SECTION B

THE GALAH (*Cacatua roseicapilla*)

(Vieillot 1817)

CHAPTER 8

HABITAT

8.1 HABITAT PREFERENCES

In north-east New South Wales the Galah prefers lightly wooded and open habitats associated with agricultural activity (Bennett 1978). High densities of Galah occur in both heterogeneous and homogeneous farming areas, as well as grasslands, savannah and woodland. Some were found on the edges of Ironbark (*Eucalyptus melanophloia*), Smooth-barked Apple (*Angophora costata*), Belah (*Casuarina cristata*) and Cypress Pine (*Callitris* sp.) forests. Like White Cockatoos, Galahs were associated with riverine areas. They were generally widespread from the northern Tablelands to the north-west Plains. Galahs tolerate more open habitats than do White Cockatoos, and are a more widespread species.

8.2 HABITAT USE

At Swan Vale and Wallangra the Galah was present in all four habitats of forest, woodland, native grassland and modified land as defined for the White Cockatoo (Chapter 3). Galahs were found throughout the ranges of the Cockatoos and their populations appeared to have slightly smaller home ranges. At Swan Vale and Wallangra there were 2 or 3 Galah populations although much interchange and overlap was evident (Fig. 34).

The activities performed by Galahs in each habitat at both field areas is shown in Table 16. Many roosting sites occurred in forest, woodland and savannah habitats. Flocks of 2 to 500 flew and perched in woodland and savannah during the day rest period and before and after

FIGURE 34

INFERRED . RANGES OF GALAH POPULATIONS

AT SWAN VALE AND WALLANGRA SITE A.

— — Range boundary
(minimum area of "home" ranges depicted)

