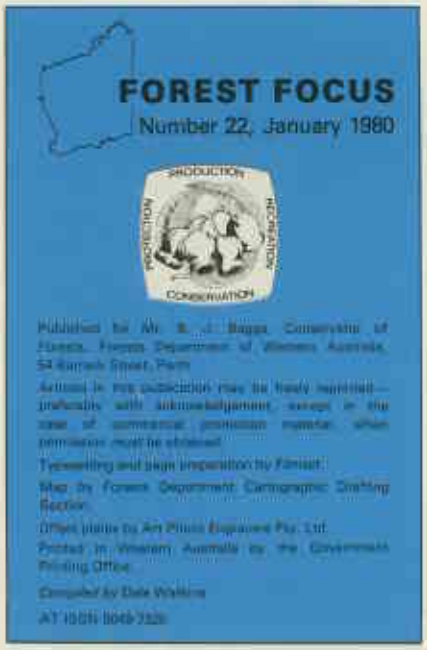


During 1979, the Minister for Forests, Mr. David Wordsworth, announced the re-appointment of Mr. Bruce Beggs for a second seven-year term as Conservator of Forests.

Mr. Wordsworth said that Western Australia was fortunate to have a man of Mr. Beggs' ability at a time when the management of forests was undergoing considerable change.

The Minister said that the government had every confidence that during Mr. Beggs' second term, Western Australia would continue in the forefront of Australian Forestry practice and in the environmentally satisfactory management of one of its major resources.

Mr. Beggs had been appointed Conservator in July 1972, following his promotion to Deputy Conservator in January of that year.

Front cover

Hakea costata *on limestone outcrops on Wabling Hill, looking eastwards over Wabling.* (*Brian Stevenson*)

Focus on Northern Jarrah Forest Conservation and Recreation Areas

by E. M. HEDDLE, J. J. HAVEL and O. W. LONERAGAN

The European settlement in Western Australia caused major changes in the landscape. Forests which originally covered the bulk of the area have been cleared to a degree that has only been realised in recent years.

It is only now, when increasing demands are being placed on the forest to supply wood, water, recreational opportunity, space for industry, transport and residence, that it has been realised how the feasibility of conserving adequate areas of native vegetation has already been reduced and is continually being reduced. This has occurred at the time when, internationally, the need to conserve representative areas of native flora and associated fauna is being increasingly recognised and publicised.

The Conservation Through Reserves Committee of the Environmental Protection Authority is currently evaluating the needs for conservation and recreation in System 6, which is centred on Perth and comprises the areas of highest population density in Western Australia. The northern forest area covered in this issue largely corresponds to System 6, in which state forest occupies a high proportion of the total land area (38 per cent). Even more importantly, the state forest represents the bulk of the land still retaining native vegetation. The ability of the department to contribute is, however, restricted to certain portions of the region, such as the northern Swan Coastal Plain, the Darling Plateau, the Collie Coal Basin and the Blackwood Plateau. There is no state forest on the Dandaragan Plateau and even on the southern Coastal Plain the opportunity is very restricted.

The Forests Department as a major land manager in the region, recognised the need to conserve flora and fauna and incorporated it in its multiple-use forestry expressed in Working Plan No. 86 (1977). The aim of multiple-use planning is to cater for more than one value or activity on the same area at the same time, if at all possible, by specifying a particular priority for a given area (Management Priority Area—M.P.A.). This intention is made clear and is given a permanent expression. When a priority is given it does not mean that alternative forms of land-use are completely excluded, as they may be compatible with the main priority. Where there is a conflict between the main priority and alternatives, the alternatives will certainly be excluded.

The department also identified a series of conservation and recreation areas in the southern forests which has already been covered in *Forest Focus* No. 18.

General features of area

The area of System 6 comprises a range of natural features. It extends from Moore River in the north to

Blackwood River in the south, and eastwards from the coast to the wheatbelt. It incorporates five main geomorphological regions:

1. Swan Coastal Plain
2. Dandaragan Plateau
3. Darling Plateau
4. Collie Coal Basin
5. Blackwood Plateau (Donnybrook Sunkland)

Landforms and soils associated with these five regions have recently been described by Churchward and McArthur (1979). As could be expected the vegetation associated with the various landforms and soils is diverse; however, there is some overlap between the five geomorphological regions in terms of vegetation. It has proved much easier to provide areas for conservation on the Darling Plateau and the Blackwood Plateau than on the remaining regions.

Identification and selection of M.P.A.s

Ideally one would wish for a full representation of the many different types of vegetation which characterise an area or region. To achieve that, one would need first an adequate knowledge of what vegetation types do in fact occur within a given area, but even more importantly this would need to be carried out at the very beginning of the settlement of a country. Subsequently, the conversion of forests to fields and pastures and the development of industry continually reduces this opportunity.

In Western Australia, the opportunity is perhaps better than in most countries, but it is certainly not unlimited. In the past, conservation of native flora and fauna was confined either to land considered unsuitable for any other purpose, or to spectacular scenery with great tourist appeal. Despite this, progress has been made towards the conservation of adequate areas of native communities. The current activity under System 6, and in particular the Forests Department Working Plan No. 86 (1977), go far beyond this. The areas set aside with the primary aim of conserving flora and fauna are often those with the best remaining stands of timber species and best potential for wood production forestry.

At least in one case there has been a long and tortuous process towards this aim. Late in the last century an attempt was in fact made to reserve a substantial portion of the northern jarrah forest in undisturbed condition, when a flora and fauna reserve (2461) was established west of Bannister. The impetus for this came from the scientific opinion, which managed to get the support of the government. This resulted in the gazetting of the reserve in 1894. Within four years, however, pressures to have the area released for timber production began and by 1907 the purpose of reservation was changed from conservation of flora and fauna to timber. In 1911 the area was incorporated into state forest (Ride, 1975). Part of the area has now in fact been set aside as a conservation M.P.A.

At the present there is far greater acceptance of the need to conserve native flora and fauna, but much has yet to be done to put this into effect. The desire to do so is often not matched with the knowledge as to which plant communities and fauna assemblies should be reserved and which are the best areas in which to implement this. In addition, the current selection of areas for conservation is limited by the constraints of earlier developments. In this regard it is fortunate, particularly in the northern jarrah region, that the bulk of the area is still only mildly disturbed or not disturbed at all. In fact, in many respects, there is no great conflict between existing activities of catchment protection, timber production and the conservation of flora and fauna. However, as conflicts could arise in future between these activities and conservation, the M.P.A.s have been selected in which conservation is clearly given the over-riding priority.

The selection of these areas was based on prior botanical and ecological studies such as those of Speck (1958) and Havel (1968, 1975 *a* and *b*). In deciding on the location and extent of the area the criteria set by Specht (1974) and Slatyer (1975) have been used as guide-lines. These criteria basically indicate that the lower limit for size of the reserve is determined by the population density of the rarer species and the range requirements of the more mobile species.

The criterion of Main and Yadav (1971) that areas greater than 20000 ha are probably necessary to conserve the full diversity of larger animals has been more difficult to fulfil within the constraints set by existing land uses. As the vast majority of the M.P.A.s are either partially or fully surrounded by native forests, even the criterion of Main and Yadav are adequately met. In addition, the variety of management both within the state forest as a whole, and more specifically within the M.P.A.s, should be able to ensure adequate habitat diversity which is so critical to fauna survival. The latter statement, however, is very much subject to the specification that this reasoning can only be applied as long as the surrounding state forest remains relatively undisturbed. Major disturbances, such as mining, agriculture or conversion to exotic plantations, would make such assumptions invalid and in that case the adequacy of size of the M.P.A.s would need to be reassessed.

Due to the long history of timber extraction in the System 6 area,

stands which are completely undisturbed by logging are relatively rare. Those undisturbed stands that still do exist are almost without exception included in the M.P.A.s in order to preserve plant communities which are intact in terms of structure as well as in terms of composition.

Virtually no attempt has been made to create M.P.A.s that will cater for a single species of plant or animal. It has been reasoned that generally the plant communities and associated fauna form integrated systems which can only survive as a whole and that their individual components cannot be preserved in isolation except perhaps in botanical and zoological gardens.

Consideration was also given to yet another criterion set by Specht (1974), namely that it is desirable to have duplication of each plant community so as to retain the basis for restoration of reserves which are disturbed or damaged by storm, fire or human activity.

Some of the plant communities in the area encompassed by System 6 could not be provided for by setting priorities on management within the state forest. This was generally the case with communities on fertile, well watered soils which were the primary target of the initial land settlement 150 years ago, e.g. woodlands of wandoo (*Eucalyptus wandoo*) on the coastal plain and the woodlands of york gum (*E. loxophleba*) north and east of the state forest.

An important consideration in delineating M.P.A.s has been the freedom from dieback disease caused by *Phytophthora cinnamomi*. The main reason for this was that the disease affects a large number of species and a plant community attacked by it can never, on present knowledge, be restored to its original condition.

▲ *Banksia woodland with morrison understorey, Melaleuca.* (Brian Stevenson)

▼ *Morrison flowers.* (Brian Stevenson)

▼ *Fringe woodland of paperbarks, Melaleuca.* (Brian Stevenson)

▲ Leucopogon oxycedrus. (*Brian Stevenson*)

▼ *Common pin-heath.* (*Brian Stevenson*)

In addition, an attempt was made to set the boundaries of the proposed M.P.A.s in such a way that the danger of the disease being introduced uphill from the boundary and gravitating into the priority area through water-borne spores would be minimised. This was very much easier to achieve in the eastern part of the jarrah forest where the level of infection is still very low, than in the western part of the jarrah forest or on the coastal plain, where it often reaches much higher proportions.

