Department of Conservation and Land Management, W.A.

Lane-Poole Reserve

Draft Management Plan
APRIL 1986

VOLUME III RESOURCE DOCUMENT

LANE-POOLE RESERVE

DRAFT MANAGEMENT PLAN

VOLUME III

RESOURCE DOCUMENT

INTRODUCTION

During the preparation of the Lane-Poole Reserve draft management plan, the planning team collected and collated considerable data about the Reserve.

It was felt that as the Reserve had a major role to play in education, and was already heavily used by schools, the publication of that data would be of value.

For that reason a summarised version of the available information is presented in this document together with an extensive bibliography and other general information which the group considered may be of interest to teachers and naturalists.

PART A: CLIMATE OF LANE-POOLE RESERVE

R. HULAJKO

INTRODUCTION

Lane-Poole Reserve lies on the western margin of the South-western Province of the Yilgarn Block. Geomorphologically it occupies the western part of the Darling Plateau near the Darling Scarp.

This Reserve contains approximately 55,000 hectares of mainly jarrah forest. Total length of its border is about 350 kilometres, consisting of about 265 km of border with uncleared land (also forest) and about 85 km of border with cleared land (farmland).

The Reserve's shape is irregular and consists basically of two parts. The northern part with the Murray River Valley as its main axis is narrow, from 1 km to several kilometres wide and about 40 km long. The southern part is broader, being roughly 25 km wide.

The climate of the Reserve is influenced by the anticyclonic belt which flows from west to east along the south coast of Western Australia. This belt oscillates in winter to the north and in summer to the south for a range of about 1,000 km. As a consequence the cool fronts in winter create a cool and wet season from May to September. In the summertime those cool fronts are farther south, so the Reserve has a hot and dry season from November to March. This type of climate is basically Mediterranean but differs from the typical in its greater equitability and occasional heavy summer storms.

PRECIPITATION

Rainfall accounts for nearly all of the Reserve's precipitation. Snowfalls occur rarely, no more than once in 50 years and lies on the ground for only a short period. The last recorded snowfall was in 1957.

Rainfall averages from about 650 mm per annum in the south-eastern section, gradually increasing up to 1300 mm per annum in the north-western section. Most areas of the Reserve receive about 800-1200 mm per annum. High rainfall of 1200-1300 mm occurs along the Darling Scarp and decreases rapidly towards the east (Fig. 1).

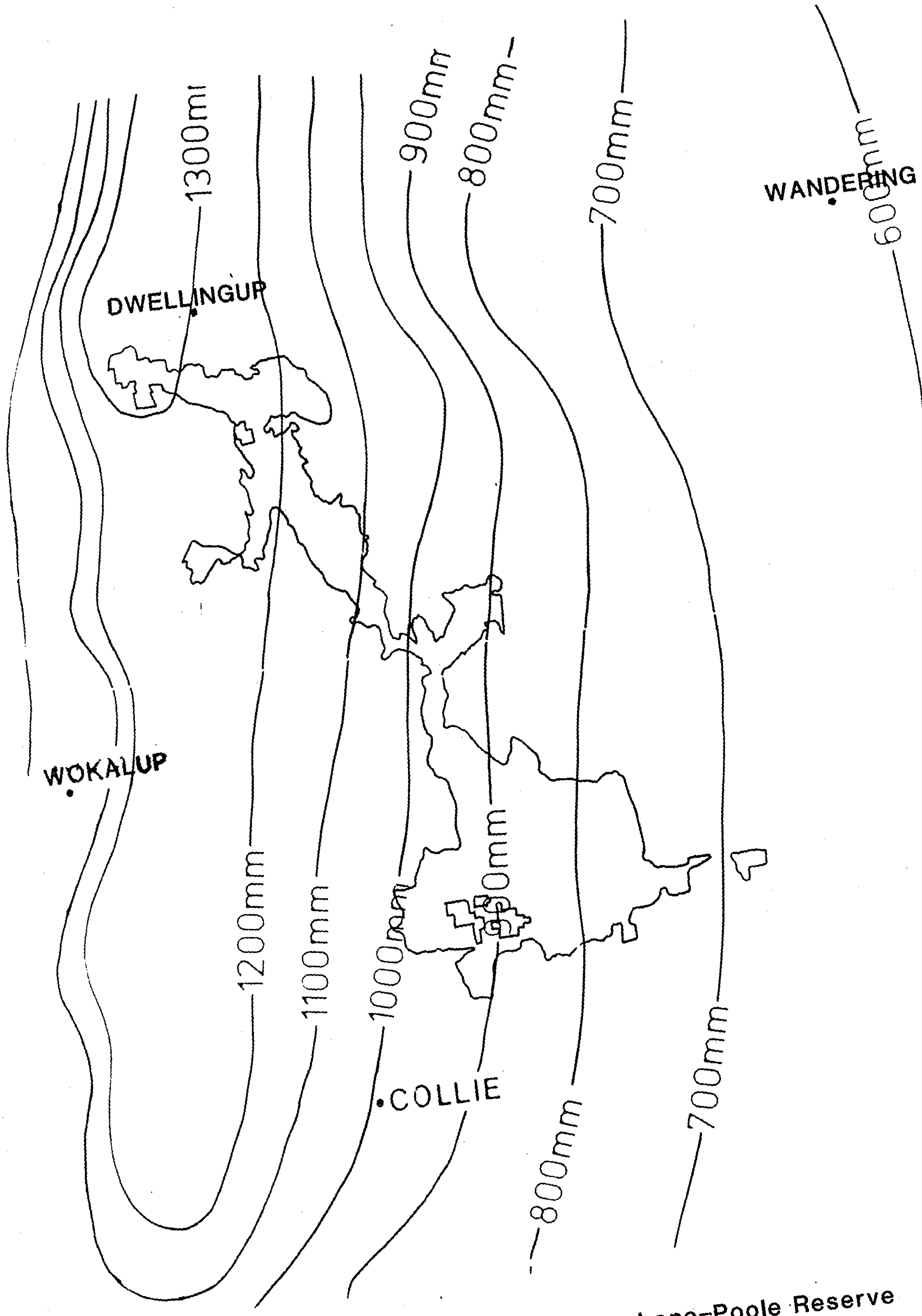

Fig.1 Rainfall isohyets for the Lane-Poole Reserve

The greater part of the rain falls in the cooler months of the year (May-October), when 85% of the annual average is received. The winter rainfall (June-August) includes over 50% of annual rainfall. The summer months (December-February) receive less than 5% of the annual rainfall (Fig. 2, Appendix 1, 2).

The average number of raindays is about 130 at Dwellingup gradually increasing to about 140 at Collie. During the year most of the raindays occur in Winter with an average of 20 days in July, rapidly decreasing through to the summer months when an average of 3 raindays occur in January; these are usually heavy falls (Fig. 3/4).

Heavy rainfalls over 10 mm per hour and over 25 mm per 24 hours recorded in Dwellingup occur mainly in winter and occasionally in summer. The highest daily rainfall noted since 1957 occurred in Dwellingup in January 1982 and amounted to 159.8 mm (Tab. 1, Appendix 2).

TABLE 1
NUMBER OF HEAVY RAINFALLS IN DWELLINGUP SINCE 1957

SEASON	OVER 10mm PER 1 HOUR		OVER 25mm PER 24 HOURS	
	OCCURRENCE (times)	HIGHEST RECORDED (mm)	OCCURRENCE (days)	HIGHEST RECORDED (mm)
AUTUMN	13	29.9	12	68.6
WINTER	35	24.1	62	61.0
SPRING	3	15.2	8	39.4
SUMMER	12	29.5	4	159.8

The average numbers of thunderdays is about 20. Severe hail of about 5 mm diameter or more falls almost exclusively in violent or prolonged thunderstorms. A rough estimate shows that about two percent of thunderstorms generate severe hail. These occur mainly during the winter months.

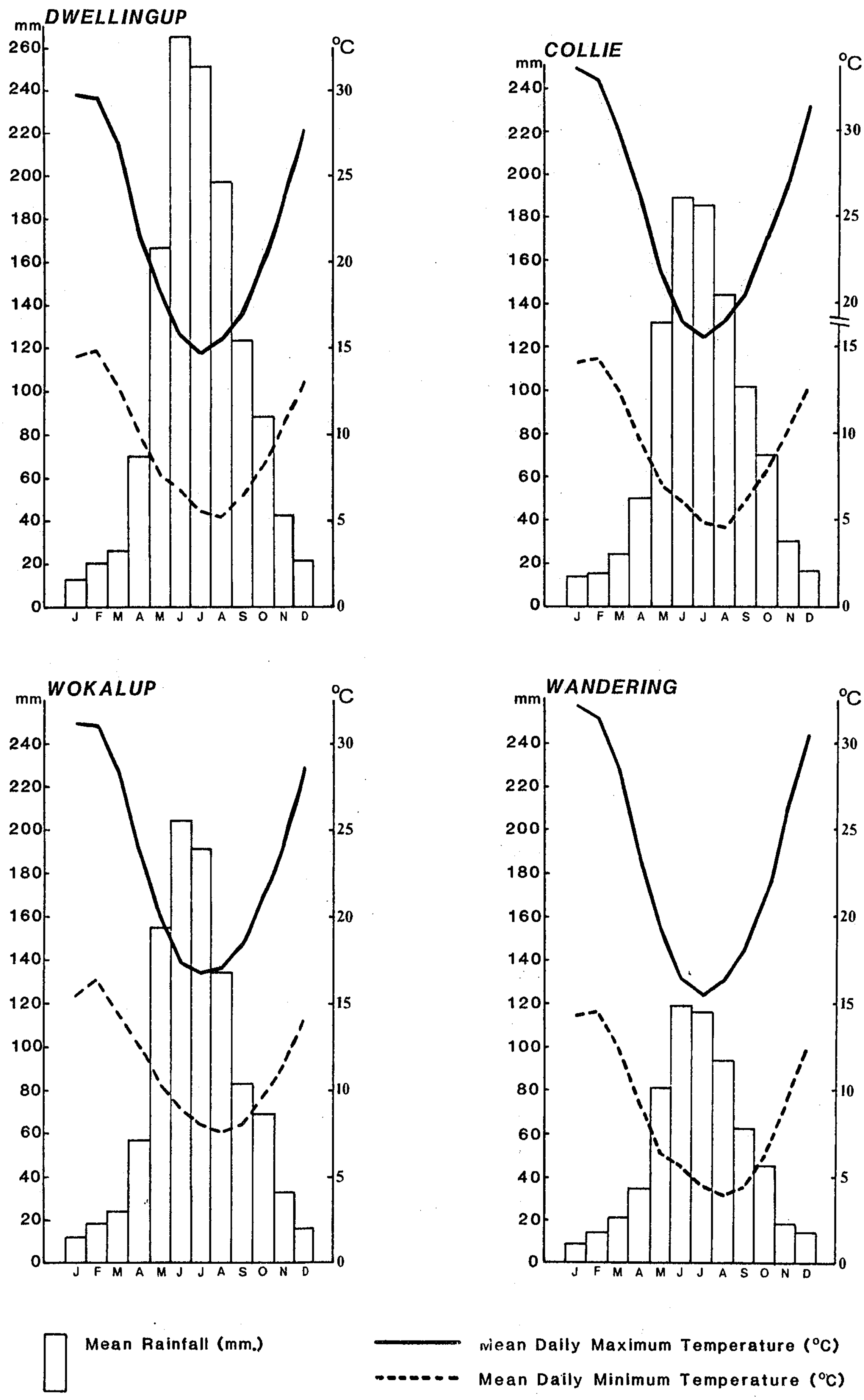

Fig.2 Rainfall and temperature characteristics

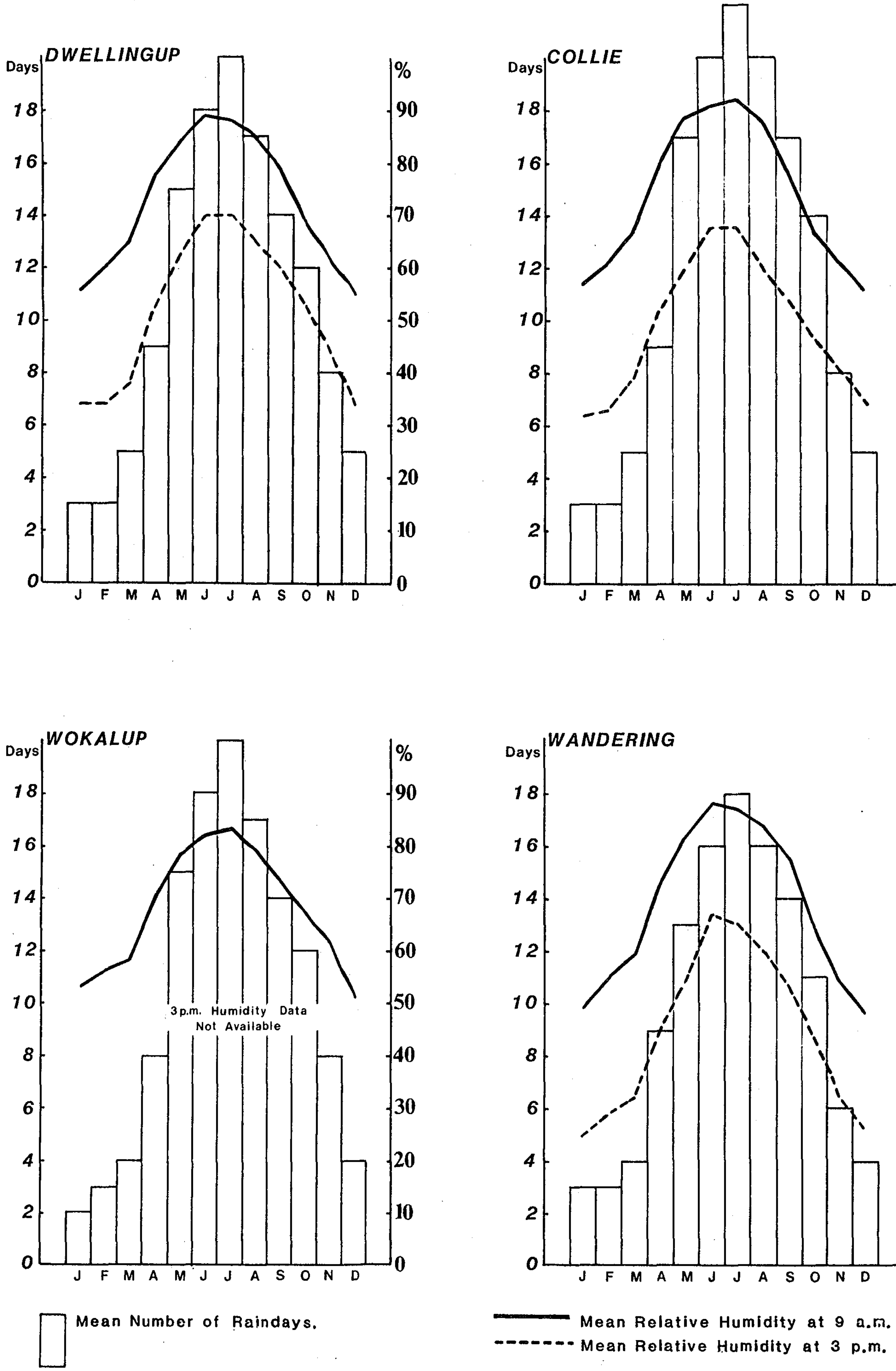

Fig. 3/4. Raindays and relative humidity

TEMPERATURE

After rainfall, temperature is probably the most important climatic factor. It has the effect of water extraction from the soil, determines the growing season and influences the evaporation factor and moisture of the air.

The mean annual temperature for the whole Reserve is about 15°C at 9 a.m. and about 20°C at 3 p.m. During the year the highest temperatures occur in January, increasing from west to east and reaching a mean of 29°C at Dwellingup. The lowest mean temperatures occur in July, when it decreases from west to east and has a mean of about 5°C. Differences of temperature between the hottest and coldest months increase to the east as the effect of distance from the ocean (App. 1, Fig. 2). Extreme temperatures of over 35°C occur in Dwellingup for an average of 13 days per year, between December and March. In some years extreme temperatures occur up to 11 days particularly in January and February. Temperatures of over 40°C occur occasionally during the summer (App. 2).

Frosts occur throughout the winter from May to August with rare occurrences recorded in April and from September to November. In general ground frost is present when ordinary measurement of temperature (1.5m above surface) reads about 2°C. Occurrence of frost is unpredictable, in some years it is very common and in others occurs only occasionally (App. 2).

HUMIDITY

Atmospheric humidity varies during the day and seasons with changes in air temperature and air mass characteristics. Low summer rainfall together with high temperatures causes low humidity levels of humidity. Humidity at 9 a.m. is higher than at 3 p.m. for the whole of the year (Fig. 3/4). Humidity in forested areas is always higher than in agricultural areas.

EVAPORATION

The measurement of evaporation is from a free water surface (pan evaporation). Evaporation at Dwellingup varies from about 2 mm per day in June and July up to about 8 mm per day in January. Average annual evaporation is less than 1,500 mm but is higher than rainfall. There is a much higher potential value of evaporation than rainfall in summer, but lesser values in winter (Fig. 5, App. 2).

SUNSHINE AND CLOUD COVER

Through empirical relationships between duration of sunshine and cloud coverage, the following general trends can be derived (Appendix 2).

1. Total annual sunshine duration decreases with a corresponding cloud cover increase from north to south along the Reserve.

2. Highest sunshine with lowest cloud coverage occurs in January, but the opposite occurs in June.

3. Sunshine is generally lower but cloud coverage higher at 9 a.m. than 3 p.m. in summer, in winter these factors are opposite.

WIND

Prevailing annual winds come from the north-west and west, with lowest occurrences from the north and the south. During summer winds usually blow from the south-west and south-east, in winter from the western sector with highest occurrences from the north-west. Windroses for autumn and spring are similar, wind blowing usually from the west and south sectors but in spring the wind has much higher speed than in autumn. Strongest winds occur mostly from the western sector. Calm wind conditions are 2 or 3 times more common at 9 a.m. than 3 p.m. and have higher occurrence in winter. Speed of the wind usually increases from the morning to afternoon (Fig. 6, App. 3).

PART B: GEOLOGY AND LANDFORM OF LANE-POOLE RESERVE

R. HULAJKO

GEOLOGY

The main geological element of the Lane Poole Reserve is the Archaean Yilgarn Block, which constitutes the major nucleus of the present Australian continent. On the west from the Yilgarn Block lies the Perth Basin, separated by a significant split in the earth's crust called the Darling Fault. The Perth basin is oriented in a roughly north-south direction with

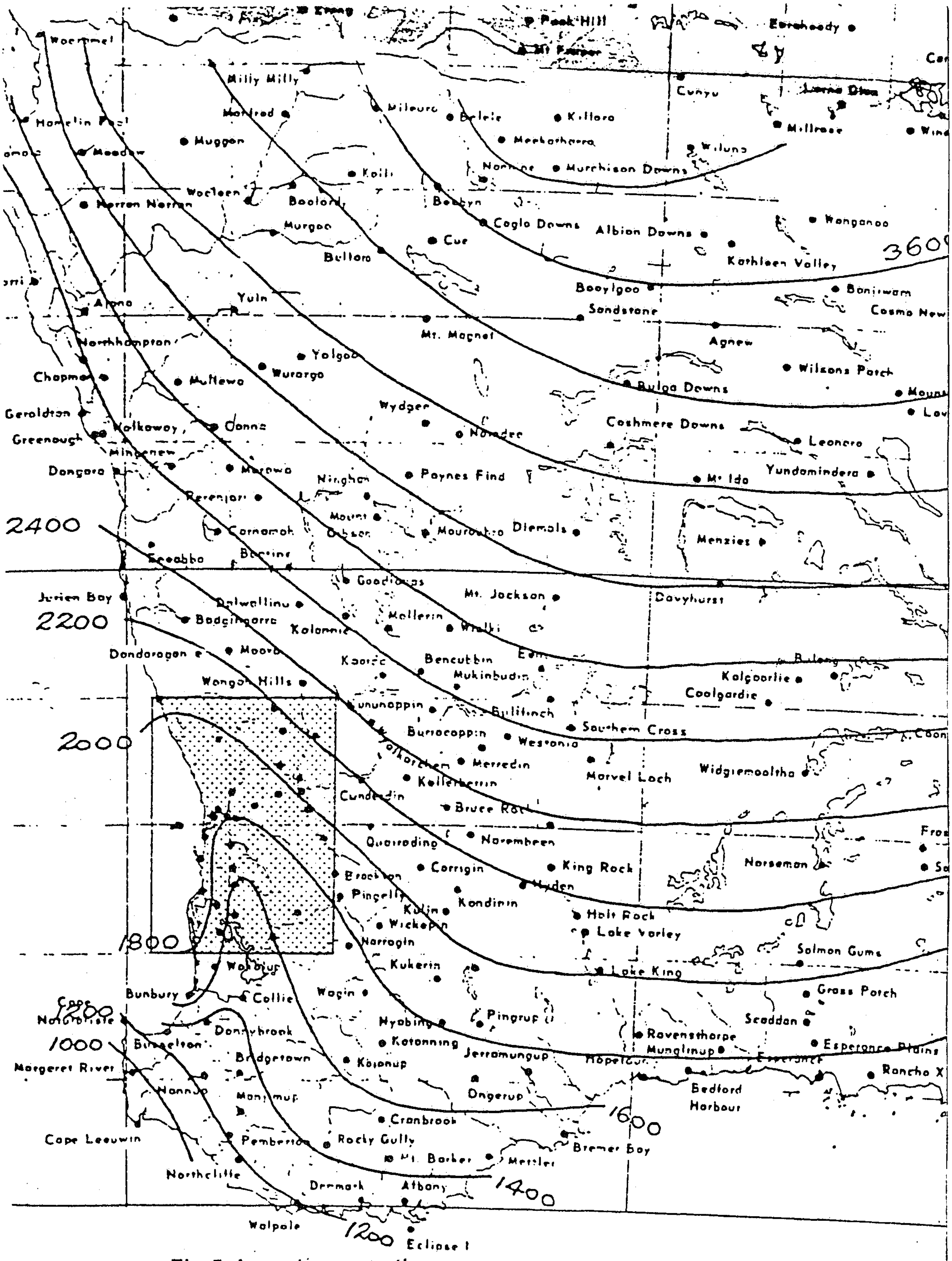

Fig.5 Annual evaporation

Class A pan (mm)

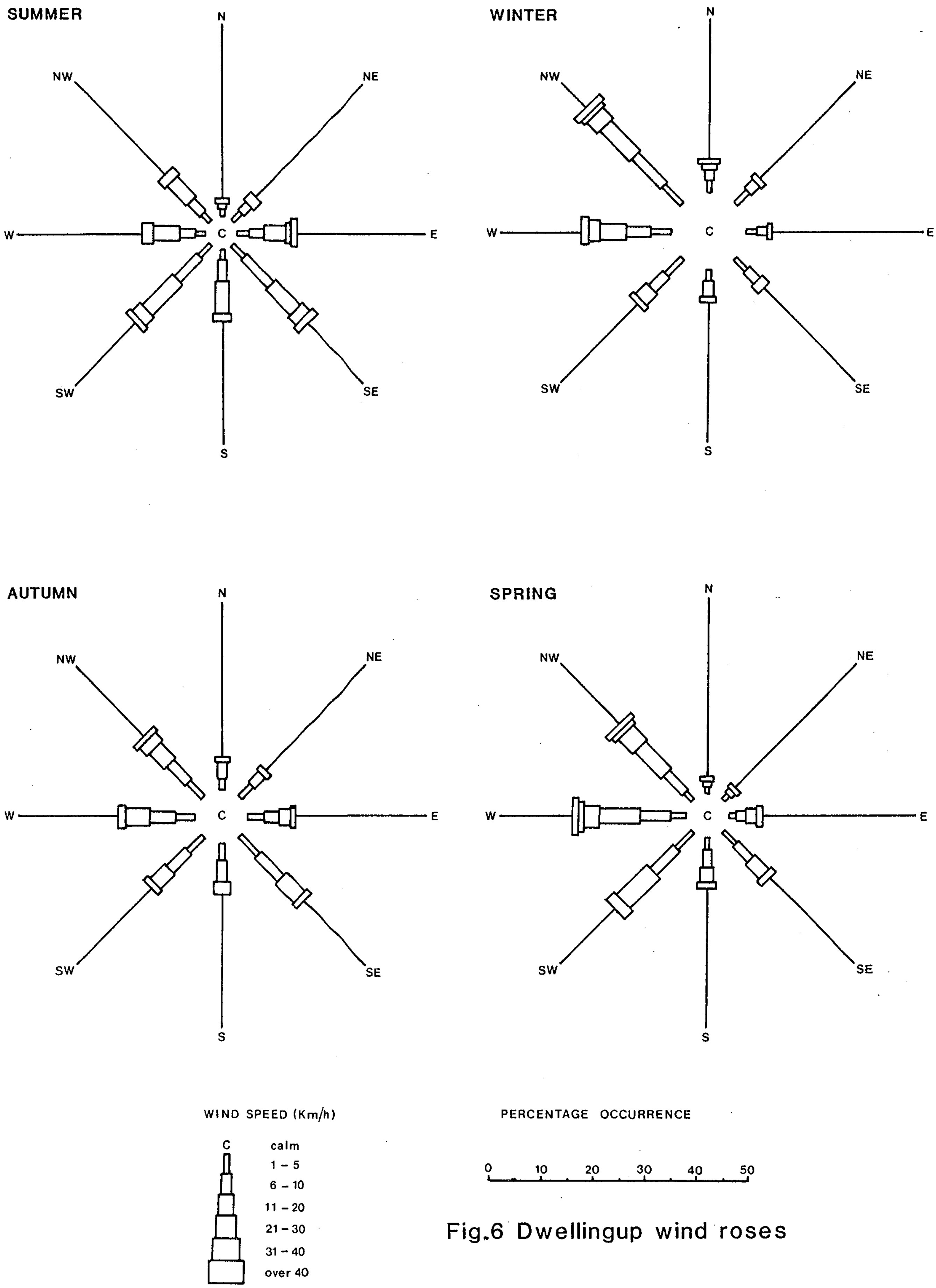

Fig.6 Dwellingup wind roses

its western margin laying along the edge of the present continental shelf (Fig. 7).

The Darling Fault is obscured by sediments, but is located approximately 1 to 3 km west of the Darling Scarp, which is its surface expression. It is a normal fault with a maximum downthrow of about 15,000 m to the west. The fault is subparallel to a zone of deformation that was probably initiated during the Archaean. However major vertical displacement did not commence until the Phanerozoic with greatest vertical movement occurring between the Late Triassic and Early Cretaceous. This was associated with the break-up of the ancient supercontinent of Gondwanaland, although separation did not occur along the Darling Fault.

The Perth Basin, which lies west of the Darling Fault, is a deep trough filled with Phanerozoic sedimentary rocks. The total thickness of sediment may exceed 15,000 m in places. Only rocks of Cretaceous age or younger out-crop on the surface, although Jurassic, Triassic, Permian and Silurian rocks occur at depth. These rocks are not exposed on the coastal plain because of the extensive cover of superficial Cainozoic deposits.

The sequence of geological events leading to the formation of the present landscape within the Yilgarn Block was in Paleozoic and Mesozoic eras; subject to erosion and contributing sediments to the then submerged Perth Basin. The Yilgarn Block became more or less base-located by the end of the Cretaceous with the harder rocks forming occasional hills. At about the end of the Cretaceous the continent was uplifted and the Perth Basin brought above the sea. The western margin was cut back by the sea, and rivers substantially deepened their beds. During the Tertiary and Quaternary a further uplifting of the plain occurred, causing it to be eroded further.

The western part of the Yilgarn block in the vicinity of Lane-Poole Reserve consists of high grade metamorphic belts partially enveloped by complex associations of granite in the form of a large batholith. These granite rocks occupy nearly all the southern part and about a half of the northern part of the Reserve (Figs. 7&8). Through the Reserve there are several places where granitic outcrops occur on the surface. The metamorphic belts contain remnants of sedimentary and volcanic rocks as well as metamorphised granitic rocks.

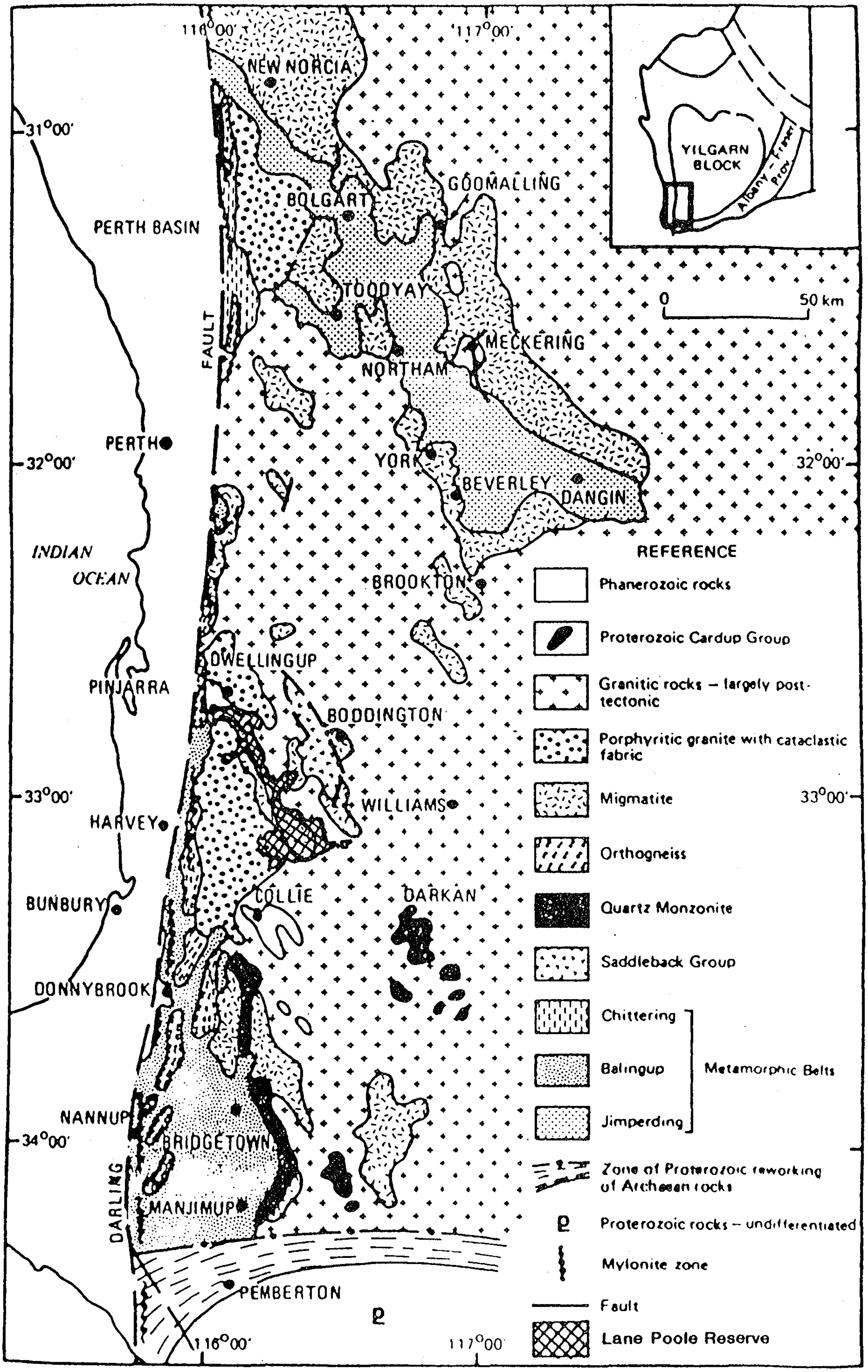

Figure 7 Regional geology of the south western part of the Yilgarn Block. (after Wilde 1980)

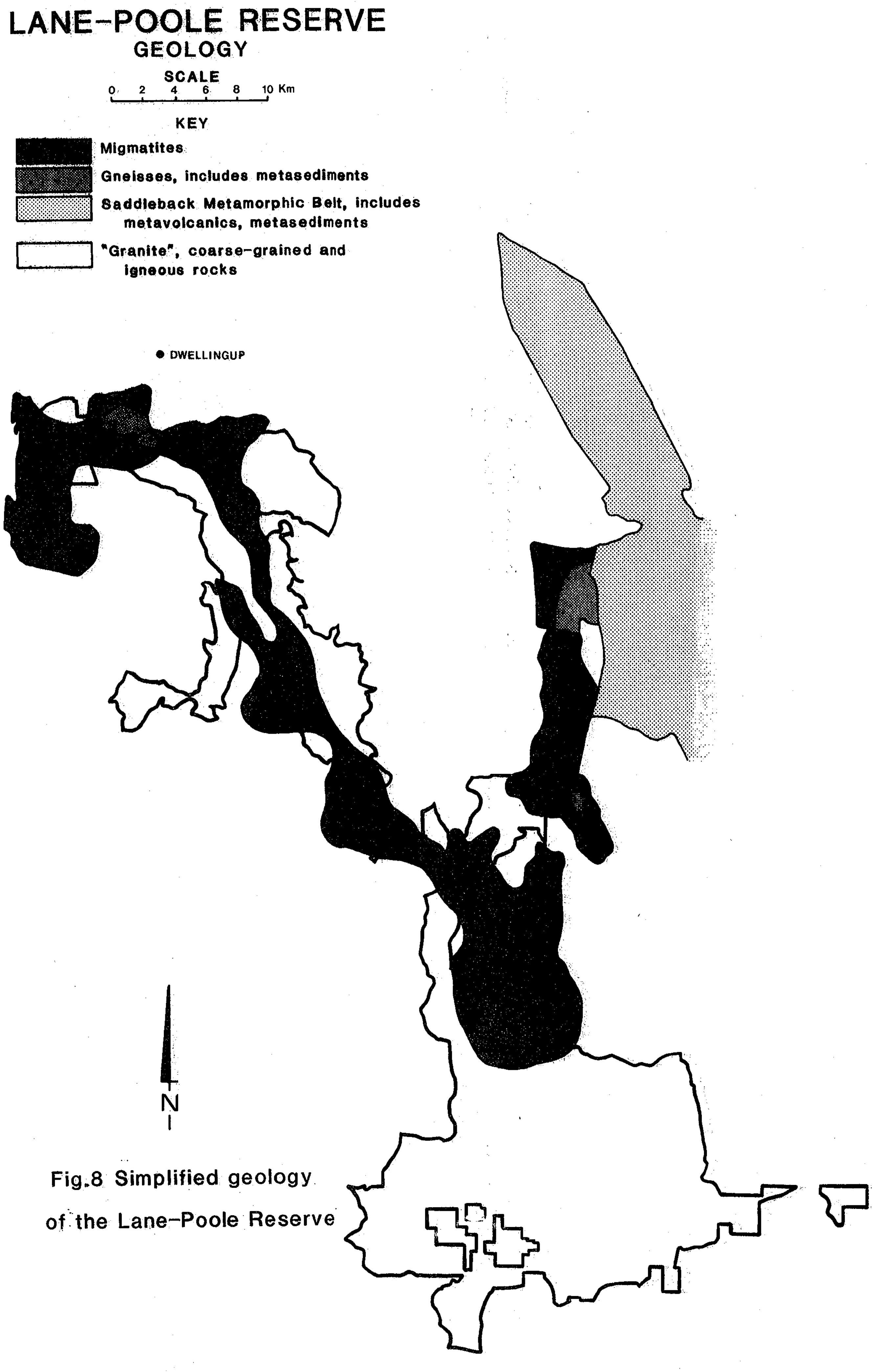

Fig.8 Simplified geology of the Lane-Poole Reserve

Archaean gneissic rocks occupy a small part in the north of the Reserve, and a narrow but long discontinuous belt along the Darling Scarp. The main body of the reserve's northern part is occupied by migmatite rocks, exposed where the Murray River has eroded its valley. To the east of the Reserve occurs a belt of weakly metamorphized volcanic and pyroclastic rocks with minor sediments, extending from Mount Saddleback to Mount Wells.

The basement rocks are intruded by many dolerite dykes. Most of these have a NW-SE orientation with others nearly at right angles. They are a small but important geological element which controls soil type, geomorphological expression, river's regime and type of land use. There are several generations of dykes, ranging from Archaean to Proterozoic in age.

Subsequent to the older formation of the gently undulating surface, probably during the early Tertiary under a regime of high rainfall and temperature, surface layers weathered deeply, and strong pedological development into the deep upper horizons created a massive laterite layer. This laterization process, which was present upon the western erosion slope of the plateau and on younger deposits on the western margin of the Yilgarn Block surrounding this Reserve, has caused bauxite deposits as alumina-rich pockets within the laterite, particularly in the deeper and larger bodies.

These bauxite pockets cover less than 10% of the Reserve and surrounding area. Alcoa of Australia Ltd has mined bauxite since 1972 in surrounding areas in the north and west of the Reserve and Worsley Pty Ltd from 1982 east of the Reserve.

Abundant supplies of pisolitic laterite gravel for road making are available around the Reserve and many pits were opened up from time to time. Cemented laterite and granitic rocks available along the Darling Scarp and at selected localities further east were used in the past for home construction and are still occasionally used for foundations. In some surrounding areas are small pits for sand or claypits associated with drainage systems and lenses of clay connected with weathered granite and migmatite rock. These are suitable for ceramic and brick manufacture.

Gold was obtained in the area from chalcedonic quartz veins cutting Archaean gneisses, or in quartz-muscovite schist and associated quartzite. Extensive prospecting in some places adjacent to the Reserve occurred in the last 10 years of the last century and continued for the first half of the present century. Further discoveries of economic gold have been made in recent years associated with bauxite deposits.

A small east trending dolerite dyke near the Murray River, east-southeast of Spion Kop, contains vanadium-bearing titaniferous magnetite. Several dolerite dykes in adjacent areas also have a high vanadium content.

LANDFORM

The major geomorphological feature of the Lane-Poole Reserve is the Darling plateau. Average elevation of the plateau is about 300 m above sea level (asl) broken in some places by granite monadnocks which rise up to 478 m asl at Mount Keats, 464 m asl at Drivers Hill to the west, 575 m asl at Mount Saddleback and 547m asl at Mount Wells, north-east of the Reserve.

The Reserve comprises two contrasting tracts of land, each associated with a particular morphological feature. The southern tract comprises gently undulating Darling Plateau where highest summits are over 360 m asl and lowest point is about 220 asl. By contrast the northern part of the Reserve has deep valleys and steeper slopes of the Murray River system and associated tributaries. The highest point of over 370m asl lies only 8 km from the Murray River Valley. The lowest point is about 100 m asl and lies in the Murray River valley in the north of the Reserve.

The surface of the Darling Plateau consists of a mantle of weathered rocks which contain ferruginous and bauxite horizons developed in the upper part of the weathered mantle: these together make up the laterite profile. The mantle has been subject to erosional modification with consequent exposure of various weathered and unweathered materials, and from movement and sorting of detritus and cementation. On this basis the landscapes may be divided into Lateritic Uplands, Minor Valleys and Major Valleys, with further sub-divisions based on morphology (Fig. 9). For further detail refer Department Conservation and Environment (1980).

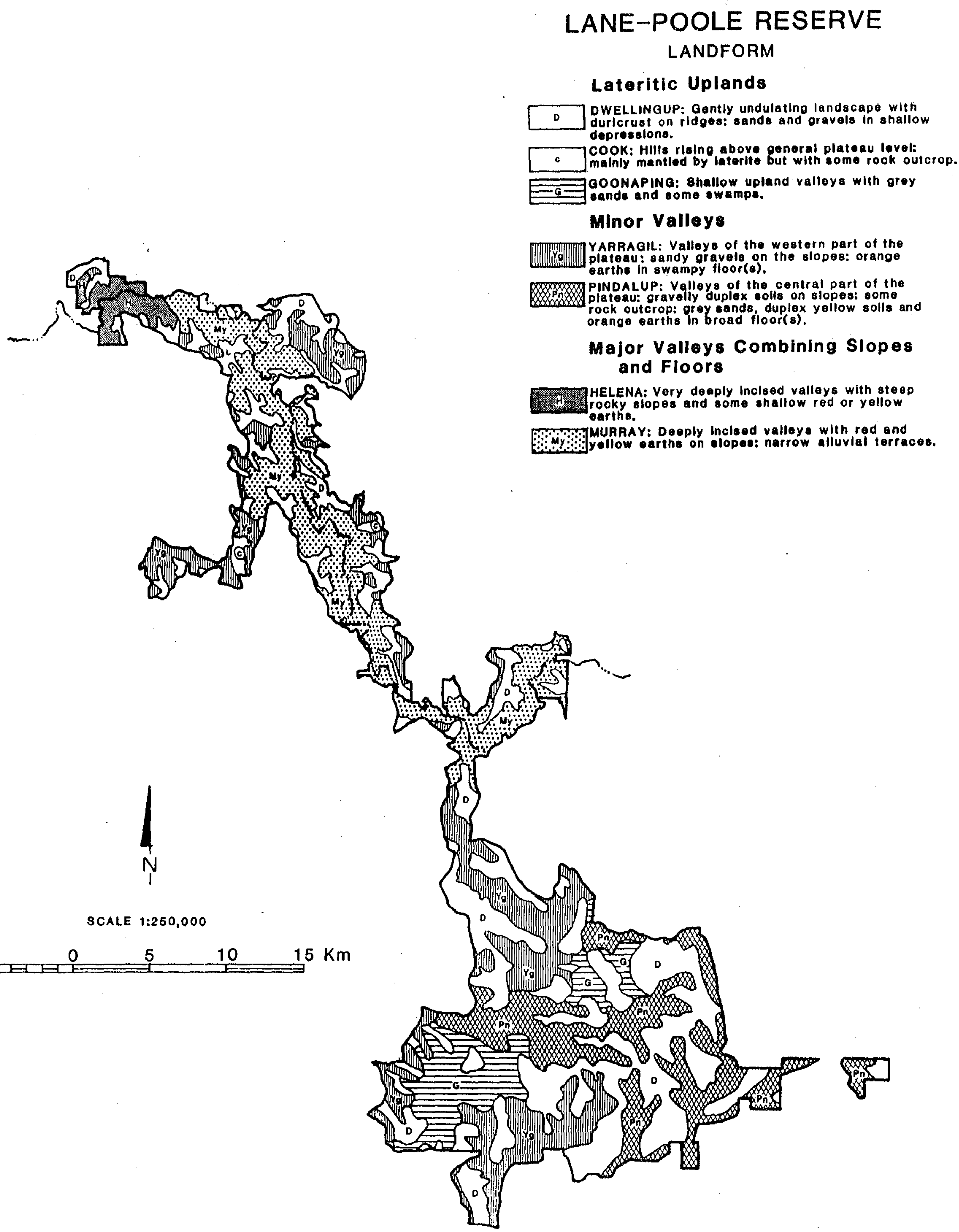

Fig. 9 Major landform types of the Lane Poole Reserve

The LATERITIC UPLANDS are dominated by duricrust, gravels and sands formed on a gently undulating surface. Several hills (the COOK unit as defined by the Department of Conservation and Environment 1980) stand above the general level up to 50 m with some rock outcropping. The main laterite surface is the DWELLINGUP unit, a gently undulating landscape with an elevation of about 250-300 m asl and with duricrust on ridges. Sandy landscapes are represented by the GOONAPING unit occurring as shallow depressions at the heads of drainage lines in the southern part of the Reserve.

