosa, Acacia rostellifera, Acanthocarpus preissii, Poa poiformis* and in some *Melaleuca cardiophylla.*

Groups 125 - 131 were much as described above with the addition of *Conostylis candicans* ssp. *calcicola, Trachymene pilosa, Cassytha racemosa* and in some *Spyridium globulosum* and *Clematis microphylla.*

Group: 125 (6 relevés)

Structure: Low Scrub B, Low Heath C, Dwarf Scrub D, Very Open Herbs, Open Low Sedges

Dominant Species: *Acacia rostellifera* 0-9, *Melaleuca acerosa* 2-7, *Spyridium globulosum* 2-8, *Acacia lasiocarpa* 0-5, *Clematis microphylla* 3-4,
Constant Species: *Acacia lasiocarpa* 4, *A. rostellifera* 4, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 4, *Clematis microphylla* 5, *Melaleuca acerosa* 5, *Phyllanthus calycinus* 4, *Poa poiformis* 4, *Spyridium globulosum* 5, *Stipa flavescens* 4, *Trachymene pilosa* 5

Landform: DS, DT, DC, BS **Age:** M **Sectors:** V4 (V3)

Group: 126 (4 relevés)

Structure: Heath A, (Dwarf Scrub D), Open Low Sedges

Dominant Species: *Acacia rostellifera* 0-9, *Acanthocarpus preissii* 2-8, *Conostylis candicans* ssp. *calcicola* 3-5, *Spyridium globulosum* 2-5,
Constant Species: *Acacia lasiocarpa* 5, *A. rostellifera* 4, *Acanthocarpus preissii* 5, *Cassytha racemosa* 4, *Conostylis candicans* ssp. *calcicola* 5, *Hardenbergia comptoniana* 4, *Hemiandra pungens* 4, *Hibbertia racemosa* 4, *Leucopogon parviflorus* 5, *Melaleuca acerosa* 4, *Poa poiformis* 5, *Rhagodia baccata baccata* 5, *Spyridium globulosum* 5, *Trachymene pilosa* 4

Landform: DS, BS **Age:** Y, M **Sector:** V4

Group: 127 (6 relevés)

Structure: Low Scrub B, Low Heath C, Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca acerosa* 3-7, *Acanthocarpus preissii* 3-5, *Acacia lasiocarpa* 2-4, *Trachymene pilosa* 2-4, *Melaleuca cardiophylla* 0-9,
Constant Species: *Acacia lasiocarpa* 5, *Acanthocarpus preissii* 5, *Allocasuarina lehmanniana* 4, *Cassytha racemosa* 5, *Clematis microphylla* 5, *Conostylis candicans* ssp. *calcicola* 5, *Daucus glochidiatus* 4, *Leucopogon parviflorus* 4, *Melaleuca acerosa* 5, *Opercularia vaginata* 4, *Podotheca angustifolia* 4, *Rhagodia baccata baccata* 4, *Rhodanthe citrina* 5, *Senecio lautus* 4, *Spyridium globulosum* 4, *Stipa flavescens* 4, *Trachymene pilosa* 5

Landform: DC (DT, THL) **Age:** Y **Sector:** V4

Group: 128 (3 relevés)

Structure: Dwarf Scrub C, Low Heath D, Low Sedges

Dominant Species: *Melaleuca acerosa* 3-7, *Poa poiformis* 3-5, *Melaleuca huegelii* 0-4, *Acacia lasiocarpa* 2-4,
Constant Species: *Acacia lasiocarpa* 5, *Acanthocarpus preissii* 4, *Cassytha glabella* 4, *Clematis microphylla* 4, *Conostylis candicans* ssp. *calcicola* 4, *Crassula colorata* 4, *Daucus glochidiatus* 4, *Frankenia pauciflora* 5, *Hemiandra pungens* 5, *Isotoma hypocrateriformis* 4, *Lepidosperma angustatum* 4, *Melaleuca acerosa* 5, *M. huegelii* 4, *Olearia axillaris* 5, *Poa poiformis* 5, *Schoenus caespititius* 4, *Senecio lautus* 4, *Spyridium globulosum* 4, *Trachymene pilosa* 4

Landform: BL, DC, WF **Age:** M, Y **Sectors:** V4, V2

Group: 129 (5 relevés)

Structure: (Scrub), Dwarf Scrub C, Dwarf Scrub D

Dominant Species: *Melaleuca cardiophylla* 3-9, moss 0-8, *Dodonaea aptera* 0-6, *Templetonia retusa* 0-4, *Trachymene pilosa* 1-4,
Constant Species: *Acacia lasiocarpa* 4, *A. truncata* 4, *Acanthocarpus preissii* 4, *Allocasuarina lehmanniana* 4, *Cassytha racemosa* 4, *Crassula colorata* 4, *Daucus glochidiatus* 5, *Dodonaea aptera* 4, *Isotoma hypocrateriformis* 5, *Leucopogon insularis* 4, *L. parviflorus* 4, *Melaleuca acerosa* 4, *M. cardiophylla* 5, moss 4, *Santalum acuminatum* 4, *Templetonia retusa* 4, *Trachymene pilosa* 5

Landform: THL, DS, DT **Age:** Y, M **Sector:** V4

Appendix 14 (Continued)

Group: 130 (4 relevés)

Structure: Heath A, Dwarf Scrub C, Very Open Herbs, Open Low Sedges

Dominant Species: *Acacia rostellifera* 0-7, *Trachymene pilosa* 3-6, *Conostylis candicans* ssp. *calcicola* 2-5, *Hardenbergia comptoniana* 1-4, *Scaevola crassifolia* 0-7,
Constant Species: *Acacia lasiocarpa* 5, *A. rostellifera* 4, *A. truncata* 4, *Acanthocarpus preissii* 4, *Cassytha racemosa* 5, *Conostylis candicans* ssp. *calcicola* 5, *Crassula colorata* 5, *Hardenbergia comptoniana* 5, *Leptomeria preissiana* 4, *Leucopogon parviflorus* 4, moss 4, *Poa poiformis* 4, *Senecio lautus* 4, *Trachymene pilosa* 5

Landform: DS, DT, BSW, THL **Age:** Y (M) **Sector:** V3

Group: 131 (4 relevés)

Structure: (Dwarf Scrub C), Low Heath D, Very Open Herbs

Dominant Species: *Acanthocarpus preissii* 3-7, *Scaevola crassifolia* 3-7, *Santalum acuminatum* 3-4, *Acacia lasiocarpa* 0-5, *Daucus glochidiatus* 0-4,
Constant Species: *Acacia lasiocarpa* 4, *Acanthocarpus preissii* 5, *Bromus arenarius* 4, *Daucus glochidiatus* 4, *Hardenbergia comptoniana* 5, *Nemcia reticulata* 4, *Poa poiformis* 5, *Santalum acuminatum* 5, *Scaevola crassifolia* 5, *Senecio lautus* 5, *Stipa flavescens* 5, *Trachymene pilosa* 4

Landform: DC, DS, WF, TLH **Age:** Y (M)
Sectors: V4 (V3)

Groups 132 - 134 were a little mixed with two dominated by *Eucalyptus obtusiflora* and the other by *Melaleuca cardiophylla*. Groups 132 and 133 were in the area east of White Point (Sector V2) where calcareous sand had passed over loamy Tamala. *Acacia rostellifera, Melaleuca acerosa, M. huegelii* and *Spyridium globulosum* were generally present. Group 134 was from Sector V4 and dominated by *Melaleuca cardiophylla, Acacia rostellifera* and *Acanthocarpus preissii.*

Group: 132 (2 relevés)

Structure: Shrub Mallee, Low Scrub B, Dwarf Scrub D, Open Low Sedges

Dominant Species: *Eucalyptus obtusiflora* 8, *Diplolaena* sp. (Kalbarri) 2-5, *Lepidosperma angustatum* 4-6, *Acacia lasiocarpa* 3-5, *Melaleuca acerosa* 3-4,
Constant Species: 5, *Cassytha racemosa* 4, *Comesperma integerrimum* 5, *Diplolaena* sp. (Kalbarri) 5, *Eucalyptus obtusiflora* 5, *Lepidosperma angustatum* 5, *Leucopogon parviflorus* 5, 5, *Spyridium globulosum* 5

Landform: TIS, TIH **Age:** M, O **Sector:** V2

Group: 133 (2 relevés)

Structure: Shrub Mallee, Low Scrub A, (Open Dwarf Scrub C), Very Open Low Sedges

Dominant Species: *Eucalyptus obtusiflora* 8, *Melaleuca huegelii* 3-5, *M. cardiophylla* 2-4, *Acanthocarpus preissii* 3,
Constant Species: *Acanthocarpus preissii* 5, *Eucalyptus obtusiflora* 5, *Melaleuca cardiophylla* 5, *M. huegelii* 5, *Senecio lautus* 5, *Spyridium globulosum* 5, *Stipa flavescens* 5

Landform: TIH **Age:** M **Sector:** V2

Group: 134 (3 relevés)

Structure: Dense Thicket, Dwarf Scrub C, Open Herbs, Open Low Sedges

Dominant Species: *Melaleuca cardiophylla* 7-9, *Acacia rostellifera* 4-5, *Acanthocarpus preissii* 3-5, *Melaleuca acerosa* 2-4,
Constant Species: *Acacia lasiocarpa* 4, *A. rostellifera* 5, *Acanthocarpus preissii* 5, *Calandrinia corrigioloides* 4, *Cassytha racemosa* 4, *Clematis microphylla* 4, *Conostylis candicans* ssp. *candicans* 4, *Daucus glochidiatus* 4, *Guichenotia ledifolia* 5, *Melaleuca acerosa* 5, *M. cardiophylla* 5, *Poa poiformis* 4, *Rhagodia baccata* ssp. *baccata* 4, *Stipa flavescens* 4, *Trachymene pilosa* 4

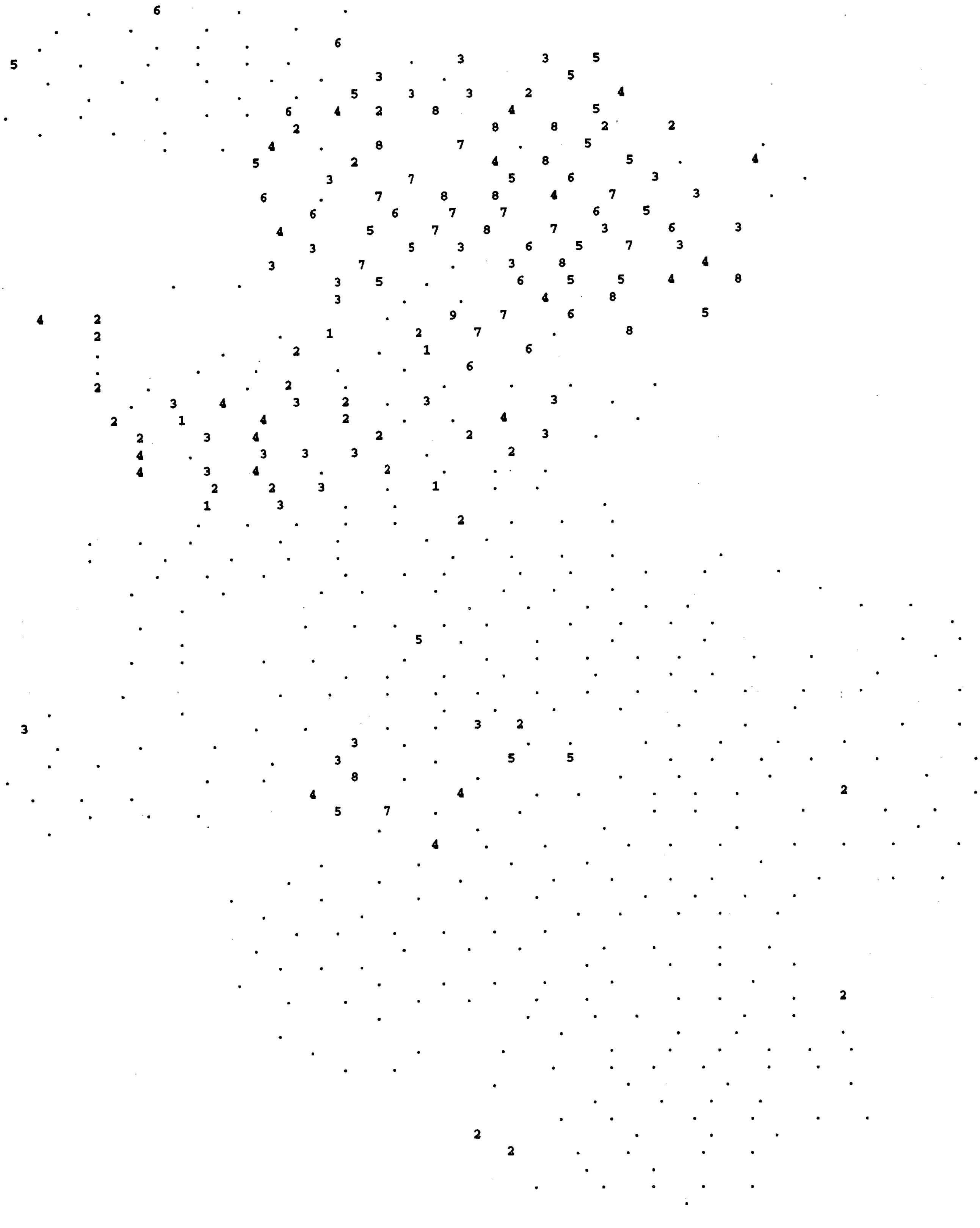
Landform: DS, DC, TSH **Age:** Y **Sector:** V4