Summing up, the criteria on which the M.P.A.s were selected were ecological ones, that is, to achieve the greatest possible coverage of existing vegetation types. However, the selection was made within constraints imposed by past and present land-uses.

Flora

As the flora of the northern forest is not only the basis of fauna survival, but is also easier to describe and map than fauna, it will be dealt with first. The earlier studies of the flora of the area were those of Diels in 1906. The next period of study was prior to or during World War II when Williams (1932 and 1945) and Gardner (1942) published their detailed and broad-scale studies respectively. The next major contribution was that of Speck (1958) and a minor contribution by Lange (1960). There are also related historical studies by Churchill (1961, 1968). This was followed by the attempts to define and map the flora of the state forest as a basis for land-use planning by Havel (1968, 1975*a* and *b*). There is also the extensive, though not very detailed, structural mapping of the vegetation by Smith (1974).

The latest and most ambitious attempt at mapping the vegetation of the area is that by Heddle, Loneragan and Havel (1979). The essence of this latter attempt is that it incorporates all earlier studies and

fuses together the ecological, floristic methods of Havel and the structural methods of Smith to provide a map on which the vegetation is described both in terms of its floristic composition, its structure and its underlying environmental conditions. In addition, because of the need to complete this very extensive mapping in a limited time, the vegetation is mapped on a basis of underlying geomorphology and climate, supported by extensive field reconnaissance. The use of a geomorphologic and climatic basis was made necessary by the fact that much of the vegetation is structurally very uniform, as is shown on the map produced by Smith (1974). The major variation in response to changes in soils, landforms and climate is in the understorey and this, of course, cannot be detected on aerial photographs.

Another important reason for using a geomorphologic and climatic basis is that the vegetation in the south-west of Western Australia tends to change progressively, without sharp boundaries and cannot be split into clear-cut types. It is not unusual for the bulk of the change to occur within a relatively short distance from the major drainage lines and beyond that change only mildly over considerable distances. Such a situation of course, is extremely difficult to map and can only be overcome by the use of vegetation complexes related to geomorphology and climate. On the scale that is necessary to cover the area in question, the mapping of the rapidly changing vegetation types near drainage lines would not be feasible. Similarly, on the uplands, any clear boundaries could only be a distortion of the true situation which is one of gradual change.

Some of the climatically and geomorphologically induced variation is relatively easy to see. For instance in the progression from north-east

▲ ***Barrens claw flower.*** *(Les Harman)*

▼ Kunzia micrantha. *(Les Harman)*

▲ ***Termite mound, Julimar.*** (Brian Stevenson)

▼ ***Sandplain cranberry.*** (Brian Stevenson)

▲ ***Edge of the Quindalup dune system, Caraban.*** (Brian Stevenson)

▲ ***Snakebush, Melaleuca.*** (Brian Stevenson)

▲ ***Wandoo woodland, Julimar.*** (Brian Stevenson)

▼ ***Mixed jarrah and marri woodland, Julimar.*** (Brian Stevenson)

to south-west the gradual replacement of wandoo by jarrah (*E. marginata*), yarri or blackbutt (*E. patens*) and marri (*E. calophylla*) is very obvious, as is the gradual disappearance of the south-western species such as bullich (*E. megacarpa*) and karri (*E. diversicolor*) with progress northwards.

Some of the species are restricted to special topographical and specific soil conditions, e.g. the rock sheoak (*Casuarina huegeliana*) is almost entirely restricted to the rock outcrops, particularly on the Darling Scarp and in the eastern portion of the state forest.

The problem that plagues conservation reserves in agricultural country, namely the invasion by exotic weeds, is as yet of minor importance in state forest. This is probably attributable to the fact that the fertility of the local soils is very poor and fertilisation is required before exotic plants can become successfully established. Nevertheless, in view of the experience of reserve managers in other parts of Australia, it is important that in the South-West any further introduction of exotic plants be detected early by monitoring, and steps be taken to limit it. The greatest tendency for this is generally in areas where the native flora has been subjected to a greater degree of disturbance, such as along the boundaries of agricultural land or on areas intensively used for recreation. Several weeds recognised as threatening the integrity of the local plant communities include veldt grass on the Coastal Plain, and golden wattle (*Acacia pycanantha*) and blackberries in the Darling Ranges.

The network of conservation M.P.A.s selected and managed by the Forests Department will enhance the chances of survival of many of the plant communities in the northern forests. Without such a network the increasing demands on the forest may have contributed to the elimination of some species and communities.

Fauna

Unlike flora, which is relatively static, fauna is much more difficult to map. Animals are continually on the move, often are nocturnal and in many cases their populations are subject to many ups and downs resulting from fluctuating availability of food and cover. For this reason, the fauna of any area is generally less adequately known than the flora, and surveys carried out to amend this deficiency are generally very time consuming and very costly. In addition, biologists do not have time to adequately study the distribution of all of the many species of native fauna. This knowledge would, of course, be highly desirable in delineating areas for the conservation of fauna, but it is simply not available. For this reason it is usual to relate the occurrence of animals and birds to plant communities and to assume that provided adequate protection is given to plant communities, the animals will also be catered for. This is also the approach taken by the Forests Department. Only in exceptional cases where additional knowledge on fauna was available, were special provisions made. One such case is the delineation of the Goonac M.P.A., so as to ensure the protection of a known population of tammars (*Macropus eugenii*). This animal is a relatively rare wallaby which elsewhere on the mainland tends to be displaced by human activity.

Fortunately, conservation of the fauna is not restricted to the M.P.A.s. Many species have proven their ability to survive quite adequately in those areas where water supply and timber production are the primary priorities of management. In fact, the continuity of the native forest managed for whatever purpose, makes it possible for fauna to survive, not only in the smaller proportion of the land that it has been possible to set aside as priority areas, but also in all the forest in between. That way the minimum size requirements for fauna, which are particularly difficult to achieve, are probably adequately met.

The information available on the individual species of native fauna is rather sketchy and is mainly restricted to vertebrates. With the growing awareness of the necessity of conservation, an improvement in the level of knowledge can be anticipated. The department itself carries out extensive fauna surveys, which are filling in gaps in our knowledge, but much more knowledge is needed for the effective management of the priority areas. Despite the gaps in our knowledge it is possible to relate some of the better known species to particular plant communities and therefore to particular M.P.A.s. For instance, the quokka (*Setonix brachyurus*), a small wallaby which is best known from Rottnest Island, was at one stage thought to be almost extinct on the mainland. Departmental fauna studies have shown that it is quite common in the swampy valleys in the western part of state forest and several of the delineated M.P.A.s contain this wallaby. Other animals with similar preferences for valley vegetation are the mardo (*Antechinus flavipes*), the short-nosed bandicoot (*Isoodon obesulus*) and the western water rat (*Hydromys chrysogaster*). As such, they would be adversely affected by drowning of river valleys by water supply dams, as well as by intensive recreational use for which these localities are favoured.

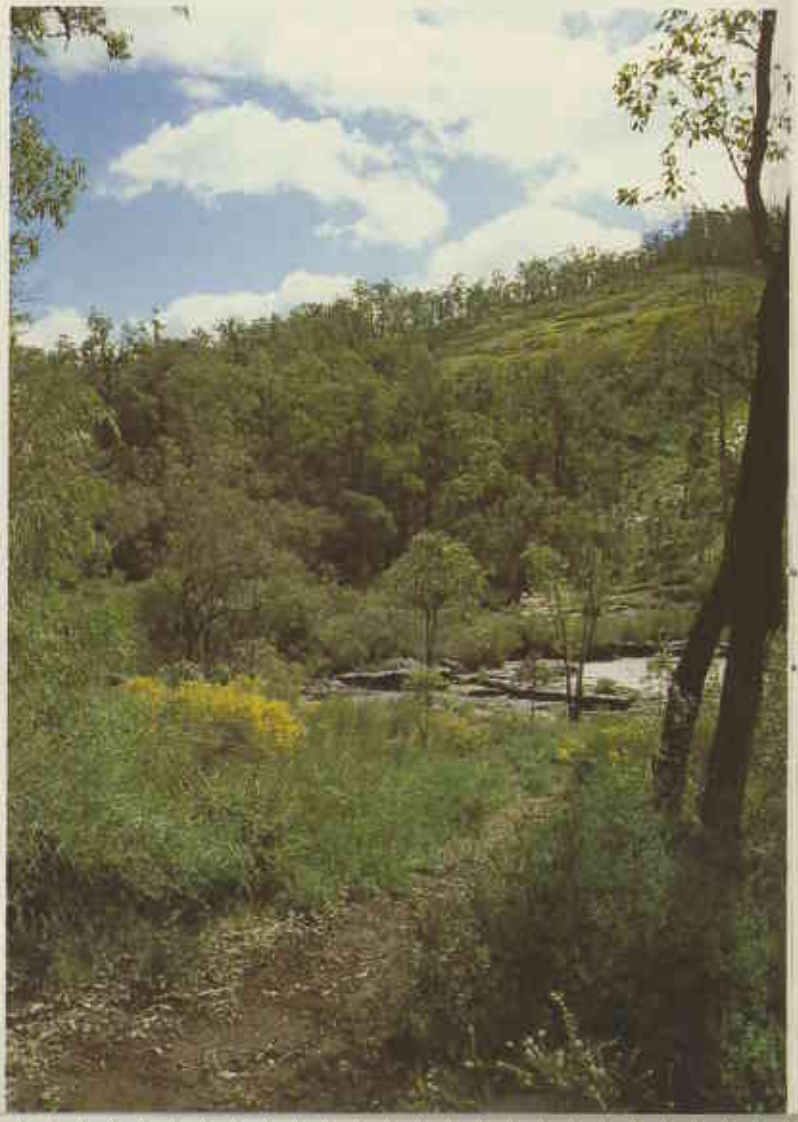
State forest contains some species whose original range has been enormously reduced. The numbat (*Myrmecobius fasciatus*) is one of these. Initially it extended eastwards into the agricultural country and the