——— Main roads

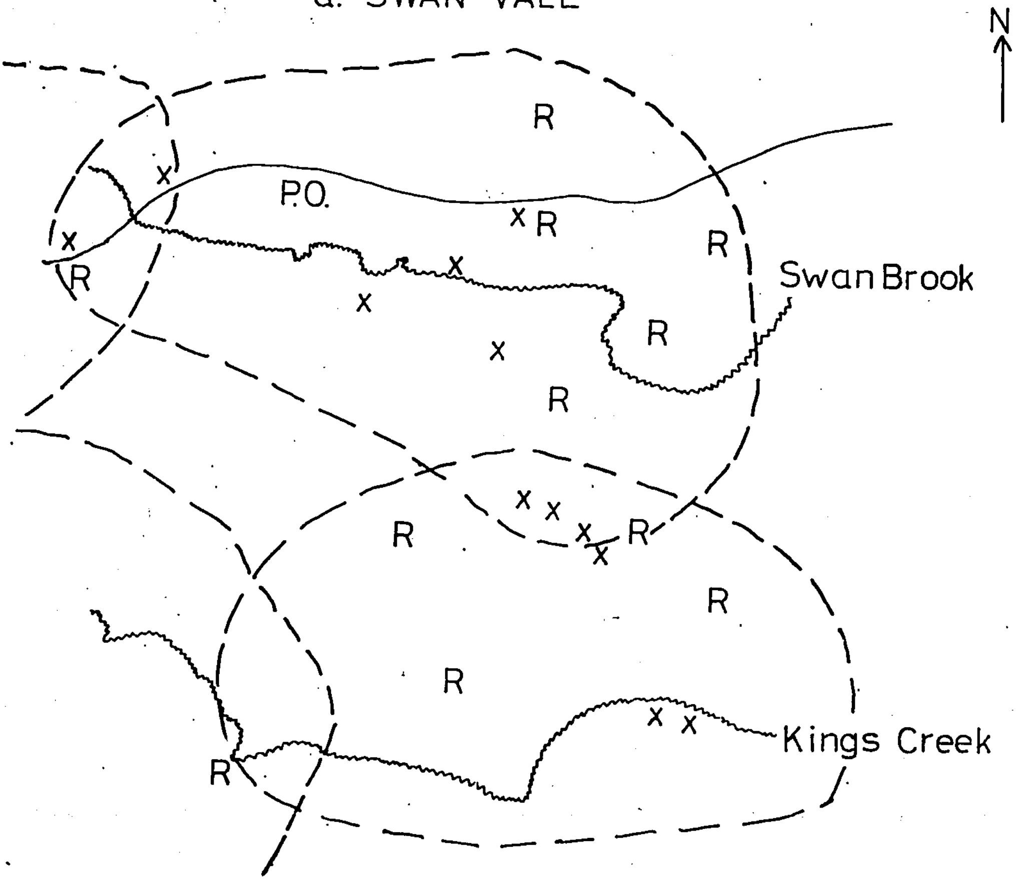
R Roost sites

X Nests

~~~~ Creeks

P.O. Post Office
~~~~

a. SWAN VALE



b. WALLANGRA

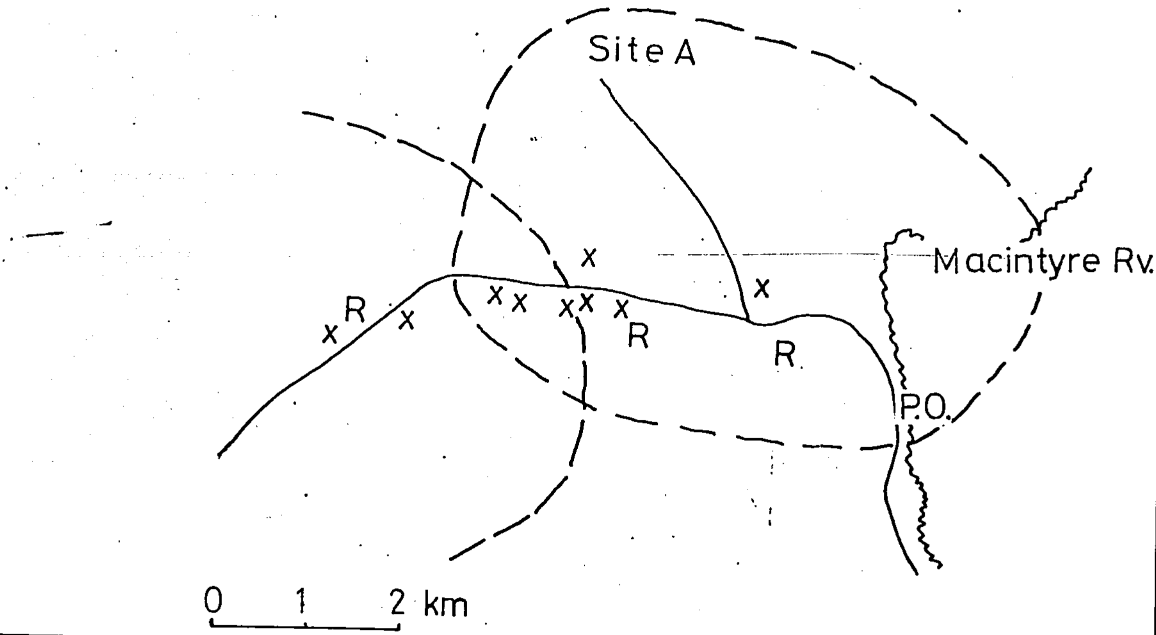


TABLE 16

HABITAT USE BY THE GALAH

Habitat	Activity	% flocks* in each habitat in each activity		Range of flock sizes in each habitat in each activity	
		SWAN VALE	WALLANGRA	SWAN VALE	WALLANGRA
Forest	Roost				
	Rest	1	1.5	1 - 50	1 - 50
	All	1	1.5		
Woodland	Roost	4	2.5	1 - 400	1 - 300
	Rest	18	19	1 - 400	1 - 300
	"Minor Feed"	0.5	1	1 - 30	1 - 50
	All	22.5	22.5		
Native Grassland	Perch	15	16	1 - 500	1 - 400
	"Minor Feed"	9.5	14	1 - 200	1 - 200
	All	24.5	30		
Modified Land	Perch	12	11	1 - 500	1 - 400
	"Minor Feed"	9	12	1 - 200	1 - 200
	"Major Feed"	31	23	1 - 800	1 - 500
	All	52	46		
	N =	450	162		

*Feeding and perching flocks included, where specific habitat also noted in data.

No statistical tests to find habitat preferences were used as observations were heavily biased towards open habitats.

feeding. Native and modified grasslands were used for feeding throughout the year by flocks of 1 to 200. Most intensive or "major' feeding" occurred in modified and crop areas. Less intensive or "minor' feeding" was observed in woodland and grasslands.

Dead or sparsely foliaged trees were used for perching near feeding or roosting areas and during flights between such areas, but day resting usually occurred in trees with heavy foliage. Galahs roosted in or under foliage (but occasionally on more exposed branches) in eucalypts such as *Eucalyptus albens*, *E. viminalis* and *E. blakelyi*. Rivers, dams, tanks and temporary pools were used as drinking places. Hollows in limbs or trunks of live or dead trees in forest, woodland or savannah were used for nest sites.

CHAPTER 9

SOCIAL ORGANIZATION

Pidgeon (1970) and Rowley (1974, 1976) described the individual and social behaviour of the Galah. Their behaviour patterns exhibit similarity to those of the White Cockatoo, and will be compared in Chapter 11. In this chapter the social organization, non-reproductive and reproductive behaviour of the Galah at my field areas will be briefly discussed and my observations related to those of Pidgeon (1970) and Rowley (1974, 1976).

9.1 POPULATION SIZE AND ORGANIZATION

At the two field areas the Galah populations lived within home ranges covering approximately 2,750 and 2,200 ha at Swan Vale and 2,100 ha at Wallangra Site A (Fig. 34). Pidgeon (1970) found home ranges of Galahs to be 1,650 ha at Armidale, 1,550 ha at Inverell and 2,690-4,450 ha at Walgett.

The population of Galahs fluctuated during the year. At Swan Vale Galahs always outnumbered White Cockatoos by 3 or 4 to one Cockatoo. At Wallangra there were 2 to 3 times more Cockatoos. Numbers of Galahs were estimated as the birds were dispersed during most activities.

At Swan Vale the population rose by at least 500% during the autumn and winter, and flocks were largest in these seasons (Fig. 35a). A peak in population numbers occurred from May to July in all three years. In August and early spring the population decreased with the onset of breeding. The 100 to 150 birds which remained were dispersed throughout the range as small flocks of 2 to 30 birds.

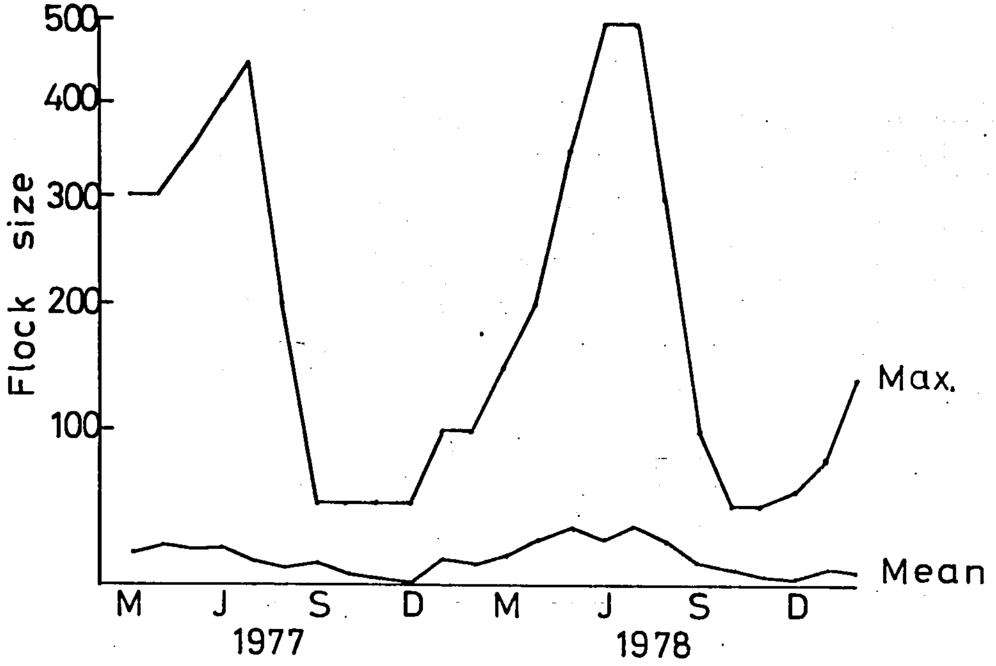
At Swan Vale there was a significant relationship between monthly

