Chapter 1. **GENERAL INTRODUCTION**

Contents

1.1 The Australian arid environment

The Australian arid environment is shaped by rainfall which is variable and unpredictable in time and space (Stafford Smith & Morton 1990). In Australia, year-to-year variability in the timing and magnitude of rainfall is higher than in areas of comparable aridity elsewhere in the world (Leeper 1970). Droughts of varying severity are a feature of the environment (Foley 1957), as are occasional floods. Spatial variation in effective rainfall, both persistent and random, is imposed on the temporal variation (Noy-Meir 1973). Random spatial variation occurs because rainfalls, especially thunderstorms, are often patchy. Persistent spatial variation occurs at a local scale where non-uniform landscapes lead to the redistribution of runoff following rain. Landscape variability comes from differences in basic landscape type, for example, ranges, slopes and floodplains, and the existence of erosional and depositional soil surfaces which occur within and between landscape types. Processes such as fire and grazing further pattern landscapes (Friedel *et al.* 1993).

Davies (1973a, 1976, 1984a) pointed out the significance of the frequent light falls of rain which occur with some regularity in the arid zone. These light falls are concentrated by microtopographical relief into small areas which he estimated occupy only about one twentieth of the total surface area of the arid zone. In addition, the occasional heavy but erratic falls of rain, which characterise the arid zone, recharge sub-surface water supplies (Stafford Smith & Morton 1990). Consequently the run-on areas with their enhanced water supplies allow for far greater regularity of plant growth (Ludwig 1987) and provide structurally more complex habitat than occurs in surrounding run-off areas. They are the site of most annual plant growth (Mott 1973) and promote perennial plant growth in which the timing, if not the level, of production is regular (Davies 1976). Persistent spatial variability in rainfall, therefore, provides birds with small areas which are relatively productive and reliable. Most importantly for birds, the arid zone is not uniformly unpredictable. Random spatial variation in rainfall provides mobile birds with usually a fair probability that favourable conditions will exist at least in some part of the species' range.

1.2 **The arid zone avifauna**

Early reviews of the avifauna of arid Australia (e.g. Keast 1959, Immelmann 1963, Serventy 1971) concluded that a common strategy adopted by birds in response to environmental unpredictability was nomadism. Nomadism involves both adults and juveniles. It is distinguished from migration by the unpredictability of the timing and direction of movement (Davies 1984a, Ford 1989). Highly nomadic species might be expected to occur in an area at any time of year. Typically nomads move into an area following rainfall and breed rapidly, regardless of season, to take advantage of a brief, post-rainfall period of abundant food. When conditions ultimately deteriorate a scarcity of food or water forces them to move in search of better conditions. Keast (1959) estimated that 26% of Australian birds were nomads and these occurred mainly in the arid inland. Most sedentary (66% of all birds) and migratory (8%) species were concentrated in the more mesic coastal environments where greater environmental predictability promoted a regular spring breeding season.

Early suppositions that nomadism was the principal adaptation of birds to arid conditions were supported by some anecdotal accounts of the spectacular reappearances and disappearances of birds. Good examples are Budgerigars, 'in good seasons their numbers are unlimited, flocks of thousands arriving one after the other' (McGilp 1923), and Flock Pigeons, in which 'a flock of over two miles in length' (MacGillivray 1929) was described feeding on a flush of grass induced by the flooding of the Darling River. However, as more and longer-term studies of the arid zone avifauna have been undertaken, some of this earlier conventional wisdom regarding the arid zone avifauna has been questioned.

Studies have now revealed that a substantial proportion of birds in the arid zone are in fact sedentary. Unlike nomads, these birds must be adapted to endure the inevitable periods of drought which are akin to 'ecological crunches', which Wiens (1977,1989) regards as unpredictable and severe reductions in resource levels. During the 'crunches' competition may be intense. If resources recover more rapidly than population sizes when environmental conditions improve, then resources may become superabundant and competitive constraints are removed. Sedentary species comprise about one third of species recorded in the Lake Eyre Basin (Badman 1991), the Milparinka district and Cooper Creek basin (Wyndham 1978) and the Nullarbor Plain (Brooker *et al.* 1979), and about one half of species in Kinchega National Park (Henle 1989). Pianka & Pianka (1970) noted only a few nomads in their censuses of birds in arid Western Australia. Studies of species once considered classic nomads, for example, the Black Honeyeater (Ford 1978), Budgerigar (Wyndham 1982) and White-browed Woodswallow (Wood 1994), have suggested an underlying seasonality to their movements. Cody (1994) censused birds in mulga scrub across arid Australia. He found that the composition of mulga bird communities was highly predictable from place to place. He did not, however, investigate temporal variability in community structure.

Long-term studies have further discerned an underlying seasonal pattern to the breeding of several well-known arid zone species including the Emu (Davies 1973b), plumed pigeons *Geophaps plumifera, G. ferruginea* (Frith & Barker 1975) and Budgerigar (Wyndham 1982, 1986). Studies of the Zebra Finch, however, have suggested both regular (Davies 1977, Zann 1994) and opportunistic (Zann *et al.* 1995) breeding patterns.

The findings of these studies suggest that arid zone bird communities might not be as different from those in mesic areas as once supposed. The distinction between nomadic and migratory species may not be clear cut. Ford (1989) proposed that migration and nomadism are at the ends of a continuum and many species fall between these extremes.

1.3 **Aims of this study**

In this study I have investigated ecological patterns in a terrestrial bird community in arid north-western New South Wales. Care was taken to select a site (described in Chapter 2) for the study that included a variety of habitats in close proximity and which would thus be subject to the same local climatic vagaries. The selected study site supported a diverse bird fauna which included sedentary, nomadic and migratory species. The central question in this investigation was how do the different strategies, residency, nomadism, and migration, relate to other ecological parameters such as population dynamics, habitat selection, foraging, nesting and drinking behaviour?

