WALPOLE-NORNALUP NATIONAL PARK

- BACKGROUND TO FIRE MANAGEMENT

1. Background

1.1 Historically, the Walpole-Nornalup area has been a remote and difficult of access place, where even the railway system failed to link up. The area remained little-known to the turn of the century and there was little development opportunity due to the lack of suitable shipping points along the whole south coast between Augusta and Albany.

1.2 Changes began at the turn of the century when increasing interest was being shown in developing the timber potential of the areas forests. Millars had already established a logging industry in the Denmark area, using Albany as a port, and the State Government was involved in classifying land for its agricultural and timber potential southward from Pemberton. The first permanent settlers arrived in the Walpole-Nornalup area in 1910[1] - some 80 years after settlements had been established at Albany and Augusta.

1.3 Also in 1910, a Ministerial party travelled up the Frankland River, and were impressed with the area's beauty. Initially, only a small "Parklands" reserve of 372 ha was set aside at this remote spot. However, it was at the instigation of Professor Ernest H. Wilson, Assistant Director of the Arnold Arboretum at Harvard University, that the principal impetus came for establishing today's National Park. Following a visit to the area in 1920, he prevailed upon Premier James Mitchell to set aside a significant area of coast, estuary and forest, and in 1924 a series of contiguous reserves were gazetted to form the original National Park of some 12,000 ha. A large tract of forest further east, based on today's "Valley of the Giants" was also intended for inclusion, but on the recommendation of the then Conservator of Forests, it became State Forest. [2]

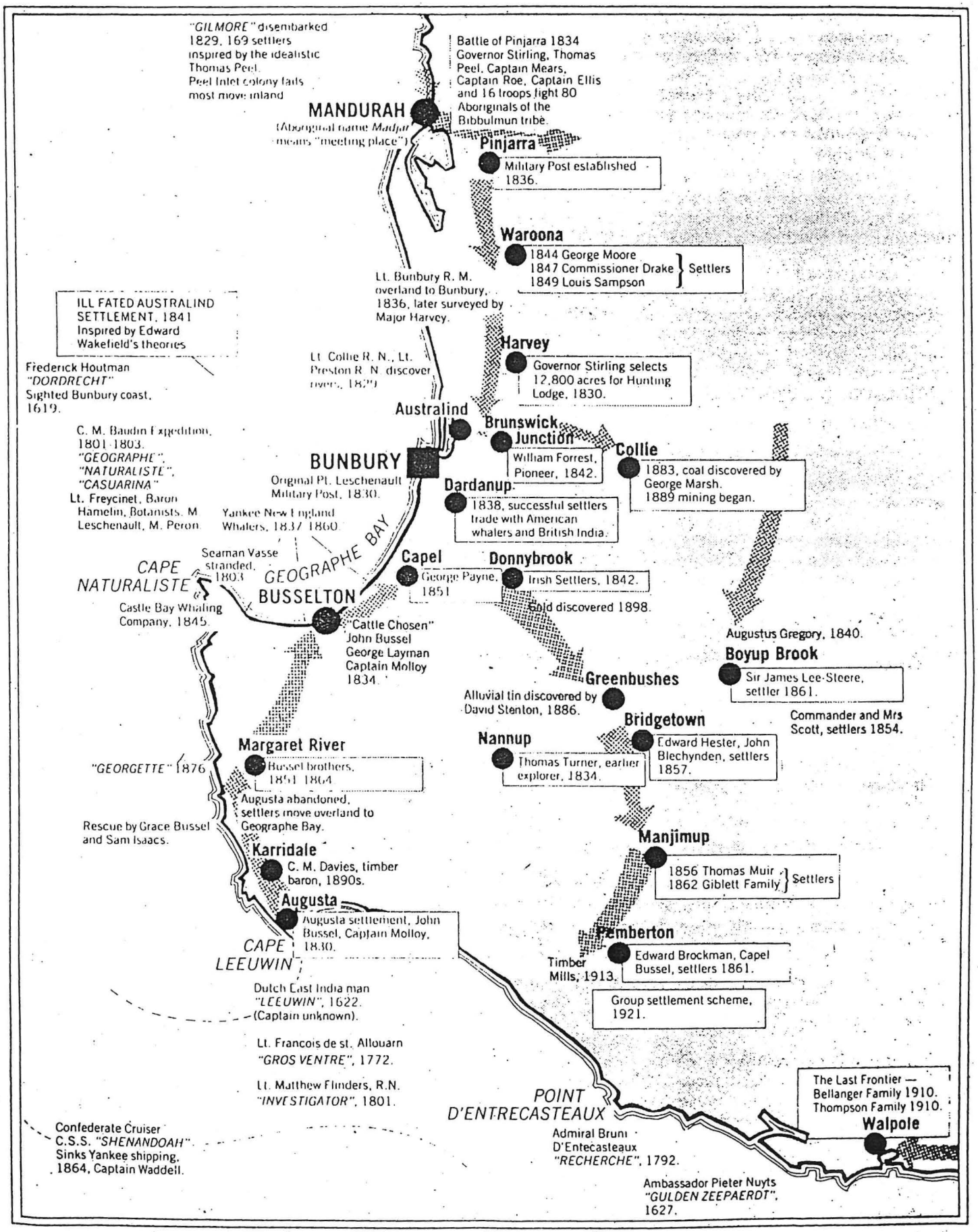
1.4 The original Nornalup National Park was vested in its own Board, operating under the Parks and Reserves Act. Board members comprised the Chief Executive Officers of the Lands and Survey Department, Forest Department, and Government Tourist Bureau, and later the Town Planning Department. Records of the Boards activities have not been located, but it probably met in Perth and because of a lack of resources would appear to have relied upon the former Forest Department to provide some basic management and public access. Later the National Park was transferred to the former WA National Parks Board, which subsequently became the National Parks Authority and eventually to be incorporated into the present Department of Conservation and Land Management. [3]

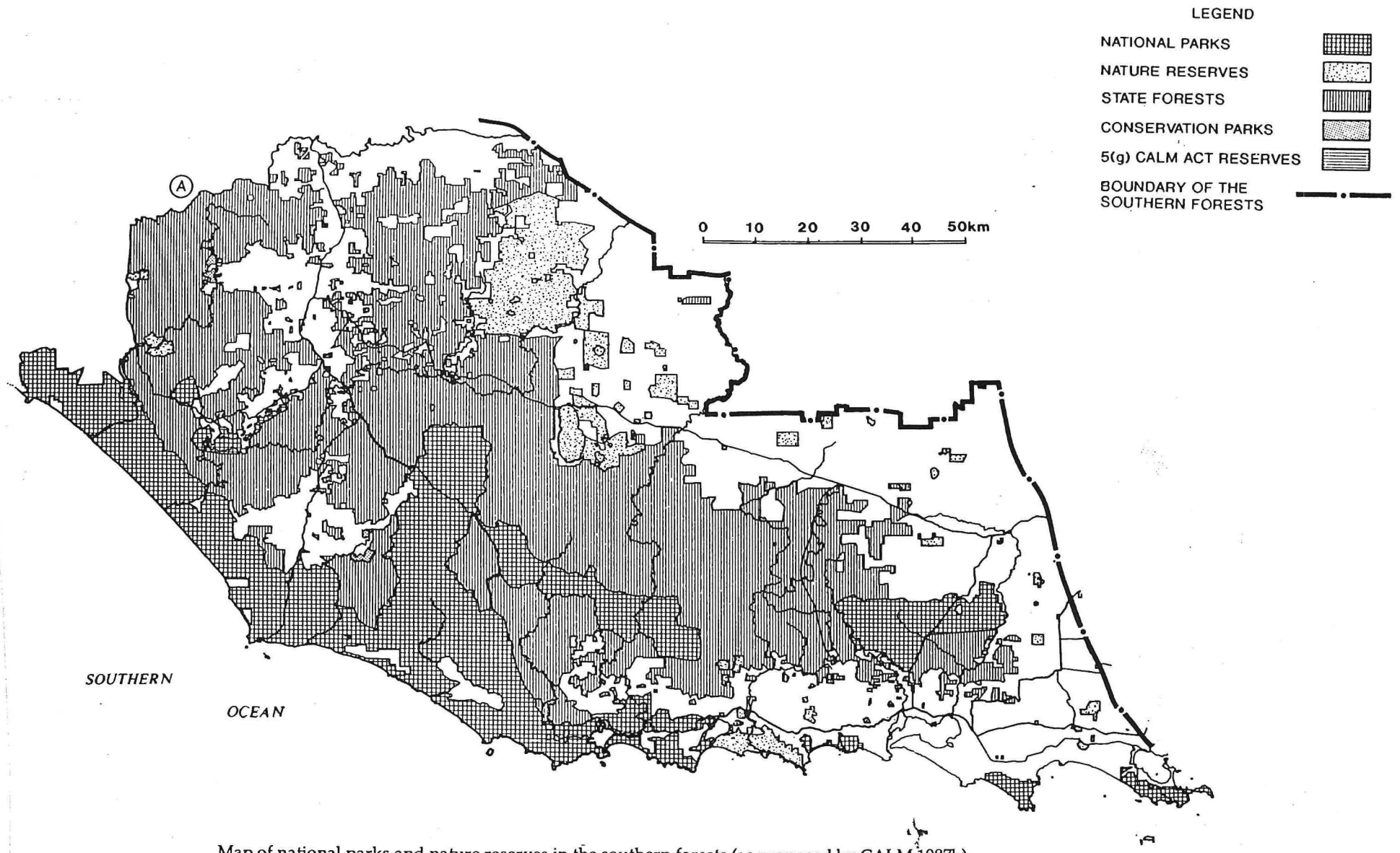
1. **Walpole-Nornalup NP Management Plan (1992), page 49.**

2. **Fernie, L. & Fernie G. (1989)**

3. **Australian Academy of Science Sub-committee (1965**

History of Exploration and Settlement





Map of national parks and nature reserves in the southern forests (as proposed by CALM 1987b).