FIGURE 35

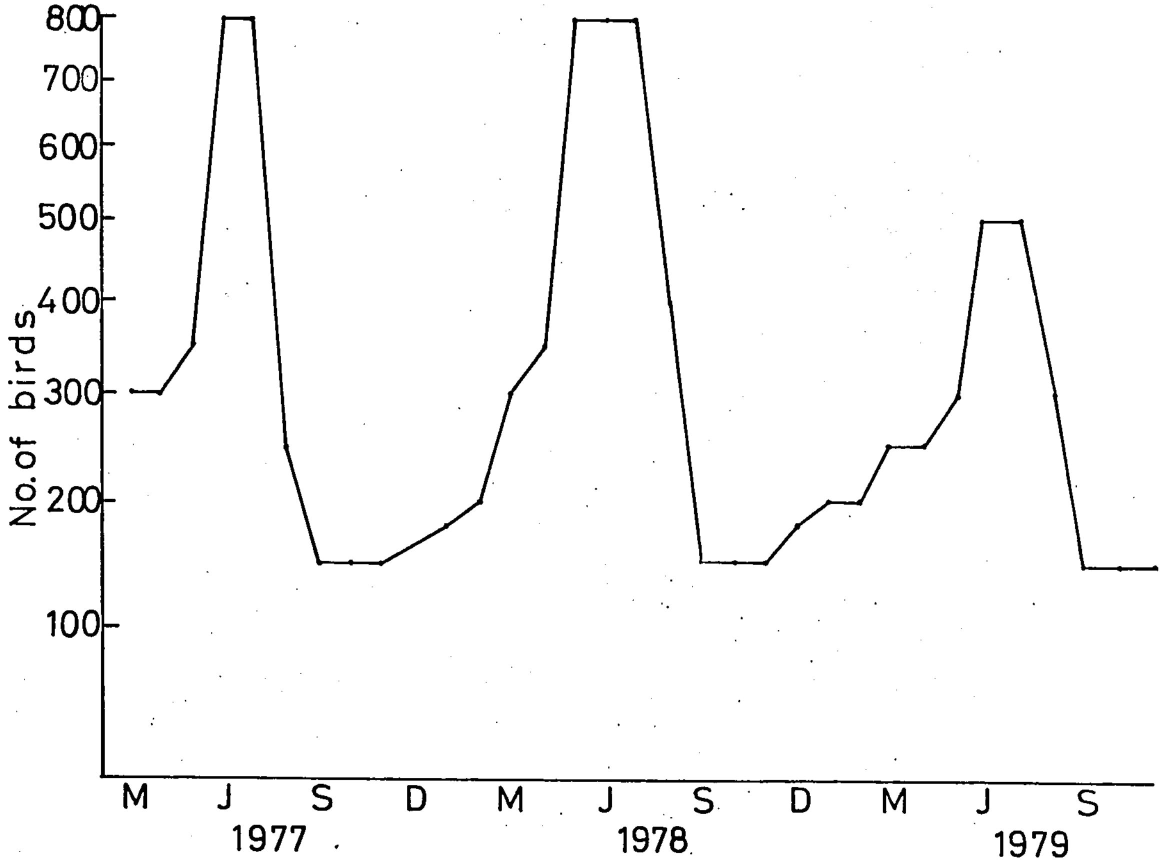
TOTAL POPULATION NUMBERS, AND

MEAN AND MAXIMUM FLOCK SIZES OF GALAHS

PRESENT EACH MONTH WITHIN THE SWAN VALE RANGE



Flock size
500
400
300
200
100
Max.
Mean
M J S D M J S D
1977
1978



No. of birds
800
700
600
500
400
300
200
100
M J S D M J S D M J S
1977
1978
1979

mean flock sizes (Fig. 35a) and monthly population numbers (Fig.35b) in the home range ($r = 0.75$, $df = 22$, $P < 0.01$) in 1977 and 1978. Monthly mean flock sizes were similar each year for 1977 and 1978 ($r = 0.81$, $df = 10$, $P < 0.01$); as were the monthly population numbers for these two years ($r = 0.75$, $df = 18$, $P < 0.01$).

At Wallangra the fluctuation in numbers of Galahs was not as great as that at Swan Vale. Breeding season numbers of 100-150 rose by about 100 to 300% during the autumn and winter months each year. By late August numbers had dropped to the breeding level.

Pidgeon's (1970) data on the fluctuation of Galah numbers during 1967-68 at Inverell (Fig. 36c), was significantly different from those I recorded at Swan Vale 1977-78 (Fig. 36a) ($r = 0.13$, $df = 11$, $P > 0.05$). After a post-breeding increase, an influx of mostly juvenile birds occurred in February 1967 and February - March 1968 at Inverell (Pidgeon 1970), earlier than at Swan Vale. Large numbers occurred in April and May but numbers dropped to the typical breeding season level by June, again earlier than at Swan Vale (Fig. 36a). At Armidale (Fig. 36d) juvenile flocks disappeared from the home range after parental feeding ceased, although one juvenile influx remained in the range for a week in December before disappearing. At Tamworth in 1967 and 1968 large numbers of Galahs appeared in May and June (Fig. 36e), coinciding with the disappearance of flocks from Inverell (Fig. 36c) and another area near Tamworth. The influx left the Tamworth area in July. Pidgeon (1970) suggested that these were non-breeding adults and immatures which had left other areas at the onset of breeding.

In some years large flocks of juveniles enter the home range at Swan Vale in the post-breeding months, from December to March (J.E. Courtney, M.G.M. Woods, pers. comm.). This occurred to a small degree in March 1977 but not in 1978 or 1979. There were some juveniles present

FIGURE 36

MONTHLY FLUCUTATIONS OF GALAH NUMBERS WITHIN

FIVE HOME RANGES

IN NORTH-EAST NEW SOUTH WALES

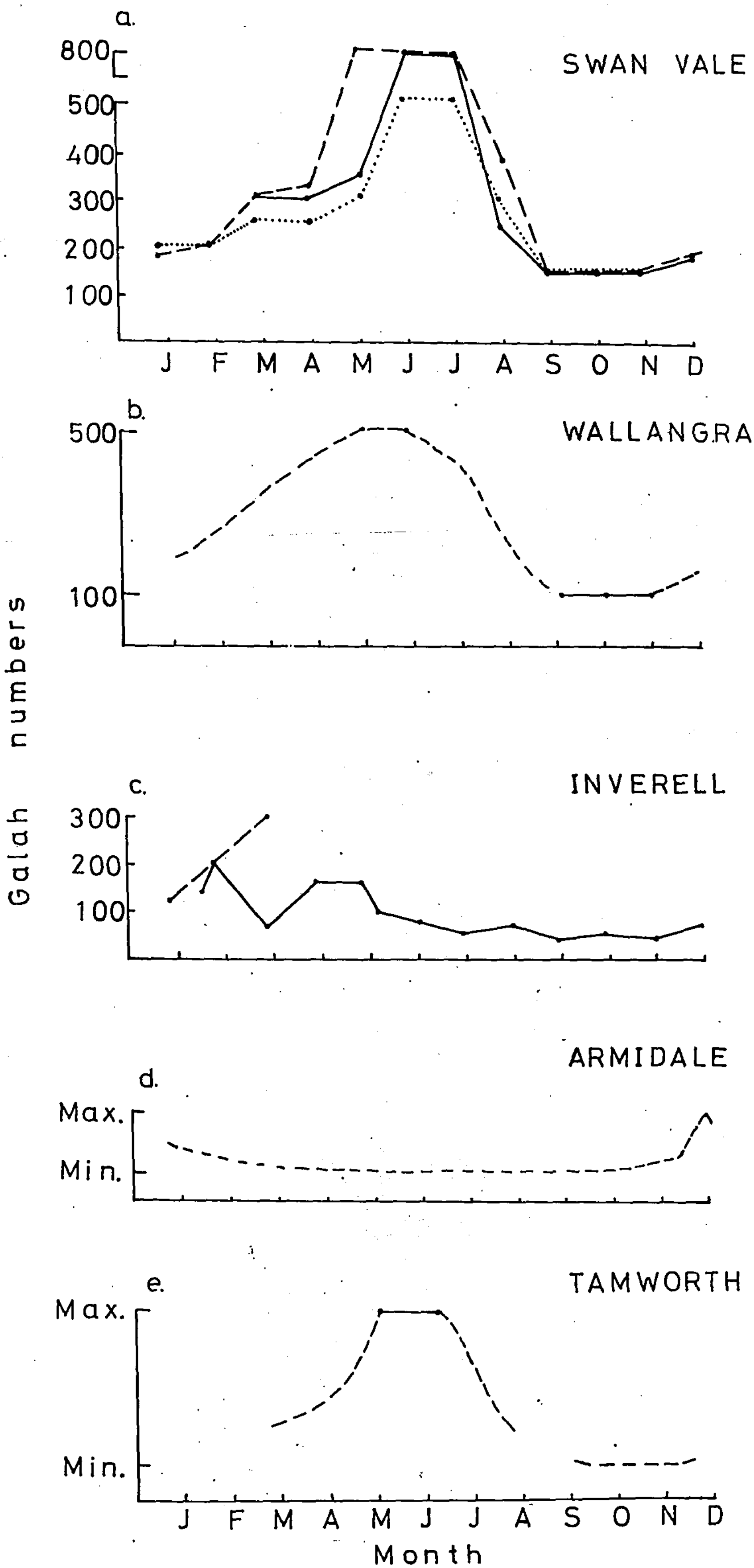
a. SWAN VALE ____ 1977 __ __ 1978 ...... 1979 (pers. obs.)