APPENDIX 15 Occurrence of Major Species on Minimum Spanning Tree

(Minimum Spanning Tree based on Presence/Absence Analysis, Figure 13)

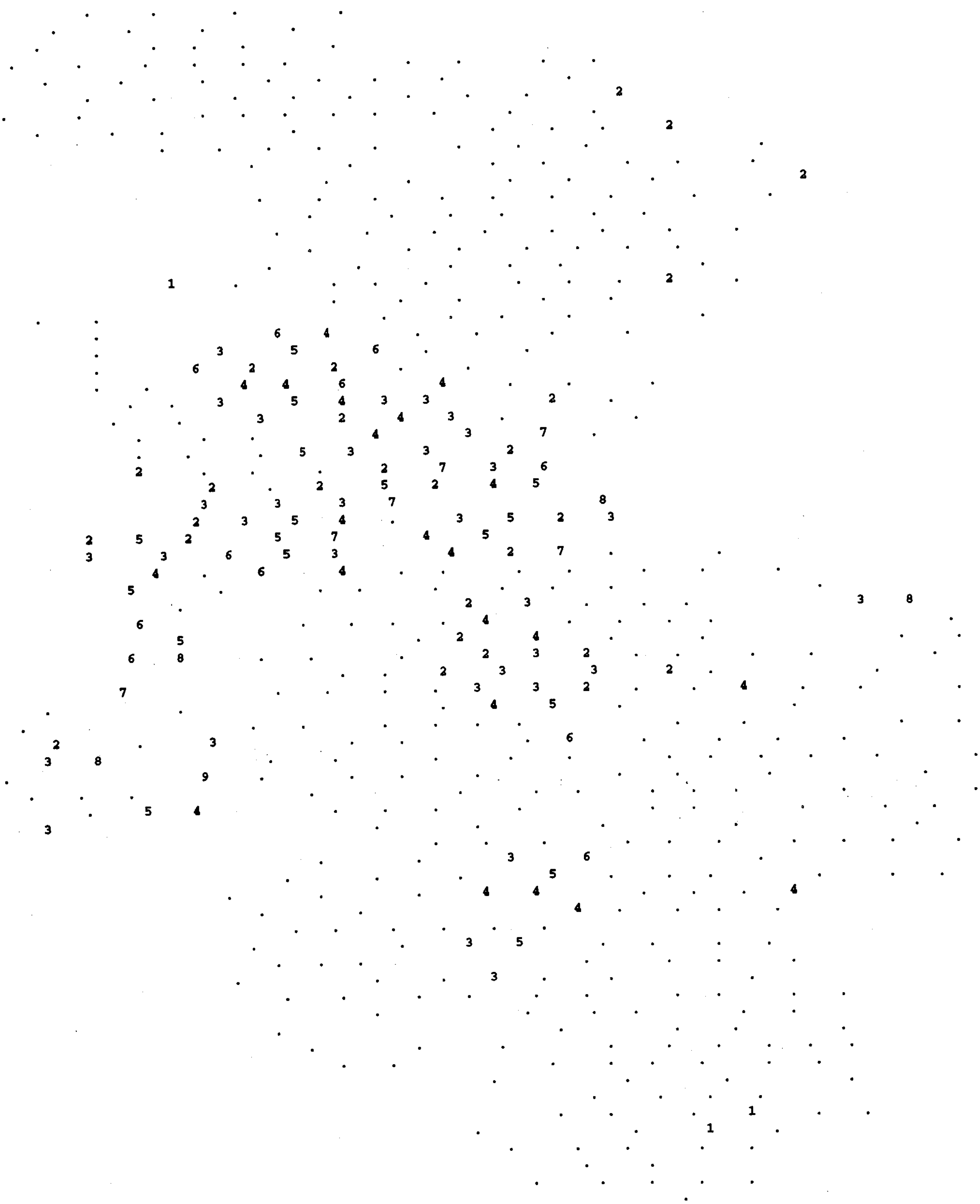
(Numbers are cover-abundance values for each species at each relevé)

Scaevola crassifolia



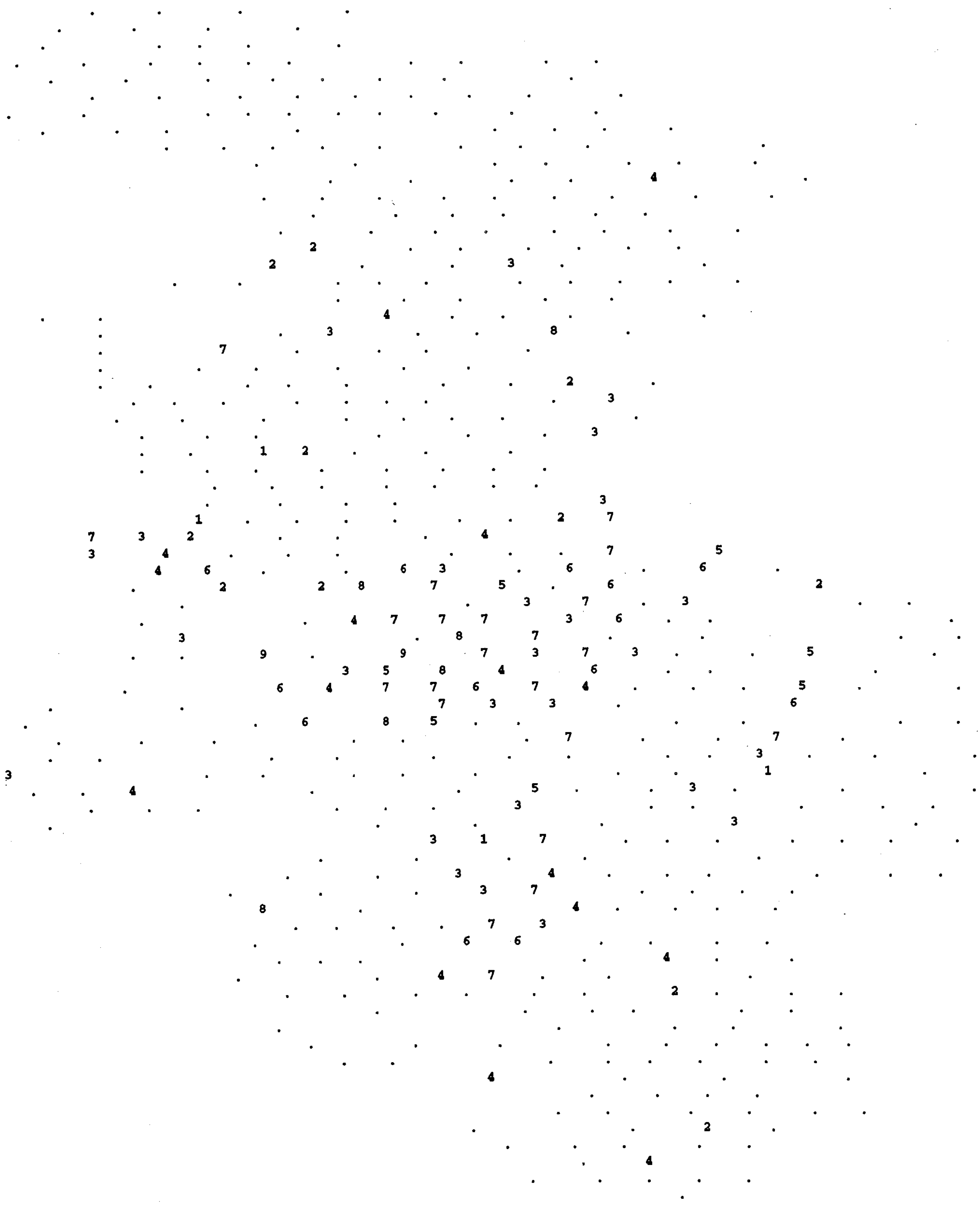
Appendix 15 (Continued)

Allocasuarina lehmanniana



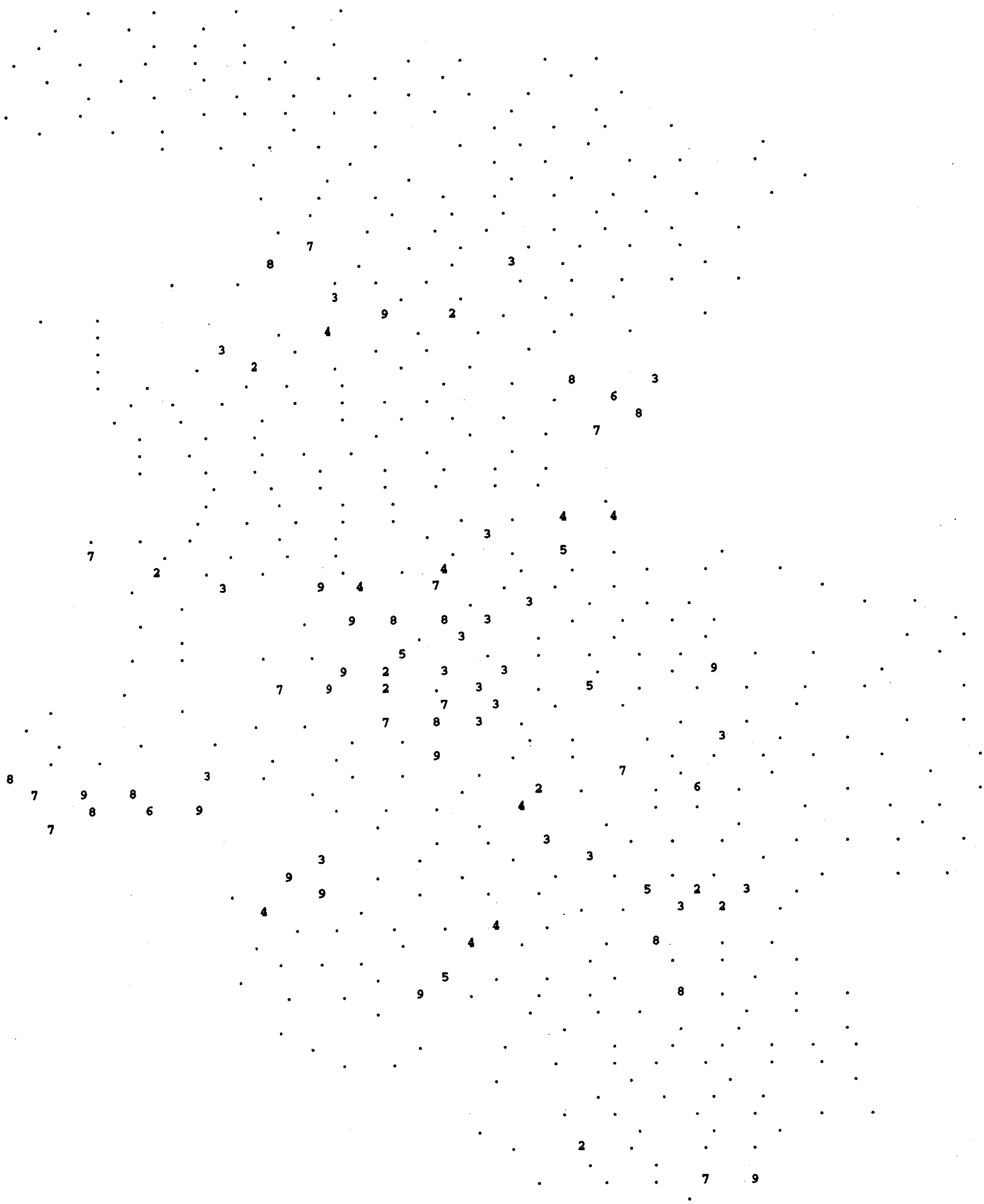
Appendix 15 (Continued)