1.5 Today, the National Park has an area of over 15,000 ha and in the near future the northern forested area will be extended eastward to include 3,000 ha of State Forest 42, known as "Giants Block", which includes the Valley of the Giants. This proposed extension was adopted via the 1987 South Forest Region Management Plan, and under government policy has been managed as though it is already within the Park. [4] This size puts the National Park in the smaller half of the State's national parks, but it is comparable in area to several other key coastal parks like Leeuwin-Naturaliste, Yalgorup and Nambung National Parks. [5]

1.6 In the west, the Walpole-Nornalup NP is contiguous with the D'Entrecasteaux NP, and to the north and east it largely adjoins farmland. To the north-west, in the vicinity of the Deep River, the Park is contiguous with State Forest; while in the east, part of the shore of Irwin Inlet is in the Park. The Park encloses the Nornalup-Walpole estuary system and includes a number of private property enclaves, as well as the small townships of Walpole and Nornalup. [6]

2. 1992 Walpole-Nornalup NP Management Plan

2.1 The first management plan for the Park was formulated in 1979, by the former National Parks Authority. [7] It was basically produced as an operations plan without formal public consultation (see further). However, the current management plan was developed by the NPNCA and CALM under a public consultation process that is provided for in the CALM Act. This management plan directs the management of 18,390 ha of mixed karri and tingle forest, coastal heath, shrubland and thicket, swampy lowlands within a Park noted for its spectacular landscapes that include:

- steep forested hills dissected by rivers
- massive, buttressed Red Tingle
- Karri to the water's edge
- picturesque estuaries
- an extensive coast line, and
- extensive areas where there is little or no evidence of humans.

The management goals for the Park are to: [8]

- conserve all native plant and animal communities and species, and the natural processes which sustain them in this park;
- conserve the park's landscape;
- conserve the indigenous plant and animal species and environmental processes and manage the park to maximise species diversity;
- fulfil the recreation requirements of visitors to the extent that they are compatible with conserving the park's flora and fauna, landscape values and wilderness qualities;
- foster a sense of stewardship for the park by the community through its conservation, landscape, recreation, cultural and historic values.

4. Southern Forest Region, Regional Management Plan, 1987-1997.

5. CALM Annual Report 1994/95.

6. Walpole-Nornalup NP Management Plan (1992), map 2.

7. B. Muir, personal communication.

8. Draft Forest Management Strategies (1992), CALM, pages 110-111.

FAUNA

Research and Monitoring

4. Continue to identify key and vulnerable species and develop a sound knowledge of the whole community response to disturbances such as dieback disease, fire, recreation use and management actions.

5. Determine the species composition of selected groups of invertebrates likely to include species that are vulnerable and of high conservation value (for example, molluscs and spiders) in the full range of community types.

6. Determine the ecology, taxonomic status, management and climate requirements of endemic relictual invertebrate species of narrow habitat requirements.

7. Investigate the habitat requirements and ecology of vulnerable species in relation to the impact of predation, fire regimes, dieback disease occurrence and climate.

8. Use the results of the above investigation to determine the processes required to maintain or enhance populations of vulnerable vertebrate species.

VEGETATION

Research and Monitoring

8. Research the response of management regimes (especially fire) on plant community types.

9. Survey areas proposed for management activities for priority, key and threatened species before the activity begins.

10. Determine the locations of populations of priority and fire sensitive species and develop management recommendations for their conservation.

11. Map the location and extent of priority flora and species vulnerable to frequent fire or fire exclusion for long periods.

12. Research the susceptibility to dieback disease, response to fire, reproductive biology, taxonomy and age to maturity of all priority plant species.

13. Determine the factors governing the distribution of key and priority species.

14. Research the susceptibility of plant species to plant pathogens in areas of coastal dune systems and assess the possible ecological impact of changes in plant communities.

PLANT DISEASE

Research and Monitoring

10. Determine boundaries of and regularly monitor known infections. Develop a comprehensive description of each infection, including information on species affected, vegetation association, infection area, rate of spread, soil profile, topography and threat to ground and surface waters.

11. Continue to survey and sample roads, tracks (including management-only) and walk tracks within the Park for signs of dieback disease.

12. Quantify the impact of each disease species. This information is necessary in order to assign and predict hazard ratings for vegetation associations in the Park.

13. Investigate possible control and eradication procedures while ensuring that they do not place other areas or values at risk. Isolation of all the infections should be of the highest priority.

14. Determine the extent of susceptibility of plant species in the Park starting with threatened and priority species.

15. Monitor the presence of other plant diseases, such as *Armillaria* and canker causing organisms, and take appropriate actions to limit their spread.

FIRE MANAGEMENT

Research and Monitoring

16. Determine the fire response, longevity and dieback disease response of each of the plant species in the Park. Priority should be given to those species listed as priority flora and fire sensitive species (see the Resource Document, Tables 19 and 20).

17. Determine the association between species and seral age, and relation with community types for fire management programs designed specifically for enhancement of conservation values.

18. Determine the fire response of the relictual invertebrates of the Park.

19. Determine the fire response and seral preferences for the vertebrate fauna.

20. Review the annual burning plan each year and where changes have occurred, a new plan will be prepared and made available for public inspection and discussion in CALM's District Office.

21. Submit the annual burning plan each year to the Bush Fires Board.

22. Proposed changes to the fire management plan in this document (Map 4) will be referred to the NPNCA.

Walpole - Nornalup NP
Manage Plan - Research
and Monitoring Commitments

2.2 The Park falls within the Warren sub-district of the Darling Botanical District. This sub-district is characterised by its relatively high rainfall. Near the coast in the Walpole-Nornalup-Denmark areas, rain falls for about ten months of the year and the area almost seasonless. As a consequence, some significant biological differences to other parts of the State's south west can be expected.

The principal biological features of the Park are: [8]

- four species of eucalyptus confined to the local area, ie. Red Tingle (*Eucalyptus jacksonii*), Rates Tingle (*E. brevistylus*), Yellow Tingle (*E. guilfoylei*) and Red-flowering Gum (*E. ficifolia)*;
- 30 as yet undescribed plant species;
- 21 species of native mammals (two gazetted rare); 109 species of birds (four gazetted rare); 12 species of reptile, nine species of frogs;
- relictual Gondwana invertebrate fauna.

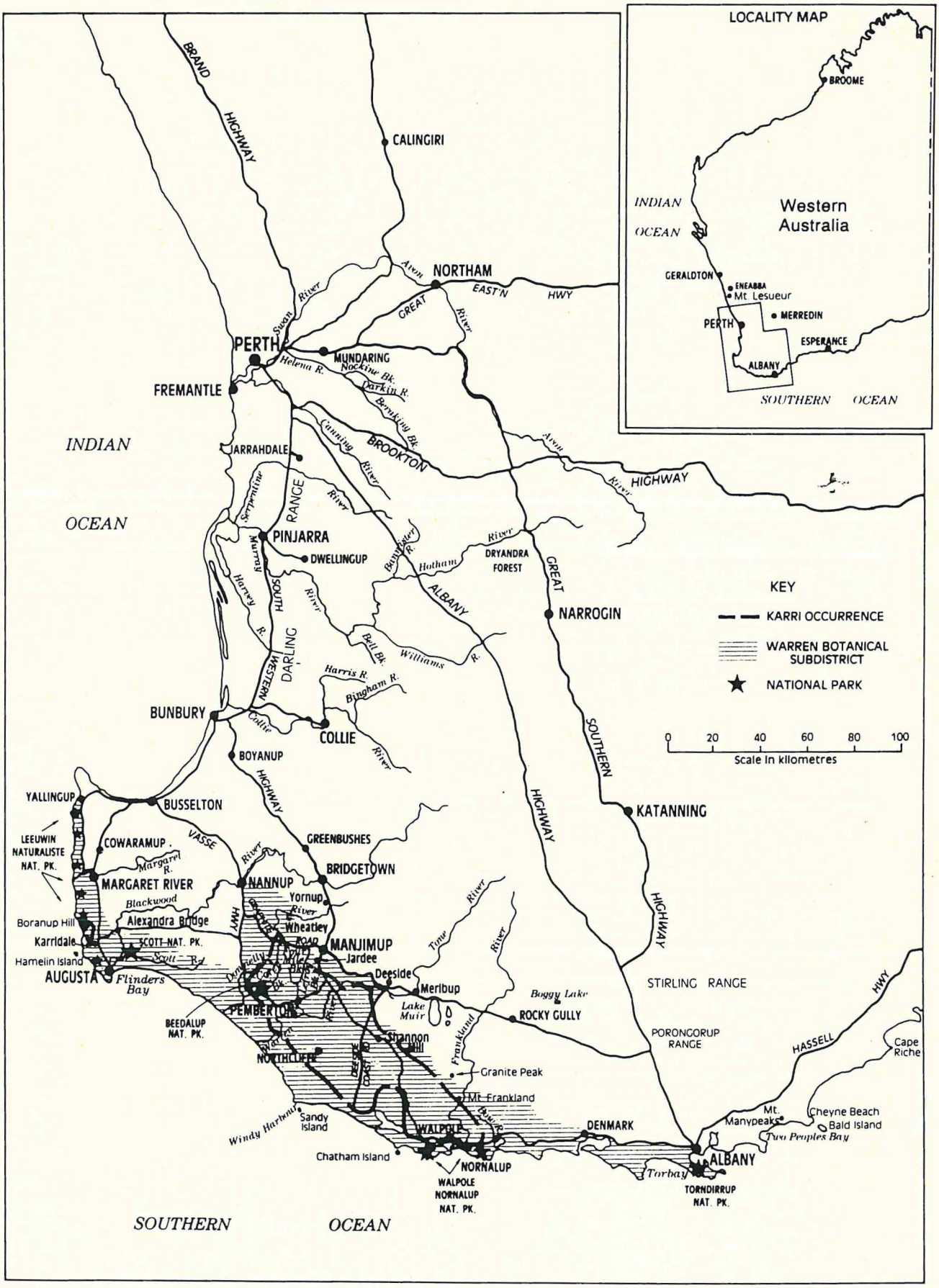
2.3 To achieve the stated management goals, the Park has been placed under four zones based on vegetation characteristics, landform and equity in meeting the needs of Park visitors. The four zones are *special conservation*, containing plant and animal communities that require careful management; *wilderness* where no facilities are provided and motorised conveyance is excluded; *natural environment*, where vehicle access and facilities will be kept to a minimum; and *recreation* where facility development will be extensive.