b. WALLANGRA 1977 - 1979 (pers. obs.)

c. INVERELL ____ 1967 __ __ 1968 (from Pidgeon 1970)

d. ARMIDALE 1967 - 1968 (from Pidgeon 1970)

e. TAMWORTH 1967 - 1968 (from Pidgeon 1970)


a.
SWAN VALE
800
500
400
300
200
100
J F M A M J J A S O N D
b.
WALLANGRA
500
100
c.
INVERELL
300
200
100
d.
ARMIDALE
Max.
Min.
e.
TAMWORTH
Max.
Min.
J F M A M J J A S O N D
Month
Galah numbers

with adults in December to March 1978 and 1979 at Swan Vale and Wallangra, but not the large numbers recorded by Pidgeon (1970) for Inverell and Armidale. Large numbers did enter the home ranges at Swan Vale and Wallangra from late April to early June, and remained until late July or August. A few of these birds had traces of juvenile plumage as distinguished through binoculars. Juveniles were paler in plumage with a grey breast band (see Appendix A). Between March and July only 24% of the 21 Galahs shot at Wallangra were immatures; most juveniles have immature plumage, with traces of grey on head and breast and a duller plumage than adults, by May of their first year (see Appendix A). At Swan Vale 42% of 19 Galahs shot were immatures.

At Swan Vale J.E. Courtney banded 404 Galahs from September 1965 to August 1971. Of these only 47 were banded as juveniles and 45 as immatures. Juveniles were banded from November to February, and immatures from June to September, and in November. Adults were trapped in every month of the year. Fifty-nine Galahs were recaptured at the banding site at Swan Vale during the period of banding; only three juveniles were recaptured. One was banded as a juvenile and caught 2 years and 3 months later as a young adult male. Adults were recaptured up to 5 years after banding, $\bar{X}$ = 1 year 10 months, (N = 47).

Six of these banded adult Galahs were killed on the road from ½ to 7 kilometres from their banding site at Swan Vale. The average duration after banding of these birds (although banded as adults) was 1 year 4 months, with a maximum of 4 years and 4 months. Another 5 Galahs were shot at Swan Vale from ½ to 2 km from their banding site. These birds banded as adults, were shot from 5 years and 3 months to 9 years and 8 months after banding ($\bar{X}$ = 7 years 2 months). This is apparently the oldest recorded for this species in the wild. A specimen found dead at its banding site near Narranderra was also over 8 years old (Anon 1977).

C.S.I.R.O. Bird Banding Scheme data suggest that birds banded as adults rarely travel more than 11.2 km (mean of 3.7 km), while juveniles travel up to 256 km (mean of 109.2 km) (Pidgeon 1970).

My field observations agree with those of Pidgeon (1970), regarding the social organization of the Galah in north-east New South Wales. A proportion of adults is sedentary, living within an undefended home range. About half of these birds breed (Pidgeon 1970). When parental feeding ceases and juveniles become independent they congregate, and may remain temporarily or return to their parents' home range, or join other nomadic (mobile) flocks. These mobile flocks contain immatures and non-breeding adults. Any permanent home range may experience an influx of such mobile birds, directly after breeding or in subsequent non-breeding months. It is not known if these birds disperse or stay in their mobile flocks during the breeding season, but no such flocks were seen in the permanent home ranges at the field areas during breeding months.

Pidgeon (1970) was able to identify certain social tendencies associated with the three stages (juvenile, nomadic (mobile) and sedentary) in the social life of captive Galahs. Mobile juvenile flocks appeared to have no internal social structure; they allopreen indiscriminately and agonistic interactions are frequent. Mobile flocks of non-breeding immatures and adults contain smaller social groups of individuals which perch together and allopreen. The sedentary population contains breeding pairs which allopreen only within a pair. I observed allopreening in adult pairs but not in larger groups or between juveniles.

9.2 DAILY ROUTINE AND FLOCK BEHAVIOUR

The daily routine of Galahs was similar to that of the White Cockatoos. Both small and large flocks vacated their communal roosts, and "minor" and "major feeding" occurred. Pidgeon (1970) called these "brief" and "full-feeding loops". After major feeding small groups dispersed towards a roost or rest area where the midday period was spent; "minor feeding" occurred before and after resting. Then the majority assembled in the mid-afternoon for "major feeding", before returning to a roost site. "Minor feeding" and drinking often took place before birds settled to night roost.

Galahs used more than one roost site each night at both field areas, although usually the majority roosted together. At Inverell, Pidgeon (1970) found that Galahs roosted together at one of several sites. He recorded that birds used roost sites for day resting at Inverell and Armidale, but on the western plains they rested near feeding areas at a considerable distance from roost sites. At Swan Vale and Wallangra rest sites were not always roost sites.

The daily pattern of flock sizes was generally bimodal, with large morning and afternoon feeding congregations at both field areas. However, three peaks in flock size often occurred in the non-breeding months due to the presence of large day resting flocks. Birds dispersed into pairs and small groups between these feeding and resting periods. Not all birds joined large aggregations or participated in "minor feeding". During each daily activity both large flocks of up to 500 birds and small flocks of 2 to 10 were observed. This may be due to the segregation of nomadic and sedentary flocks in non-breeding months. After the large mobile flocks of Galahs had left aggregations were smaller, and birds were more dispersed in all activities during the breeding months. However, at both field areas in these months I also recorded relatively large flocks numbering 20 to 40 Galahs. These may represent non-breeding members of the sedentary population.

9.3 BREEDING

The process of stripping bark from the trunk of nest trees and lining the nest with leaves, as described by Pidgeon (1970), was observed at Swan Vale from early July and Wallangra from mid June. Pairs attended their nests regularly from late July to late December at both areas. Some were seen at nest holes outside the breeding months, so possibly established pairs maintain their nest throughout the year as do White Cockatoos. Nest-holes were located in dead or living branches and trunks of White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*), Red Gum (*E. blakelyi*) and Smooth-barked Apple (*Angophora costata*). The nests were either clumped or scattered in forest, woodland and savannah habitats.