Melalueca huegelii



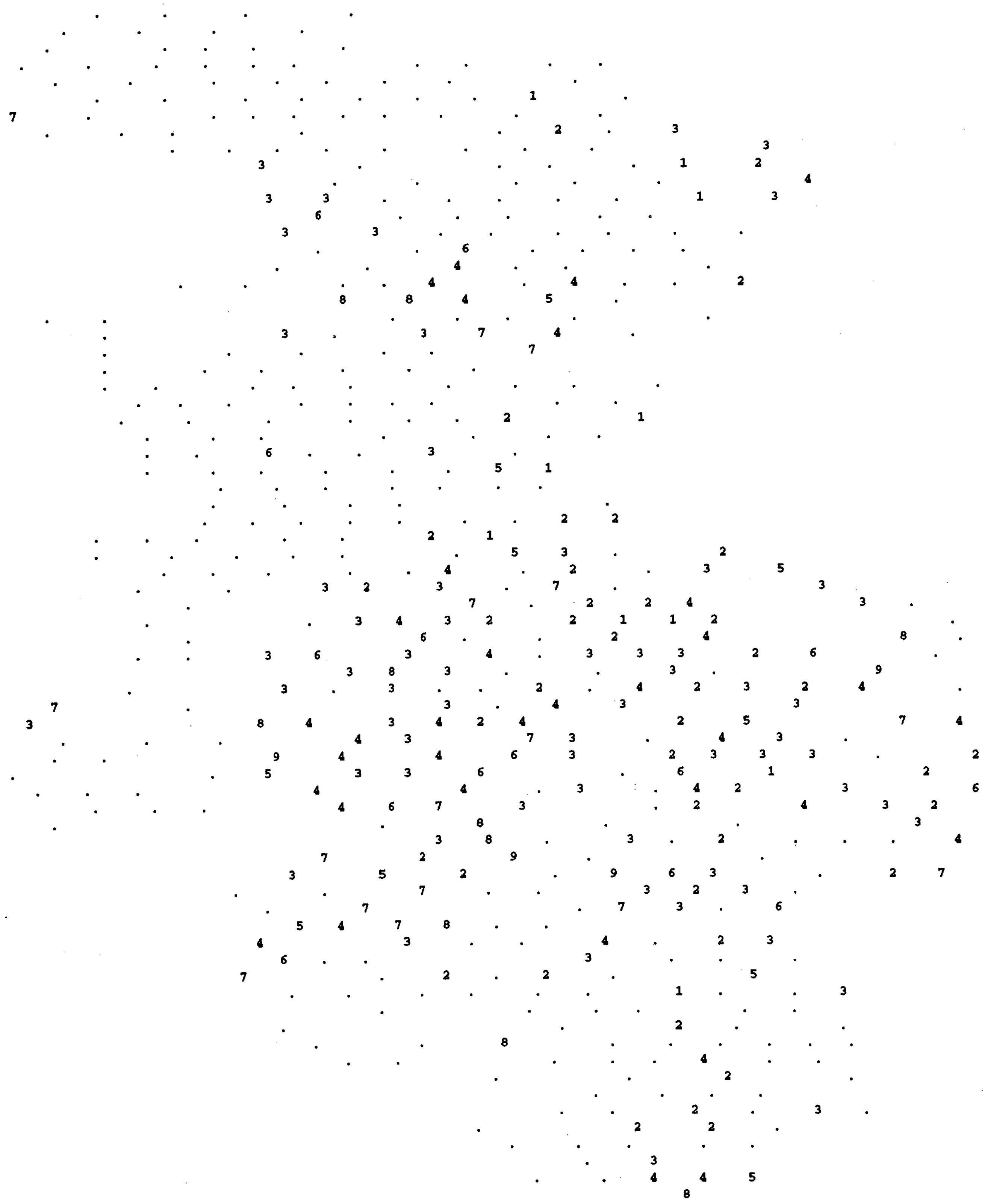
Appendix 15 (Continued)

Melaleuca cardiophylla



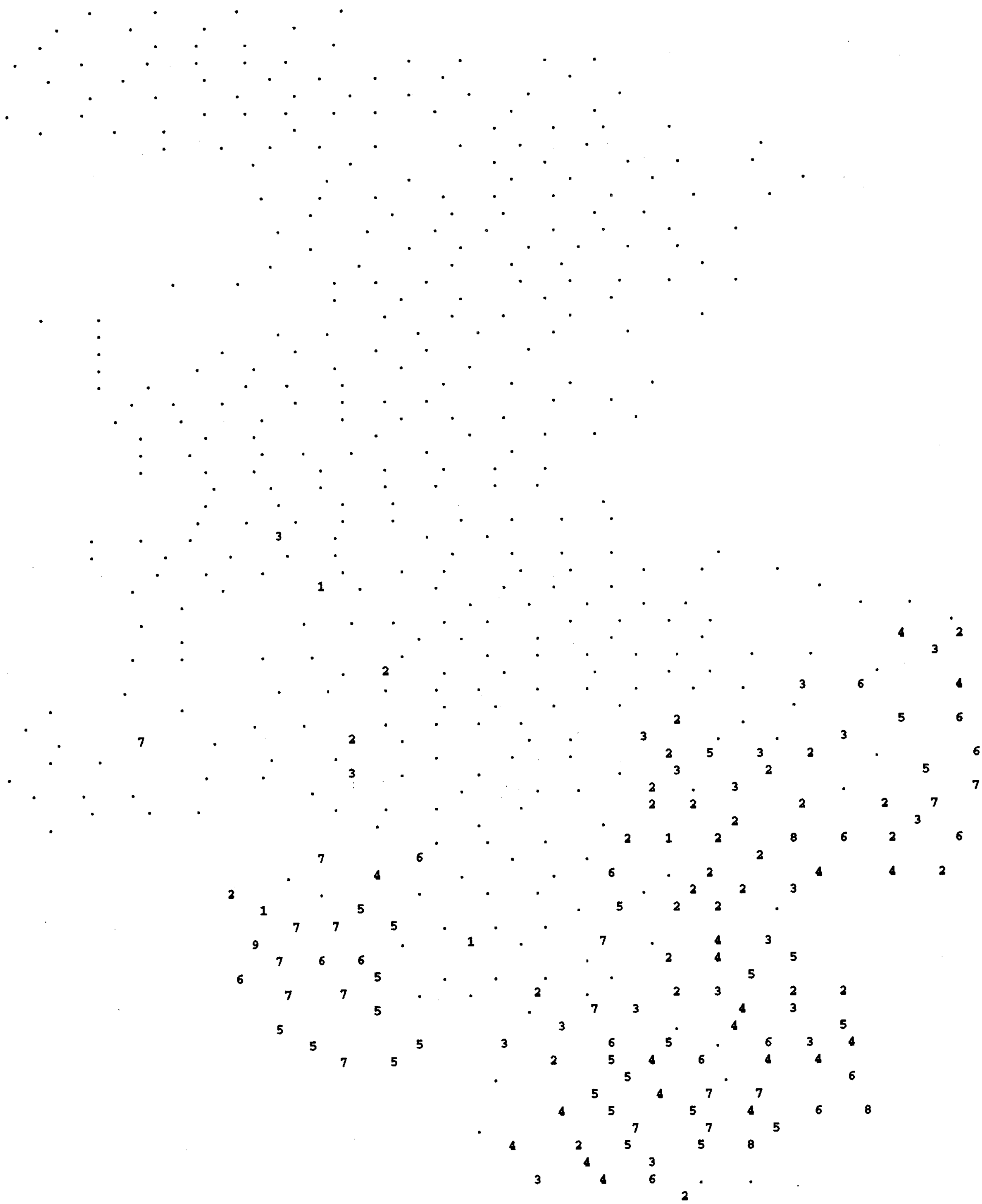
Appendix 15 (Continued)

Acacia rostellifera



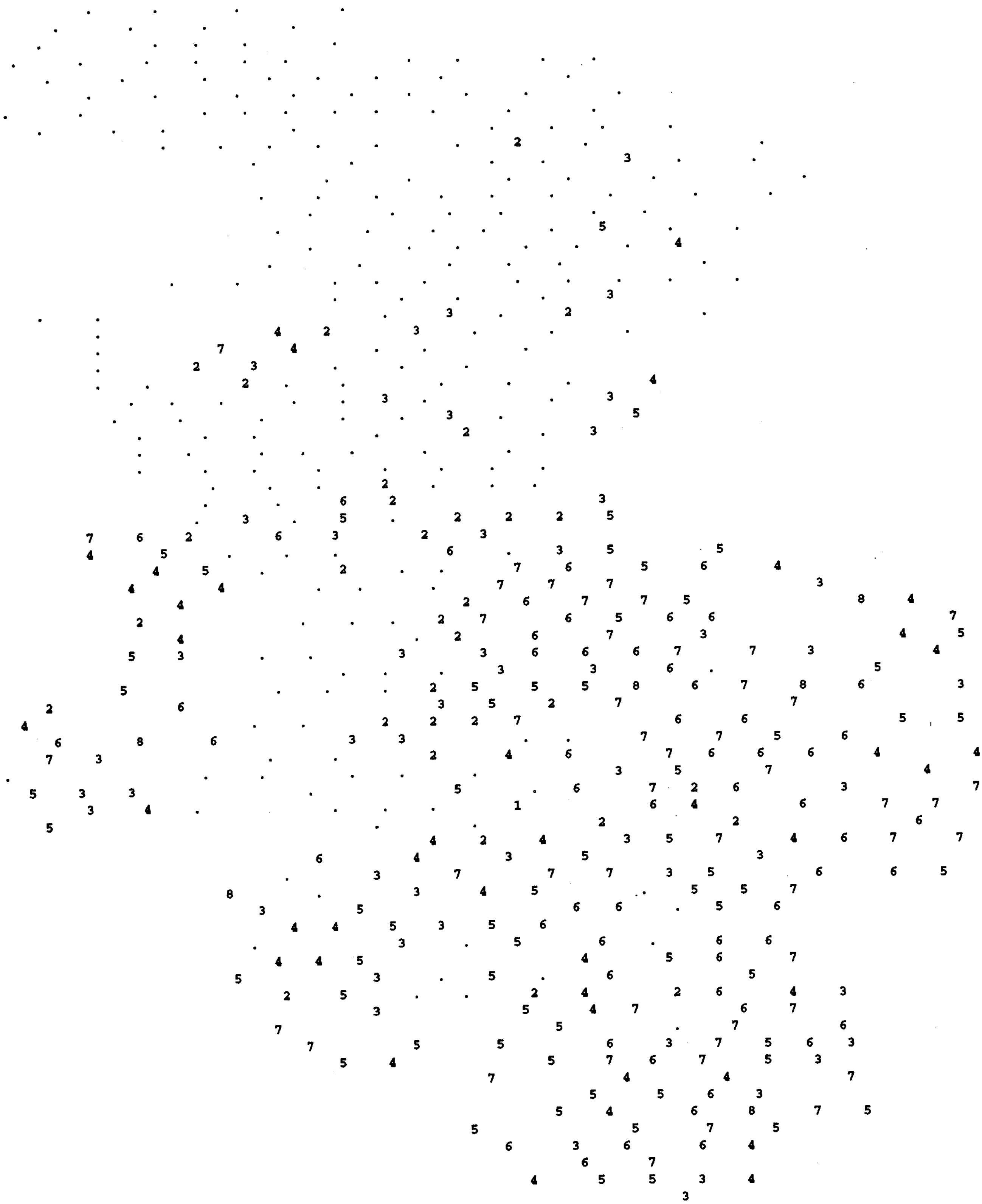
Appendix 15 (Continued)