MINOR VALLEYS include slopes and floors of up to fourth order streams. Along with other morphological features, they have a clear NW-SE lineation. This is related to dominant structural elements of the basement rock and erosional modification to the weathered mantle. The YARRAGIL unit consists of narrow, flat, swampy floors up to 200m in width. Slopes are less than 5°, with deep colluvial deposits of gravelly sand or gravel about 3 m in depth. The PINDALUP unit extends to the east and south-east part of the Reserve and has moderate slopes broken by erosion scars producing steeper elements with some rock outcrops and broad valley floors up to 400 m in width. It often has well developed drainage channels.

The MAJOR VALLEYS, including slopes and floors, occur in deep dissections of the Plateau. Further subdivision is based on local relief, steepness, rockiness and nature of the valleys. The HELENA unit extends between the Murray and the Darling Scarp units, occupies the deepest entrenchments and may have slopes up to 30° and about 200 m of relief. Rock outcrops are common on the slopes and beds. This unit occupies only a small northern part of the Reserve. The main body of the northern part is occupied by MURRAY unit which occurs upstream from the Helena unit. This unit has 90-120 m relief, steep slopes up to 15° and overall width of 2-3 km. A narrow sandy terrace occurs at about 10 m above water level. Rarely lateritic spurs extend from the upland to the alluvial terrace. In some instances, the laterites near the valley floor contain waterworn pebbles and boulders. Rock outcrops are common mostly in the bed of the river, together with dolerite dykes.

West from the Reserve toward the Darling Scarp, the surface form and linear valleys drop steeply from the ridge to the bed of their valleys. Slopes can be greater than 20°. The relief of over 200m above the level of the Swan

Coastal Plain is the result of marine erosion in the Tertiary and appears to have removed an earlier extensive blanket of Cretaceous sediment.

To the east from the Reserve, the lateritic crust has been extensively breached and reduced to mesaform remnants. The country generally is more hilly and undulating but the valleys are broader and their slopes more gentle, with swampy valley floors in some places.

The southern tract of the Reserve has gently undulating landscape and is covered by jarrah forest. The northern part contains a great variety of landscapes with recreational and aesthetic value. The most striking are the Murray and Helena units which have scenic attributes and ideal conditions for canoeing, fishing and hiking. Large rock outcrops occur sporadically and are favoured for recreational activities. Even in the drier areas the high run-off from these rocks provides a moist environment which may support unusual plant and animal communities.

Fig. 10 presents a computer constructed block diagram of part of the Lane-Poole Reserve and illustrates a typical view of the local landform.

PART C: SOILS OF LANE-POOLE RESERVE

R. HULAJKO

GENERAL

Soil formation in the Lane-Poole Reserve is influenced by the between valley ridges (interfluves) which are extensively occupied by a laterite mantle and by valleys showing morphology and soil development dependant on the amount of local relief, degree of stripping of the weathered mantle and the geological nature of the substrate.

Soils on LATERITE UPLANDS (refer to landform section in this Resource Document) have formed from weathering of the laterite duricrust and have been transported downslope by colluvial action and are free of salts and calcium carbonate. Profiles contain deep leached sand, with a pale yellow subsurface gradually changing to yellow sandy loam, often with yellow-brown pisolitic gravels. In some instances on gently undulating uplands, gravels are blackish with a matrix of grey sand. On crests and upper slopes duricrust

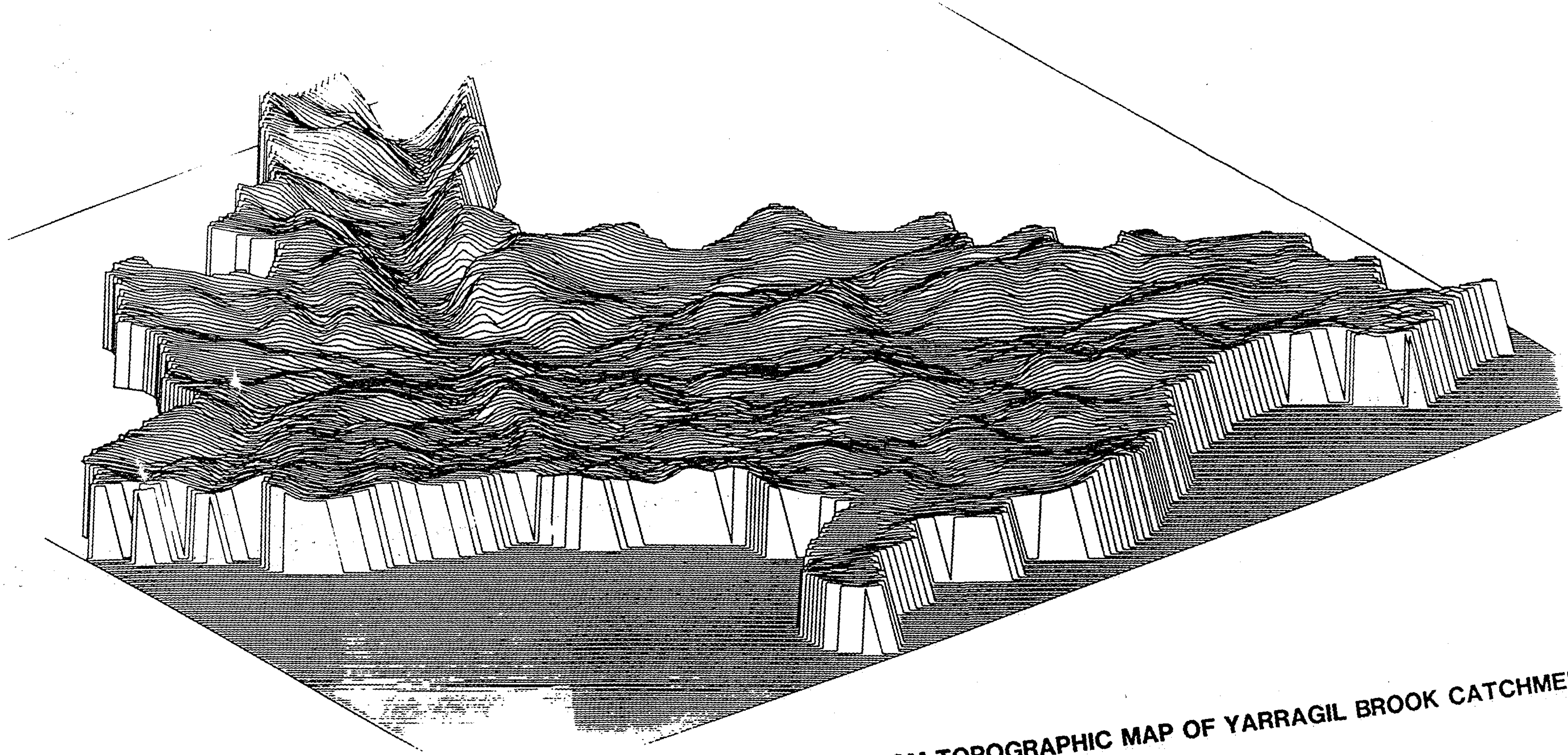

FIGURE 10 . BLOCK DIAGRAM, CONSTRUCTED BY COMPUTER FROM TOPOGRAPHIC MAP OF YARRAGIL BROOK CATCHMENT
Generated by the Public Works Dept and reproduced with their permission

outcrops or is covered in a thin veneer of sandy gravel. Where weathered granite rocks outcrop there is coarse sandy loam with kaolinitic clays and rock elements occurring in lower horizons. Downslope and extending into shallow depressions, the sandy gravel becomes deeper with some cementation in surface horizons (Profile 1).

The soil covering slopes of MINOR VALLEY UNITS is commonly lateritic gravelly colluvium. The characteristic feature of this soil is a bleached B horizon which is overlain by a darker coloured horizon containing organic matter. Quartz fragments identified in the lower profile are weathering products from the granitic bedrock. Above this is sometimes a steep erosion scar where the soil may be shallow and associated with rock outcrops (Profile 2).

PROFILE 1. Gravelly Earthy Sands

Depth (cm)	Horizon	Description
0 - 3	0	Organic Layer - leaf litter, twigs, grass.
3 - 6	A^1	Brownish black organic loamy sand, apedal, earthy fabric, laterite up to 70%, pH 6.0.
6 - 22	A^2	dark reddish-brown loamy sand, apedal, earthy fabric, laterite up to 70%, pH 6.0.
22 - 35	A^3	dark reddish brown sandy loam, apedal, earthy fabric, laterite up to 70%, pH 6.5.
35 - 80	B	reddish brown sandy loan, apedal, earthy fabric, laterite up to 70% pH 6.0.
80 - 200	C	Weathered granite

PROFILE 2. Earthy Sand

Depth (cm)	Horizon	Description
0 - 30	A	Brownish black loamy sand, apedal, earthy fabric, no stones, pH 6.0.
30 - 200	B	Bleached dark greyish yellow loamy and, apedal, earthy fabric, quartz fagments, pH 5.0.

Soils on the floor of Minor Valley units are variable and appear to relate to the parent material. If there is a high incidence of basic rock, the floor deposits are fine textured and the soil is a shallow brown or red earth. Over granitic exposures the soil is usually duplex in nature. On swampy floors, soils comprising organic matter to 30 cm deep, overlying a mottled clay or bright yellow or yellow-brown earth with textures changing from sandy loam to clay loam with depth. Sheets of bog iron-ore may occur at shallow depth. These soils are usually acid.

In the Murray and Helena units (Department Conservation and Environment 1980), the soil patterns on the valley slopes are very complex: the underlying rocks, consisting of acid granites and gneisses, are intruded by basic dykes giving rise to a variety of soils. Further, the lateritic detritus transported from the uplands is present in varying proportions. Finally the slopes, being very steep, are mantled with colluvium and and often include weathered and unweathered rock fragments and lateritic gravels. Red and yellow earths or shallow stony earths are the dominant soils but in some places pockets of deeper red and yellow earths occur.

EROSION HAZARD

The erosion hazard rating is a subjective assessment derived from interaction between soil erodibility, water erodibility, aeolian (wind) erodibility, the steepness and length of slope, vegetative cover and management of the site.

Soil erodibility is a function of soil texture, soil structure, aggregate stability, infiltration and permeability rate, and water holding capacity.

Rainfall erodability is related to the erosion potential of rain and is a function of intensity and duration of rain, raindrop size and impact.

Wind erodibility relates to velocity, frequency, magnitude and duration. Surface factors include characteristics such as density of plant cover, soil surface roughness and soil moisture status. Soil variables found to be important are particle size and cohesiveness, aggregate distribution and the amount of organic matter.

Slope steepness and length affects the velocity of run-off which in turn affects detachment and transporting ability of the run-off on soil particles. A long, steep slope will accumulate run-off thus increasing depth and velocity as a function of the flow becoming channeled.

Vegetative cover protects the soil surface from raindrop impact, wind blow and the transporting energy of run-off flows. A soil surface with bare patches between clumps of vegetation is more prone to detachment by raindrop impacts and run-off flows and lacks the plant root's holding ability of vegetated units.

Management of site has one of the major effects on erosional hazard. The natural site will be much less prone to erosion than a disturbed, unvegetated site. Consequently a landform unit with a low erosion hazard under natural conditions, may have a high or extreme erosion potential under disturbed conditions.

There are two types of erosion occurring within the Lane-Poole Reserve - natural and accelerated. Natural erosion is the detachment and removal of particles that occur under natural conditions. Accelerated erosion is the detachment, transport and deposition of material at a faster rate in disturbed areas. Under current management practices most of the Reserve area is undisturbed within the State Forest, except recreational areas along the Murray River valley and or small patches of agriculture land.

The distribution patterns of landscape elements, both in broad-scale and detail, are distinctive and may be examined in relation to the physical environment. The dominant pattern relates to the arrangement of valleys which reflect past erosional activity. It is of interest that those zones of stripping are parallel to rainfall isohyets, although no direct relationship is inferred.

The course texture and apedal structure of the Dwellingup and Yarragil units give a high rating of erodibility following disturbance. With disturbance of these soil types the soil erodibility rating will increase to high or extremely high levels. The swampy soils of the Goonarping and Pindalup units indicate low rates of erodibility. The Murray and Helena units have moderate rates of erosion, but the possibility of disturbance of the natural environment is high and consequent relative erosion processes would be high (Tab. 2).

TABLE 2 Erosion Hazard Ratings

Landform Unit	Erosion Hazard Rating (from Dames and Moore, 1984)
Dwellingup	High
Yarragil	High
Murray and Helena	Moderate
Goonaping	Low
Pindalup	Low

PART D: HYDROLOGY OF LANE-POOLE RESERVE

R. HULAJKO

GROUND WATER CHARACTERISTICS

The permanent water table has been identified in upslope locations at about 15-20 m below ground surface, but in some places exceeds 30 m. Large variations of water table of up to 4 m in seasonal response occur between years. In locations high in the landscape the depth of the transmission (unsaturated) zone is over 20 m, and the seasonal response is smaller.

The recharge of permanent groundwater depends on topography and porosity of surface weathered layers. Much of the early rainfall excess, particularly during May, is either intercepted by forest vegetation or stored in the soil profile, thereby reducing the soil moisture deficit developed during the previous dry summer months. Infiltration through the transmission zone and recharged groundwater storage occurs only after the most intense rainfall, and often creates a perched water table developed above the permanent groundwater system. However, the perched water table readily infiltrates between the gravel and subsoil clays and in winter months reaches the permanent water table.

Groundwater recharge has been estimated to range between 1% of rainfall from high in the landscape, where depth of the unsaturated zone is large, up to 9% in the lower slopes where the water table is much closer to the surface. The average for the hillslope transect is about 4%. This value is for areas with 1100 mm rainfall and decreases with decreasing rainfall (Loh, Hookey and Barrett, 1984). In general the capacity of groundwater in the Reserve is small, because the weathered layer is approximately 50 m deep. Deeper resources of water in the older geological formations have not been recognised.

In some down-slope positions the saturated soils create wetlands adjacent to water courses. Close to streamlines saturated groundwater system discharge into first or second order stream channels in winter and spring, but in summer and autumn the water table drops more than 2 m below the stream bed in most streams. Streamflow response to storm rainfall is generated from direct rainfall on these saturated areas and other impervious areas adjacent to streamlines.

SURFACE WATER

Rivers and streams draining the Reserve belong to two major catchment systems. The Harris and Bingham Rivers of the northern part of the Collie River catchment drain the southern part of the Reserve. The northern part of the Reserve is drained by stream networks of the Murray River catchment. The stream network for both catchments are different. In the southern part all streams drain <u>out</u> of the Reserve into the Collie River system. In the northern part all streams flow from the surrounding areas <u>into</u> the Reserve, to the Murray River Valley. A small part of the Reserve (Samson MPA) is drained by a network of streams flowing into the Samson Dam (Fig. 11). The watershed between the Collie and Murray catchments is located on clearly defined ridges and summits in a roughly west-east direction. The watersheds of the Murray River catchment are also clearly defined.

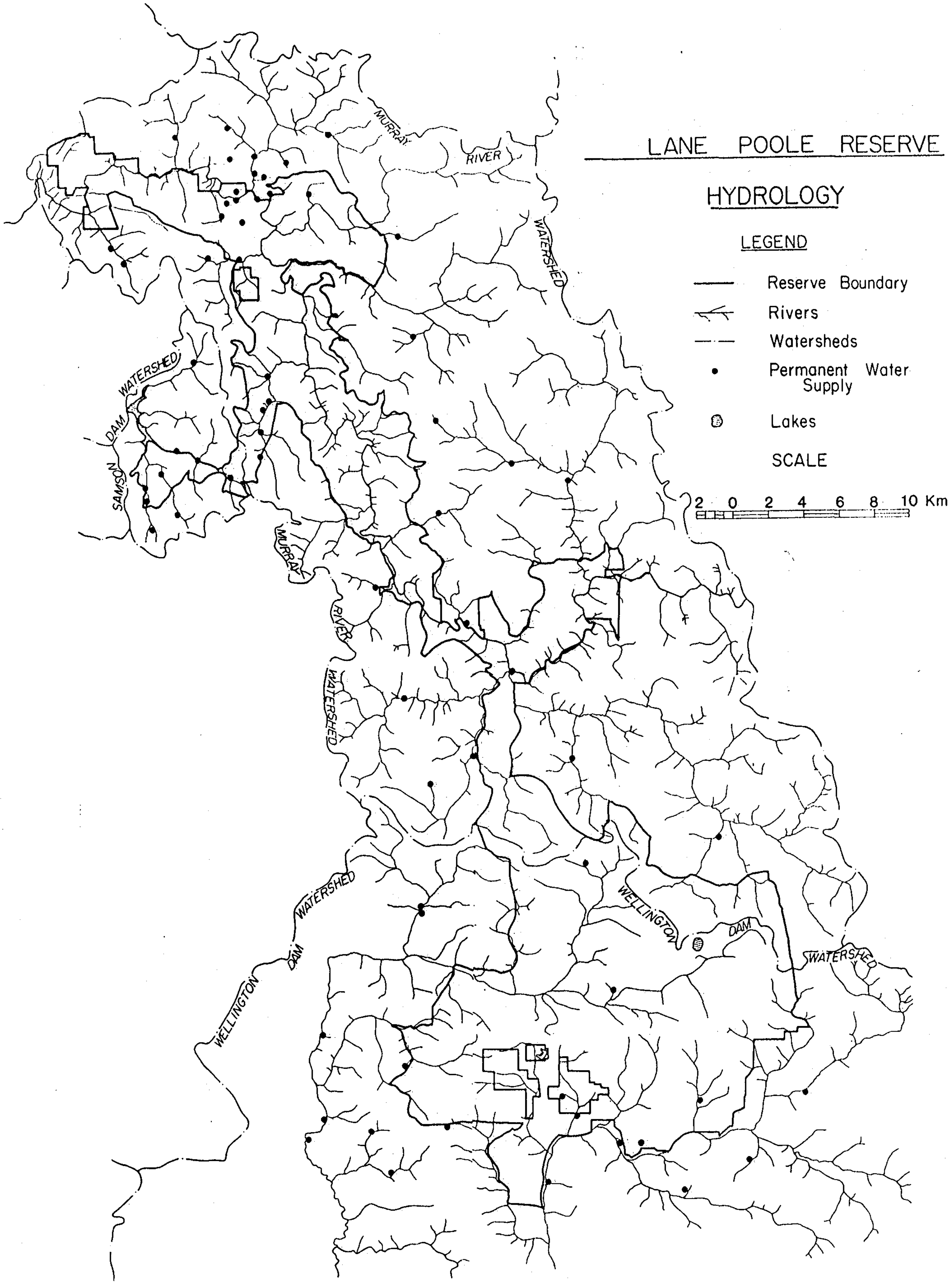

Fig. 11. Catchment boundaries, water courses, permanent water supply points and lakes

Annual rainfall-streamflow relationships cause streams up to fourth order to be intermittent. These streams exist seasonally with peak flows occurring during the winter and spring and maximum flow in July or August. They reduce flow drastically with decreasing rainfall across the Reserve. Many of them dry up before the end of summer, with minimum flow in February or March. However, in others flow is maintained by seepage from groundwater. Bigger western tributaries of the Murray River, which flow from the Darling Scarp toward the east are perennial (Table 1). They flow during the summer in some years; in other years exist partially as a series of pools or swampy areas along valleys.

Within the Reserve, there are many pools along stream channels, where water is available for fire protection. The water is very often fresh and is suitable for drinking purposes. These pools are marked on topographic maps 1:50,000 published by the Forests Department and reproduced approximately on (Fig. 1).

The Murray River is irregular with sharp bends and many loops indicating directional control by rock composition and structure. Rock bars in the form of dolerite dykes occur sporadically along the river bed and these produce a series of rapids and deep pools. The Murray River flows during the whole year, but in summer months (February, March) it flows an average 100 times less water than in winter months (July, August).

The average volume of flow from the Reserve is low, rarely being over 25% of rainfall. This is because of the tall forest, where dense canopy causes high water storage and also high transpiration and interception evaporation.

The southern tract of the Reserve contains two natural lakes, Nalyerin Lake and Yourdamung Lake, and several broad swampy flats. The lakes evaporate to dryness in the summer and exist only in the wet season. They are however the only lakes of their type in the northern Jarrah Forest. To the west from the Reserve exist several artificial water reservoirs, but they are not connected to the Reserve's water system, except for the Samson Dam.

HYDROLOGICAL MANAGEMENT

Management of the entire catchment of the Murray River is an important future consideration. The conservation and long term planning of the land in the

RIVER \ FLOW RANGE m³/sec	NO RECORD	0.00	0 - 0.01	0.01 - 0.1	0.1 - 1.0	1.0 - 10.0	10.0 - 100.0	100.0 - 1000.0
MURRAY RIVER	15.81	0.0	0.08	19.69	67.28	123.11	64.46	6.63
BELL BROOK	0.00	178.72	56.55	46.32	74.41	8.94	0.33	0.0
HARRIS RIVER	6.7	9.28	102.56	74.25	74.34	79.78	17.6	0.73

RIVER \ FLOW RANGE m³/sec	NO RECORD	0.00	0 - 0.0015	0.0015 - 0.015	0.015 - 0.15	0.15 - 1.5	1.5 - 15.0	> 15.0
YARRAGIL BROOK	41.22	82.58	15.78	54.16	99.76	66.79	4.96	0.0
DAVIES BROOK	17.93	3.13	9.69	58.88	129.04	137.05	9.52	0.0
BIG BROOK	86.19	0.06	0.16	5.12	95.8	128.42	49.5	0.0
CHALK BROOK	2.09	53.51	3.12	34.58	116.5	128.9	12.85	0.0
BINGHAM RIVER	38.38	9.67	103.49	59.12	72.91	46.91	29.98	0.33

Table 1. Flow duration (days/annum)

catchment has serious influences on the quality and quantity of water down-stream which discharges into the Peel Inlet and which affects human activities as well as aquatic flora and fauna.

The Murray River catchment is controlled by the Metropolitan Water Authority for water supply purposes for the metropolitan area of Perth. The Authority has proclaimed the Murray River catchment, approximately situated between Dwellingup and the Hotham and Williams confluence, to be a water Reserve and it may be developed (dammed) around the year 2000. There are several damming options available which may affect the water from the Murray River or only from tributaries. If any of these proposals came to fruition, the reservation value of the ecosystem would be greatly changed.

SALINITY

Salt as dry dust or dissolved in rain water in very low concentration is continuously transported inland from the Indian Ocean, and falls onto the landscape proportional with distance from the coast and with rainfall. These salts, together with others derived from the weathering of rock minerals, have resulted in the accumulation of salt in soils and groundwater.

For undisturbed areas the approximate balance between incoming and outgoing salt in the surface soils is equal. It has occurred over thousands of years during which time salt out-flow documents to the water-table equalled salt in-flow and a gradual accumulation of salt in the lower soils and groundwater resulted. As a consequence, the salinity of permanent groundwater systems, both in value and ratio, increases from high to low rainfall i.e. from west to east.

The natural balance is maintained by deep rooted forest vegetation which transpires large quantities of moisture throughout the year. Any activity such as land clearing for agriculture or mining in the eastern zone of the forest, which allows large quantities of water to infiltrate through the unsaturated zone, have the potential to raise the groundwater table. This can initiate a gradual release of accumulated salts within the landscape to the surface of the lower landscape, and from there to the stream system.

Major increases in stream salinities have been caused by agricultural development, where extensive clearing represents a removal of existing deep rooted vegetation. Consequently, the rivers and streams flowing from the wheatbelt have much more salty water than forested stream networks. The water in the Murray River is much more salty than its forested tributaries, a result of receiving very salty water from agricultural tributaries, such as the Hotham and Williams Rivers (Tab. 2). Water in the Murray River indicate higher average salinity than in other large rivers in the south-west such as the Blackwood River and Collie River.

Bauxite mining involves the clearing and subsequent revegetation of areas of forest which average 20 ha per mine pit. Currently Alcoa of Australia, Ltd are legally required not to mine in eastern areas of the forest until it can be shown that mining will not significantly affect the salinity of water resources, through either clearing or spread of dieback disease. This legal agreement is designed to ensure that the conservation values of freshwater streams will be retained.

EUTROPHICATION AND TURBIDITY

Eutrophication processes occur by increasing levels of phosphate content in water from agricultural areas. This process causes rapid growth of the algae, which depresses oxygen levels at night, followed by fish kills and finally decay with accompanying odour. Phosphorus, faeces and fertilizers such as nitrogen from the wheatbelt flow into the Murray River via the Williams and Hotham Rivers. The ratio of nitrogen to phosphorus is usually greater than 17:1 (the ratio in algae tissue).

Most nutrients (nitrogen and phosphorus) flow into the river in winter, during periods of high overland flow. The relative contribution of the nutrient loading from year to year changes depending on rainfall. The nutrient content noted in the water of the Murray River for the "Peel-Harvey Estuarine System Study" amounts to 1153 tonnes of nitrogen and 25 tonnes of phosphorus in 1978 during a season of high rainfall. The following year, when rainfall was low, the loading of nutrient was much smaller - nitrogen 110 tonnes and phosphorous 4 tonnes (Department of Conservation and Environment 1981).

River	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL	TSS salinity mg/l
Murray River	5.78	o.98	0.88	1.84	5.46	53.5	101	101	35.8	16.9	5.71	3.18	331	1680
Yarragil Brook	0.016	0.003	0.002	0.007	0.058	0.64	1.28	1.23	0.60	0.40	0.099	0.033	4.38	410
Davies Brook	0.11	0.058	0.048	0.11	0.30	1.23	1.90	1.99	1.18	0.89	0.42	0.21	8.43	210
Big Brook	0.35	0.28	0.17	0.26	0.95	3.3	7.0	6.31	5.13	4.34	1.72	0.82	30.6	no data
Chalk Brook	0.14	0.03	0.03	0.06	0.25	1.28	2.11	2.06	1.24	0.85	0.33	0.12	8.49	310
Bell Brook	0.00	0.00	0.00	0.00	0.00	1.13	0.99	0.82	0.69	0.39	0.01	0.00	4.03	270
Williams River	2.61	0.39	0.34	0.48	1.73	12.6	20.5	18.9	6.49	2.69	0.83	0.20	67.8	2800
Hotham River	2.27	0.14	0.15	0.31	1.84	18.0	34.4	31.6	9.48	3.92	0.89	0.19	103	3400
Collie River	4.92	0.24	0.22	0.52	1.38	10.6	29.7	35.1	13.1	10.8	2.46	0.49	110	890
Harris River	0.09	0.02	0.02	0.05	0.56	6.15	11.9	11.6	6.36	4.11	1.28	0.41	42.6	250
Bingham River	0.00	0.00	0.00	0.00	0.14	1.38	557	7.25	2.74	1.02	0.12	0.00	18.2	220
Blackwood River	16.4	2.79	1.21	2.07	5.85	53.5	190	228	92.6	47.4	14.9	4.72	659	1200
Harvey River	9.12	8.97	7.24	1.52	1.51	3.19	4.6	4.45	9.16	33.3	5.17	8.41	96.6	190
Serpentine River	0.49	0.21	0.18	0.44	0.83	6.67	13.6	15.6	7.04	5.86	1.87	0.782	53.7	195

Table 2. Stream flow rate (millions cu. metres) and salinity (mg/l)

Nutrient content, which causes nuisance algae blooms, and other factors such as salinity and clay-silt content, cause increased water turbidity. Higher turbidity causes greater concentration of the heating effect closer to the surface, less light at depth, and determines concentration and mixing of oxygen in bottom waters thus affecting aquatic flora and fauna. These factors occur mostly in the Murray River pools where water recharge in summer has a very small range.

PART 5: VEGETATION AND FLORA OF LANE-POOLE RESERVE

B. MUIR

GENERAL DESCRIPTION

Smiths (1974) map gives a good overall perspective of the Southern Conservation Zone of the Reserve. He described the uplands as an intimately mingled mosaic of Jarrah, (*Eucalyptus marginata*), Marri (*E. calophylla*) with some Bullich (*E. megacarpa*) and Blackbutt (*E. patens*). Some valleys have Paperbark (*Melaleuca* species) swamps.

Structurally, Smith (using Specht's 1970 classification) considers most of the plateau to be covered in Open Forest (trees 10-30 metres tall, 30-70% canopy cover) with the Bullich - Blackbutt stands to be High Open Woodland (trees above 30m tall and less than 10% canopy cover). The wetland areas along watercourses he considers Open Heath (less than 2 metres tall, 30-70% cover) with paperbarks either as Low Open Woodland or Low Woodland (below 10 metres tall and less than 30% cover). Lake Nalyerin is recorded as Closed Sedgeland with 70-100% cover.

Beards (1979) map covers the northern portion of the Reserve but is less detailed. From examination in the field, it is considered that Smiths (1974) physiognomic descriptions apply equally to the northern portion.

Heddle *et al*. (1980) consider the Murray Valley to be vegetated with "Murray Complex" in medium to high rainfall with several other landform/vegetation types higher in the landscape. These are summarised, directly from Heddle *et al*. (ibid) in Appendix 3. Ten vegetation types are considered to occur in the Reserve. Using the Heddle *et al*. (1980) map, estimates can be made as to what proportion of the Reserve is covered with each type.

Table 3.

		Vegetation Type	Percentage cover in the LPR
Type	1	Dwellingup-Hester	10
	2	Dwellingup	6
	4	Dwellingup-Yalambee-Hester	11
	10	Yarragil (minimum swamps)	9
	11	Yarragil (maximum swamps)	11
	12	Swamps	8
	13	Pindalup-Yarragil	12
	17	Helena	2
	20	Murray	20
	21	Murray-Bindoon	11

Of these types only one, Helena Complex, is relatively poorly represented. This vegetation type is regionally scarce, being entirely absent north of Perth but with scattered pockets along the Scarp edge between Wattle Grove near Perth and south to the Collie River. It is not very well preserved although the north-eastern edge of Serpentine National Park borders one of the smaller occurances and Lennard MPA has some large areas. The Lane-Poole Reserve includes nearly 1,000 ha of this vegetation complex and therefore contains one of the few representative area of this vegetation currently reserved.

An important vegetation type scarce in the Lane-Poole Reserve is the Cook complex granite outcrops. Granitic monadnocks with their associated, often unique, flora and fauna are only well represented elsewhere in the Monadnocks Reserve, although they are relatively widespread in state forest, particularly between approximately the latitude of Perth, south to about the latitude of Harvey. Numerous small outcrops occur within the Lane-Poole Reserve, but the largest are at Tumlo Hill and Mount Keates outside the boundary.

The largest single outcrop of granite in the Reserve, in Plavins Block, should be protected from disturbance. This site has a well developed low woodland of <u>Casuarina huegeliana</u> with marginal dense heaths or thickets of <u>Leptospermum erubescens</u> and <u>Acacia</u> spp. Similar vegetation, more reminiscent of the wheatbelt, has not been observed elsewhere in the Reserve.

The LPR contains fine stands of Bullich (<u>Eucalyptus megacarpa</u>) woodland, the best stands being in Federal and Keats blocks. This association is not well represented elsewhere in conservation management priority areas within the forest, or in other reserves. Special effort must be made to retain the integrity of such stands. Wandoo (<u>Eucalyptus wandoo</u>) is poorly represented in the Reserve, being found mainly in Stenes and Bell Blocks, although it is well represented in nature reserves to the east. A stand of Eucalyptus decipiens in the south-east of the Reserve is unusual in that this species is normally coastal.

Of particular interest and significance are wetland vegetation types which occur in ephemeral creeks and along larger water courses as well as at Lake Nalyerin. This vegetation type is extremely variable, ranging from Banksia littoralis woodlands to Melaleuca raphiophylla woodlands, Dodonaea thickets and complex heaths. A large stand of wetland heath dominated by Actinostrobus pyramidalis occurs on the Harris River. A. pyramidalis is scarce on the Darling plateau although widespread on the coastal plain. Wetlands of these types should be zealously protected from disturbance. They are also highly susceptible to dieback disease. Forest protection tends to lead towards greater (ofter deliberate) washdown of vehicles into watercourses, and deliberately putting roads low in the landscape profile. Although such actions assist in protecting the forests, they may place susceptible wetlands at greater risk.

WETLANDS

It is a general philosophy that wetlands are vitally important parts of any ecosystem, by providing suitable habitat for transient species such as migratory water birds as well as providing unique and specific habitats for many plants and animals. Many species of flora and fauna are unable to exist in the more widespread but less hospitable habitats such as forest.

Wetlands on the Swan Coastal Plain near Perth have been drastically reduced. Seddon (1972) points out that 49% of all wetlands between Yanchep and Rockingham had been destroyed by 1966, 31% between Rockingham and Harvey and 96% between Harvey and Dunsborough. This process has continued, until by 1982 more than 80% of wetlands between Yanchep and Rockingham had been destroyed and an equivalent increase appears to have occurred between Rockingham and Harvey.

The story of wetland destruction has continued on the Darling Plateau, but to a lesser extent. In the region of the Lane-Poole Reserve, creation of the Waroona, Samson and Stirling Dams as well as the Worsley Alumina Refinery dam and several smaller dams have altered stream characteristics downstream from the dams. If proposals to dam the Murray River eventuate, it too will be grossly changed in the vicinity of the Reserve.

Apart from damming, salt and fertilizers applied to agricultural land to the east of Lane-Poole Reserve have altered, by eutrophication, the river's chemistry and will undoubtedly continue to do so. The view has therefore been taken that all existing wetlands either completely undisturbed by man's activities or even if altered, as is the Murray, are vital components of the ecosystem of the Reserve. Every effort is necessary to retain their integrity, and if possible reverse any detrimental trends observed to arise from human interference.

Five types of wetlands occur within the Lane-Poole Reserve: the Murray River, ephemeral to semi-permanent streams, swamps in the headwaters of streams, flats in broad sections of watercourses and Lakes Nalyerin and Yourdamung.

THE MURRAY RIVER

The Murray River is brackish, with a mean total dissolved salts of 1680 mg/litre. This level increases during the summer period when evaporation is high and decreases during winter when freshwater flushes the river system. Water flows down the river at an average rate of 331 million cubic metres per year, and runs constantly throughout the year. Maximum flow rates of up to 718 cubic metres per second have been recorded. These figures set a scene of a basically fresh to brackish river, nearly always flowing, and with seasonal flushes which may be intense and temporarily destructive in terms of riverine vegetation. Consequently riverine flora tends to be ephemeral, with strong annual development of herbaceous species, or resistant to strong flows as are <u>Eucalyptus rudis</u>, <u>Melaleuca raphiophylla</u> and other woody species. Such vegetation types accordingly tend to be fairly resistant to man-made disturbance and will persist along the river's edge even in areas of fairly high recreational pressure.

Some riverine vegetation on the immediate waters edge, such as <u>Dodonoea</u> sp. tend to be displaced rapidly by Blackberry. A zealous and continuous control programme to eradicate Blackberry is needed to prevent loss of river-edge species.

The only truly aquatic plant species so far recorded in the Murray River are Triglochin procera and Myriophyllum sp.. T. procera occurs mainly near rapids or where flow rate is moderately high, the Myriophyllum in quieter areas and backwaters. There is evidence to suggest that some species such as Myriophyllum have the propensity to multiply in an uncontrolled manner if water-borne nutrients increase. With much of the headwaters of the Murray River lying in agricultural land the potential may exist for Myriophyllum to become a pest species.

EPHEMERAL AND SEMI-PERMANENT STREAMS

These wetlands vary from dry, stoney drainage lines with little or no vegetation changes distinguishable from adjacent forest but carrying surface streams after heavy rain, through to deep, well defined gulleys with cool, moist banks and abundant development of ferns, mosses and other moisture loving species. The latter streams may flow more-or-less continually in some years, being fed from springs or soakages along their length. As a general rule such watercourses are narrow and steep sided, thus providing only a relatively narrow "creekside" habitat. Such habitats are not generally useable by larger vertebrate fauna but are important for invertebrates and provide rich feeding areas for birds and other animals which normally occupy the forest but forage in the creek lines. Localised patches of Banksia littoralis in such habitats may provide, for example, abundant nectar and pollen during summer and autumn when other nectar sources are less.

SWAMPS IN THE HEADWATERS OF STREAMS

Springs and soakages occasionally occur at the source or along the length of streams. Such areas are in effect broader sections of the habitats described for the ephemeral and semi-permanent streams but here they are large enough to be utilised by larger fauna. Occasionally these swamps may be of considerable size in which case they are often dominated by Bullich (Eucalyptus megacarpa) stands over an understorey of sedges (often Ledpiaosperma spp.). Banksia littoralis is frequently abundant on the swamp edges, together with scattered Melaleuca preissiana paperbarks.

Bullich dominated swampy areas are an important feature of Samson and Federal blocks. Frogs and other fauna of moist habitats are common in these areas and several are known to contain substantial populations of Quokka (Setonix brachyurus).

FLATS IN BROAD SECTIONS OF WATERCOURSES

These flats are of heathy rather than swampy appearance, for although seasonally waterlogged, soils are sandy and well drained but may be underlain by clayey "coffee-rock". Some salt influence is frequently seen and halophytic species may occur in patches or scattered amongst the heath. Depending on moisture conditions portions may also be locally sedgey or extend into areas of open-woodland of Banksia.

The heathy vegetation layer is frequently quite rich in species, and may have emergent above it Swamp Cypress (Actinostrobus pyramidalis) or Woody Pear (Xylomelum occidentale). Swamp Cypress is uncommon in the Darling Range, being known only from the Harris River within the Reserve, and in Gunapin Management Priority Area on the Darkan River, although it does occur in localised patches on the Swan Coastal Plain. Woody Pear is widespread in the South-West but is poorly represented in forests on the Darling Plateau. Its occurrence in the flats are its main populations within the Reserve.

LAKE NALYERIN (and Lake Yourdamung)

Lake Nalyerin is the only freshwater lake per se which occurs within the Lane-Poole Reserve. The Lake and surrounds have a variety of soils supporting a swamp complex ranging from sedgelands to open woodland of paperbark (Melaleuca preissiana) and Swamp Banksia (Banksia littoralis). A stand of Eucalyptus decipiens, rare in the area, is also present.

Portions of the lake which are deepest in winter (the lake is ephemeral) have sedgelands of Beaumaea articulata and the shallower areas Lepidosperma sp. and Leptocarpus spp. Clumps of Melaleuca lateritia exist and some Eucalyptus rudis are present on the margins. Evidence of a lunette dune on the east side suggests that the geomophological origins of the Lake may be more complex than at first apparent.

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	Number of Taxa
Harris River Dam Catchment (partial list)	186
Worsley minesite study	506
Forests Department list	455

It should be borne in mind, as stated above, the Harris River Dam study covers but a small part of the watershed and was a short-term study. The Worsley study was longer in duration, and covered an area laying in the transition zone between the jarrah forest and the wheatbelt and thus contains elements of both. The Forests Department list was general and did not include many species which were ephemeral, scarce or unsuitable as vegetation site indicators.

Speculating from the available data there are probably 500-700 species of plants within the Reserve, most being fairly widespread and recorded elsewhere.

FLOWERING TIMES

Flowering times have significance for both tourism and for conservation, as they represent peak time of nectivore activity and sustainance for nectivores during leaner seasons. In the latter context knowledge of flowering times may suggest the importance certain plant species play in nectivore survival. Flowering data also give an indication of when seed set is likely to occur.

FLOWERING TIMES - THE RESOURCE

A flowering calendar is available from Worsley Alumina Pty Ltd (1985) and can be summarised as follows:

Only 220 taxa were listed:

Table 4a

Month	No of Flowering Species
J	6
F	15
M	4
A	10
M	0
J	0
J	9
A	12
S	61
O	31
N	61
D	15

Peak flowering was from August to December.

Further information is available from Majer (1981) for Karragullen, in the northern Jarrah forest about 70 km north of the Lane-Poole Reserve. Majer recorded 102 species flowering during his study, with peak flowering in October. Only one species, Adenanthos barbigera flowered continuously throughout the year. Majer (ibid) did not separate post-fire from non-post-fire flowering species in his calendar, but on the assumption that some burnt areas will usually occur in the region, this has been ignored. The calendar with number of species is set out below:

Table 4b

Month	No Species
J	15
F	13
M	13
A	9
M	7
J	6
J	5
A	31
S	24
O	45
N	19
D	26

It would appear that flowering is much more evenly distributed throughout the year at Karragullen but the peak still lies in spring.

Majer also recorded that 40 of the 102 species flowered within one year of a fire. Majer states that families which flowered prolifically in the burnt area were Asteraceae, Apiaceae, Cyperaceae, Goodeneaceae, Liliaceae, Lobeliaceae, Orchidaceae and Stylidiaceae. Many were ephemeral species and it should be noted that most members of those families are very poor nectar producers and are often poor in pollen. Flowering abundance may not therefore be an indication of nectar or pollen availability. Muir (1985 a and b) suggest that some species require up to 10 years after fire to reach peak nectar and pollen production e.g. Dryandra sessilis (common in the jarrah forest), and that plants arising from seed rather than rootstock may take 7 or more years to flower for the first time.

A list of species which flower during "the lean times" and which may be important to fauna during these periods are several in number, but some stand out in that they are prolific flowerers, highly productive in nectar or pollen, or sufficiently abundant and widespread to provide important sustainance. These are: Adenanthos barbigera, Hibbertia hypericoides, Agonis linearifolia, Mirbelia dilatata, Baeckea comphorosmae, Eucalyptus calophylla, Banksia littoralis, Hovea chorizemifolia and Hakea lissocarpha.

Little is known of the detailed biology or edaphic requirements of these species with the exception that Agonis linearifolia is dependant on wetlands, Mirbelia dilatata favours granite and Banksia littoralis favours wetlands and is killed by too frequent autumn fires. This suggests certain habitat types may hold more significance for survival of nectivores and pollen feeders during the lean months and that fire regimes and season of burn may have considerable influence.

CRYPTOGAMS

Cryptogamous flora e.g. ferns, mosses, algae, lichens and fungi, are of equal importance as vascular plants in terms of conservation. Although often ignored, these taxa are vital components in soil binding, nitrogen fixation, mycorhizzal associations with vascular plants, and in many other ways. Their survival and health may be vital in the overall well being of the environment, although this relationship is not well understood at present.

As is so often the case, cryptogams in the Reserve are poorly known. The Worsley study (1981) recorded the ferns Pteridium aquilinum, Lindsaea linearis, Adiantum aethiopicum and Cheilanthes tenuifolia of which they feel Adiantum is introduced. The Bracken (P. aequilinum) is widespread throughout the forest and greatly assists in binding the soil.

Mosses, liverworts and related taxa are very poorly known but are widespread and represented by numerous taxa. Their distribution is largely confined to watercourses, wetlands and deeper valleys but are much more widespread during winter.

Lichens have received much more attention, mostly in relation to monitoring atmospheric pollutants (Alcoa of Australia (WA) Ltd 1979a, b). These reports listed 72 recognisable taxa in 26 genera, a fairly diverse representation. The Alcoa Table of Lichens species is reproduced in Appendix 5.

Fungi are less well known in terms of this specific location, but are fairly well known for the jarrah forest in general. There is however little published information, the only definitive reference being Hilton (unpublished). Hilton points out that a great many of the jarrah forest fungi are mychorrizal and therefore essential to survival of those species with which they are associated.

Further points Hilton makes are that:

1. Several fungi are significant in helping to create hollows in standing and fallen trees and therefore are part of the process creating faunal breeding hollows, etc.
2. Certain species of fungi respond differently to various fire regimes, particularly season of burn, and several do not fruit except after fire.
3. Several species of fungi, _Rozites australiensis_ and _Cotinarius radicatus_ in particular, form part of the diet of some native mammals.