▲ *Looking westwards down the Collie River valley.* (Cliff Winfield)

▲ *W.A. peppermint growing beside Stones Brook, Gervasse.* (Cliff Winfield)

▼ *Open jarrah/marri forest with a foreground understorey of pineapple bush.* (Cliff Winfield)

▼ *View across Collie River to granite slopes on opposite hillside.* (Cliff Winfield)



pastoral country beyond, and through to the eastern states. Its known occurrence is now restricted to the eastern periphery of state forest, where it occurs in wandoo woodlands and low open-forest of jarrah.

The echidna or spiny ant-eater (*Tachyglossus aculeatus*) is known to occur among rocks in open forest and scrubland. Although it is distributed throughout the forest it probably reaches its best development in the eastern portion. While it is not known exactly how many animals are contained in the very extensive flora and fauna M.P.A.s in the eastern zone of the forest, it is reasonable to assume that the provision for the survival of this very interesting animal is adequate. Some animals, such as the brush-tail possum, possibly do not need the protection of the M.P.A.s. The highest possum populations have always been on the forest-farmland interface, on the periphery of orchards and farms, rather than in the extensive forests away from the human settlements. It appears that they, at least, have found a way of co-existing with European populations.

What has been said of mammals is also true for birds. So far the only species known to have disappeared from northern jarrah forest is the noisy scrub bird (*Atrichornis clamosus*) now known only from one south coastal colony near Albany. Most of the other birds appear to have survived satisfactorily and the studies that have been made reveal large numbers of birds occupying the many different niches that one finds in a forest. Some occur predominantly in the crowns, others on the stems of the trees, still others in the understorey. There is another large group which prefers the streams that drain the Darling Ranges. Even less is known about other types of animals such as the frogs, lizards, snakes, and about their preferences for the different parts of the forest. As to the insects, they are so numerous, and so little is known about them, that a beginning has hardly been made. It is for groups like these that the approach through the conservation of plant communities is particularly essential. This is because it will be many years before our knowledge will be sufficient to make direct provision for them.

As with the flora, the introduction of exotic species can be quite damaging. It is believed by zoologists that some of the species that have virtually disappeared, such as the woylie (*Bettongia penicillata*), have done so not merely because the area carrying suitable vegetation has been reduced, but because they have been unable to stand up against the predation by foxes and cats on the one hand and competition from rabbits on the other.

Currently the measures taken to protect native flora against the die-back disease appear to have led to an increase in the numbers of introduced wild pigs, because it is more difficult for hunters to get into the areas placed under quarantine. The cessation of poison baiting against foxes has also apparently led to an increase in their numbers and is causing problems with the conservation of smaller wallabies.

Fortunately in the forests of Western Australia there has been no commercial exploitation of native animals for some considerable time. This contrasts markedly with the past, when possums and water rats were trapped for fur and kangaroos were shot for both fur and meat.

On the whole then, it appears that the fauna characteristic of the forested areas of the South-West has a better chance for survival than the fauna of any of the surrounding areas.

Recreation

So far the main accent has been very much on the provision of M.P.A.s for the conservation of flora and fauna. Forests can also be managed for recreation. The northern forests are particularly important from this point of view because they are so close to the large population of metropolitan Perth.

The demand for recreation varies seasonally. In the forest areas close to Perth the main demand occurs during winter and spring when the streams are running and the winter rain has resulted in the flowering of the many hundreds of species of flowering plants which are characteristic of the region. The demand for recreation is naturally concentrated in those areas which appear to offer the most, such as the monadnocks arising from the Darling Plateau (Sullivan Rock, Eagle Hill, Mt. Dale and Mt. Cooke) where there is a diversity of vegetation in and around the rock outcrops and where a view can be obtained of the surrounding countryside.

In summer the demand centres on those rivers which are still open for water-based recreation, such as the Murray and Lower Collie rivers. It is a demand that is continually increasing and diversifying. The Forests Department, as the largest land manager in the area, recognises the need for providing adequate areas for recreation. The way in which this is done is by provision of barbecues, picnic sites, long distance trails (such as the Bibbulmun Track), shorter botanical walks and access for active sports such as canoeing and rock climbing.

The provision of these facilities has, in part, met public demand. Unlike conservation, priority areas have not been generally designated for recreation. An exception to this

▲ *Wandoo woodland, upper slope, Russell.* (Brian Stevenson)

▼ *Wandoo flats in the valley floor, Russell.* (Brian Stevenson)

is the Murray River M.P.A., which has been set apart in recognition of the particular value of this area for canoeing, camping and other forms of active recreation. Currently a major visitor survey is under way in the forests to define the recreation needs more precisely.

Although many recreational activities do not conflict to a great degree with conservation, there are some which can lead to serious degradation. As a basic principle recreation is not encouraged in core areas of M.P.A.s for conservation. The more destructive forms of recreation such as car rallies, trial and trail bike riding and use of off-road vehicles, all of which could lead to damage of the vegetation and soil erosion, are more difficult to accommodate.

Even the more dispersed forms of recreation, such as canoeing, bushwalking and orienteering, do have some potential to damage vegetation. It is anticipated that surveillance of these activities will be necessary. Where localised damage occurs relocation may need to take place. The impact of recreation is accentuated in the South-West by the occurrence of jarrah dieback. While motorised activity is the chief form of dispersal of this disease, even recreation on foot could contribute on a localised scale.

A novel form of provision for recreational activity is the use of former Forests Department settlements as forest camps for the public, both as organised large groups and as individual families. The chief camps in System 6 are at Wellington Mill and Myalup. They have proven very popular. The running of the camps is carried out by the Department of Youth, Sport and Recreation, which leases the areas from the Forests Department. The Forests Department co-operates by providing additional facilities around the camps, such as botanical

walks. Other forms of recreational activities are visits to historical sites and buildings, which are relatively rare in the northern jarrah forest region.

Security of tenure of conservation M.P.A.s

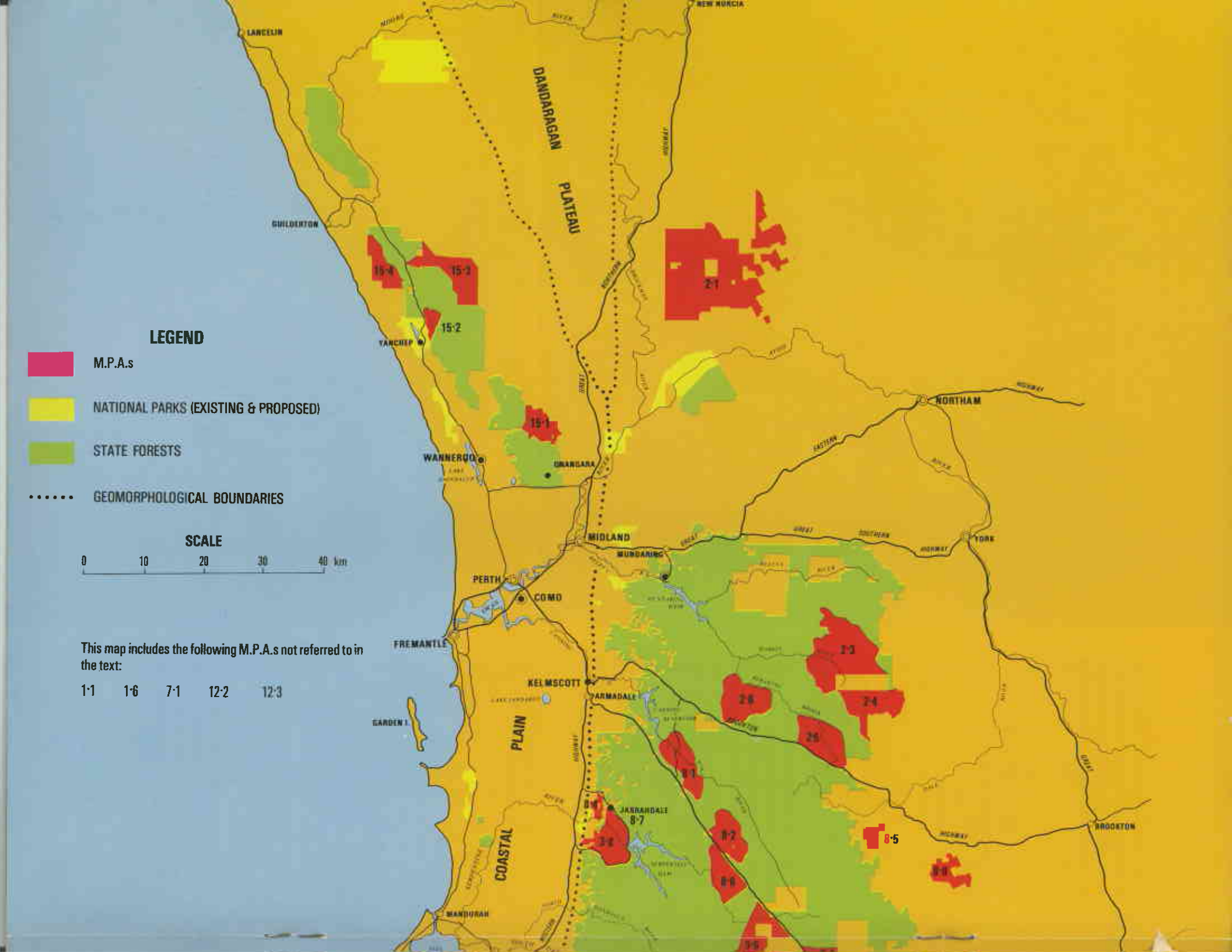
The conservation of flora and fauna in state forests and timber reserves is the responsibility of the Forests Department subject to the provision of the Forests Act, Lands Act and the Wildlife Conservation Act. State forest and the included M.P.A.s have "A" class security of tenure in that they cannot be alienated except with the approval of both Houses of Parliament. The M.P.A.s have the added protection in that the purpose of management is designated in the General Working Plan, which is approved by the Governor in Executive Council. Detailed management proposals for individual areas will be embodied in specific management programmes prepared in line with the General Working Plan.