Lomandra maritima



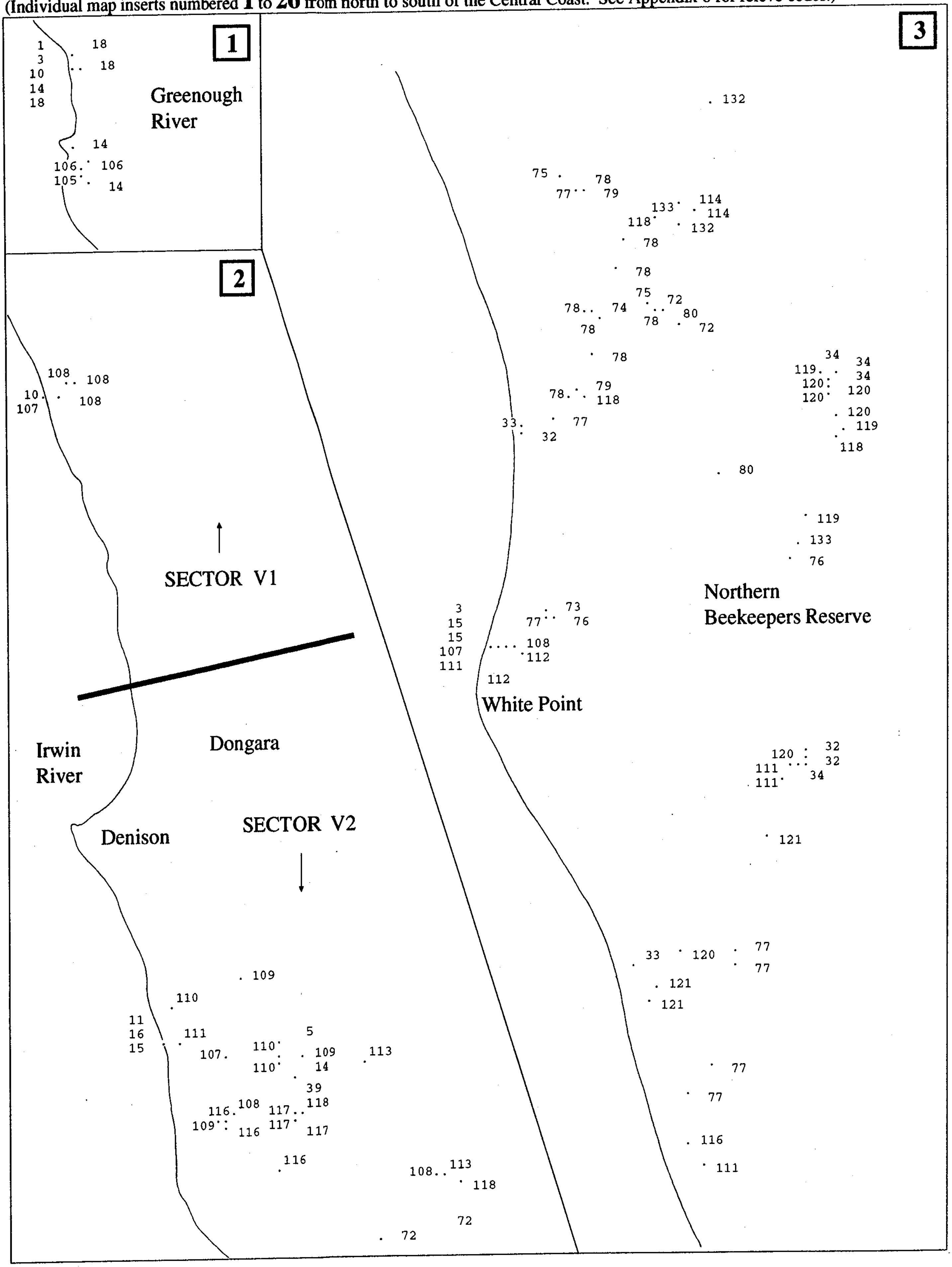
Appendix 15 (Continued)

Melaleuca acerosa

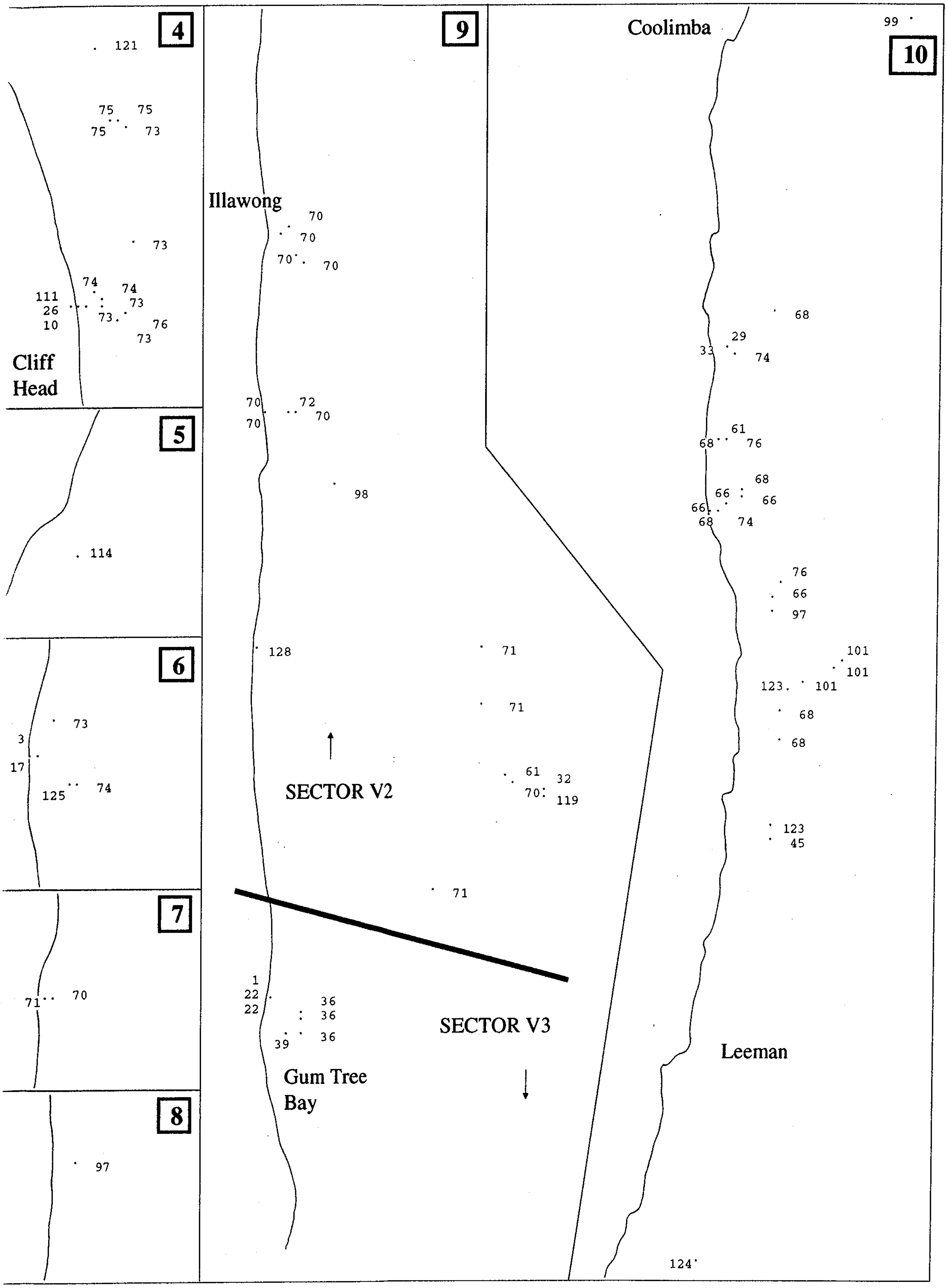


APPENDIX 16 Map with Presence /Absence Groups and Sectors

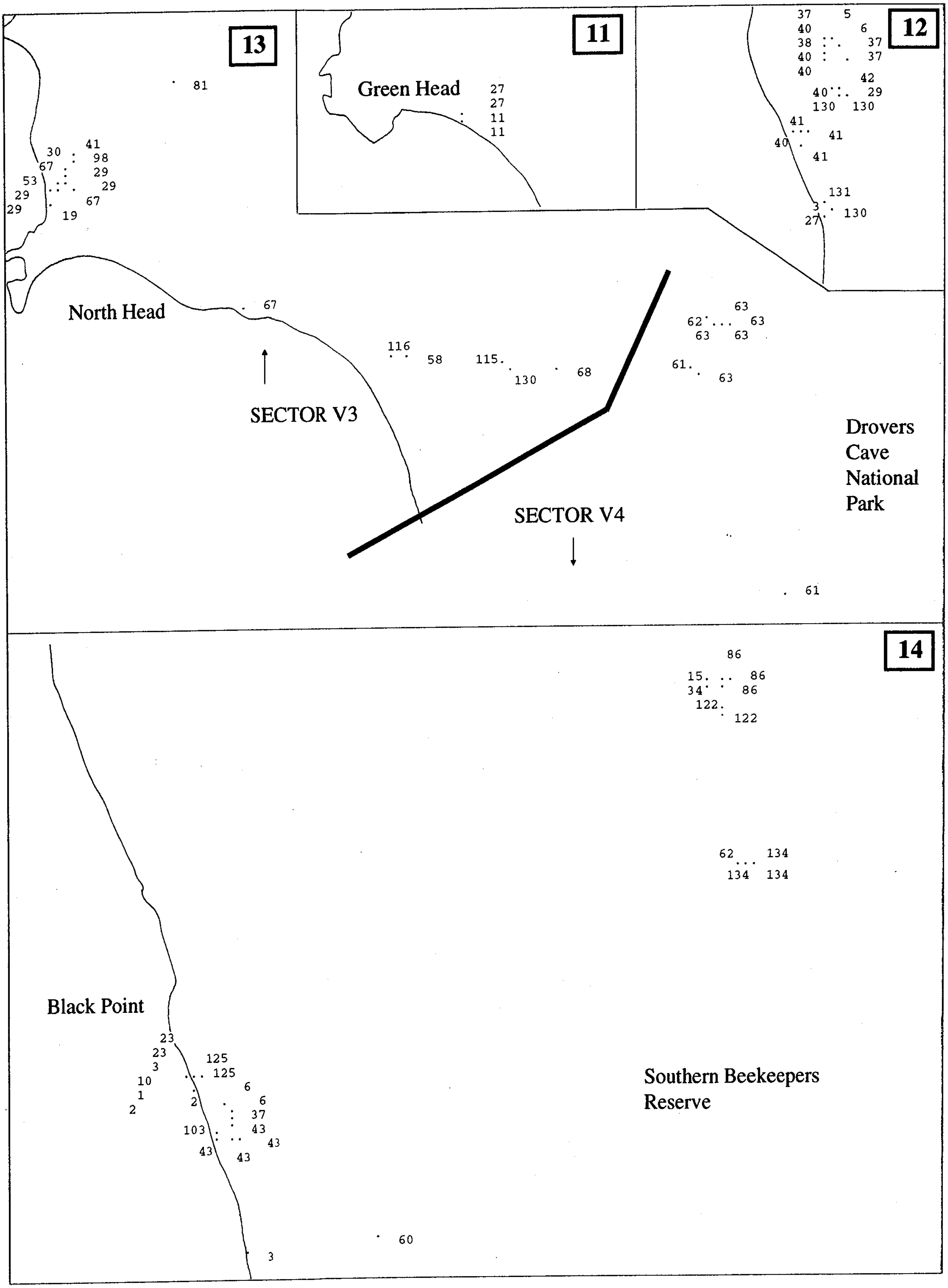
(Individual map inserts numbered **1** to **26** from north to south of the Central Coast. See Appendix 6 for relevé codes.)



