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The Cape Naturaliste Area, W.A.
An Environmental Resource Evaluation

P.S. Valentine
and N.J. Enright
THE CAPE NATURALISTE AREA, W.A. -

AN ENVIRONMENTAL RESOURCE EVALUATION

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GEOWEST 6

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Correction:

On Map 2, p.16, reserve boundaries appear indistinct. For their exact location see Map 7, p.49.

On Map 1, p.7, the main part of the key should read:

- SEALED ROADS
- CALCARENITE
- GRANULITE
- LATERITIZED GRANULITE
- PERTH BASIN SEDIMENTS
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Editor's Preface

Late in 1974 it was suggested by Professor Martyn J. Webb, Head of the Department of Geography, that I might co-ordinate and supervise an investigation of the Cape Naturaliste area, which could be undertaken for the Vasse Conservation Committee if the Australian Government made a grant to employ one or two research workers. I was very glad to accept, in an honorary capacity, because I could count on a most effective team, Peter Valentine (now Lecturer in Geography, James Cook University of North Queensland, Townsville) and Neal Enright (now research scholar, Department of Biogeography and Geomorphology, School of Pacific Studies, Australian National University, Canberra). The team was unique in its combined training in Biogeography, Ecology, Pedology and Geomorphology and in its interdepartmental experience in Geography, Botany and Soil Science.

The grant became available late in December, while Neal Enright was in Tasmania, and the initial aims and plan of research were laid out with Peter Valentine, who also undertook the direct liaison with the Vasse Conservation Committee. Research and field work began by the team in January 1975, and discussions on availability, collection, evaluation and significance of the evidence continued throughout until the eve of the departure of the researchers, early in March.

The editorial work has particularly aimed at making this report a work of reference to be readily and effectively used. Special regard has been paid to the detailed listing of contents (page i) and the locating of placenames (Map 2, p.10) and land ownership, including reserves (Map 7, p.49). Thanks are given to Mrs. Irene Simpson for redrawing the maps, and Miss Lynette Dalziell for typing the manuscript.

J. Gentilli
Acknowledgements

We wish to extend our appreciation to all those who provided information and advice pertaining to the Cape Naturaliste Area. Initial thanks must go to the Vasse Conservation Committee, and Mr. Harry Hayes in particular, for obtaining the Australian Government grant which enabled financing of the field and production work, and to Professor M.J. Webb for suggesting that the project be handled by researchers within the Department of Geography, University of Western Australia. The Editor, Dr. J. Gentilli, had a task much greater than envisaged due to the need of the authors to leave Perth in March 1975 at a time when the report was far from finalized.

Considerable assistance was provided by Dr. D. Merrilees, Dr. R. George, Mr. A. Baynes, Dr. D. Kitchener and others on the staff of the Western Australian Museum; Dr. N. Marchant, Dr. A. George and Mr. K. Kenneally of the W.A. Herbarium; Mr. Brown-Cooper of the Department of Environmental Protection; staff of the Main Roads Department and staff of the Department of Agriculture; Mr. I.D. Heppingstone of the W.A. Historical Society; staff of the W.A. Town Planning Authority and the Busselton Shire Council are also thanked.

Special thanks are extended to Mr. Peter Hammond, Curriculum Branch, Education Department of Western Australia, for accompanying the authors on fieldwork and providing use of a second four-wheel drive vehicle, a motor boat, and accommodation. Having been involved in secondary school field-centre studies at the Cape for many years, he was an invaluable source of information and ideas.

Finally, our appreciation must be extended to the people of Cape Naturaliste, especially Aub Chugg of the Banamah Wildlife Park, David Greenacre, Tony Harbison, 'Goog' Emmott, and others too numerous to mention, all of whom went out of their way to make our work in the area pleasant and rewarding.

P.S. Valentine
N.J. Enright
Introduction

This report is concerned with the natural and cultural resources of Cape Naturaliste peninsula, an oceanward projecting mass of land 225 kilometres south of Perth (Map 1). The region enjoys a slightly cooler summer than the Western Australian capital, and this, added to the beauty of its surrounds, has led to heavy pressure of recreational use at several commercialized locations. The peninsula itself, for the purpose of the present study, is defined as that area north of the stretch of Caves Road which connects Dunsborough and Yallingup, a total of some 6,880 hectares (17,000 acres).

The area is covered with a mosaic of plant associations due to the marked contrasts in soil and parent materials on the one hand, and exposure to the elements on the other. The windward coast is clothed in limestone of recent origin and supports a generally treeless heath association, whilst the sheltered north-eastern side of the cape is covered by a lateritic mantle and associated jarrah (Eucalyptus marginata) forests. Most of the coastal zone is reserved, being vested in one of several local Councils and State Government Departments, however the stated purpose of the reserves is, in most instances, non-conservational. Soils tend to be deepest towards the centre of the region and it is here that agricultural activity is concentrated.

Many groups and individuals have lobbied, in recent times, for the creation of a large national park covering part of the Naturaliste-Leeuwin Ridge, the latest and most far reaching being that of the Environmental Protection Authority's 'Conservation Through Reserves Committee' (1975). The lack of detail and specificity in such proposals, and the assessment of the situation as ripe for the production of a report with strict aims and meaningful proposals, provided the impetus for the research outlined in this report.

Besides assessing the nature and condition of resources in the area it was considered essential to determine guiding principles for development and management in the future. With this in mind the text has been divided first into a consideration of the physical and biological resources, and second, into an examination of the human usage, both pastoral and recreational. The report concludes with a plan for development and control, attempting to integrate the often conflicting interests of producer and conservationist.
In view of the very limited time and resources available for this study, there are bound to be gaps in the coverage. It is however hoped that the report may serve as a basis for future planning, and may perhaps be followed by more specialized surveys of particular resources.
PART I: PHYSICAL AND BIOTIC RESOURCES

External factors of the Cape Naturaliste environment will not be considered in detail, but frequent references will be made to them in the text. These factors are mainly climatic and oceanic. Data on climatic elements and factors are given in the Bureau of Meteorology's 1965 Meteorological Summary, which should be consulted for detailed data. The lighthouse at Cape Naturaliste is a weather station of long standing, with rainfall records begun in 1903, and good records of temperature, humidity and cloud cover. Shorter series are available for wind (direction and speed) and thunder days. Wind is a major environmental factor (cf. Ch. 1 and 2).

Oceanic circulation around Western Australia shows a southward drift of warm water along the coast (Schott, 1935) which prolongs the warming of the near offshore environment for some two months, with the warmest waters arriving in April (Gentilli, 1972). The warm, sheltered waters east of Cape Naturaliste are a distinctive environment in their own right (cf. Ch. 3).

1. Geology and Geomorphology

The Cape Naturaliste area provides contrasts in both geology and geomorphology, several of the more distinctive features of this area being noted in very early reports. Cape Naturaliste is the northernmost segment of the so-called "Leeuwin Block" (Lowry, 1967). These Precambrian rocks between Capes Leeuwin and Naturaliste were earlier referred to as the Leeuwin Naturaliste Horst (Gentilli and Fairbridge, 1951) and despite some controversy on the appropriateness of the term horst in the apparent absence of a western fault (Lowry, 1967, p.17), George (1972) still refers to the Cape Naturaliste-Leeuwin horst. Valentin (pers. comm.) suggests that there may well be a western fault some distance offshore, now much disguised because of erosion.
While there is a fundamental unity within the Leeuwin Block, there is some distinctiveness near Cape Naturaliste in terms of both geology and geomorphology (Map 1). The Precambrian rocks of Cape Naturaliste include high-grade metamorphic rocks, divided by Kay (1958) into 8 types of granulite. More recently Lowry (1967) has divided the Precambrian rocks of Cape Naturaliste into granite gneiss, medium-grained granulite, and basic granulite.

Saint-Smith (1912) considered that students of geology should visit the area "as excellent examples of gneissic bands in the granite, hornblende, gabbro dykes, pegmatite and aplite veins, limestone caves, sand dunes, etc., are to be seen along the coast between Bunker Bay and Sugarloaf Rock".

In 1926 Aurousseau similarly considered the exposures at Bunker Bay should attract the student of metamorphism; he gave an analysis of some amphibolite from Bunker Bay (1926, p.625). Since then at least one detailed study has been made of these high grade metamorphic rocks — that by Kay in 1958. In describing the rocks, Kay notes the existence of fayalite-quartz-microcline-microperthite (a minor phase of petrological interest) and the Na-pyroxene granulites of the Dunsborough suite, both of which "are not commonly recorded and are thus of considerable interest" (1958, p.26).

The granulites and granite-gneiss are exposed in numerous places along the Naturaliste coast forming rocky outcrops between bays (Map 1), adding considerable variety to the coastline. Strong structural control of certain landscape features is provided by these rocks, as for example at Canal Rocks and Torpedo Rock, and at Rocky Point on the east coast. These rocks provide the closest hard rock coastline to Perth, a factor of importance for both education and recreation.

Two distinct areas can be distinguished, characterized in the west by aeolian calcarenite and in the east by laterite and associated quartz (Map 1). Boundaries between the two are often quite sharp and provide contrasting topography. Map 2 shows the contours of the study area while Figures 1 and 2 provide a schematic representation of the geomorphology.
FIG 1. CAPE NATURALISTE PENINSULA, LOOKING S.E.
FIG 2. CAPE NATURALISTE PENINSULA, LOOKING N.E.
As can be seen in Map 2, a series of hills forms a distinct ridge to a maximum height of 220 metres, parallel to the west coast, between Cape Naturaliste Lighthouse and Yallingup. This ridge slopes steeply to the west (Figs. 1 and 2) with coastal cliffs between Sugarloaf and Yallingup reaching 20-40 metres in places. These cliffs are comprised of calcarenite (limestone) and stretch unbroken for most of this section. Midway between Yallingup and Sugarloaf is a small area of exposed granulite providing an excellent zone of contact between the calcarenite and hard rock basement (Plate 1). The eastern slopes are less steep, although quite marked. Within the calcarenite system there is virtually no surface drainage, the area exhibiting quite distinct karst features. Numerous caves are present from Yallingup north, not all of which have been properly documented. Other karst features such as dolines (collapsed caves) are present throughout the area. Particularly large examples occur towards the crest of the ridge. To the west of Mt. Duckworth, cliffs occur about 1 km from the coast including a small natural bridge feature. These cliffs provide a vantage point which has been enhanced by an attractive walk path giving access to the natural bridge from one of the tracks. Locations are shown on Map 1, p.7.

One cave near Yallingup - not far from the so-called Terrible Cave (Pick, 1973, p.166) - exhibits a regular 'breathing' pattern, the periodicity of which suggests some direct marine connection. Further evidence of extensive linkages throughout these subterranean systems is provided by a 'blow-hole' just north of the summit of Mt. Duckworth which was demonstrated to connect with an opening near the coast by using smoke (G. Emmott, pers. comm.). Speleologists have been very active in exploring caves in this area and apart from cataloguing, describing and surveying previously unknown caves, have unearthed material of considerable palaeontological interest.

As to sea caverns, in 1827 Charles Frazer, the eminent botanist, drew attention to the limestone cliffs between Bunker Bay and the Cape, together with "two magnificent ranges of caverns" (quoted in Pick, 1973). These caves can be reached by walking around the base of the cliffs from Bunker Bay (Plate 3). Several have been described in detail by Williamson et al. (1973), giving a map of the locations. In this same area considerable interest is provided by an exposed section in Shelly Bay (the bay immediately west of Bunker Bay). Here the Cowaramup Conglomerate of Fairbridge and Teichert (1953) is clearly exposed (see
Plate 2). It is of great paleogeographical significance. In this area contact occurs between the granite gneiss rocks which occur to the east, and both the medium grained granulite and a small area of basic granulite. The strong structural control of the coast is clearly evident and the occurrence of occasional pegmatite veins provides increased geological interest. The contact between the recent aeolian calcarenite (including the beach conglomerate) and the Precambrian basement rocks is quite clear and offers an excellent location for field studies. Professor H. Valentin, a coastal geomorphologist of world authority, considers this section one of the best he noted in an extensive study of the southwest coast (pers. comm., 1975).

The eastern part of the peninsula provides a striking contrast to the karst topography. Most of the eastern section is mantled by lateritic material or related quartz sands. On the higher areas duricrust occurs supporting a stand of jarrah forest (*E. marginata*) which in the vicinity of Castle Rock extends almost to the sea (cf. Vegetation chapter).

The series of cross sections shown in Figures 3, 4 and 5, demonstrate the much more subdued nature of the eastern terrain together with the existence of surface drainage. Numerous streams dissect this area, most of which show structural control when viewed on plan (see Map 4). In places the drainage lines are dissipated in a series of swamps or lagoons, as near Dunsborough, where the relative relief is very subdued. Elsewhere the streams turn north and empty into the ocean (such as at Eagle Bay and Meelup) or south to join the Yallingup Brook or streams flowing into the ocean south of Canal Rocks. Throughout this section, apart from the very small area at Dunsborough itself, the country is undulating (the roads traversing the area provide attractive views of both agricultural and coastal scenery). A rather indiscriminate selection of gravel quarries for road building sometimes mars the view, and in places lack of rehabilitation of these sites has resulted in considerable erosion (as for example just east of the lighthouse).

Mineral sands have concentrated naturally in many areas throughout the district, with particularly rich deposits in small pockets. At least two mining companies currently own land in the area. Griffin Mining Company owns the original Cape Farm at Bunkers Bay (CG 683 and 422) while Busselton Minerals owns an area near Smith's Beach and Yallingup (CG 122,
FIG. 3.

LITHIFIED DUNE
(KARST TOPOGRAPHY)

YALLINGUP TO DUNSBOROUGH CROSS-SECTION

FIG. 4.

WHALE LOOKOUT

NORTH YALLINGUP — CASTLE ROCK

FIG. 5.

ROAD

RIVERS

SUGAR LOAF TO EAGLE BAY
The holdings of Busselton Minerals (and Mideast Minerals) border the southern boundary of Yallingup National Park, in particular that section which is currently leased by the Lands Department to a farmer for grazing purposes. Mineral claims which were held over this area have been relinquished by Busselton Minerals, although under land ownership conditions mineral rights are owned by the company, particularly to the crucial block CG 122. Although ilmenite deposits extend into the National Park area values are low, probably averaging no more than 5%. The richest deposit, on CG 122, is probably less than 10% containing perhaps 508,000 tonnes of ilmenite. Levels of zircon, the most profitable heavy mineral, are low - probably in the order of 3%. Given this situation it is unlikely that mining will be viable at this site. On site beneficiation may overcome transport costs, however the high cost of plant and the relatively small deposit suggest the area will not be worth mining in the absence of significant price increases for ilmenite and/or rutile. A current mineral claim (MC 2213) for ilmenite, zircon and rutile is held by Norseman Gold Mines on portions of Sussex Location 1045, 1303 and 1304 which includes the main swamp environment mentioned in the chapter on vegetation. In addition Griffin Mining Company have a current mineral claim (MC 1318) on Location 422, although they have relinquished dredging claims which covered most of Bunker Bay and foreshore. In the case of both these current mineral claims it is difficult to assess the likelihood of mining being viable. However the area is of minor importance compared to the rich deposits at Capel. The only other mineral interest in the area is a prospecting area (PA 1284) currently held on reserve number 28665 (preservation of caves and conservation of flora) for a variety of ores but probably only being worked at present for ornamental building stone and gemstones. Regulations provide for the removal of up to 50 tonnes from a prospecting area (permission may be granted for additional quantities) which may only be held for a maximum of 18 months before conversion to a mineral claim.

The contrasting geology and geomorphology described for the Cape Naturaliste peninsula provide a basis for an understanding of the complete system and its fundamental ecology. Coastal energy situations are extremely high on the west (Yallingup–Sugarloaf–Naturaliste), and become increasingly calmer in a progression from Naturaliste to Bunker Bay to Eagle Bay to Meelup and finally Dunsborough. Hence the most active areas are between Yallingup and Naturaliste. It is along this stretch of coast that most blowouts are to be expected. On Naturaliste itself - right at the tip - winds have stripped a once stable system (following
loss of vegetation most likely due to burning) and exposed fossil soils. More recent blowouts have occurred at Cabejgup (Three Bears) and also immediately north of Yallingup - both associated with four-wheel drive vehicle activity. The massive dune system at Injidup - south of Canal Rocks - indicates the scale of sand movement which can occur in favourable circumstances. Dune buggies and other vehicles are inhibiting recovery in this area also.