Pidgeon (1970) estimated that less than half of the adult sedentary population nested on his study area near Inverell. At Swan Vale and Wallangra not all sedentary adults nested. Eighty percent of 10 and 14 adult Galahs collected at Swan Vale and Wallangra, respectively, from August to November, were in breeding condition, with enlarged testes (> 3 mm long), or oocytes (> 3 mm) and convoluted oviducts.

Three out of 7 nests Pidgeon (1970) examined at Inverell successfully raised young in each of two breeding seasons, producing a total of 6 and 7 young respectively in each year. I made no examination of nests and breeding success of Galahs. Only about 20-25% of adult pairs at Swan Vale were accompanied by up to four juveniles in December and January 1978 and 1979. Rowley (1976) found that one in ten fledglings survive to breed. The productivity of young in Galahs is low (about one fledgling per pair) (Pidgeon 1970) as is their survival to adulthood. However, breeding adults (over three years of age) may live many years (Rowley 1976).

At Swan Vale and Wallangra recently fledged Galahs were fed by adults from early November to February in 1977, 1978 and 1979. By late February each year, these family parties were not observed, possibly because juveniles aggregate to form nomadic flocks after parental feeding ceases (Pidgeon 1970). Rowley (1976) observed that young fledglings in Western Australia formed creches where they were fed for 6 to 8 weeks by parents, before wandering in large flocks of immatures for the following two or three years.

CHAPTER 10

FEEDING ECOLOGY

10.1 FEEDING HABITS

At Swan Vale and Wallangra Galahs fed whilst perching on sturdy plants such as sunflower and sorghum, and eating the seeds from the head *in situ*. They also fed on the ground, reached up to seed heads, or bent and broke off stems of less sturdy plants such as wheat and catsear, and of prickly plants such as thistles. Small seed heads were held usually in the left foot whilst seeds were extracted. Galahs occasionally harvested small seed heads such as wheat, carrying them in the bill to a tree where they ate the seed.

Small seeds were usually husked and swallowed whole. Large seeds such as sunflower were husked and broken into smaller pieces before ingestion. Husk is sometimes ingested. Infrequently Galahs used their bill, to dig for roots and corms or to uncover buried seed, by moving the head sideways. They occasionally picked apart cow pads to extract seeds.

Galahs chewed but rarely ingested eucalypt and apple (*Angophora* sp.) fruits, bark and small branches. Galahs rarely fed in trees.

10.2 FEEDING PERIODS

Galahs exhibited "major" and "minor" feeding similar to that described for the White Cockatoo (Chapter 6.1). Flocks of 10 to over 500 birds which fed intensively in cohesive units were "major feeding". Such feeding flocks ingested food mainly from standing crop and stubble areas, though occasionally in spring and summer some Galah flocks appeared to feed intensively in native and modified areas. "Minor feeding" describes less cohesive flocks of 1 to 100 birds which foraged mainly in native and modified grasslands and were rarely seen to ingest food.

Feeding occurred mainly in two periods, one in the early morning and one in the mid to late afternoon, for two to three hours duration, at both field areas throughout the year (Fig. 37). Galahs began feeding within an hour of dawn and up to five hours before dusk. Birds were occasionally observed feeding outside these two periods near day rest and roost areas.

Flocks were observed "minor feeding" before, during or after "major feeding" at both field areas. "Minor feeding" was more pronounced in spring and summer than in other seasons at Swan Vale, and in spring at Wallangra (Table 17). At Swan Vale the patterns of "major" and "minor feeding" were significantly similar between spring and summer, between autumn and winter and between autumn and summer (Table 17). Winter was the most significantly different season (that is, it had the highest G values) (Table 17).

Throughout the year at Swan Vale more birds fed in the afternoon than in the morning feeding period (Table 18). Galah 'crops' examined were generally fuller in the afternoon ($\bar{X}$ = 6.16 g dry weight) than in the morning ($\bar{X}$ = 2.72 g dry weight), at both field areas ($t = 5.38$, $df = 53$, $P < 0.001$) (Fig. 38).

10.3 FOOD AVAILABILITY

Food availability at Swan Vale and Wallangra was discussed in Chapter 6.2 for the White Cockatoo, and is identical for the Galah, as it eats the same range of foods.

Native and exotic seed from native and modified grasslands was most available from mid spring to late autumn. Crop seed was available throughout the year from standing heads or stubble areas. In autumn and winter sunflower and sorghum seeds were available, and in spring and summer wheat, barley and oats were available.