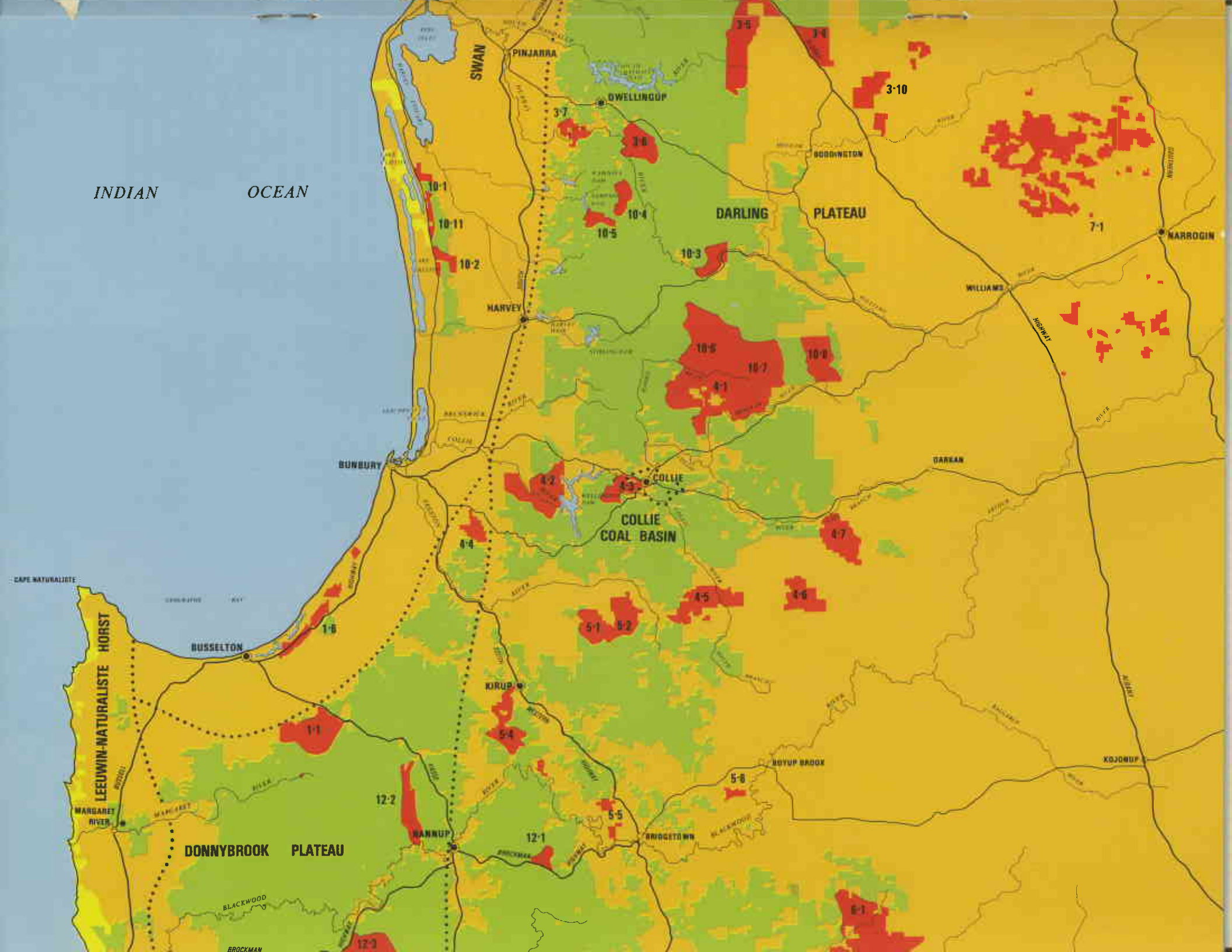
The internationally accepted concept of subdividing reserves for conservation into a central core and a surrounding buffer (U.N.E.S.C.O.) applies to most of the conservation M.P.A.s. Primarily, this is a management concern as specified by the Forests Department Working Plan No. 86 of 1977.

The core area is envisaged as the central portion in which it is essential to keep disturbance to a minimum. This may include exclusion of vehicles and equipment for protection against spread of dieback or direct damage. The core is surrounded by a buffer in which human activity is permitted, but is managed in a way that will not prejudice the conservation aim of the core.

▲ *Powder-bark wandoo on upper slopes, Russell.* (Brian Stevenson)

▼ *View from Mt. Dale lookout, showing wandoo by the track.* (Brian Stevenson)


LEGEND
M.P.A.s
NATIONAL PARKS (EXISTING & PROPOSED)
STATE FORESTS
GEOMORPHOLOGICAL BOUNDARIES
SCALE
0 10 20 30 40 km
This map includes the following M.P.A.s not referred to in the text:
1·1 1·6 7·1 12·2 12·3
LANCELIN
GINGIN
GUILDERTON
YANCHEP
WANNEROO
GRANGARA
PERTH
COMO
FREMANTLE
GARDEN I.
MANDURAH
KELMSCOTT
JARRAHDALE
MIDLAND
MUNDARING
NORTHAM
YORK
BROOKTON
DANDARAGAN PLATEAU
COASTAL PLAIN
15·4
15·2
15·2
15·1
2·1
2·3
2·4
2·6
2·5
8·1
8·7
8·2
8·5
8·6


INDIAN OCEAN
SWAN
PINJARRA
DWELLINGUP
BODDINGTON
DARLING PLATEAU
NARROGIN
WILLIAMS
HIGHWAY
HARVEY
BUNBURY
COLLIE
COLLIE COAL BASIN
DARKAN
CAPE NATURALISTE
LEEUWIN-NATURALISTE HORST
BUSSELTON
KIRUP
MARGARET RIVER
DONNYBROOK PLATEAU
BLACKWOOD
BRUNSWICK
COLLIE
MANNUP
BRIDGETOWN
BOYUP BROOK
KOJONUP
3·5
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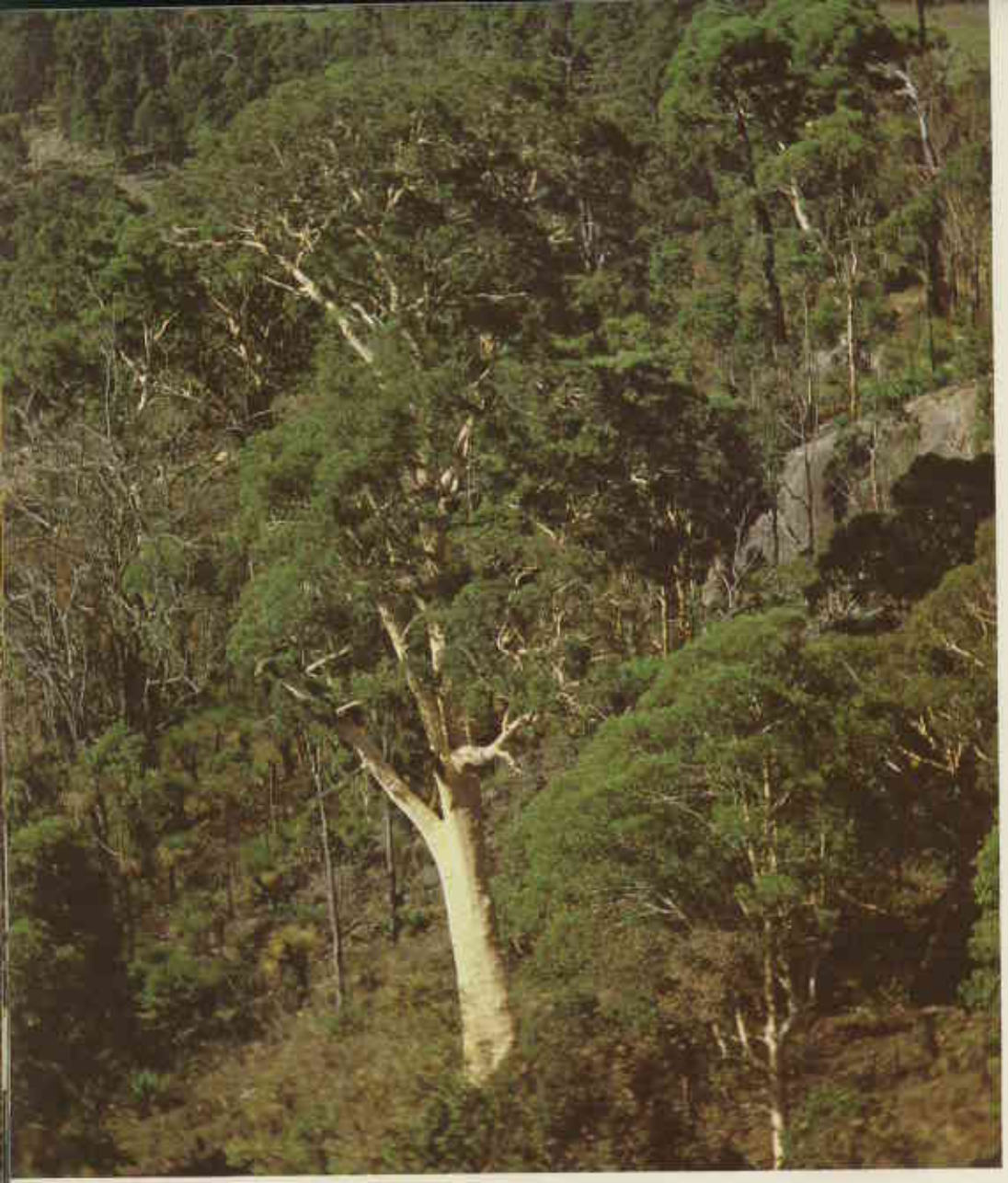