1.3.1 **Temporal variability in the avifauna**

The survey period spanned three and a half years and included a severe drought followed by above average rainfall. In Chapter 3 I document year-to-year and seasonal changes in the composition of the avifauna. I examine how changes in the avifauna relate to regular seasonal and to irregular climatic variation, especially rainfall. I compare the responses of sedentary, nomadic and migratory species to drought. I consider whether species with different diets are affected equally by drought.

1.3.2 **Spatial variability in the avifauna**

Numerous studies in arid Australia (e.g Wyndham 1978, Brooker *et al.* 1979, Badman 1989, Henle 1989) have pointed to the greater importance, in terms of bird density and species richness, of run-on as opposed to run-off areas. In Chapter 4 I examine whether the relatively mesic run-on areas of the study site (creekline habitats) do support denser and richer populations of birds, as found in these earlier studies. Creekline habitats in the study area form a continuum between those with permanent sub-surface water supplies and those that rarely have surface or sub-surface water. I investigate the structure of the creekline bird community and ask which habitat attributes have the greatest influence on bird community patterns - do species sort into well-defined assemblages along the creekline habitat gradient? I then ask if the distribution of individual species is closely associated with particular habitat characteristics. Davies (1973a, 1982) suggested that sedentary birds have adapted to arid areas by living in the relatively predictable and mesic environment of the run-on areas. I examine the relative distribution of nomadic and resident species along the mesic-xeric creekline habitat gradient.

1.3.3 **Foraging ecology**

A tendency towards generalist feeding habits has been predicted for birds in climatically variable environments (Levins 1963, McNaughton & Wolf 1970) and confirmatory evidence has been obtained in a number of studies (e.g. Wiens & Rotenberry 1979, Rotenberry 1980, Brooker *et al.* 1990). In Chapter 5 I investigate the feeding behaviour of birds at the site and determine how the community is structured in terms of feeding guilds. I compare the guild structure of this community with that of communities in more mesic regions of eastern Australia. I compare the degree of feeding niche specialisation of resident and nomadic species, and of species of arid and mesic areas. It has generally been supposed (e.g. Maclean 1974) that nomadic species tend to be granivorous or nectarivorous, while sedentary species tend to be insectivorous or raptors. I compare and contrast the use of food resources by nomadic and sedentary species at the study site.

1.3.4 **Breeding ecology**

There has been considerable debate whether there is an underlying seasonal pattern to breeding in the arid zone avifauna (e.g. Davies 1977, Breed 1982, Schodde 1982, Wyndham 1982, 1986) or whether breeding is largely opportunistic (e.g. Keast 1959, Immelmann 1963, 1971, 1973, Serventy 1971, Zann *et al.* 1995). In Chapter 6 I ask to what extent breeding effort is related to regular seasonal effects within years or to fluctuations in environmental conditions, especially rainfall, between years. Ford *et al.* (1988) proposed that aseasonal, but unpredictable environments favour a cooperative breeding strategy. I examine the incidence of cooperative breeding species at the site and compare it with that found in more mesic or seasonal areas. Successful nesting s dependent on the availability of suitable nest sites and building materials (Recher 1991). investigate the use of nest sites by species at the site.

1.3.5 **Drinking ecology**

All birds require water for surviva . They obtain water from metabolic processes, pre-formed water in food, and free water in the environment (Schmidt-Nielsen 1964, Serventy 1971). In Chapter 7 I describe the availability of free water at the study site. I investigate the drinking behaviour of species at the site and ask which species are potentially limited by the availability of free water. Nomadic species are able to quit a site when supplies of food or water diminish. Are sedentary species then less dependent on the availability of drinking water than nomadic species?

1.3.6 **Aggression**

Davies (1982) concluded that arid zone av faunas are characterised by a lack of aggression. He proposed that this lack of aggression is an adaptation to an environment in which the need to avoid excessive heat production and minimise water loss is paramount. In Chapter 8 I document the incidence of aggression in the avifauna compared with studies in more mesic areas and investigate Davies' hypo hesis.

1.3.7 **Life history strategies - residency, nomadism and migration**

If success is measured in terms of ong-term survival of a population (Davies 1976), then the three broad strategies nomadism, migration and residency, are all successful in the arid zone. In the concluding chapter (Chapter 9), I draw together the findings of the preceding chapters and ask why are some birds nomadic, others migratory and others sedentary? Are the distinctions between the different strategies clear cut, or do they form a continuum of variation? How does the arid environment allow birds employing the different strategies to coexist?

1.3.8 **Processes determining patterns in the avifauna**

Historically, community studies have been dominated by two opposing views on the main processes which structure biological communities (Noy-Meir & van der Maarel 1987, Wiens 1989). On the one hand (e.g. Clements 1916, MacArthur 1972), communities have been viewed as discrete and repeatable assemblages of species that are tightly and predictably structured by competitive interactions between species leading either to exclusion or to niche and character displacement. On the other hand (e.g. Gleason 1917, 1926, Simberloff 1978, Wiens 1989), it has been argued that communities lack internal organisation and the role of competition has been questioned. Chance and random processes were instead emphasised and communities were considered to be chance assemblages of species which respond to environmental variation in a species-specific manner.

In the concluding chapter I consider what processes might be determining the community patterns revealed in this study. I look for indications of interaction, either competitive or facilitative, between species. In such an unpredictable environment, what role does chance play?

1.3.9 **Implications for conservation of the arid zone avifauna**

Throughout the study the resources important to arid zone birds were identified. An understanding of these resources is necessary to ensure the effective conservation of the birds. In the concluding chapter the implications of the findings of this study for the conservation of the arid zone avifauna are also discussed.