The northern and eastern coastlines of the peninsula are rarely as active as the western one, although it is evident that at times northwest gales and high seas pound the north coast producing storm beaches. It is precisely the contrast between east and west coasts which provides such an attractive recreation resource. For example during summer easterly winds provide calm conditions on the west coast in the mornings, while the regular sea breezes which cause rougher conditions on the west coast in fact blow offshore in the Eagle Bay - Meelup - Dunsborough section and account for the flat seas and safe boating and swimming conditions. The role of the ridge in dissipating the strong southwest and westerly winds is important.

As the prevailing wind is southwest to west, the exposed flank of the western ridge is subject to most pressure. Such conditions, together with the sandy nature of the soil and the typically dry conditions of karst landforms, have resulted in a low heath-like vegetation, dominated by Olearia axillaris, Acacia decipiens and Melaleuca huegelii (see chapter on Vegetation). Once disturbed the stability of the slopes is destroyed and blowouts occur (as above). Consequently the western flank of the calcarenite ridge must be protected at all costs as this ridge provides protection to the entire eastern portion of the peninsula. It is in the lee of this ridge that the peppermint (Agonis flexuosa) forest occurs together with the other forest and woodland formations. That the wind is able to destroy such vegetation is evident on Location 829 where a narrow strip of peppermint trees was cleared, resulting in exposure of the main forest to wind. Trees along the edge have already been killed. A traverse from west to east over the ridge indicates a gradual increase in height of the vegetation with maximum height occurring in the completed sheltered (lee) sites. This gradation in vegetation height provides protection to successive stands. Clearing on the ridge disrupts the protective sequence and results in rapid and considerable wind damage to the newly exposed trees.
The geology and geomorphology of Cape Naturaliste are not only complex but also provide a fundamental control to other natural features. This point is clearly demonstrated in the following sections which discuss the vegetation and animal life of the area.
2. **Vegetation**

The flora of the Cape Naturaliste area, without being unique in total, provides examples of endemic species and isolated plant populations. Previous separation of the granitic ridge from the rest of the Darling Scarp system by the 'Broadwater' (C.T.R.C., 1974) (a low-lying region of sedimentation) has led to the isolation of a section of jarrah (E. marginata) forest, conserving its components in much the same way as if it had been an island ecosystem. Within this small area (6,880 ha) there are many diverse plant associations ranging from the coastal heath and peppermint (Agonis flexuosa) woodlands of the western limestone areas, to the jarrah, marri (E. calophylla) and banksia woodlands, and the granulite heaths of the eastern lateritic sector.

The position and shape of the Cape region add to its unusual geology and soils further to complicate the region's floristic character. The exposure of the western coastline and its consequent wind and salt spray effects on the vegetation give way to calmer offshore winds on the north-eastern coastline (Geographe Bay), producing marked changes in plant structure, physiology and floristics within a space of one kilometre at some points. An example of this is the leaf morphology of a recently discovered and yet unnamed Calothamnus species which grows on granulite exposures on both sides of the Cape (Plate 4). On the windward side its leaves are almost tomentose, and slightly succulent, whilst on the leeward side they are much finer and lack any succulence. This difference may reflect the need to develop stronger leaf tissue and store water more efficiently in the face of the strong and persistent winds.

Distribution of species on a regional scale is also affected by the shape of the Cape and surrounding environment. It is a natural end point in the northward extension of southern coastal species, e.g. the Pineapple-leaved Dasypogon (D. hookeri) which cannot extend around Geographe Bay and up the Swan Coastal Plain due to the drier climatic conditions and to the change in substratum east of Dunsborough. Conversely the 'Broadwater' area provides a southern barrier to the extension of Tuart (E. gomphocephala) and effectively limits mixing between the respective jarrah associations of the scarp and ridge.
These factors make consideration, and hopefully, conservation, of the Cape's plant associations a necessary step in the development of environmental awareness.

**Plant Associations**

Few descriptions of the flora of the study area have been undertaken, and those that have (e.g. Smith, 1973) deal with larger areas and hence lack any real interpretative significance and, to some extent, accuracy on the local scale. For this reason a more detailed vegetation map has been compiled and a fuller record of the components of the associations is included to aid in management and planning decisions (Map 4, p.20).

The major associations recognised are:

1. Jarrah Forest
2. Jarrah/Marri Forest
3. Stunted Marri/Jarrah Woodland
4. Marri Forest
5. Peppermint Forest and Woodland
6. Melaleuca Woodlands and Thickets
7. Granulite Heath
8. Parrot-Bush Heath
9. Coastal Heath
10. Stream and Swamp Complexes

Within many of the above there may be one or more co-dominant tree or shrub species.

(i) Jarrah Association

A large tract of almost pure Jarrah (*E. marginata*) open forest dominates the north-eastern side of the Cape, stretching from Dunsborough to Eagle Bay, and being part of the Meelup Reserve (a 'C' class reserve vested in the Busselton Shire). It is unique from both the scientific and recreational points of view. Nowhere else in the State does a Jarrah forest on laterite reach the coastline, and yet here at several points it comes within metres of the water, as at Castle Bay, west of Dunsborough.
YALLINGUP

MELALEUCA THICKETS

COASTAL HEATH (Sandy)

GRANULITE HEATH

MIXED ASSOCIATION Jarrah dominant scattered Marri, Banksia.

KEY:

JARRAH FOREST
MARRI FOREST
AGONIS WOODLAND
MELALEUCA THICKETS
COASTAL HEATH (Sandy)
COASTAL HEATH (Limestone)
GRANULITE HEATH
MIXED ASSOCIATION Jarrah dominant scattered Marri, Banksia.

CLEARED
R E. rudis
C E. cornuta
A Astartea
Ca Casuarina
The association has a rich shrub layer including in significant quantities the Grass-tree or Black Gin (*Kingia australis*), especially along creek lines where it grows to over 4 metres in height, Blackboys (*Xanthorrhoea preissii*), Persoonia longifolia, Hakea amplexicaulis, *Thysanotus spartus* (Fringed Lily), *Adenanthos meisneri*, *Banksia grandis* (Bull Banksia), *Xylomelum occidentale* (Native Pear) and many others (a partial species list of each association is given in Appendix A).

Its isolation from the main scarp associations has so far saved the stand from infection by the root-fungus *Phytophthora cinnamomi* (Jarrah-dieback) and if controls can be enforced to prevent its spread, the Cape Naturaliste Jarrah association could well be one of the few, or possibly the only, healthy stand of jarrah left in the State. Besides this beneficial effect of isolation there may be other differences due to divergent speciation between the ridge and scarp communities. This however would require detailed scientific investigation and is beyond the scope of the present study.

(ii) Jarrah/Marri Associations

As depth of sand increases over the lateritic cap of the ridge, Marri (*E. calophylla*) becomes more numerous until it is present in approximately equal quantities with Jarrah. This occurs north-west of the Meelup reserve, particularly in the vicinity of Eagle Bay Creek. Jarrah tends to be more common on the interfluve sites whilst the Flooded Gum (*E. rudis*) assumes the role as Marri's co-dominant in the moist valley locations (e.g. Naturaliste Downs, Eagle Bay Creek).

Understorey species tend to be the same as for the Jarrah forest although fewer *Kingia* and more *Banksia attenuata* were noted, as was the presence of the occasional *Nuytsia floribunda* (Christmas Tree) and *Agonis flexuosa* (Peppermint Tree), the latter again in the moist creek bed sites.

Most of this association has been cleared, probably due to the presence of a deep sandy layer over the laterite (as opposed to the Jarrah areas), only occasional belts and patches of trees or parkland-type clearings remaining in evidence.
(iii) **Stunted Jarrah/Marri Association**

A small area between Bunkers Bay and the Cape Naturaliste Lighthouse, listed as an 'A' class reserve, supports a scattered stand of stunted Jarrah and depauperate Marri. This can only be due to the exposed nature of the site and the shallowness of sand over the lateritic cap. Jarrah is the species most severely affected and in many places has assumed a mallee habit. Other species present are typically hardy, namely *Acacia cyclopis*, *Hakea prostrata*, and *Banksia grandis*. On some of the more exposed areas of the ridge, south of the Sugarloaf turnoff, stunted Jarrah and stunted Marri are locally important.

(iv) **Marri Forest Association**

The only Marri (*E. calophylla*) dominated stand remaining north of Canal Rocks in the Naturaliste area borders on, and in fact crosses, Caves Road, the main artery between Yallingup and Dunsborough. Most of the stand is within a 'C' class reserve (No. 28665) of 66 hectares.

*Banksia attenuata* comprises a second tree layer throughout the stand whilst an occasional Jarrah occurs on the drier slopes, and Peppermint (*Agonis flexuosa*) in the wetter depressions. It is within this stand that the most northerly examples of the Pineapple-leaved Dasypogon (*D. hookeri*) are to be found. They were also noted further along Caves Road towards Yallingup, bordering on cleared land which, it would appear, once supported a similar stand of predominantly Marri and Banksia species.

Three associations were noted which mark transitions from Marri-dominant lateritic habitat stands to Peppermint-dominant limestone based stands. Firstly an open woodland north-east of Naturaliste Downs where Marri and Peppermint are co-dominant on 'leached grey earths' (Smith, 1973) most of this with the understorey removed to allow parkland grazing. Secondly, a Marri/Peppermint/Yate association running along the lee side of the Naturaliste Ridge between the Downs and Sugarloaf Rock turnoff. This association has special significance in that it houses a disjunct population of Yate (*E. cornuta*; see Plate 5) which in fact is the type locality for that species (N. Marchant, pers. comm., 1975). The third association clothes the flat lands of
Naturaliste Downs and adds the Flooded Gum (*E. rudis*) as a major component to the associations noted above. Understorey species of major occurrence included two distinct forms of *Makea varia* and several *Acacia* species (*A. cyanophylla*, *A. rostellifera*).

(v) **Peppermint Association**

As opposed to Smith (1973) who has classified the woodland/forest areas around the Yallingup Cave and Mt. Duckworth as being a Jarrah/Banksia Casuarina forest, we considered the stand to be dominated by the Native Peppermint (*Agonis flexuosa*), whilst having several sub-dominant tree species, the Marri, Casuarina (*Casuarina fraseriana*) and Banksia *attenuata*. A small tree layer is comprised mainly of scattered *Xylomelum* and *Nuytsia*, and the shrub layer of *Adenanthos meisneri*, *Macrozamia reidii*, *Dryandra* and *Hakea* species (see Appendix).

This association is found on red and brown limestone-derived soils (terra rossa, rendzina) and rarely attains a height greater than 20 metres, being as low as 8 metres on drier, more exposed sites. By far the greater part is on private property bounding the Yallingup National Park, and running northwards along the leeward slopes of the Naturaliste Ridge.

Noteworthy patches of growth occur in the vicinity of Mt. Duckworth where both the Parrot-Bush (*Dryandra sessilis*) and *Hakea oleifolia* reach tree-like dimensions, being some 8-10 metres high and having a trunk with heavy secondary thickening. Of particular interest in the peppermint forest and woodland is the presence of Bullich (*Eucalyptus megascarpa*). This species is well represented in association with Peppermint trees and less frequently with Marri (*E. calophylla*). In contrast to its usual form in the Jarrah forest along the Darling Scarp, where it occurs along streams as a tall forest tree, it occurs here mainly as a mallee or low branching tree seldom in excess of 8-10 metres.

Plate 6 shows a taller specimen near Yallingup Cave, growing on the red limestone soils which are characteristic of the lee flank of the ridge. Several Quandongs (*Santalum acuminatum*) were also noted in this region, to our surprise as they do not normally extend so far west, and their density appears too low to allow their survival.
Pure, open stands of Peppermint, of unequalled beauty within the area, were found in the sandy, sheltered bays of the north-east coast, especially Bunkers, Meelup and Eagle Bays (see Plate 7).

(vi) Melaleuca Woodlands and Thickets

Thickets of *Melaleuca lanceolata* and *M. huegelii* tend towards sheltered parts of the otherwise windswept coastal zone. These occur wherever small depressions are to be found along the western coast, and on limestone outcrops at Bunkers Bay on the calmer north-eastern shoreline. Most thickets are almost single species stands, rarely exceeding 8 metres in height. Where, as in the case of *M. huegelii*, some habitats are badly exposed to the westerly winds, the thickets take on a windswept, ridged appearance (Plate 8). This is especially true of the stands at Canal Rocks.

(vii) Granulite Heath

For the purpose of mapping and interpretation the coastal heath vegetation has been divided into three distinctive types, although it is obvious that even these could be subdivided on the basis of variations in the dominant shrub species in any given area. The shallow soils and rock crevices of the exposed granulite capes and points support a floral type much more closely aligned to the laterite loving species, and, in fact, most sections of granulite heath are surrounded by laterite and their related Jarrah associations.

The yet unnamed *Calothamnus*, known only from the Naturaliste area, is restricted to the granulite environment. Its morph variation has already been noted and would appear to be its most distinctive feature. Other common species are *Viminaria denudata*, and *Nuytsia floribunda*, which occur on sandy patches in strange single stands at Pt. Picquet, *Xanthorrhoea preissii*, *Hakea varia* and *H. amplexicaulis*.

(viii) Parrot-Bush Heath

This association occurs high on the windward side of the Naturaliste Ridge blending with coastal heath on one side, and Peppermint forest on the other. It is characterised by an abundance of Parrot-Bush (*Dryandra sessilis*), and the presence of *Jacksonia* and some *Banksia* spp., but is
otherwise comprised of a mixture of its neighbouring associations including both stunted Peppermints and Olearia axillaris.

(ix) Coastal Heath

Coastal heath is the most common plant association bounding the western shore. It is comprised of a changing proportion of three or four major plant species and a number of less obviously varying lower shrub species. Olearia axillaris, Acacia deciplens, Bayeria viscosa and Scaevola crassifolia are the dominants and whilst it was evident that Olearia was dominant in the 'Sugarloaf Saddle' (Fig. 1) and Bayeria at Canal Rocks, it was not possible, in the available time, to differentiate further sub-types within this heath association.

Other species of significance within the association are Melaleuca acerosa, Leucopogon parviflorus, Jacksonia horrida and Melaleuca heugelii.

(x) Swamp Association

Several small swamps in the central Naturaliste Downs area were noteworthy for their support of Astartea fascicularis, Banksia littoralis and some Flooded Gum (E. rudis).

River and stream side associations have been discussed within other sections, and in general may be said to include the Flooded Gum, Marri, Yate (in some areas), Peppermint and a Bracken Fern (Pteridium esculentum) ground layer. Along the eastern foot of the ridge numerous specimens of Melaleuca incana provide a contrast with their paler foliage and attractive flowers.

Disturbed, Non-Agricultural Land

A small area, north of the Sugarloaf Rock turnoff, supports an almost pure stand of Jacksonia furcellata, with the occasional Acacia rostellifera. It would appear to be the result of burning and clearing at some stage, after which natural regeneration has been allowed to take place. The region has obviously not yet recovered its complexity and stability and would not appear likely to do so in the immediate future.
Micro-Habitats

Besides the macro-regions described as plant associations in the above pages, there are several small and distinctive vegetation types which are of importance in the maintenance of the faunal population of the Cape region. These micro-habitats are, firstly, the springs and seepage points which occur at the contact zone between limestone and granulite, and secondly, the collapse dolines and caves of the limestone ridge. Both create moist, humid conditions suitable for the growth of ferns and rushes, an ample water supply being available for snakes, possums, native bees, birds and other organisms. Such were noted in collapse dolines near Mt. Duckworth (see Map 1, p.7).

The Value of Uncleared Land Within Agricultural Regions

Charles Elton (1958) states that "it is no use pretending that conservation for pleasure or instruction, or the assigning of superior rights to animals will ever take precedence over human survival. Nor should it." Nevertheless he continues "that there is something very dangerous about handling cultivated land as we handle it now, and even more dangerous if we continue to go farther down the present road of simplification for efficiency."

A patchwork of uncleared, virgin bush, besides being attractive to the eye and valuable in a conservational and recreational sense, is also, provided a long term view is taken, desirable for the farmer. Simple populations, such as crop monocultures, are most prone to pest invasions due to the empty nature of many of the niches. Natural forest communities, with their high species diversity, generally have enough enemies and parasites available to turn on any species that starts being unusually numerous, through a complex system of checks and buffers. For instance the Common Dock (Rumex pulcra) has invaded much of the Cape's pasture lands, but is incapable of penetrating the uncleared land (cf. Map 3). By ensuring that areas of bush are left in their natural state (i.e. not simplified) buffer zones are created against the spread of such exotic weed species.