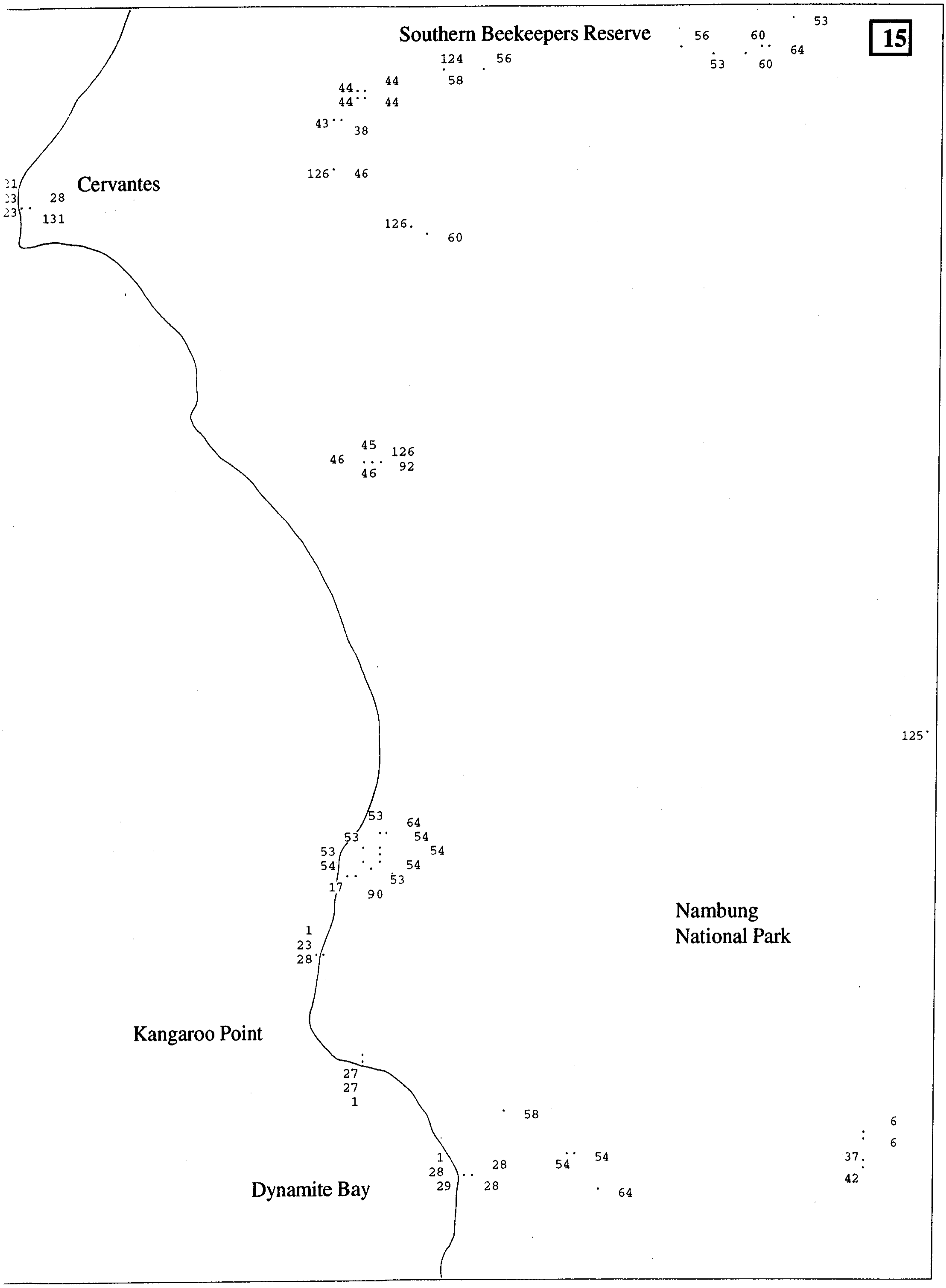
\ppendix 16 (Continued)



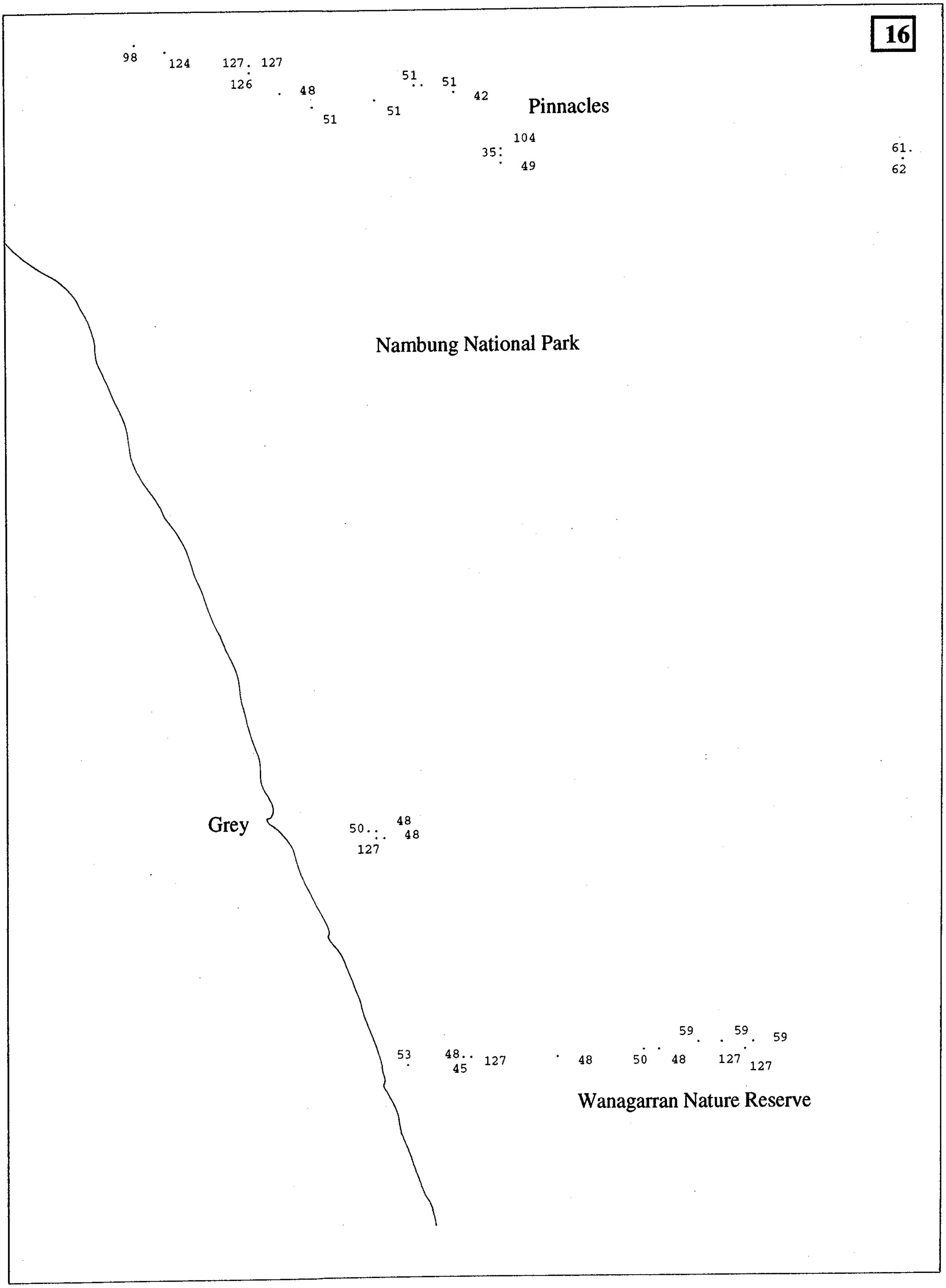
Appendix 16 (Continued)



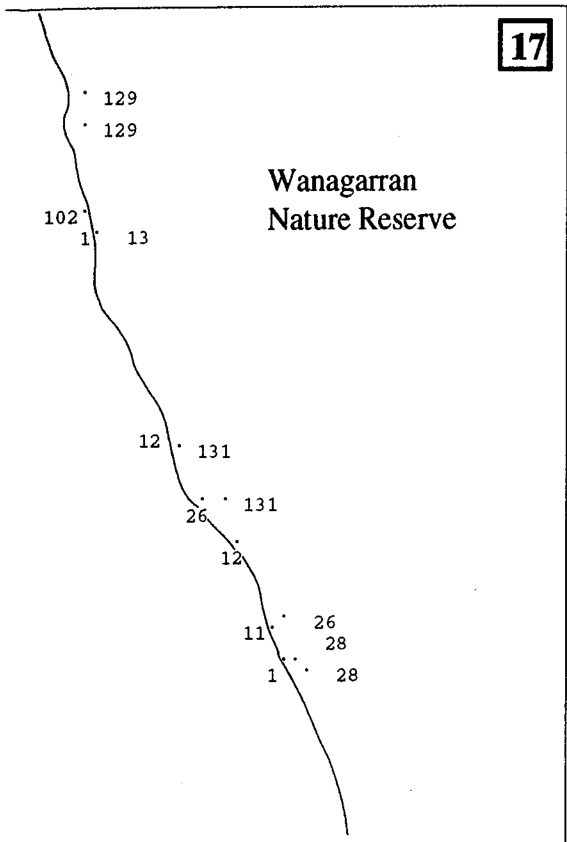
Appendix 16 (Continued)