▲ *Darling Range ghost gum on the scarp edge.* (Les Harman)

▼ *Turtle pool, Eagle Hill.* (Brian Stevenson)

The vast majority of the M.P.A.s is in part or totally surrounded by native forests controlled and managed by the Forests Department. The core-buffer concept has not been adopted for those M.P.A.s with lower levels of disturbance, or for those too small to be divisible into buffer and core.

The specifications for the core area are basically the same as developed for Forest Parks in Systems 1 and 2 by the Environmental Protection Authority. However, as the term "Forest Parks" has a connotation of recreational activity, which is at times in conflict with the conservation aim, a new term "Forest Sanctuary" is under consideration for those M.P.A.s in System 6 in which conservation, rather than recreation, is the primary aim of management. Whatever the name that is eventually adopted, the security of tenure and the clear and binding designation of management aims should ensure that the vegetation of these areas will be free from adverse man-made disturbances.

This security, however, still does not overcome the problems of conflicting land uses and resolution of legal over-riding of the Forests Act by other Acts. This conflict of other land uses with conservation requires resolution. The E.P.A. has recommended that the demands for water supply needs should be considered with the Working Plan, in full consultation with the appropriate authorities. Although the Working Plan secures Forest Parks, like M.P.A.s, from logging, they do not afford protection against bauxite mining, damming, communication and transport needs. These questions also apply to other conservation reserves including those controlled by the National Parks Authority and the Western Australian Wildlife Authority. Obviously these conflicts require careful resolution if the

security of the conservation areas (of which the Forests Department M.P.A.s are only one type) is to be maintained in the long term. The recent establishment of the Darling Range Land Use Study Group is a step in that direction.

Management of conservation M.P.A.s

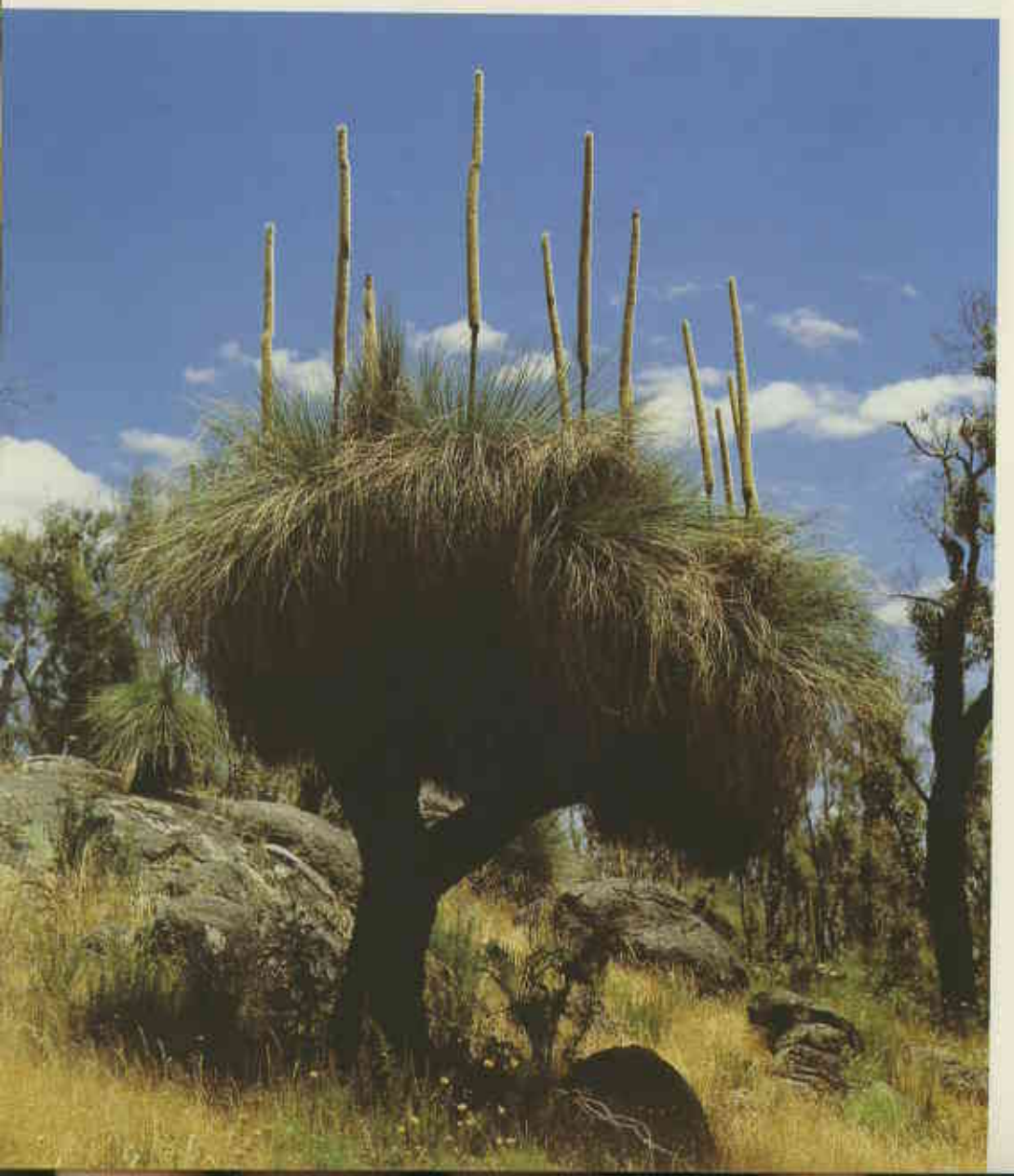
Communities of living things, whether plants or animals, change with time. The species which compose these communities do not necessarily all change together—their populations go up and down in response to changes in environmental conditions. The ability to manage areas for conservation is therefore dependent on the understanding of how the plant and animal communities operate within them. To obtain this information, the Forests Department has a continuous research programme to investigate, map and describe these communities in the forest as a whole, but more especially in the M.P.A.s for conservation. In fact such information was used initially in selection of these areas and will in future be used for their management. The areas studied in greatest detail are the Melaleuca, Russell and Surface M.P.A.s. There is still a great need to improve the level of information, simply because the plant and animal communities are so complex.

There has been a tendency in the past not to manage areas set aside for conservation of flora and fauna, that is to leave them alone. This approach is a luxury we cannot afford. Each conservation area is surrounded by other areas which are subject to other forms of management or exploitation. This in itself is sufficient to initiate changes, which unless directed or kept under control, could lead to major changes, firstly in the vegetation and then the animals which are dependent on the vegetation.

▲ *Black gins.* (Brian Stevenson)

▼ *Bullich near Dwellingup.* (Les Harman)

◀ *Yarri (blackbutt) forest, Ashendon Road, Eagle Hill.* (Brian Stevenson)



▼ *Blackboy, Gervasse.* (Les Harman)

At present, the view is being increasingly accepted that in order to maintain plant and animal communities some human interference in the form of management is necessary to offset unintentional but significant influences generated by other activities. The aim of management is seen as the conservation of the full genetic and natural diversity of the plant and animal communities. Obviously the management approach will differ from one conservation area to another; simply because they are not identical. In addition, within state forest the conservation areas cannot be considered in isolation from the rest of the forest or from the surrounding country managed for farm production, mining or water supplies. As a part of its multiple-use forestry, the Forests Department is preparing working plans for the various M.P.A.s for conservation which tie in with the management of areas for other priorities.