Chapter 2. **THE STUDY AREA**

Contents

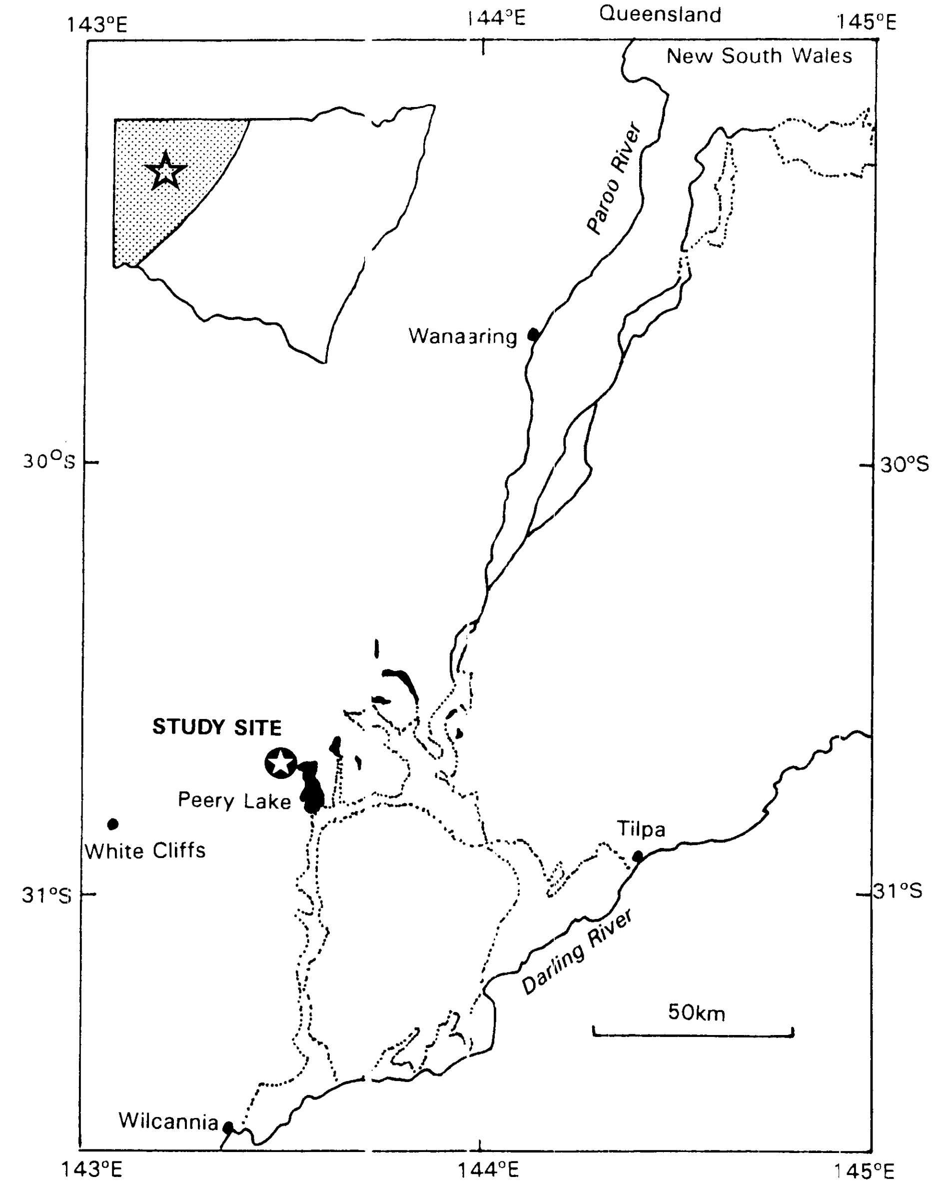
2.1 Location

The study area (30° 43'S 143° 33'E) is within a grazing leasehold in north-western New South Wales, 100 km north of Wilcannia and 50 km north-east of White Cliffs (Figure 2.1). The site encompasses approximately 1500 ha and abuts the north-west end of Peery Lake on the Paroo Overflow system.

2.2 Climate

The study area lies within the arid zone of New South Wales (Figure 2.1) which is bounded by the 250 mm median annual rainfall isohyet in the south and the 350 mm isohyet in the north (Bureau of Meteorology 1988). Rainfall is low, spatially patchy and extremely variable between months and years. It is characterised by large numbers of small falls and relatively few large falls at unpredictable intervals (Leeper 1970, Gentilli 1971, Williams & Calaby 1985, Stafford Smith & Morton 1990, Bell & Stanley 1991). Generally, large falls occur in summer. Prior to the study, substantial summer rains had not fallen in the area since 1984 (G. Barlow pers. comm.). Mean annual precipitation is assumed to be between 245 mm, as

Figure 2.1. **Location of study site**. Inset map of New South Wales indicates extent of arid zone (stippled area) and location of study site within it. ...... indicates wetland areas usually subject to inundation of less duration than overflow lakes (filled).



recorded at White Cliffs (Bureau of Meteorology 1992, 90 years of records), and 258 mm at Wilcannia (112 years of records). Rainfall in the year preceding the study was about average (239mm at White Cliffs and 250mm at Wilcannia). Between spring 1990 and spring 1992 the Peery site missed several localised falls of rain and no effective rain fell (G. Barlow pers. comm.) (Figure 2.2). By late 1991 dust storms were frequent and locally it was considered the worst drought for over 40 years (H. Barlow pers. comm.). The drought was broken by heavy rain in December 1992 which produced local flooding. Rainfall in the remainder of the study period (1993-94) was above average.