An attractive and yet potentially unsound practice in many parts of the Cape is 'parkland clearing'. By this is meant pasturelands in which the majority of trees have been left, whilst the understorey is cleared.
and the ground maintained in pasture. It is one of the most eye-catching types of farm management for its beauty, and yet within thirty years may be in a state of decline in many areas. This is due to the lack of provision for tree species regeneration. Whilst undergrowth clearing, to maintain grasses, removes the understorey species, it also removes the young tree seedlings and thus the stand becomes over-mature and eventually trees begin to die and are not replaced. Provision must be made either by selective clearing or by tree planting, to ensure the survival of this land use practice as it is enviable for both the farmer and attractive to the tourist. Parkland clearing is shown on Plate 13.

Theories of Island Biogeography and their Relevance to the Naturaliste-Leeuwin Ridge

Isolation of the Ridge from the rest of the Darling Scarp system allows it to be dealt with in much the same way as an island in terms of ecosystem characteristics. This also applies to the patches of virgin bush surrounded by large tracts of pasture and croplands both within and outside the present study area.

Several of Fosberg's (1963) island characteristics may be seen as relevant:

1. Relative isolation
2. Limitation in size (space resource)
3. Extreme vulnerability when isolation is broken

The effects of isolation include the limitation of organic diversity, reduction in interspecific competition and protection from external competition. All these combine to produce a closed gene-pool, within which the rate of evolutionary change is much more rapid.

Limitation in size of isolated communities has a direct bearing on the number of species present and thus on the complexity and stability of the ecosystem. Weins (1963) noted that species-area curves took marked steps at approximately the 4 and 40 hectare sizes on oceanic islands. Below each of these limits, the number of available niches (habitats) is generally restricted and thus only a specific number of organisms can survive. Once over this threshold, the number of niches and species tend to increase logarithmically (Fig. 6; note MacArthur and Wilson, 1967, p.8 and Niering, 1963).
FIG. 6 Relationship between size of area and number of species living in it (semi-log scale).

In continental situations, species-area curves are generally steep at first and then begin to taper off (Fig. 7, line b.). The mosaic of distinct plant communities in the Naturaliste area, it is suspected, may well tend to progress in steps as area increases, correlating with changes from one community to another. Stability of these communities could thus be suggested as being attained at or beyond the point at which the curve flattens out. With this in mind, areas of at least 400 hectares for each of the major plant communities would be required to ensure, to some degree, the conservation of examples of the total regional flora and fauna.

Isolation of the Cape region has, up to the present, saved the jarrah forest from invasion by Phytophthora cinnamomi, the jarrah-dieback root-fungus which threatens the existence of the rest of the State's forests. Its prime mode of range extension in the past has been by the adhesion of infected soil to vehicle tyres, and hence its distribution along the main arteries of the south-west. Shea (1975) notes that "a large proportion of the diseased forest area is restricted to the valley
bottoms. The fungus however, can rapidly destroy the vegetation on upland sites if infections are introduced at the top of the slope. If this occurs spores are rapidly distributed downslope in drainage lines." There would appear little likelihood of infection of upland sites in the Naturaliste area, or of the spread of the fungi via stream flow as no rivers from the scarp zone drain through the Naturaliste-Leeuwin ridge. How long the Cape jarrah will remain healthy depends on the progress made in attempting to control the disease, and the degree of contact with the Scarp, which to the present day has not been intensive.
3. Fauna

Introduction and Background

Australia, with a fauna heavily represented by marsupials, is, without doubt, in an evolutionary, and thus conservational sense, the most unusual and interesting of the world's faunal regions. The marsupials appear to have entered Australia early in the Tertiary (about 80 million years ago) at a time when mammal development had only just begun (Ride, 1971). Consequent isolation has led to the adaptive radiation of marsupials to fill niches more efficiently occupied by placental mammals on the other major land masses.

Natural invasions of mammals into Australia have been limited, although several waves of rats and mice have arrived in the last 20 million years (Ride, 1971, p.35). This has been supplemented by introduced species in much more recent times, namely the Dingo (Canis familiaris) which arrived with a late wave of aboriginal immigrants within the last 10,000 years. The earliest dating of dingo remains is put at 8,600 B.P. (Gould, 1973) for a site at Mt. Burr, South Australia. The various domestic and stock animals of the European settlers only came in the last 200 years.

(i) Climatic Change

Paleontological evidence points to the earlier existence of Koalas (Phascolarctos cinereus) in the Cape Leeuwin area, and probably the whole south-western region. A change towards a drier climate reduced the stands of Eucalypts with suitably palatable leaves until the last humid areas (along water courses) were no longer large enough to support the existence of this species.

(ii) Human Activity

Aboriginal hunting of the slow moving marsupial Diprotodon has led to its extinction throughout the continent (dates of charcoal from Mammoth Cave suggest possible human entry into southwestern Australia prior to 37,000 B.P., S. Hallam, pers. comm.).
(iii) **Dingo Competition**

The breakdown in isolation of the Australian fauna by the arrival of Aborigine and Dingo (*Canis familiaris*) may be the major reason for the eradication of the Tasmanian Tiger (*Thylacinus cynocephalus*) from the Australian mainland. Complete skeletons have been found in the Yallingup Cave and point to its existence in the Cape Naturaliste area not much later than 3,000 B.P.

(iv) **Unknown Factors Leading to Species Eradication Prior to European Settlement**

A number of other faunal finds (fossil) made in the Yallingup Cave, are of species no longer found within the study region. Reasons for their disappearance are not as clearly defined, although they are most probably a combination of the preceding three factors. These species are:

a) Tasmanian Devil (*Sarcophilus harrisii*), extinct in the south-west since approximately 700 B.P. and now only found in Tasmania.

b) Lesueur's Rat Kangaroo (*Bettongia lesueuri*) absent from the Naturaliste region since before 6,000 B.P. and now found mainly in the coastal vicinity of Sharks Bay, W.A. (Barrier Island has a well documented population).

c) Several rat species including *Rattus tunneyi* (Tunney's Rat), *Pseudomys shortridgei* (Blunt-faced Rat), and *Pseudomys praeconis* (Shark Bay Mouse).

**Changes in the Naturaliste Fauna Consequent on European Settlement**

Although settlement of the Vasse-Naturaliste area was begun in the mid-1830's no accurate inventory of the indigenous fauna was available until after the turn of the century, this being due to the collections of the Balston Expedition 1904-7 and the article by Shortridge (1909) outlining its findings. These data, combined with dated museum collections and private observations, provide a sketchy picture of the changes which have occurred as a result of human settlement.
Many of the species listed by Shortridge have not been recorded in the last twenty years and this may well be an indication of the effect of clearing (habitat destruction), niche theft by domestic livestock (their role in habitat degradation should not be ignored) and hunting on the native faunal populations. Several such species are:

(i) Quokka (*Setonix brachyurus*) collected at Yallingup near the turn of the century. Formerly thought to be present only on Rottnest and Bald Islands, its mainland numbers may be reviving, as indicated by finds east of Manjimup. Its habitat preference is thickly vegetated swampy areas in sclerophyll forest and coastal areas. Unfortunately many swamps have either been reclaimed or excavated for use as dam sites within the Naturaliste area as they are indicators of freshwater seepage points.

(ii) Brush Tailed Bettong (*Bettongia penicillata*) – not collected since 1907.

(ii) Tammar Wallaby (*Macropus eugenii*) – not collected since 1910, although an unconfirmed sighting at Mt. Duckworth has been made in 1971.

(iv) Chuditch or Native Cat (*Dasyurus geoffroyi*) – not collected since 1912. Shortridge noted that they frequented both rocky and well timbered country, and were also common along the coast where they fed on marine refuse. It is noteworthy that personal communication with the proprietor of Banamah Wildlife Park has indicated the continued presence in the area of this species, although almost solely along the beach zone, and the presence of the Freshwater Rat (*Hydromys chrysogaster*) which had also not been recorded since 1907.

Certain species continue to be recorded from the area, however this does not attest to their abundance any more than does the failure to record attest to species extinction. It would be difficult to determine the population of each species within the Cape Naturaliste area and the only course of action open in an attempt to avoid species loss is to be aware of their habitat requirements and provide adequate areas of such to ensure survival.

Marsupials and mammals recently recorded in the area include the South-west Pigmy Possum (*Cercartetus concinnus*), the Wambenger (*Phascogale tapoatafa*), the Brown Bandicoot (*Isoodon obesulus*), the
Brush-Tailed Possum (*Trichosurus vulpecula*), the Common Ringtail Possum (*Pseudocheirus peregrinus*) and the Common Dunnart (*Sminthopsis murina*). Two bat species, *Chalindobus gouldii* and *Eptesicus pumilus*, were recently recorded by Baynes and Kirsch of the Western Australian Museum who undertook a faunal survey of the Naturaliste area at the request of the authors (see Baynes and Kirsch, 1975). The Grey Kangaroo (*Macropus fuliginosus*) and Brush Wallaby (*Macropus irma*) are obviously in the area as attested to by sightings, and carcasses found on Caves Road, whilst the Honey Possum (*Tarsipes spenserae*) is a likely inhabitant, without however having been recorded.

The major faunal habitats may be divided firstly on the basis of moisture and secondly on the basis of inherent characteristics into the major types:

(i) **Moist Habitats**

a) Coastal swampy - Quokka.

b) Sheltered swampy (i.e. wetlands within wooded areas) - Quokka, Bandicoot.

c) Freshwater creeks and lakes - Water Rat and Wild Ducks.

(ii) **Dry Habitats**

a) Coastal heath and beach zone - Native Cat (*Dasyurus*).

b) Granulite heath and jarrah woodland - Dunnart.

c) Jarrah forest - Dunnart, Bandicoot, *Macropus* sp. (i.e. Wallaby and Grey Kangaroo), Ringtail Possum, Wambenger, Pigmy Possum and Brush-tailed Possum.

d) Open forest (peppermint, marri and jarrah) - as above, Dunnarts less common in peppermint woodlands.

Besides the furred components of the region's ecosystems there are many and varied birds, marine organisms and reptiles which need to be taken into account if a full picture of the Cape's biological resources is to be achieved. A partial list of bird species is given by Baynes and Kirsch (1975). A more extensive, although probably incomplete, list of bird species is given in White (1921, pp.124-129). In Appendix B is given a comprehensive list of birds recorded from the Naturaliste area, using White (with name updating where necessary), Baynes and Kirsch (1975),
local informants and the authors' own observations. A total of 76 species are thus recorded and while it is possible that some of these species no longer occur in the area, it is even more likely that other species occur which have not been listed. Of particular significance in the Cape Naturaliste area are two species, the Red-tailed Tropicbird (*Phaethon rubricauda*) and the Rufous Bristle-Bird (*Dasyornis broadbenti*). One of the earliest reports of Red-tailed Tropicbirds in the Southwest was by Shugg (1964) who recorded a juvenile at Collie. V. Serventy (1965) reported the birds nesting on the mainland near Sugarloaf Rock, and later Watts and Tarbottom (1967) made the first confirmation that they were nesting on Sugarloaf Rock itself. Since then this species has been protected and enjoys the refuge of a special reserve (number 31634) set aside to protect its breeding habitat. Sugarloaf Rock provides ideal conditions for nesting and up to 16 nesting pairs have been observed in recent years. Disturbance by visitors inhibits breeding on the mainland. The species is of particular interest as it is currently extending its range from a once tropical distribution to include areas along the south coast. Until recent years Sugarloaf Rock was its southernmost breeding ground on the west coast. The birds are attractive in flight and readily observed (and heard) from the shore.

The Rufous Bristle-Bird is important for two reasons: its rarity and its distribution. No sightings of Rufous Bristle-Birds have been made for many years in Western Australia (Slater, 1974, p.134), although the eastern 'race' is present in Victoria and South Australia. There is an apparent gradation of colour, from brown in Victoria to rufous in South Australia and brightest of all in Western Australia (ibid.). Its habitat is dense coastal thicket and a specimen was collected at Cape Naturaliste by the lighthouse keeper, circa 1903. It is possible that the species still survives in the area, and thickets of *Melaleuca huegeltii* southwest of the lighthouse probably provide the most likely habitat. Its secretive nature makes observation extremely difficult. Plate 8 shows *Melaleuca* thickets on the western flanks of the ridge between the lighthouse and Sugarloaf Rock, considered a promising habitat for the Rufous Bristle-Bird. This land is part of the English Wake holding to be purchased by the State for a reserve.

It has not been possible, in the time available, to consider marine organisms in detail as so little work has been published. Dr. B. Wilson of the W.A. Museum, makes the following comment:
"The marine habitats along the shores of Cape Naturaliste are varied and support a rich and diverse fauna. Exposed rocky headlands are populated in the intertidal zone by the Limpets, Mussels, Barnacles, Rock-Crabs and other creatures commonly found in this habitat along the South-west coast, but in more sheltered corners, such as at Bunker Bay and Yallingup Reef, there is an exceptional variety of colourful fishes and invertebrates surpassed by few localities in southern Australia. An energetic naturalist may study there at low tide representatives of all the main groups of shallow-water marine organisms. Especially numerous and diverse are the Feather Stars, Brittle Stars and Starfish (Echinoderms), the Marine Snails and Slugs (Molluscs) and Shrimps, Crabs and their relatives (Crustacea)." Australian Salmon has commercial value (cf. p.64).

"Besides its diversity, the shore fauna of the Cape Naturaliste area has significance for another reason. There is some evidence that a southward drift of warm water during winter brings down larvae of many tropical species which settle and grow on this temperate shore. Examples among the molluscs are the tropical Cowry Shells (Cypraea caputserpentis, C. vitellus and C. helvola) and the Cone Shell (Conus musicus). Below low tide level there are a number of species of tropical corals such as Turbinaria dana, Favites sp. and Coniastrea sometimes forms huge dome-shaped colonies many metres across. Examples occurring in Eagle Bay must be centuries old, for the growth rate of these corals in such temperate waters is thought to be very slow. This blending of tropical species with a predominantly temperate fauna on a granitic shore is unique to the Cape Naturaliste-Cape Leeuwin coast" (pers. comm., 1975).

In summary, it is evident that two factors are of importance. Cape Naturaliste provides the nearest hardrock coast to Perth and as such offers a most convenient location for scientific and educational purposes. In addition the Cape provides areas of distinct contrast with sections of the coastline subject to heavy swell and surf conditions (e.g. Sugarloaf Rock) and other sections where the environment is calm (e.g. Meelup Bay). A further contrast is provided by sections of the coast with limestone outcrops, including wave cut platforms and associated reef dwelling organisms, adjacent to areas of granulite, and associated biota. Freshwater springs and sandy beaches add to the diversity of habitats.
On a broader scale, there are apparently some northern species recorded at their southernmost limit in the area, while some southern species extend no further north (R. George, pers. comm.).

The limestone reefs at Yallingup provide an ideal site for educational purposes as they are readily accessible and quite safe at low tide. An early morning examination revealed numerous species of marine organisms temporarily stranded in pools providing a living laboratory. The Australian Marine Sciences Association, in a report for the Conservation through Reserves Committee of the Environmental Protection Authority on the establishment of marine reserves mention as their criteria that sites should include "portions of more than one type of habitat so that such a reserve would have the greatest possible diversity." Cape Naturaliste is an excellent example of such an area.