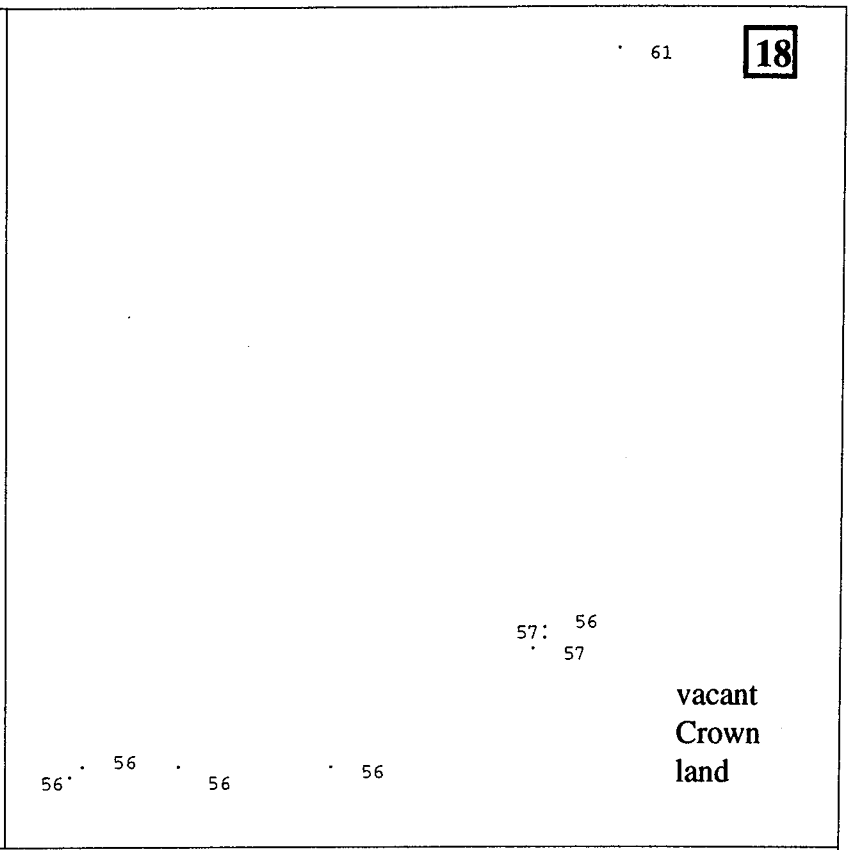


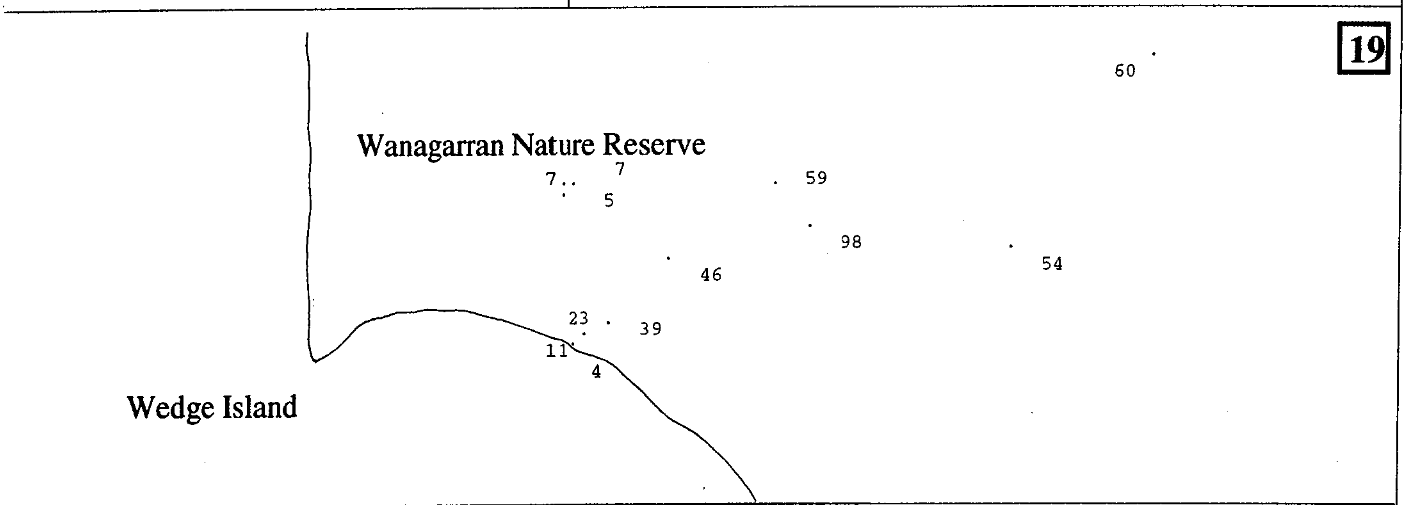
Appendix 16 (Continued)

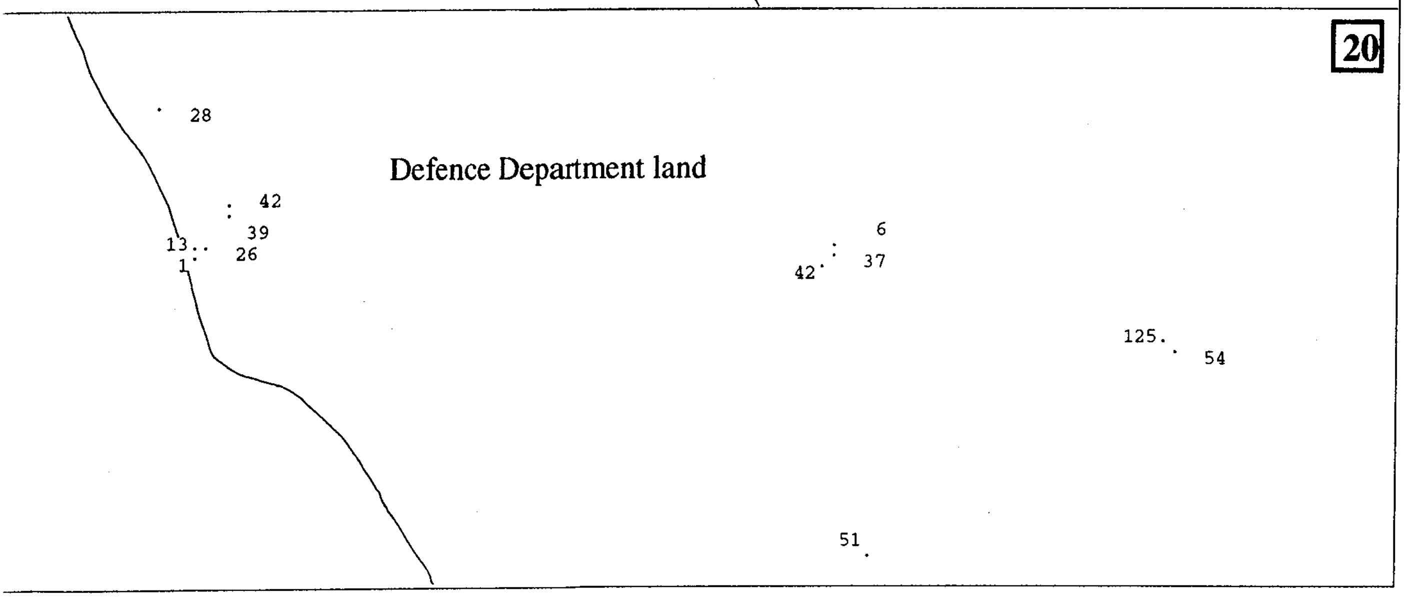


Appendix 16 (Continued)