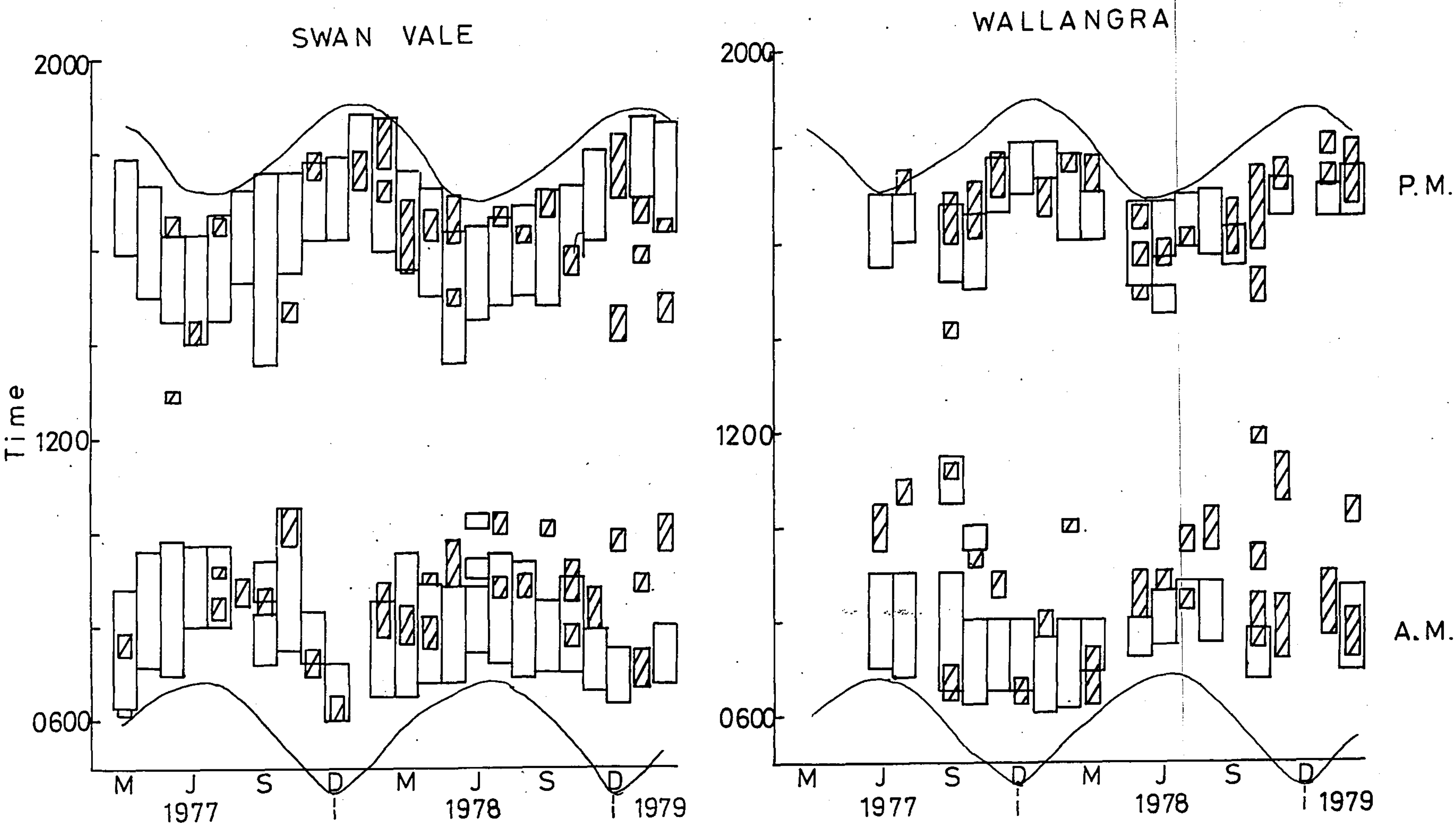
FIGURE 37

GALAH FEEDING PERIODS

"Major feeding" - crop and stubble

"Minor feeding" - native and modified grassland

—— sunrise and sunset



SWAN VALE
WALLANGRA
Time
2000
1200
0600
P.M.
A.M.
M
J
S
D
1977
1978
1979

TABLE 17

"MAJOR" AND "MINOR FEEDING" BY GALAHS

a. Swan Vale (1977 + 1978)

	"Major Feeding" %	"Minor Feeding" %	Total 'Bird hours'
Autumn	75	25	416
Winter	76	24	570
Spring	62	38	165
Summer	66	34	160

Overall $G = 16$, $df = 3$, $P < 0.005$

Testing between pairs of seasons - which seasons differ?

	Winter	Spring	Summer
Autumn	0^{NS}	4^{x}	2^{NS}
Winter		12^{xx}	6^{x}
Spring			0^{NS}

NS = $P > 0.05$ x $P < 0.05$ xx $P < 0.005$.

b. Wallangra (1977 + 1978 - estimates from Fig. 39)

	"Major Feeding" %	"Minor Feeding" %
Autumn	50	50
Winter	53	47
Spring	39	61
Summer	50	50

"Minor feeding" hours especially at Swan Vale are underestimates as few observations were made near Galah roost areas where much "minor feeding" took place. "Minor feeding" hours do not indicate actual feeding times as birds were not necessarily actively feeding. The biases are present each season in these data, thus enabling seasonal comparisons.

TABLE 18

GALAH FEEDING 'BIRD HOURS' IN EACH FEEDING PERIOD AT SWAN VALE

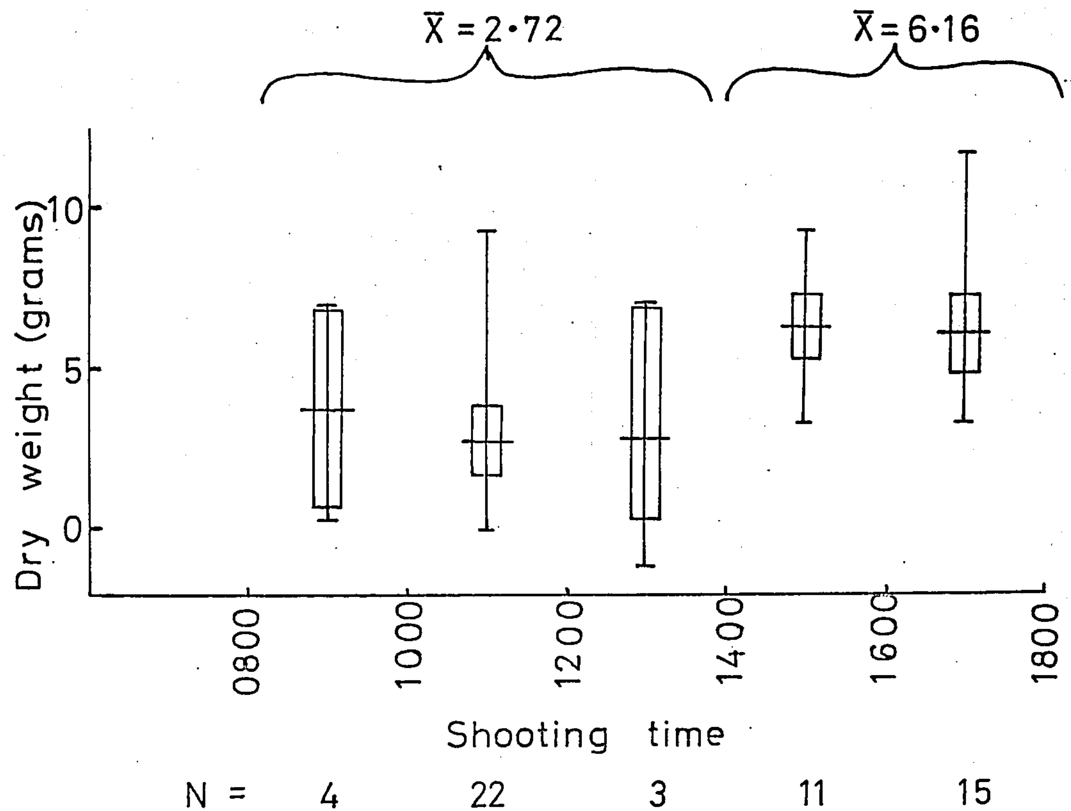
Season	Feeding period	Feeding 'Bird hours'	Hours of observations	Feeding 'Bird hours' per hour of observation
Autumn	a.m.	206	74	2.78
	p.m.	210	67	3.13
Winter	a.m.	266	66	4.03
	p.m.	304	66	4.61
Spring	a.m.	77	80	0.96
	p.m.	88	79	1.11
Summer	a.m.	71	43	1.65
	p.m.	89	48	1.85

Feeding 'Bird hours' = No. of birds feeding X hours feeding

FIGURE 38

DRY WEIGHTS OF GALAH'CROP' CONTENTS THROUGHOUT THE DAY

(Mean, 2 Standard Errors and Range graphed)



$\bar{X} = 2 \cdot 72$
$\bar{X} = 6 \cdot 16$
Dry weight (grams)
0
5
10
0800
1000
1200
1400
1600
1800
Shooting time
N = 4 22 3 11 15

10.4 FOOD EATEN

Published records and personal observations of foods eaten by Galahs in various parts of Australia are listed in Table 19. They include a variety of crop, native and exotic seeds and bulbous roots and corms.