Micro-habitats have already been mentioned in the section dealing with vegetation, however there are several interesting areas which increase the habitat diversity. While collapsed caves (dolines) and swamps have already been mentioned, it has been reported that freshwater springs provide distinctive and essential habitats in the area for a species of freshwater crab (George, 1962). *Leptograpsodes octodentatus* occurs near freshwater springs and streams along the western coast (recorded at Yallingup, Wyadup and also between Sugarloaf and Naturaliste). These crabs pose interesting problems due to their requirement of specialized localities along the generally arid western coast. In addition, freshwater burrowing crayfish have been described from swamps in the Naturaliste area. Riek (1967) named a new genus *Engaewa*, allied to *Engaeus*, to include three small burrowing species from the southwest coastal zone. *Engaewa reducta* is only known from Dunsborough and in common with the other two species in the genus requires a specialized habitat. The habitat is a soak area, precisely the kind of site which farmers utilize for water provision. General farming practice is to excavate the soak and/or dam the area, either practice producing radical changes in the crayfish environment. These species have been described as 'living fossils' (George, 1975, pers. comm.) and an implication of such great age of the species is that suitable habitats have also existed for a long time. The biogeography of *Engaewa* is interesting and it is evident that isolation and specialized habitat requirement has encouraged speciation (see Map 5). The population of these species is probably very low and very little is known of their natural history and ecology. Riek considers that "there is
every possibility that additional species of the genus (Engaewa) occur in similar situations throughout the coastal zone of the southwest corner of W.A." (op.cit.). A new species of Cherax was also described by Riek, Cherax glabrimanus, which is only known from its type locality (16 km south of Yallingup) and at Dunsborough. This species occurs in flowing streams. If such rare and interesting species are to survive, preservation of habitat is a prime requirement.

Other distinctive micro-habitats occur in the area, and of particular interest is the freshwater lagoon on Cape Farm. This provides a refuge to wildfowl and a habitat to freshwater organisms. There are also numerous tiger snakes (Notechis scutatus) in the surrounding country.
4. Land Systems

A 'land system' may be regarded as an area within which there is a recurring pattern of landforms, soils and vegetation. The concept of the 'land system' has been used in recent years by the C.S.I.R.O. for purposes of both mapping and terrain evaluation due to its adaptability to many scales of resolution. Within any one system, dimensions may be made into 'units' and 'facets' each becoming smaller and thus having greater explanatory power. Actual localities and sites are shown on Map 2, p.10.

The Cape Naturaliste area is tentatively divided into six 'land systems', two of which are subdivided into an eastern and western sector on the basis of differences in degree of exposure to prevailing winds and salt spraying. The relevance of these divisions will be seen when a consideration of the more fragile parts of the Cape is undertaken.

(i) Meelup Lateritic System

The Meelup land system stretches along the eastern part of the Cape from Eagle Bay to Point Dalling and thence inland, crossing the Caves Road approximately two miles west of Dunsborough, in the vicinity of Reserve number 28665 (Map 6). The major characteristics of the system are:

a) The shallowness at which the lateritic soil is struck, and, as a consequence
b) its support for stands of jarrah (E. marginata) and some marri (E. calophylla).

This system, as noted in the vegetation section, is an outlier of the main Darling Scarp laterite and has many of its features. Several streams dissect the landscape, provide sources of freshwater, being spring-fed, and local wet spots where large grass tree (Kingia australis) stands often occur.

The stability of this area is inherently very high, due to the good vegetation cover, high cohesiveness of the lateritic cap and protected leeward position in which it is found. However, several areas cleared for use as gravel pits and rubbish dump sites are suffering considerable gully erosion due to the effect of raindrop impact and...
KEY: LAND SYSTEMS
1: MEEUP LATERITIC
2: BUNKER BAY
3: CENTRAL LOWLAND
4: DUNSBOROUGH BROADWATER
5: NATURALISTE RIDGE
6: HEADLANDS-BEACHLANDS
overland flow of water on unvegetated surfaces. Revegetation of such areas would entail the filling in and contour banking of the affected sites and planting of suitable shrub and tree species.

(ii) **Bunker Bay Sandy Lateritic System**

This system is markedly more undulating having gentler, longer slopes and a slightly more exposed aspect than the Meelup system. The sand layer over laterite is much deeper and supports marri and peppermint (*Agonis flexuosa*) to the exclusion of jarrah in most parts, whilst the Yate (*E. cornuta*) is locally important and the Flooded Gum (*E. rudis*) occurs along creek lines, e.g. the Eagle Bay Creek.

Where exposure to the prevailing S.W. winds is greatest, that is, from the Sugarloaf turnoff to the Cape Lighthouse, vegetation associations have been adversely affected as may be seen from the stunted, mallee like habit of the jarrah and marri in this area.

Farming is of moderate intensity within this land system, much of the natural vegetation having been cleared. As with most farms on the Cape a sensible attitude towards land clearance has been adopted, and the chances of farmland erosion and landscape deterioration under the present systems of management are minimal, although it is acknowledged that vast changes can occur when properties change hands and/or purpose, (e.g. a change from pasture to mineral sand exploitation).

(iii) **Central Lowland System**

The central lowland system could, more accurately, be called a sink area rather than lowland. It is situated in the centre of the region between the 80 and 100 metre contour lines, is very flat and thus acts as a collecting area for water from both the western limestone ridge and eastern lateritic uplands. It is only efficiently drained at the northern end, where the Eagle Bay Creek is located. In the central and southern sections water is present in the form of swamps and wide laterally migrating creek lines. It stands out clearly on Map 2, p.10.

Swampy sites are clothed in *Astartea* and *Flooded Gums* (*E. rudis*), whilst the intervening drier areas support stands of *Banksia* and Marri with their associated understorey species. The soils are deep, being
derived from both wind and water deposits and probably overlying laterite at some depth.

Most of the area is managed as a single farming property and is attractively as well as functionally maintained. This has been done through the technique of parkland clearing, a method which leaves trees standing to provide shelter for stock, protection of soil and pasture from wind erosion, maintenance of a steady ground-water level (thus avoiding a rise in the swamp water levels) and, unintentionally, provides attractive scenery to passing travellers (although there are drawbacks to the practice, as noted at the end of Chapter 2).

(iv) **Dunsborough Broadwater System**

The Broadwater is a lowland, freshwater swampy area lying west of Busselton and extending just into the present study area near Dunsborough. It is a part of the Bunbury sub-basin containing more than 5,000 metres of Palaeozoic and Mesozoic sediments (Compston and Arriens, 1968). In this region its catchment is the northern extremity of the Naturaliste-Leeuwin Ridge (C.T.R.C., 1974).

Being less than 20 metres a.s.l. in all parts it is at times subject to winter inundation, although drainage channels are apparent on many cleared properties. It is at best geomorphically featureless, but supports good stands of Paperbark Melaleucas, Flooded Gums and Marri trees.

(v) **Naturaliste Ridge System**

The Naturaliste ridge comprises a thick layer of limestone overlying granulite which is the base rock of the whole Cape. At points the ridge reaches heights in the vicinity of 220 metres (ab. 720 ft.) and is thus fully exposed to the strong south westerly winds and spray on its western slopes. Figures 1 and 2 (pp.8-9) show the Ridge's alignment.

The severity of climatic conditions is reflected in each of the three elements which combine to produce a distinctive land system (that is soil, vegetation and landform). Along most of the western coast, rugged limestone cliffs up to 40 metres high dominate the scenery. Behind these the land rises rapidly to the 80 metre contour level and
then more slowly towards the 200 metre level. Almost to the interfluve of the ridge there are no trees, but rather hardy coastal heath species specially adapted to the strong winds and salty spray (which induces succulence). Soils are very shallow over the outcropping limestone and it is only in the collapsed dolines (collapsed cave systems of extensive size) and depressions that soils can accumulate and conditions are protected enough to allow trees to establish themselves. Any disturbance of this system can cause huge erosional problems as could be the case in two areas between Yallingup and Sugarloaf. The first, known locally as 'the Rabbit Patch' comprises a "ripped-up" coastal track just north of Yallingup, used by surfers to reach the surfing spot called 'The Three Bears' (Cabejgup). Recent increases in the number of users, especially those with four-wheel drive vehicles, has turned the stretch of track which has a south-west aspect, into a sandy, mobile dune. Attempts to bypass the patch have led to increased vegetation destruction and sand mobilization (Plate 9). The second area is the track's destination, 'Three Bears' (Plate 10), a surfing spot along the cliffed coast. Continual movement up and down the foredune area has led to vegetation removal along tracks and, as in the case above, sand movement in the face of the prevailing winds.

In marked contrast the leeward side of the ridge is protected from both strong winds and salt spray. Peppermint woodland and forests (Agonis flexuosa) immediately appear and stretch along the whole of the ridge from near Sugarloaf Road to Canal Rocks. North of the Sugarloaf turnoff the ridge is too exposed to allow forest growth.

Due to the permeable nature of the rock there is no surface drainage on much of the ridge and moist spots occur only in collapsed dolines and areas where the limestone beds have been cut through by stream erosion and surface denudational processes.

(vi) Alternating Headland-Beachland System

The alternating headland-beachland system is made up of a recurring pattern of granulite headlands and a mixture of sandy and rocky bays (cf. Maps 1, p.7, 2, p.10 and 6, p.39).
On the western coast there are two areas of this type, one from Canal Rocks to Yallingup (sub-system 6c), and the other from Sugarloaf Rock to Cape Naturaliste (sub-system 6b). Vegetation is of the low heath type although there are patches of Melaleuca thickets at Canal Rocks. In both areas it is evident that coastal dune systems are very finely balanced and the slightest amount of interference may create erosional problems. This is most noticeable where the bays face south-west, as is the case with part of Smith's Beach and at the Cape itself. In both instances there is evidence of former blowouts, and at the Cape, there is a huge blowout which threatens (in the future) to cut the Cape promontory off from the mainland. This blowout is said to have begun at about the turn of the century due to grazing and burning of the area. Once the sand was exposed, vegetation could not become re-established, and has still to recolonize the area. A similar, but more visibly dynamic situation exists at Cape Clairault where the moving sand dune (approx. 10 metres high) is burying trees (Melaleuca and Peppermint) alive, and has moved eastwards a distance in excess of 15 metres in the last twelve months, cutting off the road to a once popular picnic area and spilling seaward on the other side of the Cape (see Plates 11 and 12).

The eastern shore (sub-system 6a), facing Geographe Bay is much more stable. Trees (especially Melaleuca and Peppermint, but also Marri) extend to within several metres of the water at some points and provide a permanence to the coastal form, as do the headlands whose structure (see Chapter 1) is a dominant force in determining the shape of the whole coastline. It is this coastal section which would appear most capable of withstanding the pressures of 'human grazing' activities (i.e. camping, recreation, etc.) as long as basic managerial safeguards are maintained.
PART II: HUMAN USE

5. Land Ownership

(i) Historical Perspective

The Baudin expedition charted and named many geographical features in the area: Cape Naturaliste and Geographe Bay (named after its ships on May 30th, 1801), Point Picquet, Hamelin and Depuch Bays. Other names bestowed were Leschenault, Lesueur and de Freycinet. A sailor named Vasse was stranded ashore at Toby’s Inlet (between Dunsborough and Busselton) during a storm and had to be abandoned. He apparently lived with the natives for some years. His name was given to the local district and river.

British settlers came to the Swan River in 1829. Within a year the Secretary of State for the Colonies ordered a southward expansion, presumably to make safe from the French the more strategically valuable part of the State. Stirling moved quickly and by May, 1830 three land grants (to the Molloys, Bussells and Turners) had been taken up in the Augusta area. Within three years it was found that the site was too difficult; all three families moved to the less wooded Vasse district in the mid-1830's.

Details of intensive whaling activity by American whalers in Geographe Bay are recorded by Georgiana Molloy, who noted (in her diary) in January 1840 two whalers at Castle Bay, the 'Izette' of Salem and the 'Duces' of Falmouth. More had been recorded by April and each succeeding year in the December to March quarter.

At first relations with the Americans were cordial; however, when two local companies decided to enter the whaling industry in the early 1840's, resentment of the Americans followed. Operations of one company were short lived due to the destruction of the Castle Bay factory by a bushfire in 1849. By the 1880's whaling had all but ceased in the area and the only remains are the whaling lookout point at Castle Rock and factory ruins in Castle Bay.
The Chapman, Seymour and Curtis families are of historical significance due to their continued presence in the area, their association with early farming, the discovery of the caves, and the building of the lighthouse.

The Chapmans came to Western Australia at the same time as the Bussells and took up land in the Sussex district. Henry Chapman owned Cape Farm and Inlet Park, George was the original owner of Jack Seymour's property and James had land at Eagle Bay. Inlet Park was apparently the hub of the property and Prospect Villa the family's town house.

The original homestead blocks of forty acres were granted so early they had no block numbers - only a small letter "D" which was still shown on the Cape Farm grant in 1910. Inlet Park became "Sussex Location 1" and Prospect Villa "Sussex Location 2". Besides these grants the Chapmans also had a pastoral lease of a great deal of the land on the Yallingup side of the Cape Naturaliste Road.

On the Eagle Bay property, James Chapman had trouble finding good water, but finally found it near where a heap of stones still marks the site of the first house. The chimney of the second cottage may be seen near Mr. Hammond's home at Eagle Bay.

Henry Chapman married Amelia Glindon, whose sister Susan married a Captain Curtis. All the Chapmans died without issue, and Amelia inherited the property, except Cape Farm which Henry Chapman had given to his nephew, William Curtis - son of Captain Curtis - on the occasion of his first marriage to Julia Smith in 1862. Julia died early and is buried by the Church in Busselton. William's second wife was Mary Jane Dawson of Vasse, by whom he had eleven children.

The two original rooms built of clay are still there at Cape Farm. The property changed hands and was finally bought by the Griffin Mining Company which was going to work the sands for metals. Due to saturation of mineral and markets at the present time, there are no immediate plans to mine the property, which is, in the meantime, being used as a holiday site for the manager of the mining company. The property is one of the few remaining local landmarks of the 19th Century.
According to the Busselton Historical Society, the spot where William Seymour settled on 1st January, 1853 was known as Quedjinup, later named Dunsborough. There he built his cottage consisting of two rooms, made from clay found in nearby fields. The workmanship was such that the house still stands today.

William (1820-1874) came to Western Australia with the first batch of whalers to work for Lionel Sampson & Co., signed on for three years. In 1855 he married Mary Scanlon at Busselton, and their daughter Elizabeth was the first white child born in Dunsborough. There followed seven more children, one of whom, Fred, was many years later to discover the hole leading to the Yallingup Caves while on a hunting trip on the Wardenup Cattle Run.

William Henry Curtis (born at Cape Farm, Bunker Bay, in 1877, died in 1964, one of the eleven children of William and Jane Curtis) spent his boyhood between the two farms at the Cape and Inlet Park, Wonnerup which his father inherited from his Aunt, Mrs. Henry Chapman. He was an excellent bushman and horseman, and was out hunting dingo pups (a menace in those days) in the company of Ned Dawson and Fred Seymour, when they found the entrance of the N'gilgi Cave at Yallingup in 1892.

William Curtis helped build Cape Naturaliste Lighthouse in 1902. At the time he helped to save the crew of the timber ship "Electra" (200 tons) which ran on a reef and sank. He guided the crew ashore to Bunker Bay by lighting flares on the Cape hills.

Thus three families gave their first imprint to the Cape Naturaliste landscape. There still are many historical buildings and monuments in the Cape Naturaliste area which are of interest to tourists and should be maintained as part of the total landscape. The old water-wheel, just south of Yallingup, provides an excellent example of restoration which could be followed at other sites of historical note.

(ii) Ownership by Type of Land User

The control of land use in any area begins with land ownership and for this reason the Cape Naturaliste peninsula (Yallingup - Dunsborough) pattern of land ownership was examined. Data were obtained from Busselton Shire Council and a study of the most recent lithograph (413A/40). Of a total area of approximately 17,000 acres (6,880 ha),
some 60% is alienated for agricultural purposes (3,770 ha). A proposal by English and Wake to develop their holding of 1,200 acres (486 ha) for a tourist and recreation resort was refused by the State Government, which announced its intention to purchase most of this land for a park reserve. Consequently this land has been included in the area held by the National Parks Board although final details of the government purchase have yet to be released. With this addition, approximately 25% of the area (1,720 ha) is vested in the National Parks Board. Of the remainder, 1,052 ha is vested in the Busselton Shire Council, mainly for recreation, camping and park lands, with minor areas set aside for such council purposes as water, rubbish disposal and gravel. Residential land comprises some 2% by area, supplying in excess of 600 private residential blocks and several larger blocks which are used for residential purposes. There are two caravan parks (Dunsborough and Yallingup) together with an area set aside by the Busselton Shire Council for a caravan park at Meelup. The Council has not been successful in their endeavour to attract a private enterprise investment in this site.