Current management practice probably preserves most fungal species, except that unseasonal or too frequent burning may disadvantage some taxa. If these taxa are significant, especially as mycharrhizal associates, their loss may lead to alteration of the environment either in terms of vegetation structure or species composition.

RARE AND GEOGRAPHICALLY RESTRICTED PLANTS

M. CAVANA AND B. MUIR

Gillen (1982) recorded 11 rare plant species as possibly occurring in the area. These are _Acacia subflexuosa_, _Aotus cordifolia_, _Conostylis setosa_, _Danthonia pilosa_, _Eucalyptus laeliae_, _Grevillea ripicola_, _Hibbertia nymphaea_, Lascopetalum bracteatum, L. cardiophyllum, Pultenaea skinneri, Senecio leucoglossus and Templetonia drummondii. Of these Eucalyptus laeliae is already known to be present in the Reserve.

The survey by Dames and Moore (1984) of the Harris River catchment states that another 8 species, Acacia flagelliformis, A. semitrullata, Adenanthos teges, Grevillea drummondii, Hemigenia microphylla, Stylidium rhipidium, Synaphaea pinnata and Tetratheca pilifera may also be present and that of these G. drummondii had in fact been found within the catchment. Similarly the Worsley Alumina Pty Ltd (1985) report considered five species present in their study area as rare. These were Boronia tenuis, Grevillea drummondii, Pultenaea skinneri, Lasiopetalum cardiophyllum and Thomasia glutinosa. They also consider another four species Gonocarpus cordiger, Lomandra hermaphrodita, Senecio leucoglossus and Templetonia drummondii as being vulnerable and another dozen or so as requiring further studies to determine their status.

In summary there is little doubt that the Lane-Poole Reserve has a high potential for preserving as many as 20-30 rare, restricted or poorly known plant species.

PART F: FAUNA OF LANE-POOLE RESERVE

M. CAVANA

INTRODUCTION

The Lane-Poole Reserve is situated in Western Australia's northern jarrah forest straddling the Murray River near Dwellingup. It stretches some 59 km from north to south and some 32 km from east to west at its widest point.

Several biological surveys have been conducted in the northern jarrah forest although few actually within the Reserve. There is a need for a basic understanding and knowledge of the reserve's fauna, their behaviour and abundance, and for this reason an extrapolation of previous studies pertaining to the northern jarrah forest has been utilized in the compilation of this review.

The Murray River is the last major undammed river valley in the northern jarrah forest and in the declaration of the Lane-Poole Reserve only one quarter of the Reserve was zoned for recreation, the remainder being zoned for conservation.

HABITAT TYPES

The vegetation of the northern jarrah forest has been extensively studied and documented by numerous researchers (Smith, 1974; Havel, 1975 a, b; Heddle et al, 1978; Kaeschagen, 1978; Beard, 1979: In Worsley Alumina Pty. Ltd. and Dames and Moore, 1981). At least twenty-five different vegetation communities exist in the Reserve, ranging from dense forest and woodland to river and stream communities, shrub and heathlands.

The survival of our native fauna has been under constant pressure since the arrival of European man. The natural dangers of wildfire, predation and disease have been compounded by several 'unnatural' disturbances in the form of clearing, mining, logging, protection burning and the damming of water courses.

Many species of mammal presently classified as rare or in need of special protection, such as the Woylie or Brush-tailed Rat Kangaroo (Bettongia penicillata) whose distribution spanned across southern Australia prior to the arrival of Europeans, have suffered drastic reductions in population numbers following the clearing of the land and introduction of feral predators. At present, the Woylie is restricted, in Western Australia, to the Perup and Dryandra MPA's in State forest (designated for Conservation of Flora and Fauna) and the Tuttanning Nature Reserve near Pingelly.

There are also several other expected, but unrecorded mammals, reptiles and amphibians. The apparent absence of these vertebrates does not however suggest their non-existence within the Lane-Poole Reserve, many being habitat-specific and possibly present in low numbers or scattered distributions.

The fish fauna of the Reserve are also not well known, but some species e.g. the Pouched Lamprey, are of interest as indicators of biological change occurring within the Murray River.

Invertebrate fauna of the Lane-Poole Reserve is believed to be both large and complex. It is discussed below, and the available invertebrate species lists are presented in Appendix 4.

FAUNA OF PARTICULAR INTEREST

Quokka (*Setonix brachyurus*)

The mainland populations of this small pademelon wallaby have scattered distributions throughout the south-west forests of Western Australia. For this reason, they are not frequently detected in biological surveys.

A population of these herbivorous marsupials was first recorded in the Wongong Brook/Manjedal Brook area near Jarrahdale, in 1957 (Baker, Main & Sadleir, 1957). Their preferred habitats are densely vegetated swamps usually dominated by *Agonis linearifolia* and situated in upland depressions. If Quokkas are present in numbers in the Lane-Poole Reserve, the vegetation complexes of the Samson and Federal MPA's would be the most suitable locations (Havel, pers. comm.).

The effect of prescribed burning on a population of Quokkas was studied in the early 1970's by Kimber and Schmidt, in swamp complexes within a 20 km radius surrounding Dwellingup. The study concluded that a cool, mosaic burn was required every 12 - 15 years in order to supply unburnt vegetation as a refuge plus regenerated vegetation as a food source (Christensen & Kimber, 1975b).

Although a resident population of the animal has not been confirmed, sightings of several single quokkas near the northern end of the Murray Valley MPA (R. Hearn, pers. comm.) indicate that this species may be present in viable numbers.

Common Ringtail Possum (*Pseudocheirus peregrinus occidentalis*)

The southwestern Western Australian subspecies of the common ringtail possum has not been recorded in the northern jarrah forest. It is known that this species of ringtail possum is largely associated with the peppermint tree, *Agonis flexuosa*, which is predominantly a coastal species. Vegetation maps show isolated patches of peppermint in the vicinity of Harvey along the

Darling Scarp and also in the valley towards Wellington Mill, approximately 15 Km east of Dardanup.

The occurrence of the common ringtail possum in the Lane-Poole Reserve, and in fact along the Darling Plateau, is highly unlikely despite the fact that Harvey is only about ten kilometres west of the Reserve.

The species has been gazetted rare or otherwise in need of special protection and if discovered in the Reserve, the strongest conservation measures should be taken.

Common Brushtail Possum (*Trichosurus v. vulpecula*)

Although this common and widespread possum has adapted well to urban living conditions, commonly found occupying the space between ceilings and roofs, it has a natural preference for valley woodland associations of *Eucalyptus wandoo* and *Casuarina huegeliana* (Sampson, 1971 in Smith & Hume *ed*, 1984). These vegetation complexes are abundant in the south-eastern part of the Reserve in Trees and Stene M.P.A.'s. Allen (1982) from the same paper, describes the brushtail possum as being common in coastal sandplain woodland dominated by *Eucalyptus marginata* and *E. calophylla*.

Specimen records from the Western Australian Museum indicate that this species is relatively common along the Darling Scarp with collections being made from Pinjarra, Dwellingup, Yarloop and Brunswick Junction.

The common brushtail possum is expected to occur throughout the Lane-Poole Reserve although possibly in localised populations.

Numbat (*Myrmecobius fasciatus*)

The numbat is one of the few mammals whose diet consists mainly of ants and termites. It has also been gazetted rare and in need of special protection under the Wildlife Conservation Act (1950-1983).

Wandoo woodlands are the preferred habitat of the numbat although jarrah dominated woodlands sometimes suffice. These vegetation types supply the numbat with hollow logs, not only to shelter in but to utilize as food sources once they are infested with termites (Ride, 1970).

Records from the Western Australian Museum indicate that the numbat could occur in the Lane-Poole Reserve or surrounding forest. Specimens have been collected from North Bannister, Jarrahdale, Pinjarra, Brunswick Junction, Worsley and Mumballup (approximately fifteen kilometres south of Collie), and unsubstantiated sightings have been made along the Murray Valley within the Reserve.

In recent years the status of this species has undergone dramatic changes. In one area of the south-west, numbers of numbats declined during the mid-1970s (Christensen, 1978 in Christensen et al. 1984) and a reduction in density was recorded over the entire range (Turner and Borthwick, 1980 in Christensen et al. 1984).

Fire and predation by the introduced fox (Vulpes vulpes) are the major threats to the survival of the numbat and in the event of this species being confirmed within the Reserve, its conservation is essential and management practices must account for the protection of one of Australia's unique marsupials.

Southern Bush Rat (Rattus fuscipes)

Although widespread and common, the Bush Rat is seldom seen in the wild (Strahan ed, 1983). This may account for the absence of captures or observations of this rodent. The Bush Rat is one of the commonest small mammals in southern bushland and has a preference for dense undergrowth of shrubs and ferns usually occurring in gullies (Strahan, ed, 1983).

According to Christensen and Kimber (1977), the Southern Bush Rat is common in jarrah forest, south coast communities including yate, peppermint, banksia woodland and heath areas, and pine plantations.

The small number of biological surveys conducted in the Lane-Poole Reserve may account for the apparent absence of the Bush Rat. Densely vegetated moist areas such as the Murray River valley, have the potential to support populations of the rodents and in fact an observation made by a camper along Nanga Brook of a 'fawny-coloured rat' (in May 1985) was thought to have been a Southern Bush Rat (Muir, pers. comm.).

Tammar (Macropus eugenii)

Interference by European man has isolated the mainland populations of the Tammar throughout the southwest of Western Australia. Of all the species of Macropus, the Tammar is one of the smallest, averaging approximately 60cm in height.

An interesting feature of the wallaby is its specialization for life under dry conditions. In some cases, fresh water is unavailable for long periods and their water intake is supplemented by drinking saline or even sea water (Ride, 1970).

In order to survive, the Tammar requires dense cover of low to medium height vegetation not only for protection from the elements but for signalling the approach of predators. Thickets of "Tammar Scrub" (Casuarina spp.) are suitable but the dense, moist gully vegetation common throughout the jarrah and wandoo forests seems adequate.

The Goonac MPA, situated approximately 30 km south-east of Collie, currently supports a population of the Tammar. It is possible that the Lane-Poole Reserve also supports a viable population in the south-eastern portion of the Conservation Zone. Despite the fact that Tammars may benefit slightly from the clearing of their habitat for roads, firebreaks etc. (as it provides regenerated vegetation as a temporary food source), excessive clearing of their habitat for agriculture, mining etc. would prove catastrophic. (W.A. Fisheries & Wildlife, 1972).

Amphibians and Reptiles

In addition to the list of mammals possibly occurring in the Lane-Poole Reserve, several species of amphibia and reptilia are also known to have distributions encompassing the Reserve but not actually recorded within it. Their apparent absence may be attributed to the lack of biological survey work conducted in the specific habitat types most suited to these species.

The Turtle Frog, Myobatrachus gouldii, (the only species of the genus Myobatrachus) is expected to occur within the Lane-Poole Reserve. Its diet consists predominantly of termites and it is usually found burrowed under logs in association with termite nests (Cogger, 1975).

The burrowing frog Heleioporus psammophilus is also expected to occur within the Reserve. It has a distribution described by Cogger as '... coast and western edge of Darling Scarp from Dongara region to Esperance'. This species is similar in almost all respects to H. eyrei and would probably occur in association with it.

Watercourses and stream vegetation communities supply Egernia luctuosa, E. pulchra and E. kingii with their preferred habitats. These large scincid lizards (up to 200mm snout-vent length) are also likely to be fairly common within the Lane-Poole Reserve. In fact, the sighting of a "large, thick-set lizard, very black in colour" alongside Dawn Creek in May 1985, by a Technical Officer with the Department of Conservation and Land Management, was most likely to be King's Skink, Egernia kingii, and several have been sighted by visitors at Baden-Powell waterspout.

The skinks Morethia lineocellata and Sphenomorphus australis are possibly present although the distribution of the latter is described as "far south west of W.A., north to Collie ..." (Storr et al, 1981). Both these skinks are small and terrestrial, commonly being found under the bark of fallen dead trees or under stones and logs on moist soils (Cogger, 1975).

The spiny-tailed gecko, Diplodactylus spinigerus, the tree dtella, Gehyra variegata, the legless lizard Pygopus lepidopodus or Common Scaly-foot which is associated with a wide variety of habitats, also have distributions encompassing the Reserve. Specimen records from the Western Australian Museum (reg. no. 1808 and 10993) indicate that the Western Brown snake or Gwardar, Pseudonaja nuchalis, may also be present. The skink Ctenotus fallens (WAM reg. No. 25095 and 88481) which is predominantly a coastal plain species, may occur in the most western part of the Reserve i.e. Teesdale MPA.

BIRDS

A provisional list of the avifauna of the Lane-Poole Reserve is presented in Appendix 3. The list is combination of several studies pertaining to birds in the Reserve area, namely by Kimber (1972), Sedgewick (1973), Christensen & Kimber (1975), Nichols & Nichols (1983), Nichols et al (1981) and Worsley Alumina Pty Ltd (1985).

Of the 100 species listed only two have been gazetted rare and/or in need of special protection under the Wildlife Conservation Act (1950-1983); the Peregrine falcon (Falco peregrinus) and the Red-eared Firetail Finch (Emblema oculatum). The large number of sightings, however, by Nichols, Watkins & Kabay (1981), who studied the distribution of the latter in relation to bauxite mining in the northern jarrah forest, indicate that this species is not as uncommon as previously thought. In fact, the potential for conflict between the conservation of the bird and bauxite mining appears very low. All sightings were in streamside vegetation and such areas do not contain bauxite.

The Peregrine falcon (Falco peregrinus) was represented by a single bird observed over mid-slope jarrah (Worsley Alumina Pty Ltd, 1985). This species is distributed over the entire continent but is not common anywhere and therefore it is unlikely to be seen frequently over the Lane-Poole Reserve.

Occasionally, several Wheatbelt species may be observed in the drier, more eastern regions of the Reserve. The Crested Shrike-tit (Falcunculus frontalis), recorded in wandoo woodland during a Royal Australian Ornithologists Union camp (1981), is one such example. Nichols and Nichols (1984) recorded the Bush Stone curlew (Burhinus grallarius), the Yellow-plumed Honeyeater (Meliphaga ornata) and the Pied Butcherbird (Cracticus nigrogularis), which appear as occasional visitors or when weather and flowering patterns cause movements into the area from the Wheatbelt. Similarly, Job (1969, in Worsley Alumina Pty Ltd, 1985) recorded the Chestnut Quail-thrush (Cinclosoma castanotum) and the White-browed Babbler (Pomatostomus superciliosus), species which prefer the drier, more open country but may also be occasionally seen in the eastern regions of the Reserve.

An important point to note is the sighting of a Black Bittern (Dupetor flavicollis) within the Reserve by B. Goodale in 1985, at the junction of Nanga Brook and the Murray River. This water bird usually roosts in dense paperbark (Melaleuca spp) in association with flooded gum (Eucalyptus rudis) along watercourses. However, the isolated southwest populations of this species has suffered a marked decline in numbers in the last thirty yars due to extensive clearing of its habitat. Records indicate the species was once common along the Swan Coastal Plain with birds being seen at Herdsman Lake, Midland, Pinjarra, Vasse River, Capel River and Preston River (R. Johnstone, pers. comm.). If a breeding population does exist along the watercourses within the Reserve then its conservation must be of high priority.

Many of the previously listed species inhabit the jarrah forest on a seasonal basis only. Migratory species such as the cuckoos (Cuculus spp.) and bronzecuckoos (Chrysococcyx spp.) occupy the forest during the late winter/early spring months whereas the Rainbow bee-eater (Merops ornatus) and the sacred kingfisher (Halcyon sancta) have been recorded during the months of October and November (Worsley Alumina Pty Ltd and Dames & Moore, 1981). The striated and spotted pardalotes (Pardalotus spp.) undergo major seasonal movements as does the White-winged triller (Lalage sueurii) while the honey-eaters are usually predominant during the flowering periods of their food sources.

By preserving and protecting plant communities, and thus conserving vegetation diversity, the native fauna are presumably also catered for. Due to the difficulty in studying the distribution of all native species, including frogs, lizards and snakes, this attitude towards conservation of habitat diversity is essential in the management of native fauna as a whole.

FISH

The fishes of the southwest of Western Australia have been relatively well documented although there are few publications on species of the inland waters and, unfortunately, even less pertaining specifically to the Murray River.

Iredale and Whitly (1938), in Allen (1982), divided Australia into nine regions, called fluvifaunulae, based on animal distributions and drainage patterns. Only ten principal species of fish constitute the fish fauna of one of these regions, namely the Vlaminghian, which includes the inland waters of the south-west. (The term 'principal species', as opposed to 'secondary species', follows nomenclature by Allen, 1982).

There is a single endemic family to this region, the Lepidogalaxiidae, of which the species Lepidogalaxias salamandroides or Western Australian Salamander-fish, has extremely ancient origins which probably go back more than 90 million years (Meyers, 1949 in Allen, 1982). However, the distribution of this species is essentially the streams and ponds of the south coast between Augusta and Albany and it is highly unlikely to be found in the Murray River.

The Murray River and its tributaries may contain four of the ten principal species of fish of the south-west of Western Australia. This is further supported by Dames & Moore (1984), whose survey revealed a similar number of species for the Harris River. Table 5 below lists both native and introduced species currently known to inhabit the waters of the Lane-Poole Reserve.

PROVISIONAL LIST OF NATIVE AND INTRODUCED FISH SPECIES OCCURRING IN THE MURRAY RIVER, WESTERN AUSTRALIA

TABLE 5

FAMILY	SCIENTIFIC NAME	COMMON NAME
Native:		
Kuhlidae	Edelia vittata	Western Pigmy Perch
Galaxiidae	Galaxias occidentalis	Western Minnow
Percichthyidae	Bostockia porosa	Night fish
Introduced:		
Poecilidae	Gambusia affinis	Mosquito fish
Percidae	Perca fluviatilis	Redfin Perch
Salmonidae	Salmo gairdneri	Rainbow Trout

Of the native species listed above, the Western Minnow is the most common member of its family and possibly the most common inland species in the southwest, being found in a variety of habitats including ponds and lakes, tea-coloured forest streams of the south coast and saline streams such as the Moore River Lake (1971) suggests that all species of Galaxias On the contrary, are restricted often to one or two river systems and/or with very patchy or discontinuous distributions.

The Nightfish is the only representative of the family Percichthyidae in Western Australia and is aptly named after its nocturnal behaviour. It feeds on a variety of crustaceans, small fish and aquatic insects. The diet of the Western Pygmy Perch, however, consists mainly of caddis-fly larvae (Trichoptera). The maximum size of the Pygmy perch is approximately 6 cm in contrast to the 13 cm sometimes reached by the Nightfish.

According to Allen (1982), the freshwater cobbler, Tandanus bostocki, is found in coastal streams between the Frankland and Moore Rivers. It is the only catfish occurring inland in southern Western Australia. Its presence in the Murray River is possible although several surveys conducted in nearby streams (Worsley Alumina Pty Ltd and Dames & Moore, 1981; Dames & Moore, 1984) produced no indication of it.

Similarly, specimen records from the Western Australian Museum (Reg No's 416, 914, 955 and 1400) are evidence that the Pouched Lamprey, Geotria australis, was present in the lower Murray in the early 1930's. The adult lampreys live at sea but migrate into fresh water at spawning time. The ammocoetes, or larval lampreys, may tolerate an average salinity level (of total soluble salts) between 1,000 and 1,200 ppm. (I Potter, pers. comm). Extensive clearing of the land upstream has raised the average salinity of the Murray River to 1700 ppm, with maximums exceeding 8100 ppm, (Streamflow Records of Western Australia, Vol. 2 (1984)), which is certainly lethal to the ammocoetes and thus may explain the absence of ammocoetes and the lack ofrecords of the species since the 1930's.

The introduced species of fish have little to commend them since there is good evidence that these introductions have upset the ecological balance existing in the streams of the south-west. Fortunately, the environmental impact of introduced species in Western Australia is not as extensive as in the Eastern States where the European Carp, (Cyprinus carpis), is creating major environmental devastation. (W.A. Fisheries & Wildlife Dept., 1976).

The Mosquitofish has become a genuine pest in streams and ponds of the south-west due to its prolific breeding habits. In some cases it has drastically reduced numbers of native species or even depleted them altogether. The Redfin Perch, fortunately, is confined mainly to a few lakes and dams. It may grow as large as 50cm in length and is considered a good angling and eating species.

The Rainbow trout (Salmo gairdneri) has been introduced into the cool forest streams of the southwest for the sport of fishing. Aside from providing sport for a relatively small number of anglers, trout may cause significant environmental damage.

The streams and dams of the south-west are stocked annually with trout fry from the Department of Fisheries' hatchery at Pemberton, the Murray River and Nanga Brook included. The 1982 stocking figures show that 60,000 Rainbow trout fry were released in the Murray River and 5,000 in Nanga Brook. In addition to this, 5,000 Rainbow trout yearlings were released into the Murray during the same season (FINS (1983), 16(1).p.27).

Trout are a carnivorous species feeding on a wide range of items including insects, crustaceans, molluscs and small fishes. They also feed on the fry of native species (Tizley, 1976 in Allen, 1982).

The impact of this introduced fish on native species has not been extensively monitored but it is known that competition with the Redfin Perch, expecially in Waroona Dam, has resulted in a decline in Rainbow trout numbers. Thus a decline in trout fishing has prompted the recent introduction of the Brown trout (<u>Salmo trutta</u>) into the northern jarrah forest, the first major stocking in the area for about ten years. This species is hardier and more predatory than the Rainbow trout and potentially a greater threat to native fauna. However, the Murray River is not included amongst the initial targets of streams flowing into Waroona Dam, the Brunswick River, Serpentine and upper Harvey rivers. (West Australian, Friday 28 June (1985): p.41).

INVERTEBRATES

TERRESTRIAL INVERTEBRATE FAUNA

Few studies have been performed on the invertebrates of the southern Western Australian forest region. However, the ecological importance of a dense and diverse invertebrate population in the jarrah forest cannot be over emphasised. They are a major food source for many species of mammal, amphibian, reptile and bird and the complexity of the world of invertebrates must be maintained in order to establish an equilibrium in the forest ecosystem.

Springett (1976) described the effect of prescribed burning on the soil fauna and litter decomposition in Western Australian forests. Her data suggested that the current burning regime of rotational burns every 5-7 years, will permanently simplify the litter flora and fauna. Species diversity and population density are both reduced after a prescribed burn and, in some cases, this decrease is still evident at the end of the 5-7 year rotation period. Some more recent data however (Abbott et al. 1984) refutes Springett's work. Obviously a closer examination of these management practices and further research is called for if long term conservation of the ecosystem as a whole is the primary aim.

The role of forest litter and its associated invertebrate fauna is probably of even greater importance to plant nutrient availability (Springett, 1976). Any simplification in habitat (i.e. by excessive burning) could be expected to produce a progressive reduction in plant species richness and a reduction in ant species richness (Majer, 1977). On the contrary, Abbott et al. (1984) concluded that the physical and chemical properties of the soil were enhanced in a regularly burned stand as compared with an adjacent unburned stand (46+ years since last burned). However, sampling of the invertebrate fauna within this study also showed a marked reduction in density of individuals after regular exposure to prescribed burn. ("A total of 274 animals was obtained from the burned stand and 464 from that unburned.").

The litter and upper soil layers of the jarrah forest support a diverse invertebrate fauna population including flatworms (Tricladida), earthworms (Megascolecidae), spiders (Araneae), millipedes (Diplopoda), centipedes (Chilopoda), slaters (Isopoda), pseudoscorpions (Pseudoscorpionida), silver fish (Thysanura), cockroaches (Blattodea), termites (Isoptera), earwigs (Dermaptera), crickets (Orthoptera), bugs (Hemiptera), beetles (Coleoptera) and ants (Hymenoptera Formicidae). Several of the above taxa and their larvae constitute a major food source for certain ant species (Springett, 1976).

According to Worsley Alumina Pty Ltd (1985), at least 89 species of ant occur across the Darling Range (from the scarp to the eastern Wandoo regions), representing 30 genera of which the Iridomyrmex and Camponotus species are predominant. Of this number of ant species, 14 were uncommon or had local distributions. One point of interest revealed in these surveys was the record of Austromerope poultoni, a species of scorpion-fly only previously recorded twice in Western Australia. The fact that this species has evolutionary importance warrants its protection and conservation whenever possible.

The diversity of terrestrial invertebrate communities associated with the forest floor is a reflection of the diversity of the vegetation types within the forest and similarly, the invertebrate parameters within a single vegetation type varies as much as that between different vegetation types. A greater understanding of the forest invertebrates and their ecology is needed if their importance within the forest ecosystem is to be assessed.

AQUATIC MACROINVERTEBRATE FAUNA

There has been very little work performed on the macroinvertebrate fauna of streams in the southwest of Western Australia. Studies by Bunn, Edward & Loneragan (in press) on streams in the northern jarrah forest have marked relevance to the Lane-Poole Reserve, the Murray River and its tributaries. The combined list of taxa of macroinvertebrates identified in this study and that of the Harris River (Dames and Moore, 1984) is shown in Appendix 4.

Over the summer months (between December and May) the invertebrate fauna become dominated by only a few taxa, namely the midges *Tanytarsus* and *Riethia*, commonly termed "collectors". The "filter-feeders" and "shredders" become dominant over the winter months (June to November) (Edward & Bunn, 1983). Any reduction in the proportion of filter-feeders usually implies an increase in inorganic sediment in fast-flowing streams. This is strongly associated with any form of earthworks where run-off is not adequately contained. In the past, this has included road construction across streams for logging, bauxite mining and other purposes. The mayfly, *Tasmanocoenis tillyardi*, has been used as an indicator of inorganic sediment pollution downstream of older bauxite mine sites and this relationship has been supported in the above study (Bunn, Edward & Loneragan, in press).

Of the 110 taxa recorded (1982), the Chironomidae (midges) were the most diverse family followed by the small, blind amphipod crustacean Uroctena sp. It is interesting to note that the streams of the northern jarrah forest support certain rare, ancient and relictual elements of the invertebrate fauna. These include the gastropod snail *Glacidorbis occidentalis*, the isopod crustaceans *Hyperoedesipus* sp. nov and *H. plumosus*, and the chironomid *Aphroteniella filicornis*.

The only Western Australian species of the caddisfly family Atriplectididae were recorded in streams of the northern jarrah forest and because of the zoogeographic importance of these animals some consideration should be given to its conservation (Edward & Bunn, 1983).

MARRON

Marron are not natural to the Murray River, having been deliberately introduced, perhaps as long ago as 1913, and some of the anecdotal comments surrounding their introduction are of interest. These are set out below as an extract from Morrissy (1978).

> A Mr. A. Smith related (December 2, 1969, pers. comm.) "... how the marron got into the Serpentine River ...".
>
> He and his wife caught thirty marron, "... all with spawn ...", about 28 or 29 years ago (1940) in Wellington Dam and transported them by utility (car) in an old tub with wet bags, releasing them in the river about 100 yards on the right hand side of the (south-west highway) bridge behind "Turner's old house".
>
> Departmental Technical Officer, J. S. Simpson, while investigating the marron stocks in the North Dandalup River received the information that "... the first stocking was made in 1954 and the public have apparently only recently learned that there are marron in these waters." (Departmental file 50/44, November 20, 1959).
>
> Mr. C. W. Brown, Hon. Sec. Murray-Dwellingup Trout Acclimatization Society later also recorded that "... marron were not native to our waters"; but were planted in the Murray and North and South Dandalup Rivers (Departmental File 194/46, October 31, 1961).
>
> The minute book records of the early Acclimatization Committee of Western Australia contain only one reference to marron for the period 1896–1932; in 1913 the meeting "resolved to procure some marron to be placed in the Murray and Canning Rivers" (Acclimatization Committee 1913).
>
> Technical Officer, J. S. Simpson, reported that, in general, "... marron are not indigenous to the waters of the Canning, Serpentine and Murray Rivers, having been introduced some fifteen years ago (about 1940)." (Departmental File 11/29, June 24, 1954).
>
> A President of the Murray Trout Society, Dwellingup, Mr. H. Birmingham, related that "... The Murray River does not naturally carry marron. In the spring of 1938 some of the local fishermen caught two or three dozen marron in the Collie which ... they released in the Murray ...". (*West Australian*, October 12, 1954).
>
> "In the Murray, Serpentine, North and South Dandalup and the Canning Rivers, where marron have been planted, the population is steadily increasing, despite the fact that these waters have been stocked with trout for a number of years." (Departmental File, 11/29, 1960).

The Departmental files referred to are those of the Department of Fisheries and Wildlife.

There is considerable evidence that populations of marron are declining as a result of eutrophication arising from agricultural practices, predation by Redfin Perch and to a lesser degree other factors such as salinity, temperature fluctuations and overfishing. There are no available data to suggest they are harmless to native fauna. In every case known where a species has been introduced for some purpose (other than biological control) there has been some detrimental effect. There is therefore no reason why this could not also apply to marron.

SUMMARY AND DISCUSSION

With very little specific knowledge of the fauna of the Lane-Poole Reserve, much of this report has been extrapolated from other sources pertaining to the northern jarrah forest. These consist of numerous studies on the effects of prescribed burning on forest fauna, e.g. Schmidt and Mason (1973), Christensen (1974) and Christensen & Kimber (1975), biological surveys of the surrounding areas, e.g. Saddleback Timber Reserve (Worsley Alumina Pty Ltd, 1985), the Harvey district (Sedgewick, 1973) and Samson MPA (Nichols, Glossop & Smurthwaite, 1981) and studies concentrating on specific species of forest fauna, e.g. the Quokka (*Setonix brachyurus*) (Storr, 1963) and the Red-eared Firetail Finch (*Emblema oculatum*) (Nichols, Watkins & Kabay, 1981).

The establishment of the diversity and abundance of each faunal species is of prime importance. This knowledge forms a basis around which management practices may be revised and manipulated for the conservation of the species and the habitat type for which it has a preference. In particular, the conservation and protection of endangered species, such as the Western Native Cat (*Dasyurus geoffroii*) or the Numbat (*Myrmecobius fasciatus*), against the threat of fire, predation, clearing etc. warrant special attention.

One of the major influences on the abundance and diversity of the terrestrial vertebrates and invertebrates (soil and litter fauna) is that of fire, whether in the form of a prescribed burn or a wildfire. A succession of animal species invade burnt areas as the vegetation returns and conditions become favourable for them once again. That is, each different seral stage in the plant succession favours distinct species of animal (Christensen, 1974). One such example is the rapid return by the mainland Quokka (*Setonix brachyurus*) to its swamp habitat after a fire. According to Christensen and Kimber (1975), the burnt habitat is probably utilized as a feeding ground for at least one year after the fire but, by year five, a high resident population may be established. A decline in numbers is evident after twelve years and once the regenerated vegetation has reached its full age and deterioration of the Quokka's shelter begins then population numbers dwindle until the habitat is deserted.

Prescribed burning and the fire/fauna relationship have been the subject of much discussion in recent years (Christensen & Kimber, 1975; Christensen, 1974; Schmidt & Mason, 1973; Springett, 1976; Whelan, Langedyk & Pashby, 1980). The population levels of terrestrial fauna are strongly influenced by the frequency and intensity of fires and hence, prescribed burning has a marked effect on the distribution, abundance and diversity of all species. In some cases, the influence of fire on litter fauna still seemed evident four years after a burn (Majer, 1985).

Cool burns often result in a mosaic of burnt and unburnt patches of vegetation which may supply some food and shelter for the surviving fauna. Unfortunately, no one burning regime encourages maximum population levels of all species in an ecosystem (Christensen & Kimber, 1975).

The long term effects of frequent burning and logging may be deterimental and has been cited as a possible limiting factor in populations of the Brushtailed Possum, Trichosurus vulpecula. (Sampson, 1971 in Smith & Hume ed, 1984). Similarly, the Great Pipistrelle (Pipistrellus tasmaniensis) usually roosts in tree hollows in the higher rainfall forests. One of the most serious threats to its survival is loss of roosting trees due to intensive forestry operations (Strahan ed, 1983).

Many species of native mammal have also had their distributions severely reduced by the introduction of predators such as the European fox (Vulpes vulpes) and the feral cat (Felis cattus). Similarly, competition between native and introduced species for food and/or territory often leads to drastic reductions, and sometimes complete exhaustion, of native species populations. This was the case in the Samson MPA where "the January and May trapping programme yielded no native mammals whatsoever. Feral fauna such as mice, foxes, rats, pigs, rabbits and possibly cats are present and must have a detrimental effect on the native fauna in the area." (Nichols, Glossop & Smurthwaite, 1981).

Native fishes in particular are sensitive to environmental changes especially competition with introduced species such as Redfin Perch (*Perca flviratilis*) and Rainbow Trout (*Salmo gairdneri*). The loss of streamside vegetation either by dam construction or overwhelming utilization (public pressure, etc.) would greatly reduce native species and possibly enhance introduced species. The construction of stream gauging weirs, on the other hand, should not have any effect on the movement of native fishes and therefore their numbers would possibly remain stable. For instance, the Nightfish (*Bostockia porosa*) and the Pygmy Perch (*Edelia vittata*) do not migrate while the Western Minnow may migrate during years of widespread flooding (Coy, 1979 in Dames & Moore, 1984).

The short and long term effects of bauxite mining may also have an effect on faunal populations and their distributions. Several researchers have made environmental assessments of both potential mine sites and the rehabilitation of abandoned mine sites, including Majer (1977), Nichols, Watkins & Kabay (1981), Nichols *et al*. (1981), Nichols & Watkins (1984) and Wykes (1985). According to Wykes (1985), at least ten of the more common northern jarrah species of bird could be affected in some way in the short term by bauxite mining. These species have a range of requirements not satisfied by the initial rehabilitation of depleted mine sites. For instance, several ground foragers, including the Grey Currawong, Scarlet Robin and Boobook Owl are affected by the shrub layer which is initially too dense. Similarly, the lack of sufficient tree canopy for certain tree foraging species such as the Grey Shrike-thrush, Striated Pardalote and White-naped honeyeater and the lack of available tree hollows for nesting purposes prevents these birds from inhabiting the area in the same numbers as in unmined forest.

The long term effects of bauxite mining are much more difficult to assess and it is suggested, by Wykes (1985), that of the species of avifauna common to the northern jarrah forest the Rufous Treecreeper and Red-tailed Black Cockatoo may be affected by loss of habitat and breeding sites.

Generally, there is tendency for precedence to be given to the forest mammalia and avifauna, their abundance, diversity and general ecology. The remainder of the forest fauna, including the amphibians, reptiles, fish and both the aquatic and epigaeic invertebrates deserve equal attention, if not more, as they constitute the base of the food chain.

PART G: ABORIGINAL AND EUROPEAN HISTORY

B. MUIR & J. BARTLE

The area was occupied by the Wilmen Aborigines with possibly some influence from the Binjeb people who tended to be more coastal. Both groups belong to the "Perth type" i.e., groups with matrilineal moieties and totemic clans but patrilineal local descent groups. This is to say that all people were split into two distinct social categories or moieties and must not marry within the moiety to which they belong. With matrilineal moieties the children inherit the moiety of their mother; in patrilineal moieties that of their father. Superimposed on these two major moieties were matrilineal totemic clans; descent groups associated with the name of a plant or animal species which is of mythological significance to its members, and the recognition of actual patrilineal relationships.

The Aborigines of the Lane-Poole area spoke a language common to the south west of the State known as Nyungar (Noongar).

The Aboriginal population of the region is now concentrated in towns, all that remains in the Lane-Poole Reserve being artifact scatters and other remnants of former occupation. Judging from these remains, which include stone arrangements and native burials, the area was heavily populated. Studies from powerline routes, railway alignments, etc, from outside but near the Reserve have discovered artifact scatters at a frequency of up to 3 sites per km^2. The Reserve itself has never been surveyed.

Undoubtedly the Murray River was a major attraction to the natives, being fresh water before agricultural clearing to the east turned it salt, and rich in mussels, freshwater fish, waterfowl and with abundant kangaroos in the adjoining forest.

EUROPEAN HISTORY

The history of the region has not been specifically documented but some portions, e.g. the Harvey area, are well covered in available literature. An intense, but not exhaustive survey has been made of references to key townsites, etc, at both the J.S. Battye Library and in the records of Royal W.A. Historical Society.

References obtained during these surveys are presented at the end of this section, and may provide a useful introduction to further studies.

Historical features within the Reserve and which may require management fall into three classes.

1. Remains of historic constructions e.g. old bridges, ruins.

2. Historic locations where the site has significance but nothing remains in terms of protectable material.

3. Names of historical significance. These names should be preserved for their intrinsic value and interest.

Remains of historic constructions:

Nanga Bridge Millars Pty Ltd established a sawmill at Nanga Brook in 1908 with townsite lots upstream of the millsite. The townsite was gazetted as "Nanga" on 23 April 1909, but lots within the townsite were leased but never sold. The bridge was constructed to provide easy access over Nanga Brook and was probably built between 1908 and 1910. The townsite was destroyed by the "Dwellingup bushfire" of 1961 but the bridge survived. The Nanga townsite was cancelled on 9 June 1972.

Long Gulley Bridge The date of construction of this bridge is unknown but is believed to be the early 1900's. The aboriginal name for the site is Gnardarup.

Dawn Creek Bridge This bridge, now in ruins following the 1961 bushfires, was part of a complex system of small railways laid through the forest to haul timber to the mills. It was constructed in the early 1900's and shows adze-work and other features of construction easily accessible and visible to park users.

Railway Formations These formations, consisting of numerous banks and cuttings, were installed by hand and horse-drawn machinery. Their main purpose was to cart timber from the forest to the mill sites located at various points within the forest. They were also used to transport men to and from the job and to carry the materials for construction of temporary "line-camps" which formed the point of operations for the timber cutters. The railway lines were made of jarrah and have largely been destroyed by termites and decay, but short sections of wooden line persist in the Inglehope area. It is not known if any of the timber trains used on these lines are preserved.

Historic Locations

Nanga Townsite - refer to Nanga Bridge.

Railway Formations - refer to remains of historic constructions.

Treesville - an open cleared area and scattered plants escaped from gardens is all that remains of Treesville townsite. Treesville mill opened in the 1950's (Millars Timber and Trading Co with a steam driven mill. About 45 houses were build. Sawn Timber was sent to Mornington and Wokalup by rail. The name Treesville first appeared on Army Ordance maps in 1942 but its origin at this time is unknown. The mill closed down between 1956 and 1959. Water supplies for Treesville were railed from Mornington.

Names of Historical Significance

Baden-Powell Waterspout - Discovered Christmas 1914 by the W.A. Scouting Association. Troop leader John W. Gibson recommended protection of the area. The name, after the founder of the Scout Movement (in 1908) was approved on 8 April 1915. The granitic bar in which the waterspout is located was first noted by W.A. Saw during a traverse of the Murray River on 22 December 1890. (Daily News 1 January 1915).

Mount Keats - First sighted and ascended by Lt. Henry W. Bunbury of 21st Fusiliers on 21 October 1836. Name probably introduced by John Septimus Roe, the Surveyor General, who was also responsible for naming Port Keats in the Northern Territory after Vice-Admiral Sir Richard G. Keats. Name Mt Keats not included on public plans until about 1913-1920.

Teasdale Hill - Named from a forestly lookout tower called "Teesdale". Probably named after Henry Teesdale Smith, a well known persomality of the timber industry and General Manager of Millars Karri and Jarrah Co

Ltd. This company held a lease over the area in 1902. Name first appeared on plans in 1966.

Treesville - Named after the original timber company "Trees Ltd" who first operated in the area. Name first appeared on Army Ordnance maps in 1942.

Plavins - A small mill town established by the south-west Timber Hewer's Co-operative Society shortly after a railway line was installed in August 1913. It was called the "Hotham Valley" Line SW Timber Siding until the mill transferred to Mr C Plavin in December 1918. The mill was resold in July 1922 to Westralia Timber and Trading Co. Ltd. The mill was finally closed in 1925 but the name Plavins persisted. The town's population in 1924 was 18.

Tallanalla - No information available, but the name first appeared on public plans on 1942 Army Ordnance maps.

Etmylin - One of the original sidings on the "Hotham Valley Line". Named by W.A. Government Railways, but origin of the name unknown. Name first appeared on documents in July 1927.

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Other references include the following documents:

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RECREATION

SURVEY

PART H

A SURVEY OF VISITORS TO THE

MURRAY VALLEY, WESTERN AUSTRALIA

DURING EASTER, 1984

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DEPARTMENT FOR SPORT AND RECREATION

The survey was conducted by Ken Burton, Peter Sharp and Paul Stephenson of the Research and Planning Branch.

Members of the survey teams were:

Chris Bell	Jill Hodgson
Peter Buck	Gail Ipsen
Jane Cornish	Craig Martin
Roger Cornish	Katherine McCann
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Advice and assistance was provided by Maxine Copeman, Eugene Herbert, Wayne Schmidt and Russell Bone of the Department of Conservation and Land Management.

Preface

The Department for Sport and Recreation is charged with the responsibility of providing advice and assistance to agencies that carry out functions that relate to recreation. In this instance we have undertaken some research to help us improve our knowledge and carry out that responsibility as well as being of benefit to the Department of Conservation and Land Management and other recreational land managers.

This study is a descriptive survey that indicates the levels of recreational use of one of the states most important riverine recreational resources. It deals with peoples recreational activities and reasons underlying their visits as well as some of their attitudes toward certain management issues.

Some critics may question the validity of the findings or the methods used, and it is freely admitted there are weaknesses in this study as there are in all others.

However, the strength lies in the interview procedure whereby people engaged in critical examination of their attitudes and opinions. It is our opinion that the discussion and thought clarification that occurred within most groups has led to the visitors improved perception of the worth of the natural outdoor environment and its recreation significance.

The study was undertaken with the assistance of staff of the Department of Conservation and Land Management and students from the Western Australian College of Advanced Education and University of Western Australia.

Lastly the Department acknowledges the good work being done in the Murray Valley by the Dwellingup Divisional Office of CALM, the Lane Poole Management Advisory Committee and the planning Branch of CALM. It is important work and vital for the millions of future visitors to the Murray Valley.

Peter Sharp
Research and Planning

Background to the Study

The Department for Sport and Recreation has been responsible for providing advisory and consultative services to government and non government agencies since its inception.

During the period 1978 to 1984 there was an increasing level of awareness of the importance to recreation of natural outdoor areas, in particular the coast and perennial water bodies. Studies such as the System 6 Tourism and Recreation Sub-committee Report highlighted a need of planning for recreational access to outdoor environments to ensure that a satisfactory range of opportunities would be available to meet this increasing level and diversity of recreational demand.

It was during these years that most Western Australian agencies responsible for researching behavioural requirements of the environment marked time, favouring to rely on the results of earlier research and studies conducted both interstate and overseas. The arguments for undertaking minimal research on recreational usage of outdoor areas were strong and therefore energies and monies were spent on other subjects. However, it became increasingly obvious that there was a need to improve our data base and conduct local research into the recreational use of important natural areas.

The Department has been involved with several projects in association with the Department of Conservation and Land Management and enjoyed a good working relationship at several levels of the organisation. This situation was strengthened when the Department prepared a series of brochures outlining rivers which were suitable for recreational canoeing. Several rivers passed through sections of State forest, and liaison occurred to ensure that the public would be directed to forest areas which were developed in such a way as to withstand the impacts of recreational use. The Murray River was one such area.