Strategies in the management plan to achieve the objectives within the zones include: [8]

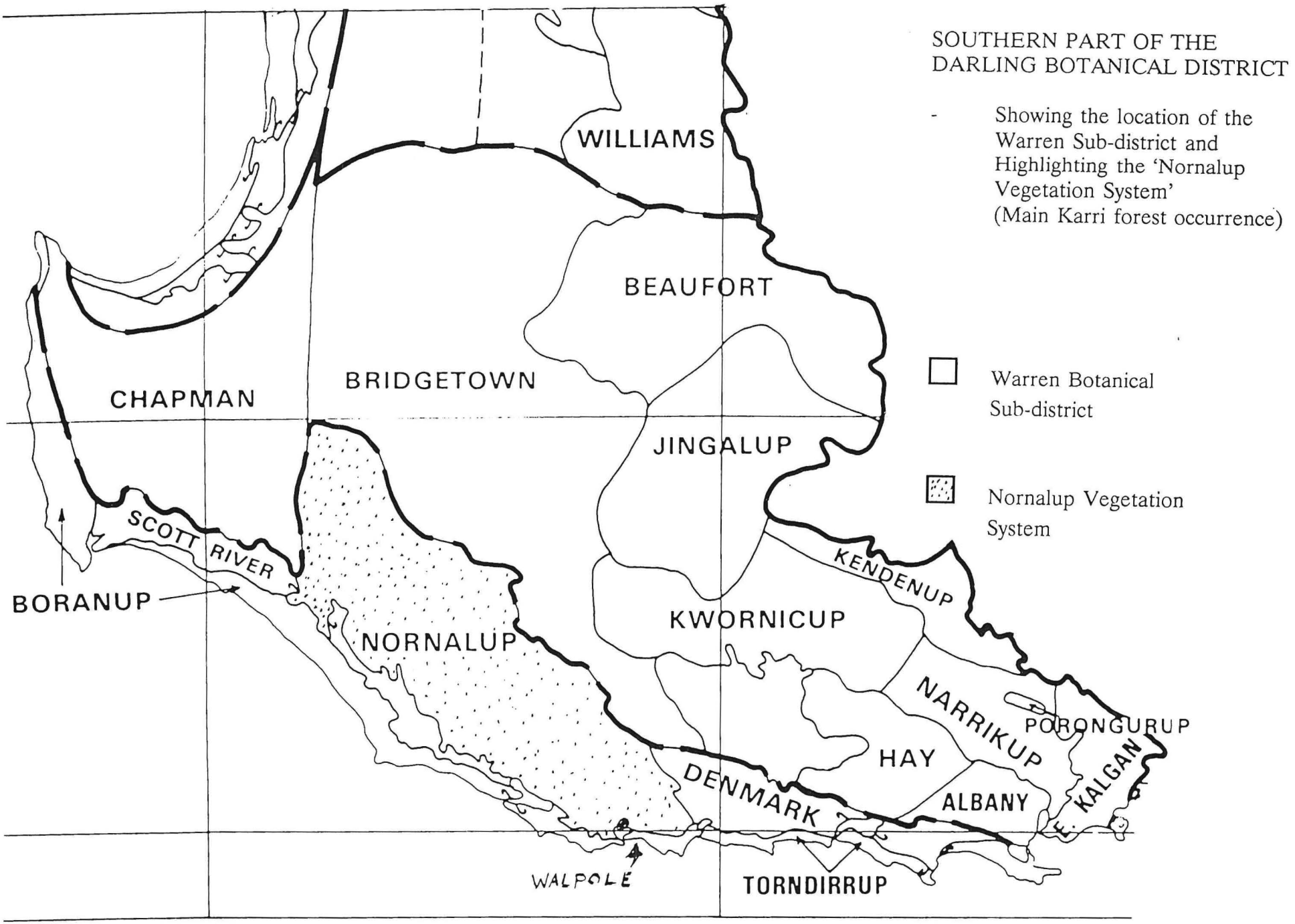
- ***development of a fire management plan which protects species populations;***
- hygiene procedures to prevent dieback disease introduction or spread;
- particular protection to particular animals which are known to be declining, ie. chuditch, ring-tailed possum, honey possum, noisy scrub-bird and bristlebird;
- increased control of feral animals;
- ***protection of the township and recreational facilities from wildfire;***
- substantially improve access to the coast;
- redeveloping the Coalmine Beach Caravan Park as a low-key caravan and camping area;
- maintaining the integrity of the Nuyts wilderness area.

(A summary of crucial goals and objectives in the management plan is given at Appendix C to these notes).

8. Draft Forest Management Strategies (1992), CALM, pages 110-111.



Map of the south-west of W.A. showing karri occurrence and Warren Botanical Subdistrict



SOUTHERN PART OF THE
DARLING BOTANICAL DISTRICT

- Showing the location of the Warren Sub-district and Highlighting the 'Nornalup Vegetation System' (Main Karri forest occurrence)

Warren Botanical Sub-district

Nornalup Vegetation System

2.4 As well as being responsible for the preparation of management plans for the conservation reserves that are vested in it, the NPNCA is also responsible for monitoring their implementation by CALM. A formal process for doing this has been under development for the past several years and progressively refined via a number of trials. An adopted methodology and reporting procedure will become a formal NPNCA Guideline. [9] Under this guideline it is anticipated that management plans will be reviewed during mid-term, and at end-of-term prior to having a further management plan prepared. The current (1992) Walpole-Nornalup NP Management Plan has a ten year term, and the plan is now entering its mid-term period for formal monitoring. It is therefore anticipated that this will be shortly programmed by the Authority. *Appendix F to these notes compares crucial statements in the 1992 management plan with the current (1996) state of knowledge. Basically, those in the management plan still stand.*

3. Red Tingle Forest

3.1 Tall forests of Karri are confined to the Warren Sub-district of the Darling Flora District (see map opposite). Beard (1981) has mapped several vegetation systems within the Sub-district and Karri occurs in several of these, but especially in the Nornalup Vegetation System. This system extends from the north-west of Manjimup in the valleys of the Donnelly River and its tributaries, towards the south and south east to near Irwin Inlet, and almost reaches the coast itself.

3.2 Karri high open forest occurs on the light granitic soils on the slopes and in the valleys while Jarrah open forest occurs on the lateritic gravels of the hills, interwoven with the Karri forest in an intricate mosaic. In the valleys and on the richer sandy soils Marri becomes a prominent component of the Karri forest. In the southern part near the coast, in the Walpole-Nornalup area, both Red Tingle and Yellow Tingle are important components. In the valleys the vegetation tends to be closed scrub or low closed forest, but in the broader valleys to the south, low open woodland of stunted Jarrah and Paper-barks with heath understorey, and sedgelands occur. [11] This complex mosaic of vegetation, coupled with steep hill and valley terrain provide complexities in fuels, drying characteristics and winds that affect fire behaviour (see further para).

3.3 Researchers developed a floristic classification of the Walpole-Nornalup NP and identified 14 vegetation community types that are associated with landform soils units. [12] This forms the basis of the coloured vegetation map at the rear (appendix 1) of the Park's management plan. Broadly speaking, however, the vegetation and landform can be divided into three types: [13]

- tall forest on hilly terrain that is underlain by granite, and mainly concentrated in the Parks northern half but coming down to the estuary itself and near the coast in the Parks centre.

9. National Parks and Nature Conservation Authority Annual Report, 1994/95, pages 20-21.

10. Beard (1981), page 193

11. Smith (1972), pages 8-9

12. Wardell-Johnson *et al* (1990)

13. Walpole-Nornalup NP Management Plan (1992), page 11

- a broad band of recent coastal dune systems characterised by heath, shrubland and thicket.

- a narrow band of poorly drained soils and peat through which the lower-reaches of the main rivers flow to the estuary.

The Karri/Red Tingle forest forms a single unit and predominates on soils developed over granite rocks, which in turn comprise the hills and steep slopes within the Park. While some people may refer to a 'Red Tingle' forest, researchers have classified it as one of several variations of Karri forest - ie. it is Karri forest in which Red Tingle *(Eucalyptus jacksonii)* is prominent.

3.4 There are three species of tingle which have a patchy distribution in the eucalypt forests between Walpole and Denmark. However, despite their common names, the tingles are not particularly closely related. Yellow Tingle *(Eucalyptus guilfoylei)* is more common and widespread and can occur in both the Karri and Jarrah forest types. On the other hand, the Red Tingle and Rates Tingle *(Eucalyptus brevistylis)* are associated with the Karri forest type - and are virtually confined to the Walpole-Nornalup NP, where all three tingle species can occur in close proximity. The table below compares the extent of the three tingle species and indicates their conservation status. It is considered that Rates Tingle is the least secure: [14]

Total area and distribution by tenure of the three tingle species

Species	National Park/Nature Reserve (ha)	State Forest (ha)	Private Property (ha)	Total Area (ha)
Rate's Tingle	1900	0	0	1900
Red Tingle	5000	600	400	6000
Yellow Tingle	8400	19300	8000	35700

3.5 The general area between Walpole and Torbay (West Cape Howe NP) is the southern-most part of Western Australia, and the projecting shape of the coast here exposes it to numerous rain-bearing fronts - including up to late summer. As a consequence, this part of the Warren flora sub-district lies within the highest rainfall area of the State (annual average rainfall of 1324mm at Walpole).[15] While seasonal changes in temperature, rainfall, and wind direction are marked, they are less extreme than elsewhere. As a consequence, the usual four distinct seasons are more blended and less distinct with 'spring/summer' occurring much later, and peak flowering of vegetation occurs into December. [15]

14. Smith (1996) pages 4, 16

15. Walpole-Nornalup NP Management Plan (1992), page 10

3.6 Because rain falls on an average of 185 days per year [16], and because of the usual mildness of summer temperatures, there is also longer retention of moisture in the upper soil profile and overlying leaf litter. These factors have narrowed the window of opportunity and flexibility for carrying out successful prescribed burns[17] (see further para 7.5). At the same time, coupled with other factors the present wetter conditions have apparently provided a refugium for the persistence of relictual flora and fauna in various vegetation communities and habitats [18] (see further para 4.3).

3.7 Further studies have been able to separate Karri forest in the region into several 'types', depending upon the composition of the understorey community. These variations are largely due to soil changes. Thus, the Karri/Red Tingle forest mapped in the Park management plan can be separated into one or another of two community types, Stoate or Wallace, with the Wallace community-type representing Karri forest containing a heavy presence of Red Tingle [19] - the so-called 'Red Tingle forest'. (See map opposite).

3.8 The Karri forest community containing Red Tingle is significantly colder and has a higher summer rainfall than other Karri community types. Typically it is found on light-brown gravelly duplex soils and red and yellow earths over granite rock in hilly terrain. The soils are well drained, significantly more acid than those of other Karri communities and of low fertility. Studies also indicate that the vegetational composition of the Karri/Red Tingle tall open forest is close to one of the Karri tall open forest community types on the same soil type [20] (see further para 9.3, 9.4, 9.5).