Although some 60% of the total area is currently alienated as agricultural land, not all of this proportion has been cleared. Within the general class of agricultural land a further distinction has been made between three sets of land owners:

a) Properties >100 Hectares. Only six farmers have more than 100 hectares, and of these six, one owns 75% of the total land owned by this group (2,700 ha) and in fact owns 65% of all the agricultural land on the peninsula. This group of six farmers controls 3,642 hectares, amounting to 90% of the agricultural land in the area.

b) Properties >40 Hectares <100 Hectares. A further six farmers own properties in this class and it is evident that in most cases significant contributions to income are derived from off-farm activities. This class owns approximately 7% of the total agricultural land.

c) Properties >2 Hectares <40 Hectares. There are 20 landowners in this class who between them own the remaining 3% of the agricultural land. In this group non-farm activities are important income sources and include for example the Banamah Wildlife Park.
Land vested in the National Parks Board includes some set aside for recreation (ocean frontage); as a tourist resort (west coast), and some for the protection of caves (Yallingup). Other than reserve 8427 (about 253 hectares which incorporates flora protection as well as caves and pleasure resort) there is no land specifically set aside as a nature reserve or for the conservation of flora which is vested in the National Parks Board. Land set aside for conservation of flora (332 ha) is either vested in the Busselton Shire Council (263 ha), or control is retained by the Lands Department (69 ha). Reserves are listed in Appendix C, pp.92-94.

The only area specifically set aside for conservation of fauna is reserve number 31634 (Sugarloaf Rock) which is vested in the W.A. Wildlife Authority. In this case the objective was to protect the Red-tailed Tropicbirds (Phaethon rubricauda) which nest on Sugarloaf. However, it is evident that although most areas held by the National Parks Board have not been set aside specifically for the protection of flora and fauna, as a by-product of the Board's control the local flora and fauna enjoy considerable protection. On the other hand no positive programme of management has been initiated by any of the groups which control land set aside for flora and fauna or caves protection, and none of the approximately 1,133 hectares controlled by the National Parks Board in the area is exclusively set aside for preservation or conservation purposes. Each of the four large reserves thus vested incorporates an aspect of public use, such as "health and pleasure resort", "tourist resort", or "recreation". It seems inappropriate to vest recreation and tourist resorts in the National Parks Board, and equally so to vest conservation of flora in the Busselton Shire Council. However, such vesting may have been a fortunate event. It is clear that this circumstance has inhibited rash development and provides the opportunity for rational planning now.

In general, Cape Naturaliste land ownership is distributed among numerous groups and individuals, however 40% of the total area of Cape Naturaliste (as defined above) is owned by one farmer, while other major portions of the Cape are controlled by the Busselton Shire Council and the National Parks Board. The majority of people who own land on the Cape have residential blocks in the main areas of settlement.
(iii) The Spatial Pattern of Land Ownership

As can be seen from the map there is a very distinct pattern of land ownership which correlates with land use. Soils, particularly as a function of geomorphology and geology, have exerted a strong influence on land use potential and hence land ownership patterns. The western ridge, exposed to strong winds and consisting of porous relatively impoverished soils, has not been utilized for agriculture, other than periodic grazing.

Most of the western flank has been set aside for recreation and other non-agricultural land use. The only exceptions are the blocks owned by English and Wake (to be purchased by the Government for a park) and block 1044 owned by J. D'Espesselis and used for grazing. The valley formed by the Yallingup Stream was recognized as highly suitable for residential development, particularly in association with the Yallingup Cave attraction and the wide beach nearby. This is the only settlement on the western face of the ridge although a tourist road to Sugarloaf Rock utilizes a break in the ridge further north. Yallingup had approximately 160 residential blocks in January 1975 (refer to Figs. 1 and 2, block diagrams on pp.8-9).

On the lee slopes of the western ridge the sparse vegetation which covers the exposed flank is replaced by taller woodland and forest on more fertile soils. Parts of these lee slopes have been cleared for agriculture but the majority of agricultural holdings occupy a wedge of land extending north-south along the eastern foot of the ridge, widest at the south and narrowing in the north, although agricultural activity extends to the ocean front at Bunker Bay. Further south-east and east the stony granulite ridges and the duricrust mantle have been ignored by agriculture and most of this type of country is vested in the Busselton Shire Council as a recreation, grazing, camping and timber reserve (Meelup). The north-east coastline, from Bunker Bay to Dunsborough, is the most attractive recreation area due to calm waters and shelter from the westerly winds. Along this coast there are numerous landowners as a result of subdivision, beginning with a small group at Bunker Bay, two at Rocky Point, 41 blocks at Eagle Bay with even more planned (a total of 12 hectares), and finally the major subdivision of Dunsborough containing approximately 400 building blocks west of the Caves Road turnoff.
Meelup reserve (21629) has inhibited private subdivisions to date, and the caravan park reserve (28933) of 6.9 hectares at Meelup itself has not attracted private developers despite the Council's desire for this development. The owners of the smallest class of agricultural blocks, apart from those along the north-eastern coast, are concentrated along Caves Road between Dunsborough and Yallingup.

As a result of this general pattern, together with the reserve on Caves Road itself (28665) which is particularly important in that it contains the northern most outlier of *Dasypogon hookeri*, the flora is well represented on existing reserves. The most significant exception is the grove of yate trees (*Eucalyptus cornuta*) which occurs on the lee of the ridge on portions of blocks 1046, 70 and 1314, all of which are developed for agriculture. As this grove is the most northern outlier and represents the type habitat, its long term conservation is important.

Most of the area at present protected (sometimes inadvertently) is on the western exposed flank of the ridge and consists of a heath formation (see Chapter on Vegetation). Some of the distinctive Peppermint forest (*Agonis flexuosa*) is preserved by reserve number 8427 surrounding Yallingup Cave. Meelup reserve (21629), on the leeward side, contains a stand of Jarrah/Marri open forest which extends closer to the ocean than anywhere else in the State. Within this stand are numerous attractive Grasstrees (*Kingia australis*) together with an apparently normal complement of Jarrah forest species. The C.T.R.C. report overlooked this area in its recommendations for reserves and it is the authors' opinion that an area of this open forest, in the Castle Rock vicinity, should be set aside for conservation purposes. Careful management of this land would be required, since part of the forest was accidentally burnt out in January 1975 due to a fire escaping from Dunsborough rubbish dump. Severe summer fires are now ecologically unsound due to the possibility of invasion by grasses from adjacent agricultural areas, and possible loss of indigenous herbs.

It is evident from the foregoing that most of the indigenous flora is preserved within existing reserves however fortuitous this may have been. With the exception already noted, it seems unlikely that further land will be required to conserve flora. On the other hand some judicious land purchase might extend existing reserves and enhance the chances of survival of both flora and fauna. For example block 885 is
almost totally uncleared and contains about 81 hectares of Peppermint forest. Such a block would enable better scope for sound management of the total area of Peppermint forest. It is important to remember the pressures of human use which to some extent might conflict with preservation objectives. On the other hand this type of country is particularly attractive for bush walking and picnics and human use should not be excluded. At present definite areas of human pressure are restricted to tracks and around Yallingup Cave itself. The acquisition of block 885 is considered particularly useful in terms of overall management of the Peppermint forest for the dual purpose of conservation of flora and fauna and human recreation activity. The present owner of the property is keen to sell to the Government for this purpose.

The remaining land ownership pattern to be considered is although minor in size, quite marked in impact. This is the location of Council gravel pits. Throughout the area gravel pits intrude on the landscape with dismayingly frequency. Little or no attempt seems to have been made to locate them out of sight from tourist roads or indeed away from recreation areas. These ubiquitous gravel pits are abandoned like so much litter over the landscape. No attempt has been made to rehabilitate any of them and they remain scars on the land. In some cases severe erosion has added to the problem, for example just south-east of the lighthouse on an area not even set aside for gravel. Numerous Councils in the State have demonstrated not only the feasibility but also the advantages of revegetating gravel pits (for example converting them to picnic areas, or tourist parking areas).
6. **Land Use and Control**

Map 3 shows the land use pattern north of Caves Road, in particular the extent of clearing on private and public land. Not evident from the map is the fact that within the public lands there are several groups of different land use activities some of which may be in conflict. Each of the major land use activities will be considered separately.

a) **Agricultural Land Use.** The major agricultural activity is grazing on both cleared and uncleared land. Beef cattle probably provides the major income from agricultural products in the area although sheep for wool are also important. Very little area is devoted to cropping either for sale or for on-farm use. Some of the smaller landowners produce lucerne hay under irrigation and the prospect for this activity seems bright provided adequate water supplies are available. Present water supplies in the area include some bores, soaks and springs with occasional dams.

Much of the agricultural land has been cleared; however some of the land is in a "parkland" condition (see Plate 13). Undoubtedly these "parkland" landscapes are very attractive to tourists, with the improved pastures providing distinctive backgrounds for the native trees (*Eucalyptus* species and *Agonis flexuosa* - Peppermints). Parkland clearing is thus a positive attraction to the tourists who visit the area because it breaks the monotony of cleared fields. However there is no evidence that farmers with parkland areas are allowing or encouraging regeneration. In the absence of such positive management policies the established trees will eventually die and the parkland will be reduced to bare fields. There are already many dead trees in some paddocks, caused in some cases by exposure to wind and in others by natural disasters (e.g. a severe willy-willy has left a trail of dead trees in the Eagle Bay area). Local experience suggests that while Jarrah seldom regenerates in parkland situations, Marri, Bullich and Peppermint do so readily. Some of the parkland clearing is a relic of an earlier era when some trees were left because they were too large to clear. Modern practice has been to leave distinctive groves of uncleared bush as shelter belts. The result is often equally attractive, particularly where the farmer has considered aesthetic appeal and landscape design, as well as sound management practices.
The proportion of each holding that is cleared varies considerably, but in some cases is quite high (80-90%). It is difficult to assess the likelihood of further clearing, although farmers recognize the need for shade and shelter as part of animal husbandry. Under existing legislation taxation allowances are available for "the destruction and removal of timber, scrub or undergrowth indigenous to the land" without any qualification as to future use and need (Barwick, 1970). If preservation of certain types of landscape is desired then the alternatives seem to be either the imposition of controls over the proportion of land cleared and/or positive assistance in the form of advice, cash grants and encouragement (e.g. taxation allowances for retaining stands of trees).

Such areas may not prove of major importance as nature reserves although Elton (1958, p.155) has pointed out the ecological importance of the network of hedgerows and roadside verge habitats in England as nature reserves. Ehrenfeld (1970, p.178) also considers these "analogues of natural communities" important both locally (as refuges) and regionally (as migratory routes). The role of such areas in the southwest of W.A. as either refuge areas or as migratory aids has not been assessed at the time of writing.

Despite the present difficulties caused by low prices in the beef cattle industry, no radical change in the type of agricultural land use is foreseen in the near future. Eventually an extension of dairy product demands, due to increasing urban populations in Perth and the regional centre of Bunbury may stimulate milk production in the area but this would probably not occur for many years.

In terms of land use, a major agricultural problem in the area is dock infestation. Two species of dock occur, *Rumex crispus* which is present mainly in moist areas and along roadsides, and fiddle dock (*Rumex pulcrus*) which in places covers entire paddocks. Dock infestation is causing concern throughout the State and the plant is considered the worst agricultural weed in the State at the moment (J. Allan, Agricultural Department, pers. comm.). At Cape Naturaliste infestations also detract from the summer landscape. In neglected places there are large populations of Sodom's apple shrubs (*Solanum sodomium*) which detract from the scenic beauty of agricultural land (e.g. Cape Farm).
Rabbits have caused concern in the area for many years and attempts to eradicate these animals continue. Experimental work with the European rabbit flea is being undertaken locally. There are some reports that the fleas are also infesting indigenous mammals but experimental evidence suggests this would not occur as the rabbit flea is highly host-specific.

b) **Government and Semi-Government Authorities.** Foremost in this class of land users is the National Parks Board, but only in terms of area held. At the present time no ranger is employed in the area and the Board has no plans for either management or development of its holdings. Abuse of land in its care, for example erosion caused by excessive vehicle use on the west coast, seems to have occurred without any attempt at correction or prevention. It seems obvious that lack of manpower is a major problem to the Board in managing areas vested in its control. The establishment of a permanent ranger costs in the order of $40,000 (Board's estimate) with annual maintenance of approximately $12,000. If the ranger was involved with management and development of public access and recreation facilities as well as management of preservation areas, such a cost does not seem exhorbitant. Of major importance is the likely cost of a continuation of existing conditions in the presence of increased public pressure on fragile areas.

The Busselton Shire Council, also due to the large area of land under its control, is also a major land user on the peninsula. In many ways the Council has contributed to recreation facilities in the area, such as the provision of toilets and showers. However the Council has not been particularly innovative in providing for tourists. For example, none of the roads have adequate parking areas to enable the travellers to stop and either enjoy a particular view or walk in the bush. As previously mentioned, gravel pits have been abandoned with no attempt at rehabilitation, a fact of considerable importance due to the lack of aesthetic considerations when locating pit sites. The Council rangers who visit the area mainly during summer spend much of their time enforcing 'no camping' regulations, a fact which does little to encourage tourists. It is evident that the legal requirements that no camping be permitted within 25 km of a caravan park is of particular concern on the Naturaliste peninsula. There is no site further than 25 km from a caravan park in the area although overnight camping continues to occur in the more isolated locations. This point will be discussed in more detail below.
Other Government activities include a 405 hectare field research centre of the Agriculture Protection Board, on land leased from a farmer, where studies on the rabbit flea have been continued since 1967. The centre is important for such research which includes detailed investigations into population dynamics.

The Cape Naturaliste Lighthouse, apart from its obvious function, is a tourist attraction and provides employment for three families. At the time of writing Navy personnel have been using land near the lighthouse for activities associated with a hydrographic survey. As part of this project a mast was erected on the highest point of land, entailing the complete removal of vegetation on an area of approximately 0.5 hectare. It is hoped that some attempt will be made to revegetate this area before wind erosion begins to extend it.

c) Educational Use. Important users of Cape Naturaliste resources in the past 12-18 months have been high school teachers and students on field study excursions. Hammond (1974) has pointed out the great value of the area to various groups of students and teachers. A recent estimate of use for the past twelve months is 40 persons per weekend. During 1975 every weekend is booked throughout the year and some schools are using the area during weekdays. Students and teachers involved come from all over the State and cover such subjects as Geography, Biology and History. This type of use contrasts with recreation use in that the latter has a distinct seasonal component (see below) while the field study activities spread throughout the year. In the past year this has meant a considerable bonus to private enterprise establishments which supply accommodation and food. During 1975 it is anticipated that more than 2,000 students and teachers will be involved in educational activities at Cape Naturaliste. Mr. P. Hammond of the Curriculum Branch of the Education Department considers Cape Naturaliste an ideal location for a field study centre and it is evident from teacher and student response in 1974 and 1975 that strong support exists for this location. Some of the specific advantages of Cape Naturaliste include the following points listed by Hammond (pers. comm., 1975):

1. Compactness - ease of access and movement within the area.
2. Variety and clarity of physical features, especially contrasting lithology and structure, surface and subsurface expressions.
4. Sequent occupancy study potential.
5. Historical sites and data available locally.
6. Recreational activities, particularly bush walking and caving.
7. Landscape development processes including areas suitable for measurement and experimentation.
8. Sociological aspects of value to participants including community involvement.
9. Increased awareness of the environment together with motivation to read and learn.

Support for field study centres had been growing rapidly throughout the world. "They supplement the work of schools, universities and adult education centres, and have an important part to play in renewing the interest of people who live and work in urban and suburban surroundings in their rural countryside, its natural resources and the problems of conservation" (Bird, 1965). According to Piesse and Strom, in their excellent paper on Field Studies Centres (1970), an essential location criterion is habitat diversity. Cape Naturaliste is probably one of the most suitable locations in the southwest of W.A. for such an activity. However its suitability depends largely on the preservation of habitat diversity and sound management to ensure the long term conservation of a stable environment. It is significant that those concerned with existing field study activities at Cape Naturaliste are already considering management proposals to avoid over-use by student/teacher visits. Intensive human use, like any other form of over-stocking, inevitably requires careful management to avoid erosion. That Cape Naturaliste is already important is indicated by comparing anticipated 1975 use (2,000 persons) with the 1967-68 Field Studies Council activities in Britain where 15,000 students used the several centres available under a total budget of £160,000 (Piesse and Strom, 1970, p.32). In that year, students studied Biology, Countryside and Natural History, Geography and Geology, Art and Archaeology amongst others. By far the major portion was shared by Biology and Geography and Geology (over 90%). A spin-off benefit in Britain has been a significant contribution to knowledge which has been derived from the field studies of students and teachers.
If demand for this facility (and the use of Naturaliste resources) continues, it appears likely that a formal secondary/tertiary field studies centre may be established in the area. An ideal site for a field studies centre would be along the eastern (protected) coast between Bunker Bay and Dunsborough - possible on one of the farming properties adjacent to the coast.

d) Recreation Use of Cape Naturaliste. As an indicator of tourist use, road traffic counts provide useful data. Unfortunately very little monitoring has been done in this area. The Main Roads Department has carried out two brief counts; at one site from 21.11.69 to 25.11.69 and at another site from 27.5.71 to 3.6.71. Map 8 gives the results of these two counts. The Main Roads Department has estimated that traffic flows have increased during the period 1968-1974 at an average rate of 6% per annum (pers. comm.). From the data shown by the Map it is evident that a large proportion of the vehicles using Caves Road visit Yallingup. It is not possible to determine the proportion of each count that would be local residents although it is obvious for example that a major component of the Yallingup figure would be tourists (there are few permanent residents in Yallingup).