At Swan Vale and Wallangra I observed Galahs feeding on sunflower, sorghum, wheat, barley and oat seeds during "major feeding" periods. During an occasional "major feeding" period but usually during "minor feeding" on the ground, Galahs were observed feeding on the native grass seeds of wallaby grass (*Danthonia* sp.), blue grass (*Bothriocloa macra*) and canary grass (*Phalaris* sp.), or the exotic seeds of clover (*Trifolium* sp.), burr medic (*Medicago* sp.), dandelion (*Taraxacum officinale*), catsear (*Hypochoeris* sp.), barnyard grass (*Echinocloa crus-galli*), thistles (*Cirsium vulgare* and *Silybum marianum*), dock (*Rumex* sp.), and plantain (*Plantago* sp.). The young shoots of wheat, barley and oats were sometimes eaten.

On rare occasions Galahs were seen feeding in trees. At Wallangra they ate the seeds from Black Cypress Pine (*Callitris endlicheri*) and Kurrajong (*Brachychiton populneum*). At Swan Vale and Wallangra they occasionally chewed the seeds or fruits of eucalypts (*Eucalyptus albens* and *E. melliodora*) and apples (*Angophora floribunda* and *A. costata*). At Swan Vale Galahs were seen chewing the seeds of Almond trees (*Prunus* sp.).

These "minor feeding" activities occurred throughout the year when the seeds of grasses, weeds and trees were available. "Major feeding", with the rapid ingestion of seed from crops, appeared to be the most important feeding period to the birds. Many Galahs did not actively feed or participate in "minor feeding". However, some Galah flocks also fed during "minor feeding" on native and modified grasslands, instead of, or as well as, "major feeding" on crops. This "minor feeding" with some food ingestion occurred throughout the year at both field areas, but was

TABLE 19

FOODS EATEN BY GALAHS IN VARIOUS PARTS OF AUSTRALIA

1. SEEDS OF:

A. GRAIN CROPS		
Sunflower	*Helianthus annuus*	pers.obs.
Sorghum	*Sorghum* sp.	"
Wheat	*Triticum aestivum*	p.o.; Anon. 1944
Barley	*Hordeum vulgare*	pers.obs.
Oats	*Avena sativa*	"
Maize	*Zea mays*	Anon. 1901
B. NATIVE GRASS/HERB		
Button grass	*Dactyloctenium radulans*	Allen 1950
Flinders grass	*Iseilema membranaceum*	Allen 1950
Mitchell grass	*Astrebla lappacea*	Allen 1950
Button grass	*Dactyloctenium aegypticum*	Carruthers 1968
Rolypoly	*Bassia* sp.	Macarthur Onslow 1929
Wallaby grass	*Danthonia* sp.	pers.obs.
Canary grass	*Phalaris* sp.	"
Blue grass	*Bothriocloa* sp.	"
?	*Alternanthera nana*	"
?	*Boerhavia* sp.	Hall 1974
Cottonbush	*Kochia* sp.	Hall 1974
C. EXOTIC GRASS/WEED		Chisholm 1940; Macgillivray 1920
Cape weed	*Cryptostemma calendulaceum*	Forshaw 1969
Storksbill	*Erodium cicutarium*	Forshaw 1969
Prickly Jacks	*Emex australis*	Serventy 1927
Clover	*Trifolium* sp.	pers.obs.; Frith 1969
Pigeon grass	*Setaria* sp.	pers.obs.
Barnyard grass	*Echinocloa crus-galli*	"
Dandelion	*Taraxacum officinale*	"
Catsear	*Hypochoeris* sp.	"
Variegated thistle	*Silybum marianum*	"
Spear thistle	*Cirsium vulgare*	"
Medic	*Medicago* sp.	"
Dock	*Rumex* sp.	"

TABLE 19 (Cont'd)

C.	EXOTIC GRASS/WEED		
	[illegible]	*Amaranthus retroflexus*	pers.obs.
	Weed	*Polygonum* sp.	"
	Plantain	*Plantago* sp.	"
	Crowfoot	*Erodium* sp.	CSIRO 1974
D.	TREES		
	Black Cypress Pine	*Callitris endlicheri*	pers.obs.
	Kurrajong	*Brachychiton populneum*	"
	Yellow Box	*Eucalyptus melliodora*	"
	White Box	*E. albens*	"
	Smooth-barked Apple	*Angophora costata*	"
	Rough-barked Apple	*A. floribunda*	"
2.	BULBOUS ROOTS/CORMS		Serventy & Whittell 1967
	Onion grass	*Romulea rosea*	Cleland 1969
	?	*Microseris forsteri*	Cleland 1969
3.	OTHER		
	Salt licks		Shanks 1949; Hindwood & McGill 1951
	~~Young shoots of crops~~		Anon 1901; pers.obs.
	Flowers	*Bauhinia* sp.	F.H.Crome pers. comm.

most conspicuous in spring and early summer during the breeding season.

At Swan Vale, (Fig. 39a) and Wallangra (Fig 39b) crop seed was eaten throughout the year, despite the relatively small areas of crop available in the total grassland area (Fig. 26a, b). At Swan Vale (Fig. 39a) sunflower was eaten from February/March to September/October each year, although fewer birds ate it from stubble in July/August when the majority of birds vacated the home range. Sorghum was eaten in 1977 and 1978 from stubble and self-sown crop. In 1979 no sorghum was planted in the main Swan Vale field area. Wheat and barley were eaten from sown fields in July 1977 and from standing and stubble areas in late spring and summer. In 1979 Galahs transferred from wheat stubble to standing sunflower earlier than in 1978, as the 1979 stubble was ploughed. Oats were eaten when at the soft dough stage at various times of the year. Native and modified grasslands were used mainly for "minor feeding" by some Galah flocks throughout the year. However, significant amounts of food were probably consumed only in spring and summer during "minor feeding".

At Wallangra (Fig. 39b) sorghum was eaten mainly from January/February to August/September each year. In spring and summer wheat and barley was the main crop seed consumed. Native and modified grasslands were feeding sites used throughout the year, but most often in spring and summer breeding months.

In all, 91 Galah 'crops' which contained food were examined to study the diet of the birds. Eighty-seven % of these contained some crop seed and 79% contained some native or modified seed. Only 21% of 'crops' however, contained exclusively crop seed; 13% contained only native and modified seed. The remaining 66% contained both crop seed presumably eaten during "major feeding", and native and modified seed mostly consumed during "minor feeding". Green matter, bark and husk were ingested by 48% of the birds.

FIGURE 39

USE OF FEEDING AREAS BY GALAHS AT

a. SWAN VALE b. WALLANGRA

LEGEND

- standing sunflower
- stubble sunflower
- standing sorghum
- stubble sorghum
- standing wheat/barley
- stubble wheat/barley
- standing oats
- native grassland
- modified grassland

Proportions of feeding 'bird hours' in certain feeding areas are depicted for each month.