3.9 CALM's 1992 Draft Nature Conservation Strategy contains a section on conserving significant habitats: [21]

- *Within the diverse ecosystems of Western Australia there are many specific habitats which have particular significance for nature conservation and which are often in need of special management. Some of these, such as sandplains or "Kwongan", coastal ecosystems, ranges and scarps are extensive, and their inclusion in the conservation estate can be based on the principles for developing a reserve system for nature conservation discussed elsewhere in this Chapter.*

- *Other special habitats are often much smaller and occur in a patchy way across the landscape. They may range from less than a hectare, up to small to large off-shore islands. Often their small size, discreteness and localised distribution makes them vulnerable to external influences.*

16. **Walpole-Nornalup NP Management Plan (1992), page 20; Smith (1996) page 1**

17. **Personal communication with CALM Walpole District staff**

18. **Hopper et al (1992), page 4; Wardell-Johnson and Christensen (1992), page 41;**

19. **Inions *et al* (1990); Smith (1996) page 5**

20. **Smith (1996) page 5**

21. **Draft Nature Conservation Strategy (1992), CALM, p 44 and Table 7.**

- *Wetlands, and restricted areas of upland or unusual geology, including granitic outcrops, are examples of discrete habitats which may need special consideration in conserving biological diversity in Western Australia. Other habitats which should be considered are underground caves, remnant rainforests, unique coastal habitats and off-shore islands. All of these habitats may occur on private as well as public lands. Even when they occur in existing reserves they often require special management.*

In conclusion, the Red Tingle forest is not specifically cited as a "special" or "significant" habitat requiring special management attention, although Kimberley rainforest remnants are. Nor elsewhere in the draft strategy (Table 7) [21] is the Red Tingle forest identified as a threatened plant community, as is Tuart forest. Nevertheless, the "Red Tingle forest" does seem to have special features that warrant special management.

4. Evolutionary Studies

4.1 From a study of pollen derived from peat deposits in swamps, including in Boggy Lake in the Walpole-Nornalup National Park, changes in the extent of the Karri, Jarrah and Marri occurrence over the past 6000 years have been documented. Pollen abundance has suggested that periods favouring Karri occurred from 4000-3000 BC, 500 BC - 700 AD, and 1500 AD to the present. It has also been suggested that Karri distribution has fluctuated markedly during the past 5000 years. [22]

4.2 Beard (1981) has commented on the 'problem' of Karri distribution - in that while it occurs on similar soil types in the Warren Sub-district in both high and lower rainfall areas, Karri does not always occur on favourable soils where rainfall is high. He concluded that the common factor was not so much dependence on high rainfall - but the summer dry period being relatively short ie. under four months as found near the coast [23]. Using the same data, it would seem that Red Tingle is confined to areas with an even briefer dry season of around two months, and does not occur far from the coast at all.

4.3 In the same notes, Beard (1981) discussed other eucalypt distributions. He commented that the restricted occurrence of the three tingle trees and Red Flowering Gum appear to be relict species:[24]

"*.... which have lost their habitat and become fringe-dwellers. They are the little orphans of the storm, victims of the Quaternary climatic oscillations.*"

21. Draft Nature Conservation Strategy (1992), CALM, p 44 and Table 7.

22. Churchill (1968)

23. Beard (1981), pages 130-135

24. Beard (1981), pages 135-138

4.4 It has also been considered that Red Tingle forest is perhaps the original eucalypt forest which replaced Gondwanan Antarctic Beech (or "Southern" Beech; ie. *Nothofagus* spp) forests in this area [25] (relicts of which still survive in Tasmania, New Zealand and Chile). It is generally considered that plant species (or genera) largely restricted to temperate rainforests, as found in the eastern states of Australia, are absent from the tall open forests of the wetter areas of Western Australia. This has recently been questioned, however, based on the occurrence of several undescribed plant and fungus taxa found within the "tingle mosaic" as relicts which establish an ancient link to the warm, perhumid climate of Gondwana. [26]

4.5 A report to the Australian Heritage Commission in 1991 lists relictual Gondwanic faunal elements occurring in the Warren botanical sub-district, and suggests the habitat conditions where they might occur, including in the Red Tingle forest. Following the break-up of the super continent, the present position of Australia is about 35 degrees latitude-north of its former position in Gondwana. Because the Warren botanical sub-district currently has a Mediterranean climate with a pronounced summer drought, it follows that biotic elements of Gondwanic origin can only persist when summer conditions are ameliorated in some way - such as having a shorter summer drought, or by orographic or topographic effects, or by drainage or site aspect. In summary Gondwanic elements would be expected to persist and found if searched for in: [27]

- high rainfall areas with short summer drought (see paras 2.2, 4.2).
- topographically high coastal areas subject to on-shore south-east winds and drizzle.
- areas adjacent to granite rocks from which water is shed.
- areas of impeded ground water flow so producing 'winter-wet' swamps.
- stream with extensive head waters and year round flow.
- areas where vegetation can harvest water from fog or cloud by drip from leaves and stem flow (eg. tingle forest, and coastal dunes and heaths).
- areas with southern or south-western aspect and thus sheltered from summer insolation.

4.6 The existence of several relict spiders of Gondwanan origin which have persisted in various damp, shady habitats has been documented in southern Western Australia. One of these, *Moggridgea* is restricted to the Stirling Range and tingle forest near Walpole. It is considered to be vulnerable to bushfires because its burrows are shallow and the spider is killed by heat. Another taxon, *Chasmocephalon*, a tiny spider found in eroded trees, buttresses of trees and other damp, shady habitats in long unburnt forest near Walpole, and also need protection from fire. [28]

25. Walpole-Nornalup NP Management Plan (1992), page 31

26. Smith (1996) page 12

27. Main & Main (1991); Christensen ( ), pages 55-59

28. Smith (1996) page 12

5. Invertebrates

5.1 The least known organisms of an area are usually the lower order groups, such as invertebrates and microbial communities. The importance of invertebrates in forest ecosystems is acknowledged and the deficiency of knowledge is also recognised. However, apart from litter fauna, research has generally concentrated on species that are an economic problem (eg. leaf damaging insects). Litter fauna are important in cycling nutrients from dead vegetation into the soil, hence disturbance to them has been studied, principally in connection with fire. [29]

5.2 Reviews have identified the poor taxonomic base of invertebrate research and urge high priorities be given to taxonomic work in the Warren Botanical Sub-district, and the Karri forest in particular. Experimental work to examine the effects of disturbance on invertebrate will establish those vulnerable taxa and sites in need of special consideration in management operations - and allow operations to be designed accordingly. Groups that include relictual taxa of poor colonisation ability are in particular need of study, and sites in high rainfall zones in Karri/Tingle forest may be expected to harbour such species. [30]

5.3 Research involving the impact of fire on invertebrates, including the season of burning, is inconclusive. It is acknowledged that further research is needed on the **long-term effects** of various fire regimes on key species [31]. Similarly, little is known about the importance of micro fauna and flora in the functioning of ecosystems, and some researchers consider that studies in the Warren Sub-district requires urgent attention [30] (see further, para 9.4).

6. Pre-European Fire Regimes

6.1 In his notes on the Swan 1: 1 000 000 vegetation map sheet Beard, (1981) comments that almost all mainland communities are subject to fires and most of them are periodically destroyed and regenerate after fires, or alternatively seedling regrowth only effectively appears from fires [32]. Other researchers have concluded that with the onset of pre-historic aridity which caused the contraction of tropical and temperate rainforest that once clothed much of the Australian landscape, fire has been a naturally occurring element in the environment [33]. This in turn had been modified by perhaps 40 - 50 000 years of Aboriginal practices.

6.2 The collapse of Aboriginal culture in the south west of the State was rapid, following the commencement of European Settlement, but during the brief period that it "co-existed" with European settlement little contemporary documentation of it has surfaced. There are, therefore, large gaps in our knowledge. Secondly, recorded observations of Aboriginals and their activities is confined to localities frequented by the European explorers and settlers. Since the Jarrah and Karri forests were largely avoided by Europeans

29. Draft Forest Management Strategy (1992), CALM, page 59

30. Wardell-Johnson & Christensen (1992), pages 39, 41-42, 48-50

31. CALM Submission to Ministerial Fire Review Panel (1994), page 44

32. Beard (1981), page 73

33. White, M. E. (1994)

until timber exploitation commenced in earnest in the 1880's, the recorded knowledge of Aboriginal use of forested land is negligible. The dearth of Aboriginal feature names on older maps is evidence of this, when compared with the coastal fringe and more open woodland country inland of the forest belt. It has been concluded by some that just as the forest was least attractive to European settlement, so it was to Aboriginal use [34]. Early explorers traversing the forest rarely came across signs of Aboriginal occupation. On the other hand, constant references to Aboriginal sightings and signs are made along the coast between Perth and Albany and the fringing plains behind, and in the broader river valleys and open woodland, behind the main forest belt, between the Avon Valley and Albany.

6.3 The best accounts of Aboriginal burning practices come from the vicinity of Albany in the 1830's and 1840's, which is in fact a region of plain ascending gently inland from the coast, once comprising woodland merging into open forest. Here it was obvious that while burning occured annually in the summer ("about Christmas"), it was done in "consecutive portions" [35] It is probable that the particular clans or traditional owner(s) included a person who was a specialist 'fire master' and area selection and burn timing was done to his instruction or guidance. While direct comparisons can't be made, traditional burning of the countryside by Aboriginals has continued to this day in parts of northern Australia [36], and researchers have also concluded that recent cessation of Aboriginal traditional burning in desert areas has contributed to ecosystem changes. [37]

6.4 The frequency with which a piece of ground was fired by Aboriginals in the south-west, and the intensity of burning can, at this stage, only be subjects of conjecture. Early European accounts were subjective and relative to their own experience and conceptions. [38] Thus reference to the "*violence of [Aboriginal burning] is frequently very great*" [35] might in fact refer to a relatively mild burn. At the same time, one needs to be wary of extrapolating research conclusions about "frequent fires" occurring over tens of thousands of years [39] as also being very frequent in terms of a century of time.

6.5 The CALM submission to the Ministerial Fire Review Panel broadly categorised forest fires in an ecological context as

- high intensity fires which result in the complete destruction of the existing stand and open the way for a whole new succession; or
- low intensity fires in which more or less of the original stand survive and carry through into the next generation.