The Busselton region is of course a major tourist and recreation area. Busselton Shire Council has more caravan parks than any other Shire Council in Western Australia - a total of 23 parks supplying 4,959 beds (Department of Industrial Development, 1973, p.21). Permanent population increased by 21% in the decade between 1961 and 1971 (ibid.). The proportion of elderly people increased most rapidly and the number of people over 65 years of age almost doubled between 1961 and 1971, and in 1971 over 12% of the total population were in this age group. Apart from this evident attraction as a retirement area, recreation use is bound to increase as the urban centres of Perth (4 hours by road) and Bunbury grow. The recently published Borrie Report estimates an increase in the population of Perth from its 1971 figure of 701,000 to between 909,100 and 1,317,700 by the year 2001 (using various assumptions). Thus even the most conservative growth estimate provides an increase of over 200,000 people in the next 26 years (Borrie et al., 1975, p.441).
M.R.D. ROAD TRAFFIC COUNTS (TWO-WAY)

YALLINGUP
27/5/71 3/6/71

DUNSBOROUGH
2/6/71 3/6/71

SUGARLOAF
21/11/69 25/11/69

306
403

ANNUAL AVERAGE DAILY TRAFFIC
RAW DATA (DAILY AVERAGE)

(M.R.D.) GROWTH RATE BETWEEN 1968 1974 6% per annum

SOURCE MAIN ROADS DEPT. (BROWN PERS. COMM.)
The pattern of recreation use at Cape Naturaliste is distinctly seasonal, as interviews with local people revealed. For example the caravan park at Dunsborough, owned by D. Greenacre, has accommodation for 120 caravans (another 80 berths are planned) and in addition a total of 23 cottages are available for hire. The caravan park is usually completely booked for a brief 6 week period in summer. All cottages are booked during January and February and in the May and August school vacations. There are always vacancies through the winter months. In an effort to extend the season this park offers reduced rates during off-season periods while charging a premium price for peak times.

An examination of records at Caves House (Yallingup) shows a similar pattern and also explains the anomaly in road traffic count figures at the Yallingup and Dunsborough ends of Caves Road. The Dunsborough figures were taken on 2nd and 3rd June, 1971 while the much higher Yallingup figures were from the period 27.5.71 to 3.6.71. Had the Dunsborough count been taken between 25.5.71 and 28.5.71 a much higher figure would have been obtained. Table 2 shows the number of people in residence at Caves House between 25.5.71 and 3.6.71.

TABLE 2 - Number of People in Residence at Caves Road for Selected Dates (Data courtesy G. Emmott)

<table>
<thead>
<tr>
<th>DAY</th>
<th>DATE</th>
<th>NO. IN RESIDENCE</th>
<th>DAY</th>
<th>DATE</th>
<th>NO. IN RESIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tues.</td>
<td>25.5.71</td>
<td>39</td>
<td>Sat.</td>
<td>30.5.71</td>
<td>9</td>
</tr>
<tr>
<td>Wd.</td>
<td>26.5.71</td>
<td>41</td>
<td>Mon.</td>
<td>31.5.71</td>
<td>4</td>
</tr>
<tr>
<td>Thurs.</td>
<td>27.5.71</td>
<td>33</td>
<td>Tues.</td>
<td>1.6.71</td>
<td>0</td>
</tr>
<tr>
<td>Fri.</td>
<td>28.5.71</td>
<td>37</td>
<td>Wed.</td>
<td>2.6.71</td>
<td>0</td>
</tr>
<tr>
<td>Sat.</td>
<td>29.5.71</td>
<td>21</td>
<td>Thurs.</td>
<td>3.6.71</td>
<td>4</td>
</tr>
</tbody>
</table>

It is evident that the period 25.5.71 to 30.5.71 was the tail end of the May vacation and that numbers rapidly declined to a more usual winter level during the period of Main Roads Department road counts. Consequently the figures for Yallingup contain a proportion of traffic from the busier period while those from Dunsborough miss the busier period altogether.

In general Caves House (which provides a total of 72 beds) is fully booked from mid-December to mid-February, May and August school vacations and all public holidays. June and July are the worst months for bookings. A further indicator of tourist use comes from the Banamah
Wildlife Park, on Caves Road between Dunsborough and Yallingup. Of the estimated 12,000 people who passed through the park in 1974, some 2,000 visited the park over Easter. A similar pattern of concentration in summer and other holiday periods was reported by the proprietor (A. Chugg, pers. comm.). On the other hand Hideaway Holiday Homes, who provide self-contained units in Yallingup, have had some of the seasonality reduced by students and teachers on field studies throughout the year.

Caves in the area are of course a major attraction and figures supplied by the cave guide (Mr. C. Pell) show increasing numbers of visitors. During 1972-73 (July to June year) a total of 16,418 people visited Yallingup Cave. The following year the number was 17,303. Between July 1974 and January 1975 (inclusive) there were 12,900 visitors. While there is a distinctly seasonal pattern in the numbers visiting the cave, it is evident that many of the visitors are travellers who spend a very limited amount of time in the district. The publicity given to 'The Leeuwin Way' as the most attractive route through the southwest has undoubtedly contributed to increasing numbers of Eastern States visitors following Caves Road, from Augusta to Cape Naturaliste.

As with the Banamah Wildlife Park, Easter proves to be a popular time for visitors. Yallingup Cave always has its record day during Easter each year (over 400 people) and a total of about 1,000 pass through the cave over the three day period.

Apart from formal tours of Yallingup Cave, numerous people explore the other cave systems each year. Many other caves have been explored and mapped by speleologists whose accounts are recorded in the local publication Western Caver.

When Caves House was a Government Hotel there were a series of walk trails, each marked by different coloured pegs, leading to different places of interest including caves, dolines, coastal views and a natural bridge. Unfortunately these walk trails are no longer marked, and the attractive routes through woodland, forest and heath are overgrown. A new walk trail carefully routed through coastal scrub, runs between one of the tracks leading to the west coast and the natural bridge (see Plate 14). This type of trail (put in by people
involved with educational field studies) does minimal harm to the environment, is inconspicuous, and yet provides easy access to a vantage point.

Recreation activity takes many forms on the Cape Naturaliste peninsula. Along the eastern sheltered coastline family holidays are enhanced by still water conditions, safe for children to swim, clean beaches and clear water. A variety of headlands and bays provide interesting venues for aquatic activities such as skin-diving and fishing. On the sheltered waters numerous powerboats tow skiers while an occasional yacht adds variety. A launching ramp at Dunsborough provides access to the calm water for boating enthusiasts.

Also popular at places like Meelup, Eagle Bay and Bunker Bay are family picnics. Day-trippers come by tourist bus from Busselton to enjoy the scenery and calm water conditions. The section of coastline near Meelup and again between Bunker Bay and the tip of the peninsula is important for field studies. A walk trail from Bunker Bay follows the foot of the cliffs and leads to sea caves and particularly good geological sections (see Plate 2).

Climbing to the crest of the ridge, either at the lighthouse or on the Sugarloaf Road, provides panoramic vistas of unequalled beauty. However once on the western flank of the ridge steep cliffs, windy conditions and a lack of beaches result in few family activities along the coast. However, sea conditions create ideal waves for surfing and surfboard riding accounts for the bulk of aquatic activities. Recently the semi-finals of the 1975 State Surfboard Championship were held at "Three Bears" (Cabejgup), a site about midway between Sugarloaf and Yallingup. Yallingup itself is a popular surfing spot, as is the area just north of Sugarloaf known locally as "the Windmill". It is evident that most of the local people, particularly on the west coast, are not prejudiced against the surfing fraternity, but at a public meeting in Busselton to consider the C.T.R.C. Report (25.2.75), some speakers were disturbed at the thought of increased use of the area by 'people from Perth' including 'surfies'. It is probably true that the ranger from Busselton spends much of his time in the Cape Naturaliste area ensuring that surfers do not camp away from Caravan Parks. Despite such efforts it seems that much illegal camping occurs and that in many instances this is detrimental to the environment (e.g. the destruction of trees.
and shrubs for firewood). It is worth noting that, despite the original gazetting of the Meelup reserve for (in part) camping purposes, it is now illegal to camp there.

The west coast is also very popular to anglers who together with surfers have created most of the bush tracks along the western flank. Apart from these two major active uses of the environment, many people make passive use of the environment by enjoying the scenic views. At present such activity is restricted to the lighthouse and Sugarloaf unless one is prepared to walk or has the use of a four-wheel drive vehicle.

A limited amount of horse-riding forms part of the alternative recreation activities, together with wildflower observation, general sightseeing and visits to local attractions such as the Yallingup Cave, Banamah Wildlife Park and the functioning waterwheel at the Old Mill just south of Yallingup.

McHenry (1972) provides a useful discussion of benefits which accrue to various types of users of 'wilderness areas'. Most of these would be of value to those prepared to treat parts of Cape Naturaliste as a wilderness area. For example McHenry lists a set of 'psychological benefits' from wilderness areas as follows:

a) Improvement or maintenance of mental health.
b) Realization of human potential.
c) Attainment of spiritual benefits.
d) Escape from the 'rat race'.
e) Beauty of nature.
f) Sociability.
g) Pioneer spirit.
h) Wilderness as heritage.
i) Achievement of personal gratification.
j) Inspiration from wilderness.

Each of these will probably have different meanings (and values) to different individuals. Presumably of prime importance is the maintenance of diverse options (probably best achieved through the conservation of habitat variety).
e) Other Land Use Activities on Cape Naturaliste. Salmon fishing occurs on several beaches on the peninsula during the season (April-August) including Eagle Bay, Bunker Bay, Smith's Beach, Meelup and Dunsborough. Recently a C.S.I.R.O. research project has just commenced aimed at gaining a greater understanding of the reproduction, ecology and migration of the Australian Salmon (Arripidae), particularly as catches have been declining in this area in recent years.

Few of the farmers in the area have shown any interest in developing 'farm holidays' as either a service to holiday-makers or as an additional income source, although one farmer has an open invitation to visitors. With the growing interest of urban populations in 'farm holidays' it seems possible that this is one development which could increase recreation potential. Suitable locations occur to the east of the ridge and along the north-east coast from Bunker Bay to Meelup. Of particular popular interest might be fine wool production and beef cattle, together with stud breeding activities. Of some note is the fact that the first ovum transplant calf in Western Australia was born on a local farm.

Other private enterprise ventures in the area include a surfboard manufacturing business and a very popular restaurant in a rural setting. Dunsborough itself is well supplied with small businesses serving both the local and tourist communities.

Concluding Comment

It is evident that the variety of habitats, which have always provided for great diversity in life forms in the Cape Naturaliste area, have also provided an opportunity for diversity in human activity. Such diversity is clear from the range of economic, educational and recreational activities which presently occur. Diversity is an obvious advantage to any environment and it is a fundamental principle of ecology that diversity helps create stability. A stable environment requires very little human management - it is the simplified ecosystem, such as a field of wheat, which require elaborate management to ensure long term productivity. Consequently a fundamental assumption in the management proposals which follow is that diversity may be increased but only where this is possible without threat to existing stability. Similarly land use pressures should be controlled so that potentially
unstable (fragile) areas are protected from abuse and human activities channelled to areas less subject to degradation.
7. Development and Management

(i) Introduction

Throughout this report the study area has been more or less arbitrarily defined as north of the stretch of Caves Road between Yallingup and Dunsborough. It is important to recognize however that while the peninsula is distinctive, it still forms part of a broader system known generally as the Leeuwin-Naturaliste ridge. The C.T.R.C. Report for example considers the whole of this ridge as a single unit and makes recommendations to incorporate all reserves (together with small amounts of Crown and purchased land) into a single Class A National Park, placed under the control of the W.A. National Parks Board (C.T.R.C., 1975, pp.1-24). The Leeuwin Conservation Group has commissioned a report on the Leeuwin-Naturaliste ridge and the findings of this survey will probably demonstrate similar features throughout the area. Cape Naturaliste peninsula is to a large extent, however, bounded by natural features (e.g. Caves Road from Dunsborough to Yallingup for the most part follows valley lines) sufficiently distinctive to justify separate consideration.

There are an infinite number of alternatives for future resource use of Cape Naturaliste, but only some of these will be ecologically sound. In terms of management principles however, it is increasingly accepted that resource management derives its soundest guidelines from the ecosystem concept. In previous chapters various existing resource uses have been described, some of these in obvious conflict (e.g. gravel pits and scenic drives, erosion and conservation). One of the objects of resource management is to minimize conflict. It is largely due to a desire to remove potential (or existing) landuse conflict that National Parks were established, and that land use zoning was introduced. Situations of potential conflict arise when any given area is subject to more than one land use. As the number of different land uses which occur in a given area increase, the possibility of conflict also increases. The simplest solution is probably rigid zoning of land use - the completely planned environment (and some might suggest rather sterile environment). In few cases is this either desirable or necessary.
An examination of six categories of landuse for conservation purposes clarifies this solution. Each category was suggested by Huxley *et al.* (1947) in their Report on Nature Conservation in England and Wales which remains one of the clearest statements on the objectives of National Parks and other reserves:

a) **National Nature Reserves**—of biological, geological, physiographical or experimental interest. These reserves are seen as representatives of flora and fauna regions and would serve as areas for conservation and maintenance of flora and fauna; survey and research; experiment, and education and amenities where these last two do not conflict with the other objectives. They would be subject to limited access and strict control.

b) **Conservation Areas**—of similar importance to nature reserves with the addition of landscape, and such areas would be controlled in terms of changes in land use.

c) **National Parks**—these are viewed as providing a balance between economic use and preservation (*ibid.*, p.28). Such parks would include economically valuable forest and agricultural land which will often contribute to the beauty of the landscape.

d) **Geological Monuments**—including physiographic features of special interest.

e) **Local Nature Reserves**.

f) **Local Education Reserves**.

To some extent the last two categories are seen as important in rectifying the uneven spatial distribution of National Nature Reserves.

It is obvious that National Parks as described above at (c) and which are common in Britain and continental Europe do not yet exist in Australia. Because of the multiple use within such a park, management is most difficult. Nature Reserves on the other hand simply exclude most people and thus avoid conflict. It should not be assumed that each of the six categories is in any way an alternative form of
conservation, rather they are complementary. However criteria for the selection of areas in each category may vary. There are of course numerous reasons for Nature Reserves, derived from philosophies ranging from purely humanitarian to purely utilitarian. Many recent writers view Nature Reserves as essential control areas: "permanent reference areas where the condition and trend of plant communities and soils can be recorded over long periods of time" (Costin and Mosley, 1969, p.161), "biological conservation is essentially concerned with the interaction between man and the environment" (Usher, 1973, p.204).

Despite the almost universal agreement that Nature Reserves are an essential component in the human environment, there is considerable reluctance to exclude human activity from traditional recreation areas which might now be required for conservation. In part this is a reflection on the lack of public understanding of conservation objectives and a confusion over the meaning of new concepts in National Parks. For example, the concept of a 'scenic reserve' outlined by the C.T.R.C. (1975, pp.10-18) met with considerable reaction at the public meeting held in Busselton (25.2.75) to discuss the Report. The area west of Caves Road is an area viewed by the C.T.R.C. as ideally suited to a 'scenic reserve', which would require that "development in the area and the uses to which both public and private lands are put must be carefully planned and controlled" (C.T.R.C., 1975, pp.1-24). Some people were concerned at the suggestion that controls might be placed over private land. It was explained that such controls would be relatively minor in that they would attempt to preserve the character and beauty of the landscape - an aim which few would consider alarming. Land use controls already exist of course, authority being derived through various acts of parliament treating land zoning, noxious weeds, vermin control, public health and environmental protection. Legislation protecting 'scenery' (as distinct from flora and fauna) has already been enacted in Britain, and in the U.S.A. the State of Wisconsin has legislation to create scenic easements, and has a fund of $50,000,000 to cover a ten year programme (Barwick, 1971, p.8).