In early 1990 heavy rain in southern Queensland caused major flooding on the Paroo River which subsequently overflowed into and filled Peery Lake, a terminal playa (Goodrick 1984), in April 1990. Normally the lake dries completely in about three years (G. Barlow pers. comm.) but, in this instance, it was recharged by heavy local rain in summer 1992/93 and there was water in the lake throughout the study.

Temperatures at the site are high in summer and mild in winter. Average daily temperatures in January range from 21.2 to 35.1°C and 19.9 to 35.5 °C and in July from 4.3 to 17.0°C and 4.4 to 17.4°C at White Cliffs and Wilcannia respectively (Bureau of Meteorology 1992).

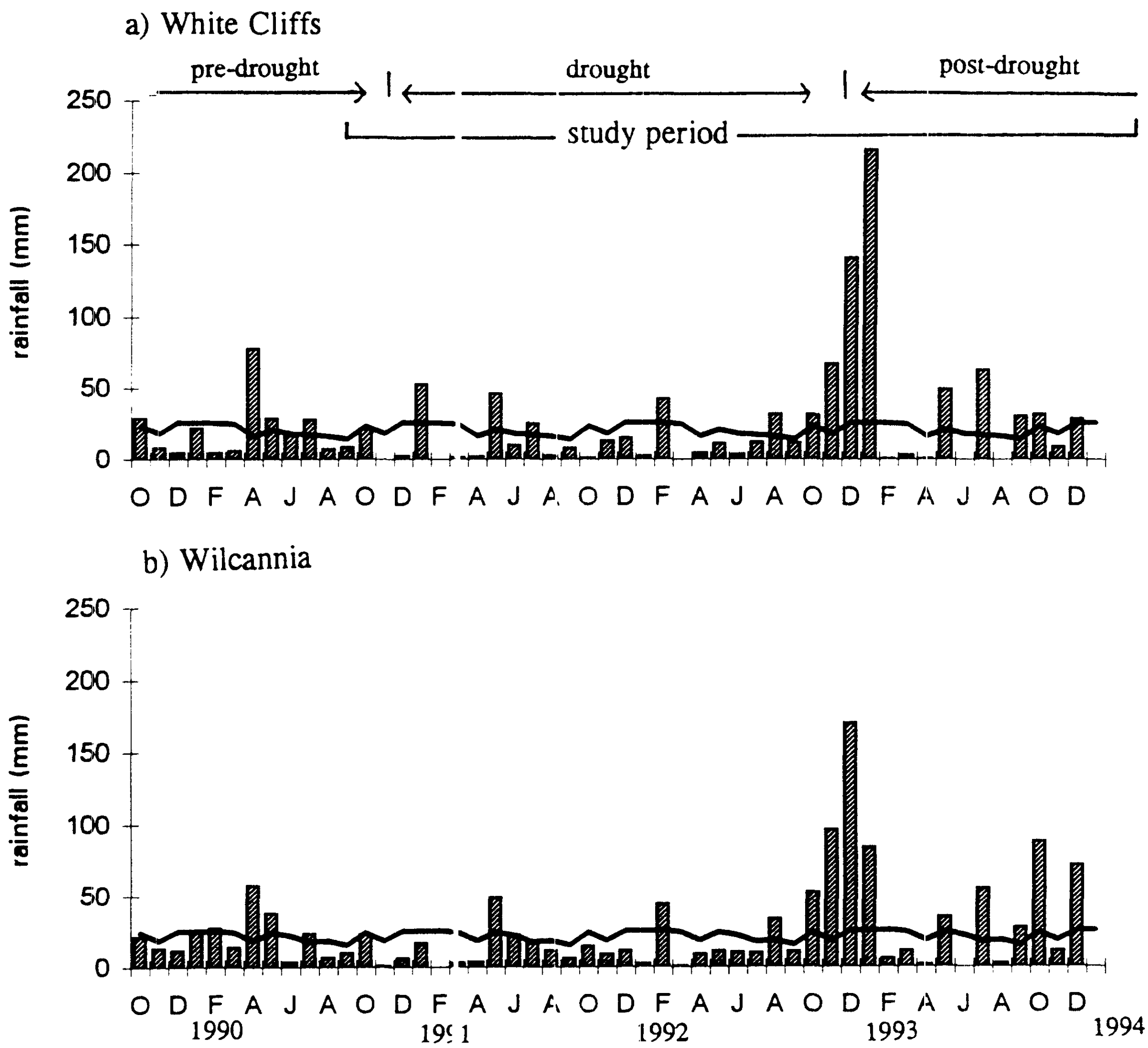
Photoperiod (duration of daylight) ranges from 10.2 hours in June to 14.1 hours in December (Linacre & Hobbs 1977).

2.3 **Land systems**

Land systems, 'areas or groups of areas throughout which there is a recurring pattern of topography, soils and vegetation' (Christian & Stewart 1953), within the study area have been mapped by the Soil Conservation Service of New South Wales (1980) and described by Milthorpe *et al.* (1991). Two land systems, Fowlers and Mount Pleasant, are predominant, while Pulchra, Euramurtie and Yapunyah land systems intrude at the margins of the study area.

The Fowlers land system overlies Quaternary alluvium and encompasses a broad flood plain cut by two major drainage lines, Rutherfords Creek and Box Creek, and a number

Figure 2.2. **Longterm mean monthly rainfall (–) and actual monthly rainfall (bars) in the study period and preceding 12 months at the two closest weather stations at a) White Cliffs and b) Wilcannia.**



of smaller drainage lines (Figure 2 3). Soils include texture contrast soils on the back plains, brown clays in depressions on the plain and creek sands in drainage channels. The backplains are badly scalded and creek channels are subject to scouring and undercutting of their banks.