34. Hallam (1975)

35. Nind (1831)

36. Bright (1995), pages 59-62

37. Draft Nature Conservation Strategy (1992), CALM, pages 72-73

38. Christensen and Abbott (1989), page 104

39. Churchill (1968)

The more the existing system carries through into the post-fire situation, the less the impact of the fire, and the more rapidly the pre-fire situation returns [40]. CALM also submitted that: [41]

> *Analysis of fire scars on tree stumps or on partially burnt out old trees ("hollow-butts") (Rayner, 1993) and the examination of flowering records of species like Xanthorrhea (Lamont and Downes, 1979) are useful in suggesting the frequency of high intensity fires, but they suggest nothing about the frequency of low intensity fires. The latter can regularly burn through the forest without igniting the wood on standing trees or stimulating blackboys to flower.*

6.6 Aboriginal burning was designed to produce outcomes that favoured their way of life, and there remains uncertainty that Aboriginals did in fact generally impose their own fire regime over the forest [42], apart perhaps from the broad river valleys which they may have found more attractive as food sources and/or movement corridors. Today, a different culture and land use exists and desired outcomes from land management are also different. Planned burns are now designed for different objectives than Aboriginal ones, but where maintaining biodiversity is a paramount objective it is essential to understand the long-term consequences of particular fire regimes. It is unlikely that we can uncover sufficient evidence to reconstruct with certainty the regimes that prevailed immediately prior to European settlement (see further para 9.3, and page opposite it).

6.7 The two principal factors of a fire regime are the intensities of burns and the frequency of their occurrence, but there are many other variables. It has been concluded that a wide range of fire regimes probably occured in south west forests before European settlement [43]. Although the research base is incomplete, there is a need for on-going management to continue on the basis of available knowledge. Accordingly, CALM is pursuing a regime where there is a variety of spring and autumn burns, together with occasional periods without fire to meet both protection and environmental needs [44] (see further para 7.13).

40. CALM Submission to Ministerial Fire Review Panel (1994), page 15

41. CALM Submission to Ministerial Fire Review Panel (1994), page 15

42. Beard (1981), pages 69, 70

43. CALM Submission to Ministerial Fire Review Panel (1994), pages 14-15, 40

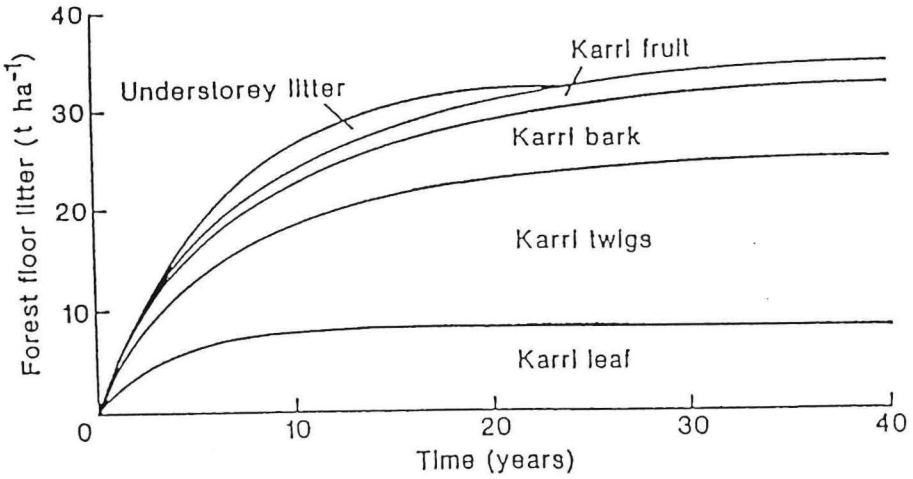
44. CALM Submission to Ministerial Fire Review Panel (1994), pages 50-51

7. Some Aspects of Fire Management

7.1 Appendix D describes fuel components and related factors of a forest in some detail, and broadly relates these to Jarrah, Karri and Wandoo forest types. While the dead leaves, twigs and fallen branches littering the forest floor is the dominant fuel type in most of the northern Jarrah and Wandoo forest - southern forests present some differences. In general, the Red Tingle forest has been treated as a Karri forest type (see para 3.6) and the summary below focuses on Karri, with supplementary information on ***'Red Tingle forest'*** from CALM *fire's* Manager (R. Sneeuwjgt) given in brackets [ ].

7.2 Litter is still the most important fuel in the southern Jarrah and Karri forests, but live understorey vegetation (often referred to as "scrub") and young trees also become an important fuel, especially in wildfires burning in hot windy weather. [*In 'Red Tingle forest', scrub cover can be dense on upper slopes and ridges*]. Karri forest "scrub" is also important in that it traps some of the leaves, twigs and bark shed by the overstorey vegetation. This suspended fuel, called "trash", is well aerated and burns intensely when dry. Along creek systems, riverbanks and on wetlands within forest areas, live "scrub" forms a dominant and flammable fuel.[45]

7.3 The quantity and distribution of forest fuels depends upon various factors, particularly the time since the last fire, and on local climate, vegetation and site characteristics. Litter fuel tends to accumulate rapidly then to stabilise as the rate of natural decomposition equals the rate of litter fall. In a typical Karri forest, litter and trash fuel may accumulate at a rate of up to 3-4 tonnes per hectare in the first 5-6 years after a fire and stabilise at abut 46-50 tonnes after about 20 years. [*In 'Red Tingle forest', fuel accumulation often exceeds that of Karri and 20 years after a fire fuel loads of 60-80 tonnes per hectare are common*]. Karri forest understorey, or "scrub" fuel, also accumulates as the community re-establishes itself after a fire and this live fuel accumulation rate is around 0.5 to 1 tonne per hectare annually in the first 5-6 years. [46]



Predicted accumulation of forest floor litter based on measured rates of litterfall and decay constants for ten karri forest litter fractions. Accumulated understorey litter fractions have been grouped for clarity.
[From CALM submission to Ministerial Fire Review Panel]

45. **Draft Forest Management Strategies (1992), CALM, page 44**

46. **Draft Forest Management Strategies (1992), CALM, page 45**

7.4 Fuel moisture content is the most important factor affecting fuel flammability and fire behaviour. In dead fuels (litter and trash), fuel moisture content is affected by the amount of rain, the interval between rain and seasonal conditions. In the absence of rain, fuel moisture content depends upon ambient air temperature and relative humidity. Dead fuels become very dry during extended periods of high temperatures and low humidities. Dead fuel moisture content can vary from 2% or 3% of own dry weight on a hot summer day, to 200% on a rainy day in winter - and litter fuels will not burn when the moisture content exceeds about 25%. [47] [*However, it is rare for surface moisture content in Karri and 'Red Tingle forest' to drop below 5% because of dense cover (shade) and proximity to coastal influences*].

7.5 Thus, Red Tingle forest occurring in the wettest part of Western Australia with the shortest period of summer drought (a little over 2 months per year) presents a very small window of opportunity to undertake fuel reduction burns, and even fewer opportunities where critical factors are likely to coincide for specific prescriptions aimed at leaving unburnt mosaics and protecting gully and riparian vegetation where this also an objective. While the Walpole area has the shortest 'fire season' of the State's forest areas, factors can vary this annually and a longer than usual rainless break will quickly increase the fire hazard where fuel loadings are high and drying out. If coupled with the occasional summer/autumn tropical cyclonic depression that drifts southward, without producing rain - then the potential wildfire situation becomes very critical. [48]

7.6 A wildfire in dry windy situations presents a formidable and unpredictable hazard. Fires as intense as 2 000 kw/m may display erratic behaviour; under heavy fuel loads, wildfires rapidly exceed 2 000 kw/m and may achieve intensities up to 100 000 kw/m. It is therefore not possible to rely on suppression as a fire control strategy. Prescribed burning to reduce fuel loads and to lower potential intensities to manageable levels is considered to be the only course of action which has so far been successful in managing wildfires. [49]

Difficulty of fire suppression

Flame Length (m)	Fire intensity (kw/m)	Suppression Difficulty
< 1.8	< 800	Fires can generally be attacked directly at the head and flank with hand tools.
1.8 - 6.2	800 - 2000	Fires too intense for attack with hand tools. Bulldozers and heavy duty water tankers with retardant can be effective on flanks, and possibly on the head.
6.2 - 12.00	2000 - 5000	Fires present serious control problems. Crowning and long distance spotting likely. Head fire attack will probably fail and could endanger fire fighters. Fires may display erratic behaviour.
> 12	> 5000	Crowning, long distance spotting, whirlwinds and highly erratic behaviour are likely. Control efforts at head fire will fail. Severe hazard to fire fighters many kilometres downwind.

47. **Draft Forest Management Strategies (1992), CALM, page 46**

48. **Draft Forest Management Strategies (1992), CALM, page 49**

49. **Draft Forest Management Strategies (1992), CALM, page 51 / Sneeuwjgt (199)**

7.7 Threshold levels of fuels have been set for the main forest types, based on a combination of knowledge of fire intensity and flame heights and the practical experience of expert fire fighters. These levels are, for jarrah forest 8 tonnes/ha, and for the karri forest 17 tonnes/ha: [50]

- they represent the level of fuels above which headfires cannot be successfully attacked under average summer conditions.

- they are the upper limit of fuel quantities beyond which fire intensity will cause unacceptable damage to young trees and will generate crown fires and spotting (ie. wind carried burning fuel starting fires ahead of the main fire).

The rate of fuel accumulation after fire is much more rapid in the karri than in the jarrah forest. Conditions are also more 'damp' in the karri forest, and the fire season is shorter and generally much less severe. For these reasons a higher threshold level for fuels is considered acceptable; to maintain fuels below eight tonnes per hectare in the karri forest would require a two to three year burning rotation, which would be impractical and probably unacceptable ecologically. [50]

7.8 These threshold fuel levels are also used as the basis for setting prescribed burning return times ("rotations") for the forest where fuel reduction for wildfire mitigation is the policy. The time taken for fuels to build up to eight tonnes per hectare in the jarrah forest or 17 tonnes per hectare in the karri forest varies considerably, depending on climate, site fertility and forest structure. The average is five to seven years in the jarrah, 7-10 years or more in the eastern jarrah/wandoo and six to eight years in the karri forest. In practice, prescribed burning rotations are determined by actual measurement of fuel accumulation, not years elapsed since last burn. [50] The high fuel accumulation in karri regrowth prompted the techniques for conducting the fuel reduction burns in young karri regrowth in the 1980's. There, fire is excluded until stands can survive with minimal damage - after about 14 to 20 years, depending upon site factors. [51]

7.9 Fuel can burn in three different ways: as a mild creeping fire, confined to litter on the forest floor; a more intense fire, with flames up to eight metres high, consuming litter and shrubs and mildly scorching the treetops; and a high intensity fire, which rages through the treetops. Most planned burns are of the first type, and occasionally the second; wildfires are generally of the third kind. [52] Normal planned fuel reduction burns are set under cool, humid conditions, when flames trickle through the undergrowth at knee height [*but up to three times as high (1.5m) in 'Red Tingle forest'*], slowly consuming dead leaves and twigs that have accumulated on the forest floor. Such a fire can only be set after the opening rains in autumn or at the end of the rains in spring. These are set every five to seven years, depending upon fuel accumulation and management priorities. [53] [*Because of heavier fuel loads 'Red Tingle forest' burn intensities are generally higher than for the same fuel age of jarrah forests*].