In recent years many people have proposed that an 'integrated reserve' be established covering the Cape Naturaliste peninsula (see for example papers from the 1972 seminar on "Multi-Purpose Planning of the 'Many Capes' Region" conducted by the University of W.A., Extension Service). The Conservation Council of W.A. has also made numerous
representations to State Government Departments concerning integrated reserves, and a more recent seminar held at Dunsborough requested a feasibility study be undertaken by the State Government on the possibility of Cape Naturaliste being set aside as an integrated reserve (see press report in 'The West Australian', 30.4.73 and also 7.4.70). In proposing the concept of an integrated reserve, Shepherd (1972) gives a comparison between an existing integrated reserve in Wales, and the "Many Capes" area of W.A. together with an outline of criteria for such reserves and development processes.

It is suggested that serious consideration be given to the Cape Naturaliste area as an integrated reserve, incorporating essential nature reserves, scenic and recreation reserves, agricultural activity and residential and educational facilities. If such a proposal were accepted it would be essential that planning and development of such a reserve be undertaken by a group which included all present resource users and managers with particular emphasis on the local community.

Whether or not an integrated reserve is established the Cape Naturaliste peninsula will require careful management if its future attractiveness to the community is to be assured. The remainder of this chapter is concerned with pinpointing areas that require particular attention, and suggesting various alternatives for development.

(ii) Legal Aspects Peculiar to Western Australia

G. Rundle (pers. comm.) points out that:

"there are three basic legal aspects concerning the establishment of reserves for any purpose, and their management in Western Australia. Firstly, most reserves for a variety of purposes are set aside under the provisions of the Land Act 1933; although the Land Act provides for the setting aside of areas of State Forest and timber reserves, these are generally established under the provisions of the Forests Act 1918. Secondly, in general, control, administration and management of reserves set aside through the Land Act is carried out under the provisions of other Acts which relate specifically to appropriate management authorities. The third important aspect is the overriding nature of some other legislation, such as that relating to mining and to environmental protection."
The creation of a reserve includes "identification of the land reserved, and dedication of that reserved land to a specific purpose. When a reserve is set aside under the provisions of the Land Act, information relative to the above is published by notice in the Government Gazette, as are any subsequent changes. Under the Land Act 1933, it is within the power of the Governor to dispose of Crown Land in any manner which serves the public interest. 'Crown Land' is public land not committed to any purpose (e.g. not already reserved) and for practical purposes may be considered as Crown Land which is not leased (e.g. for grazing) under the Land Act (i.e. 'vacant' Crown Land); for purposes of reservation, the definition of Crown Land does not include land below the low-water mark in tidal areas - which precludes the establishment of reserves under the Act in the marine and estuarine environments."

"In general, 'conservation' reserves may be considered to include reserves set aside as National Parks and as Wildlife Sanctuaries; reserves for the protection, preservation, conservation, etc. of flora or fauna, and natural, historic or scientific (e.g. anthropological) features; and reserves for recreation and for resorts. However, the purpose may state a specific aspect to the protected (e.g. reserves for Pitcher Plants, and for Caves) and may also be set aside for a joint purpose (e.g. 'Protection and Preservation of Caves, and Flora, and Health and Pleasure Resort')." See 'Purpose' column, Appendix C.

"The above purposes are not defined in the Land Act, although the following specific purposes are referred to in regard to the establishment of reserves: 'for State Forests, areas for the conservation of timber, and indigenous flora or fauna; and for camping grounds'. The two main types of reserve in Western Australia set aside for nature conservation are National Parks and Wildlife Sanctuaries; neither are defined under any State Legislation, although the term 'Fauna Sanctuary' is defined in the Fauna Conservation Act 1950."

"While the Land Act provides for the Governor (i.e. the Governor in Executive Council, which includes Cabinet) to set aside reserves, a provision states that this Act does not affect the operation of the Mining Act 1904; in turn, the Mining Act states that the specific approval of the Minister (for Mines) is required for the 'disposal' under the Land Act of Crown Land situated within a gold-field or mineral field (which covers most of the State). Parliament
has been advised that this requirement does not apply to reserves set aside by the Governor; nevertheless, over the past few years the Department of Lands and Surveys and Mines Department have appeared to act as though such a requirement does exist. The Committee of Inquiry into the Mining Act recommended (in 1971) that this outmoded provision be deleted from the Mining Act as it seemed unnecessary and now unwarranted restriction.

"Reserves set aside under the Land Act 1933 may be classified as either 'A', 'B' or 'C'. This classification designates a reserve's degree of security against alienation for other purposes, including boundary changes that would excise land from a reserve, cancellation of a reserve, or any change of purpose for which a reserve is dedicated. Such classification is quite independent of size, purpose or other aspects and may be applied to any reserve set aside under the Act; some reserves are not classified in practice (e.g. reserves for townsites, foreshore reserves not dedicated to a specific purpose)."

"Under the Act, a Class 'A' reserve is forever dedicated to the purpose for which it has been proclaimed 'until by Act of Parliament ... it is otherwise enacted'. An Act of Parliament is required to cancel any Class 'A' reserve, to amend its boundaries to excise land from the reserve, or change its designated purpose: even when the purpose of a Class 'A' reserve is expanded (e.g. from 'conservation of flora' to 'conservation of flora and fauna'), an Act of Parliament is required; however, additional land may be included in a Class 'A' reserve by the Governor without need for an Act of Parliament. Such enactments are usually facilitated by an annual special Reserves Act which deals collectively with those Class 'A' reserves for which the Government wishes to effect changes. However, such action may also be carried through other special Acts." cf. Appendix C, pp.92-94.

(iii) Areas of Special Concern

a) Roads. Given that a particular resource occurs and that there is a demand for the use of it, accessibility becomes important. "Clearly accessibility affects what could be supplied to the consumer of amenity and this factor must therefore form part of any useful evaluation technique" (Whitby et al., 1974, p.121). In the Cape Naturaliste area accessibility is largely a function of sealed road
siting. At present the road pattern, with major spine roads (Naturaliste and Caves Roads), and spur roads leading to coastal sites (Yallingup, Canal Rocks, Sugarloaf, Meelup and Eagle Bay) is seen as ideal for the existing needs of the area. The development of a coastal road between Yallingup and Sugarloaf Rock (i.e. along the fragile western flank of the ridge) is considered extremely hazardous. If a central road is required it should be sited on the lee side of the ridge, possibly along the existing road reserve which runs east of blocks 1049 and 1045, but which would then require resumption of private land. Alternatively, and in a location providing excellent views while remaining reasonably safe from wind erosion effects, a road could travel east of block 1049, south of block 1045 and west of blocks 1045 and 660 to join Naturaliste Road. In this case land resumption would be necessary to avoid steep climbs up the ridge (subject to water erosion). However neither of these roads seems desirable (necessary?) in the immediate future. The question of tracks which at present provide limited (i.e. four-wheel drive) access to the coast is particularly vexatious. One track runs from Yallingup to Cabejgup (Three Bears) along the coast. Another runs along the southern boundaries of blocks 876 and 885 and hence north along the western boundaries of blocks 885, 829, 1045 and 660. Access to this track is also provided by a track from Yallingup Cave to the southwest corner of block 885. Both of these two north-south tracks (the coastal track and the ridge crest track) are linked by east-west tracks at both Cabejgup (Three Bears) and closer to Yallingup more or less along the boundary between reserve number 8427 and reserve number 8768. An additional coastal track runs north of Sugarloaf to Willanup Spring, while others radiate from near the lighthouse giving access to the north coast between Cape Naturaliste and Bunker Bay (see Map 9 and Map 7 for location of land blocks).

Each of these tracks has degraded the environment and two blowouts have already developed due to excessive vehicle use – one just north of Yallingup (see Plate 9) and the other at Cabejgup (see Plate 10). The situation is particularly bad just north of Yallingup as each time one patch of track becomes churned up vehicles shift laterally destroying a new stretch of vegetation and mobilizing even more sand. As the winding track is at times running west-east, winds from the ocean are able to blow straight up the track preventing regrowth. Even without wind blasting, the frequency of vehicles is sufficient to inhibit revegetation. It is deemed essential that this stretch of
ROADS and TRACKS on CAPE NATURALISTE.

KEY:
- SEALED ROADS
- 4 WHEEL DRIVE TRACKS
- BLOWOUTS
- BOAT RAMP
- CARAVAN PARK
- WALKING TRACK

SCALE 1:100,000

1 0 1 2 3
track be closed to avoid development of a large mobile sand mass. Even
now some planting may be necessary to stabilize the drift. If access to
the coast is required, then the route to the east, through the natural
bridge, is preferred. The east-west road past the natural bridge
follows a winding notch valley through the ridge and consequently is
far less susceptible to wind erosion than the track further north near
Cabejgup.

The blowout at Cabejgup is quite extensive and might also require
planting. However if the track was blocked just prior to the blowout,
cars could park behind the foredune which sits at the top of the cliff.
This slightly hollowed area is protected from the westerly winds and
would not be subject to as much erosion as the present blowout site
which is in effect a raised knoll. For long term protection it would
be necessary to provide a planked pathway over the dune giving access
to the beach with minimum erosion.

Other parts of the coastal track are probably not causing
excessive erosion in the short term as the track is either behind a
cliff top foredune, or on exposed calcarenite not likely to erode.
Should the Mt. Duckworth track be maintained it will require careful
management. In the first instance minimal upgrading, probably with
minor re-routing, would lessen existing erosion.

In general it may be stated that coastal processes along the
western section mobilize and transport less material than along
comparable sandy beaches, due solely to the protection of calcarenite
(and in places granulite) cliffs. Some retreat of the cliff line is
evident from recent landslip scars. Where sand deposits sit on the
top of the cliffs (as is often the case) such landslips or caving of
the cliff face expose unconsolidated sand to the powerful west wind
(see Plate 15). This in turn results in sandblasting of the vegetation
and minor blowouts occur. Provided additional pressure from vehicle
traffic is not too great such areas probably revegetate fairly quickly.

There are also tracks on the eastern coast, for example within
the Meelup reserve. In this environment however wind erosion is not
a problem. Duricrust mantles protect the landsurface from all but the
most severe water erosion, as is the case on an abandoned gravel pit
near the lighthouse. One such track, to Castle Rock, could usefully
be upgraded (not sealed) to allow easier access. In addition it could be re-routed to avoid passing through the gravel pit and rubbish dump which are of dubious aesthetic value. Once past these two eyesores the road provides easy access to the jarrah forest through which it winds, ultimately finishing at Castle Rock with its magnificent views over Geographe Bay. In places the wheel ruts have been eroded and the track may require careful resiting to avoid water erosion.

Given the precautions suggested above, it is considered that accessibility by road in the area might be improved a little to be quite adequate. One additional feature should not be overlooked and that is roadside parking. The provision of small, unobtrusive parking bays, aesthetically located would increase accessibility to both forest and views. There is at present a speed limit of 80 km/hour on the sealed roads, and it is considered that a reduction of this between Yallingup and Dunsborough, and on the Naturaliste Road, would be advantageous. A slower speed protects those who wish to view the country from those who (at present) are compelled to speed. In no circumstance should Caves Road be treated as a rapid transit route. Caves Road, from its original inception, has always been considered a tourist road and as such speed limits should be kept low and rigidly enforced.

One final comment on roads and access is to repeat an earlier suggestion that abandoned gravel pits be revegetated. Selected sites might even be considered for picnic or resting places, particularly if shielded by trees from public view. The Forests Department of W.A. provides numerous examples of what can be done to such sites.

b) Camping Facilities and Walk Trails. One of the major problems in the Cape Naturaliste area, with regard to camping, is the rigid State Government ruling that no camping shall occur within 25 kms of any caravan park. Such rigidity effectively excludes local councils from catering for those people to whom crowded caravan parks are anathema. A more flexible policy would enable overnight camping in selected areas which if carefully chosen would extend the resource base without detriment to the environment. It is considered that permanent camping is unacceptable except at caravan parks due to the environmental degradation to other resource users (e.g. picnic families, day-trippers). Consequently it is suggested that regulations might allow overnight
camping which would require tents to be erected only after 5.00 p.m. at night and to be removed by 10.00 a.m. thus avoiding conflict with daytime users of the resource. Sites for overnight camping might be set aside at three places which appear environmentally safe and yet aesthetically desirable. These sites are:

1. Meelup - set back from the beach but within reasonable access of the toilet facilities.
2. Near the western end of Bunker Bay within the protection of a stand of trees.
3. Between Cabejgup and Yallingup in a distinct depression area which is bounded on the east by steep cliffs rising abruptly from the floor of the depression and is protected on the west by a foredune.

That there are difficulties in the provision of such services is recognized, but none of these is considered insurmountable. The provision of built facilities should be limited to toilets, coldwater showers and drinking water, together with brick fireplaces for cooking (open fires should be prohibited to protect the vegetation). Servicing should include only water and firewood (to protect the adjacent vegetation from abuse). These facilities and services might be paid for by issuing overnight camping permits from the Council and also on the spot. Obviously careful supervision would be required. It is possible that such sites might be run by organizations such as the Youth Hostels Association or a Bushwalking Club. Honorary local wardens are another alternative which might be considered.

The major stumbling block at present is the legal situation. When the camping and caravan provisions were enacted it was intended to approximate European conditions more closely. However the specific recreation activity of camping, whilst carefully defined, was completely overlooked except where such camping forms part of an organized or particular event (see Health Act (Caravan Parks and Camping Grounds) Regulations 1974, Government Gazette 22.2.74 page 550, Clause 16(2)). Similarly the 25 km restriction ignores special circumstances as might apply at Naturaliste. These types of problems need to be overcome if an extension of the resources of Cape Naturaliste is desired. Establishment of such sites would not affect caravan parks, as they cater for people who do not normally stay in caravan parks.
In association with this idea, the concept of 'nature trails' (Usher, 1973, p.261) or bushwalking trails has been considered. These may be either:

a) Formal (signposted with a guide book and markers).
b) Semi-formal (some guides but no markers).
c) Informal (no guide posts but a broad descriptive guide book).

Education users of the Cape Naturaliste area already make extensive use of informal nature trails and have compiled descriptive booklets to help students understand the environment. One semi-formal trail takes students to the natural bridge. It is considered that suitable areas exist for walk trails of varying length catering for different tastes and capacities. For examples a short walk trail from Dunsborough through jarrah forest to Curtis Bay and returning along the coastline would suit family groups. Similarly inspection of the sea caves west of Bunker Bay is feasible in 2-3 hours from either the lighthouse or Bunker Bay. Short trails from Yallingup to various caves and dolines (with the marked changes of vegetation and several micro-habitats) could be developed. Long distance trails between Dunsborough and Bunker Bay and Sugarloaf and Yallingup are also feasible for those with more time and perhaps a desire to camp out. The trail from Sugarloaf to Yallingup provides magnificent views and also passes an outcrop of granulite with calcarenite capping clearly exposed. Camping overnight at the depression site (see above) would break the journey and make it feasible for children. It is recommended that local people and/or specialist groups might be asked to develop such trails and produce guide books. The education groups who already use the area are an obvious source. Considerable information is available on the development of nature trails, much of it based on British experience.

A final point to consider on camping and bushwalking is the likelihood of over use. As such activities become more popular, careful management is required to prevent damage to the environment. In addition, as solitude is often one of the motives of such activity, it may be necessary eventually to control numbers of people. This problem has already been faced in parts of the U.S.A. where restrictions apply in certain areas simply to maintain a set level of use (so that users do not meet too many other users during their walk!).
c) **Residential Development.** At present most residential land is in the form of private blocks (see land use and land ownership chapters) and is clustered at three sites (Yallingup, Dunsborough and Eagle Bay). A major limitation to development at Dunsborough and Eagle Bay has been water supply and the most recent subdivisions have had requirements attached to the agreement that each house shall have a rainwater tank to preserve water shed from its roof.