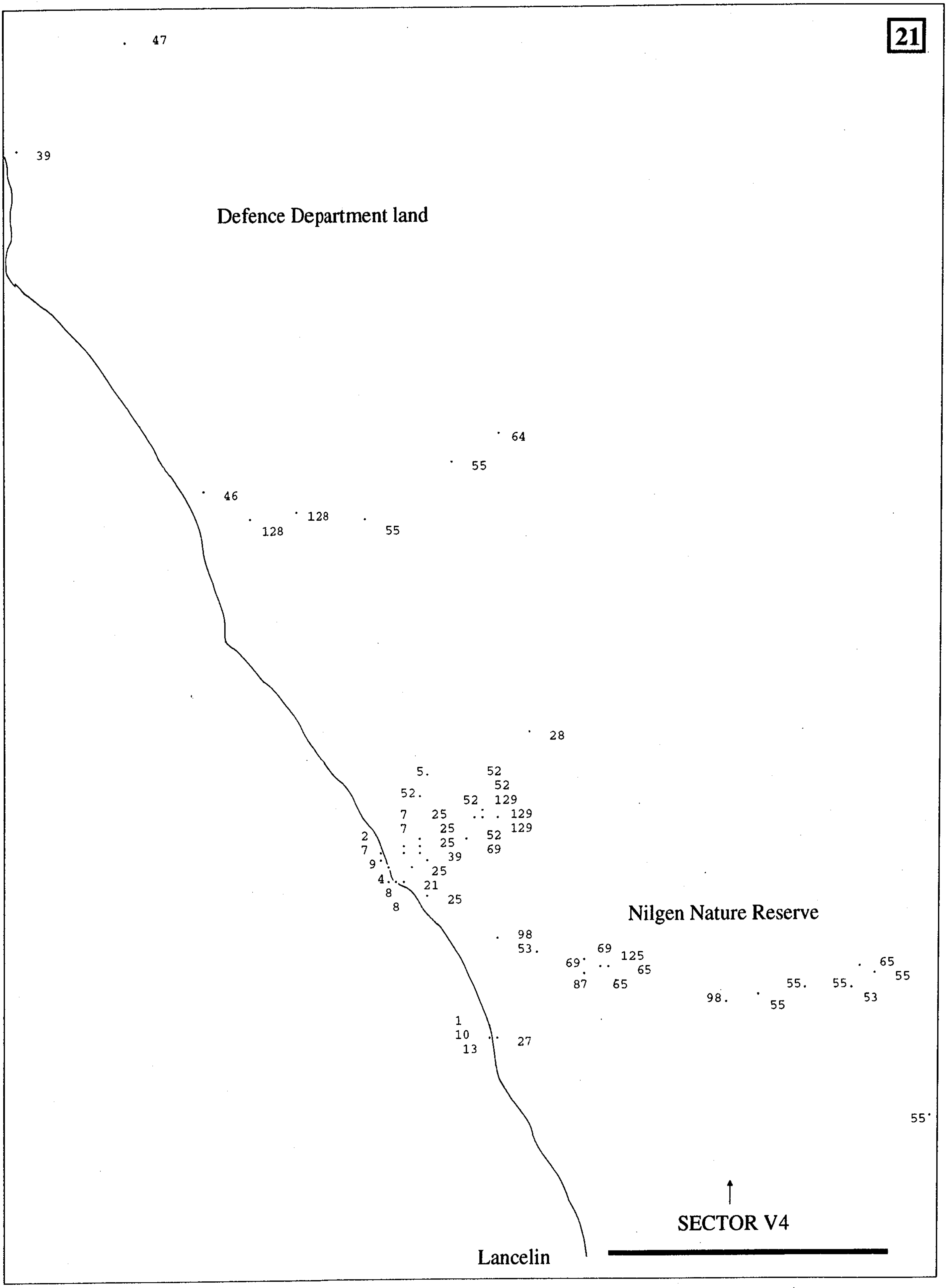




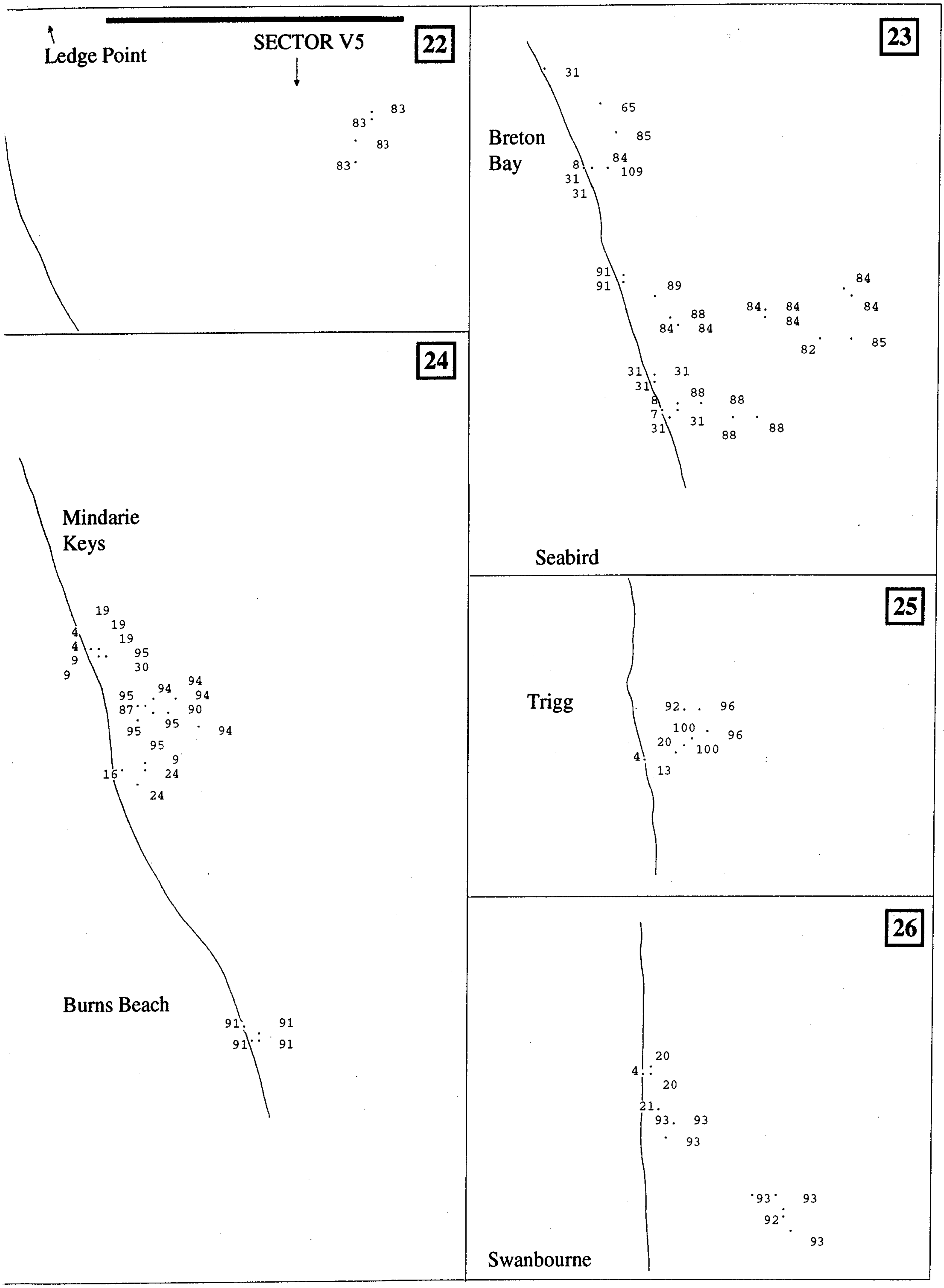




Appendix 16 (Continued)



Appendix 16 (Continued)



APPENDIX 17 Brief description of variation in vegetation of Sectors

The 'typical' descriptions for each major landform are presented in the text. Differences between the 'typical' in each Sector only are described.

It should be remembered that the Sectors were identified through the analysis of the variation in the floristic composition (Appendix 10).

Table 16 provides an indication of the vegetation succession in each Sector based on Groups of relevés.

Some indication of the difference in composition of Sectors can be gained from Appendix 9 which provides an indication of the species whose distributions cover only part of the Central Coast.

Appendix 5 should also be referred to for description of the landforms of each Sector.

Sector V1. Greenough to Irwin River

There was not sufficient relevés to adequately describe this Sector, except to indicate that it was probably distinct from areas to the south.

The major difference was the increased importance of *Acacia rostellifera* on both dunes and plains and even the foredunes. This may be related to the inclusion of sediments from the Irwin River into the dunes. The soils were darker and McMillan and Foulds (1980) noted that there were areas with a redish hew.

Two species (*Stylobasium spathulatum* and *Pimelea microcephala ssp. microcephala*) were present here and not further south. There were also a large number of species which appeared to be absent from this Sector (cf. Appendix 9).

Sector V2. Port Denison to Gum Tree Bay

a. Incipient foredunes

Beaches were generally quieter than areas to the south hence, although similar to that described for the Central Coast, there were more areas with *Atriplex cinerea* dominating, particularly south of Cliff Head.

b. Frontal dunes

These were similar to that described, but there were more areas with *Acacia rostellifera* right on the coast, mainly near Cliff Head, Port Denison and further north, but not in the White Point area.

c. Inland dunes

Again these were similar to that described. More of the younger dunes appeared to be dominated by *Acacia rostellifera, Melaleuca cardiophylla* and *M. huegelii* than areas south to Lancelin. The herbs *Parietaria debilis* and *Zygophyllum fruticulosum* were more important, perhaps reflecting the thicker vegetation.

Older dunes were similar to that described but *Acacia rostellifera* appears to be commonly present although it is usually not dominant. *Podotheca canescens* was in this Sector but rarely in Sectors to the south. *Opercularia spermacocea* was important rather than *Opercularia vaginata.*

d. Plains

These were similar to that described although there was less *Scaevola crassifolia, Olearia axillaris, Calocephalus brownii* and *Conostylis candicans* ssp. *calcicola* in the very young stages of succession than in areas to south. *Acacia truncata* was almost completely absent. *Opercularia spermacocea* appears to replace *Opercularia vaginata.*

Again *Acacia rostellifera* appears to be often present although usually only of minor importance. As for the dunes above *Podotheca canescens* was in this Sector but rarely in Sectors to the south.

Older plains were similar to that described with the same provisos as above for younger dunes. In addition *Gahnia lanigera* was important in many of the older plains, particularly in the southern part of this Sector where it overlies the loamy Tamala unit.

The vegetation associated with *Eucalyptus obtusiflora* was unique to this Sector. These mallee areas were mostly in an unusual loamy soil on the Tamala limestone. Typically this was between Cliff Head and Illawong. On the edge of the Holocene deposits, east of White Point the mallees were growing in areas over which Holocene dunes had past.

There were a few soaks with sedges close to the coast at While Point. Also the unusual presence of *Melaleuca lanceolata* growing on the coast at Freshwater Point, suggests what the name implies. Unfortunately this area has been disturbed by squatters and little natural remains.

Appendix 17 (Continued)

Sector V3. Gum Tree Bay to north of Jurien

a. Incipient foredunes

These were similar to that described.

b. Frontal dunes

These were similar to that described.

c. Inland dunes

Although not extensive in this Sector these older dunes were similar to that described. *Thryptomene baeckeacea* commonly dominated, particularly near the coast.

d. Plains

These were similar to that described. Some areas were dominated by *Thryptomene baeckeacea*, especially those with shallow calcareous Holocene sand over Tamala limestone.

The salt lakes, some partially covered by Holocene sand, were a feature of this Sector. However, the description of these were not part of this Study. They were often dominated by *Casuarina obesa, Melaleuca brevifolia, Allocasuarina lehmanniana* and a number of Sedges and halophytes.

Sector V4. North of Jurien to Lancelin

a. Incipient foredunes

These were similar to that described. There was just a little *Spinifex hirsutus* and *Atriplex cinerea. Atriplex isatidea* was important in places, particularly in the Wedge Island area.

b. Frontal dunes

These were similar to that described.

c. Inland dunes

These were similar to that described. Some *Calothamnus quadrifidus* and *Chamelaucium uncinatum* occurred on some older dunes in the south and very east of Sector.

d. Plains

These were similar to that described. The plains in the Pinnacles area (on Tamala yellow sand) were distinct from most others in that virtually no calcareous sand covered the moderately thick and sometimes earthy yellow sand. Species such as *Scaevola crassifolia, Calocephalus brownii* and *Isolepis nodosus* were mostly lacking in even the youngest of these areas. They were replaced by *Allocasuarina lehmanniana, Dryandra sessilis* and *Hibbertia racemosa.* Older plains reflected either Tamala or Holocene surfaces depending on the location.

Small patches of wetlands occurred close to the coast in a number of places, particularly in the Cervantes area. The remnants of salt lakes (e.g. Lake Thetis) were also present east of Cervantes.

Sector V5. South of Lancelin

a. Incipient foredune

These were typical as described with the note that *Spinifex hirsutus* was important if not dominant compared to *S. longifolius.* There was only the occasional *Atriplex isatidea.* The lack of very quiet coastlines means that there was no *Atriplex cinerea.*

b. Frontal dunes

Similar to that described, however, *Conostylis pauciflora* ssp. *euryrhipis* appeared to replace *Conostylis candicans* spp. *calcicola. Helichrysum cordatum* and *Lepidosperma gladiatum* were more important also, the latter mainly in swales and possibly moister sites. **Pelargonium capitatum* was relatively common, mostly in younger and disturbed areas.

c. Inland dunes

These dunes were much higher in silica than many of the dunes in other Sectors. Their floristic composition appeared to vary considerably from north to south within this Sector but the intensity of sampling was not adequate to define subdivisions.

The vegetation was generally similar to that described but with more *Acacia rostellifera* and/or *Calothamnus quadrifidus* and *Chamaleucium uncinatum.* As with the frontal dunes, *Conostylis candicans* ssp. *calcicola* was replaced by *C. pauciflora* ssp. *euryrhipis* . Again **Pelargonium capitatum* was present in some areas. There were more annual weeds including such as **Anagallis arvensis, *Laguris ovatus* and **Heliophylla pusilla. Acacia cochlearis* was nearing its northern limit.

d. Plains

These were usually smaller in extent and therefore less distinct from the dunes than most plains further north. They were mostly over Tamala surfaces, often with much yellow sand.

The youngest plains, mainly near the beach, had the addition of **Pelargonium capitatum*, quite often as a dominant species. This species has only established on older plains (and dunes) where the area has been disturbed. It is possible that this species has not been in the Western Australian environment for long enough to naturally proceed to older undisturbed areas.

Older plains may be dominated by species such as *Melaleuca cardiophylla, M. acerosa, Dryandra sessilis, Banksia attenuata* and *Callitris preissii.*

APPENDIX 18 Conservation of vegetation and landforms

This appendix provides details of the vegetation and landform values of each Sector defined from the analysis of flora and vegetation (Appendix 10). The adequacy of reservation in existing conservation reserves (mostly National Parks and Nature Reserves) vested in the National Parks and Nature Conservation Authority (NP&NCA) is assessed. Opportunities for redressing deficiencies in the conservation estate are identified and recommendations made. Table 1 should be referred to for the current size and status of the reserves mentioned here.

Sector V1. Greenough to Irwin River

The moderately tall dunes (stable parabolics of accumulation) which predominate in this Sector are mostly covered by *Acacia rostellifera* and *Melaleuca cardiophylla*. They appear to be slightly different in floristic composition to dunes to the south (cf. Appendix 9).

McMillan and Foulds (1980) recommended that much of the Holocene dunes in this Sector, particularly in the north, should be a 'landscape protection area' or even a National Park.

There is a need to conserve an area with maximum landscape / landform diversity running from the coast to the eastern limit of the dunes.

A recreation reserve 7276 at the mouth of the Greenough river provides a good opportunity to conserve the dunes and vegetation of this Sector. It contains a mobile sand mass, and both young and old vegetated dunes. It has, however, significant management conficts.

Complementing this is a small nature reserve 23600 and a contiguous public utility reserve 25581 just north of the Irwin river.

There are also significant areas of privately owned land in this Sector with high conservation values and few potential management conflicts.

Recommendations:

- S1.1 The purpose of Reserve 7276 should be amended to Conservation of Flora, Fauna and Recreation and remain vested in the Greenough Shire. A management plan should be prepared for this area as a matter of urgency.
- S1.2 The Department of Conservation and Land Management should negotiate for acquisition of privately owned land south of Cape Burney with suitable diverse landscape which could be vested in the NP&NCA as a Nature Reserve.
- S1.3 Reserve 25581 (or most thereof) should be added to Nature Reserve 23600. Any residue from Reserve 25581 should be added to reserve 39959.

Sector V2. Port Denison to Gum Tree Bay

Although the composition of some of the vegetation types was relatively uniform throughout, some others were localised in either the northern or southern half of this Sector. This is in obvious response to variations in geology and geomorphology. In terms of geomorphology, this Sector is best divided into two at just north of Cliff Head. Accordingly this Sector will be discussed in two parts.