50. CALM Submission to Ministerial Fire Review Panel (1994), page 19

51. Wardell-Johnson & Christensen (1992), page 40

52. Burrows (1990)

53. Sneeuwjgt (1994)

Table 3: Spring vs Autumn Burning

Autumn: The beginning of the rainy season which establishes rapidly and is usually characterised by conditions experienced in March-May. Wetting of a dry soil, vegetation and fuel profile.

Spring: The end of the rainy season which tapers off into a dry summer period and is usually characterised by conditions experienced in September-November. Drying of a wet soil, vegetation and fuel profile.

Spring Burning	*Autumn Burning*
Operational considerations	
• More days available to safely execute fuel reduction burns, therefore: ➢ better able to achieve protection program.	• Fewer days available.
• Fire weather and behaviour more predictable and stable, therefore: ➢ facilitates good planning and efficient resource allocation; ➢ low risk of escapes; ➢ lower intensities therefore easier, cheaper control; ➢ low ignition rate of logs etc. so reduced pre-suppression and mop-up costs.	• Fire weather and behaviour less predictable and more unstable, therefore: ➢ burning opportunistic, poorer allocation of resources; ➢ high risk of escapes; ➢ higher fire intensities so increased costs; ➢ higher ignition rate of logs and trees, so increased pre-suppression and mop-up costs.
• Low impact on commercial and aesthetic values.	• High impact on commercial and aesthetic values.
• Higher risk of re-ignition over following summer.	• No risk of re-ignition over following summer.
Environmental Considerations	
• Less physical damage to vegetation/habitat.	• More physical damage (higher levels of scorch and defoliation).
• Incomplete removal of litter and vegetation.	• Complete removal of fuel, especially leaf litter, scrub, logs and some trees.
• Burns patchy, with pockets of unburnt vegetation especially along streams therefore greater habitat diversity, refuge areas.	• Burns complete, entire area including streams burnt therefore reduced habitual diversity, no refuge sites.
• High retention of hollow logs, dead and old trees therefore available habitat.	• High consumption of logs, dead trees and old trees often burnt down.
• Lower losses of volatile nutrients (function of fuel consumption).	• Higher losses of volatile nutrients especially from green foliage burnt.
• Disruption to flowering at peak flowering period.	• Flowering not disrupted during peak flowering period.
• Gradual depletion of soil stored seed (but not eliminated).	• Superior germination of soil stored seed.
• Lower germination and seedling survival rate.	• High seedling germination and survival rate.
• Decreased abundance of hard seeders (acacias, legumes, obligate seed species), but these are not eliminated.	• Increased abundance of hard seeders and obligate seed species.
• No effect on resprouting vegetation. These are often favoured.	• Resprouting vegetation can be reduced in density, but not eliminated.
• Low Impact on fauna (mammals, birds).	• High adverse short-term impact on fauna.
• Short-term disruption to birds nesting and foraging in low shrubs.	• Short-term disruption to birds using shrubs and trees for food shelter.
• Lower emission of smoke and of greenhouse gasses especially CO_2.	• High emission of smoke and greenhouse gasses due to higher levels of fuel consumption.

From CALM's submission to the Ministerial Fire Review Panel (1994)

7.10 While the Department of Conservation and Land Management has a legal and moral responsibility to ensure that wildfires on the land it manages do not threaten life and property, it also has the responsibility of ensuring that the ecosystems on this land are sustained and that the public use for a variety of purposes is optimised. [54] The effects of fire on the ecology of WA forests have been studied for over 30 years. So far the results have shown that the effects of fire are very variable, and depend on the fire regime which applies. The 'fire regime' amounts to the cumulative effects of the interval between fires, their intensity (how hot the fires have been), the season during which they burn and their size. Forest ecosystems can persist and appear to thrive under a wide range of fire regimes, although some plant and animal species are favoured by regimes which may not suit others. [55]

7.11 With regard to planned burns, only two periods are contemplated for applying them - spring/early summer and autumn. In the winter, fuels are too wet to readily ignite and in much of the summer they are usually too dry to safely manage a burn with certainty. In a recent *Landscope* article, CALM researcher Dr Neil Burrows has explained:[56]

- The most important difference between spring and autumn fires is the amount of live and dead vegetation (fuel) consumed by the fire. The amount of fuel burnt by a fire largely depends on fuel moisture content. In spring, following winter rains, logs, leaves, twigs, soil and living vegetation are damp. In summer and early autumn the entire forest is much drier, and fires burn more intensely and spread more rapidly.

- Flames in a typical prescribed spring fire are usually about half to one metre high, whereas, in autumn, flames are often two or three times this height. Flame height is a useful estimate of fire intensity, which is a measure of the heat energy output of a fire. The taller the flames, the more intense the fire.

- The dry forest fuels in autumn result in fires which burn almost the entire forest. It is rare to find unburnt patches. In spring, however, moister areas such as swamps, and along creeks and gullies, rarely burn. Surveys have shown that about 20 per cent of a forest ignited under spring conditions does not burn. These unburnt patches and gullies are important animal habitat and provide refuge areas from which animals can recolonise the burnt forest when vegetation regenerates. Autumn burns tend to burn more hollow logs, used by many native mammals for nests and burrows, than spring burns (see also the table opposite).

- There are some predictable short and long-term effects on flora and fauna of planned burns. However, over the relative short term that studies have been made (30 years is short in relation to cumulative effects and subtle ecosystem changes), the results of much of forest research and monitoring is still inconclusive, particularly regarding impacts on invertebrates.

[*It is considered that these principles also apply to 'Red Tingle forest' fairly well, although the 'spring' burning season there actually equates more with <u>early summer</u>*].

54. CALM Submission to Ministerial Fire Review Panel (1994), page 2

55. Sneeuwjgt (1994)

56. Burrows (1990)

7.12 In CALM's 1992 Forest Management Strategy, it has been concluded that for forest vegetation and wildlife habitat: [57]

- Management operations should be diversified to accommodate the regeneration requirements of the taxa represented in an ecosystem (e.g. diversity of burning frequency and intensity).

- Diversity in habitat is required on a whole of forest level and at the local level (2000 - 8000 hectares is the usual size of several burns in all forest types) to ensure conservation of viable populations of animals. [*However in 'Red Tingle forest' the burn size is 300-800 hectares only*].

- It is not possible to devise a fire regime which is either "natural" or simultaneously appropriate for all species:

  - any regime should have a high diversity, including variation in intensity and season and including unburnt controls; and
  - be within the ecological tolerances of all forest species.

- Disturbance to plant communities in sensitive sites (e.g. shallow or moist soils, ecotones) should be avoided.

- Disturbance to vegetation should be avoided where recovery cannot be guaranteed.

7.13 As a consequence, over extensive areas of State Forest a strategy aimed at maintaining diversity is now being implemented via a combination of fuel reduction and vegetation management prescription burns, as well as areas formally set aside where burning is not planned at all. For many years, CALM has been progressively increasing the area of forest burnt in autumn, and implementing a burning cycle, that incorporates a mixture of spring and autumn burning. A more systematic approach is now being developed. For example, a forest would be given two spring burns, then an autumn burn, at five to seven year intervals. Then a 10 to 14 year period would elapse before the cycle was recommenced, with another fuel reduction burn in spring. The extended period between burns would allow seed stored in the soil to replenish, and provide a range of vegetation ages throughout the forest. [58]

7.14 With both fuel reduction and vegetation management burns, an objective is usually to also achieve a mosaic of unburnt patches. However, this is less likely to occur with autumn burning (see para 6.9). Planning to achieve unburnt mosaics, comprising as much as 20% of the area subjected to a burn, may include igniting a number of separate points and also timing their commencement so that advantage can be taken of the cool of the night and increased fuel moisture that also occurs then. Thus, the burnt areas reduce fuel loadings to levels that reduce wildfires occurring and enabling firefighters to control them when they do occur during extreme conditions. [59] At a local scale, the unburnt patches provide refuges during the fire and immediately afterwards for fire-sensitive biota to survive and an opportunity to more readily re-establish in adjoining burnt areas as they recover.

57. Draft Forest Management Strategies (1992), CALM, pages 58, 62

58. Burrows (1990)

59. Sneeuwjgt (1994)

7.15 Proposed management burns are planned up to ten years ahead, and Appendix E describes in more detail some of the principal elements of forward planning. This allows CALM staff to take account of the needs of other forest operations such as logging, activities such as tourism, and habitat regeneration. It also means that within a district a large number of planned burns are identified for a particular season and if circumstances result in any being deferred, the budgeted resources can be diverted to alternative areas for which planning has also been done. Buffer zones are identified in the planning process as well, where fuel reduction will be needed before a main area is burnt. [60]

7.16 In the year of the burn, environmental impacts are assessed before the burn is approved; then all involved persons, assets (eg. bridges, recreation facilities, etc), properties or operations are identified. A detailed 'prescription' is then prepared: a set of objectives, a calculation of the type of burn which will meet them, the weather and fuel moisture which must exist on the day of the burn, and the lighting pattern to be adopted. Boundary tracks are then cleaned up, and other preparations undertaken, such as "edge" burning along roadsides to improve their functioning as firebreaks. [60] [*However, edge burning in the 'Red Tingle forest' (and some other localities and situations) is usually done as part of the main burn while resources are assembled*]. As fuels in the forest begin to dry, CALM alerts neighbours about proposed burns. Warning signs are placed, and announcements are made on ABC radio on the day of the burn. Staff compare the day's weather forecast, fuel moisture conditions, etc., with the conditions prescribed. If the conditions match, guidelines for smoke dispersion are checked. If these are acceptable the burn goes ahead, controlled by skilled, professional crews. [60] At the end of each day, edges are made safe. A senior officer subsequently inspects the burn before it is considered safely completed. Planned burns can, however get out of control. The cause is usually the result of changes in predicted weather conditions after a burn has commenced, or application of too much or too little fire at the time of ignition. CALM planned burns getting out of control represented 13% of wildfire causes during 1981-1987; [61] however, more recent statistics indicate a declining trend (down to 7.5%-3% over the past five years).[62]

7.17 CALM's planned burning program has a wide range of constraints. Some occur naturally, such as weather conditions, limits to funds and manpower, and the need to avoid special areas. Others are statutory; for example, the Bush Fires Act states, amongst other things, that burns cannot be performed on days of very high fire danger; and burns are usually undertaken during a period determined by the local government authority. Smoke would occur with or without planned burns,

60. Burrows (1990)

61. Draft Forest Management Strategies (1992), CALM, page 51

62. CALM submission to Ministerial Fire Review Panel (1994), page 60 / Sneeuwjgt (1994)

but CALM sets management guidelines anyway to match the Environmental Protection Authority's air-quality standards. [63] Some planned burns have also been delayed by community action (eg. approaches to government Ministers, and court action) which in turn put a proposal outside of that year's ideal period for burning. [64]

7.18 In its submission to the recent (1994) review of CALM's fire management strategy by a Ministerial Fire Review Panel (see Appendix B), CALM highlighted the fact that it was behind in its fuel reduction burning programme: [65]

- 46% of the land managed by CALM in the SW was carrying fuels which are six years old or older, when generally they should not exceed 6 years.
- the figure is as high as 66% in forested conservation reserves.
- 48% of strategic buffer zones carry older, heavier fuel, meaning bigger wildfires are likely.
- average forest fire size in 1988 was 14 ha, while in 1992-93 it was 46 ha in SW forests.