There was concern about the limited opportunities that were available for outdoor recreation activities associated with camping and the restrictive regulations which at the time prohibited camping in State forests.

The importance of riverine environments for public recreation is evident when reviewing the current water supply scheme and proposal for future water storage which exclude recreational use of the water. The Murray River remains the only major stream between the Helena and Collie Rivers which has not been dammed for either domestic, industrial or irrigation purposes.

As a starting point in the development of a meaningful data base it was necessary to identify the current levels of visitor use of the Murray Valley, and over the next five years assess the effectiveness of changes to site developments and their potential effect on the profile of visitors and their patterns of usage.

It was apparent that the work being undertaken by managers of outdoor recreation resources is biased heavily toward the identification and evaluation of the suitability of the physical resource for various recreational activities. Little effort is made to approach resource management from a users perspective, focussing on their psycho-sociological requirements as well as their expressed needs for access, facilities and information.

Studies previously undertaken in Western Australia such as the 1978 Forest Visitor Survey are invaluable in assisting our understanding of recreational use of natural outdoor areas. This study aims to complement that work and provide managers with an improved insight into the people behind the label "recreationalist".

Aim of Study

The study aimed at providing information about the levels of recreational use, the characteristics of the recreation use and the characteristics of the recreational users of the Murray Valley now a part of Lane Poole Reserve, during Easter 1984.

This information was to be collected and presented in a format that enabled the Department of Conservation and Land Management and other organisations to make comparisons with research findings and visitor data which had been generated in previous years and to appraise the extent to which available data adequately meets the information needs of recreational site managers.

The study was to elicit qualitative data that would assist managers identify some of the psycho-sociological aspects of recreational use of natural resources and thereby better structure their development and management programmes to meet the needs of the various public market segments.

The Objectives

1. To identify the level of use made of the Murray Valley in particular the numbers of visitors and their distribution throughout the study area.

2. To identify the characteristics of the recreational visitors and use of the area, with special emphasis being given to the characteristics of the trip, the visit and traffic patterns in the area.

3. To identify the socio-demographic characteristics of the recreation visitors to the Murray Valley and record visitor attitudes and preferences relating to facility developments, visitor fees and the general management of the area.

Information Needs

The basis for assessing the range of information on the use of the Murray Valley was established through discussions with Forests Department staff and a review of reports and registers of data which were held by various land management agencies.

Particular attention was given to the range of information which was available in the 1980 Forests Visitor Survey, as well as identifying additional information required for policy development and resource management particularly if Recreation Area Strategy Plans are to be developed.

In an ideal situation a Recreation Area Strategy Plan would accommodate the demand and supply of recreation opportunities. To do so information would be required on

- Present levels of recreation participation across a wide spectrum of sites.

- Changes in participation levels.

- Defining sectors of the community utilising outdoor areas.
- Assessment of the attractions of areas used by particular sectors of the community.
- Size and extent of catchments from which visitors are drawn.
- Awareness levels of alternative areas of State forest which can be substituted for the Murray Valley.

Data Requirements

The following data were nominated to be collected

1. Levels of Use

    - Total number of visitors
    - Numbers of vehicles
    - Vehicles using each road
    - Numbers of people at various sites

2. Characteristics of Recreation Use

    (a) Journey
    - Distance
    - Type - special trip or longer journey
    - Mode of transport

    (b) Visit
    - Duration of stay
    - Accommodation
    - Frequency of visits
    - First visit
    - Equipment used
    - Activities and preferences
    - Traffic flows and patterns
    - Vehicle occupancy

3. Characteristics of Visitors

(a) Socio-Demographic

- Age
- Sex
- Group composition
- Residential origin
- Name and address list

(b) Attitudes

- Likes
- Dislikes
- Improvements desired
- User pays
- Trail bikes

(c) Reasons for Behaviour

- Activity motivators
- Weekend selection
- Choice of site
- Alternative forest areas
- How learnt about Murray Valley

Constraints on Data Collection

The constraints placed on collection were

- Lack of trained staff
- Financial limitation of $5000
- Geography of the study area and its access points

Research Method and Survey Technique

The purpose of the study dictated that visitors had to provide information on a wide range of questions that could only be collected in the field.

Recreation data collection methods can generally be placed into the following six categories.

1. Self administered questionnaires
2. Interviews
3. Observation
4. Physical evidence
5. Electronic/mechanical devices
6. Document analysis

The combination of interview and observation techniques was determined as being most appropriate for the study as much of the data to be collected required direct observation and recording e.g. vehicle occupancy or direct questioning and answering.

On site interviews were selected in preference to self administered questionnaires for the following reasons

- Higher probable response rate
- Ability for clarification of questions
- Ability to probe into the subjects' responses
- Ability to develop a rapport and maintain the interviewee's interest and participation
- Observations could be directly related to respondents

On site interviews were conducted on the weekends prior to and after Easter in order to measure any difference in responses between peak and non-peak visitor periods. Unfortunately due to inclement weather this could not be achieved and the responses for each weekend were aggregated into the Easter survey period.

At the same time four traffic checkpoints were established to monitor traffic flows into and out of the study area.

Interviews

The survey schedule consisted of both closed and open ended questions, the former relating to characteristics of the visitors and site use, the latter relating to visitor attitudes, behaviour and opinions.

Teams of two or three interviewers surveyed each of the nine areas on a daily basis, interviewing a spokesperson for each identifiable group of visitors. Each group was interviewed only once during the survey period.

Interviewers recorded the responses of visitors to each question and were instructed on basic probing techniques to elicit detailed responses.

The survey was aimed to coincide with a period of peak visitor activity during which time the area, facilities and services would be subject to a high level of use. At such times the inadequacies of site design and management procedures can be readily identified.

Ten contract interviewers were used to conduct the interviews in addition to three Departmental officers. Two Forests Department staff conducted some interviews in addition to normal duties.

Each interviewer joined one of four teams ascribed specific survey sites and they repeated sweeps of the sites on a daily basis while one member of the team manned the traffic checkpoint on one of the four access roads.

Interpretation and Presentation of Results

The survey was structured so the results would allow for an analysis of user profiles as follows:

1. Type of visitor group
2. Age and sex of visitors
3. Postcode of home address
4. Accommodation type

5. Journey type
6. Visits during the last twelve months
7. The year in which the first visit to the area was made
8. Length of stay
9. Activity preferences
10. Likes and dislikes
11. How the group learnt about the facilities of the valley

The results could thus be compared to the broader findings of the Forest Visitor Survey as well as the results for the Dwellingup district which concentrated on the Murray Valley.

The results were to be presented in a similar format to the Forest Visitor Survey forming a separate report on visitor activity during the Easter period.

The use of the same categories for each question was deemed desirable though not essential.

The information was translated onto computer and a series of two way tables produced. The use of the computer enabled further analysis of the data to be undertaken as required. The use of open ended questions necessitated a content analysis of each response and the production of a coding sheet subsequent to the conduct of the survey. Such an approach tends to elicit responses which are more reflective of the visitor's attitudes and opinions than if the respondent selects answers from a pre-coded sheet.

The major disadvantage encountered was the amount of time required to undertake the content analysis.

Anticipated Data Interpretation

It was anticipated that a sample of 650 visitor groups would be achievable over the study period, however only 328 usable responses were obtained of which 46 were obtained on the weekends other than Easter. Because of the lower than anticipated sample, it was decided to aggregate the data and interpret it as one.

Survey Results

Types of Visitor Groups

The results indicate the predominance of families in the study area comprising approximately 58% of visitors. Additionally, friendship groups account for over one-third of visitors.

The relevance of this finding to the management authority is that expected behaviour of family groups and friendship groups may be disparate and some form of separation may be desirable to reduce visitor conflicts.

Table 1 - Types of Groups Visiting the Murray Valley

Group Types	Number	Relative Frequency %
Single Person	7	2.1
Single Family	80	24.4
Two or More Families	110	33.5
Group of Friends	117	35.7
Organised Group	14	4.3
	328	100.0

Numerous groups indicated they sought to bring the family into the bush for the purpose of teaching children the principles of camping and enjoyment of the outdoors. Therefore visitor interpretation programmes could be marketed to family groups during public holidays.

Age and Sex of Visitors

There is an 8% difference between the numbers of male and female visitors.

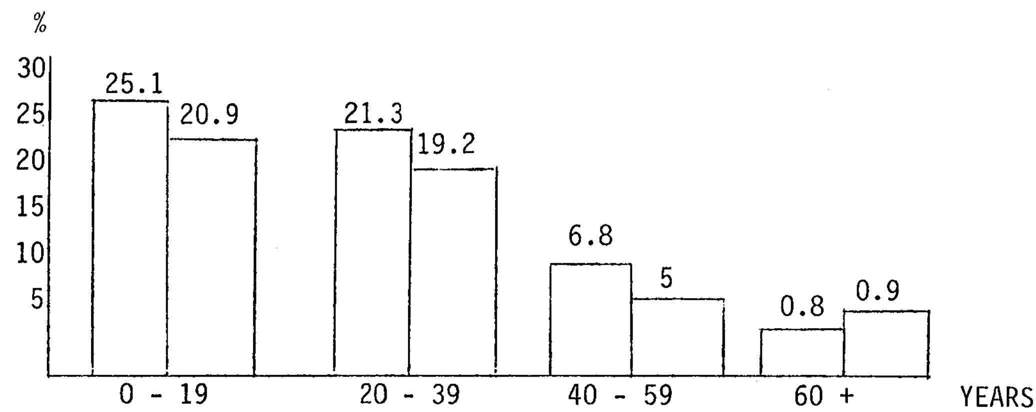
Table 2 - Age and Sex of Visitors to the Murray Valley

	Males		Females	
Years	Number	Relative Frequency %	Number	Relative Frequency%
0 - 4	57	2.4	63	2.6
5 - 9	139	5.8	117	4.9
10 - 14	201	8.3	172	7.1
15 - 19	207	8.6	151	6.3
20 - 29	288	12.0	228	9.5
30 - 39	224	9.3	234	9.7
40 - 49	126	5.2	83	3.4
50 - 59	39	1.6	39	1.6
60 +	19	0.8	21	0.9
	1300	54.0%	1108	46.0%

Total Visitors = 2408
Males = 54%
Female = 46%

The under representation of people aged forty years and over suggests that the attractions of the Murray Valley have greater appeal for younger people.

Figure 1. AGE DISTRIBUTION OF VISITORS



When compared with findings of the 1978 Forest Visitor Survey, the visitor levels for the above forty age group has declined from 14.7% to 13.5% for the Murray Valley. This may be due to a general lack of awareness by older people of the comfort that can now be enjoyed when camping.

VISITOR CATCHMENT

Approximately 88% of all visitors reside in the Perth Metropolitan Region. The distribution of the metropolitan postcodes indicated that 38% came from the north of the Swan River and 50% from south of the river. This supports the assertion that natural resource recreation areas close to Perth play an important role in recreation provision for its inhabitants.

Table 3. PLACE OF ORIGIN OF VISITORS

	Postcodes	Number	% Relative Frequency	Cumulative Frequency %
Perth Central	6000 - 6005	2	0.6	0.6
Nth West Metro	6006 - 6049	75	23.2	23.8
Nth East Metro	6050 - 6099	66	20.5	44.3
Sth East Metro	6100 - 6149	53	16.4	60.7
Sth West Metro	6150 - 6199	88	27.2	87.9
Sth West W.A.	6200 - 6299	35	10.9	98.8
Gt. Southern W.A.	6300 - 6399	1	0.3	99.1
Central Coast W.A.	6500 - 6599	2	0.6	99.7
Nth West W.A.	6700 - 6799	1	0.3	100.0
			100%	100%

N = 323
Missing Cases = 5

There was a total absence of interstate/international respondents due to the fact that the Murray Valley is not promoted to interstate caravan/camping tourists and that out of state visitors spending Easter in the valley were likely to be in the company of Western Australians who would tend to reply on behalf of identified visitor groups.

It is worth noting that 11% of visitors came from the Southwest region of the State, particularly, the city of Bunbury and towns of Mandurah, Pinjarra and Collie. Three groups using the valley were from Dwellingup.

DURATION OF VISIT

Only 16% of visitors fall into the category of day trippers who journey from and back to their place of residence in one day. The remaining 84% stayed from between 1 and 6 nights in the valley.

The Easter survey period was comprised of four public holidays consisting of Good Friday through to Easter Monday. Almost 50% of the visitors stayed at least four days and three nights.

Table 4. Duration of visits to the Murray Valley

No. of Days/Nights	Number	Relative Frequency %	Cumulative Frequency %
Day Visit	54	16.5	16.5
2 Days/1 Night	56	17.0	33.5
3 Days/2 Nights	61	18.7	52.2
4 Days/3 Nights	87	26.6	78.8
5 Days/4 Nights	37	11.3	90.1
6 Days/5 Nights	24	7.3	97.4
7 Days/6 Nights and longer.	8	2.4	99.8
Missing	1	0.2	100.0

N= 328

PLACE OF STAY

The Murray Valley contains several discreet sites and features where the majority of visitors stayed overnight.

The old Nanga townsite - Pines area - contained approximately one third of the campers as it has a large capacity and ablution and cooking facilities.

Table 5. Places of stay of Overnight Visitors to the Murray Valley

Site	Number	Relative Frequency%	Cumulative Frequency %
Charlies Flat	19	6.9	6.9
Baden Powel Water Spout	45	16.3	23.2
Island Pool	17	6.2	29.3
Yarrigil	16	5.8	35.1
Stringers	15	5.4	40.6
Nanga Townsite - Pines	80	29.0	69.6
Bobs Crossing	10	3.6	73.2
Towns Crossing	3	1.1	74.2
Scarp Pool	25	9.1	83.3
Other	46	16.7	100.0

N = 276

ACCOMMODATION TYPES

The respondents were asked to indicate what types of accommodation they utilized whilst staying in the valley and as expected approximately 85% of all groups camped in tents.

Table 6. Accommodation types utilized by overnight visitors to the Murray Valley

ACCOMMODATION	NUMBER	RELATIVE FREQUENCY%
Camper Van	28	10.2
Caravan	22	8.0
Tent	234	85.4
Panel Van-Car	18	6.6
Other	12	4.4
	314	114.6

N = 274

Missing Cases 2

Multiple responses were obtained where groups used more than one type of accommodation. Forty groups used more than one type of accommodation.

YEAR OF FIRST VISIT

Twenty three percent of respondents indicated their first visit to the valley took place in 1984.

Table 7. Year of first visit to the Murray Valley

Year	Number	Relative Frequency %	Cumulative Frequency
1984	76	23.3	23.3
1983	47	14.4	37.7
1982	32	9.8	47.5
1981	23	7.2	54.7
1976-1980	74	22.7	77.4
1971-1975	28	8.6	86.0
1961-1970	21	6.4	92.4
1951-1961	6	1.8	94.2
Before 1951	19	5.8	100.00

Over half of the respondents first visited the Murray Valley within the previous three years rising to about 85% of all respondents first visiting the valley within the last 10 years.

FREQUENCY OF VISITS

Respondents were asked to indicate how many visits they had made to the Murray Valley, within the last year.

Table 8. Frequency of Visits to the Murray Valley during the previous year

No. of Past Visits	Number	Relative Frequency %	Cumulative Frequency %
0	88	27.5	27.5
1	84	26.2	53.7
2	52	16.2	70.0
3	27	8.4	78.4
4	25	7.8	86.2
5 +	44	13.4	100.0

N = 320

Missing Cases 8

NB Respondents did not include their current visit when answering the question.

The results show clearly that over half of the respondents had visited the valley only once during the previous twelve months, indicating that there is a high turnover of users of the valley.

Vehicles

Repondents were asked to indicate what type and how many vehicles their group brought to the Murray Valley.

There were 773 vehicles catering for the 328 groups or on average 2.4 vehicles per group.

Table 9. Number and types of vehicles brought into the Murray Valley

Vehicle Type	Number	Relative Frequency %	Cumulative Frequency %
Car	548	70.0	70.0
4WD	91	11.7	81.7
Truck/Van	84	10.9	92.6
Bus	6	0.8	93.4
Motorcycle Road	13	1.7	95.1
Motorcycle Trial	38	4.9	100.0

N = 773

Thirty eight trial bikes, comprising about 5% of the total vehicles, were recorded in the valley.

Equipment

Respondents indicated which items of equipment were brought into the valley.

Table 10. Amount of Equipment brought into the Murray Valley by visitors

Equipment	Number	Relative Frequency %
Cassette Recorder	152	98.7
Tent	242	77.6
Camera	221	70.8
Barbecue-Stove	212	67.9
Radio	164	52.6
Sports Equipment	131	42.0
Marron Nets	106	34.0
Fishing Tackle	82	26.3
Trailer with goods/canoes	79	25.3
Canoes	55	17.6
Boat-Dinghy	50	16.0
Camper-Trailer	31	9.9
Tyre-Tube	28	9.0
Bicycle	24	7.7
Caravan	22	7.1
Chain Saw	20	6.4
Generator	19	6.1
N = 312	1653	529.8

Missing Cases 16

Other than shelter the visitors brought with them items of equipment which heightened their recreation experiences. Radio/casettes, sporting equipment and cameras were popular, indicating that music, games and memories are important components of a camping experience.

Recreation Activities

Respondents were asked to indicate which recreational activities they would engage in over the weekend. The most common activities were associated with a relaxing stay in the bush whilst many other groups engaged in specific activities such as fishing, marroning and canoeing, which are closely related to the resource.

Table 11. Activities of Visitors to the Murray Valley

Activity	Number	Relative Frequency %
Fishing	84	26.0
Marroning	119	36.8
Horse riding	1	0.3
Orienteering	35	10.8
Reading	161	49.8
Photography	167	51.7
Canoeing-Boating	95	29.4
Sightseeing	276	85.4
Picnic-Barbecue	280	86.7
Metal Detecting	2	0.6
Cycling	4	1.2
Log Chopping	2	0.6
Viewing flora and fauna	213	65.9
Bushwalking	282	87.3
Swimming	218	67.5
Solitude-Retreat	181	56.0
Lazing Around	295	91.3
Camping	254	78.6
Games-Play	173	53.6
Trailbike Riding	20	6.2
Drinking-Socialising	34	10.5
Rock Climbing	2	0.6
4 Wheel Driving	3	0.9
	2901	898.1

N = 323

Missing Cases 5

The activities can be categorised according to their dependency on the physical resources of the river and forest as well as the level of development of access (roads and trails) and facilities (picnic & camping areas). The remaining activities appear to be of a type that could be undertaken in any other setting.

Table 12. Groupings of Activities of Visitors to the Murray Valley

River Based Activities	Number	Relative Frequency %
Fishing	84	26.0
Marroning	119	36.8
Canoeing-Boating	95	29.4
Swimming	218	67.5
	516	159.7
Forest Based Activities		
Orienteering	35	10.8
Viewing flora and fauna	213	65.9
Rock Climbing	2	0.6
Log Chopping	2	0.6
Metal Detecting	2	0.6
	254	78.5
Trail Access Based Activities		
Horseriding	1	0.3
Sightseeing	276	85.4
Cycling	4	1.2
Bushwalking	282	87.3
Trailbike Riding	20	6.2
4 Wheel Driving	3	0.9
	586	181.3
Facility Based Activities		
Picnic-Barbecue	280	86.7
Camping	254	78.6
	534	165.3
Other Activities		
Reading	161	49.8
Photography	167	51.7
Solitude-Retreat	181	56.0
Lazing Around	295	91.3
Games and Play	173	53.6
Drinking and Socialising	34	10.5
	1011	312.9

Although the grouping is somewhat arbitrary it attempts to indicate that the activities undertaken in the forest are dependent on the physical presence of the river and the forest ecosystem, as well as the development of access routes and the provision of areas and facilities that encourage or discourage social interaction.

Activity Preferences

Respondents were asked to indicate in priority order which three activities were most important to the group's visit.

Clearly, rest and relaxation (lazing around), bushwalking and camping were important activities.

Grouping the activities under the same five classes used before indicates their relative importance.

Table 13. Preferred Activities of Visitors to the Murray Valley

River Based Activities	Number	Relative Frequency
Fishing	22	7.1
Marroning	43	13.9
Canoeing-Boating	40	12.9
Swimming	63	20.6
	168	54.5
Forest Based Activities		
Orienteering	6	1.9
Viewing flora and flauna	33	11.0
Rock Climbing	0	0
Log Chopping	0	0
Metal Detecting	0	0
	39	12.9
Trail Access Based Activities		
Horseriding	0	0
Sightseeing	65	21.1
Cycling	2	0.6
Bushwalking	145	46.9
Trailbike Riding	14	4.5
4 wheel Driving	1	0.3
	227	73.4

Facility Based Activities	Number	Relative Frequency
Picnic-Barbecue	58	18.8
Camping	96	31.2
	154	50.0

Other Activities		
Reading	11	3.5
Photography	19	6.3
Solitude-Retreat	87	27.7
Lazing Around	173	55.8
Games-Play	26	8.7
Drinking & Socialising	20	6.3
	336	108.3

N= 924

The scores for the above groupings show that solitude, rest and relaxation are most important followed by Trail Access Based, River Based, Facility Based and Forest Based Activites.

Although the activities that are dependent on a forest environment are important in their own right it is worth noting that activities requiring social interaction and access to the forest and river are regarded by the visitors as most important. This suggests that planning, site design and management should focus attention on the social compatibilities and interactions between and within visitor groups in addition to the development of forest and river access.

Attitudes to Trail Bikes

Respondents were asked to indicate whether trail bikes should be banned, allowed anywhere or restricted to specific areas within state forests.

Table 14. Visitor Attitudes to Trail Bikes In State Forest

	Number	Relative Frequency %	Cumulative Frequency %
Banned	93	28.7	2.87
Restricted	222	68.5	97.2
No Restriction	9	2.8	100.0

N = 324

Missing Cases 4

Clearly the majority of visitors are of the opinion that restrictions should be placed on the use of trail bikes in state forests. Most felt that trail bike riding was a legitimate recreational activity and that areas of state forest should be set aside to enable trail bike riders to pursue their sport without causing inconvenience and annoyance to others.

The subject of trail bike usage was very topical and many of the respondents expressed concern for the environmental protection of the forest from erosion and dieback. The other major concern was for the safety of the public, especially for children who may be at risk from indiscriminate usage of trail bikes.

Table 15. Comments on Trail Bikes in the State Forest

Comment	Number	Rel. Freq %
Trail bikes are noisy and disturbing	125	27.2
Provide trails and segregate from other users	122	26.6
Hazardous situation exists and need for policing use	77	16.8
Destroy wildlife	17	3.7
Destroy landscape and pollute	40	8.7
Dislike trail bikes	20	4.4
Restrict times	33	7.2
Pay for trail area	1	0.2
Don't damage environment	21	4.6
In favour of use of trail bikes in the area	3	0.6
	459	100.0

N = 272

Missing Cases 56

44% of comments referred to the noise and safety aspects associated with the trail bikes.

These findings indicate that trail bikes usage in the Murray Valley is a primary management issue.

Source of Information

Respondents were asked to indicate from which source they learnt about the recreational facilities in the Murray Valley.

Table 16. Visitor Information Sources for the Murray Valley

Source	Number	Relative Frequency %
Friends, Family, Acquaintances	233	60.7
Familiarity with area	14	11.5
Other	43	11.2
Accidental	38	9.9
Forests Dept Staff	12	3.1
Forests Dept Printed Material	10	3.1
Tourist Bureau	4	1.0
	384	100.0

N = 324

Missing Cases 4

Over 60% of the responses fell in the Friends, Family, Acquaintances class, indicating that social networks which spread information by word of mouth are very influential.

Substitute Areas

Respondents were asked if they knew of any other areas of state forest which offered the same recreational opportunities to the group.

Table 17. Visitor Knowledge of Substitute Areas for the Murray Valley

	Number	Relative Frequency %
Yes	126	38.8
No	199	61.2
	325	100.0

N = 325

Missing Cases 3

A clear majority of visitors did not know of any area of state forest which could be substituted for the Murray Valley as a recreational venue offering similar opportunities.

Table 18. Forest Districts Containing Nominated Areas to Substitute for the Murray Valley.

District	Number	Relative Frequency %
Wanneroo	2	1.1
Mundaring	20	11.4
Jarrahdale	18	10.2
Dwellingup	6	3.4
Harvey	9	5.1
Narrogin	2	1.1
Collie	28	15.9
Busselton	7	4.0
Kirup	2	1.1
Nannup	17	9.7
Manjimup	1	0.6
Pemberton	29	16.5
Walpole	8	4.5
South West WA	5	2.8
Kalbarri	1	0.6
Esperance	17	9.7
Other	11	2.3
	176	100.0

N = 125

Missing Cases 203

For those who did nominate substitute recreation areas, the forest districts of Collie, Pemberton, Mundaring and Jarrahdale were most frequently cited.

Site Attractions

Respondents were asked to indicate what had attracted them to their particular recreational site.

Table 19. Visitor Attractions of the Murray Valley

Attraction	Number	Percent Responses	Percent of Cases
Forest aesthetics and atmosphere	237	39.2	73.1
Convenience and facilities	53	8.8	16.4
Referred by literature	12	2.0	3.7
Can bring dogs	21	3.5	6.5
Proximity to Perth	73	12.1	22.5
River and running water	125	20.7	38.6
Barbecues	4	0.7	1.2
Wildlife, fishing, marroning	19	3.1	5.9
Ideal area for children	31	5.1	9.6
Visiting friends	29	.8	9.0
No cost	1	0.2	0.3
	605	100.2	186.7

N = 324

Missing Cases 4

The table indicates that over 70% of the visitors were attracted to their recreational sites by the forest environment, particularly the aesthetics and atmosphere of the area. Terms usually applied to describe the aesthetics were, beauty, forest, trees, picturesque, scenery, views, surrounds. Atmosphere were described by words such as fresh air, open skies, mother nature.

The findings reinforce the importance of the relationship between the visitor and the landscape. Some groups looked for open field areas, others for riverside banks whilst others preferred to stay in the thick of the trees. The element of choice is evident.

The next most frequent answers were the presence of the river and running water and the proximity to Perth.

The question aimed at attaining feedback on the attractions of particular sites but it was found that site selection was generally based on presence of suitably sized area.

Selection of Weekend

Respondents were aked to indicate why they chose that weekend to visit the Murray Valley.

Table 20. Choice of Weekend to Visit the Murray Valley

Reason	Number	Percent Responses	Percent of Cases
Long weekend Public holiday	254	75.8	78.6
Good weather	14	4.2	4.3
Convenient	51	15.2	15.8
School-Club organised	8	2.4	2.5
Impulse	8	2.4	7.5
	335	100.0	103.7

N 323

Missing Cases 5

As expected, long weekends and public holidays provide a stimulus for people to visit and camp in the Murray Valley and other areas of state forest. This suggests that the duration of stay in one place is important to visitors as well as managers.

Motivations

Respondents were asked to express the motivations or reasons for participating in their activities in the Murray Valley.

Table 21. Motivations for Recreational Visits to the Murray Valley

Reason	Number	Percent Responses	Percent of Cases
Escape from routine	161	30.6	50.2
Outdoor living-aesthetic experience	85	16.1	36.5
Fun, pleasure, recreation	80	15.2	24.9
Relaxation	68	12.9	21.2
Quiet - private	20	3.8	6.2
Outdoor education	17	3.2	5.3
Inexpensive	4	0.8	1.2
Common interests	92	17.5	2.8
	527	100.0	164.2

N = 321

Missing Cases 7

The findings illustrate that groups were generally able to identify two major motivational reasons for their recreation participation.

From the seven motivational reasons, four seem to dominate, covering approximately 75% of the total responses.

It appears that the most important motivational reason for visiting the Murray Valley for recreation is the need to escape temporarily from familiar urban surroundings, and the routines and tensions of everyday life. This is summed up in the often repeated reason of 'get away from it all'.

Other reasons of importance are the outdoor living-aesthetic experiences that are enjoyed when recreating in the Murray Valley and the opportunity to engage in activities in which all members of the group share a common interest as well as attaining pleasure and having fun in participating.

Likes and Dislikes

Respondents were asked to indicate their particular likes and dislikes about the area.

Table 22. Likes and Dislikes of the Murray Valley

Likes	Number	Percent Responses	Percent Cases
Tranquil atmosphere and quiet	131	29.8	43.4
Level of facility development	30	6.8	1.3
Proximity to river	29	6.6	9.6
Wildlife	4	0.9	1.3
Everything	2	0.5	0.7
		38.0	55.3
Dislikes			
Level of facility development	60	13.7	19.9
Excessive noise	57	13.0	18.9
Ablutions - cleanliness or absence	49	11.2	16.2
Level of cars and people	39	8.9	12.9
Litter and pollution	30	6.8	9.9
Chopping of trees	8	1.8	2.6
		62.0	80.4

N =

Missing Cases

The findings indicate the visitor preference for a relatively tranquil forest environment free from noisy disturbances. The proximity of sites to the river and the type and level of facility developments each received favourable comment from approximately 10% of the visitors.

Almost 20% of respondents disliked the level of facility development that had taken place in the Murray Valley, particularly the use of log barriers to restrict automobile access and the provision of ablutions. These people were generally in favour of retaining the area in its natural state and viewed the development of facilities as a negative action which will detract from the sites by increasing visitor numbers and displacing those who prefer an undeveloped setting.

Other major dislikes were noise,excessive number of cars and people and the absence of uncleanliness of ablutions. The first two are closely associated with visitors' desires to escape the urban setting and enjoy a quiet, and forest setting.

Clearly there is an expectation by visitors that ablutions when provided, be maintained in a clean state.

Improvements

Respondents were asked to suggest improvements to the area.

Table 23. Suggested Improvements to the Murray Valley

Improvements	Number	Percent Responses	Percent Cases
No changes	108	27.3	38.0
Toilets and showers	110	27.8	38.7
Preserve forest	41	10.4	14.4
Expand camping parking	34	8.6	12.0
Information signs	25	6.3	8.8
Clean Barbecues	13	3.3	4.6
Provide firewood	23	5.8	8.1
Remove fences	3	0.8	1.1
Ban dogs and motor bikes	19	4.8	6.7
More ranger control	19	4.8	6.7
	395	100.0	139.1

N = 284

Missing Cases 44

Approximately 40% of visitors felt no further facilities should be developed and that the natural setting should be retained as far as possible, whilst about the same number were of the view that toilets or showers might be provided. This suggests that both developed and undeveloped sites are necessary to cater for the expectations of different visitor profiles.

A minority of groups saw a need to undertake more positive action to preserve the forest and introduce controls on dogs and motorcycles. The introduction of a park ranger was considered by some to be of benefit to the valley and its visitors.

Visitor Fee

Respondents were asked to indicate their preparedness to pay a visitor fee to visit the Murray Valley.

Table 24. Willingness to pay a Visitor Fee in the Murray Valley

	Number	Relative Frequency	Cum. Frequency
Yes	212	70.2	70.2
No	90	29.8	100.0

N = 302

Missing Cases 26

The overwhelming majority indicated that they were not opposed to the concept of 'user pays' and would be willing to pay a park visitor fee. This suggests a high level of awareness that natural resource areas require funding to ensure they are not degraded.

The following comments were received on the concept of a charge for use.

Table 25. Comments on a Visitor Fee to the Murray Valley

Comment	Number	Percent Responses	Percent Cases
Maintain and improve area	105	23.3	35.7
Maintain but no more development	145	32.2	49.3
Provide Ranger	82	18.3	27.9
Don't want facilities	36	8.0	12.2
Prefer not to pay	12	2.7	4.1
Taxes pay for service	17	3.8	5.8
Will not visit	8	1.8	2.7
Nominal fee	9	2.0	3.1
Fee for camping	5	1.1	1.7
Bush should be free	31	6.9	10.5
	450	100.0	153.1

N = 294

Missing Cases 34

The vast majority felt collected monies should be spent on park maintenance. About 50% of the respondents felt that while monies collected should be directed toward the maintenance of the park they should not be used for the development of further facilities. At the same time about 35% of respondents felt the monies should be spent on maintenance and improvements the valley.

Approximately 28% of respondents felt that collected monies should contribute toward the provision of a park ranger service.

Approximately 16% were of the view that no fee should be charged because taxes are paid and the bush should be freely accessible to all.

General Comments

Respondents were asked if they wished to make any further comments about the Murray Valley or outdoor recreation.

Table 26. General comments about the Murray Valley and Outdoor Recreation

Comments	Number	Percent Responses	Percent Cases
Need improved facilities	27	7.3	9.9
No further development	108	29.0	39.6
Convenient location	6	1.6	2.2
Pleased with the area	88	23.7	32.2
Concern for environment	17	4.6	6.2
Love of outdoor activities	8	2.2	2.9
Maintain and improve roads	40	10.8	14.7
Ideal environment for children	8	2.2	2.9
Develop alternative types of camping areas	42	11.3	15.4
Promote the area	26	7.0	9.5

It is clear from the table that over a third of all visitors are pleased with the Murray Valley and would prefer it to be managed in a way that does not alter the environmental setting.

Fifteen percent suggested there was a need to develop two types of camping areas, those with facilities and ready access and those without facilities.

Only 10% felt the area should be promoted.

Findings and Conclusions

This section is an analysis and interpretation of the findings in the light of current literature. It should provide the managers with information which can be used in the planning and management of the Murray Valley.

Levels of Use

Number of Visitor Groups

There were 328 identifiable groups interviewed representing 2,408 visitors.

Average Number of Persons Per Group

There was an average of 7.34 persons per group.

$$\text{Average Group Size} = \frac{\text{Total Number Visitors}}{\text{Total Number Groups}}$$
$$= \frac{2{,}408}{328}$$
$$= 7.34 \text{ persons}$$

Estimated Sample

It is estimated that 90% of all groups staying overnight or longer were included in the survey and that 40% of all day visitor groups were included.

Estimated Total Number of Visitors

It is estimated that 438 groups visited the Valley representing 3,215 people.

$$\text{Est. Total} = \frac{\text{Total Day Visitors}}{\text{Est. Sample}} + \frac{\text{Total O'night Visitors}}{\text{Est. Sample}} \quad \begin{matrix}\text{Average}\\ \text{group size}\end{matrix}$$
$$= \left(\frac{54}{0.4} + \frac{273}{0.9}\right) \quad 7.34$$
$$= (135 + 303) \quad 7.34$$
$$= 438 \times 7.34$$
$$= 3{,}215 \text{ persons}$$

Average Duration of Stay

The average duration of stay for each visitor was 3.3 days

$$\text{Average Stay} = \frac{N_1 + 2N_2 + 3N_3 + 4N_4 + 5N_5 + 6N_6 + 7N_7}{\leq N}$$

Where: N_1 = number of groups visit 1 day

N_2 = number of groups visit 2 days

N_7 = number of groups visit 7 days

$$\Sigma N = \text{Total number of groups}$$

$$= \frac{54 + 112 + 183 + 348 + 185 + 144 + 56}{327}$$

$$= \frac{1082}{327}$$

$$= 3.3 \text{ days}$$

Estimated Total Visitor Days Spent in Murray Valley

It is estimated that 10,610 visitor days were spent in the Murray Valley over the 1984 Easter.

Estimated Total Visitor Days = Estimated Total Visitors x Average Stay
= 3,215 x 3.3
= 10,610 days

Estimated Number of Vehicles

There were 773 vehicles recorded with 328 groups, or 2.4 vehicles per group.

Estimated Total No. Vehicles = Estimated Total Visitors Groups x Average number Vehicles per Group
= 438 x 2.4
= 1,051 vehicles

Therefore it is estimated that 1,051 vehicles were in the Murray Valley over Easter 1984.

Characteristics of Recreation Use

Journey

The following figures provide the estimated road distance between the nominated places of origin and the Murray Valley.

Origin	Distance Kms
Perth Central	130
North West Metro	145
North East Metro	140
South East Metro	115
South West Metro	115
South West WA	80
Great Southern	350
Central Coast	600
North West	1,100

Total journey distance is double the distance between origin and destination.

Average Return Journey $\dfrac{(N_1D + N_2D_2 + N_9D_9) \times 2}{N}$

Where N_1 = Number of Groups from Origin 1 (Perth Central)

N_2 = Number of Groups from Origin 2 (North West Metro)

D_1 = Distance from Origin to Destination

ΣN = Total number of groups

$$= \frac{[(2x130)+(75x145)+(66x140)+(53x115)+(88x115)+(35x80)+(1x350)+(2x600)+(1x1100)}{323}$$

$$= \frac{42{,}040 \times 2}{323}$$

= 260

The average return journey was 260 kilimoetres.

Total Vehicle Journey= Av. Return Journey x Av. No. Vehicles Per Group

= 260 x 2.4

= 624 kilometres

Total Estimated Distance Travelled by Visitors

It is estimated that the total distance of all visitor journeys to the Murray Valley was 273,312 Km.

Total Est. Visitor Journey = Total Vehicle Journey x Est. Total No Visitor Groups

= 624 x 438

= 273,312 kilometres

Type of Journey

The findings show that nearly all trips to the Murray Valley were destination orientated and not part of a longer journey.

Mode and Cost of Transport

The most common vehicle (70%) is the family car. Four wheel drive vehicles comprise about 12% of total vehicles. Trailbikes comprise about 5%.

It is clear that visitors to the Murray Valley expended a great deal of cost and time in travelling to the Murray Valley.

The average journey consists of 260 kilometres of travel with 3.1 persons per vehicle. This doesn't account for any travel under-taken while in the Murray Valley.

Assuming an average cost of travel at 30¢ per kilometre, with an estimated total distance travelled at 273,312 km it is reasonable to conclude that visitors expended approximately $82,000 getting to and from the Murray Valley during Easter 1984.

Visit

Duration of Stay

The average duration of stay for visitors was 3.3 days. Only 16% of visitors fell into the category of day visitors during the study period.

Accommodation

Over 85% of visitors used tents, 10% stayed in campervans, the remainder using caravans, panel vans or other forms of accommodation. 15% of visitors groups used more than one type of accommodation.

Frequency of Visits

Only 27.5% of visitors had not visited the Murray Valley within the last twelve months. This suggests that Murray Valley is a return attraction, with about 20% returning more than four times within the last year.

First Visit

Approximately 20% of visitors were making their first ever visit, whilst over 50% had first visited the Valley within the last 3 years. This indicates that every year approximately 20% of visitors to the Murray Valley are new recruits.

Equipment Used

Visitors to the Valley bring with them a range of assorted goods, many of which are expensive. The fact that about half of all groups had cassette recorders or radios and that 19 had generators and 20 brought chainsaws suggests that some campsites would have been far from quiet and tranquil locations. Infact one group had festoon lighting and two large electric refrigerators set up next to the river.

We must accept that many people going into the Valley bring some of the comforts of home whilst others venture into the bush with minimal equipment.

Twenty-five percent of groups brought one or more trailers with them carrying canoes and/or goods.

It was clear that many groups required their vehicle parking areas to be in close proximity to their campsites, especially when transporting large amounts of equipment. However, equally obvious was the fact that some groups were willing to be physically separated from their vehicles by distances of more than 100 metres.

Activities

The findings of the survey show that swimming, sightseeing and bushwalking were very popular activities with all groups. These activities are dependent on both road and foot access and their popularity should be noted. The development of swimming holes, trails and scenic viewing areas can be justified on these high popularity figures. It is also significant that the viewing of flora and fauna was an activity undertaken by 65% of all groups. Clearly trails should focus on providing a variety of landscape scenes and interesting examples of flora and fauna.

The high scores for activities that were sedentary and relaxing indicate that many visitors venture into the forest to recharge their batteries by escaping the stresses of the urban environment.

Preferences

Although people engage in many activities whilst visiting the valley it is important to discriminate between observed behaviour and stated preferences. Planning that is based solely on observed behaviour encourages more of the same, more picnic facilities and the like because they are well used. The cost of doing this is uniformity of forest recreation areas which cater for the majority and ignore tastes and preferences of the minority.

The Visitors to the valley indicated their preferences for sedentary activities.

The following list shows the order of activities preferred by visitors to the valley and their respective scores out of a total possible 300.

Preferred Activity	Score
Relaxation/Lazing Around	55.8
Bushwalking	46.9
Camping	31.2
Solitude-Retreat	27.7
Sightseeing	21.5
Swimming	20.6
Picnic-Barbecuing	18.8
Marroning	13.9
Canoeing-Boating	12.9
Viewing flora and fauna	11.0
Games-Play	8.7
Fishing	7.1
Photography	6.3
Drinking-Socialising	6.3
Trailbike Riding	4.5
Reading	3.5
Orienteering	1.9
Cycling	0.6
4 Wheel Driving	0.3
	300.0

Planning and management of the valley should continue to cater for the public's diverse range of preferences, however special attention should be given to the provision of bushwalking and sightseeing opportunities.

It is fact that a proportion of visitors engage in activities that conflict with activities of other groups. Further attention should be given to separating trailbike users from mainstream campers.

Characteristic of Visitors

Socio-Demographic

The study showed that slightly more males (54%) than females (46%) visited the valley and that 46% were under the age of 20 years whilst 40.5% were of the age cohort 20-39 years.

Families were the predominant social grouping (58%) whilst 36% of visitors were with friends.

The Managers should be cognizant that familes provide a ready target market for the introduction of environmental awareness and appreciation programmes.

It is not surprising that the majority (88%) of visitors come from Perth whilst 11% came from towns in the south west of the state. Bunbury was the origin of 5 groups whilst Mandurah, within easy day tripping distance, was the origin of 16 groups.

Attitudes

Trail Bikes

Although a minority (28.7%) of visitors were adamant that trail bikes should be banned from state forests, main concerns were:

1. For the continued health of the forest which could be threatened by the spread of dieback and erosion.
2. For preservation of the forest as a refuge for people from the noise and stresses of urban living. Trail bikes were viewed as'noisy things, disturbing the peace and quite'.
3. For the protection of children and adults from the threat to personal safety which arises at areas where uncontrolled trail bike riding occurs.

Similar concerns were expressed by the 68.5% who thought restrictions should be placed on the use of trail bikes. However two differences were noticeable between the groups' attitudes. The 68.5% were also concerned with:

1. The right of individuals and groups to pursue chosen activities in forest environments.
2. The safety of trail bike riders, particularly children, who were taking unnecessary risks on public roads or not adopting satisfactory safety precautions such as the wearing of helmets.

Interestingly only 2.8% were of the view that trail bike riding should be unrestricted, although 6.2% engaged in trail bike riding. Clearly there is a recognition by riders that controls and restrictions may need to be applied and accepted if they are to continue to use areas of state forest.

Visitor Fee

Over 70% of visitors indicated a willingness to pay a park visitor fee.

The method of collection and amount varied markedly. The following suggestions were made:

Collection Methods - All visitors entry fee
- Campers only fee
- Vehicle entry fee
- Donation
- Facility charge
- Weekend only fee

Collection Amounts - 50¢ to $2 per head
- $1.50 - $10 per car
- $1.50 - $10 per campsite
- Donation
- $1 Firewood/Canoe Hire
- Free at non-peak times

Clearly there are numerous ways of collecting visitor fees and just as many pricing alternatives.

It was the impression of the study team that the majority of visitors were in favour of levying a visitor fee during popular holiday periods and encouraging a donation at other times. Such visitor fee schemes are used at many existing national parks and recreation reserves within Western Australia and interstate.

Alternative methods of revenue generation should be considered alongside a critical cost-benefit analysis of the introduction of visitor fees in the Murray Valley.