Port Denison to North of Cliff Head

This area has low heath on the Holocene plain varying in composition according to successional stage and proximity to the coast. The younger trailing dunes perched on this plain are mainly covered by *Acacia rostellifera* with some *Melaleuca cardiophylla*. The older ones are mostly low heath of *Melaleuca acerosa* fringed at their base with *Acacia rostellifera* or *Melaleuca cardiophylla*. This plain is fringed by low to moderate foredunes with relatively typical coastal vegetation. A narrow set of beach ridges occur at the prograding White Point.

The Holocene plain has indurated surfaces of several ages. Some is made up partly of beach ridge sequences much of which have been overwhelmed and stripped by mobile sand masses. A narrow band of intact beach ridges occur at White Point.

The composition of the vegetation on the plain is distinct from the plains further south e.g. in the Cervantes area. The climax is dominated by *Melaleuca acerosa* and *Melaleuca huegelii*. It has numerous mobile sand masses and there is a wide range of successional stages represented.

East of this plain, the dunes become parabolics of accumulation at the end of their path. Here they ride over a loamy Tamala limestone unit, some of which has been exposed after their passing. The climax vegetation is mainly *Melaleuca huegelii* and *M. cardiophylla* on the dunes and *Eucalyptus obtusiflora* with *M. huegelii* and *M. cardiophylla* on the deflated surfaces.

The whole of this portion of this Sector has high significance for the conservation of flora and presumably fauna. It also has scientific values for the historical records of the Holocene period locked in the undisturbed beach plain sequences. A marl bed on the western end of Mt Adams road has provided

Appendix 18 (Continued)

the oldest Holocene date for a lagoonal shell bed on the West Coast of Australia (A. Mory pers comm.).

Virtually all it is within the Northern Beekeepers Reserve. There are in addition several small reserves for various purposes (landing ground, lime sand and common) just south of Port Denison.

The area appears to have been used minimally by beekeepers. There are a number of mineral claims presumably for lime sand.

Recommendations:

- S2.1 The northern part of the Northern Beekeepers Reserve (24496) and perhaps also the reserve for lime sand (23373) should have the purpose of Conservation of Flora and Fauna and be vested in the NP&NCA as a Nature Reserve, perhaps separate from the major part of the Northern Beekeepers Reserve.
- S2.2 Consideration of applications to extract lime sand should recognise the high conservation values of the Northern Beekeepers Reserve. Should mining be allowed, the most sensitive approach would be to limit it to those mobile sand sheets close to Dongara.

Cliff Head to Gum Tree Bay

This portion of this Sector has a narrow strip of Holocene deposits fringing and perched on the CLiff Head deposit. The vegetation on these dunes appears to be intermediate between areas immediately to the north and to the south.

Thryptomene baeckeacea is commonly dominant on older dunes near the coast. The loamy soils are generally dominated by either *Eucalyptus obtusiflora* or *Melaleuca cardiophylla*. This is the main part of the Central Coast in which *E. obtusiflora* occurs.

The unusual deposits make this area of interest geologically. The coastline, particularly that south of Illawong, has high scenic qualities.

There are several privately owned blocks in the Sector which is otherwise mostly the Northern Beekeepers Reserve (24496).

There are significant landuse conflicts mainly originating from the proliferation of squatter dwellings.

Recommendations:

- S2.3 The majority of the Cliff Head deposit in Crown ownership with its *Eucalyptus obtusiflora* etc. should be part of the Nature Reserve recommended above which could be separate from the main part of the Northern Beekeepers Reserve.
- S2.4 The coastal strip south of Cliff Head, i.e. that part west of the main road and as far south as Gum Tree Bay, should be separate reserves for Conservation of Flora and Recreation vested in the relevant local municipal authorities. Management plans should be prepared as a matter of urgency which would protect the conservation and scenic qualities of the area, particularly that south of Illawong.
- S2.5 Consideration should be given to encouraging any expansion of residential development in the Cliff Head to Gum Tree Bay area on cleared privately owned land.

Sector V3. Gum Tree Bay to north of Jurien

This Sector is dominated by a Holocene plain comprising mainly lagoonal deposits. Calcareous sand has covered these to varying degrees. The vegetation on this plain is thus highly variable with consequent high conservation values. Although these areas are poorly documented, it is clear this is the most significant area for hyper-saline lagoons south of Shark Bay.

The narrow coastal strip of Tamala limestone outcrops with its calcareous sand clothing is vegetated mainly by low heath, commonly dominated by *Thryptomene baeckeacea*. The young coastal dunes abutting or perched on the limestone are dominated by *Acacia rostellifera*.

Tinley (1992) recognised the diversity of this Sector to be highly significant. In addition he made reference to the barchan dunes on the salt lakes east of North Head. These are unique in south-western Australia and warrant protection.

The majority of the Sector is currently in the Conservation Estate (Northern Beekeepers Reserve and the Lesueur National Park). There are several coastal Recreation reserves between Coolimba and south of Green Head. There is also a block of vacant Crown land adjacent to the Drovers Cave National Park.

There are a few mineral claims for lime sand and gypsum in this area.

Recommendations:

- S3.1 The majority of the Holocene plain between Coolimba and North Head, especially the lagoonal deposits, should be included in a Reserve for the Conservation of Flora and Fauna and vested in the NP&NCA as a Nature Reserve. This probably should be separate from the main part of the Northern Beekeepers Reserve but boundaries would need to be considered in association with any expanded Lesueur National Park.

Appendix 18 (Continued)

- S3.2 The portion of coastal reserve 42477 between Coolimba and Leeman should remain a recreation reserve vested in the Carnamah Shire. Except for that covered by Recommendation S2.4, the remainder should revert the Northern Beekeepers Reserve.
- S3.3 The coastal reserve between Leeman and Green Head (22521) should remain vested in the Coorow Shire Council.
- S3.4 The recreation reserve (40544), camping reserve (19759), the southern part of the Northern Beekeepers Reserve and the vacant Crown land between that and the Drovers Cave National Park should be added to the Lesueur National Park.
- S3.5 Consideration should be given to the creation of a marine reserve extending from south of Green Head to North Head.
- S3.6 The acquisition for conservation of the privately owned land at North Head, known as Pumpkin Hollow (cg 8836), would be a useful addition to the conservation estate but not as high a priority as acquisition of land in Sectors V1 or V5.

Sector V4. North of Jurien to Lancelin

The Holocene plain including the cuspate beach ridge plains on which Jurien and Cervantes are sited dominates this Sector.

The climax vegetation on the plain is essentially low heath of *Melaleuca acerosa* and *M. huegelii*. Limited areas of young successional stages are present in the northern part of this Sector but more extensive areas are present between Wedge Island and Lancelin. The dunes perched on this plain have *Acacia rostellifera* or *Melaleuca acerosa* dominating depending on the age of the dune. Some small lagoonal deposits are present with sedges dominant.

The backing Tamala Limestone with its yellow sand covering have been much transgressed by Holocene sand masses. The vegetation on the resulting Tamala plain is dominated by *Melaleuca acerosa, Allocasuarina lehmanniana* or *Dryandra sessilis* depending in part by the successional stage and how much calcareous sand is present.

There are significant patches of Tuart woodland in this area.

The Sector includes an apparently unique situation where Holocene sandmasses have travelled over the Bassendean dune system. This is a small area east of the Nambung National Park in private ownership. It has not been inspected but extrapolating from the results of this study it would be safe to conclude that the uncleared areas are of significance for the conservation estate.

The severed drainage lines between Black Point and the mouth of the Hill River are unique in the Central Coast and warrant protection. The coastline along much of this Sector has high scenic qualities. That between Grey and Wedge Island is much admired by visitors.

The stromatolites at Lake Thetis (Cervantes) is the only such occurrence in the Central Coast. They are different from and therefore complement other stromatolite deposits such as Shark Bay and Lake Clifton (Gozzard 1985, Grey *et al.* 1992). They must be protected. The Dandaragan Shire have recently implemented measures to do so.

Much of the Sector is included in the Conservation Estate (Southern Beekeepers Reserve, Nambung National Park and Wanagarran and Nilgen Nature Reserves). There are several small reserves for other purposes in the vicinity of Jurien and Cervantes. In addition there is the Defence Department's leased land north of Lancelin.

Some of the privately owned land has significant conservation values.

Recommendations:

- S4.1 The existing Conservation Estate in this Sector should be retained but rationalised to acknowledge the recreational values and current usage of the coastal parts of the Nature Reserves.
- S4.2 The northern part of the Jurien beach ridge plain should be protected in a reserve which would allow for the study of the Holocene depositional history. This might be added to the Drovers Cave National Park or an extended Lesueur National Park as recommended above.
- S4.3 Most of reserve 19206 at Black Point should be added to reserve 36053. By way of compensation, part of 36053 should be excised so as to cater for the eastward expansion of Cervantes.
- S4.4 The purpose of Lake Thetis (35819) should altered to Recreation and Conservation of Stromatolites and remain vested in the Dandaragan Shire. Its Class should be increased to A and a management plan prepared which would ensure the protection of the stromatolites.
- S4.5 The town site of Grey should be cancelled and incorporated into the Nambung National Park on the proviso that a suitable camping area be provided within the National Park in the vicinity.
- S4.6 Aquisition of sufficient private land should be made to ensure the protection of the Hill River mouth and immediate surrounds.
- S4.7 Consideration should be given to the aquisition of the enclave of private land (CG 2490) in the Nambung National Park for the conservation of the important Tuart woodlands and the Nambung River.
- S4.8 Consideration should be given to acquiring a portion of Leased land 347 18175 east of the Nambung National Park where the Holocene dunes have over ridden the Bassendean system.

Appendix 18 (Continued)

Sector V5. South of Lancelin

The thin veneer of Holocene sand over Tamala limestone and yellow sand dominates this Sector. This undulating surface was dominated by *Dryandra sessilis, Melaleuca cardiophylla* and *M. acerosa*. The older Holocene dunes perched on the Tamala have *Melaleuca acerosa* and the younger ones *Acacia rostellifera* and *A. cochlearis* dominating. There is also a narrow band of coastal dunes with typical vegetation for this landform.

The composition of most of the vegetation types in this Sector is distinct from Sectors to the North and probably also those to the south (see Trudgen, 1991 and Trudgen *et al.* 1990).

One portion of the coast south of Seabird has very high conservation values because of the presence of the rare plants *Chorizema varium* and *Eucalyptus argutifolia*. A number of species of significance are at their northern limit in this Sector.

While the coastline in much of this Sector has high scenic qualities, the urban and rural land uses have degraded this potential for all but a few areas. The area south of Seabird has such values.

The unconsolidated sand mass at Mindarie appears to be the only remaining one in near natural condition in this Sector.

There are no conservation reserves in this Sector covering Holocene deposits. There are just a few small and narrow recreation or other reserves. Although much of the Sector is dominated by land cleared for urban or rural landuses, there are several significant areas of uncleared vegetation. Some are privately owned (e.g. between Ledge Point and Seabird) but a number are owned by the Crown (Alkimos, Ningana and Wilbinga - Trudgen and Keighery 1990a,b and Trudgen *et al.* 1990) or leased vacant Crown land.

Recommendations:

- S5.1 The conservation values of reserves 31258, 28303 and 24408 should be investigated with a view to incorporating all or part in the conservation estate.
- S5.2 The coastal portion of leased Crown land south of Seabird (lease 392 428) should be excised and declared a reserve for the Conservation of Flora and Fauna and vested in the NP&NCA as a Nature Reserve.
- S5.3 The Crown owned locations 9755, 9756 and 9757 (Wilbinga) currently leased, should be added to the Caraban Management Priority Area which together should be declared a Conservation Park vested in the NP&NCA.
- S5.4 The Public Recreation reserve at Mindarie (35890) should be enlarged to the east and south by the aquisition of privately owned land and be declared a reserve for the Conservation of Flora and Recreation and vested the Wanneroo City Council.
- S5.5 Recreation reserve (16921) and the part of location 1911 (south of Bold Park) should be added to Bold Park and managed for the Conservation of Flora and Fauna.