8. Fire Management
Walpole-Nornalup NP

8.1 Some 14 vegetation types have been identified within the Walpole-Nornalup National Park, including Karri-Tingle forest (community type 8) [66] which is the most extensive. The overall strategy is to maintain a range of fuel ages for each vegetation type, so that there is a diversity in vegetation structure and habitat types. [67] This is consistent with CALM's stated strategy for forested areas generally (see para 7.13). In the management plan it is also considered undesirable to allow an extensive fire that burns most or all of each major vegetation association.

8.2 The management plan therefore intends to produce seral stages through a combination of designated **fuel reduction areas** to protect critical locations such as townsites (which will provide sufficient young seral stages), while designated **vegetation management areas** will be developed to provide a range of mid to late stages of succession. There are also extensive designated **no planned burn areas** which will contribute to the mix. [67] These are described here in relation to the Park's three broad landform/vegetation types (see para 3.3):

- tall forest on hilly terrain
- heath, shrubland and thicket on coastal dune systems
- swamp vegetation along the lower reaches of rivers and other poorly-drained peaty soils.

63. CALM submission to Ministerial Fire Review Panel (1994), pages 30-31

64. CALM submission to Ministerial Fire Review Panel (1994), pages 21, 30

65. CALM submission to Ministerial Fire Review Panel (1994), pages 33, 57

66. Walpole-Nornalup NP Management Plan (1992), Appendix 1

67. Walpole-Nornalup NP Management Plan (1992), page 31

8.3 **No Planned Burn Regime** - these are areas that are not intended to be subjected to planned (prescribed) burns within the life of the management plan. Those portions that escape possible wildfires will thus have vegetation ages of ten years and more since last being burnt. These areas are usually located away from likely ignition sources (eg. major roads and recreation areas) and require maximum protection by way of good perimeter access and fuel reduction buffers. Most of the designated no planned burn areas cover the coastal vegetation types (communities 9, 10, 11 and 12, and granite outcrop and headlands) [68]. *Recently (August 1996) the NPNCA amended the fire management component of the management plan by correcting two drafting errors and converting about 560ha of forest shown as no planned burn to fuel reduction regime. This action followed a formal public consultation process.* [69]

8.4 **Vegetation Management Regime** - the aim of these areas is to contribute to ecological diversity by providing a variety of fuel ages. To ensure this, these areas have been segregated into areas that are proposed to be prescribed burnt during the life of the management plan (ie. have a range of vegetation ages up to ten years) and a smaller number to be prescribed burnt later than 10 years after the plan's commencement. The expectation is that collectively most of these regimes will entail rotations of 10-20 years. Most of the vegetation management regime areas also cover hilly vegetation communities, including Karri/Red Tingle forest.[70]

8.5 **Fuel Reduction Regime** - these are strategically positioned areas within which ground fuel loads are to be contained, by prescribed burning, to levels that enable safe direct attack by fire fighters in the event of a wildfire. The rotational period between burns will depend on the rate of fuel accumulation, but is expected to vary between six and eight years. Where natural water boundaries of river and estuary don't exist, fuel reduction areas have been positioned to help isolate no planned burn areas in coastal vegetation types, and high fuel load forest areas under vegetation management or no planned burn areas. In particular, fuel reduction areas abut the Walpole, Nornalup and Peaceful Bay townsites and strategic areas of private land. Because of the scenic quality of the forested slope across the Frankland River from the Nornalup township, it has been specifically identified as a fuel reduction area to be burnt at a different time to the main Douglas Hill area behind. [71]

68. Walpole-Nornalup NP Management Plan (1992), page 34, Map 4, Appendix 1

69. NPNCA Minutes, August 1996, item 5.3

70. Walpole-Nornalup NP Management Plan (1992), page 34, Map 4, Appendix 1

71. Walpole-Nornalup NP Management Plan (1992), page 34, Map 4, Appendix 1

8.6 In summary, most of the coastal vegetation communities fall within no planned burn areas which are largely segregated from adjoining areas needing protection by fuel reduction buffers and natural water features. Hilly vegetation communities (mainly Karri/Red Tingle forest) fall approximately half within vegetation management/no planned burn areas and half in fuel reduction regime areas. *Most of the Park's swamp communities, however, fall within fuel reduction regime areas. Under proposals of the management plan, there is little prospect of the majority of these communities remaining unburnt for periods longer than eight years. The proportions of Park area involved are roughly as follows:*

	Fuel Reduction	Vegetation Management/No Planned Burn	Total
Coastal vegetation communities	5%	35%	40%
Hilly vegetation communities	25%	30%	55%
Swampy terrain vegetation communities	5%	-	5%
	35%	65%	100%

8.7 CALM's overall nature conservation strategies and objectives are summarised at Appendix A to these notes, and its fire management policy and reviews are summarised at Appendix B. A difficult task that these set for the Department is obtaining a rational balance when at times they can be in conflict. This has raised specific issues that have been identified in the Walpole-Nornalup NP management plan's section on fire management:[72]

- The complex shape of the Park which encloses a major highway and large tracts of private land, and the close proximity of three towns - has produced a long perimeter that requires fuel reduction burns and firebreak maintenance, increasing the cost of Park management and reducing the options for a range of fire regimes.

- The safety of Park visitors and management staff; the townships of Walpole, Nornalup and Peaceful Bay; and private property enclaves and that adjoining the Park's outer boundaries.

- Fuel reduction strategies around townsites and in adjacent State forest to be consistent with aesthetic and environmental management objectives.

- Karri/Tingle regeneration areas in the Valley of the Giants and Hilltop area

- The Red Tingle forest

- The possible alteration of ecos3ystems due to too frequent burning and damage to Red Tingle trees by fires if they are too intense (*"it should be considered sensitive to fire"*).

- Coastal areas used for the translocation of the Noisy Scrub Bird.

- Education of the public and obtaining co-operation from neighbouring landholders regarding fire management needs.

72. **Walpole-Nornalup NP Management Plan (1992), pages 32-33**

8.8 Apparent issues not specifically identified in the fire management section of the management plan are

- The subjugation of most of the small area of swamp vegetation communities to short seral stages through the more frequent management burning of a fuel reduction regime (see para 8.6) - **even in areas zoned as Special Conservation** *(ie. containing unique, vulnerable, or threatened species/best examples of natural features/or representatives of plant communities)*. [73]

- CALM biologists apparently assuming (and therefore CALM managers adopting compatible actions) that 'Red Tingle forest' and associated relictual biota must be fire adaptive because they have survived numerous large-scale and intense wildfires in the past. [74] Other researchers have pointed to factors that suggest that more of the biota is of relictual significance than has been generally accepted to date and that they are not necessarily fire adaptive - and their persistence may in fact be progressively diminishing. *This suggests that a precautionary approach should therefore be taken in management decisions and more monitoring and research be carried out to obtain data that is more conclusive* (see further, paras 9.4, 9.5, 9.6).

- CALM fire managers apparently assuming (on the basis of experience elsewhere) that 'Red Tingle forest' fuel loadings will burn in a predictable way to leave mosaics of unburnt patches of vegetation - when in fact this has not been readily achieved in recent prescribed burns. [75]

- Autumn burning poses the lowest risk to one burrowing relictual spider species, while another is surface-dormant during summer. While on the one hand it is said that autumn is the time when most prescribed burns are undertaken in tingle forest [76] - it is clear from CALM documents that unburnt mosaics (refugia) cannot be achieved under autumn conditions and in Red Tingle Forest this might be achievable only in early summer (see para 7.11).

- The very small window of opportunity for conducting management burns when litter fuels are likely to be dry enough (eg. a limited two month period - see para 7.5).

- Despite the management plan's acknowledgment that Red Tingle trees should be regarded as sensitive to fire [77], even 'mild' (in the view of experienced fire managers) prescribed burns tend to set trees alight and for scorching to extend beyond set acceptable levels, and hollow butting and some tree toppling also occur (see para 7.9).

- Rates Tingle possibly has an insecure conservation status (see para 3.14) and thus requires monitoring.

73. Walpole-Nornalup NP Management Plan (1992), Table 3, Map 3

74. Smith (1996), page 12, 13

75. CALM Media Release 6/3/1996 ("Prescribed burns to protect tingles and towns"); Albany Advertiser 12/3/1996 ("Environment lobby delays prescribed burn")

76. Smith (1996), page 12

77. Walpole-Nornalup NP Management Plan (1992), page 33

- The management plan acknowledges that the area of long unburnt tingle forest at Douglas Hill poses a threat to the Nornalup township and needs progressive burning [78] - but needs to be done in a manner that leaves the area immediately across the Frankland River from the town to be burnt at a different time (see para 8.5).

- While the Walpole-Nornalup NP Management Plan has a ten year operation period (to 2002), fire management strategies covered by it appear to enable prescribed burn planning and implementation to continue beyond 2002. As Section 55(2) of the CALM Act permits such management plans to remain in operation until replaced, assurance from managers is necessary that in fact the existing management plan provides adequate guidance for continuing fire management beyond 2002 (see paras 8.4, 8.5).

9. Research and Monitoring

9.1 CALM's 1992 draft forest management strategy states that: [79]

> *"It is an accepted premise that management of ecosystems should be based on the best understanding of scientific principles available and the most up-to-date knowledge of ecosystem components and processes. Ecosystems are, however, enormously complex and the current level of knowledge is far from complete. In all probability it never will be. On the other hand, society uses resources from ecosystems, and it is unrealistic to expect a halt to be called to this whilst "enough" information is gathered."*

The Department's 1992 draft nature conservation strategy takes the premise several steps further: [80]

> *Effective management for conservation requires a sound knowledge of which plants and animals occur in an area, and why they occur where they do. Monitoring the results of any action is an integral part of management. Thus there should be a close relationship between inventory, research and monitoring.*

9.2 CALM acknowledges that it has a responsibility to carry out, encourage, support and publish research relevant to its needs. This requires liaison with other research and land management organisations to define, establish priorities for, and co-ordinate research programs, and publish results. CALM also has a responsibility to ensure the efficient transmission of research findings into operational practice, in order to provide optimum management of the State's conservation values. [81] Most research in CALM is carried out within it's Science and Information Division ("SID", previously known as the Research Division).