Likes and Dislikes

The majority of visitors liked the tranquility of the forest and the peace and quiet. The presence of excessive noise and traffic volumes concerned many and this appears to be somewhat under-presented in the results.

The most popular dislike was the level of facility development reflected in the appearance of toilets, car-parking areas and abundance of log barriers. These visitors felt the encroaching organisation and development of the forest was an anathema to escaping urban settings and allowing freedoms commonly associated with outdoor settings.

Clearly it is important that development in the valley does not strongly impart conscious controls on visitor behaviour, lest the feelings of regimentation and order which are associated with urban settings be imparted to a forest.

The next most important thing for managers to realise is that when facilities such as toilets are provided, they should be cleaned frequently, otherwise dissatisfactions quickly arise.

The range of likes and dislikes again shows there is no average visitor to the forest. Preconceived stereotypes should be cast aside and recognition given to the fact that there are several publics that constitute the majority of visitors.

The support for conservation and preservation of the forest environment is evident, but not at the cost of excluding recreational activities that are consumptive e.g. fishing and marroning. The introduction of a ban on dogs may impact a significant portion of families who choose to take along their pets.

Improvements

The provision of toilets was viewed as an improvement by 38.7% and as almost a despoilation by 38%. Clearly there is a need to ensure that sufficient toilets and other facilities are provided to meet health requirements and minimal acceptable standards; it's just a matter of determining what is acceptable for whom and matching the two on the ground, although this might be easier said than done.

Motivations and Satisfactions

The survey included questions about attitudes and motivations/ reasons for recreation behaviour. Although the approach was somewhat clumsy the findings did reflect many of the arguments presented in current literature.

The survey showed that:

1. Visitors are able to consider underlying reasons for their visit and recreational behaviour and contribute to the managers understanding.
2. The motivations and satisfactions that have been identified in the literature were also identified in the field by the respondents without prompting.
3. Visitors to the Murray Valley sought the following types of satisfactions

- Psychological
- Educational
- Social
- Relaxation and Relief
- Physiological
- Aesthetic

The following classification of reasons was condensed from the responses:

1. Common interest
2. Escape routine
3. Outdoor life - aesthetic experience
4. Fun, pleasure, recreation
5. Relaxation
6. Quite - private
7. Outdoor education

However in total there was a very broad range of reasons given which corresponded extremely closely with the following list of leisure motivations presented by Crandall.

Social	Non Social
Social contact	Nature enjoyment
Meeting new people	Escape from civilisation
Heterosexual contact	Escape from routine
Family contact	Physical exercise
Recognition or status	Creativity
Altruism	Relaxation (mental & physical)
Social power	Stimulus seeking
	Self actualisation
	Achievement
	Competition and challenge
	Avoidance of boredom
	Intellectual aestheticism

The responses covered every motivational factor listed above, although no respondent was able to list more than eight.

There were numerous respondents who identified that different reasons prompted recreational activities during their stay. For example canoeing may have been undertaken on one occasion to have physical exercise and competition, and on the next occasion for avoidance of boredom.

It was clear from the survey that the following four motivations were of primary importance to visitors.

1. The need to escape temporarily from the urban surroundings and the stresses, tensions and responsibilities of every day life.
2. The desire to experience nature, to enjoy the beauty and pleasures of outdoor living and the natural environment.

3. To engage in activities which are of a common interest amongst the group and thereby strengthen family, friendship and social bonds.
4. To engage in activities that are stimulating and encourage self actualisation through using one's skills and abilities.

Planners and managers should bear in mind that visitors will engage in activities that relate to:

1. The full range of leisure motivations as expressed by Crandall.
2. The situational restraints they experience on site.

The manager can contribute toward affecting behaviour by introducing situational restraints through levels of development, levels of crowding, levels of staffing and procedures of regimentation and control.

Alternative Forest Areas

There aren't too many visitors who are aware of alternative forest areas they could substitute for the Murray Valley. This is obviously related to the fact that there are few, if any, forest settings closer to Perth that contain significant water bodies and rivers and in which recreational activities such as swimming are allowed.

The other obvious reason for little knowledge of substitute areas is the general dearth of information that has existed on recreation opportunities in forest. This is being corrected through the preparation of additional forest visitor guides by CALM.

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APPENDICES

Appendix 1. Temperature, rainfall and raindays tables for Dwellingup, Collie, Wokalup and Wandering Meteorological Stations.

Station Name DWELLINGUP FORESTRY WESTERN AUSTRALIA

Number 009538 Latitude 32 Deg 43 Min S Longitude 116 Deg 3 Min E Elevation 267.0 M

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	21.0	20.5	18.5	14.8	12.0	10.4	9.3	9.9	11.9	14.6	17.2	20.0	15.0
Wet Bulb	15.9	16.0	14.8	12.8	10.7	9.5	8.4	8.7	10.1	11.6	13.2	14.9	12.2
Dew Point	12	13	12	11	9	9	7	7	8	9	10	11	10
Humidity	56	61	65	78	84	89	88	85	79	68	61	55	72
3 pm Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	28.5	28.5	25.8	20.8	17.3	14.9	13.9	14.4	15.8	18.7	22.1	26.5	[illegible]
Wet Bulb	18.4	18.5	17.2	15.3	13.5	12.1	11.2	11.1	11.9	13.5	15.1	17.0	14.6
Dew Point	11	11	11	11	10	10	9	8	8	9	9	9	10
Humidity	34	34	38	53	63	70	70	65	60	53	44	34	52
Daily Maximum Temperature (C)													
Mean	29.9	29.7	26.9	21.7	18.3	15.8	14.8	15.5	16.9	19.9	23.4	27.8	21.7
86 Percentile	35.2	35.0	32.2	26.4	21.4	18.0	16.8	17.8	19.7	24.5	29.2	33.9	
14 Percentile	24.4	24.4	21.7	17.3	15.2	13.5	12.8	12.9	14.0	15.8	18.3	22.2	
Daily Minimum Temperature (C)													
Mean	14.5	14.9	13.1	10.2	7.8	6.9	5.6	5.2	6.4	8.1	10.4	13.0	9.7
86 Percentile	17.8	18.3	16.9	14.0	11.9	10.8	9.4	9.2	10.0	11.6	13.4	16.5	
14 Percentile	11.2	11.4	9.4	6.5	3.9	2.5	1.7	1.1	2.8	4.2	7.1	9.4	
Rainfall (mm)													
Mean	13	20	26	70	166	265	251	197	123	88	42	21	1262
Median	7	7	13	67	164	235	235	182	106	77	38	15	1263
Raindays (No)													
Mean	3	3	5	9	15	18	20	17	14	12	8	5	129

FRAME L07

Station Name COLLIE POST OFFICE WESTERN AUSTRALIA

Number 009628 Latitude 33 Deg 22 Min S Longitude 116 Deg 9 Min E Elevation 190.0 M

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	21.3	20.6	18.3	14.3	10.8	9.4	8.1	8.8	11.5	14.8	17.5	20.1	14.6
Wet Bulb	16.2	16.1	14.8	12.5	9.9	8.7	7.5	7.9	9.7	11.7	13.5	15.1	12.0
Dew Point	12	13	12	11	9	8	7	7	8	9	10	11	10
Humidity	57	61	67	80	89	91	92	88	78	67	61	56	74
3 pm Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	29.9	29.6	26.5	21.3	18.1	15.5	14.5	15.4	16.9	20.0	23.6	27.8	21.6
Wet Bulb	19.2	19.2	17.8	15.6	13.9	12.4	11.5	11.5	12.2	13.9	15.9	17.9	15.1
Dew Point	12	12	11	11	10	10	9	8	8	8	10	10	10
Humidity	32	33	39	52	60	68	68	60	54	47	41	34	49
Daily Maximum Temperature (C)													
Mean	31.2	30.6	27.6	22.3	19.1	16.5	15.7	16.4	18.1	21.3	24.7	28.9	22.7
86 Percentile	36.7	36.2	33.3	26.8	22.7	18.9	17.8	19.3	21.2	26.1	30.6	34.5	
14 Percentile	25.6	25.6	22.3	18.1	16.1	14.0	13.3	13.9	15.2	17.2	19.4	23.6	
Daily Minimum Temperature (C)													
Mean	14.1	14.2	12.3	9.5	7.0	6.1	4.9	4.7	6.0	7.8	10.1	12.5	9.1
86 Percentile	17.2	17.9	16.7	13.9	11.4	10.6	8.9	8.6	9.8	11.7	13.6	16.1	
14 Percentile	10.7	10.0	8.0	5.5	2.8	1.7	1.1	0.6	2.2	3.9	6.2	8.9	
Rainfall (mm)													
Mean	14	15	24	50	131	189	187	144	101	70	30	16	971
Median	7	7	15	46	122	179	184	141	81	65	24	12	939
Raindays (No)													
Mean	3	3	5	9	17	20	22	20	17	14	8	5	143

FRAME 008

Station Name WOKALUP RESEARCH STATION — WESTERN AUSTRALIA

Number 009642 Latitude 33 Deg 8 Min S Longitude 115 Deg 53 Min E Elevation 116.0 m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	23.4	23.2	21.1	18.0	14.9	12.8	12.0	12.3	14.0	16.5	18.8	22.2	17.4
Wet Bulb	17.5	17.7	16.2	14.9	12.9	11.3	10.6	10.5	11.6	13.2	14.6	16.3	13.9
Dew Point	13	14	12	12	11	10	9	9	9	10	11	12	11
Humidity	53	56	58	70	78	82	83	79	73	67	61	51	68
3 pm Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb													
Wet Bulb													
Dew Point													
Humidity													
Daily Maximum Temperature (C)													
Mean	31.2	31.1	28.5	23.8	20.0	17.4	16.8	17.1	18.4	21.3	24.2	28.7	23.2
86 Percentile	36.6	36.4	33.6	28.2	22.9	19.7	18.7	19.1	20.8	25.6	28.9	34.7	
14 Percentile	26.0	25.7	23.7	19.6	17.3	15.3	14.9	15.1	16.2	17.7	20.1	23.3	
Daily Minimum Temperature (C)													
Mean	15.5	16.4	14.6	12.6	10.4	9.0	8.1	7.6	8.0	9.6	11.4	14.0	11.4
86 Percentile	19.2	20.0	18.5	16.4	13.4	12.1	11.0	10.7	11.0	12.7	15.0	18.0	
14 Percentile	11.6	12.8	10.8	9.0	7.1	5.8	5.1	4.6	5.3	6.2	8.2	10.0	
Rainfall (mm)													
Mean	12	18	24	57	155	204	191	134	83	69	33	16	996
Median	4	9	10	56	144	200	181	131	80	71	27	11	973
Raindays (No)													
Mean	2	3	4	8	15	18	20	17	14	12	8	4	125

FRAME G08

Station Name WANDERING POST OFFICE — WESTERN AUSTRALIA

Number 010648 Latitude 32 Deg 41 Min S Longitude 116 Deg 40 Min E Elevation 335.0 M

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	22.3	21.5	19.5	15.5	11.8	9.9	8.9	9.7	11.9	15.2	18.3	21.4	15.5
Wet Bulb	16.0	16.1	14.9	12.9	10.3	9.0	7.9	8.5	10.0	11.7	13.3	15.1	12.1
Dew Point	11	12	11	11	9	8	7	7	8	8	9	10	9
Humidity	49	55	59	73	82	88	87	84	78	64	54	48	68
3 pm Mean Temperatures (C) and Mean Relative Humidity (%)													
Dry Bulb	30.9	30.3	27.5	22.1	18.3	15.3	14.5	15.2	17.0	20.6	24.9	29.1	22.1
Wet Bulb	18.4	18.7	17.4	15.3	13.3	12.1	11.2	11.3	12.1	13.8	15.5	17.4	14.7
Dew Point	9	10	10	10	9	9	8	7	7	8	7	8	9
Humidity	25	29	32	45	54	67	65	60	53	43	32	26	44
Daily Maximum Temperature (C)													
Mean	32.2	31.5	28.6	23.2	19.3	16.3	15.5	16.3	18.1	21.8	26.1	30.4	23.3
86 Percentile	37.8	37.2	34.4	28.5	23.0	18.6	17.8	19.0	21.6	27.0	32.2	36.0	
16 Percentile	27.0	26.1	23.4	18.5	15.8	13.9	13.0	13.7	15.0	17.2	21.1	25.0	
Daily Minimum Temperature (C)													
Mean	14.3	14.5	12.4	9.2	6.3	5.7	4.4	3.9	4.6	6.2	9.1	12.3	8.6
86 Percentile	17.8	18.3	16.9	14.0	11.4	10.1	8.6	7.9	8.9	10.9	13.0	16.1	
14 Percentile	11.0	10.2	7.4	4.4	1.5	1.0	0.0	-0.1	0.1	1.7	5.0	8.2	
Rainfall (mm)													
Mean	9	14	21	35	81	119	116	94	62	45	18	14	628
Median	4	4	12	28	78	110	106	87	53	37	13	6	612
Raindays (No)													
Mean	3	3	4	7	13	16	18	16	14	11	6	4	115

FRAME J10

Appendix 2. Some climatic parameters recorded at Dwellingup since 1957:

Table 1. Highest recorded daily rainfall.
2. Days over 40° Celcius.
3. Days over 35° Celcius.
4. Days experiencing frost.
5. Mean daily pan evaporation.
6. Mean daily duration of sunshine.

Table 1. Highest recorded daily rainfall (Dwellingup)

HIGHEST DAILY RAINFALL MM UNITS: MILLIMETRES DEPARTMENT OF SCIENCE BUREAU OF [illegible]

STATION 009538 DWELLINGUP (DWELLINGUP FORESTRY) LAT 32 43 S LONG 116 03 E ELEVATION [illegible]

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1957	8.4	0.3	5.8	46.2	71.9	64.8	36.1	35.8	23.6	20.1	2.3	4.6	71.9
	21	02	19	22	27	19	02	17	10	19	03	04	05
1958	15.7	4.1	2.5	18.0	30.7	23.1	51.8	33.8	4.6	21.6	15.7	20.3	51.8
	25	13	02	29	31	30	06	04	23	14	08	21	07
1959	4.8	24.1	1.3	53.8	18.0	58.4	27.2	53.8	8.1	37.6	32.0	64.3	64.3
	19	08	01	28	04	17	31	09	30	06	02	31	12
1960	41.1	3.8	48.5	24.4	34.8	57.2	35.3	17.8	37.6	12.7	5.1	3.8	57.2
	01	25	27	07	25	27	20	16	23	15	14	28	06
1961		6.4	20.6	27.9	20.3	53.1	47.8	34.8	24.6	27.4	5.6	21.8	-
		19	29	21	12	06	27	05	04	18	20	15	
1962	23.6	7.4	5.6	6.1	57.4	57.4	35.1	41.1	24.9	37.3	39.1	17.3	57.4
	03	17	16	26	26	18	30	27	25	03	09	06	06
1963	7.1	6.4	2.8	41.1	55.6	55.9	41.9	46.7	42.2	44.5	7.9	4.1	55.9
	01	20	12	23	25	13	05	22	18	17	27	09	06
1964	0.3	0.0	7.9	12.4	51.8	78.7	38.1	103.0	15.7	14.5	13.5	26.7	103.0
	05	01	03	02	07	11	29	04	14	09	29	19	[illegible]
1965	1.3	6.4	19.3	10.4	66.3	39.4	39.9	47.0	24.1	45.2	16.8	10.4	66.3
	28	02	26	12	27	27	19	21	25	04	04	02	05
1966	3.0	5.6	7.1	17.8	16.5	46.0	69.1	31.8	21.1	13.5	6.4	20.3	69.1
	03	22	11	12	16	05	20	27	18	23	06	27	07
1967	9.1	15.2	11.4	26.4	57.7	43.2	69.3	32.3	29.2	26.7	23.9	7.6	69.3
	05	18	15	22	09	11	15	16	02	08	16	09	07
1968	40.6	4.1	39.4	28.2	33.8	89.4	36.8	35.6	67.6	38.6	10.9	2.8	89.4
	27	03	17	26	30	13	15	27	10	15	18	21	06
1969	4.8	0.3	11.7	43.2	24.9	41.7	29.2	15.2	3.6	2.8	11.4	9.9	43.2
	14	13	13	08	19	28	27	10	01	13	03	10	04
1970	2.0	29.0	3.0	28.2	40.9	81.5	64.0	26.2	17.3	38.6	12.2	4.8	81.5
	15	07	15	20	31	11	23	08	02	03	04	30	06
1971	5.8	10.7	58.4	3.3	51.8	34.5	33.0	44.5	51.8	34.0	9.4	6.4	58.4
	08	02	28	06	16	09	03	15	30	05	26	09	03
1972	0.3	0.3	4.8	33.0	17.8	25.1	60.2	38.9	30.5	30.2	3.0	1.5	60.2
	21	11	28	20	31	21	23	25	04	28	27	22	07
1973	7.1	2.5	2.5	27.9	34.3	47.0	45.5	30.0	42.2	16.5	10.7	0.8	47.0
	08	04	15	28	30	22	21	06	24	29	01	29	06
1974	1.6	4.0	0.0	21.0	53.0	41.4	73.6	30.8	14.6	46.8	9.8	2.2	73.6
	26	03	01	13	24	23	17	04	29	23	18	26	07
1975	0.8	0.0	11.6	12.0	40.0	38.6	60.0	32.0	41.0	8.8	12.4	1.4	60.0
	07	01	22	04	27	26	29	17	16	10	16	11	07
1976	48.6	25.4	1.0	43.4	55.3	29.8	27.1	47.2	34.4	29.0	27.4	7.2	55.3
	07	21	31	15	15	22	24	15	18	03	11	10	[illegible]
1977	10.8	4.2	2.8	0.4	45.8	28.6	26.2	62.2	21.2	31.6	9.6	2.2	[illegible]
	18	21	29	03	16	26	17	08	07	01	24	02	[illegible]
1978	0.2	13.9	6.4	8.4	29.0	37.8	48.2	21.6	28.2	86.8	9.2	9.2	[illegible]
	12	24	11	05	16	21	15	29	15	01	25	16	[illegible]
1979	6.8	5.8	10.6	26.8	30.8	38.2			22.1	19.2	29.4	5.8	-
	19	16	15	19	21	29			21	20	13	04	
1980	0.6	43.8	8.1	42.8	54.2	51.0	40.2	51.6	26.4	14.0	13.6	46.0	54.2
	09	11	20	21	28	22	10	09	14	22	26	31	05
1981	0.0	18.6	24.4	52.8	42.0	38.6	68.2	33.3	56.2	40.6	26.2	10.6	68.2
	01	18	06	04	25	08	22	15	08	01	26	10	07
1982	159.8	10.0	12.4	1.0	12.8	27.6	39.0	31.8	66.8	24.4	2.6	11.6	159.8
	21	14	21	09	08	03	15	23	[illegible]	05	27	11	01
1983	2.2	35.0	3.8	10.7	30.2	65.4	47.4	57.4	24.6	14.4	20.2	22.0	65.4
	31	06	30	01	03	28	25	05	12	13	07	31	06
1984	1.6												-
	15												
HIGHEST	159.8	79.0	58.4	53.8	71.9	89.4	73.6	103.0	67.6	86.8	39.1	64.3	
LOWEST	0.0	0.0	0.0	0.4	12.8	23.1	26.2	15.2	3.6	2.8	2.3	0.8	
NO OF ENTRIES	27	27	27	27	27	27	26	26	27	27	27	27	

FRAME D03

Table 2. Days over 40 degrees Celsius (Dwellingup)

DAYS OVER 40 CELSIUS   UNITS: NUMBER   DEPARTMENT OF SCIENCE   BUREAU OF METEOROLOGY

STATION 009538   DWELLINGUP (DWELLINGUP FORESTRY)   LAT 32 43 S   LONG 116 03 E   ELEVATION 267.0 M

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUM
1957	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961		0	1	0	0	0	0	0	0	0	0	0	-
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	1	0	0	0	0	0	0	0	0	0	0	1	2
1969	2	1	0	0	0	0	0	0	0	0	0	0	3
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	1	0	0	0	0	0	0	0	0	0	0	0	1
1975		0	0	0	0	0	0	0	0	0	0	0	-
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	1	0	0	0	0	0	0	0	0	0	0	0	1
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0			0	0	0	0	-
1980	2	0	0	0	0	0	0	0	0	0	0	0	2
1981	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	1	0	0	0	0	0	0	0	0	0	0	1
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	1												-
AVERAGE	0	0	0	0	0	0	0	0	0	0	0	0	
HIGHEST	2	1	1	0	0	0	0	0	0	0	0	1	
LOWEST	0	0	0	0	0	0	0	0	0	0	0	0	
NO OF ENTRIES	26	27	27	27	27	27	26	26	27	27	27	27	

FRAME F01

Table 3. Days over 35 degrees Celsius (Dwellingup).

DAYS OVER 35 CELSIUS UNITS: NUMBER DEPARTMENT OF SCIENCE BUREAU OF METEOROLOGY

STATION 009538 DWELLINGUP (DWELLINGUP FORESTRY) LAT 32 42 S LONG 116 03 E ELEVATION 267.0 M

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUM
1957	3	3	1	0	0	0	0	0	0	0	1	4	12
1958	8	0	4	0	0	0	0	0	0	0	2	3	17
1959	6	5	1	0	0	0	0	0	0	0	0	0	12
1960	0	1	0	0	0	0	0	0	0	0	0	5	6
1961		7	4	0	0	0	0	0	0	1	0	3	-
1962	9	6	0	0	1	0	0	0	0	0	2	2	20
1963	3	3	0	0	0	0	0	0	0	0	0	2	8
1964	2	3	5	0	0	0	0	0	0	0	0	1	11
1965	7	5	0	0	0	0	0	0	0	0	0	5	17
1966	3	4	2	0	0	0	0	0	0	0	2	1	12
1967	4	5	1	0	0	0	0	0	0	0	0	0	10
1968	7	2	0	0	0	0	0	0	0	0	0	4	13
1969	5	3	4	0	0	0	0	0	0	0	0	0	12
1970	2	7	1	0	0	0	0	0	0	0	0	1	11
1971	4	2	1	0	0	0	0	0	0	0	0	1	8
1972	4	11	2	0	0	0	0	0	0	0	1	6	24
1973	4	1	2	0	0	0	0	0	0	0	0	1	8
1974	11	1	0	0	0	0	0	0	0	0	0	4	16
1975		0	0	0	0	0	0	0	0	0	0	5	-
1976	1	6	1	0	0	0	0	0	0	0	0	2	10
1977	4	8	0	0	0	0	0	0	0	0	1	5	18
1978	7	5	2	0	0	0	0	0	0	0	1	4	19
1979	5	3	5	0	0	0			0	0	0	6	-
1980	9	2	2	0	0	0	0	0	0	0	0	0	13
1981	5	0	0	0	0	0	0	0	0	0	0	0	5
1982	2	5	0	0	0	0	0	0	0	0	3	1	11
1983	8	1	1	0	0	0	0	0	0	0	0	3	13
1984	7												-
AVERAGE	5	4	1	0	0	0	0	0	0	0	0	3	
HIGHEST	11	11	5	0	1	0	0	0	0	1	3	6	
LOWEST	0	0	0	0	0	0	0	0	0	0	0	0	
NO OF ENTRIES	26	27	27	27	27	27	26	26	27	27	27	27	

FRAME G01

Table 4. Days experiencing frost (Dwellingup).

PHENOMEN SEEN -FROST DAYS UNITS: NUMBER DEPARTMENT OF SCIENCE BUREAU OF METEOROLOGY

STATION 009538 DWELLINGUP (DWELLINGUP FORESTRY) LAT 32 43 S LONG 116 03 E ELEVATION 267.0 M

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1957	0	0	0	0	0	4	13	3	4	0	[illegible]	[illegible]	[illegible]
1958	0	0	0	2	3	6	9	14	11	4	[illegible]	[illegible]	[illegible]
1959	0	0	0	2	5	4	9	10	6	0	0	[illegible]	[illegible]
1960	0	0	0	4	9	14	10	15	3	7	[illegible]	0	[illegible]
1961		0	0	0	0	6	7	2	0	0	[illegible]	[illegible]	-
1962	0	0	0	1	1	2	11	6	6	[illegible]	0	0	[illegible]
1963	0	0	0	0	1	5	6	5	5	5	0	[illegible]	[illegible]
1964	0	0	0	0	7	2	0	4	0	0	0	0	13
1965	0	0	0	0	0	0	1	2	0	0	0	0	3
1966	0	0	0	0	1	1	7	10	0	4	1	0	19
1967	0	0	0	0	2	1	14	10	1	0	0	0	28
1968	0	0	0	0	5	3	6	12	12	7	1	0	46
1969	0	0	0	0	0	5	7	8	17	1	0	0	38
1970	0	0	0	1	0	0	5	10	2	0	0	0	18
1971	0	0	0	2	1	7	4	2	2	1	0	0	[illegible]
1972	0	0	0	0	0	5	4	6	4	0	0	0	19
1973	0	0	0	0	1	3	0	0	1	0	0	0	5
1974	0	0	0	0	0	6	0	3	2	5	0	0	16
1975	0	0	0	0	1	1	2	6	1	0	0	1	12
1976	0	0	0	0	0	[illegible]	1	3	3	0	0	0	[illegible]
1977	0	0	0	0	0	3	2	1	5	0	0	0	11
1978	0	0	0	0	0	0	2	[illegible]	0	2	0	0	[illegible]
1979	0	0	0	0	1	2			2	0	0	0	-
1980	0	0	0	0	0	2	0	0	1	0	0	0	3
1981	0	0	0	0	0	4	1	3	2	0	0	0	[illegible]
1982	0	0	0	0	1	0	6	4	[illegible]	0	0	0	[illegible]
1983	0	0	0	0	0	0	1	2	0	0	0	0	[illegible]
1984	0												-
AVERAGE	0	0	0	0	1	3	5	6	[illegible]	1	0	0	
HIGHEST	0	0	0	4	9	14	14	15	17	7	1	1	
LOWEST	0	0	0	0	0	0	0	0	0	0	0	0	
NO OF ENTRIES	27	27	27	27	27	27	26	26	27	27	27	27	

FRAME HO2

Table 5. Mean daily pan evaporation (Dwellingup).

MEAN DAILY PAN EVAPORATN MM UNITS: MILLIMETRES DEPARTMENT OF SCIENCE BUREAU OF METEOROLOGY

STATION 009538 DWELLINGUP (DWELLINGUP FORESTRY) LAT 32 43 S LONG 116 03 E ELEVATION 267.0 M

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUM
1968	7.9	7.0	5.0	3.5	2.5	1.8	1.8	2.1	2.8	4.5	5.5	8.1	4.4
1969	8.4	8.5	5.9	3.5	-	-	-	-	-	-	6.2	7.7	-
1970	-	-	-	-	-	-	1.6	-	2.4	3.6	4.9	7.3	-
1971	6.1	5.8	5.1	2.5	2.0	1.7	2.0	2.4	3.1	3.3	4.0	6.5	3.7
1972	7.8	7.9	5.5	3.3	2.3	1.8	2.1	2.7	2.7	4.3	6.8	8.9	4.7
1973	7.7	7.1	5.8	3.2	-	1.7	-	-	2.8	3.2	5.6	7.0	-
1974	-	-	5.6	2.7	-	-	-	-	2.7	4.4	5.2	7.7	-
1975	8.2	8.3	5.4	3.2	2.1	2.6	2.4	-	2.9	-	5.3	8.1	-
1976	-	7.6	5.7	3.4	2.4	-	2.1	2.4	-	3.9	5.2	6.7	-
1977	8.3	7.7	5.6	3.9	-	2.0	2.1	2.2	2.7	-	5.4	7.7	-
1978	8.0	7.6	5.5	3.6	2.3	1.8	1.7	1.9	2.6	4.1	6.2	6.5	4.3
1979	7.4	6.6	4.9	3.3	1.9	1.6			2.2	-	4.8	7.3	-
1980	8.3	6.4	5.3	2.4	1.9	1.5	1.4	2.1	2.3	3.3	4.2	6.2	3.8
1981	7.8	6.7	4.6	2.2	2.1	1.3	1.2	1.8	2.6	3.7	4.5	6.3	3.7
1982	6.3	6.6	4.9	2.9	1.9	2.4	2.5	2.1	2.5	6.2	5.6	6.4	4.2
1983	8.0	5.1	5.4	2.8	2.0	2.2	1.9	2.5	2.7	3.9	6.0	6.4	4.1
1984	7.4												-
AVERAGE	7.7	7.1	5.3	3.1	2.1	1.9	1.9	2.2	2.6	4.0	5.3	7.2	1528.2
HIGHEST	8.4	8.5	5.9	3.9	2.5	2.6	2.5	2.7	3.1	6.2	6.8	8.9	
LOWEST	6.1	5.1	4.6	2.2	1.9	1.3	1.2	1.8	2.2	3.2	4.0	6.2	
NO OF ENTRIES	14	14	15	15	11	12	12	10	14	12	16	16	

FRAME 002

MEAN DAILY SUNSHINE DURN HR UNITS: HOURS DEPARTMENT OF SCIENCE BUREAU OF METEOROLOGY

STATION 009538 DWELLINGUP (DWELLINGUP FORESTRY) LAT 32 43 S LONG 116 03 E ELEVATION 267.[illegible] M

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUM
1957	10.9	-	-	-	-	2.3	-	-	-	-	-	-	-
1958	-	-	-	-	-	-	-	-	-	-	-	-	-
1959	-	-	-	-	-	-	-	-	-	-	-	-	-
1960	-	-	-	-	-	-	-	-	-	9.2	10.5	11.0	-
1961		-	-	-	-	4.9	5.0	5.1	6.8	8.2	10.8	9.2	-
1962	11.0	10.0	7.5	6.7	4.5	4.1	6.1	5.9	7.0	8.3	8.7	10.0	7.5
1963	9.7	9.0	8.5	7.4	3.7	4.2	3.3	4.8	5.5	7.4	9.3	9.7	6.9
1964	10.9	8.9	7.4	5.2	5.4	1.7	1.9	5.7	5.5	6.7	10.0	10.5	6.7
1965	9.9	9.9	7.9	3.8	4.1	3.1	4.3	5.2	5.2	6.7	4.4	8.7	6.1
1966	10.0	10.1	7.9	4.3	4.5	3.3	3.6	5.9	4.7	7.0	8.6	10.2	6.7
1967	10.7	9.4	8.4	4.9	4.5	3.0	4.2	5.0	5.5	6.7	8.4	9.0	6.6
1968	8.8	7.8	7.2	4.0	5.8	2.5	4.8	4.3	6.2	6.7	9.1	10.4	6.5
1969	10.6	11.4	7.2	4.3	4.2	3.9	4.4	5.9	7.1	8.4	10.0	10.8	7.3
1970	-	8.8	7.4	6.2	5.[illegible]	2.8	3.9	5.4	5.1	8.4	9.2	11.2	-
1971	9.7	9.5	7.6	6.3	5.2	4.6	4.7	4.7	4.2	6.4	7.1	11.0	6.7
1972	10.7	10.1	8.1	6.9	5.5	4.1	3.6	4.5	5.9	7.6	8.4	10.4	7.1
1973	10.5	10.2	8.7	5.2	4.6	-	3.5	4.4	5.7	6.6	8.5	11.2	-
1974	11.7	10.1	8.0	5.5	4.0	5.1	3.7	5.1	6.7	7.4	9.1	11.7	7.3
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	5.0	4.6	5.8	-	6.8	7.0	-	-	-
1978	10.0	-	8.0	-	5.7	4.3	-	6.5	6.3	9.2	9.9	9.7	-
1979	10.8	8.8	8.0	5.9	6.4	3.5			5.6	7.1	7.7	10.2	-
1980	-	9.1	8.5	6.2	[illegible]	4.1	4.3	5.0	4.9	8.1	8.1	10.0	-
1981	10.9	9.8	8.6	5.4	6.4	3.7	3.3	5.1	5.8	7.6	7.5	10.0	7.0
1982	9.7	10.1	8.5	7.1	5.3	4.2	5.0	-	6.0	7.1	7.0	9.3	-
1983	10.3	-	[illegible]	7.2	4.6	3.2	4.9	4.6	6.0	-	8.1	9.0	-
1984	11.4												-
AVERAGE	10.4	9.6	8.0	5.7	5.0	3.7	4.2	5.2	5.8	7.5	8.6	10.2	
HIGHEST	11.7	11.4	8.7	7.4	6.4	5.1	6.1	6.5	7.1	9.2	10.8	11.7	
LOWEST	8.8	7.8	7.2	3.8	3.7	1.7	1.9	4.3	4.2	6.4	4.4	8.7	
NO OF ENTRIES	19	17	19	18	20	21	19	18	21	21	21	21	

FRAME E02

Table 6. Mean daily duration of sunshine (Dwellingup).

Appendix 3. Percentage occurence of speed versus wind direction.

BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 27 YEARS OF RECORDS

STATION : 009538 DWELLINGUP FORESTRY 32 43 S, 116 03 E 267.0 M ELEV

JANUARY 0900 HOURS LST — SPEED (KM/HR) — CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	*	*			2
NE	2	3	3	1		*		8
E	3	6	9	3	1	*	*	23
SE	5	10	13	5	1	1	*	35
S	2	3	3	1	*	*		10
SW	3	2	3	1				8
W	1	1	1	*	*			4
NW	1	1	2	1	*	*	*	5
ALL	18	27	34	12	3	1	*	

NO. OF OBS. 805

FEBRUARY 0900 HOURS LST — SPEED (KM/HR) — CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	*	*					[illegible]
NE	4	3	3	1	*	*		10
E	5	6	9	4	1	1	*	25
SE	6	12	13	4	1	1	*	37
S	2	3	2	*		*		8
SW	1	2	2	*				5
W	1	2	1	*	*			3
NW	*	2	1	*	*			3
ALL	20	29	31	10	2	2	*	

NO. OF OBS. 723

MARCH 0900 HOURS LST — SPEED (KM/HR) — CALM 8

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	*	*				2
NE	3	3	2	1	*	*		9
E	5	7	6	3	1	1	*	22
SE	10	12	11	3	1	1	*	38
S	2	3	1	1	*			8
SW	2	1	1	*	*			4
W	1	2	1	*	*	*		4
NW	1	2	2	*	*	*		5
ALL	24	30	24	8	3	2	*	

NO. OF OBS. 805

APRIL 0900 HOURS LST — SPEED (KM/HR) — CALM 16

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	1	1	*		*		4
NE	3	2	2	1	*			7
E	6	6	4	1	*	*		17
SE	12	11	5	1	1	*		29
S	3	3	1	*	*	*		8
SW	1	2	1	*	*			4
W	2	3	1	*	*	*		6
NW	2	3	3	*	*	*		9
ALL	32	29	17	4	2	1		

NO. OF OBS. 777

JANUARY 1500 HOURS LST — SPEED (KM/HR) — CALM 3

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	*	1					2
NE	1	1	3	*	*			6
E	2	3	4	1	1	*		10
SE	3	7	8	2	1	*		21
S	1	4	4	1	*	*	*	11
SW	3	6	9	2	1	*		22
W	2	3	5	2	1	*		13
NW	2	3	5	2	1	*		12
ALL	15	28	40	9	4	2	*	

NO. OF OBS. 803

FEBRUARY 1500 HOURS LST — SPEED (KM/HR) — CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	*	1					2
NE	3	3	1	*	*	*	*	7
E	2	4	4	1	1	*		13
SE	4	8	9	3	1	1		26
S	2	4	4	*	*			10
SW	3	4	6	2	1	*		16
W	1	4	5	2	*	*		13
NW	2	4	4	1	*			10
ALL	17	31	33	9	4	2	*	

NO. OF OBS. 724

MARCH 1500 HOURS LST — SPEED (KM/HR) — CALM 3

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*				2
NE	2	2	2	*	*	*		7
E	2	3	3	1	*	*	*	11
SE	4	9	8	2	1	*	*	24
S	3	4	3	*	*	*		11
SW	2	5	6	1	*	*		14
W	2	3	7	1	1	*		14
NW	1	4	4	2	*	1		12
ALL	18	32	34	7	3	2	*	

NO. OF OBS. 804

APRIL 1500 HOURS LST — SPEED (KM/HR) — CALM 5

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	1	1	*	*			4
NE	3	3	1	1	*			7
E	3	3	2	1	*	*	*	10
SE	5	6	6	1	*	*	*	18
S	3	4	2	*		*		9
SW	5	5	4	1	*	*		16
W	4	5	4	1	*	*		14
NW	3	5	4	1	1	*	*	[illegible]
ALL	27	32	24	7	2	1	*	

NO. OF OBS. 773

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 5/ 5/83

FRAME M04

BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 27 YEARS OF RECORDS

STATION · 009538 DWELLINGUP FORESTRY 32 43 S, 116 03 E 267.0 M ELE.

MAY 0900 HOURS LST

SPEED (KM/HR) — CALM 26

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	4	1	1	*	*	*		7
NE	5	2	1		*			8
E	7	3	2		*			12
SE	11	5	1	*	*			18
S	5	2	1					7
SW	2	2	1	*				5
W	2	2	1	*	*	*	*	6
NW	4	3	3	1	*	*		11
ALL	39	20	12	2	1	*	*	

NO. OF OBS. 805

JUNE 0900 HOURS LST

SPEED (KM/HR) — CALM 25

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	4	2	2	1	*			9
NE	5	3	2	*	*	*		10
E	4	2	1	*		*		8
SE	7	3	1	*				11
S	4	2	*	*	*			6
SW	2	1	1	*	*			5
W	4	2	2	*	*	*		8
NW	5	6	5	2	1	1	*	19
ALL	35	20	13	4	2	1	*	

NO. OF OBS. 779

JULY 0900 HOURS LST

SPEED (KM/HR) — CALM 27

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	4	2	1	*	*	*		9
NE	4	2	1	*	*	*		8
E	6	2	1	*		*		10
SE	6	3	1	*		*		11
S	3	2	*	*	*	*		5
SW	3	2	1	*	1			6
W	2	2	1	1	1	*		7
NW	7	5	4	1	1	*		18
ALL	35	20	10	3	3	1		

NO. OF OBS. 804

AUGUST 0900 HOURS LST

SPEED (KM/HR) — CALM 21

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	4	2	1	*	*	*		8
NE	6	2	1	*	*			9
E	8	2	1	*	*			12
SE	9	3	1					14
S	4	2	1	*				7
SW	3	2	1	*				5
W	2	2	2	1	*	*		8
NW	4	4	5	1	*	*		16
ALL	39	21	14	3	1	1		

NO. OF OBS. 806

MAY 1500 HOURS LST

SPEED (KM/HR) — CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	3	1	*	*	*	*	7
NE	5	3	1		*			8
E	4	3	1	*	*	*		8
SE	6	4	2	1	*	*		12
S	3	3	1	*				8
SW	4	4	2	1	*	*		12
W	5	6	4	*	*	*	*	16
NW	7	6	5	2	1	*	*	21
ALL	36	31	17	5	2	1	*	

NO. OF OBS. 801

JUNE 1500 HOURS LST

SPEED (KM/HR) — CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	3	2	1	1	*		9
NE	4	3	1	*				9
E	3	2	2	*	*	*		7
SE	4	3	2	*				9
S	3	3	1	*				6
SW	2	4	3	1	*	*		11
W	4	4	4	1	*	*	*	13
NW	5	9	8	3	1	1	*	29
ALL	27	32	23	6	3	2	*	

NO. OF OBS. 763

JULY 1500 HOURS LST

SPEED (KM/HR) — CALM 8

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	2	1	1	1	*	*	7
NE	3	2	2	*	*			7
E	2	1	1	1	*			5
SE	3	3	2	1	*			8
S	2	2	1	*	*			5
SW	4	4	2	1	*			12
W	4	5	5	1	1	1		18
NW	6	9	9	3	2	2	*	29
ALL	25	29	23	7	5	3	*	

NO. OF OBS. 792

AUGUST 1500 HOURS LST

SPEED (KM/HR) — CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	3	2	1	1	*	*		7
NE	3	2	1	*	*			6
E	2	3	1	*				6
SE	3	3	1	*		*		7
S	2	3	1	*	*	*		7
SW	4	5	4	1	1	*		15
W	5	6	5	3	1	*		21
NW	5	7	8	4	1	1		26
ALL	25	32	22	9	3	3		

NO. OF OBS. 794

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 5/ 5/83

FRAME N04

BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 27 YEARS OF RECORDS

STATION : 009538 DWELLINGUP FORESTRY 32 43 S, 116 03 E 267.0 M ELEV

SEPTEMBER 0900 HOURS LST

SPEED (KM/HR) — CALM 13

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	2	2	1	*	*	*	6
NE	3	3	1	*	*			7
E	6	3	3	1	1	*		14
SE	9	5	2	1	*	*		18
S	4	3	2	1	*			9
SW	3	2	2	1	*	*		8
W	3	3	3	1	1	*		10
NW	3	5	3	2	1	*	*	15
ALL	32	26	17	7	3	1	*	

NO. OF OBS. 780

OCTOBER 0900 HOURS LST

SPEED (KM/HR) — CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	2	1		*		5
NE	3	3	3	1		*		9
E	5	3	4	2	*	*		15
SE	9	6	5	1	*	*		22
S	4	3	3	1	*			10
SW	3	3	2	1	*	*		9
W	2	3	3	2	*	*		10
NW	2	3	5	3	1	*		14
ALL	29	25	26	10	2	1		

NO. OF OBS. 800

NOVEMBER 0900 HOURS LST

SPEED (KM/HR) — CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	1	1	*				3
NE	2	3	2	1	*	*		9
E	4	4	6	2	1	*		18
SE	5	8	7	2	1			23
S	2	4	2	1	*			10
SW	2	5	3	1	*	*		12
W	2	3	3	1	*	*	*	9
NW	2	4	4	1	*	*	*	12
ALL	22	32	29	9	2	1	*	

NO. OF OBS. 778

DECEMBER 0900 HOURS LST

SPEED (KM/HR) — CALM 3

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	*				2
NE	2	3	3	1	*			10
E	4	5	11	2	*	*	*	23
SE	5	9	9	3	2	1		28
S	2	3	3	1		*		10
SW	3	3	3	1	*	*		10
W	2	2	2	*		*		7
NW	2	2	3	*		*		8
ALL	20	28	36	8	2	1	*	

NO. OF OBS. 806

SEPTEMBER 1500 HOURS LST

SPEED (KM/HR) — CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*	*			3
NE	2	1	1	*	*			4
E	1	2	2	1	*	*		6
SE	4	4	2	1	*			11
S	2	3	1	1	*	*		7
SW	6	6	5	1	*	*		19
W	4	6	7	2	1	1	*	21
NW	4	6	8	4	1	1	*	23
ALL	23	28	27	10	4	2	*	

NO. OF OBS. 770

OCTOBER 1500 HOURS LST

SPEED (KM/HR) — CALM 3

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	*	1	*	*	*	*	2
NE	1	1	1	*		*		4
E	2	2	2	1	*			7
SE	3	4	3	1	*	*		11
S	2	4	2	1		*		8
SW	5	5	7	3	*	*		21
W	3	6	8	3	1	1	*	23
NW	2	5	7	4	1	1	*	21
ALL	18	28	33	13	2	2	*	

NO. OF OBS. 795

NOVEMBER 1500 HOURS LST

SPEED (KM/HR) — CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	*				2
NE	1	1	1	*				4
E	1	2	3	1	*			7
SE	3	4	6	1	*	*		14
S	2	3	4	1	*		*	10
SW	3	7	12	3	1		*	27
W	2	5	9	3	1	*		20
NW	1	4	6	4	*	*	*	15
ALL	14	27	42	12	3	1	*	

NO. OF OBS. 778

DECEMBER 1500 HOURS LST

SPEED (KM/HR) — CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	*				2
NE	2	2	1	*				4
E	2	3	3	1	*	*		10
SE	3	5	5	2	1	*		16
S	3	4	4	1	*	*		12
SW	3	7	10	3	1	*		24
W	2	3	9	3	*	*	*	17
NW	1	3	7	2	*	*		14
ALL	15	28	40	12	2	1	*	

NO. OF OBS. 805

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 5/ 5/83

FRAME 004

APPENDIX 4

VEGETATION TYPES IN LANE-POOLE RESERVE

Extracted from Heddle *et al*. (1980) with permission of the Authors.