The Peery Hills belong to the Mount Pleasant land system and rise to 120m above the floodplain in the southern portion of the study area. These rounded hills are part of a range with rocky cliffs of dipping Devonian sandstone and quartzite. Drainage is dendritic and runoff from the Hills flows rapidly into Camp and Goanna Gully Creeks. Soils are red lithosols in hilly country and red desert loams on lower slopes. Large numbers of stones cover the ground.

The Pulchra land system includes a broadly undulating plain which overlaps the north-west of the site. A small sandy area associated with the Peery Hills in the south-west of the site belongs to the Euramurtie land system. The broad floodplain to the north of Peery Lake is within the Yapunyah land system.

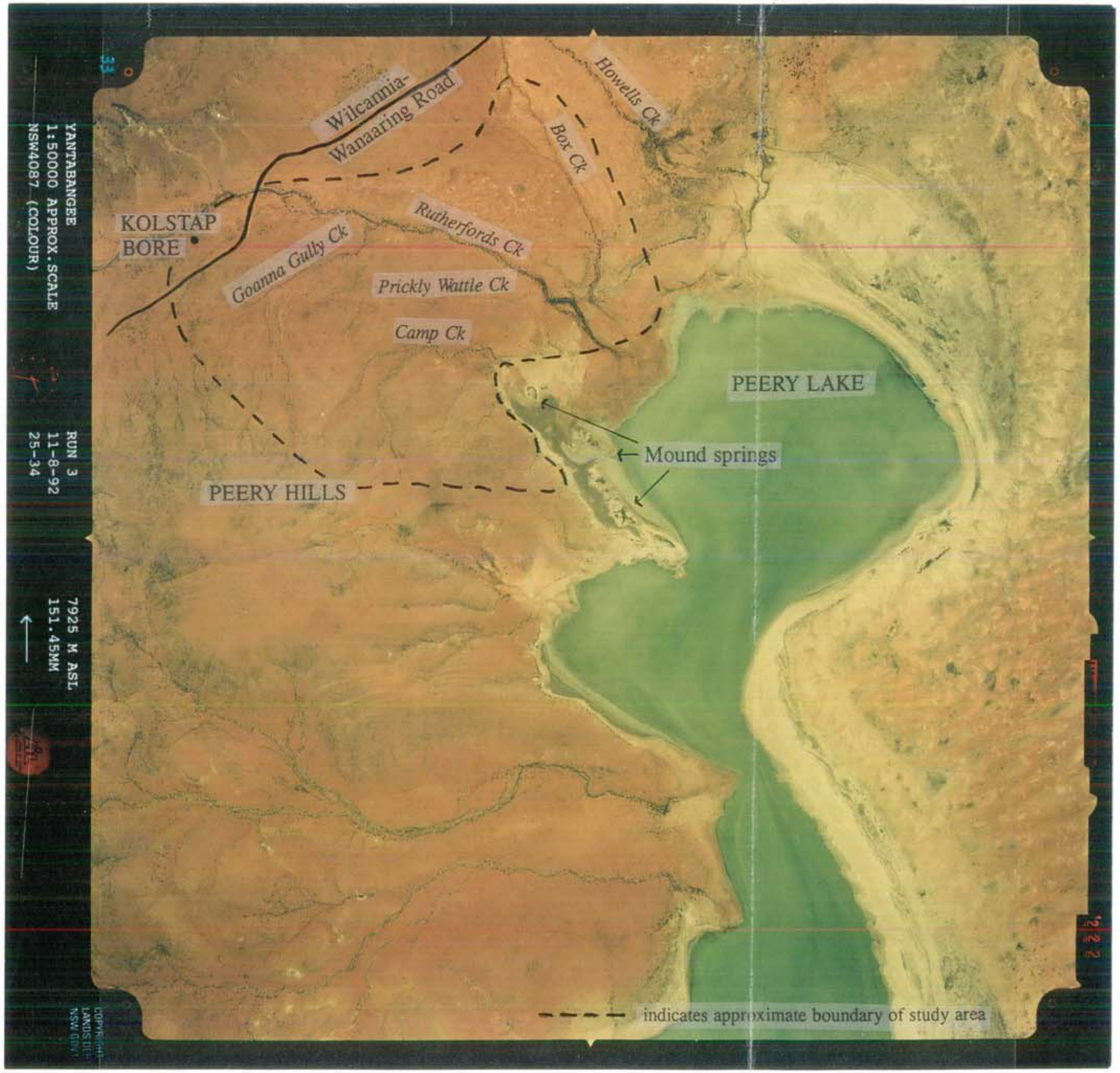
2.4 **VEGETATION**

The study area is within the bounds of vegetation maps produced for the Western Division of New South Wales (Beadle 1948), Paroo-Upper Darling region (James 1960), 'Momba' Station (Pickard 1993) and north-western New South Wales (Pickard & Norris 1994). Milthorpe (1991) provided the most comprehensive account of the vegetation in his description of the vegetation of north-west New South Wales in relation to land systems (Soil Conservation Service of New South Wales 1980)

I recorded 256 plant species within the study area (Appendix 2.1). Additional species may also occur. As is typical of arid Australia (Perry & Lazarides 1962, Boyland 1970, 1974, Milthorpe 1991), vegetation was dominated by the families Poaceae, Asteraceae, Chenopodiaceae and Fabaceae and most species were native (241/256). Plants included perennials, biennials, annuals and ephemerals. In the dry 1991-1992 period, virtually all grasses, forbs, vines and subshrubs, including species considered to be perennial, either died or were reduced to below ground components and seeds. Perennial trees and shrubs suffered considerable leaf fall.