Recreation area on Cape Naturaliste is already in the category 'scarce resource' and this is specially true of residential land, most of which is for holiday and/or retirement home use. If private enterprise, using the price mechanism, were allowed complete control of the area, the scarcity of sites would eventually create an elite group of owners and deny access to the majority. In addition uncontrolled short term development might eventually degrade the resource to such an extent that demand would fall. Because neither of these possibilities is likely to appeal to many people, stringent controls are recommended with regard to location and type of residential development within Cape Naturaliste.

Protection of the fragile western flank precludes any subdivision or housing development north of Yallingup. This is a major requirement to protect the area and has been recognized by each study of the Leeuwin-Naturaliste Ridge. In the remainder of the area the land zoned rural should be maintained as such due to the contribution such land makes to the scenic nature of the landscape.

It is expected that considerable pressure will be applied to extend the Dunsborough townsite boundary westward into the Meelup reserve. Any extension is fraught with difficulties at the present due to water supply and sewage disposal problems. In addition valuable forest areas (conservation, education and recreation) would be lost. Similar types of considerations apply at Eagle Bay although the provision of water is probably the most important at present.

In general it may be stated that extreme care is required in the siting of any further residential land and indeed the question of whether any further land should be opened up for residential purposes needs careful consideration.
Attention is also drawn to the alternative types of residential development. Hiller (1972) points out that caravan parks, campsites, motels and institutional accommodation all waste less land than private cottages. In addition, as Griffith (1972) remarks, far more people are able to enjoy a holiday (within a given area) if the proportion of higher density rental accommodation is increased. Where residential land is likely to be scarce, as it is in this case, it may be necessary to control the type of accommodation and increase the proportion of rental accommodation. There are of course alternatives to large developments. For example a group of private cottage owners could combine and appoint a manager to let their cottages when they were not using them.

The idea that scarce resources should be controlled by legislative action is not new and in fact almost all critical resources are in most societies the property of the State (Coombs, 1972, p.9). The objective of such control is generally optimum use of these resources by the community. Essentially this is the concept of valorization, originally used by Gentilli (1969) with regard to landscapes but also applicable to other scarce resources. The scarce resource is consequently conserved for optimum use.

Because control over residential development is presently shared between the local authority and various State authorities, it is unlikely that rash development projects will occur. The recent intervention of the State Government over the English and Wake proposals to develop part of the fragile western flank should give heart to those concerned with protecting the total environment.

d) Conservation Aims on Cape Naturaliste Peninsula. As has already been noted in previous chapters, reasonable protection is afforded to the flora and fauna with existing reserves. However these reserves need to be rationalized and placed under a single authority with the expertise and funds to manage the environment properly. Within the conservation objective there are several areas of concern. Management of the reserves is urgently required, as the example of degradation through track erosion given above demonstrates. In addition special attention should be given to locating and preserving habitats which contain the two rare freshwater crayfish and the freshwater crab. Special measures may be necessary to protect the unnamed
species of Calothamnus which is restricted to Naturaliste, although the present authors have extended its known range considerably, particularly along the northeast coastline.

The preservation of the stand of Yate trees in the district is at present under the control of private landowners and perhaps agreements may be reached with these people to preserve these trees, as will be necessary in the case of freshwater crayfish habitats (particularly Engaeva reducta).

With regard to the spatial distribution of reserves, it has already been suggested that locations 885 and 829 which are available for purchase by the Government should be acquired. In addition, and probably of greater priority, it is recommended that negotiations be undertaken to purchase block 1044. This is the only remaining freehold land on the exposed western flank. Although the present owner is particularly conscious of conservation practices, it is unwise to have such a fragile environment subject to pressures which might be applied (without regard to conservation) from such legitimate agricultural practices as burning, clearing or even heavy stocking.

There are also some problems with regard to the purposes for which reserves were gazetted. It is clear that neither the National Parks Board, nor the Lands Department, has recently reviewed the purposes of each of these reserves. As pointed out in the chapter on land ownership, there are several examples of illogical vesting. Of even greater concern is the gazetted purpose of reserve 20455. Set aside on the 30th May, 1930, the gazetted purpose was as a tourist resort (and this is the sole purpose). Although vested with the National Parks Board since 8th January, 1970 the implications of the original gazetted purpose (combined with its status as an A Class Reserve) need to be examined. A change of purpose of an A Class Reserve requires an act of Parliament. This reserve is listed on p.92 (Appendix C).

It is also of concern that the C Class Reserve number 21629 (Meelup) officially has no conservation function, particularly as it contains the main population of Calothamnus sp. (unnamed), located along the coastal road, together with the important stand of Jarrah open forest on the higher ground. At least a portion of the reserve should be set aside for conservation and vested in the National Parks Board. Its present purposes are shown in Appendix C, p.93.
The question of access to reserves requires careful consideration. Some of these need to be set aside as restricted access areas, excluding general public use. These should include representative samples of the major habitats as described in the preceding chapters, together with special areas mentioned above. Other areas however will require access if the conservation objective is not to conflict with recreation and education objectives. It should be understood that management of the reserves will require continuing research as so little information of a synecological nature is available for these habitats.

Conclusion and Recommendations

Within the confines of a brief study period and the consequent limitations, the Cape Naturaliste peninsula has been examined to provide an inventory of natural and cultural resources and suggest guidelines for its management and development. The information in this report should provide a satisfactory basis for future planning, together with additional research to overcome deficiencies in current knowledge.

On the basis of the authors' study, and of material derived from numerous sources, a series of specific recommendations, together with other more general guidelines, have been proposed. For convenience a summary of major recommendations is listed below:

1. It is recommended that the Cape Naturaliste area be utilized for the experimental development of an integrated National Park, similar in concept to the British and European systems of integrated reserves. The area is compact and involves a relatively small number of landowners and resource managers, and yet offers the type of habitat diversity and land use variety essential to the concept of an integrated reserve.

2. It is recommended that all reserves in the Cape Naturaliste peninsula be vested in a single authority with expertise and finance to manage the area. It is considered that the National Parks Board would be suitable provided adequate funds were provided for management and research.

3. It is further recommended that full time resident rangers be employed to manage the park and to service certain recreation and education facilities.
4. It is recommended that a set of nature trails be designed and established and that suitable guide books or pamphlets be produced for each trail. The responsibility of such a task might be best delegated to specialist groups in the community.

5. Encouragement should be given to rural landowners in the area to practice various types of conservation activities (with some special cases). Rural landowners should also be encouraged to participate in the provision of recreation and education facilities and to maintain a high standard of landscape scenery on their properties (especially in the location and management of parklands and shelter belts).

6. Consideration should be given to controlling the proportion of land cleared, either through cash incentives or legislation (or both).

7. In the event that an experimental integrated reserve is established it is recommended that the managing authority should include representatives of all local resource managers and also resource users. A community based council, together with professional personnel and resource managers, would have far greater chance of succeeding in the development of this new concept than an authoritarian Perth-based Council. Full access to essential expertise for guidance is of course understood.

8. Part of the Meelup reserve should be set aside for conservation purposes, particularly areas of Jarrah open forest and coastal areas containing the unnamed Calothamnus shrubs.

9. The gazetted purposes of each reserve be carefully examined and where necessary changed in the light of new knowledge.

10. Under no circumstances should residential development occur on the fragile western flank of the Naturaliste Ridge. This area should be further protected by the acquisition of one additional freehold property.

11. Road development should not occur along the coast between Sugarloaf and Yallingup. Any new roads should be located east of
the ridge crest. Some of the four-wheel drive tracks should be blocked to allow blowouts to recover.

12. Two blocks of Peppermint forest, adjacent to Yallingup National Park, should be purchased from the owners who are willing to sell in order that management of this area be simplified and the conservation of this habitat ensured.

13. Amendments to the necessary legislation covering camping should be sought to enable carefully controlled and located overnight camping. Three possible sites are suggested, together with the simple facilities which should be provided.

14. Expansion of residential development should be carefully and stringently controlled especially as to location and type of accommodation. Increased use of rental accommodation is recommended to enable maximum access to the public.

15. As part of the general maintenance of aesthetic attraction, gravel pits should be rehabilitated and more carefully sited in future. In addition high speed on tourist roads should be discouraged and provision made for more roadside parking in selected scenic and reserve areas.

16. Council notice boards might be better designed and worded less aggressively as part of a general campaign to make visitors feel more welcome.

17. In the event that an integrated reserve experiment is rejected, those authorities in control of the various resources of Cape Naturaliste should be actively considering development possibilities and resource management in the long term. This process should involve the local community and present resource users, together with professional advisors. As a fundamental principle the peninsula should be treated as a complex set of interacting ecosystems. The ideal of maximising options in human use is best achieved by maintaining habitat diversity.
References


Bastian, L., 1964. Morphology and development of caves in the south west of Western Australia, Helectite, 2:105-118.


**Abbreviations Used**

A.C.F. = Australian Conservation Foundation  
A.N.U. = Australian National University  
C.S.I.R.O. = Commonwealth Scientific and Industrial Research Organisation  
C.T.R.C. = Conservation Through Reserves Committee (W.A.)  
C.U.R.R.G. = Combined Universities Recreation Research Groups  
E.P.A. = Environmental Protection Authority (W.A.)  
R.A.O.U. = Royal Australasian Ornithologists' Union  
S.G.A.P. = Society for the Growing of Australian Plants  
T/S = Town Site
APPENDIX A

List of Plants

(Types are numbered as in Chapter 2)

1. **Jarrah Open Forest**
   - E. marginata
   - E. colophylla
   - Hakea varia
   - H. prostrata
   - H. amplexicaulis
   - Leucopogon propinquus
   - L. parviflorus
   - Persoonia sp.
   - Hibbertia sp.
   - Kingia australis
   - Xanthorrhoea preissii
   - Acacia pulchella
   - A. decipiens
   - Thysanotus apterus
   - Scirpus nodosus
   - Isopogon sp.
   - Adenanthos meisneri
   - Casuarina sp.
   - Banksia grandis
   - B. attenuata
   - Verticordia plumosa
   - Dryandra nivea
   - Nuytsia floribunda
   - Xylomelum occidentale
   - Calothamnus sanguineus
   - Viminaria denudata
   - Macrozamia reidii

2. **Marri/Peppermint Forest**
   - E. calophylla
   - Dryandra nivea
   - Agonis flexuosa
   - Banksia attenuata
   - Dasypogon hookeri
   - E. marginata (rare)
   - Xanthorrhoea preissii
   - Hakea amplexicaulis
   - Adenanthos meisneri
   - Xylomelum occidentale
   - Viminaria denudata
   - Thysanotus apterus

3. **Marri/Peppermint Forest**
   - E. calophylla
   - Dryandra nivea
   - Agonis flexuosa
   - Banksia attenuata
   - Dasypogon hookeri
   - E. marginata (rare)
   - Xanthorrhoea preissii
   - Hakea amplexicaulis
   - Adenanthos meisneri
   - Xylomelum occidentale
   - Viminaria denudata
   - Thysanotus apterus

4. **Marri/Peppermint Forest**
   - E. calophylla
   - Dryandra nivea
   - Agonis flexuosa
   - Banksia attenuata
   - Dasypogon hookeri
   - E. marginata (rare)
   - Xanthorrhoea preissii
   - Hakea amplexicaulis
   - Adenanthos meisneri
   - Xylomelum occidentale
   - Viminaria denudata
   - Thysanotus apterus

5. **Marri/Peppermint Forest**
   - E. calophylla
   - Dryandra nivea
   - Agonis flexuosa
   - Banksia attenuata
   - Dasypogon hookeri
   - E. marginata (rare)
   - Xanthorrhoea preissii
   - Hakea amplexicaulis
   - Adenanthos meisneri
   - Xylomelum occidentale
   - Viminaria denudata
   - Thysanotus apterus

6. **Thickets**
   - Melaleuca lanceolata

7. **Granulite Heath**
   - Xanthorrhoea preissii
   - Calothamnus sp.
   - Nuytsia floribunda
   - Viminaria denudata
   - Isopogon sp.
   - Hakea varia
   - H. amplexicaulis
   - Melaleuca lanceolata

8. **Limestone Heath**
   - Melaleuca lanceolata
   - M. huegelii
   - Scaevola sp.
   - Olearia axillaris
   - Bayeria viscosa
   - Jacksonia horrida
   - Acacia rostellifera
   - A. decipiens
   - A. cyclopis
   - Dryandra nivea
   - Hakea prostrata
   - H. varia
   - H. ruscifolia
   - E. marginata (stunted, rare)
   - Agonis flexuosa

9. **Swamp Vegetation**
   - Astartea fascicularis

10. **Stream Vegetation**
    - E. rudis
    - E. cornuta
## APPENDIX B

### List of Birds

(i) Ex. S.A. White, 1921.

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Acanthiza chrysorrhoa
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<td>Strepera plumbea (sic)</td>
<td>Grey Currawong</td>
<td>? C. nigrolearis</td>
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<tr>
<td>Cracticus leucopterus (sic)</td>
<td>White Winged Butcher Bird (sic)</td>
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<tr>
<td>Gymnorhina dorsalis</td>
<td>Magpie (Western)</td>
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<tr>
<td>Platycercus icterotis</td>
<td>Western Rosella</td>
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<tr>
<td>Lophoictinia isura</td>
<td>Square Tailed Kite</td>
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</table>


Falco cenchroides                      | Nankeen Kestrel                   |
Phaps chalcoptera                      | Common Bronzewing                 |
Podargus strigoides                    | Tawny Frogmouth                   |
Artamus cinereus                       | Black Faced Wood                  |
                                          | Swallow                           |

(Note: Gymnorhina tibicien is probably an error - mistaken for G. dorsalis. The former is a northern species (Slater, 1974) not found in the southwest).

(iii) Ex. Aub Chugg
      (Banamah Wildlife Park)

Tyto alba                             | Barn Owl                          |
Tyto novaehollandiae                  | Masked Owl                         |
<table>
<thead>
<tr>
<th>SPECIES</th>
<th>COMMON NAME</th>
<th>MODERN (if different)</th>
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<tr>
<td>Phaethon rubricauda</td>
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<td>Hirundo neoxena</td>
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<td>Synopsis australis</td>
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<td>Anas superciliosa</td>
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<td>Biziura lobata</td>
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<td>Anas gibberifrons</td>
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<td>Tadorna tadornoides</td>
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<td>Fulica atra</td>
<td>Coot</td>
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<td>Haematopus ostralegus</td>
<td>Pied Oyster Cotcher</td>
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<tr>
<td>Phalacrocorax sulcirostris</td>
<td>Little Black Cormorant</td>
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### APPENDIX C

**List of Reserves**

<table>
<thead>
<tr>
<th>Reserve No.</th>
<th>Class</th>
<th>Size (hectares)</th>
<th>Purpose</th>
<th>Control</th>
<th>Remarks</th>
<th>Cadastral plan</th>
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<td>9041</td>
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</tbody>
</table>
Plate 1. Exposed granulite

Plate 2. Cowaramup conglomerate exposed at Shelly Beach
Plate 3. Sea caves and boulder beach west of Bunker Bay

Plate 4. Unnamed Calothamnus in typical granulite habitat at Sugarloaf
Plate 5. Yate (Eucalyptus cornuta).

Plate 6. Bullich (Eucalyptus megacarpa) in Peppermint woodland near Yallingup Cave.
Plate 7. Peppermint (*Agonos flexuosa*) forest and woodland near Yallingup Cave

Plate 7a. Grey Kangaroo (*Macropus fuliginosus*) at Banamah Wildlife Park
Plate 8. View across English-Wake property showing *Melaleuca huegelii* thicket (habitat of Bristle Bird) with Sugarloaf Rock in the background, breeding site of Tropicbirds.

Plate 9. Track just north of Yallingup being actively degraded by excessive vehicular use. The edge of the blowout is on the left.
Plate 10. Blowout at Cabejgup ('Three Bears') between Yallingup and Sugarloaf.

Plate 11. Effect of windblasting: severely affected Calocephalus brownii shrub and exposed roots at Cape Clairault.
Plate 12. Blowout at Cape Clairault

Plate 13. Attractive parkland clearing on Naturaliste Downs
Plate 14. Carefully routed walking trail giving access to the natural bridge near Yallingup.

Plate 15. Part of the cliff between Yallingup and Sugarloaf Rock showing recent landslip scar and small clifftop blowout.