Type 1. Dwellingup and Hester Complex in High Rainfall - Central and South supports an open-forest of jarrah-marri. Localised patches of tall open-forest are found but are restricted in occurrence. This vegetation complex is characteristic of the high rainfall zone, receiving more than 1100 mm average annual rainfall. The dominant site-vegetation types are S and T; less consistently O, P and R. This complex covers a large area of the uplands of the Darling Plateau and the floristic composition of the understorey reflects the moister conditions.

Type 2. Dwellingup complex in Medium to High Rainfall is also dominated by an open-forest of jarrah-marri on the uplands. The significant difference from the previous complex is that it is restricted to medium-high rainfall areas (receiving 900-1100 mm average annual rainfall) with a resultant change in the floristic composition of the understorey. It extends from the Avon River in the north, along most of the eastern fringes of the Dwellingup and Hester complex to the northern limits of the Collie Basin in the south. The dominant site-vegetation types are P and S; less consistently H, O, and Z.

Type 4. Dwellingup, Yalanbee and Hester Complex in low to Medium Rainfall is similar to previous complexes on the uplands in that it supports an open-forest of jarrah-marri; however the floristic composition of the understorey species reflects the lower rainfall (700-900 mm) and warmer conditions in the northern and eastern sections of the jarrah forest. This complex extends from Lower Chittering in the north, along the full length of the eastern section of the Darling Plateau to the series of ridges just south of Boyup Brook. the dominant site-vegetation types are H and Z; less consistently P.

Type 10. Yarragil Complex (Mininum Development of Swamps) in Medium to High Rainfall, consists predominantly of a mixture of open forest of jarrah-marri with admixtures of Blackbutt (*E. patens*) and Bullich (*E. megacarpa*). Bullich is restricted to the upper gullies of the high rainfall areas on the western fringes of the Darling Plateau, receiving an average annual rainfall of more than 1100mm. Its distribution pattern is patchy between Perth, Albany and Yallingup. Blackbutt on the other hand is relatively widespread. The dominant site-vegetation types are C, D and W; less consistently Q, T and U.

Type 11. Yarragil Complex (Maximum Development of Swamps) in Medium to High Rainfall has affinities with the previous complex but differs in the large areas of swamps. It is restricted to the upper reaches of rivers receiving an annula average rainfall greater than 850mm. Most of this complex consists predominantly of an open-forest of jarrah-marri with some admixture of blackbutt.

On sandier soils a well-defined second storey of Banksia spp. is distinguishable, but on the moist valley floors the open-forest is replaced by a low open-woodland od *Melalueca preissiana* - *Banksia* littoralis. The dominant site-vegetation types are D, E and W; less consistently P, F, J, A and B. Site vegetation type E is particularly important here as it is restricted in occurrence outside this complex.

Type 12. Swamp Complex is associated with the swampy valley floors of the Yarragil and Pindalup unit. The vegetation is varied due to the wide distribution of this complex from high rainfall areas in the west to low rainfall areas in the east of the Darling Plateau. Maximum development of the swamps occurs in the upper reaches of the Darkin (Darkin Swamp), Bingham, Harris and Collie Rivers and the Beraking Brook. The vegetation ranges from a low open-woodland of M. preissiana, B. littoralis to sedgelands on the wetter soils. Distinctive features of the swamps are the variety of species of Melaleuca which include M. viminea and M. lateritia. Other species include Actinostrobus pyramidalis, Hakea varia and species of Verticordia including V. acerosa, V. densiflora, V. grandiflora, A. pyramidalis is restricted in numbers on the Darling Plateau but does occur in several vegetation complexes on the Swan Coastal Plain. The dominant site-vegetation type is A.

Type 13. Pindalup and Yarragil Complex in Low to Medium Rainfall defines the distribution of the most westerly extension of wandoo in the shallow upper valleys, although in the north the wandoo woodlands extend through the deeply dissected Murray and Bindoon units and Helena unit westwards to link up with those on the shallow soils of the Darling Scarp.

Generally this complex is confined to the east and north of the Reserve in areas receiving an annual average rainfall of less than 900mm. The vegetation complex consists predominantly of an open-woodland of wandoo with some admixture of marri, blackbutt and jarrah and an open-forest of jarrah-marri. As the valleys carrying wandoo-blackbutt woodlands occupy more fertile sites, most have been cleared for agricultural purposes. The dominant site-vegetation types are H, M and Y; less consistently A, L, Z and E.

Type 17. Helena Complex in Medium to High Rainfall is restricted to medium to high rainfall areas (greater than 1100mm annual average rainfall) on the western fringes of the Darling Plateau. The most northerly occurrence of this complex is on the lower, deeply incised, narrow valleys of Munday Brook; it occurs in the lower reaches of all water courses along the western fringes of of the Darling Plateau to Logue Brook in the south. The vegetation is variable depending on the depth of soil, and ranges from an open-forest of jarrah-marri on the lower slopes and valley floors to heaths on shallow soils on the upper slopes, to herblands and lithic complex on the granitic rocks. It has affinities with both adjacent complexes: the Murray (medium to high rainfall) and the Darling Scarp. The dominant site-vegetation types are G and R; less consistently C, Q and T.

Type 20. Murray Complex in Medium to High Rainfall occurs on the moderately incised valleys of the Murray unit in the medium to high rainfall area on the western fringes of the Darling Plateau. As a result of damming it has been largely flooded, so except for the Murray River all the major areas of this complex are now inundated with water.

The vegetation is dominated by an open-forest of jarrah-marri on the valley slopes and by an open-forest of jarrah-marri-blackbutt on the lower slopes. Along the streams is a fringing woodland of *E. rudis*-*M. rhaphiophylla*. The dominant site-vegetation types are C, Q, U and T; less consistently D, O, R and W.

Type 21. Murray and Bindoon Complex in Low to Medium Rainfall occurs in the moderately incised valleys of the Murray and Bindoon units in the low to medium rainfall area (less than 1100mm annual average rainfall) in the eastern and northern areas of the Darling Plateau. Except for the Helena Reservoir the major areas of this complex are not flooded. There are minor occurrences on the Collie East and Murray Rivers, but maximum development occurs on the Darkin and Helena Rivers and northwards. The distinctive vegetation feature is the wandoo woodland on the valley slopes, intermixed with some open-forest of jarrah-marri-blackbutt and a woodland of *E. rudis*-*M. rhaphiophylla* on the fringes of the water courses. The dominant site-vegetation types are G, R and Y; less consistently A, C, H, L, M, Q and W.

APPENDIX 5

Definition of vegetation types on the Darling Plateau. (Tables from Heddle *et al.*, 1980).

Table 1 Summary of vegetation complexes of the Darling Plateau in relation to structural formations.

Table 2 Summary of vegetation complexes of the Darling Plateau in relation to site-vegetation types as defined by Havel (1975a,b).

Table 3 Definition of site-vegetation types in the northern jarrah forest of the Darling Plateau (Havel 1975a,b).

TABLE 1 : SUMMARY OF VEGETATION COMPLEXES OF THE DARLING PLATEAU IN RELATION TO THE STRUCTURAL FORMATIONS

STRUCTURAL FORMATIONS

Mapping Unit No.	Vegetation Complexes	TALL OPEN-FOREST: *E. diversicolor*	TALL OPEN-FOREST: *E. marginata-E. calophylla*	OPEN-FOREST: *E. marginata-E. calophylla*	OPEN-FOREST: *E. marginata-E. calophylla-E. patens*	WOODLAND: *E. wandoo-E. calophylla*	WOODLAND: *E. wandoo*	WOODLAND: *E. wandoo-E. accedens*	WOODLAND: *E. loxophleba*	WOODLAND: *E. rudis-M. rhaphiophylla*	OPEN-WOODLAND: *E. wandoo*	LOW OPEN-FOREST: *C. huegeliana*	LOW OPEN-FOREST: *M. preissiana*	LOW OPEN-FOREST: *C. obesa*	LOW OPEN-FOREST: *Agonis flexuosa*	LOW OPEN-FOREST: *E. rudis-M. rhaphiophylla*	LOW OPEN-WOODLAND: *E. wandoo-E. calophylla*	LOW OPEN-WOODLAND: *B. attenuata-B. menziesii*	LOW OPEN-WOODLAND: *M. preissiana-B. littoralis*	OPEN-SCRUB: *C. obesa-Acacia spp.-Melaleuca spp*	HEATH: Closed	HEATH: Open	HERBLANDS	SEDGELANDS
1	Dwellingup-Hester	–	●	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	Dwellingup	–	○	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	Dwellingup-Yalanbee	–	–	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	Dwellingup-Yalanbee-Hester	–	–	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	Yalanbee-Dwellingup	–	–	●	–	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	Yalanbee	–	–	○	–	○	–	●	–	–	–	○	–	–	–	–	–	–	–	–	–	–	–	–
7	Cooke **	–	–	○	–	○	–	–	–	–	–	○	–	–	–	–	–	–	–	–	●	●	●	–
8	Goonaping	–	–	○	–	–	–	–	–	–	–	–	○	–	–	–	–	●	○	–	–	–	–	–
9	Wilga	–	–	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	Yarragil (Min. Swamps)	–	○	●•	●•	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	Yarragil (Max. Swamps)	–	○	●	○	–	–	–	–	–	–	–	–	–	–	–	–	–	○	–	–	–	–	–
12	Swamp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	●	–	–	–	–	○
13	Pindalup-Yarragil	–	–	●	–	○•	–	–	–	–	●	–	–	–	–	–	–	–	–	–	–	–	–	–
14	Coolakin	–	–	–	–	○•	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15	Catterick	–	○	●	●	–	–	–	–	○	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16a	Yarragil-Catterick	●	●	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16b	Balingup	●	●	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	Helena **	–	–	○	○	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	○	○	○	–
18	Helena **	–	–	○	○	–	–	–	–	–	●	–	–	–	–	–	–	–	–	–	○	○	○	–
19	Bridgetown **	–	○	●	○	–	–	–	–	–	–	–	–	–	–	○	–	–	–	–	○	○	○	–
20	Murray	–	○	●	●	–	–	–	–	○	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	Murray-Bindoon	–	–	●	○	–	●	–	–	○	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	Balingup	–	○	●	○	–	–	–	–	○	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	Williams-Avon-Brockman-Mumballup	–	–	–	–	–	–	–	–	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	Nooning	–	–	–	–	–	–	–	–	○	–	–	–	●	–	–	–	–	–	○	–	–	–	–
25	Lowdon	–	–	●	–	–	–	–	–	●	–	–	–	–	○	–	–	–	–	–	–	–	–	–
26	Bindoon	–	–	–	–	–	○	–	●	–	–	○	–	–	–	–	–	–	–	–	–	–	–	–
27	Michibin	–	–	–	–	–	●	–	○	–	–	○	–	–	–	–	–	–	–	–	–	–	–	–
28	Darling Scarp * **	–	–	–	–	–	–	–	–	–	–	○	–	–	–	–	●	–	–	–	○	○	○	–

* Local admixtures of *E. megacarpa*
** Lithic complex associated with granitic rocks
• Local admixtures of *E. patens*
• Local admixtures of *E. laeliae* and *E. haematoxylon*
● Structural Formation should be present
○ Structural Formation should be present, but absence not critical
– Structural Formation generally absent

TABLE 2 : SUMMARY OF VEGETATION COMPLEXES OF THE DARLING PLATEAU IN RELATION TO THE SITE-VEGETATION TYPES AS DEFINED BY HAVEL (1975A AND B)

		SITE-VEGETATION TYPES (*)																				
Mapping Unit No.	Vegetation Complexes	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
1	Dwellingup-Hester	–	–	–	–	–	–	–	–	–	–	–	○	○	–	○	●	●	–	–	–	–
2	Dwellingup	–	–	–	–	–	–	–	○	–	–	–	○	●	–	○	●	–	–	–	–	○
3	Dwellingup-Yalanbee	–	–	–	–	–	–	○	●	–	–	–	–	●	–	○	–	–	–	–	–	●
4	Dwellingup-Yalanbee-Hester	–	–	–	–	–	–	–	●	–	–	–	–	○	–	–	–	–	–	–	–	●
5	Yalanbee-Dwellingup	–	–	–	–	–	–	○	●	–	–	●	–	–	–	–	–	–	–	–	–	●
6	Yalanbee	–	–	–	–	–	–	○	○	–	–	●	–	–	–	–	–	–	–	–	–	○
7	Cooke	–	–	–	–	–	–	●	–	–	–	○	–	○	–	●	○	–	–	–	–	○
8	Goonaping	○	○	–	–	–	●	–	–	●	–	–	–	–	–	–	–	–	–	–	–	–
9	Wilga	–	–	–	–	○	–	–	●	–	–	–	–	–	–	●	–	–	–	●	–	–
10	Yarragil (Min. Swamps)	–	–	●	●	–	–	–	–	–	–	–	–	–	○	–	–	○	○	●	–	–
11	Yarragil (Max. Swamps)	○	○	–	●	●	○	–	–	○	–	–	–	○	–	–	–	–	–	●	–	–
12	Swamp	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	Pindalup-Yarragil	○	–	–	–	○	–	–	●	–	○	●	–	–	–	–	–	–	–	–	●	○
14	Coolakin	–	–	–	–	–	–	○	○	–	○	●	–	–	–	–	–	–	–	–	●	○
15	Catterick	–	–	●	●	–	–	–	–	–	–	–	–	–	●	–	–	–	–	●	–	–
17	Helena	–	–	○	–	–	–	●	–	–	–	–	–	–	○	●	–	○	–	–	–	–
18	Helena	–	–	○	–	–	–	●	–	–	–	–	–	–	○	●	–	–	–	–	○	–
19	Bridgetown	–	–	●	–	–	–	○	–	–	–	–	–	–	●	○	–	●	○	–	–	–
20	Murray	–	–	●	○	–	–	–	–	–	–	–	○	–	●	○	–	●	●	○	–	–
21	Murray-Bindoon	○	–	○	–	–	–	●	○	–	○	○	–	–	○	●	–	–	–	○	●	–
22	Balingup	–	–	●	●	–	–	–	–	–	–	–	–	–	–	–	○	○	–	●	–	–
28	Darling Scarp	–	–	–	–	–	–	●	–	–	–	–	–	–	–	●	–	–	–	–	–	–

● Site-vegetation type should be present
○ Site-vegetation type should be present, but absence not critical
– Site-vegetation type generally absent
* Site-vegetation types as defined by Havel (1975a and b)

TABLE 3. DEFINITION OF SITE-VEGETATION TYPES IN THE NORTHERN JARRAH FORREST OF THE DARLING PLATEAU (HAVEL 1975A AND B)

PLANT SPECIES	A	B	C	D	E	F	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
	SITE-VEGETATION TYPES																			
Acacia alata	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acacia extensa	-	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-	○	-	-
Acacia browniana	-	-	-	-	-	-	○	-	-	-	-	●	-	-	●	-	-	-	-	○
Acacia urophylla	-	-	-	-	-	-	-	-	-	-	○	-	○	-	○	○	-	-	-	-
Adenanthos barbigerus	-	-	-	-	-	-	-	○	-	-	-	●	-	○	●	-	-	-	-	-
Adenanthos obovatus	○	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agonis linearifolia	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Astartea fascicularis	●	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baeckea camphorosmae	-	-	-	○	●	-	○	○	-	○	-	-	-	-	-	-	-	-	●	-
Banksia attenuata	-	-	-	-	-	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-
Banksia grandis	-	-	-	-	-	-	-	-	-	-	●	●	-	-	○	○	-	-	-	-
Banksia littoralis	●	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bossiaea aquifolium	-	-	-	-	-	-	-	-	-	-	○	-	○	-	○	○	-	-	-	-
Casuarina fraserana	-	-	-	-	-	-	-	○	-	-	○	●	-	-	○	-	-	-	-	-
Casuarina humilis	-	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-
Caustis dioica	-	○	-	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chorizema ilicifolium	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-	○	○	-	-	-
Clematis pubescens	-	-	-	-	-	-	-	-	-	-	-	-	●	-	-	●	○	-	-	-
Conospermum stoechadis	-	●	-	-	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-
Dampiera alata	-	-	○	●	●	-	-	-	-	○	-	-	-	-	-	-	-	○	●	-
Dasypogon bromeliaefolius	○	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daviesia pectinata	-	○	-	-	○	-	●	●	-	-	-	○	-	-	○	-	-	-	-	-
Diplolaena drummondii	-	-	-	-	-	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-
Dillwynia cinerascens	-	-	-	-	○	-	-	-	-	○	-	-	○	-	-	-	-	-	-	-
Eucalyptus calophylla	○	●	-	●	○	-	-	○	-	○	●	○	●	●	○	●	●	●	-	○
Eucalyptus marginata	-	●	-	○	●	●	●	●	-	○	●	●	○	●	●	●	-	○	-	●
Eucalyptus megacarpa	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus patens	●	-	○	○	-	-	-	-	○	○	-	-	●	-	-	○	●	●	-	-
Eucalyptus wandoo	-	-	-	-	-	-	-	-	●	●	-	-	-	-	-	-	-	-	●	-
Gastrolobium calycinum	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-	-	-	○	○
Grevillea diversifolia	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grevillea wilsonii	-	-	-	-	○	-	-	●	-	-	-	●	-	-	-	-	-	-	-	-
Hakea cyclocarpa	-	-	-	-	-	-	○	○	-	-	-	-	-	-	○	-	-	-	-	-
Hakea ceratophylla	●	-	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hakea lissocarpha	-	-	-	○	○	-	-	-	●	●	-	-	●	●	○	○	○	●	●	●
Hakea ruscifolia	-	-	-	-	○	-	○	●	-	-	-	○	-	-	-	-	-	-	-	-
Hakea varia	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hibbertia lineata	-	-	-	-	-	-	-	-	●	-	-	-	○	-	-	-	-	-	●	-
Hibbertia polystachya	-	●	-	-	-	○	-	●	-	-	-	-	-	-	-	-	-	-	○	-
Hovea chorizemifolia	-	-	-	-	-	-	-	-	-	-	○	●	○	-	●	●	-	-	-	-
Hypocalymma angustifolium	●	○	○	●	●	-	○	-	●	○	-	-	●	○	-	-	-	●	●	-
Isopogon dubius	-	-	-	-	-	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Kennedia coccinea	-	-	-	-	-	-	-	-	-	-	○	-	○	-	-	○	-	-	-	-
Kingia australis	-	-	-	○	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lasiopetalum floribundum	-	-	-	-	-	-	○	-	-	-	-	○	-	-	●	●	-	-	-	○
Lepidosperma angustatum	○	●	●	●	●	-	●	○	-	-	●	●	○	○	○	-	-	●	○	○
Lepidosperma tetraquetrum	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptocarpus scariosus	●	●	●	●	●	○	-	○	-	-	-	-	-	-	-	-	-	○	○	-
Leptomeria cunninghamii	-	-	-	-	-	-	-	-	-	○	-	○	-	○	●	○	-	-	-	○
Leptospermum ellipticum	●	-	-	●	○	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-
Leucopogon capitellatus	-	-	-	-	-	-	-	-	-	-	-	-	○	●	●	○	-	-	-	●
Leucopogon oxycedrus	-	-	-	-	-	-	-	-	-	-	-	○	-	-	-	-	-	-	-	-
Leucopogon cordatus	-	●	-	-	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leucopogon propinquus	-	-	-	-	-	-	-	-	-	-	○	-	○	●	○	○	-	-	-	●
Leucopogon verticillatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	○	●	-	-	-	-
Lyginia tenax	-	●	-	-	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-
Macrozamia riedlei	-	-	-	-	-	-	-	-	○	●	-	-	●	●	●	●	●	-	-	●
Melaleuca preissiana	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mesomelaena tetragona	●	●	●	●	●	○	●	●	-	-	-	-	-	-	-	-	-	●	○	-
Nuytsia floribunda	-	-	-	-	-	○	-	○	-	-	-	-	-	-	-	-	-	-	-	-
Patersonia occidentalis	-	●	-	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-	○	-
Patersonia rudis	-	-	-	-	○	-	●	○	-	○	-	●	-	○	○	-	-	-	-	●
Persoonia longifolia	-	-	-	-	-	-	-	-	-	-	-	●	-	-	○	-	-	-	-	-
Phyllanthus calycinus	-	-	-	-	-	-	-	-	-	○	-	-	●	●	●	○	-	-	-	○
Pteridium esculentum	-	-	-	-	-	-	-	-	-	-	-	-	○	-	-	●	●	-	-	-
Sphaerolobium medium	-	○	-	-	○	-	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Stirlingia latifolia	-	-	-	-	-	●	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Styphelia tenuiflora	-	-	-	-	-	-	●	○	-	-	-	●	-	○	○	-	-	-	-	●
Synaphea petiolaris	○	○	-	○	●	-	○	-	-	-	-	-	-	-	-	-	-	●	-	-
Trymalium ledifolium	-	-	-	-	-	-	○	-	-	-	-	○	-	●	-	-	-	-	-	○
Trymalium spathulatum	-	-	-	-	-	-	-	-	-	-	-	-	●	-	-	-	-	-	-	-

● Species should be present
○ Species should be present, but absence not critical
- Species generally absent

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*, *E. wandoo* and *Casuarina huegeliana*

APPENDIX 6

Plant species lists relevant to the Lane-Poole Reserve

List 1 Harris River Dam catchment (Dames and Moore (1984)).

List 2 Worsley study area (Worsley Alumina Pty Ltd (1985)).

List 3 General forest species list. (Forest Department submission to System Six, 1981).

Extracted from Dames & Moore (1984).

TABLE 2

VASCULAR PLANT SPECIES OF HARRIS RIVER DAM CATCHMENT (Partial)

SCIENTIFIC NAME	FAMILY	HABITAT		
		FORESTS	HEATH/ SHRUBLANDS	WATER
Acacia dentifera Benth.	MIMOS			
Acacia divergens Benth.	MIMOS		X	
Acacia drummondii Lindl. ssp. candolleana	MIMOS	X		
Acacia extensa Lindl.	MIMOS	X	X	
Acacia pulchella R. Br.	MIMOS	X		
Acacia saligna Wendl.	MIMOS			
Acacia urophylla Benth. ex Wendl.	MIMOS	X		
Acacia willdenowiana Wendl.	MIMOS	X		
Actinostrobus pyramidalis Miq.	CUPRE		X	
Adenanthos barbigerus Lindl.	PROTE	X		
Adenanthos obovatus Labill.	PROTE		X	
Agonis flexuosa (Spreng.) Schauer	MYRTA	X		
Agonis linearifolia Schauer	MYTRA		X	
Albizia lophantha (Willd.) Benth.	MIMOS		X	
Allocasuarina fraserana (Miq.)	CASUA	X		
Andersonia aristata Lindl.	EPACR		X	
Andersonia involucrata Sond	EPACR		X	
Anigozanthos flavidus Redoute & DC.	HAEMO		X	
Anigozanthos manglesii D. Don	HAEMO	X		
Anigozanthes? viridis Endl.	HAEMO			
Astartea fascicularis (Labill.) DC.	MYRTA		X	
Astroloma humifusum (Cav.) R. Br.	EPACR			
Banksia attenuata R. Br.	PROTE			
Banksia grandis Willd.	PROTE	X		
Banksia litteralis R. Br.	PROTE		X	
Baumea? acuta (Labill.) Palla	CYPER			X
Baumea vaginalis (Benth.) S.T. Blake	CYPER			X
Boronia dichotoma Lindl.	RUTAC		X	
Boronia spathulata Lindl.	RUTAC	X		
Boronia sp.	RUTAC		X	
Borya scirpoidea Lindl.	LILIA		X	
Bossiaea aquifolium Benth.	PAPIL	X		
Bossiaea eriocarpa Benth.	PAPIL	X		
Bossiaea linifolia R. Br.	PAPIL	X		
Bossiaea ornata (Lindl.) Benth.	PAPIL	X		
Caladenia longiclavata E. Colem.	ORCHI	X		
Caladenia uliginosa A.S. George	ORCHI		X	
Calothamnus lateralis Lindl.	MYRTA		X	
Calytrix flavescens A. Cunn.	MYRTA	X	X	
Cassytha glabella R.Br.	LAURA			
Caustis dioica R. Br.	CYPER			
*Centaurium erythraea Rafn.	GENTI			
Centella asiatica (L.) Urban	APIAC			X
Chorizema ilicifolium Labill.	PAPIL	X		
Chorizema rhombeum R.Br.	PAPIL			

TABLE 2 CTD

SCIENTIFIC NAME	FAMILY	HABITAT		
		FORESTS	HEATH/ SHRUBLANDS	WATER
Clematis pubescens Hueg. ex Endl.	RANUN	X		
Compeserma virgatum Labill.	POLYG		X	
Conostylis aculeata R. Br. ssp. aculeata	HAEMO	X		
Conostylis setosa Lindl.	HAEMO	X		
Conostylis serrulata R. Br.	HAEMO			
Cyathochaeta avenacea Benth.	CYPER			
Dampiera linearis R. Br.	GOODE			
Dasypogon bromeliifolius R. Br.	LILIA			
Daviesia hakeoides Meisn.	PAPIL			
Daviesia juncea Sm.	PAPIL			
Daviesia pectinata Lindl.	PAPIL			
Daviesia polyphylla Benth.	PAPIL			
Dianella revoluta R. Br.	LILIA			
Diplolaena microcephala Bartl.	RUTAC			
Diuris longifolia R. Br.	ORCHI			
Drosera spp.	DROSE			
Dryandra nivea (Labill.) R. Br.	PROTE	X		
Eucalyptus calophylla Lindl.	MYRTA	X		
Eucalyptus decipiens Endl.	MYRTA			
Eucalyptus marginata Donn ex Sm.	MYRTA	X		
Eucalyptus megacarpa F. Muell.	MYRTA	X		
Eucalyptus patens Benth.	MYRTA	X		
Eucalyptus rudis Endl.	MYRTA	X		
Eucalyptus wandoo Blakely	MYRTA	X		
Eutaxia virgata Benth.	PAPIL		X	
Gahnia decomposita Benth.	CYPER		X	
Gahnia trifida Lindl.	CYPER		X	
*Gladiolus angustus L.	IRIDA			
Gompholobium capitatum A. Cunn.	PAPIL		X	
Gompholobium knightianum Lindl.	PAPIL			
Gompholobium preissii Meisn.	PAPIL			
Gonocarpus hexandrus (F. Muell.) Orchard	HALOR			X
*Gratiola peruviana L.	SCROP			X
Grevillea drummondii Meissn.	PROTE	X		
Grevillea paniculata Meisn.	PROTE			
Grevillea sp.	PROTE			
Grevillea wilsonii A. Cunn.	PROTE	X		
Haemodorum simplex Lindl.	HAEMO		X	
Hakea cyclocarpa Lindl.	PROTE			
Hakea aff. lasiantha R. Br.	PROTE	X		
Hakea lissocarpha R. Br.	PROTE	X		
Hakea marginata D.C.	PROTE		X	
Hakea prostrata R.Br.	PROTE		X	
Hakea ruscifolia Labill.	PROTE			
Hakea sulcata R. Br.	PROTE		X	
Hakea trifurcata (Sm.) R. Br.	PROTE			
Hakea varia R. Br.	PROTE			

TABLE 2 CTD

SCIENTIFIC NAME	FAMILY	HABITAT		
		FORESTS	HEATH/ SHRUBLANDS	WATER
Helipterum manglesii (Lindl.) Benth.	ASTER	X		
Hemigenia pritzelii S. Moore	LAMIA			
Hibbertia amplexicaulis steud.	DILLE	X		
Hibbertia hypericoides (DC.) Benth.	DILLE	X		
Hibbertia montana Steud.	DILLE	X		
Hibbertia polystachya Benth.	DILLE			
Hibbertia racemosa (Endl.) Gilg	DILLE			
Hibbertia stellaris Endl.	DILLE		X	
Hibbertia subvaginata (Steud.) F. Muell.	DILLE	X		
Hybanthus debilissimus F. Muell.	VIOLA	X		
Hypocalymma angustifolium Endl.	MYRTA		X	
Hypocalymma cordifolium (Lehm.) Schauer	MYRTA		X	
Isopogon dubius (R.Br.) Druce	PROTE			
*Ixia maculata L.	IRIDA			
Jacksonia capitata Benth.	PAPIL		X	
Kingia australis R. Br.	LILIA			
Kunzea recurva Schauer	MYRTA		X	
Labichea punctata Benth.	CAESA		X	
Lasiopetalum floribundum Benth.	STERC			
Laxmannia minor R. Br.	LILIA		X	
Lechenaultia biloba Lindl.	GOODE	X		
Lepidosperma angustatum R. Br.	CYPER			
Lepidosperma longitudinale Labill.	CYPER		X	
Lepidosperma tenue Benth.	CYPER			
Leptocarpus scariosus R. Br.	RESTI			
Leptocarpus tenax (Labill.) R.Br.	RESTI			
Leptomeria cunninghamii Miq.	SANTA			
Leptospermum erubescens Schauer	MYRTA		X	
Leucopogon capitellatus DC.	EPACR	X		
Leucopogon strictus Benth.	EPACR			
Leucopogon verticillatus R. Br.	EPACR	X		
Lobelia alata Labill.	LOBEL			X
Lomandra glauca (R. Br.) Ewart	LILIA	X		
Lomandra sonderi (F. Muell.) Ewart	LILIA	X		
Lomandra sp.nov.	LILIA	X		
Loxocarya fasciculata (R. Br.) Benth.	RESTI	X		
Melaleuca lateritia A. Dietr.	MYRTA		X	
Melaleuca leptoclada Benth.	MYRTA		X	
Melaleuca polygaloides Schauer	MYRTA		X	
Melaleuca preissiana Schauer	MYRTA			
Melaleuca rhaphiophylla Schauer	MYRTA		X	
Melaleuca spathulata Schauer	MYRTA		X	
Melaleuca viminea Lindl.	MYRTA		X	
Mesomelaena tetragona (R.Br.) Benth.	CYPER	X		

TABLE 2 CTD

SCIENTIFIC NAME	FAMILY	HABITAT		
		FORESTS	HEATH/ SHRUBLANDS	WATER
Microtis atrata Lindl.	ORCHI		X	
Microtis orbicularis Roger	ORCHI		X	
Mirbelia dilata R. Br.	PAPIL	X		
Nuytsia floribunda (Labill.) R. Br. ex Fenzl	LORAN		X	
Opercularia echinocephala Benth.	RUBIA			
Opercularia hispidula Endl.	RUBIA			
Oxylobium reticulatum Meisn.	PAPIL		X	
Oxylobium linearifolium D. Don	PAPIL		X	
Patersonia occidentalis R. Br.	IRIDA			
Persoonia longifolia R. Br.	PROTE	X		
Pericalymma ellipticum (Endl.) Schauer	MYRTA		X	
Petrophile linearis R. Br.	PROTE			
Petrophile seminuda Lindl.	PROTE		X	
Phlebocarya ciliata R. Br.	LILIA			
Phyllanthus calycinus Labill.	EUPHO	X		
Pimelea imbricata R. Br.	THYME		X	
Polypompholyx multifida (R.Br.) F. Muell.	LENTI		X	
Poranthera huegelii Klotsch	EUPHO			
Prasophyllum macrostachyum R. Br.	ORCHI		X	
Pteridium esculentum (Forst. f.) Nakai	DENNS	X		
Pterostylis nana R. Br.	ORCHI			
Scaevola striata R. Br.	GOODE	X		
Scaevola sp. ASW 13623	GOODE		X	
Senecio leucoglossus F. Muell.	ASTER	X		
Sollya heterophylla Lindl.	PITTO			
Stackhousia huegelii Engl.	STACK		X	
Stirlingia latifolia (R.Br.) Steud.	PROTE	X		
Stylidium spp.	STYLI			
Styphelia tenuiflora Lindl.	EPACR	X		
Tetraria octandra (Nees) Kuecken.	CYPER			
Tetratheca sp.	TREMA			
Thomasia grandiflora Lindl.	STERC			
Thomasia pauciflora Lindl.	STERC			
Thysanotus dichotomus (Labill.) R. Br.	LILIA			
Tribonanthes violacea Endl.	HAEMO		X	
Triglochin procera R. Br.	JUNCA			X
*Tritonia sp.	IRIDA			
Utricularia hookeri Lehm.	LENTI		X	
Velleia trinervis Labill.	GOODE		X	
Verticordia acerosa Lindl.	MYRTA		X	
Verticordia plumosa Desf.	MYRTA		X	
Villarsia albiflora F. Muell.	MENYA			X
Villarsia parnassifolia R. Br.	MENYA		X	
Villarsia sp.	MENYA		X	
Viminaria juncea (Schrad. & Wendl.) Hoffm.	PAPIL			
Xanthorrhoea gracilis Endl.	LILIA	X		
Xanthorrhoea preissii Endl.	LILIA	X		
Xanthosia huegelii (Benth.) Steud.	APIAC	X		
Xanthosia sp.	APIAC	X		
Xylomelum occidentale R. Br.	PROTE			

* Established alien species

Extracted from Worsley Alumina Pty Ltd (1985).

Species List of Vasular Plants

		TRE-1 REHABILITATION AREA	COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY												COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981), WITH ADDITIONS FROM PHASE TWO STUDY Note: All data for Phase One was extracted from species x plots matrix provided from that study.																					
FAMILY	SPECIES		19JHI	19JMr	19JPs	19JLc	19JBg	19JSd	11W — gully	11W — ridge	22HHu	23HDc	24HCq	21AAh	20S	26C	25J	19J	18MF	17J	16P	15Y	14F	13Y	12G	11W	10J	9F	8B	7BP	6B	5J	4J	3B	2Y	1J
DENNSTAEDTIACEAE	*Pteridium aquilinum*(L.)Kuhn		x																	x			x	x			x	x	x		x	x	x	x	x	x
LINDSAEACEAE	*Lindsaea linearis* Sw.																								x								x			x
ADIANTACEAE	• *Adiantum aethiopicum* L.																																			
	Cheilanthes tenuifolia (Burm.f.)Sw.																								x											
ZAMIACEAE	*Macrozamia riedlei* (Fisch.ex Gaud.) C.A. Gardner		x	x	x	x	x	x	x	x	x	x	x											x	x	x	x				x			x		x
PODOCARPACEAE	• *Podocarpus drouyniana* F. Muell.																																			
JUNCAGINACEAE	• *Triglochin centrocarpa* Hook.																																			
POACEAE	• *Aira caryophyllea* L.	x							x																											
	• *Amphipogon laguroides* R.Br.																																			
	• *Briza maxima* L.		x							x																										
	Danthonia caespitosa Gaud								x		x	x																								
	Neurachne alopecuroidea R.Br.	x						x	x	x	x	x													x	x										
	Poa drummondiana Nees.				x																															
	Stipa elegantissima Labill.									x																										
	Stipa tenuifolia Steud.										x																									
	Stipa trichophylla Benth.					x																														
	• *Stipa* sp.(DB20)																																			
	Tetrarrhena laevis R.Br.		x	x	x	x	x	x		x																			x				x	x		x
	Themeda australis (R.Br.)Stapf										x																									
	• *Vulpia myuros* (L.) C.C. Gmelin	x																																		
CYPERACEAE	*Baumea juncea* (R.Br.)Palla																										x						x		x	
	Baumea vaginalis (Benth.)S.T. Blake																																x			
	Chorizandra enodis Nees.													x																						
	Cyathochaeta avenacea Benth.																												x			x	x			
	Gahnia ancistrophylla F. Muell. ex Benth.								x	x																										
	Gahnia decomposita Benth.																			x						x		x					x			
	Gahnia sp.		x	x	x	x			x			x																								
	Lepidosperma angustatum R.Br.										x	x							x	x			x	x	x	x				x		x				x
	Lepidosperma brunonianum Nees			x		x			x		x	x												x												
	Lepidosperma gracile R.Br.								x																											
	Lepidosperma aff. *gracile* R.Br.(JK33a)			x	x	x	x		x	x		x												x												
	Lepidosperma leptostachyum Benth.					x											x																			
	Lepidosperma scabrum Nees						x																													x
	Lepidosperma tenue Benth.	x	x	x	x	x	x	x	x	x	x	x	x											x		x	x								x	x
	Lepidosperma tetraquetrum Nees																			x	x	x		x				x			x		x	x	x	
	Lepidosperma tuberculatum Nees																			x	x	x		x				x			x		x	x	x	
	• *Mesomelaena gracilipes* (C.B. Clarke) K.L. Wilson																																			
	Mesomelaena tetragona (R.Br.) Benth.																																			x
	Schoenus armeria Boeck.									x		x																								
	Tetraria capillaris (F. Muell.) J.M. Black	x	x	x	x	x	x	x	x	x		x	x					x			x			x		x				x		x		x	x	x
	Tetraria octandra (Nees) Kuekenthal		x		x	x			x																	x	x								x	
RESTIONACEAE	*Empodisma gracillimum* (F.Muell.) L.A.S. Johnson and Cutler								x			x																								
	Hypolaena exsulca R.Br.																															x			x	
	Lepidobolus preissianus Nees				x							x																				x				
	Leptocarpus coangustatus Nees																													x						
	Lepyrodia macra Nees																			x										x						
	Loxocarya cinerea R.Br.					x			x	x		x																								x
	Loxocarya fasciculata (R.Br.) Benth.				x		x		x																	x	x					x		x		x
	Lyginia barbata R.Br.																															x				
	Restio megalotheca F.Muell.											x														x										
PHILYDRACEAE	• *Philydrella pygmaea* (R.Br.) Caruel																																			
JUNCACEAE	• *Luzula meridionalis* Nordensk																																			
LILIACEAE	*Agrostocrinum scabrum* (R.Br.) Baill.			x		x					x																								x	
	Arthropodium capillipes Endl.				x					x				x																						
	Borya sphaerocephala R.Br.											x													x		x									
	Burchardia multiflora Lindl.								x																											
	Caesia parviflora R.Br.								x		x																									
	Chamaescilla corymbosa (R.Br.) F. Muell. ex Benth.					x			x									x																		
	Dianella revoluta R.Br.		x	x	x	x	x		x	x	x		x													x										x
	• *Johnsonia lupilina* R.Br.																																			
	Laxmannia squarrosa Lindl.			x		x					x	x														x						x				
	Sowerbaea laxiflora Lindl.								x																											
	Thysanotus dichotomus (Labill.) R.Br.			x	x	x	x					x																								
	Thysanotus multiflorus R. Br.				x	x																														x
	Thysanotus patersonii R.Br.		x				x		x			x											x													

FAMILY	SPECIES	TRE-1 REHABILITATION AREA	COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY												COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981), WITH ADDITIONS FROM PHASE TWO STUDY Note: All data for Phase One was extracted from species x plots matrix provided from that study.																					
			19JHl	19JMr	19JPs	19JLc	19JBg	19JSd	11W — gully	11W — ridge	22HHu	23HDc	24HCq	21AAh	20S	26C	25J	19J	18MF	17J	16P	15Y	14F	13Y	12G	11W	10J	9F	8B	7BP	6B	5J	4J	3B	2Y	1J
	Thysanotus tenellus Endl.				x	x					x	x														x										
	• *Thysanotus thyrsoideus* Baker																																			
	Tricoryne elatior R.Br.				x																															x
	Tricoryne humilis Endl.	x			x	x						x																								
	Wurmbea dioica (R.Br.) F. Muell.								x																											
	Wurmbea tenella (Endl.) Benth.									x																										
XANTHORRHOEACEAE																																				
	Dasypogon bromeliifolius R.Br.																															x				
	Kingia australis R.Br.																															x				
	Lomandra caespitosa (Benth.) Ewart																	x																		
	Lomandra hermaphrodita (C. Andrews) C.A. Gardner	x	x	x	x	x	x		x	x		x						x									x									x
	Lomandra micrantha (Endl.) Ewart	x	x	x	x	x	x	x	x																											x
	Lomandra pauciflora (R.Br.) Ewart																																			x
	Lomandra preissii (Endl.) Ewart				x						x	x												x												x
	Lomandra purpurea (Endl.) Ewart				x																														x	x
	Lomandra sericea (Endl.) Ewart					x																														x
	Lomandra spartea (Endl.) Ewart		x	x	x	x	x		x									x									x									
	Lomandra suaveolens (Endl.) Ewart																									x										
	Lomandra sp. (JK 12)	x	x	x	x	x	x	x	x	x		x														x	x			x		x			x	x
	Lomandra sp. (JK 122)				x	x																				x										
	Xanthorrhoea gracilis Endl.		x	x	x	x	x	x																			x								x	x
	Xanthorrhoea preissii Endl.	x	x	x	x	x	x	x	x	x	x	x	x					x					x	x	x	x	x		x	x		x			x	x
HAEMODORACEAE																																				
	Anigozanthos flavidus Redoute & DC.																																		x	
	• *Anigozanthos manglesii* D.Don																																			
	Conostylis aculeata R.Br.																															x				x
	Conostylis serrulata R.Br.																															x				x
	Conostylis setigera R.Br.		x	x	x	x	x		x	x		x	x	x				x							x	x	x									x
	Haemodorum laxum R.Br.				x	x			x	x	x	x														x										
	Phlebocarya ciliata R.Br.																															x				
	• *Tribonanthes uniflora* Lindl.																																			
HYPOXIDACEAE																																				
	Hypoxis occidentalis Benth.								x																											
IRIDACEAE																																				
	• *Patersonia babianoides* Benth.																																			
	Patersonia juncea Lindl.						x																													
	Patersonia occidentalis R.Br.																													x		x				x
	Patersonia pygmaea Lindl.									x																x										
	Patersonia sericea R.Br. ex Ker-Gawl.				x	x						x																								