Major creeklines were fringed by eucalypt woodland dominated by River Red Gum

Figure 2.3. **Aerial view of Peery study area, August 1992.**



Eucalyptus camaldulensis and Black Box *E. largiflorens* with occasional Bimble Box *E. populnea*. Their lower reaches supported a low tree layer of River Cooba *Acacia stenophylla* and a shrub layer dominated by Boobialla *Myoporum montanum* and Lignum *Muehlenbeckia florulenta*. The width of the riverine woodland strip ranged from 180m at the lower end of Rutherfords Creek to a single line of trees in upper Box Creek. More ephemeral drainage lines were fringed by perennial shrubs and low trees, especially Whitewood *Atalaya hemiglauca*, Prickly Wattle *Acacia victoriae*, Mulga *A. aneura* and Lignum. The Peery Hills supported Mulga scrub in which Dead Finish Wattle *A. tetragonaphylla* and cassias *Senna* spp. were occasional. Apart from an area of Harlequin Eremophila *Eremophila duttonii* scrub adjacent to Goanna Gully Creek, the plains were virtually bereft of trees and shrubs. River Red Gum, Black Box and River Cooba lined the southwestern edge of Peery Lake while the northwestern edge was generally open. Ground layer vegetation in the area varied in response to rainfall and consisted mainly of short-lived grasses and herbs with occasional sub-shrubs including saltbushes *Atriplex* spp. and copper burrs *Sclerolaena* spp.

2.5 **Avifauna**

Ninety-seven landbird species were recorded at the site (see Appendix 3.1). A further 55 waterbirds and three raptors, the Whistling Kite *Milvus sphenurus*, White-bellied Sea-eagle *Haliaeetus leucogaster* and Swamp Harrier *Circus approximans*, associated with Peery Lake were also recorded, but are not considered further in this study.

2.6 **Land use**

Since the late 1860's, when the Paroo River frontage was first occupied by squatters (Jeans 1972), the predominant landuse of the area has been extensive grazing of unimproved pastures by sheep and cattle. The study area is within Peery Station, a grazing leasehold held in perpetuity and administered by the Western Lands Commission on behalf of the Crown. Since the 1950's, Peery Station has been grazed chiefly by sheep with only low numbers of cattle (H. Barlow pers. comm.). Throughout the study, stock numbers at the site were low. However, numbers of other grazing and browsing animals, including Red Kangaroos *Macropus rufus*, Euros *M. robustus*, Eastern Grey Kangaroos *M. giganteus*, Western Grey Kangaroos *M. fuliginosus*, feral goats *Capra hircus*, rabbits *Oryctolagus cuniculus* and feral pigs *Sus scrofa* fluctuated and were at times high.

Appendix 2.1 **Peery study site plant list: spring 1990 - summer 1993/94.**
STATUS **P** perennial **B** biennial **A** annual or ephemeral * introduced. Nomenclature follows Harden (1990-1993).