Conclusions

Although much of the countryside in Western Australia has been modified by intensive land-use, within state forest it is possible to make provision for the conservation of plant and animal communities which characterise the south-west of the state.

The degree to which it is possible varies from place to place, but an extensive network of M.P.A.s for conservation has already been established and is currently being studied to ensure optimum management. However, there still remains much to be done. Fortunately the climate of public opinion is now favourable to conservation.

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▲ *Mixed jarrah and marri forest, Ashendon Road, Eagle Hill.* (Brian Stevenson)

▼ *Bullich in an upper valley south of Brookton Highway.* (Brian Stevenson)

TABLE 1—VEGETATIVE ASSOCIATIONS

VEGETATIVE ASSOCIATIONS			GEOMORPHOLOGICAL REGIONS					
STRUCTURAL FORMATION	No.	ALLIANCES UPPER STRATA SPECIES	Swan Coastal Plain	Darling Plateau (High Rainfall)	Darling Plateau (Medium Rainfall)	Darling Plateau (Low Rainfall)	Collie Coal Basin	Darling Plateau (Low Rainfall)
Tall open forest	1	*E. diversicolor*		x				
	2	*E. marginata/E. calophylla*		x	x			
Open forest	3	*E. marginata/E. calophylla*	x	x	x	x	x	x
	4	*E. gomphocephala*	x					
	5	*E. wandoo*		x	x	x		
	6	*E. patens*		x	x			
	7	*E. megacarpa*		x				
Woodland	8	*E. marginata/E. calophylla*	x	x	x	x	x	x
	9	*E. gomphocephala*	x					
	10	*E. wandoo*		x	x	x		
	11	*E. rudis/Melaleuca* spp.		x			x	
Open woodland	12	*E. marginata/E. calophylla*		x	x	x	x	x
	13	*E. wandoo*				x		
	14	*E. gomphocephala*	x					
Low closed forest	15	*E. rudis/Melaleuca* spp.				x		
Low open forest	16	*E. marginata/E. calophylla*		x	x	x		x
	17	*E. rudis/Melaleuca* spp.		x	x	x		x
	18	*B. menziesii/B. attenuata/C. fraserana/E. todtiana*	x					
Low woodland	19	*E. marginata/E. calophylla*	x					
	20	*E. rudis/Melaleuca* spp.	x	x	x	x		x
	21	*E. wandoo*				x		
	22	*C. huegeliana*				x		
	23	*C. obesa*				x		
	24	*B. menziesii/B. attenuata/C. fraserana/E. todtiana*	x					
	25	*B. prionotes*	x					
Low open woodland	26	*E. marginata/E. calophylla*		x	x	x		
	27	*E. wandoo*				x		
	28	*B. menziesii/B. attenuata/C. fraserana/E. todtiana*	x					
Closed scrub	29	*Proteaceae/Myrtaceae* (limestone scrub)	x					
Open scrub	30	*Dryandra* spp., *Hakea* spp., *Casuarina* spp.			x	x		
	31	*Actinostrobus pyramidalis*			x	x		
Closed heath	32	*Proteaceae/Leguminosae/Myrtaceae* (limestone)	x					
Swamp complex	33	Common plants include species of *Baumea, Juncus, Carex, Gahnia, Scirpus* and *Typha*	x		x	x	x	x
Lithic complex granitic	34	Common plants include *Borya nitida, Crassula* spp., lichens and moss		x	x	x		
Limestone	35	Common plants include *Dryandra sessilis, Threlkeldia diffusa, Westringia rigida* and *Zygophyllum* spp.	x					
Aquatic complex freshwater plants	36	*Azolla filiculoides, Lemna* spp., *Marsilea* spp., *Myrophyllum* spp., and *Potamogeton* spp.	x					

TABLE 2—DEFINITION OF SITE VEGETATION TYPES NORTHERN JARRAH FOREST (DARLING PLATEAU)

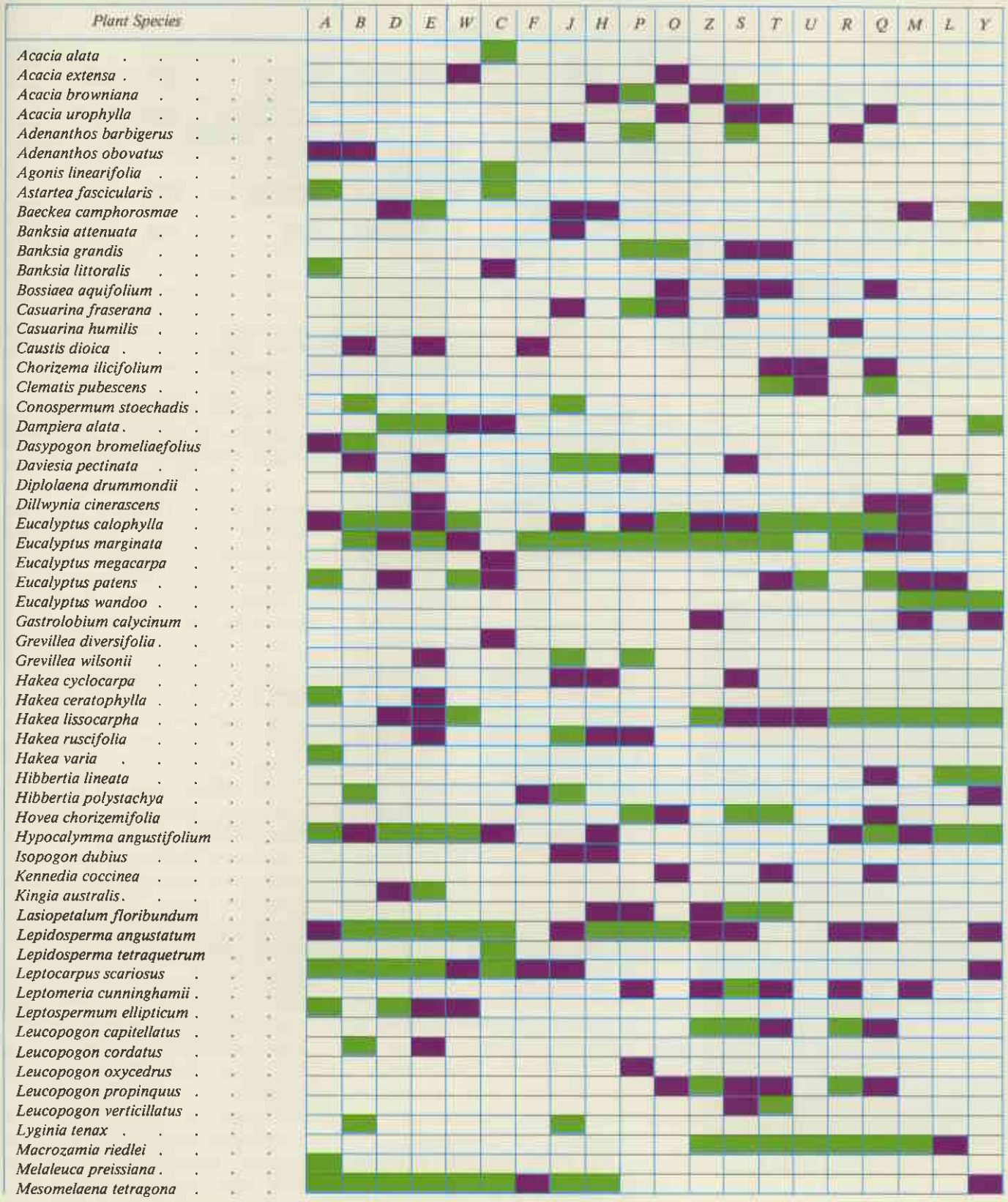
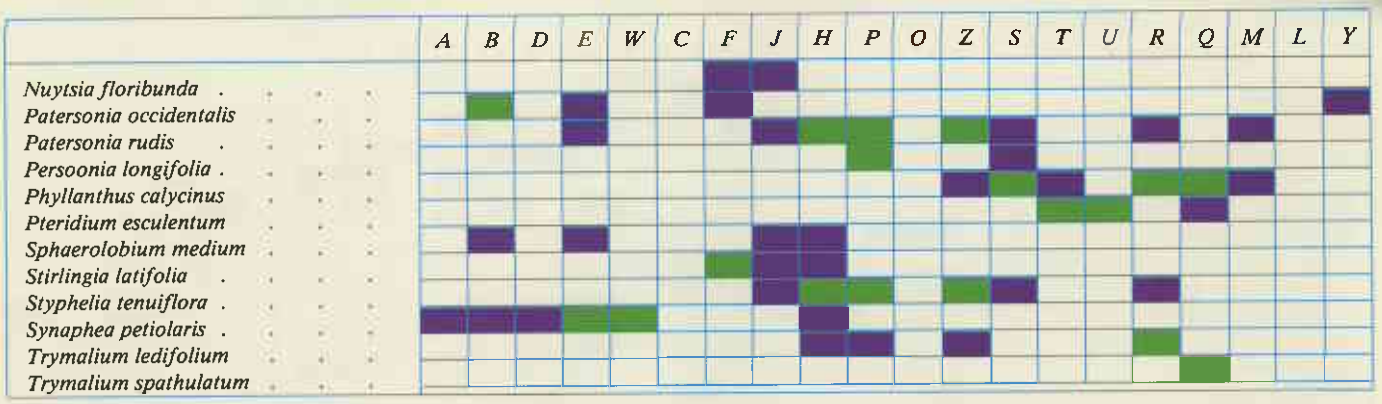


TABLE 2—DEFINITION OF SITE VEGETATION TYPES NORTHERN JARRAH FOREST (DARLING PLATEAU)—CONTINUED



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Species generally absent.