FAMILY	SPECIES	TRE-1 REHABILITATION AREA	COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY												COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981), WITH ADDITIONS FROM PHASE TWO STUDY Note: All data for Phase One was extracted from species x plots matrix provided from that study.																					
			19JHl	19JMr	19JPs	19JLc	19JBg	19JSd	11W — gully	11W — ridge	22HHu	23HDc	24HCq	21AAh	20S	26C	25J	19J	18MF	17J	16P	15Y	14F	13Y	12G	11W	10J	9F	8B	7BP	6B	5J	4J	3B	2Y	1J
ORCHIDACEAE																																				
	Acianthus reniformis (R.Br.) Schlechter							x	x																											
	• *Caladenia deformis* R.Br.																																			
	• *Caladenia filamentosa* R.Br.																																			
	Caladenia flava R.Br.					x						x																								
	Caladenia gemmata Lindl.													x																						
	Caladenia latifolia R.Br.																																			x
	Caladenia macrostylis Fitzg.					x																														
	Caladenia nana Endl.							x																												x
	Caladenia patersonii R.Br.				x	x						x																								
	• *Caladenia reptans* Lindl.																																			
	Caladenia sericea Lindl.						x		x				x																							x
	• *Cryptostylis ovata* R.Br.																																			
	• *Diuris longifolia* R.Br.																																			
	• *Drakaea elastica* Lindl.																																			
	Elythranthera brunonis (Endl.) George					x						x																								
	Eriochilus dilatatus Lindl.					x																														
	Lyperanthus nigricans R.Br.						x						x																							x
	• *Paracaleana nigrita* (Lindl.) Blaxell																																			
	Prasophyllum hians H.Reichenb.			x																																
	Prasophyllum parvifolium Lindl.											x																								
	Pterostylis barbata Lindl.																																	x		x
	Pterostylis nana R.Br.																																		x	x
	Pterostylis recurva Benth.																																			x
	• *Pterostylis rufa* R.Br.																																			
	Pterostylis vittata Lindl.					x	x		x				x																					x	x	x
	Thelymitra antennifera (Lindl.) Hook.											x																								
CASUARINAÇEAE																																				
	Allocasuarina fraseriana (Miq.) L. Johnson			x	x	x	x	x																			x									x
	Allocasuarina huegeliana (Miq.) L. Johnson													x		x									x											
	Allocasuarina humilis (Otto & Dietr.) L. Johnson				x	x						x													x	x	x									
	Allocasuarina microstachya (Miq.) L. Johnson											x																								
PROTEACEAE																																				
	Adenanthos cygnorum Diels					x						x																								
	Adenanthos obovatus Labill.											x																				x				
	Banksia grandis Willd.		x	x	x	x	x	x	x									x									x		x			x		x		x
	Banksia littoralis R.Br. var. *littoralis*																					x		x		x			x		x			x	x	

			COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY												COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981), WITH ADDITIONS FROM PHASE TWO STUDY. Note: All data for Phase One was extracted from species x plots matrix provided from that study.																					
FAMILY	SPECIES	TRE-1 REHABILITATION AREA	19JHl	19JMr	19JPs	19JLc	19JBg	19JSd	11W — gully	11W — ridge	22HHu	23HDc	24HCq	21AAh	20S	26C	25J	19J	18MF	17J	16P	15Y	14F	13Y	12G	11W	10J	9F	8B	7BP	6B	5J	4J	3B	2Y	1J
	Banksia sphaerocarpa R.Br.				x	x						x																		x									
	Conospermum amoenum Meisn.											x																									
	Conospermum capitatum R.Br.											x																					x				
	Dryandra armata R.Br.												x																								
	Dryandra bipinnatifida R.Br.																									x											
	Dryandra carduacea Lindl.					x						x																									
	Dryandra nivea (Labill.) R.Br.	x	x	x	x	x	x		x	x		x						x							x	x	x								x	x
	Dryandra aff. *nivea* (Labill.) R.Br., var. 1 (ASW 12574)											x																									
	Dryandra aff. *nivea* (Labill.) R.Br. var. 2 (KA 242)											x																									
	Dryandra sessilis (Knight) Domin	x	x	x	x	x	x	x	x	x							x	x									x									
	Grevillea bipinnatifida R.Br.				x	x			x			x	x	x											x	x	x									
	• *Grevillea brevicuspis* Meisn.																																			
	Grevillea drummondii Meisn.																																		x	
	Grevillea quercifolia R.Br.					x																														
	Hakea amplexicaulis R.Br.																															x			x	x
	Hakea gilbertii Kipp.ex Meisn.											x																								
	Hakea incrassata R.Br.										x	x	x																							
	Hakea lasiantha R.Br.																													x						x
	Hakea lissocarpha R.Br.		x	x	x	x	x	x	x	x	x	x	x												x	x									x	x
	Hakea prostrata R.Br.								x																	x						x				
	Hakea ruscifolia Labill.					x						x																								
	Hakea trifurcata (Sm.) R.Br.											x																								
	Hakea undulata R.Br.			x		x			x	x	x	x	x	x																						
	Hakea varia R.Br.								x																							x				x
	Isopogon buxifolius R.Br.											x																								
	Isopogon formosus R.Br.					x						x						x																	x	
	Persoonia angustiflora Benth.				x	x						x																								
	Persoonia elliptica R.Br.					x																														
	Persoonia longifolia R.Br.		x	x	x	x	x	x	x	x																	x		x			x		x	x	x
	• *Persoonia quinquenervis* Hook.																																			
	Petrophile ericifolia R.Br.											x																								
	Petrophile heterophylla Lindl.					x						x																								
	• *Petrophile ? seminuda* Lindl. (DAH 180190)																																			
	Petrophile serruriae R.Br.				x	x						x																								
	Petrophile squamata R.Br.				x	x						x																								
	Petrophile striata R.Br.		x	x	x	x	x																													
	Synaphea petiolaris R.Br.				x	x	x					x														x									x	
	Synaphea aff. *petiolaris* R.Br. (DAH 801210)			x	x			x			x						x																			

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FAMILY	SPECIES	TRE-1 REHABILITATION AREA	19JHl	19JMr	19JPs	19JLc	19JBg	19JSd	11W — gully	11W — ridge	22HHu	23HDc	24HCq	21AAh	20S	26C	25J	19J	18MF	17J	16P	15Y	14F	13Y	12G	11W	10J	9F	8B	7BP	6B	5J	4J	3B	2Y	1J
SANTALACEAE	*Leptomeria cunninghamii* Miq.		x	x	x	x	x	x	x	x	x															x										x
	Santalum acuminatum (R.Br.) DC.																																		x	
OLACACEAE	*Olax benthamiana* Miq.											x														x										x
POLYGONACEAE	*Muehlenbeckia adpressa* (Labill.) Meisn.											x																								
	• *Rumex acetosella* L.	x																																		
	• *Rumex crispus* L.																		x																	
CHENOPODIACEAE	*Atriplex* sp. (ASW 12527)																		x																	
AMARANTHACEAE	*Ptilotus drummondii* (Moq.) F. Muell.		x	x	x	x	x		x			x																								
	Ptilotus manglesii (Lindl.) F. Muell.			x	x					x	x	x												x												
RANUNCULACEAE	*Clematis pubescens* Huegel ex Endl.		x			x	x	x		x														x			x		x					x	x	x
LAURACEAE	*Cassytha glabella* R.Br.			x					x	x	x	x		x												x	x									
	Cassytha racemosa Nees					x	x																											x		
DROSERACEAE	*Drosera barbigera* Planch.						x																													
	Drosera bulbosa Hook.					x												x																		
	Drosera erythorhiza Lindl.							x																												
	Drosera gigantea Lindl.								x																											
	• *Drosera glandulifera* Lehm.																																			
	• *Drosera heterophylla* Lindl.																																			
	Drosera leucoblasta Benth.										x																									
	Drosera menziesii R.Br.								x																											
	Drosera pallida Lindl.			x			x			x									x								x									
	Drosera platystigma Lehm.			x	x	x	x	x				x																								
	• *Drosera pulchella* Lehm.																																			
	• *Drosera stolonifera* Endl.																																			
	• *Drosera stricticaulis* (Diels) O.H. Sargent																																			
PITTOSPORACEAE	*Billardiera bicolor* (Putterl.) E.M. Bennett				x		x		x																											
	Billardiera floribunda (Putterl.) F. Muell.																					x												x		
	Billardiera varifolia DC.				x	x		x			x		x	x																				x		x

FAMILY	SPECIES	TRE-1 REHABILITATION AREA	COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY												COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981), WITH ADDITIONS FROM PHASE TWO STUDY Note: All data for Phase One was extracted from species x plots matrix provided from that study.																					
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	Sollya heterophylla Lindl.							x																					x						
ROSACEAE	*Acaena echinata* Nees								x														x											x
MIMOSACEAE	*Acacia alata* R.Br.		x	x		x		x		x	x	x	x	x			x							x				x					x	x	x	x
	Acacia celastrifolia Benth.	x	x	x	x	x	x	x	x	x		x																x								
	Acacia deflexa Maiden & Blakely											x																								
	Acacia dentifera Benth.									x																										
	Acacia divergens Benth.																				x									x				x	x	
	Acacia drummondii Lindl.	x	x	x	x	x	x	x	x	x	x	x															x							x		x
	Acacia ericifolia Benth.											x																								
	Acacia extensa Lindl.	x																		x				x		x	x								x	
	Acacia gilbertii Meisn.	x	x																																	
	Acacia incurva Benth.																																			
	Acacia lateriticola Maslin	x			x																x							x							x	x
	Acacia leptospermoides Benth.											x																								
	Acacia myrtifolia (Sm.) Willd.	x																																		
	Acacia myrtifolia (Sm.) Willd. var. *angustifolia*(Benth.)Benth	x																																		
	Acacia nervosa DC			x					x	x	x															x										
	Acacia preissiana (Meisn.) Maslin		x	x	x	x	x	x	x	x		x						x								x	x									
	Acacia pulchella R.Br.	x	x			x		x	x	x	x	x	x	x			x					x	x	x	x	x	x								x	x
	Acacia saligna (Labill.) Wendl.	x			x																				x		x									
	Acacia stenoptera Benth.											x																								
	Acacia urophylla Benth.ex Lindl.	x																																		x
	Acacia willdenowiana Wendl.			x	x				x																											
	Albizia lophantha (Willd.) Benth.																																		x	
CAESALPINIACEAE	*Labichea punctata* Benth.		x	x	x	x	x			x																	x									
FABACEAE	*Bossiaea aquifolium* Benth.																			x	x								x	x	x	x	x	x	x	x
	Bossiaea eriocarpa Benth.								x																											
	Bossiaea linophylla R.Br.	x																																		
	Bossiaea ornata (Lindl.) Benth.	x	x	x	x	x	x	x	x	x		x	x				x	x								x	x									x
	• *Bossiaea rufa* R.Br.																																			
	Chorizema aciculare (DC.) C.A. Gardner									x																										
	Chorizema ilicifolium Labill.																				x							x		x						
	Chorizema rhombeum R.Br.																																			x
	Daviesia cordata Sm.			x					x	x																										
	• *Daviesia costata* Cheel																																			

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	Daviesia decurrens Meisn.	x		x	x	x	x					x														x										
	Daviesia juncea Sm.								x																x											
	Daviesia longifolia Benth.				x	x		x				x																								
	Daviesia polyphylla Benth.					x																														
	Daviesia preissii Meisn.	x	x	x	x	x	x	x	x																											
	Daviesia rhombifolia Meisn.				x	x	x	x		x		x														x										
	Dillwynia cinerascens R.Br. ex Sims											x																								
	Gastrolobium spinosum Benth.																								x											
	Gompholobium capitatum A. Cunn.																															x				
	Gompholobium marginatum R.Br.	x	x	x	x	x			x	x	x	x												x		x										
	• *Gompholobium ovatum* Meisn.																																			
	Gompholobium polymorphum R.Br.			x	x	x			x	x																										
	Gompholobium preissii Meisn.	x	x		x	x			x																											
	Gompholobium venustum R.Br.											x																								
	Hardenbergia comptoniana (Andr.) Benth.	x																																		
	Hovea chorizemifolia (Sweet) DC.	x	x	x	x	x	x	x	x	x																	x									x
	Hovea trisperma Benth.											x																								x
	Isotropis cuneifolia (Sm.) Benth. ex B.D. Jackson.						x		x																											
	Jacksonia alata Benth.											x														x										
	Jacksonia furcellata (Bonpl.) DC.																															x				
	Jacksonia racemosa Meisn.											x																								
	Kennedia coccinea Vent.		x		x	x	x			x																								x	x	x
	• *Kennedia microphylla* Meisn.																																			
	Kennedia prostrata R.Br.	x		x	x	x			x		x		x																							
	Mirbelia dilatata R.Br.																											x							x	x
	• *Mirbelia floribunda* Benth.																																			
	Oxylobium lanceolatum (Vent.) Druce																				x							x			x		x	x	x	
	• *Pultenaea skinneri* F. Muell.																																			
	Sphaerolobium vimineum Sm.				x				x			x																								
	Templetonia drummondii Benth.	x			x	x	x		x			x																								
	Viminaria juncea (Schrad. & Wendl.) Hoffm.				x																															
GERANIACEAE	• *Geranium molle* L.					x																		x												
	Pelargonium littorale Huegel					x																		x												
OXALIDACEAE	*Oxalis corniculata* L.								x																											
LINACEAE	*Linum marginale* A. Cunn. ex Planch.		x																																	

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RUTACEAE	*Boronia crenulata* Sm. var. *gracilis* (Benth.) P.G. Wils.					x		x																			x									
	Boronia aff. *defoliata* F.Muell. (KA 256)											x																								
	Boronia fastigiata Bartl.		x	x	x	x	x		x	x																			x			x		x	x	x
	Boronia molloyae Drumm.																											x		x						x
	Boronia ovata Lindl.											x																								
	• *Boronia tenuis* (Lindl.) Benth.																																			
	Diplolaena microcephala Bartl.																																		x	
	Eriostemon spicatus A. Rich.																															x				x
TREMANDRACEAE	*Platytheca galioides* Steetz												x	x																						
	Tetratheca hirsuta Lindl.		x	x	x	x	x	x																			x									x
	Tetratheca virgata Steetz									x																										
	Tremandra stelligera R.Br.																																x	x	x	x
POLYGALACEAE	*Comesperma calymega* Labill.			x	x	x																		x		x	x									x
	Comesperma virgatum Labill.		x	x	x	x	x	x	x																											x
	Comesperma volubile Labill.										x																									
	Comesperma sp. (KA 307)									x																										
EUPHORBIACEAE	*Amperea ericoides* A.Juss.																																		x	x
	Phyllanthus calycinus Labill.		x	x		x	x	x	x	x							x	x						x	x	x	x					x				x
	Poranthera huegelii Klotzsch					x																														
	Poranthera microphylla Brongn.													x																						
STACKHOUSIACEAE	*Stackhousia brunonis* Benth.				x	x	x		x			x																								
	Stackhousia huegelii Endl.											x														x									x	
	Stackhousia pubescens A. Rich.				x			x	x	x	x	x	x	x																						
	Stackhousia scoparia Benth.			x		x																														
	Stackhousia viminea Sm.				x	x			x									x																		
SAPINDACEAE	*Dodonaea attenuata* A. Cunn.																										x									
	Dodonaea ceratocarpa Endl.											x	x	x																						
	• *Dodonaea pinifolia* Miq.																																			
RHAMNACEAE	• *Cryptandra arbutiflora* Fenzl																																			
	Cryptandra glabriflora Benth.										x																									
	Cryptandra aff. *polyclada* Diels (KA 309)										x																									
	Cryptandra tomentosa Lindl.											x																								
	Spyridium complicatum F.Muell.											x																								
	Spyridium oligocephalum (Turcz.) Benth.											x																								
	Trymalium floribundum Steud.								x	x	x		x	x						x							x				x			x	x	x
	Trymalium ledifolium Fenzl		x	x	x	x	x		x	x	x	x	x				x	x							x	x	x							x	x	x
STERCULIACEAE	*Lasiopetalum cardiophyllum* S.Paust			x	x	x	x			x		x																								
	Lasiopetalum floribundum Benth.																											x					x	x	x	x
	Thomasia foliosa J.Gay								x																											
	Thomasia glutinosa Lindl.											x																								
	• *Thomasia grandiflora* Lindl.																																			
	Thomasia paniculata Lindl.																											x					x	x	x	
	Thomasia pauciflora Lindl.																				x									x						
DILLENIACEAE	*Hibbertia acerosa* (R.Br. ex DC.) Benth.		x	x	x	x	x		x	x		x						x								x	x									x
	Hibbertia amplexicaulis Steud.	x	x	x	x	x	x	x	x	x													x	x		x	x			x					x	x
	Hibbertia commutata Steud.		x			x	x		x	x		x														x	x									
	Hibbertia aff. *commutata* Steud. (KA 268)		x																																	
	Hibbertia gracilipes Benth.																									x						x				
	Hibbertia hypericoides (DC.) Benth.		x						x	x	x	x	x												x	x	x					x			x	x
	• *Hibbertia perfoliata* Endl.																																			
	Hibbertia polystachya Benth.								x			x														x						x				
	Hibbertia rhadinopoda F. Muell.																										x									
	Hibbertia serrata Hotchkiss																																	x	x	
	Hibbertia silvestris Diels																			x				x										x	x	
	• *Hibbertia subvaginata* (Steud.) F. Muell.																																			
	• *Hibbertia vaginata* (Benth.)F. Muell.																																			
	Hibbertia sp. (JK 150)	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x						x			x									x
VIOLACEAE	*Hybanthus floribundus* (Lindl.) F. Muell.				x				x		x	x																						x		
THYMELACEAE	*Pimelea imbricata* R.Br.		x						x				x													x										
	Pimelea rosea R.Br.								x			x	x																							
	• *Pimelea suaveolens* (Endl.) Meisn.																																			
	Pimelea sylvestris R.Br.				x																						x							x		

Worsley Alumina Pty Ltd

FAMILY	SPECIES	TRE-1 REHABILITATION AREA	COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY												COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981), WITH ADDITIONS FROM PHASE TWO STUDY Note: All data for Phase One was extracted from species x plots matrix provided from that study.																						
			19JHI	19JMr	19JPs	19JLc	19JBg	19JSd	11W — gully	11W — ridge	22HHu	23HDc	24HCq	21AAh	20S	26C	25J	19J	18MF	17J	16P	15Y	14F	13Y	12G	11W	10J	9F	8B	7BP	6B	5J	4J	3B	2Y	1J
MYRTACEAE	• *Agonis flexuosa* (Spreng.) Schauer																																			
	Agonis linearifolia (DC.) Schauer																			x	x								x	x	x	x		x	x	x	x
	Astartea fascicularis (Labill.) DC.											x							x		x	x	x	x				x		x					x	
	Baeckea camphorosmae Endl.								x																	x						x				
	Baeckea aff. *crispiflora* F.Muell. (JK 146)										x																									
	Beaufortia macrostemon Lindl.					x						x																								
	Calothamnus planifolius Lehm.			x		x				x		x																								
	Calothamnus quadrifidus R.Br.											x	x	x																						
	Calothamnus sanguineus Labill.											x																								
	• *Calytrix brachyphylla* (Turcz.) Benth.																																			
	• *Calytrix flavescens* A.Cunn.																																			
	Calytrix stenophylla W.V. Fitzg.					x						x																								
	Darwinia citriodora (Endl.) Benth.										x																									
	• *Darwinia thymoides* (Lindl.) Benth.																																			
	Eucalyptus accedens W.V. Fitzg.	x																																		
	Eucalyptus calophylla Lindl.	x	x	x	x	x	x	x	x	x	x	x					x			x		x		x	x	x	x		x			x		x	x	x
	Eucalyptus drummondii Benth.											x																								
	• *Eucalyptus maculata* Hook.	x																																		
	Eucalyptus marginata Donn ex Sm.	x	x	x	x	x	x	x	x	x							x	x		x				x	x	x	x					x	x	x	x	x
	Eucalyptus megacarpa F. Muell.	x																										x	x	x	x			x		
	Eucalyptus sp. nov. series Oleosae (ASW 12583)												x																							
	Eucalyptus patens Benth.	x																			x	x		x						x		x	x		x	x
	Eucalyptus rudis Endl.																		x		x		x	x				x								
	Eucalyptus wandoo Blakely	x							x	x	x	x														x										
	Hypocalymma angustifolium Endl.										x	x	x	x						x				x	x	x	x			x						x
	Hypocalymma cordifolium (Lehm.) Schauer																				x				x			x		x	x			x	x	x
	Kunzea recurva Schauer											x																								
	Leptospermum erubescens Schauer											x	x														x									
	Melaleuca holosericea Schauer											x																								
	Melaleuca polygaloides Schauer								x			x																								
	Melaleuca preissiana Schauer											x									x		x					x		x		x	x			
	Melaleuca radula Lindl.										x																									
	Melaleuca rhaphiophylla Schauer								x			x							x																	
	Melaleuca scabra R.Br.				x							x																								
	Melalauce viminea Lindl.											x			x																					
	Verticordia densiflora Lindl.											x																								

FAMILY	SPECIES	TRE-1 REHABILITATION AREA	COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY											COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981). WITH ADDITIONS FROM PHASE TWO STUDY Note: All data for Phase One was extracted from species x plots matrix provided from that study.																					
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	Verticordia huegelii Endl.																																			
	Verticordia pennigera Endl.					x					x	x																								
	Verticordia picta Endl.											x																								
	• *Verticordia plumosa* (Desf.) Druce																																			
	Verticordia serrata (Lindl.) Schauer											x																								
HALORAGACEAE																																				
	Glischrocaryon aureum (Lindl.) Orchard					x				x	x		x	x																						
	Gonocarpus benthamii Orchard																																	x	x	
	Gonocarpus cordiger (Fenzl) Endl. ex Nees		x		x	x	x		x	x		x														x	x									
APIACEAE																																				
	Apium prostratum Labill. ex. Vent.																		x																	
	Eryngium pinnatifidum Bunge								x									x																		
	Pentapeltis peltigera (Hook.) Bunge		x	x	x	x	x																	x			x								x	x
	Platysace compressa (Labill.) Norman																															x	x	x	x	x
	Platysace juncea (Bunge) Norman										x																									
	Platysace teres (Bunge) Norman				x																															
	• *Trachymene ornata* (Endl.) Druce																																			
	Trachymene pilosa Sm.								x																											
	Xanthosia atkinsoniana F.Muell.	x		x	x	x	x	x	x	x								x									x									x
	Xanthosia candida Benth.		x	x		x			x	x																									x	x
	Xanthosia huegelii (Benth.) Steud.	x	x		x	x	x		x	x		x														x										x
	Xanthosia sp. (KA 257)					x																														
EPACRIDACEAE																																				
	Andersonia involucrata Sond.					x	x			x			x																			x				
	Andersonia lehmanniana Sond.				x							x																								
	Andersonia sp. (DAH 80131)					x																														
	Astroloma ciliatum (Lindl.) Druce	x	x	x	x	x	x	x	x	x			x					x								x	x									
	Astroloma compactum R.Br.		x						x																											
	Astroloma drummondii Sond.				x	x					x																									
	Astroloma epacridis (DC.) Druce					x	x		x		x	x	x	x																		x				
	Astroloma pallidum R.Br.	x	x	x	x	x	x	x	x	x	x	x	x					x								x	x									
	Astroloma aff. *pallidum* R.Br. (ASW 12516)				x												x								x											
	• *Leucopogon australis* R.Br.																																			
	Leucopogon capitellatus DC.	x	x	x	x	x	x	x	x	x	x		x	x									x	x			x							x	x	x
	Leucopogon conostephioides DC.											x																								
	Leucopogon hirsutus Sond.																													x						
	Leucopogon oxycedrus Sond.	x	x	x	x	x	x	x	x	x	x	x																								x
	Leucopogon propinquus R. Br.		x	x	x	x	x	x	x	x			x											x		x	x						x			

FAMILY	SPECIES	TRE-1 REHABILITATION AREA	COMMUNITY TYPES IN INITIAL MINING AREA AS DEFINED IN PHASE TWO STUDY												COMMUNITY TYPES IN REFINERY LEASE AREA AND ON CONVEYOR CORRIDOR AS DEFINED IN PHASE ONE (WORSLEY ALUMINA & DAMES AND MOORE 1981), WITH ADDITIONS FROM PHASE TWO STUDY Note: All data for Phase One was extracted from species x plots matrix provided from that study.																					
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	Stylidium glaucum Labill.					x																														
	Stylidium imbricatum Benth.			x	x	x																														
	Stylidium junceum R.Br.		x	x	x	x	x		x																											
	Stylidium lineatum Sond.											x																								
	Stylidium petiolare Sond.										x																									
	Stylidium piliferum R.Br.	x	x	x		x	x	x	x	x		x												x		x	x									x
	Stylidium pulchellum Sond.																																			
	Stylidium repens R.Br.											x																								
	Stylidium rhynchocarpum Sond.																																	x		x
	Stylidium schoenoides DC.				x		x		x	x		x	x	x																						
	Stylidium spathulatum R.Br.						x																											x	x	x
	Stylidium uniflorum Sond.		x								x																									
ASTERACEAE	• *Aster subulatus* Michaux																		x																	
	• *Athrixia gracilis* (A.Gray) Benth.																																			
	Brachycome iberidifolia Benth.																				x															
	• *Chrysocoryne drummondii* A. Gray																																			
	• *Conyza bonariensis* (L.) Cronquist																		x																	
	Craspedia uniflora Forst.								x																											
	• *Dittrichia graveolens* (L.) W. Greuter	x																																		
	Gnaphalium sphaericum Willd.																							x												
	Helichrysum bracteatum (Vent.) Andr.					x																														
	Helichrysum ramosum DC.		x	x		x																													x	x
	Helipterum cotula (Benth.) DC.																									x										
	• *Helipterum demissum* (A. Gray) Druce																																			
	• *Helipterum manglesii* (Lindl.) Benth.																																			
	• *Hypochoeris glabra* L.	x	x						x															x										x		x
	Lagenifera huegelii Benth.								x	x																x										x
	Olearia paucidentata (Steetz) Benth.				x				x			x															x									
	Podolepis gracilis R. Grah.		x																					x												x
	• *Quinetia urvillei* Cass.																																			
	Senecio hispidulus A. Rich.		x	x	x	x	x	x	x	x	x			x										x			x									x
	Senecio lautus Forst. ex Willd.		x	x		x		x	x	x		x																								x
	Senecio leucoglossus F.Muell.		x	x	x	x	x	x					x																							x
	• *Senecio* sp. (ASW 12618)																																			
	Senecio sp. (JK 163)																																		x	
	Siloxerus filifolius (Benth.) Ostenf.																					x														
	•• *Silybum marianum* (L.) Caertn.																																			
	Trichocline spathulata (A.Cunn. ex DC.) Willis					x			x	x																										
	Waitzia citrina (Benth.) Steetz										x																									

Extracted from Forests Dept. submission to System Six (1981).

OCCURRENCE OF INDIVIDUAL PLANT SPECIES IN VEGETATION TYPES

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
<u>Dennstaedtiaceae</u>																																
Pteridium esculentum									x	x													x		x			x	x			
<u>Adiantaceae</u>																																
Adiantum aethiopicum														x				x							x							
<u>Cupressaceae</u>																																
Actinostrobus pyramidalis												x																				
<u>Typhaceae</u>																																
Typha angustifolia											x																					
<u>Cyperaceae</u>																																
Baumea articulata											x																					
Baumea juncea											x																					
Baumea laxa											x																					
Caustis dioica		x	x																	x											x	
Gahnia trifida												x		x																		
Lepidosperma angustatum	x														x	x	x		x				x	x					x			
Lepidosperma longitudinale																	x															
Lepidosperma scabrum							x	x	x	x																						
Lepidosperma tenue														x					x				x	x								
Lepidosperma tetraquetrum														x																		
Mesomelaena stygia	x	x	x	x																												
Nesomelaena tetragona															x	x	x		x	x												
Schoenus fascicularis								x	x	x																						
Schoenus grandiflorus	x	x	x	x																												
Scirpus curvifolius								x	x	x			x			x				x												
Scirpus nodosus												x																				
Tetrariopsis octandra																			x				x	x								

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
<u>Restionaceae</u>																																
Lepidobolus preissianus								x	x	x		x								x												
Loxocarya flexuosa															x								x	x							x	
Restio leptocarpoides										x	x																					
Restio laxus										x	x																					
Restio stenostachyus										x	x																					
Restio tremulus							x	x	x																							
Leptocarpus scariosus								x	x	x	x	x	x		x	x				x												
Lyginia tenax																							x	x								
<u>Liliaceae</u>																																
Borya nitida																		x														
Dianella revoluta																		x	x					x	x	x						
Johnsonia pubescens															x	x																
Lomandra caespitosa																			x				x	x								
Lomandra collina																			x				x	x								
Lomandra endlicheri																	x			x												
Lomandra glauca																			x				x	x								
Lomandra purpurea																			x				x	x								
Lomandra sonderi																	x			x												
Sowerbaea laxiflora			x	x	x																											

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Stypandra grandiflora																		x														
Thysanotus dichotomus																			x				x	x								
Calectasia cyanea				x	x	x	x																									
Dasypogon bromeliaefolius								x	x	x			x																			
Kingia australis														x		x																
Xanthorrhoea gracilis																	x		x				x	x								
Xanthorrhoea preissii		x	x	x	x	x	x	x	x						x						x				x		x	x	x	x		x
Haemodoraceae																																
Anigozanthos bicolor																				x												
Anigozanthos manglesii			x	x	x	x	x	x					x			x	x		x	x				x								
Conostylis candicans		x	x																													
Conostylis setigera																			x				x	x								
Conostylis setosa																			x				x	x			x					
Phlebocarya ciliata					x				x				x			x				x												
Dioscoreaceae																																
Dioscorea hastifolia																		x														
Iridaceae																																
Patersonia juncea											x																					
Patersonia occidentalis					x	x	x	x	x				x							x												
Patersonia pygmaea															x																	

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Patersonia rudis																			x			x										
Casuarinaceae																																
Casuarina acuaria												x								x												
Casuarina fraserana			x	x															x					x			x					
Casuarina huegeliana																		x														
Casuarina humilis			x	x	x	x	x	x					x					x	x			x				x						
Casuarina microstachya			x	x									x							x												
Casuarina obesa												x																				
Casuarina thuyoides													x				x															
Proteaceae																																
Adenanthos barbigera																								x			x					
Adenanthos meissneri				x	x	x							x							x												
Adenanthos obovata									x	x			x																			
Adenanthos sericea						x	x	x	x							x				x												
Banksia attenuata		x	x	x	x	x	x	x	x											x												
Banksia grandis																x							x	x			x	x				
Banksia ilicifolia			x	x					x				x																			
Banksia littoralis										x	x	x		x																		
Banksia littoralis var. seminuda														x																		

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Banksia meissnerii												x																				
Banksia menziesii			x	x	x	x	x	x												x												
Banksia prionotes			x						x	x										x												
Banksia sphaerocarpa		x	x																x					x								
Conospermum acerosum				x	x	x																										
Conospermum amoenum																										x						
Conospermum caeruleum																																x
Conospermum capitatum						x																										
Conospermum densiflorum																			x			x										
Conospermum huegelii																		x														
Conospermum incurvum				x	x	x																										
Conospermum stoechadis				x	x	x	x										x			x												
Conospermum triplinervium	x	x	x																													
Dryandra armata																		x								x						
Dryandra bipinnatifida																						x										x
Dryandra carduaceae																			x					x		x						
Dryandra fraseri																							x	x			x					
Dryandra nivea		x	x	x																		x	x	x		x					x	
Dryandra polycephala																			x					x		x						
Dryandra praemorsa																		x				x										

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Dryandra sessilis	x	x																	x				x	x		x	x					
Grevillea bipinnatifida																		x				x										
Grevillea diversifolia														x																		
Grevillea drummondii															x															x		
Grevillea endlicherana																		x														
Grevillea flexuosa																								x								x
Grevillea glabrata																		x								x						
Grevillea monticola																	x															
Grevillea pilulifera																		x								x						
Grevillea pulchella																	x		x													
Grevillea quercifolia																		x								x						
Grevillea ripicola														x																		
Grevillea synapheae																			x		x	x	x	x								
Grevillea thelemanniana	x	x																														
Grevillea vestita	x	x	x																													
Grevillea wilsonii																			x					x								
Hakea amplexicaulis																							x			x						
Hakea auriculata																						x				x						
Hakea costata		x	x	x														x				x										
Hakea cyclocarpa																	x		x					x								
Hakea erinaceae																		x								x						

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Hakea incrassata																		x								x						
Hakea lasiantha														x																		
Hakea lissocarpha		x	x																			x			x	x	x	x				x
Hakea marginata																		x								x						
Hakea petiolaris																		x														
Hakea prostrata															x															x	x	
Hakea ruscifolia			x	x	x												x		x													
Hakea stenocarpa																		x				x										
Hakea sulcata												x																				
Hakea trifurcata	x	x																x								x						
Hakea undulata																		x								x						
Hakea varia											x	x																			x	
Isopogon buxifolius																	x		x													
Isopogon dubius																	x		x				x	x								
Isopogon sphaerocephalus																								x								
Isopogon teretifolius																		x														
Persoonia angustiflora													x				x			x												
Persoonia comata						x	x	x																								
Persoonia elliptica																			x					x								

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Persoonia longifolia																			x				x	x	x	x	x	x				
Persoonia saccata							x	x																								
Persoonia striata																	x			x												
Petrophile biloba																		x														
Petrophile brevifolia		x	x																													
Petrophile ericifolia																		x														
Petrophile linearis				x	x	x	x	x	x				x																			
Petrophile longifolia													x																			
Petrophile macrostachya			x	x	x	x																										
Petrophile seminuda																x				x												
Petrophile serruriae		x	x	x													x	x	x													
Petrophile squamata												x																				
Petrophile striata																	x		x					x								
Stirlingia latifolia			x	x	x	x	x	x									x		x	x												
Stirlingia simplex																		x														
Synaphea decorticans																			x													
Synaphea favosa												x				x																
Synaphea petiolaris													x		x	x			x				x	x								
Synaphea polymorpha													x	x	x	x																
Xylomelum occidentale				x	x	x	x	x	x				x		x	x																

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Santalaceae																																
Leptomeria cunninghamii																			x					x			x	x				
Santalum acuminatum																			x							x						
Olacaceae																																
Olax benthamiana																			x													
Loranthaceae																																
Nuytsia floribunda		x	x	x	x	x	x	x	x	x	x		x		x	x	x		x	x												
Polygonaceae																																
Muehlenbeckia adpressa																					x											
Chenopodiaceae																																
Rhagodia baccata	x	x																														
Amarantaceae																																
Trichinium manglesii																					x	x									x	
Ranunculaceae																																
Clematis pubescens	x	x																							x			x	x			
Lauraceae																																
Cassytha glabella										x	x	x																				
Cassytha pubescens												x																				
Pittosporaceae																																
Sollya heterophylla																							x	x	x							

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Mimosaceae																																
Acacia acuminata																					x											
Acacia alata														x	x									x						x		
Acacia aphylla																		x														
Acacia barbinervis		x	x																													
Acacia cochlearis	x	x																														
Acacia cuneata	x																															
Acacia dentifera																		x							x							
Acacia diptera				x	x										x	x																
Acacia divergens														x																		
Acacia drummondii																						x										x
Acacia extensa														x	x		x								x							
Acacia huegelii							x	x																								
Acacia incurva															x					x												
Acacia lateriticola																										x	x	x				
Acacia nervosa																						x										x
Acacia pulchella		x	x	x	x	x	x	x									x	x	x			x	x	x		x	x	x		x	x	x
Acacia preissiana																	x		x													
Acacia saligna			x	x	x					x																						
Acacia sphacelata						x																										
Acacia squamata																															x	

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Acacia stenoptera				x	x							x																				
Acacia subflexuosa																		x														
Acacia urophylla																								x			x	x				
Albizzia lophantha														x																		
Caesalpiniaceae																																
Labichea punctata				x	x																											
Papilionaceae																																
Aotus cordifolia														x																		
Aotus preissii								x	x	x																						
Aotus villosa											x																					
Bossiaea aquifolium																							x		x			x	x			
Bossiaea eriocarpa			x	x	x	x	x	x	x				x				x			x												
Bossiaea linophylla														x	x										x							
Bossiaea ornata																			x			x	x	x				x	x			x
Bossiaea pulchella																			x					x								
Burtonia conferta									x	x							x			x												
Burtonia scabra										x																						
Chorizema dicksonii																		x				x										
Chorizema ilicifolium														x											x			x	x			
Chorizema rhombeum																			x													

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Daviesia cordata																									x	x	x					
Daviesia costata																	x															
Daviesia divaricata				x	x	x																										
Daviesia hakeoides																							x	x								
Daviesia horrida																		x								x						
Daviesia incrassata				x	x				x	x			x																			
Daviesia juncea					x	x											x															
Daviesia longifolia																	x															
Daviesia nudiflora				x	x	x																										
Daviesia pectinata				x	x								x			x	x		x					x			x					
Daviesia polyphylla																			x					x		x						
Daviesia quadrilatera						x																										
Daviesia rhombifolia																	x		x													
Daviesia uniflora																															x	
Euchilopsis linearis										x	x		x																			
Gastrolobium bilobum												x		x								x										
Gastrolobium calycinum																		x				x									x	
Gastrolobium ovalifolium																		x														
Gastrolobium parvifolium																		x								x						
Gastrolobium spinosum																		x														

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Gastrolobium trilobum																		x				x										
Gastrolobium villosum																	x	x								x						
Gompholobium knightianum																								x								
Gompholobium marginatum																			x					x								
Gompholobium polymorphum																	x			x												
Gomphologium shuttleworthii																						x										x
Gompholobium tomentosum				x	x	x																										
Gompholobium venustum																	x			x												
Hardenbergia comptoniana	x	x	x	x																					x		x	x				
Hovea chorizemifolia																							x	x		x	x	x				
Hovea pungens							x																									
Hovea trisperma			x	x	x	x																										
Isotropis cuneifolia			x	x	x																											
Jacksonia alata													x		x																	
Jacksonia angulata																	x			x												
Jacksonia floribunda					x	x	x																									
Jacksonia furcellata				x	x								x							x												
Jacksonia hakeoides		x	x																													
Jacksonia stenbergiana		x	x	x	x																											

	COASTAL											PLATEAU																			
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y
Kennedia coccinea																x			x				x	x	x		x	x			
Kennedia prostrata			x	x	x	x										x				x											
Mirbelia dilatata														x	x															x	
Mirbelia spinosa																		x								x					
Oxylobium capitatum				x	x	x	x	x											x												
Oxylobium drummondii														x				x													
Oxylobium linearifolium														x																	
Pultenaea ericifolia																		x								x					
Pultenaea reticulata									x	x																					
Sphaerolobium macranthum				x	x																										
Sphaerolobium medium															x	x	x							x							
Templetonia retusa	x	x																													
Viminaria juncea											x	x																			
Geraniaceae																															
Pelagornium littorale		x	x	x	x																										
Rutaceae																															
Asterolasia pallida																		x								x					
Boronia defoliata																	x			x											
Boronia megastigma												x		x																	
Boronia molloyae														x																	

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Boronia ovata																								x								
Boronia purdieana							x																									
Boronia ramosa								x	x																							
Boronia spathulata																							x	x			x					
Diplolaena angustifolia	x																															
Diplolaena drummondii var. microcephala																					x	x			x							x
Eriostemon nodiflorus																		x														
Eriostemon spicatus			x	x	x	x	x	x											x	x			x	x								
Tremandraceae																																
Platytheca verticillata									x	x			x																			
Tetratheca viminea																			x						x		x	x				
Tetratheca virgata																			x													x
Tremandra diffusa																									x				x			
Polygalaceae																																
Comesperma confertum																									x							
Comesperma flavum				x	x																											
Comesperma polygaloides																								x			x					
Comesperma virgatum																								x			x					
Euphorbiaceae																																
Phyllanthus calycinus		x	x														x	x	x					x		x	x	x				

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Stachystemon vermicularis																x																
Stackhousiaceae																																
Stackhousia huegelii			x	x	x	x																										
Stackhousia pubescens																		x														
Sapindaceae																																
Diplopeltis huegelii	x	x																			x											
Dodoneae attenuata																		x														
Dodonaea aptera	x	x																x														
Dodonaea microzyga																		x														
Rhamnaceae																																
Cryptandra arbutiflora																		x														
Cryptandra pungens		x	x																													
Trymalium ledifolium	x	x																	x				x	x	x	x	x	x				x
Trymalium spathulatum														c											x				x			
Sterculiaceae																																
Lasiopetalum cardiophyllum																			x													x
Lasiopetalum floribundum																											x	x		x		
Lasiopetalum glabratum															x				x	x												
Thomasia foliosa																						x										
Thomasia glutinosa														x	x									x								

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Thomasia grandiflora														x																		
Thomasia macrocarpa														x																		
Thomasia pauciflora														x																		
Thomasia triphylla				x	x																											
Dilleniaceae																																
Hibbertia amplexicaulis																x	x		x				x	x	x	x						
Hibbertia cuneiformis																															x	
Hibbertia helianthemoides										x																						
Hibbertia huegelii			x	x	x	x											x		x													x
Hibbertia hypericoides		x	x	x	x	x	x	x								x	x		x			x	x	x	x	x	x	x		x		x
Hibbertia lasiopus																			x		x	x										x
Hibbertia lineata																					x				x						x	
Hibbertia montana																			x					x	x		x	x	x			
Hibbertia pachyrrhiza																				x												
Hibbertia polystachya													x			x	x			x											x	
Hibbertia quadricolor																						x										x
Hibbertia racemosa	x	x	x														x		x													
Hibbertia silvestris																									x							
Hibbertia spicata																		x								x						
Hibbertia stellaris													x							x												
Hibbertia subvaginata						x	x	x	x	x			x							x												
Violaceae																																
Hybanthus calycinus		x	x	x	x																											
Thymelaeaceae																																
Pimelea floribunda			x	x																												
Pimelea imbricata																		x														
Pimelea rosea			x	x															x			x										
Pimelea spectabilis															x									x								
Pimelea suaveolens																	x		x					x			x					
Pimelea sulphurea				x	x	x																										
Pimelea sylvestris				x	x																											
Myrtaceae																																
Agonis flexuosa														c											x							
Agonis grandiflora																		x														
Agonis linearifolia														x																		
Astartea fascicularis										x	x	x		x																		
Baeckea camphorosmae															x	x			x			x									x	
Beaufortia elegans							x	x																								
Beaufortia macrostemon																			x													x
Beaufortia squarrosa											x																					

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Callistemon speciosus												x	x																			
Calothamnus lateralis											x																					
Calothamnus quadrifidus	x	x	x																x					x								
Calothamnus rupestris																		x														
Calothamnus sanguineus			x	x	x	x													x							x						
Calytrix angulata			x	x	x													x		x												
Calytrix brachyphylla																				x												
Calytrix flavescens				x	x	x	x	x	x				x																			
Calytrix sapphirina							x																									
Conothamnus trinervis				x	x																											
Darwinia citriodora																		x								x						
Darwinia thymoides														x																		
Eremaea fimbriata				x	x																											
Eremaea pauciflora					x	x	x	x																								
Eremaea purpurea						x																										
Eucalyptus accedens																						x										x
Eucalyptus calophylla													x		x	x		x	x				x	x	x	x	x	x	x	x		x
Eucalyptus decipiens		x	x															x								x						
Eucalyptus decurva																		x														
Eucalyptus drummondii																		x														
Eucalyptus gomphocephala		x	x																													

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Eucalyptus haematoxylon																							x			x						
Eucalyptus laeliae																		x														
Eucalyptus leptophylla	x	x																														
Eucalyptus marginata	x	x		x	x				x				x		x	x	x		x	x		x	x	x		x	x	x		x		x
Eucalyptus megacarpa														x	x															x		
Eucalyptus patens												x		x	x	x		x			x	x			x			x	x	x		
Eucalyptus rudis										x	x	x		x																		
Eucalyptus todtiana			x	x	x	x	x																									
Eucalyptus wandoo																					x	x										x
Hypocalymma angustifolium									x	x		x	x	x	x	x					x	x		x						x	x	
Hypocalymma cordifolium													x																			
Hypocalymma robustum			x	x	x																											
Hypocalymma xanthopetalum			x	x																												
Kunzea ericifolia			x	x					x	x		x	x							x												
Kunzea recurva												x			x				x					x								x
Leptospermum ellipticum										x	x	x		x	x	x		x												x		
Leptospermum spinescens			x	x	x																											
Melaleuca acerosa		x	x																													
Melaleuca cardiophylla	x																															
Melaleuca ciliosa			x	x																												
Melaleuca cymbifolia												x																				

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Melaleuca depauperata												x																				
Melaleuca huegelii	x																															
Melaleuca incana												x		x	x																	
Melaleuca lanceolata												x																				
Melaleuca lateritia										x	x	x																				
Melaleuca preissiana										x	x	x	x																			
Melaleuca radula																		x														
Melaleuca rhaphiophylla											x	x		x																		
Melaleuca scabra					x	x	x	x											x							x						
Melaleuca seriata								x	x				x																			
Melaleuca subtrigona												x																				
Melaleuca teretifolia										x	x																					
Melaleuca tenella												x																				
Melaleuca thymoides			x	x	x																											
Melaleuca uncinata												x																				
Melaleuca viminea												x																				
REgelia ciliata											x	x																				
Regelie inops							x																									
Scholtzia ciliata				x	x																											
Scholtzia involucrata					x	x	x	x																								

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Verticordata acerosa																		x														
Verticordia chrysantha												x																				
Verticordia densiflora								x	x			x						x													x	
Verticordia grandiflora																	x	x														
Verticordia huegelii																		x														
Verticordia insignis																		x														
Verticordia nitens				x	x	x	x	x																								
Verticordia ovalifolia						x	x																									
Verticordia pennigera																		x														
Verticordia picta																		x														
Verticordia plumosa																		x														
Verticordia serrata																										x						
<u>Haloragaceae</u>																																
Haloragis pithyoides			x	x																												
Loudonia aurea															x							x									x	
<u>Apiaceae</u>																																
Eryngium pinnatifidum																		x														
Platysace compressa																			x					x								
Xanthosia atkinsoniana																			x					x								x
Xanthosia candida																			x					x								x

	COASTAL												PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K		A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Xanthosia peltigera																									x			x					x
Epacridaceae																																	
Andersonia aristata																			x														
Andersonia brevifolia																			x														
Andersonia lehmanniana				x	x	x	x												x		x												
Astroloma ciliatum			x	x	x															x					x								
Astroloma drummondii																				x					x								
Astroloma microcalyx				x	x																												
Astroloma microdonta																				x							x						
lor pallidum				x	x	x														x					x			x					
Astroloma xerophyllum						x	x																										
Brachyloma preissii																		x			x												
Conostephium minus							x																										
Conostephium pendulum			x	x	x	x	x																										
Leucopogon australis											x																						
Leucopogon capitellatus																							x			x	x	x	x	x			x
Leucopogon conostephioides							x	x																									
Leucopogon cordatus														x			x		x		x												
Leucopogon oxycedrus																					x				x								x

	COASTAL												PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K		A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
Leucopogon parviflorus													x		x																		
Leucopogon polymorphus			x	x	x	x	x	x																									
Leucopogon propinquus																							x			x	x	x	x	x			x
Leucopogon racemulosus			x																														
Leucopogon sprengelioides							x	x																									
Leucopogon strictus							x	x											x														
Leucopogon verticillatus																												x	x	x			
Lysinema ciliatum				x	x	x	x														x												
Styphelia tenuiflora																				x	x			x	x		x	x					x
Loganiaceae																																	
Logania serpyllifolia															x																		
Logania vaginalis		x																															
Dicrastylidaceae																																	
Lachnostachys verbascifolia																					x												
Pityrodia bartlingii						x																											
Lamiaceae																																	
Hemiandra linearis							x	x																									
Hemiandra pungens			x	x	x															x	x												
Hemigenia barbata	x																																
Hemigenia pritzelii				x	x														x														
Hemigenia sericea																			x														

	COASTAL											PLATEAU																				
	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	J	L	M	O	P	Q	R	S	T	U	W	Y	Z
<u>Rubiaceae</u>																																
Opercularia hispidula																									x							
Opercularia vaginata																									x							
<u>Goodeniaceae</u>																																
Dampiera alata															x	x			x				x	x								x
Dampiera lavendulaceae																		x				x									x	
Dampiera linearis																			x				x	x								
Lechenaultia biloba															x	x			x				x	x								
Lechenaultia formosa												x																				
Lechenaultia linarioides	x	x																														
Scaevola canescens			x	x																												
Scaevola striata														x	x								x	x	x		x	x				
Verreauxia reinwardtii				x	x																											
<u>Asteraceae</u>																																
Olearia rudis	x	x	x																													

Extracted from Alcoa (W.A.) Ltd 1979

TABLE 2.3.2-1 LICHEN SPECIES LIST

Several unclassified crustose species and a few foliose species are unlisted. All fruticose species are included. These unlisted species are currently being determined. Affinity groupings are assigned where equivalence is in doubt.