PLANT SPECIES	STATUS	GROWTH FORM
FERNS		
Family **CHEILANTHACEAE**		
Cheilanthes sieberi	P	fern
Family **MARSILEACEAE**		
Marsilea drummondii	P	fern
FLOWERING PLANTS - DICOTYLEDONS		
Family **ACANTHACEAE**		
Rostellularia adscendens var. *pogonanthera*	P	forb
Family **AIZOACEAE**		
Tetragonia tetragonoides	A	forb
Trianthema triquetra	A	forb
Zaleya galericulata	P	forb
Family **AMARANTHACEAE**		
Alternanthera sp.	A	forb
Alternanthera nodiflora	A	forb
Ptilotus nobilis	P	forb
Ptilotus obovatus	P	forb
Ptilotus polystachyus	P	forb
Family **APIACEAE**		
Daucus glochidiatus	A	forb
Family **ASCLEPIADACEAE**		
Leichhardtia australis	P	creeper
Sarcostemma australe	P	shrub
Family **ASTERACEAE**		
Actinobole uliginosum	A	forb
Brachycome ciliaris var. *lanuginosa*	P	forb
Brachycome lineariloba	A	forb
Calotis cuneifolia	P	forb
Calotis hispidula	A	forb
Calotis latiuscula	P	forb
Calotis plumulifera	A	forb
**Carthamus lanatus*	A	forb
Centaurea melitensis	A	forb
Centipeda thespidioides	P	forb
Chrysocephalum apiculatum	P	forb
Epaltes australis	A	forb
Glossogyne tannensis	P	forb
Gnaphalium sphaericum	A	forb
Gnephosis arachnoidea	A	forb
Helichrysum bracteatum	P	forb
**Hypochaeris glabra*	A	forb
Isoetopsis graminifolia	A	forb
Ixiolaena leptolepis	P	forb
Lemooria burkittii	A	forb
Leucochrysum albicans	P	forb
Minuria integerrima	P	forb
Myriocephalus rhizocephalus	A	forb
Myriocephalus stuartii	A	forb
Pseudognaphalium luteoalbum	A	forb
Pterocaulon sphacelatum	A	forb
Pycnosorus globosus	A	forb
Pycnosorus pleiocephalus	A	forb
Rhodanthe floribunda	A	forb
Rhodanthe microglossa?	A	forb
Rhodanthe moschata	A	forb
Rhodanthe stricta	A	forb
Rhodanthe uniflora	A	forb
Rutidosis helichrysoides	P	forb
Senecio glossanthus	A	forb
Senecio lautus subsp. *dissectifolius*	A	forb
Senecio magnificus	P	sub-shrub
**Sonchus oleraceus*	A	forb
Vittadinia cuneata	A/P	forb
Vittadinia eremaea	A	forb
Vittadinia sulcata	A	forb
**Xanthium occidentale*	A	forb
**Xanthium spinosum*	A	forb
Family **BORAGINACEAE**		
**Echium plantagineum*	A	forb
Heliotropium curassavicium	P	forb
Heliotropium sp. A	A	forb
Omphalopappula concava	A	forb
Plagiobothrys plurisepaleus	A	forb
Trichodesma zeylanicum	P	forb
Family **BRASSICACEAE**		
Arabidella procumbens	A	forb
Harmsiodoxa blennodioides	A	forb
Harmsiodoxa brevipes var. brevipes	A	forb
Lepidium oxytrichum	A	forb
Sisymbrium erysimoides	A	forb
Stenopetalum lineare	A	forb
Family **CAMPANULACEAE**		
Wahlenbergia communis	P	forb
Wahlenbergia fluminalis	P	forb
Wahlenbergia gracilenta	A	forb
Wahlenbergia graniticola	P	forb
Wahlenbergia stricta subsp. *stricta*	P	forb
Wahlenbergia tumidifructa	A/P	forb
Family **CAPPARIDACEAE**		
Capparis mitchellii	P	Low tree
Family **CASUARINACEAE**		
Casuarina pauper	P	Low tree
Family **CHENOPODIACEAE**		
Atriplex angulata	A	subshrub
Atriplex conduplicata	A	subshrub
Atriplex eardleyae	A/B	forb
Atriplex fissivalvis	A	forb
Atriplex holocarpa	A	subshrub
Atriplex intermedia	A	subshrub
Atriplex leptocarpa	B	subshrub
Atriplex limbata	A/B	subshrub
Atriplex lindleyi	A	subshrub
Atriplex nessorhina	A/B	subshrub
Atriplex nummularia	P	shrub
Atriplex pseudocampanulata	A	subshrub
Atriplex spongiosa	A	subshrub
Atriplex suberecta	A	subshrub
Chenopodium cristatum	A	forb
Chenopodium desertorum	A/B	subshrub
Dissocarpus biflorus var. *biflorus*	A/B	subshrub
Dissocarpus paradoxus	A/B	subshrub
Einadia nutans	P	climber
Enchylaena tomentosa	P	shrub
Halosarcia pergranulata	B/P	shrub
Maireana brevifolia	B/P	shrub
Maireana coronata	P	subshrub
Maireana integra	P	shrub
Maireana pyramidata	P	shrub
Maireana triptera	P	shrub
Maireana turbinata	P	shrub
Osteocarpum acropterum var. *deminuta*	A	forb
Rhagodia spinescens	P	shrub
Salsola kali var. *strobilifera*	A	subshrub
Sclerolaena articulata	P	subshrub
Sclerolaena bicornis var. *bicornis*	P	subshrub
Sclerolaena bicornis var. *horrida*	P	subshrub
Sclerolaena brachyptera	A	forb
Sclerolaena calcarata	B	subshrub
Sclerolaena convexula	P	subshrub
Sclerolaena decurrens	P	subshrub
Sclerolaena diacantha	B	subshrub
Sclerolaena divaricata	P	shrub
Sclerolaena eriacantha	P	subshrub
Sclerolaena intricata	P	shrub
Sclerolaena lanicuspis	P	subshrub
Sclerolaena longicuspis	P	shrub
Sclerolaena obliquicuspis	P	subshrub
Sclerolaena parallelicuspis	P	subshrub
Scerolaena patenticuspis	P	subshrub
Sclerolaena ventricosa	P	subshrub
Family **CONVOLVULACEAE**		
Convolvulus erubescens	P	forb
Evolvulus alsinoides	P	forb
Family **CRASSULACEAE**		
Crassula sieberi	A	forb
Family **CUCURBITACEAE**		
**Citrullus lanatus*	A	vine
**Cucumis myriocarpus*	A	vine
Zehneria micrantha	A	vine
Family **EUPHORBIACEAE**		
Chamaesyce drummondii	A	forb
Phyllanthus lacunarius	A	forb
Family **FABACEAE**		
Acacia aneura	P	low tree
Acacia ligulata	P	low tree
Acacia oswaldii	P	low tree
Acacia stenophylla	P	tree
Acacia tetragonaphylla	P	low tree
Acacia victoriae	P	low tree
Glycine canescens	P	climber

Appendix 2.1 continued

PLANT SPECIES	STATUS	GROWTH FORM
Lotus cruentus	A	forb
Psoralea cinerea	A	forb
Rhynchosia minima	A	herb
Senna artemisioides		
nothosubsp. *artemisioides*	P	shrub
nothosubsp. *sturtii*	P	shrub
subsp. *helmsii*	P	shrub
subsp. *oligophylla*	P	shrub
subsp. *petiolaris*	P	shrub
subsp. *zygophylla*	P	shrub
Swainsona affinis	P	forb
Swainsona campylantha	P	forb
Swainsona phacoides	P	forb
Swainsona stipularis?		
Trigonella suavissima	A	forb
Family **FRANKENIACEAE**		
Frankenia sp.	P	subshrub
Family **GERANIACEAE**		
Erodium crinitum	A	forb
Family **GOODENIACEAE**		
Goodenia fascicularis	P	forb
Goodenia glauca	A	forb
Goodenia heteromera	A	forb
Goodenia pinnatifida	A	forb
Scaevola spinescens	P	shrub
Family **HALORAGACEAE**		
Haloragis aspera	P	forb
Family **LAMIACEAE**		
Prostanthera striatiflora	P	shrub
**Salvia verbenaca*	P	forb
Teucrium racemosum	P	forb
Family **LORANTHACEAE**		
Amyema maidenii ssp. *maidenii*	P	mistletoe
Lysiana exocarpi	P	mistletoe
Lysiana murrayi	P	mistletoe
Lysiana subfalcata ssp. *subfalcata*	P	mistletoe
FAMILY **MALVACEAE**		
Abutilon fraseri	P	subshrub
Abutilon halophilum	P	subshrub
Abutilon leucopetalum	P	subshrub
Abutilon macrum	P	subshrub
Abutilon oxycarpum	P	subshrub
Lavatera plebeia	A	shrub
Lawrencia glomerata	P	subshrub
**Malvastrum americanum*	A	forb
Sida fibulifera	P	forb
Sida filiformis	P	forb
Sida intricata	P	subshrub
Sida petrophila	P	forb
Family **MYOPORACEAE**		
Eremophila bignoniflora	P	shrub
Eremophila duttonii	P	shrub
Eremophila goodwinii	P	shrub
Eremophila longifolia	P	shrub
Eremophila sturtii	P	shrub
Myoporum montanum	P	shrub
Family **MYRTACEAE**		
Eucalyptus camaldulensis	P	tree
Eucalyptus intertexta	P	tree
Eucalyptus largiflorens	P	tree
Eucalyptus populnea	P	tree
Family **OLEACEAE**		
Jasminum lineare	P	climber
Family **OXALIDACEAE**		
Oxalis perenanns	P	forb
Family **PITTOSPORACEAE**		
Pittosporum phylliraeoides	P	low tree
Family **PLANTAGINACEAE**		
Plantago turrifera	A	forb
Family **POLYGONACEAE**		
Muehlenbeckia florulenta	P	shrub
Family **PORTULACACEAE**		
Calandrinia ptychosperma	A	forb
Calandrinia remota	A	forb
Portulaca oleracea	A	forb
Family **PROTEACEAE**		
Grevillea striata	P	tree
Hakea tephrosperma	P	low tree
Family **RUBIACEAE**		
Canthium oleifolium	P	low tree
Family **RUTACEAE**		
Flindersia maculosa	P	tree