Species should be present, but absence not critical.

Species should be present.

TYPE G was defined subsequently. It has a variable and unique set of indicator species which are characteristic of granite outcrops and their surroundings in low to medium rainfall zone, such as lichens, *Borya nitida, Grevillea bipinnatifida, Hakea elliptica, Hakea undulata, Eucalyptus laeliae, Eucalyptus wandoo* and *Casuarina huegeliana.*

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▲ *Creek vegetation and yarri (blackbutt) slopes near Ashendon Road, Eagle Hill.* (Brian Stevenson)

TABLE 3—KNOWN HABITAT REQUIREMENTS OF ANIMALS IN THE NORTHERN JARRAH FOREST REGION

Common Name	*Scientific Name*	*Cover or Nesting Requirements*	*Food Requirements*	*Corresponding Site Vegetation Type* (Havel, 1975 *a* and *b*)
Quokka	*Setonyx brachyurus*	In dense scrub on valley floors	Herbage	C, to lesser extent A, D, W, Q.
Numbat	*Myrmecobius fasciatus*	Open forest and woodland	Termites	L, Y, M, H, Z, O, P, S, T.
Tammar	*Macropus eugenii*	Closed scrub, open underneath	Herbage	A, to lesser extent Y, M, H, Z.
Ring-tail possum	*Pseudocheirus peregrinus*	Woodland and tall closed scrub	Buds, leaves	C, Q, A, H, Z, G.
Spiny ant-eater or echidna	*Tachyglossus aculeatus*	In rocks or under stones or logs, open forest or scrubland	Ants, termites	R, G, M, Q, particularly in northern section.
Mardo, yellow-footed marsupial mouse	*Antechinus flavipes*	Forest with dense understorey near streams. Also on rocky slopes and on fully fire-free uplands	Insects, small mammals	C, D, but also T, O, G.
Common or black-tailed wambenger	*Phascogale tapoatafa*	Arboreal, nests in tree hollows	Rats, mice, birds, insects, fungi	S, T, P, O, G.
Red-tailed wambenger	*Phascogale calura*	In mature stands of *Casuarina huegeliana*	Insects, small mammals	M, dry form of G.
Fat-tailed dunnart	*Sminthopsis crassicaudata*	In wandoo woodlands, heaths, stony places	Insects, small mammals	M, Y, L, dry form of G, Z.
Chuditch, native cat	*Dasyurus geoffreyii*	Arboreal, but also on ground, in sclerophyll forests	Mammals, birds, insects	Recorded from wide range of sites—M, R, S, Y, Z.
Quenda, short-nosed bandicoot	*Isoodon obesulus*	Forest with dense shrub cover, in logs, rocks	Bulbs, insect larvae, small mammals	C, D, G, M.
Noolbenger, honey possum	*Tarsipes spencerae*	Arboreal, in flowering shrubs and trees, in blackboys	Pollen, nectar, small insects	A, B, G, F, J.
Mundarda, pigmy possum	*Cercacetus concinnus*	In hollows of casuarinas and banksias, blackboys, stumps	Nectar, insects	A, B, G, R, F, J.
Common dunnart	*Sminthopsis murina*	In hollow logs, blackboys	Insects, small mammals, lizards	E, F, O, P, G.
Brush-tailed possum	*Trichosurus vulpecula*	Chiefly in hollows in wandoo and marri, stumps, houses	Buds, leaves, eggs, birds	M, L, Y, E.
Black-gloved wallaby	*Macropus irma*	Open forest country with shrub understorey	Grasses and sedges	Recorded from wide range of sites, rarer in swamps and wandoo forest; maximum occurrence T, S, O, P, R, Z, H, E.
Western grey kangaroo	*Macropus fuliginosus*	Open forest with shrubby or grassy understorey		
Western water rat	*Hydromys chrysogaster*	In dense vegetation on banks of streams and swamps	Crayfish, shells	C, D, Q.
Western swamp rat	*Rattus fuscipes*	In dense vegetation in swamps and valleys	Vegetable matter—bulbs, leaves, rhizomes	Q, A, C, D; probably only in southern-most section.
Dingo	*Canis familiaris*	Wide ranging over the landscape	Mammals, birds, reptiles	Now virtually extinct due to heavy poisoning pressure; chiefly H, Z, Y, M in past.

ECOLOGICAL IMPORTANCE

1. Unique, scarce or not replicated.
2. May be replicated but likelihood of damage as a result of dams, recreation, etc., therefore replication required.
3. Replication, geographical disjunct distribution, very important.
4. Replication important.

TABLE 4—MANAGEMENT PRIORITY FOREST R

Working Plan 86 No.	*M.P.A. Name*	*Area (ha)*	*Priority Use*	*Geomorpho-logical Region*	*Dominant Structural Vegetation (see Table 1)*	*Minor Structural Vegetation (see Table 1)*	*Ecological Importance*	*Climatic Region (Rainfall)*	D
15.1	Melaleuca	3208	Conservation of flora and fauna	Swan Coastal Plain	24, 28	8, 20, 33, 36	1	Low	G,
15.2	Ridges	1260	Conservation of flora and fauna	Swan Coastal Plain	14, 28, 29	8, 18, 19, 24, 32, 35	1	Low	A-
15.3	Wabling	5030	Conservation of flora and fauna	Swan Coastal Plain	24, 28, 29	18, 20, 25, 32, 33, 35	1	Low	A,
15.4	Caraban	2966	Conservation of flora and fauna	Swan Coastal Plain	14, 24, 28, 29	18, 32, 35	1	Low	A.
2.1	Julimar	27798	Conservation of flora and fauna	Darling Plateau	3, 5, 10	13, 17, 20, 21, 27	1	Low	H,
2.3	Gunapin	13497	Conservation of flora and fauna	Darling Plateau	3, 5, 8, 10, 12, 20, 30, 33	12, 13, 16, 17, 21, 22, 23, 27, 31, 34	1	Low	A,
2.4	Sullivan	4555	Conservation of flora and fauna	Darling Plateau	3, 5, 10, 17, 20, 33	8, 12, 15, 16	1	Low	A,
2.5	Russell	5702	Conservation of flora and fauna	Darling Plateau	3, 5, 10	6, 8, 12, 17, 20, 21, 22, 26, 27, 30, 34	1	Low	H,
2.6	Dale	6272	Conservation of flora and fauna	Darling Plateau	3, 5, 10, 12	6, 8, 17, 20, 34	1	Medium	G,
8.1	Eagle Hill	4638	Conservation of flora and fauna	Darling Plateau	3	6, 8, 12, 26, 34	1	Medium	P,
8.2	Cooke	4695	Conservation of flora and fauna	Darling Plateau	3, 8, 26, 34	5, 6, 10, 12, 16, 17, 20	1	Medium	G,
8.4	Gooralong	705	Conservation of flora and fauna	Darling Plateau	3	2, 6, 8, 17, 26, 34	2	High	S,
8.5	Boyagarring	1480	Conservation of flora and fauna	Darling Plateau	5, 10	3, 20, 21, 22, 27, 34	1	Low	Y,
8.6	Windsor	4225	Conservation of flora and fauna	Darling Plateau	3, 33, 34	5, 6, 8, 10, 16, 17, 20	3	Medium	D,
8.7	Serpentine	1496	Conservation of flora and fauna	Darling Plateau	3	6, 17, 34	4	High	P,
8.8	Lupton	2770	Conservation of flora and fauna	Darling Plateau	3, 5, 10	20, 21, 22, 27, 34	3	Low	H,
3.4	Gyngoorda	3453	Conservation of flora and fauna	Darling Plateau	3, 5, 10	8, 17, 20, 21, 22, 27, 34	3	Low	H,
3.5	Duncan	9935	Conservation of flora and fauna	Darling Plateau	3, 5, 10, 12	17, 20, 21, 22, 27, 34	1	Low	D,
3.6	Plavins	3495	Conservation of flora and fauna	Darling Plateau	3, 6	2, 17	1	High	S,
3.7	Teesdale	1728	Conservation of flora and fauna	Darling Plateau	3, 6	2, 17	1	High	Q,
3.8	Karnet	3688	Conservation of flora and fauna	Darling Plateau	3	2, 6, 8, 17, 26	3	High	P,
3.10	Wandering	4334	Conservation of flora and fauna	Darling Plateau	3, 5, 10	13, 17, 20, 21, 22, 27	1	Low	H,