78. Walpole-Nornalup NP Management Plan (1992), page 34

79. Draft Forest Management Strategies (1992), CALM, page 176

80. Draft Nature Conservation Strategy (1992), CALM, page 108

81. Draft Nature Conservation Strategy (1992), CALM, page 110

Implications for fire management in forests with a nature conservation priority

Our review indicates that the jarrah forest, like all other dry sclerophyll forest ecosystems, is well adapted to a wide range of fire regimes. The karri forest differs only in degree as we consider it was burnt slightly less frequently in the past than the jarrah forest, with the southernmost moist karri and tingle forest perhaps being burnt the least often.

The aim of forest management should be to devise fire regimes, based on the best available scientific evidence, that maintain conservation values and at the same time are compatible with fire protection objectives. We propose the following principles as a guide to devising these systems:

1. A fire regime incorporating some deliberate burning should be instituted. The proviso is that any regime decided on should have a high diversity, including an unburnt 'control' and a wide range of fire intensities, frequency and season of burning. Western Australian foresters have recognised this and by 1987 there were 42 areas of forest or woodland set aside to be protected from all fire (Figure 1 and Table 1). Some of these areas have now been retained unburnt for 50 years. The remark by Walker *et al.* (1986) that such long-term reference areas are 'few in number' presumably applies to other States of Australia and certainly not to Western Australia.

   Fires at the intense end of the spectrum should be minimised. The jarrah forest has mainly experienced mild, short rotation fires since aboriginal occupation, with only occasional intense fires. High intensity fire in the karri forest simply converts diverse mature forest to even-aged regeneration.

2. Monitoring should take place in selected reserves. However, it is not possible nor is it necessary to monitor every single burn in every reserve. It is quite impracticable to attempt to monitor every species of the organisms present. Monitoring should therefore take three forms:

   (a) Monitor special species which are likely to indicate change in the community. This should include the identification and monitoring of vulnerable species (i.e. those which by virtue of their life history strategy are most threatened by a proposed fire regime, such as plant species regenerating solely from seed and taking many years to flower and set seed). Amongst animal species, indicator species are often the vertebrates and sometimes the rarer species. It is the less common species which often become common when circumstances change. These are the species which often given the community its robustness and resilience to change.

   (b) Monitor core (sometimes called keystone) species i.e. those species upon which many other species in one ecosystem depend. In the forests and woodlands of southern Western Australia, jarrah, marri, karri and wandoo are the four most important keystone species.

   (c) Monitor for direction of change in the community. Any fire will induce a response which will vary with each of the many species of organism in the community. The sum total of these responses will be the response of the community. It follows, as no fire is the same, that each community response will be different, i.e. community response over time will oscillate following each fire. The amplitude of these oscillations indicates the range of responses but the oscillations themselves are of little importance. What is important is the general direction of change in the community over and above the individual oscillations.

   If there is a general and consistent shift in any direction, land managers should be aware of it and be concerned. The problem is to detect such changes and if they occur to distinguish them from natural shifts. It is not known what the natural direction of change in the jarrah and karri forest communities might be. What is certain is that there is one. No community has been stable over geological time because species are continually becoming extinct and others are evolving to take their place as environmental changes occur. To detect change of this nature, long term monitoring plots are necessary. Monitoring should also be used as a means of validating process-based mechanistic simulation models of the effect of fire regimes on ecosystem functions.

3. An attempt should be made to find out the nature of the past fire regimes in the jarrah and karri forests and wandoo woodlands. This study would assist in the more accurate definition of future burn regimes. The approach of counting growth rings in the lower boles of trees scarred by fire has been successfully used in North America (e.g. McBride and Laven 1976) and could be applied to jarrah, marri, karri and wandoo. Large trees would yield information about the frequency of moderate-high intensity fires (sufficient to cause scarring) over the last 500–1000 years. Studies of *Xanthorrhoea preissi* and the structure of karri stands could also provide information about the frequency of low intensity fire. Methods by which information could be obtained on past fire intensity and season of burning should be investigated.

4. Relevant information from other places should be used. Although the jarrah and karri forest ecosystems may be unique, many of the basic processes at work within them are not. Many of the plants and animals living in them have parallels in other ecosystems which react similarly to fire.

Following the recent restructuring to form SID, the Division developed a strategic plan for the five-year period 1995-1999. One of the strategy's principle objectives is to see that research findings are communicated to managers for practical management use. [82] Regional Ecologists provide an obvious focus for such interaction in this area at the regional level, with the Wildlife Branch (Nature Conservation Division) playing a co-ordinating role at the Departmental level regarding wildlife research and outcomes. [81] Currently, it is the Bio-conservation Group within SID which provides the scientific information that assists operational managers of forest and conservation reserves to achieve their conservation objectives. The Group also provides the scientific information for developing and supporting CALM conservation policies. [83]

9.3 Appendices A and B point out that reviews of scientific literature were carried out by CALM scientists on the state of knowledge of the impact of fire on Western Australian forest ecosystems (Christensen and Abbott, 1989), and the impact of other aspects of forest management (Occasional Paper, 2/92) - the latter concentrating on the southern forest area of the Warren Botanical Sub-district. The conclusions of Christensen and Abbott (1989) regarding the implication of the then state of knowledge for fire management in forests with a nature conservation priority (eg. Walpole-Nornalup National Park) are reproduced opposite. In the 1992 review, seven papers were produced on the state of knowledge of management (mainly for timber production) impacts on various elements of the State's 'southern' forests. Each paper identified high priority additional research requirements and a group of CALM senior research scientists subsequently ranked these as follows, with those applicable to the Walpole-Nornalup National Park highlighted in bold: [84]

Flora

- **Production of a Flora of the Warren Botanical Sub-district**
- **Taxonomic studies on poorly known plant groups**
- **Enhanced survey effort, especially surveys of poorly known areas**

Effects of timber harvesting and regeneration on flora and fauna

- Study effects on selected vertebrates and invertebrates
- Study hollow formation in karri, marri and jarrah
- Study effects of thinning on fauna

Nutrition

- Quantify fertiliser response during early growth of jarrah and karri
- Extend later age fertiliser experiments in jarrah and karri to a greater range of sites
- **Research role of prescribed burning in nitrogen economy of karri forest**

82. **SID Strategic Plan 1995-1992, page 3**

83. **SID Triennial Report 1992/95, page 7**

84. **CALM Occasional Paper No. 2/92 (1992), page 4**

Hydrology

- None

Insect Pests

- Study impact of repeated chronic defoliation on nutrient levels in and physiological condition of jarrah
- Clarify reasons for the initiation and continuation of insect outbreaks
- Study insect pests of *Eucalyptus globulus*

Plant diseases

- **Develop a database of susceptibility of plants to *Phytophthora* species and determine long term effects of infection on community diversity**
- **In addition, the Group believed that research on wood rots (not covered in the review) was a high priority**

Aquatic fauna

- **Develop an inventory of aquatic invertebrates**
- Study impact of logging and regeneration on aquatic communities

9.4 Other specific high priority research needs that are identified in the reviews and which can also be related to the Walpole-Nornalup National Park included:

- "The identification of taxa most in need of conservation initiatives is a priority, and will come only with an enhanced survey effort and biological survey program. The latter may enable the categorisation of vulnerable species according to life-history attributes. **For example, obligate seed regenerators may be the most vulnerable group to fire."** [85]
  [Karri/Red Tingle forest, includes the highest proportion of species with soil seed storage in the Park [86] *- see also Appendix E, tables at page 2]*

- "The role of microflora/fauna communities; the impact of disturbance on invertebrate communities; and the identification of indicator species, vulnerable species (including Gondwanan relicts) and their habitats." [87]

- "Further work is also needed on the fire ecology of relictual groups such as the spiders mentioned by Main (1987)." [88]
  [ie. Gondwanan relicts in the tingle forests]

85. Hopper *et al* (1992), page 9

86. Walpole-Nornalup NP Management Plan (1992), page 31

87. Wardell-Johnson and Christensen (1992), page 50

88. Christensen and Abbott (1989), page 115

9.5 Under provisions of the 1992 management plan for the Walpole-Nornalup National Park, the principal research and monitoring commitments are listed under sections dealing with flora, plant diseases, fauna and fire management. These are displayed opposite. The management plan also contains a 'Research and Monitoring' section, in which it is stated: [89]

> *While a great deal of knowledge of the Park exists, future research of specific elements is required. Of particular importance are plant diseases and Gondwanan relicts.*

This priority has been incorporated into the plans objective for research and monitoring and associated commitments: [89]

Objectives

- *Promote and undertake research on the flora, fauna, ecosystem processes, and archaeology of the Park, with emphasis on disease, the Gondwanan relicts and processes/activities that threaten or enhance conservation values.*

- *Develop and implement a monitoring program to determine:*

  a) the impacts of management and human use on the Park
  b) changes in the natural environment and other natural processes.

Actions

- **Implement an integrated program of survey, research and monitoring based on the actions in relevant sections of this plan.**

- Continue to require all researchers to follow dieback disease hygiene procedures.

- Continue to require all researchers to make their findings readily available to Park, District staff and the public.

- Encourage and support other groups, agencies, institutions, volunteers and individuals to carry out research and monitoring projects relevant to the conservation and management of the Park.

- Encourage the establishment of a field station in the Park, or close by, for research and educational purposes.

9.6 More recently, Smith (1996) has reviewed information specific to fire ecology of forest containing Red Tingle, Yellow Tingle and Rates Tingle. Based on the review, he made suggestions for further research: [90]

- The post-fire recovery of young Red Tingle and Rate's Tingle.

- The reproduction of Red Tingle and Rate's Tingle, in particular the links between flowering and environmental factors.

89. Walpole-Nornalup NP Management Plan (1992), page 90

90. Smith (1996), page 13

- Nutrient uptake studies to shed more light on the proposed reliance of Red Tingle on deep litter.

- Factors which influence the regeneration success of Red Tingle and Rate's Tingle.

- Studies on the taxonomy, distribution and phenology of deep litter invertebrates in the tingle forest and the post-fire recovery from varying seasons, fire intensity and frequency.