PLANT SPECIES	STATUS	GROWTH FORM
Family **SANTALACEAE**		
Santalum lanceolatum	P	low tree
Family **SAPINDACEAE**		
Alectryon oleifolius	P	tree
Atalaya hemiglauca	P	tree
Dodonaea viscosa ssp. *angustissima*	P	shrub
Dodonaea viscosa ssp. *mucronata*	P	shrub
Dodonaea viscosa ssp. *spatulata*	P	shrub
Family **SCROPHULARIACEAE**		
Mimulus repens	A	forb
Stemodia florulenta	P	forb
Family **SOLANACEAE**		
**Nicotiana glauca*	P	shrub
Nicotiana simulans	A	forb
Nicotiana velutina	A	forb
**Solanum nigrum*	A	forb
Solanum quadriloculatum	P	subshrub
Solanum sturtianum	P	subshrub
Family **THYMELACEAE**		
Pimelea microcephala	P	shrub
Pimelea trichostachya	A	forb
Family **ZYGOPHYLLACEAE**		
Tribulus terrestris	A	forb
Zygophyllum ammophilum	A	forb
Zygophyllum iodocarpum	A	forb
Zygophyllum simile	A	forb
FLOWERING PLANTS - MONOCOTYLEDONS		
Family **AMARYLLIDACEAE**		
Crinum flaccidum	P	forb
Family **ANTHERICACEAE**		
Thysanotus baueri	P	forb
Family **CYPERACEAE**		
Cyperus gymnocaulos	P	sedge
Cyperus sp.	A/B	sedge
Eleocharis pallens	P	rush
Family JUNCACEAE		
Juncus aridicola	P	rush
Family **LILIACEAE**		
**Asphodelus fistulosus*	A	forb
Bulbine semibarbata	A	forb
Family **PHORMIACEAE**		
Dianella longifolia	P	forb
Family **POACEAE**		
Agrostis avenacea	A	grass
Aristida contorta	A	grass
Aristida holathera var. *holathera*	A	grass
Aristida ramosa var. *ramosa*	P	grass
**Cenchrus ciliaris*	P	grass
Chloris pectinata	A	grass
Cymbopogon obtectus	P	grass
Dactyloctenium radulans	A	grass
Dicantheum sericeum	P	grass
Digitaria brownii	P	grass
Digitaria coenicola	P	grass
Enneapogon avenaceus	A/P	grass
Enneapogon cylindricus	P	grass
Enneapogon polyphyllus	A/P	grass
Eragrostis australasica	P	grass
Eragrostis dielsii	A	grass
Eragrostis parviflora	A	grass
Eragrostis sp.	A	grass
Eulalia aurea	P	grass
Panicum decompositum	P	grass
Panicum laevinode	A	grass
Panicum sp.	A	grass
Paspalidium constrictum	P	grass
**Schismus barbatus*	A	grass
Sporobolus actinocladus	P	grass
Sporobolus mitchellii	P	grass
Stipa nodosa	P	grass
Stipa sp.	A	grass
Themeda australis	P	grass
Tripogon loliiformis	A	grass
Triraphis mollis	A/P	grass
Urochloa praetervisa	A	grass

The following series of photos illustrates a selection of habitat types included in bird census transects. Figure 3.1 (Chapter 3) indicates the location of census transects referred to in photo captions.

Eucalypt woodland fringing Rutherfords Creek (transect RC2), a major creekline (October 1990).

Whitewood *Atalaya hemiglauca* and Beefwood *Grevillea striata* trees lining the middle reaches of Camp Creek (transect CC2), a minor creekline (October 1990).

Prickly Wattle *Acacia victoriae* scrub fringing Prickly Wattle Creek (transect PW), a minor creekline (October 1990).

Looking across the open plains (transect NH) to eucalypt woodland in Rutherfords Creek (transect RC2) (October 1990).

Mulga *Acacia aneura* scrub in the Peery Hills (transect PH) (October 1990).

Harlequin Eremophila *Eremophila duttonii* scrub (transect HP) on the plains adjacent to Goanna Gully Creek (July 1991).