SPECIES	SITES WHERE PRESENT
Acarospora sp.	15
Anaptychia obscurata	93
Anaptychia sp.	59
Buellia sp.	93
Caloplaca aurantiaca	15, 16, 91, 97, 110
Caloplaca citrina	0
Caloplaca fulgens	15, 16, 60
Candelariella vitellina	0, 28
Cladia aggregata	0, 57
aff. *Cladia aggregata*	0, 27, 59, 91, 110
Cladia fernandii	0
aff. *Cladia fernandii*	0
Cladionia cariosa	0, 18, 51, 93, 99, 101
Cladonia coniocrea	94
Cladonia ochrochlora	16, 58
Cladonia pitrea	41, 59, 94
aff. *Cladonia pityrea*	94
Cladonia chlorophaea	59
aff. *Cladonia squamosa*	0, 57
Cladonia verticillata	0,16,57,59,101,102,105,110
aff. *Cladonia verticillata*	28
Cladonia sp. 425	91
aff. *Cladonia* sp. 39	4, 15, 29, 56, 104
aff. *Cladonia* sp. 432	0, 91

TABLE 2.3.2-1 (Contd)

LICHEN SPECIES LIST

SPECIES	SITES WHERE PRESENT
aff. *Cladonia* sp. 290	15, 44
aff. *Cladonia* sp. 96	0, 14, 15, 91, 96, 107
Dermatocarpon sp.	0, 59, 91
Ephebe tasmanica	59
Graphidaceae	0, 2, 3, 4, 5, 19, 20, 41 50, 53, 93, 99
Haematomma punicea	0, 42, 91, 96
Heterodea muelleri	0, 91
Hypogymnia physodes	41, 104
Hypogymnia subphysodes	43
Lecanora casiorubella	5, 96, 101, 104
Lecanora atra	41
Lecanora sp.	54
Lecidea contigua	15, 50, 51, 93, 99
Lecidea planata	27
Lecidea sp. 112	15, 99
Lecidea sp. 301	54
Lecidea sp. 54	5
Lecidea sp. 495	105
Parmelia caperata	2, 101
Parmelia conformata	2, 23
Parmelia cheelii	0
Parmelia conspersa	0, 2, 15, 30, 91
aff. *Parmelia harrisii*	0, 110
Parmelia perlata	97, 110
Parmelia rutidota	4, 5, 41, 42, 43, 44, 59, 97, 105, 108, 110

TABLE 2.3.2-1 (Contd)

LICHEN SPECIES LIST

SPECIES	SITES WHERE PRE
Parmelia subalbicans	0, 5, 42, 96, 1
Parmelia sp. 460	99,
Parmelia sp. 491	15, 92, 93, 104
Parmelia sp. 257	44
Parmelia sp. 440A	2, 93
Parmelia sp. 107	15
Pertusaria sp.	0, 4, 5
Porocyphus lichenelloides	29, 110
Ramalea cochleata	51, 93
aff. *Ramalea cochleata*	92, 99, 102
Ramalina fastigiata	0, 5, 108
Rhizocarpon geographicum	0, 15, 60
Siphula caesia	0
Siphula coriaceae	0, 15, 99
Teloschistes chrysophthalmus	5, 97
Thysanothecium hookeri	16, 27, 93
Thysanothecium hyalinum	15, 23, 24, 44, 94, 98, 99, 101.
aff. *Thysanothecium hyalinum*	18, 33, 91, 101
Umbilicaria sp. 199	29
Umbilicaria sp. 203	30
Usnea barbata var. *xanthopoga*	2, 5, 0, 41, 44. 101, 103, 104, 1
Usnea barbata	41
Usnea barbata var. *scabrida*	0, 108

APPENDIX 8: Mammalian fauna and their habitat requirements in the Lane-Poole Reserve. Status is symbolised as follows; VC = very common, C = common, L = locally distributed, R = restricted.

MAMMAL	HABITAT REQUIREMENTS	STATUS
Macropodidae		
Macropus fuliginosus Western Grey Kangaroo	Open forest with shrubby or grassy understorey	VC
Macropus irma Western Brush Wallaby	Open forest country with shrub understorey	C
Burramyidae		
Cercartetus concinnus Western Pygmy Possum	Hollows of Casuarinas, Banksias, blackboys, stumps	L
Tarsipedidae		
Tarsipes rostratus Honey Possum	Flowering shrubs and trees; in blackboys	C
Dasyuridae		
Dasyurus geoffroii Western Native Cat	Dry sclerophyll forest, scrub, heathland	L
Phascogale tapoatafa Common Wambenger	Open dry sclerophyll forest with little ground cover	R
Antechinus flavipes Yellow-footed Antechinus	Forest with dense understorey: Rocky slopes; fire-free uplands	C
Sminthopsis griseoventer Common Dunnart	Hollow log, blackboys, open forest and heathland	L
Sminthopsis gilberti Dunnart	Hollow log, blackboys, open forest and heathland	L
Tachyglossidae		
Tachyglossus aculeatus Echidna	In rocks or under stones, logs: Open forest or scrubland	L
Peramelidae		
Isoodon obesulus Southern Brown Bandicoot	Forest with dense scrub cover, logs and rocks under dense cover.	R
Hydromyinae		
Hydromys chrysogaster Water Rat	Dense vegetation on banks of streams and swamps	C

Molossidae		
<u>Tadarida australis</u> White-striped Mastiff Bat	Stream zones; tree hollows, loose tree bark in woodlands	
<u>Mormopterus planiceps</u> Little Mastiff Bat	Hollow trees, cracks, crevices etc. in open or dense forest	
Vespertilionidae		
<u>Nyctophilus timoriensis</u> Greater Long-eared Bat	Watercourses that traverse open dry woodlands	
<u>Nyctophilus geoffroyi</u> Lesser Long-eared Bat	Hollows in trees, dried sheets of bark in sclerophyll forest	
<u>Nyctophilus gouldii</u> Gould's Long-eared Bat	Stream zones in dry sclerophyll forest. Hollows in branches	
<u>Eptesicus regulus</u> King River Eptesicus	Hollow limbs or cracks etc. in dry sclerophyll forest	
<u>Chalinolobus gouldii</u> Gould's Wattled Bat	Tree sprouts, bird nests etc. in open or dense forest	
<u>Chalinolobus morio</u> Chocolate Bat	Tree hollows, bird nests etc. in open or dense forest	
<u>Pipistrellus tasmaniensis</u> Tasmanian Pipistrelle	Tree hollows in higher rainfall forest	
Muridae		
<u>Mus musculus</u> House mouse	Survives in almost any kind of habitat	VC
<u>Rattus rattus</u> Black Rat	Distribution determined by access to water, shelter, food	R
Canidae		
<u>Vulpes vulpes</u> European Red Fox	Distribution determined by food supply and adequate refuge	C
Leporidae		
<u>Oryctolagus cuniculus</u> European Rabbit	Open grassy valleys; distribution determined by food supply, refuge	C
Suidae		
<u>Sus scrofa</u> Feral Pig	Distribution determined by food supply, access to water, shelter	L
Bovidae		
<u>Ovis aries</u> Sheep	Open grassy valleys; distribution determined by food supply, refuge	L

Felidae		
Felis cattus Feral Cat	Logs, disused burrows; distribution determined by food supply, refuge	L

APPENDIX 9: The amphibian and reptilian fauna of the Lane-Poole Reserve. Status is represented as such: VC = very common, C = common, L = locally distributed, R = restricted. Nomenclature follows Storr et *al*. (1981, 1983), Tyler *et al*. (1984) and Cogger (1979).

AMPHIBIA		STATUS
Leptodactylidae:	*Crinia georgiana*	VC
	Geocrinia leai	C
	Heleioporus barycragus	L
	Heleioporus eyrei	L
	Heleioporus inornatus	C
	Limnodynastes dorsalis	VC
	Pseudophyrne guentheri	C
	Ranidella glauerti	VC
	Ranidella pseudinsignifera	C
Hylidae	*Litoria adelaidensis*	L
	Litoria moorei	VC
REPTILIA		
Cheluidae:	*Chelodina oblonga*	L
Gekkonidae:	*Crenadactylus o. ocellatus*	L
	Diplodactylus polyophthalmus	VC
	Diplodactylus granariensis	L
	Oedura reticulata	C
	Phyllodactylus marmoratus	VC
	Phyllurus milii	C
	Gehyra variegata	C
Pygopodidae:	*Aprasia pulchella*	L
	Delma fraseri	L
	Lialis burtonis	L
	Aprasia repens	L

Agamidae	*Pogona m. minor*	C
	Ctenophorus ornatus	L
Scincidae	*Cryptoblepharus plagiocephalus*	VC
	Ctenotus delli	L
	Ctenotus labillardieri	VC
	Egernia luctuosa	C
	Egernia napoleonis	VC
	Egernia p. pulchra	L
	Hemierges i. initalis	VC
	Hemierges p. peronii	L
	Hemierges p. quadrilineata	L
	Leiolopisma trilineatum	L
	Lerista distinguenda	C
	Lerista m. microtis	L
	Menetia greyii	C
	Morethia obscura	VC
	Tiliqua r. rugosa	C
Varanidae	*Varanus rosenbergi*	L
	Varanus gouldii	L
	Varanus tristis	L
Typhlopidae	*Ramphotyphlops australis*	L
	Ramphotyphlops pinguis	L
Boidae	*Python spilotes imbricatus*	C
Elapidae	*Acanthophis antarcticus*	R
	Notechis coronatus	L
	Notechis scutatus occidentalis	L
	Pseudonaja a. affinis	L
	Rhinoplocephalus gouldii	C
	Rhinoplocephalus nigriceps	L

APPENDIX 10: A provisional list of avifauna of Lane-Poole Reserve.
Abundance is estimated as scarce(S), uncommon(U), moderately common (MC) or common (C).
Preferred habitat: Jg: Jarrah/gravel soils. Sparse understorey.
Sw: Swamps, jarrah/red loam, riverside forest.
Cl: Clearings, forest edges.
R : Rivers and dams.

SPECIES	STATUS	HABITAT
Emu Dromaius novaehollandiae	U	Jg
Hoary-headed Grebe Poliocephalus poliocephalus	S	R
Australasian Grebe Tachybaptus novaehollandiae	MC	R
Great Cormorant Phalacrocorax carbo	U	R
Little Black Cormorant Phalacrocorax sulcirostris	U	R
Little Pied Cormorant Phalacorcorax melanoleucos	U	R
Pacific Heron Ardea pacifica	S	R
White-faced Heron Ardea Novaehollandiae	MC	R
Black Bittern Dupetor flaricollis	S	Sw
Black Swan Cygnus atratus	S	R
Australian Shelduck Todorna tadornoides	U	R
Pacific Black Duck Anas superciliosa	MC	R
Grey Teal Anas gibberifrons	U	R
Australasian Shoveler Anas rhynehotis	U	R
Maned Duck Chenonetta jubata	U	R
Musk Duck Biziura lobata	U	R

Black-shouldered Kite *Elanus notatus*	U	Cl
Square-tailed Kite *Lophoictinia isura*	U	Jg
Whistling Kite *Haliastur sphenurus*	U	Jg
Brown Goshawk *Accipiter fasciatus*	S	Jg
Collared Sparrowhawk *Accipiter cirrhocephalus*	S	Jg
Wedge-tailed Eagle *Aquila audax*	MC	Jg
Little Eagle *Hieraaetus morphnoides*	U	Jg
Peregrine Falcon *Falco peregrinus*	S	Jg
Australian Hobby *Falco longipennis*	U	Jg
Brown Falcon *Falco berigora*	MC	Jg
Australian Kestrel *Falco cenchroides*	S	Cl
Brown Quail *Coturnix australis*	MC	Sw
Painted Button-quail *Turnix varia*	MC	Sw
Purple Swamphen *Porphyrio porphyrio*	S	Sw
Black-fronted Plover *Charadius melanops*	MC	R
Common Bronzewing *Phaps chalcoptera*	C	Jg
Brush Bronzewing *Phaps elegans*	U	Jg
Red-tailed Black-Cockatoo *Calyptorhynchus baudinii*	MC	Jg
Purple-crowned Lorikeet *Glossopsitta porphyrocephala*	U	Jg

Regent Parrot Polytelis anthopeplus	U	Jg
Red-capped Parrot Purpureicephalus spurius	C	Jg
Western Rosella Platycercus icterotis	C	Jg
Port Lincoln Ringneck Parnardius zonarius	C	Jg
Elegent Parrot Neophema elegans	U	Jg
Pallid Cuckoo Cuculus pallidus	MC	Jg
Fan-tailed Cuckoo Cuculus pyrrphohanus	MC	Jg
Horsfield's Bronze-Cuckoo Chrysococcyxz basalis	MC	Jg
Shining Bronze-Cuckoo Chrysococcyx lucidus	U	Jg
Southern Boobook Ninox novaeseelandiae	U	Jg
Barn Owl Tyto alba	S	Jg
Tawny Frogmouth Podargus strigoides	MC	Jg
Australian Owlet-nightjar Aegoyheles cristatus	MC	Jg
Laughing Kookaburra Dacelo novaeguinae	C	Jg
Sacred Kingfisher Halcyon sancta	U	Jg
Rainbow Bee-eater Merops ornatus	MC	Jg
Welcome Swallow Hirundo neoxena	U	Jg
Tree Martin Cercropis nigricans	MC	Jg

Richard's Pipit *Anthus novaeseelandiae*	U	Cl
Black-faced Cuckoo-shrike *Corcacina novaehollandiae*	MC	Jg
White-einged Triller *Lalage sueurii*	S	Jg
Scarlet Robin *Petroica multicolor*	C	Jg
Red-capped Robin *Petroica goodenovii*	U	Jg
White-breased Robin *Eopsaltria georgiana*	MC	Sw
Western Yellow Robin *Eopsaltria griseogularis*	C	Jg
Golden Whistler *Pachycephala pectoralis*	C	Jg
Rufous Whistler *Pachycephala rufiventris*	U	Jg
Grey Shrike=thrush *Colluricincla harmonica*	C	Jg
Restless Flycatcher *Myiagra inquieta*	MC	Jg
Grey Fantail *Rhipidura fuliginosa*	C	Jg
Willie Wagtail *Rhipidura leuchophrys*	MC	Jg
Splendid Fariy-wren *Malurus splendens*	C	Sw
Red-winged Fairy-wren *Malurus elegans*	MC	Sw
White-browed Scrub wren *Sericornis frontalis*	MC	Sw
Weebill *Smicornis breviostris*	C	Jg
Western Gerygone *Greygone fusca*	C	Jg
Inland Thornbill *Acanthiza apicalis*	C	Jg

Western Thornbill *Acanthiza inornata*	C	Jg
Yellow-rumped Thornbill *Acanthiza chrysorrhoa*	C	Jg
Varied Sitella *Daphoenositta chrysoptera*	C	Jg
Rufous Treecreeper *Climacteris rufa*	MC	Jg
Red Wattlebird *Anthochaera carunculata*	MC	Jg
Little Wattlebird *Anthochaera chrysoptera*	MC	Jg
Singing Honeyeater *Lichenostomus virescens*	U	Jg
Brown-headed Honeyeater *Milithreptus breviostris*	MC	Jg
White-naped Honeyeater *Melithreptus lunatus*	C	Jg
Brown Honeyeater *Lichmera indistincta*	C	Jg
New Holland Honeyeater *Phylidonyris novaehollandiae*	C	Sw
White-cheeked Honeyeater *Phylidonyris nigra*	U	Sw
Tawny-crowned Honeyeater *Phylidonyris melanops*	MC	Jg
Western Spinebill *Acanthorhynchus superciliosus*	C	Jg
White-fronted Chat *Ephthianura albifrons*	U	Sw
Mistletowbird *Dicaeum hirundinaceum*	S	Jg
Spotted Pardalote *Pardalotus puncatatus*	MC	Jg
Striated Pardalote *Pardalotus striatus*	MC	Jg
Silvereye *Zosterops lateralis*	C	Sw

Red-eared Firetail _Emblema oculata_	MC	Sw
Australian Magpie-Lark _Grallina cyanoleuca_	MC	Cl
Black-faced Woodswallow _Artamus cinereus_	MC	Jg
Dusky Woodswallow _Artamus cyanopterus_	MC	Jg
Grey Butcherbird _Cracticus torquatus_	U	Cl
Australian Magpie _Gymnorhina tibicen_	MC	Cl
Grey Currawong _Strepera versicolor_	MC	Jg
Australian Raven _Corvus coronoides_	C	Cl

APPENDIX 11: Systematic list of taxa of macroinvertebrates from streams of the northern jarrah forest.

CNIDARIA
  HYDROZOA
      Hydridae

PLATYHELMINTHES
  TEMNOCEPHALIDEA
      Temnocephalidae
        Temnocephala sp

  TURBELLARIA
    TRICLADIDA
      Dugesiidae

NEMATODA
      Mermithidae

NEMATOMORPHA
      Gordiidae
        Gordius sp

MOLLUSCA
  GASTEROPODA
    PROSOBRANCHIA
      ?Hydrobiidae
        Glacidorbis *occidentalis* Bunn and Stoddart
    PULMONATA
      Ancylidae
        Ferrissia sp
      Planorbiidae
        Physastra sp

  BIVALVIA
      Hyriidae
        Westralunio *carteri* Iredale

ANNELIDA
  OLIGOCHAETA
      Several Species
  HIRUDINEA
      Richardsonianidae
        Richardsonianus *australis*

ARTHROPODA
  ARACHNIDA
    HYDRACARINA
  CRUSTACEA
    BRACHIOPODA
      Daphniidae
        Daphnia *carinata*
    OSTRACODA
      Cyprididae
        Ilyodromus sp

- COPEPODA
  - CYCLOPOIDA
    - Cyclopidae
      - *Macrocyclops albidus* (Jurine)
  - HARPACTICOIDA
- SYNCARIDA
    - Parabathynellidae
- ISOPODA
  - PHREATOICIDEA
    - Amphisopidae
      - *Hyperoedesipus plumosus* Nicholls and Milner
- AMPHIPODA
    - Gammaridae
      - *Perthia branchialis* (Nicholls)
      - *Uroctena* sp
- DECAPODA
    - Parastacidae
      - *Cherax quinquecarinatus* (Gray)
      - *C. plebejus* (Hess)
      - *C. tenuimanus* (Smith)
    - Palaemonidae
      - *Palaemonetes australis*

INSECTA

- EPHEMEROPTERA
    - Baetidae
      - *Baetis ?soror* Ulmer
      - *Cloeon* sp
    - Caenidae
      - *Tasmanocoenis tillyardi* (Lestage)
    - Leptophlebiidae
      - Three undescribed
- ODONATA
  - ZYGOPTERA
    - Coenagrionidae
      - *Ischnura aurora*
      - *Austroagrion coeruleum*
    - Megapodagrionidae
      - *Argiolestes minimus* Tillyard
      - *A. pusillus* Tillyard
  - ANISOPTERA
    - Gomphidae
      - *Hemigomphus armiger* (Tillyard)
      - *Austrogomphus lateralis* (Selys)
    - Petaluridae
      - *Petalura hesperia* Watson
    - Aeshnidae
      - *Aeshna brevistyla*
      - *Austroaeschna anacantha* Tillyard
    - Synthemidae
      - *Synthemis cyanitincta* Tillyard
      - *S. leachii* Selys
    - Corduliidae
      - *Hesperocordulia berthoudi* Tillyard
      - *Lathrocordulia metallica* Tillyard
    - Libellulidae
      - *Orthetrum caledonicum* (Brauer)

PLECOPTERA
Gripopterygidae
Leptoperla australica (Enderlein)
Newmanoperla exigua (Kimmins)
Riekoperla occidentalis Hynes and Bunn
HEMIPTERA
Veliidae
Corixidae
Micronecta sp
MEGALOPTERA
Chauliodidae
Archichauliodes cervulus Theischinger
DIPTERA
Tipulidae
Tipuliinae undescribed species
Limoniinae four undescribed species
Psychodidae
Two undescribed species
Culicidae
Anopheles annulipes
Chironomidae
Tanypodinae
Ablabesmyia spp
Macropelopia sp
Paramerina levidensis (Skuse)
Indet gen Aphroteniinae
Aphroteniella filicornis Brundin
Orthocladiinae
Cricotopus annuliventris (Skuse)
Diplocladius (Stictocladius) uniserialis Freeman
Limnophyes sp
Thienemaniella sp
One Indet gen and sp
Chironominae
Chironomini
Chironomus aff. alternans Walker
C. (Chryptochironomus) griseodorsum Kieffer
Chryptochironomus curtivalva
?Paraborniella sp
Polypedilum sp
Riethia strictoptera Kieffer
R. zeylandica Freeman
Three Indet gen and sp (V14)
Tanytarsini
Rheotanytarsus sp
Stempellina sp
Tanytarsus spp
One Indet gen an sp
Other Chironomidae
Six Indet gen and sp
Ceratopogonidae
Forcipomyiinae
One Indet gen and sp
Other Ceratopogonidae
Four indeterminate species
Simuliidae
Austrosimulium furiosum
Austrosimulium spp

        Cnephia tonnoiri tonnoiri (Drummond)
        Simulium ornatipes Skuse
        Four undescribed gen and sp
    Thaumaleidae
        Tow indeterminate sp
    Tabanidae
    Athericidae
    Dolicopodidae
    Empididae
        Three indeterminate sp

TRICHOPTERA
    Hydrobiosidae
        Apsilochorema urdalum Neboiss
        Taschorema pallescens (Banks)
    Hydroptilidae
        Oxyethira retracta Wells
        Maydenoptila sp
        Acritoptila globosa Wells
        A. margaretae Wells
        One Indet gen and sp
    Philopotamidae
        Hydrobiosella michaelseni (Ulmer)
    Ecnomidae
        Ecnomina ?trulla Neboiss
        Ecnomina sp
        Two Indet gen and sp
        Indet gen and sp
    Polycentropodidae
        Indet gen and sp
    Hydropsychidae
        Cheumatopsyche modica (McLachlan)
        Smicrophylax *australis* (Ulmer)
    Leptoceridae
        Triplectides spp
        Notoperata tenax Neboiss
        Notalina fulva Kimmins
        Notalina sppB
        Lectrides parilis Neboiss
        Condocerus aptus Neboiss
        Oecetis sp
        One Indet gen and sp
    Atriplectididae
        Atriplectides ?dubius Mosely

COLEOPTERA
    Dytiscidae
        Antiporus femoralis (Boheman)
        Hypodes tambreyi
        Liodessus sp
        Necterosoma darwini (Babington)
        Platynectes aenescens Sharp
        P. ?decempunctatus (Fabricius)
        Rhantus ?suturalis (MacLeay)
        Sternopriscus browni Sharp
        ?Sternopriscus sp
    Gyrinidae
        Aulonogyrus sp
        Macrogyrus sp

Hydropilidae

Two indeterminate sp

Helodidae

Chrysomelidae

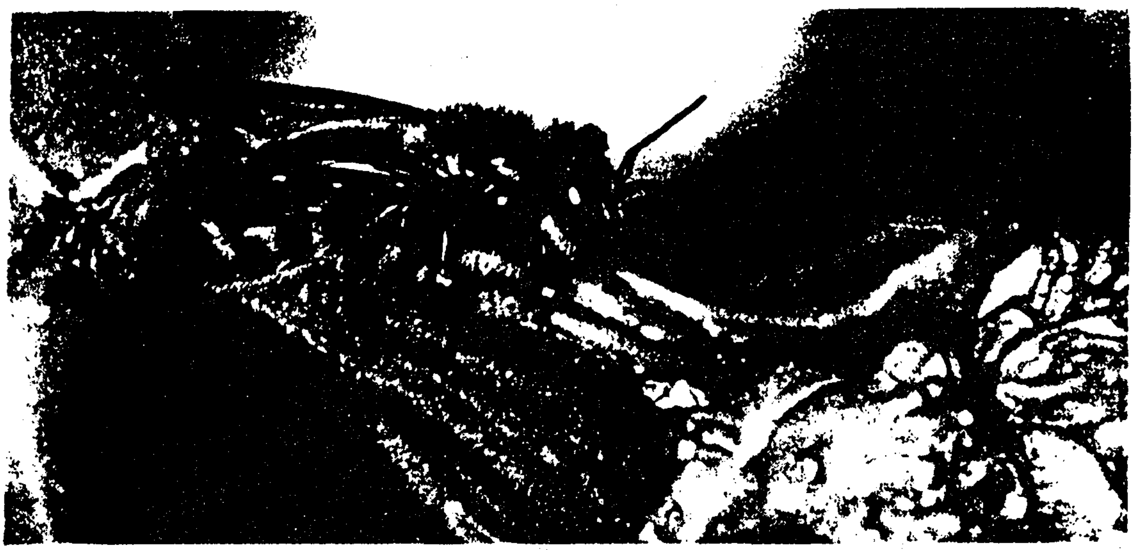
TO BEE OR NOT ....?!

BEES IN NATIONALS PARKS ?

The Introduced Honeybee in Conservation Parks in South Australia.

ERIC MATTHEWS

CURATOR OF INSECTS S.A. MUSEUM



INTRODUCTION:

The following report summarises the available information on the effects of honeybees and was prepared in response to several expressions of public disquiet received at the Museum over recent months regarding the National Parks and Wildlife Service's policy of continuing to tolerate the presence of large numbers of bee sites within the boundaries of conservation parks (6). Numbers in parentheses refer to the references cited in Appendix A,B, and C.

I understand that political considerations make it difficult for such sites to be quickly eliminated, particularly when they have been 'inherited' from times when the park was still private land or when policies were more lax (6). At least the policy of the Dept of Envrionment and Planning is " not... to increase the number of sites, but rather to better manage those which are existing." (The Minister of Environment and Planning, letter 1). Also, " The Service has no intention of encouraging the establishment of bee sites on its estate and indeed is looking for the opportunity to reduce site numbers because of the possible impact on and competition with native fauna." (Director, National Parks and Wildlife Service, 6).

On the other hand, statements in the Minister's letter (1) and in the news release (12) give cause for concern. One is that " there is a lack of scientific evidence that the presence of bees in Reserves interferes with the ecological balance in the long term." (1). As this report will show, this is manifestly untrue. There is one study from South Australia itself (10) and much work being done interstate which points to severe interference effects from honeybees. Although the Minister refers to scientific research on honeybee effects (1), none is being conducted by the South Australian Government.

Even more disturbing are statements from the Minister of Environment and Planning that " The Government's policy is to cater for the mutual needs of conservation and the important apiary industry (in National Parks)" and "there are reasons apiarists need access to these sites," contained in the letter also quoted in (1) and in a news release (12). It is inconceivable that the Government could condone the exploitation of National and Conservation Parks by commercial interests, to the detriment of the biota and the interest of the people as a whole. The parks and the reserves are the last remaining refuges for genetic diversity and represent the heritage of all the people in perpetuity.

Exploitation of the park flora by the apiary industry is no different in principle to the opening of the reserves to grazing by cattle or sheep.

Those persons who support the Government policy on this matter may believe that there are times when nectar is so abundant that it becomes in effect an inexhaustible resource, able to meet the needs of both honeybees and native pollinators. All available evidence points to the fact that such circumstances never occur, nectar supply is always a limited resource, and honeybees will always deprive native insects and birds of a significant amount of their energy resources (4,5,7,8,9,10) except in the cold of the early morning, when only birds are active (9, 14).

The potential impact of honeybees is not limited to those insects and birds with which they compete directly for nectar and pollen, but extends also to the possible severe effects on the native flora (8,10,11,13,17) and to those animals with which feral bees compete for nesting sites.

In order to keep this report within reasonable bounds, the rapidly accumulating body of scientific evidence on honeybee effects is only very briefly summarised.

POTENTIAL DELETERIOUS EFFECTS OF HONEYBEE FORAGING AND NESTING ACTIVITIES:

1. Reduction in nectar supply for native pollinators.

Introduced honeybees are exceptionally efficient foragers compared to native pollinators. This comes about through (a) their greater tolerance of low temperature, enabling them to reach nectar sources earlier in the day than native insects and during more days of the year (3,7,8,15,16,), (b) their extraordinary communication system, which enables them to exploit nectar sources rapidly and in concentrated numbers (7,11,16,), (c) their longer tongues, which enable them to exploit deep flowers which are normally bird pollinated, thus robbing honeyeaters of part of their food supply (9,10,11), (d) their aggressive behaviour (7,8,16), and (e) their large individual size and sheer weight of numbers when given the advantage of man-made shelters and favourable siting (11,15).

Honeybees usually forage about 1km from their hives, but can extend their range up to 14km in times of scarcity (16).

It is interesting to note that some Eucalyptus can exclude honeybees from exploiting all but about 20% of their nectar production (14).

2. Inefficient pollination of native plants.

This is brought about in three ways: (a) by the honeybee not positioning itself properly on the flower such that it fails to pick up pollen or deposit it on the stigma (10,11,13), (b) by the honeybee making successive visits on flowers of the same plant, rather than darting from plant to plant after visiting just one or two flowers on each; this means that that where plants are self incompatible, most honeybee visits are ineffective for pollination (10,11,13), and (c) by the honeybee damaging native flowers when extracting nectar (11). I have seen no written reference to the phenomenon reported on television by Harry Butler, that honeybees chew their way into the base of deep flowers to obtain nectar without coming into contact with the anthers. If this did happen it would represent one more case of honeybees defeating the plant's evolved pollination system.

All the above effects interfere with native plants' reproductive biology and, in the case of rare plants, could result in serious depletion of the population (8).

3. Hybridization of native plant species.

This would be expected to occur where plants and their pollinators have evolved together such that the plant relies mainly on oligolecty (faithfulness) in its pollinator to maintain reproductive isolation from other related plant species (13). At least one instance of hybridization due to honeybees has been recorded (17) and others are suspected (8,11).

4. Long-term decline of native pollinators.

This will follow naturally from the known short-term effects mentioned under 1. above, and the apparently increasing rarity of certain myrtaceous beetle pollinators particularly jewel beetles (S.Barker, pers. comm.) and cetoniine scarabs (personal observations), which are specialised for nectar feeding and pollination, indicates that they need as much protection as we can give them from competition by the aggressive and efficient honeybee (see also reference 5).

5. Usurpation of tree-hole nesting sites.

It is known that White-tailed Black Cockatoos in Western Australia have been driven out of their nesting sites through invasion by swarms of feral honeybees (10). This has also occurred on Kangaroo Island with Yellow-tailed Black Cockatoos (S.Parker, pers.comm).

CONCLUSIONS AND RECOMMENDATIONS:

1. All evidence points to severe detrimental effects at all times resulting from competition by introduced honeybees with native insect and vertebrate pollinators, not only on the pollinators themselves but on the native flora as well.

2. Although few studies have been published, quite a few are presently being undertaken and enough scientific evidence is already available to warrant rapid removal of all bee sites from conservation parks now. Even if beekeepers station their hives just outside the boundaries of the parks (and this presumably cannot be prevented) , there will be some gain because bee visitations decline with distance from the hive.

3. The exploitation of conservation parks by any commercial interests is not compatible with their purpose as biosphere reserves or with the interests of the people as a whole over future generations. No-one can be permitted to use reserves in a way which will cause damage to them.

4. Apart from the removal of tended hives, feral honeybee nests should be located and poisoned as part of regular park management, so as further to reduce pressure on native pollinators and native vertebrates needing to use the sites for nesting. Most species of parrots, which are hole nesting are suffering a rapid decline.

Appendix A

Excerpts from letters referred to in text. (Arranged in chronological order).

1. At this stage there is a lack of scientific evidence that the presence of bees in Reserves interferes with the ecological balance in the long term. In the meantime, the National Parks and Wildlife Service keeps the allocation of beestand licences to a minimum until scientific research is carried out.

11.1.82.
The Hon. David C. Wotton,
S.A. Minister of Environment and Planning.

2. With regard to your query regarding bees (Apis sp.).... I find that they certainly have posed problems for hole nesting species. As you know, I worked on the White-tailed Black Cockatoo (Calyptorhynchus funereus latirostris) in several areas in the south-west of W.A..... For example, during 1975 bees swarming into hollows were responsible for at least two nesting failures... These accounted for 5% of the failures for that season and that may be a significant factor if a population of birds is low or the number of available hollows is small.

In my experience, it is the areas of vacant Crown Land, conservation reserves or National Parks which provide important refuges for species like the White-tailed and Yellow-tailed Black Cockatoos. These areas are coveted by beekeepers because of the abundance of flowering plants. The opening of these areas to bee-keepers may increase competition for nest hollows at a time when hollows in trees are a dwindling resource of native wildlife.

21.1.82
Denis Saunders,
C.S.I.R.O. Division of Wildlife Research,
Midland, W.A.

3 I have no doubt that the introduced honeybee will outcompete most native bees for pollen and nectar of those plants it favours because its greater tolerance of low temperatures means it reaches pollen and nectar sources earlier, works them during more of the day, and on more days, than do its native competitors.

29.3.82
Dr T.F. Houston,
Curator of Insects,
Western Australian Museum.

4. I can summarize the results of the honeybee studies by saying that all available evidence indicates that honeybees have a deleterious effect on native bees. It is quite possible, I believe, that honeybees have had a larger effect than rabbits or any other better known introduction. I believe that they should be excluded from National Parks to the maximum extent possible.

4.5.82
Dr Graham H.Pyke, Dept of Vertebrate Ecology, The Australian Museum.

con't

5. Our major investigation is not yet written up. However, preliminary analysis indicates that when we introduced hives, the native insect population was altered. Native bees and wasp numbers were significantly reduced and probably numbers of native Coleoptera as well. Interpretation of a result such as this is problematic, but we feel that long term stationing of introduced honeybees in National Parks must have detrimental effects on native insect numbers. Our study supports this hyphothesis. No doubt the introduced honeybee is an exceptionally good pollinator, but our National Parks are already riddled with feral hives. I believe that huge numbers of tended hives in National Parks would provide intense competition for resources between honeybees and native insects. The native insects would surely lose out, especially in poor environmental conditions.

1.6.82·
Dr J.M.E. Anderson,
School of Zoology,
The University of N.S.W.

6. The Service has approximately 400 bee sites on its estate, the majority of those sites being within the Ngarkat Conservation Park. A submission has been prepared for Cabinet to establish the licencing system which will give consistency on the use of apiarists of Government land. It is proposed that no existing bee site holder further than 40km from Adelaide be issued with a licence.

7.6.82.
Mr R.I. Nichols,
Director,
S.A. National Parks and Wildlife Service.

Appendix B

Excerpts from unpublished reports. (Arranged in alphabetical order).

7. Apis mellifera L. wins most of the nectar produced by Angophora, for its daily visitation rate parallels that of the nectar flow rate. Native insects are less well organised and apparently spend most of the day visiting when nectar flow is declining.

J.M.E. Anderson,
Paper submitted to General and Applied Entomology.

8. Native bees are more restricted than honeybees in the time of year, and sometimes time of day, during which they forage, and in the species of plants which they visit... Most species of native bees were found foraging on only one or two species of plants. Therefore their survival and reproduction may be seriously affected by any decrease in the amount of food available in the particular species of plants which they visit...Honeybees reduce the amount of nectar available in flowers for native bees. A decrease in the amount of food gathered by honeybees was shown to result in an increase in the amount of food gathered by native bees or a decrease in the cost to native bees of foraging. Since honeybees displace native bees from flowers while they are both foraging , this suggests that honeybees have an effect on the native bees' chances to survive and reproduce... Since native bees are important pollinators of native plants (Armstrong, 1979) , the pollination of native plants may be severely reduced by the presence of honeybees. Therefore some species of native plants may be in danger of becoming rare in certain areas due to the influence of honeybees.

L. Balzer,
The Effect of the Introduced Honeybee
(Apis mellifera) on Australian native Bees. 1981.
Honours Thesis,
School of Biological Sciences,
University of Sydney.

9. Insects (Apis mellifera) clearly consume a high proportion of the nectar produced during summer, and their presence must reduce the number of honeyeaters that can be supported in an area.

D.C. Paton,
The behaviour and feeding ecology of the New Holland Honeyeater
Phylidonyris noveahollandiae in Victoria. Ph.D. Thesis 1979.
Monash University.

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10. A preliminary study...was carried out in Nov 1980 on Callistemon macropunctatus at Scott Conservation Park, South Australia. A large apiary was present on the boundary of the park. The numbers of bees working the flowers declined with the distance away from the apiary and into the park.

D.C. Paton,
Grant Application, March 1981.

11. It is generally assumed that A. mellifera out-competes the native bees for nectar and pollen through sheer weight of numbers, through a larger nectar requirement per bee due to their larger body size and by their ability to fly under a wider range of conditions than native bees.

A. mellifera does effectively pollinate some native specimens... but are obviously not adapted to the majority of flowers of our fauna. In most cases they rob flowers of their nectar and pollen resources - especially in the case of the ' gulletshaped bird flowers ' such as many Grevilleas. When they do bring about pollination, it is often inefficient. In Boronia ledifolia honeybees will visit up to 15 flowers in one bush before moving to another bush in the same site. Since B. ledifolia is self incompatible, 14 of the visits from the plant's point of view ineffective. A W.A. example of inefficient pollination is described by S. Hopper (17)... the indigenous pollinator, a black native bee (Halictus sp.) forages in such a manner as to effect the pollination... In contrast the position adopted by A.mellifera to probe for nectar: head thrust between style and anther would rarely have resulted in effective pollination ...A. mellifera is known to damage flowers of native species, especially of the pea family, when foraging with the possibility of resultant ineffectual pollination and reduced seed set, which is of especial importance in the conservation of rare plants (11,13,17).

M.Scheltema,
To bee or not to bee.
Project Report,
Murdoch University.

12. Mr Wotton said that reserves provided a major area for the livelihood of apiarists in South Australia, and that the interests of conservation and the apiary industry were interwoven.

The Hon. David C. Wotton,
News Release dated 27.10.81.

Appendix C

Published Papers.

13. Armstrong, J.A. 1979. Biotic pollination mechanisms in the Australian Flora a review. N.Z. J. Bot. 17, 467-508.

14. Bond, H.W. and Brown, W.L. 1979. Exploitation of floral nectar in Eucalytus incrassata by honeyeaters and honeybees. Oecologia 44, 105-111.

15. Douglas, A.M. 1977. Some inimical effects of the domestic bee on the native fauna and flora. W.A. Naturalist 14, 1-2.

16. Eickwort, G.C. and Ginsberg, H.S. 1980. Foraging and nesting behaviour in Apoidea . Ann. Rev. Entomol. 25, 421446.

17. Hopper, S.D. 1980. Bird and mammal pollen vectors in Banksia communities at Cheyne Beach, W.A. Aust. J. Bot 28, 61-75.

18. Wilson, P.G. 1970. A taxanomic revision of the genera Crowea, Eriostemon and Phebalium (Rutaceae). Nuytsia 1, 3-155.