AREAS IN NORTHERN JARRAH REGION

Dominant Site—Vegetation Types (see Table 2)	Minor Site—Vegetation Types (see Table 2)	Adequacy of Conservation		Special Fauna Represented	Special Features
		Duplication	Similar		
G, H-I	J, K	—	—	—	Bassendean dune system.
A-B, C, E	D, I-J	—	15.3, 15.4	—	*Melaleuca preissiana*. Extension of Yanchep National Park.
A, B, C, D	E, F, G, H, I, J, K	—	15.2, 15.4	—	Transition from Spearwood and Bassendean dune system. Wabling Hill.
A, C, D	B, E	—	15.2, 15.3	—	Tuart, limestone heath.
H, M, Y	A, G	—	—	—	Northern extension of jarrah marri, wandoo forests; *Dryandra polycephala, Hibbertia miniata.*
A, H, M	B, J, F, G, Y	—	2.4, 10.6, 10.7	—	Swamp vegetation and associated fauna. Deep sandy soils typical of Goonaping landform and soil unit.
A, H, Y	B, J, F, M	—	2.3, 10.6, 10.7	—	Swamp vegetation (and associated fauna).
H, M, Y	A, D, E, F, G, J, L, Z	3.4	3.5, 3.10, 10.8	—	Virgin wandoo.
G, M, P, H	A, D, E, F, J, L, R, Y, Z	—	8.2	—	Large-range of landforms, vegetation types and fauna. Vegetation type L.
P, S, T	C, D, G, Q, R, W	8.2	3.4, 8.4, 8.6	—	Virgin jarrah, *Kingia australis.*
G, P, H, Z	A, B, C, E, J, M, R, T, Y, S, W	8.1	2.6, 3.4, 8.6	—	Virgin jarrah, *Eucalyptus laeliae,* range of vegetation types, Mt. Cooke. Scenic.
S, T	C, D, G, P, R, W	3.8	8.7	—	Virgin jarrah. Extension to serpentine National Park.
Y, M	A, S, H, Z, G	8.8	—	—	*Eucalyptus wandoo, Eucalyptus accedens.* Dissected lateritic slopes.
D, G, H	A, B, C, J, M, P, R, Y, Z	3.4	8.1, 8.2, 3.5	—	Granitic monadnocks. Swamp vegetation and fauna. Scenic.
P, Q, S	C, D, G, T	3.8	8.4	—	Valley vegetation, marri and yarri.
H, M, Y	A, G	8.5	—	—	*Eucalyptus wandoo, Eucalyptus accedens.*
H, M	A, D, E, G, J, P, Y, Z	2.5, 8.6	3.5, 10.8, 3.10	—	Rock sheoak and *Eucalyptus drummondii.*
D, H, Y	A, F, G, M, P, Z	—	3.4., 2.5, 8.6	—	Virgin wandoo, *Eucalyptus drummondii.* Vegetation type D.
S, T	C, Q, U, W, Q, L	3.7	3.3, 10.3	—	High quality jarrah, marri, *Banksia littoralis* var. *seminuda.*
Q, S, T	C, U, W	3.6	3.3, 10.3	—	Virgin jarrah. Scenic.
P, Q, S	C, D, G, H	8.4, 8.7	—	—	Valley vegetation, *Eucalyptus laeliae.*
H, M, Y	A, L, G	10.8	2.5, 3.4	—	Woodlands of jarrah, marri, wandoo, rock sheoak, jam and eastern extension of yarri in state forest.

Working Plan 86 No.	*M.P.A. Name*	*Area (ha)*	*Priority Use*	*Geomorpho-logical Region*	*Dominant Structural Vegetation (see Table I)*	*Minor Structural Vegetation (see Table I)*	*Ecological Importance*	*Climatic Region (Rainfall)*
10.1	Clifton	533	Conservation of flora and fauna	Swan Coastal Plain	14	3, 4, 8, 9, 19, 29	1	Medium
10.2	Myalup	868	Conservation of flora and fauna	Swan Coastal Plain	14	3, 4, 8, 9, 19, 20, 29, 33	1	Medium
10.3	Bell	2590	Conservation of flora and fauna	Darling Plateau	3	5, 6, 8, 10, 11, 16	2	High
10.4	Federal	1412	Conservation of flora and fauna	Darling Plateau	2, 3, 6	7, 16	1	High
10.5	Samson	1035	Conservation of flora and fauna	Darling Plateau	3, 7	2, 6, 16	1	High
10.6	Surface	15125	Conservation of flora and fauna	Darling Plateau	3, 8, 31	,2, 16, 17, 20, 30, 33	1	Medium
10.7	Nalyerin	10375	Conservation of flora and fauna	Darling Plateau	3, 16, 33	5, 8, 10, 12, 17, 20	1	Medium
10.8	Stene*	4487	Conservation of flora and fauna	Darling Plateau	3, 5, 10	8, 17, 20, 21, 22, 27	3	Low
10.11	McLarty	727	Conservation of flora and fauna	Swan Coastal Plain	14, 29	3, 4, 8, 9, 19	2	Medium
4.1	Trees*	7837	Conservation of flora and fauna	Darling Plateau	3, 5, 10	8, 12, 17, 20	1	Medium
4.2	Lennard*	7562	Conservation of flora and fauna	Darling Plateau	3, 6, 34	8, 12, 17, 26	1	High
4.3	Westralia*	2131	Conservation of flora and fauna	Darling Plateau, Collie Coal Basin	3	6, 8, 10, 11, 12, 16, 17, 20	1	High
4.4	Dardanup*	1480	Conservation of flora and fauna	Blackwood Plateau	3	8, 12, 16, 17, 20	1	Medium
4.5	Goonac*	5211	Conservation of flora and fauna	Darling Plateau	3	5, 6, 10, 16, 17, 20	1	Medium
4.6	Muja*	3411	Conservation of flora and fauna	Darling Plateau	3, 17, 20, 33	5, 10, 16, 31	1	Medium
4.7	Bennelaking*	5635	Conservation of flora and fauna	Darling Plateau	3	5, 10, 12, 17, 20	1	Low
5.1	Preston*	2707	Conservation of flora and fauna	Darling Plateau	2, 3, 6	17	1	High
5.2	Noggerup*	3487	Conservation of flora and fauna	Darling Plateau	2, 3, 6	17, 20	1	High
5.4	Mullalyup*	4134	Conservation of flora and fauna	Darling Plateau	2, 3	6, 8, 17, 34	1	Medium
5.5	Greenbushes*	1351	Conservation of flora and fauna	Darling Plateau	3	6, 8, 17	1	Medium
5.6	Nollajup*	661	Conservation of flora and fauna	Darling Plateau	3, 5, 10	17, 20, 21, 22, 27	3	Low
12.1	Dalgarup*	3552	Conservation of flora and fauna	Darling Plateau	1, 2, 3	6, 7	1	High
12.2	St. John's Brook	3194	Conservation of flora and fauna	Blackwood Plateau	3, 4, 5, 6, 9	26, 27	1	High

Dominant Site—Vegetation Types (see Table 2)	*Minor Site—Vegetation Types (see Table 2)*	*Adequacy of Conservation*		*Special Fauna Represented*	*Special Features*
		Duplication	*Similar*		
C, D	A, B, E	10.2	10.11	—	Tuart with peppermint understorey. Spearwood dune system.
C, K	A, B, D, E, H, I, J	10.1	10.11	Swamp fauna	Swamp vegetation, tuart; transition between Spearwood and Bassendean dune systems.
Q, S, T	C, M, Y, W	3.3	3.6, 3.7	—	Paperbarks. Range of vegetation.
C, Q, T	P, S, W	—	—	—	High quality yarri.
C, Q, S, T	P, W	—	—	—	High quality bullich.
O, P, R, S	A, B, E, F, H, O-R	—	4.1, 10.7, 2.4, 2.3	—	A large area of virgin jarrah forest.
A, B, H	D, F, J, P, Y, Z	4.1	10.6, 2.3, 2.4	—	Lake Nalyerin. Large range of flora and fauna.
H, M, Y	A, G, Z	3.10	2.5, 3.4	—	Virgin jarrah and wandoo.
B, C, D	—	—	10.1, 10.2	—	Tuart. Spearwood dune system.
D, H, Z	A, J, F, M, Y	10.7	10.6	—	Virgin jarrah.
S, T	C, G, P, Q, R, U, W	4.3	—	—	High quality yarri, granitic outcrops.
S, T	A, B, C, J, O, Q, U, W	4.2	—	Numbat	Range of vegetation types, including only representatives of vegetation from Collie Coal Basin.
B, D, Z	A, J, F, P	—	—	—	Includes northern extension of Blackwood Plateau. *Eucalyptus haematoxylon.*
D, H	A, B, C, E, Y, Z	4.6	—	Tammar	Virgin jarrah.
A, B, H	D, Y, Z	4.5	—	—	Lake Ngartiminy; swamp vegetation.
H	A, B, E, F, P, Y, Z	—	—	—	Remnant forests representative of Collie River catchment.
S, T	C, O, Q, W	5.2	—	—	Virgin jarrah.
S, T	A, C, O, Q, W, Z, G	5.1	—	—	*Banksia littoralis,* high quality jarrah.
R, S, T	C, D, G, Q, P, W	—	—	—	Yarri, heaths, on granitic outcrops.
P, S, T	C, Q, R, W	—	—	—	Virgin jarrah.
H, Y	A, G, Z	—	—	—	Southern virgin jarrah and wandoo.
Q, S, T	C, O, U, W	—	—	—	Northern extension of karri in state forest.
C, Q, T	U, W	—	—	—	Incised valley of St. John's Brook in east Sunkland. Outstanding development of blackbutt with shrub understorey. Possible rare fauna habitat. Recreation. Historical (Barrabup Mill and Pool).