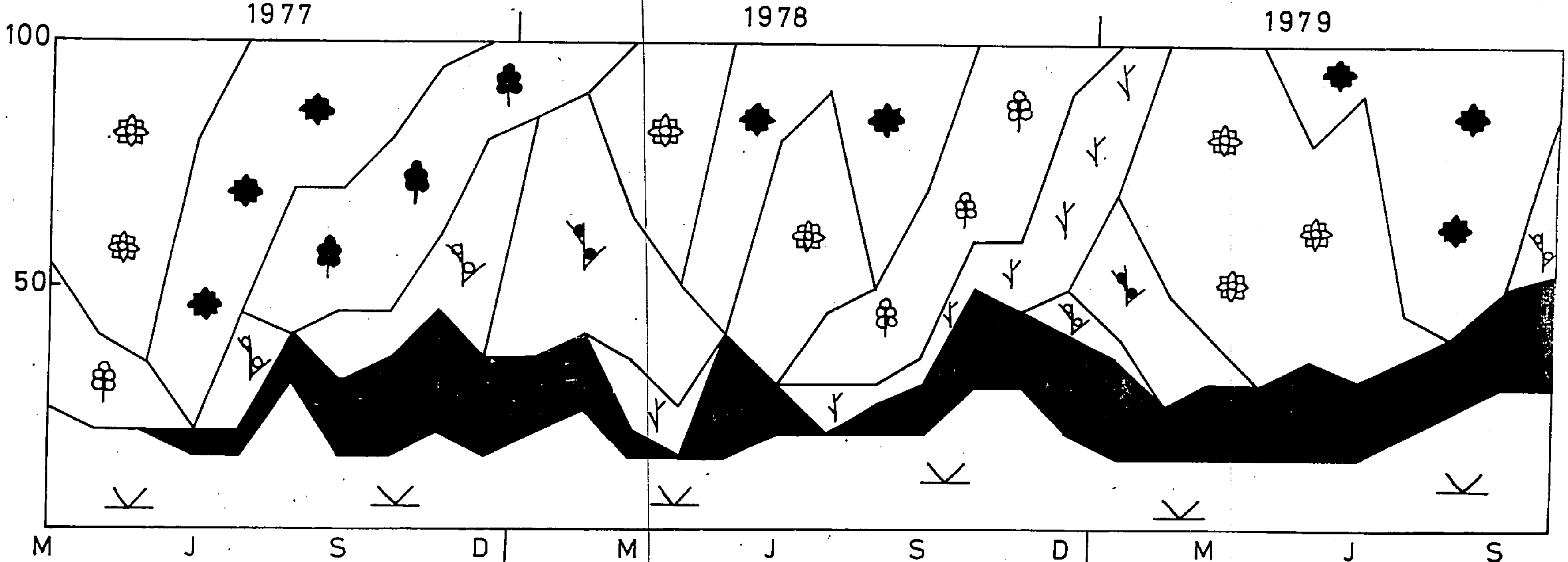
$$\text{Feeding 'bird hours'} = \frac{\text{No. of birds x No. of minutes on ground}}{60}$$

Proportions were calculated from March 1977 to February 1979 at Swan Vale; and estimated for March 1977 to October 1979 for Wallangra, and for March 1979 to September 1979 for Swan Vale.

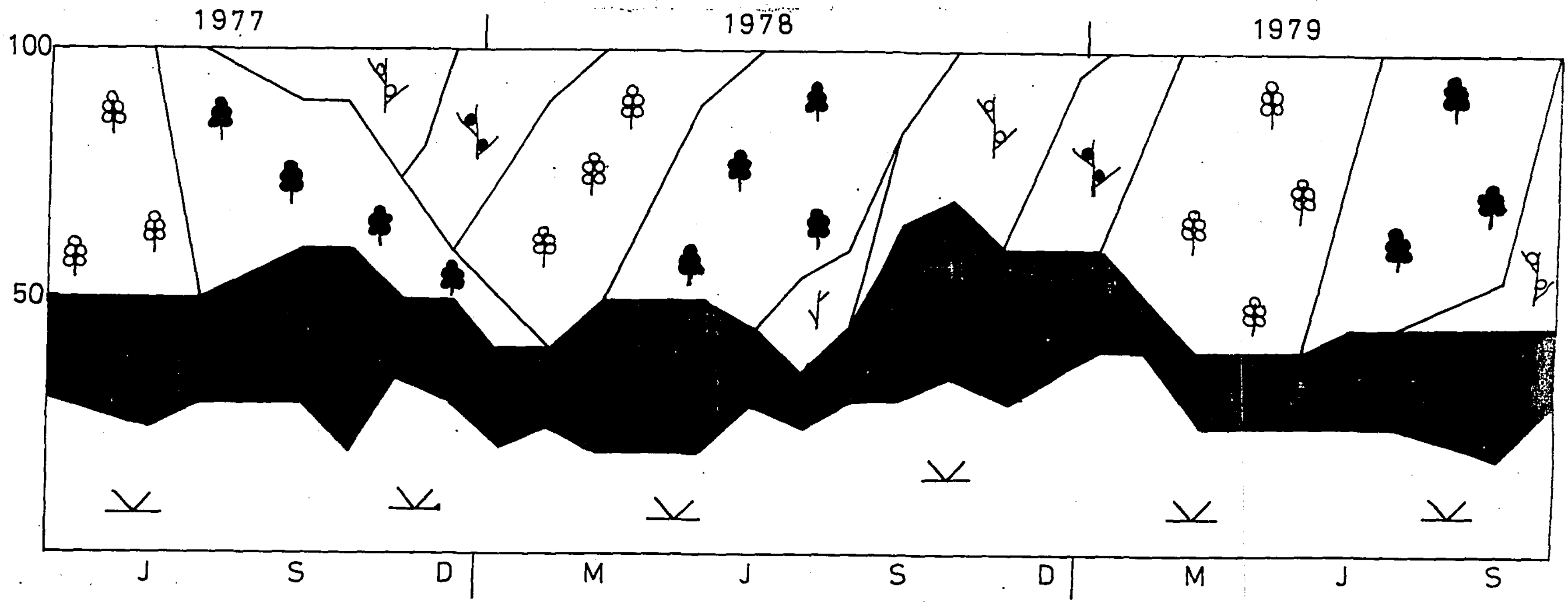
Feeding 'Bird hours'

Swan Vale	J	F	M	A	M	J	J	A	S	O	N	D
1977	–	–	42	58	80	110	119	31	30	25	28	12
1978	19	24	62	71	103	115	101	94	29	27	26	18
1979	46	41			estimates							

a. SWAN VALE



b. WALLANGRA



At Swan Vale crop seeds were eaten throughout the year (Fig. 40a). Wheat and oats were consumed in October and February to April, making up 22.5% of diet by weight in these four months. No birds were shot from November to January. Sunflower was the most common food eaten from February to September, comprising 73.4% of diet by weight. Sorghum was not grown in 1979 but was grown and eaten in 1977 and 1978. Seed of native and modified plants were consumed each month. They did not form a significant part of the Galah diet from February to August, being 1.9% of diet by weight, though in September and October they comprised 72.5% of diet by weight (Fig. 40a). The most common of these seeds eaten was the thistle seed (*Cirsium vulgare*). Other modified seeds consumed were *Rumex* sp., *Hypochoeris* sp., *Setaria* sp., *Phalaris?* sp., *Amaranthus retroflexus*, *Echinocloa crusgalli*, *Polygonum* sp., and *Medicago polimorpha* (Plate 4). The native grass seed *Bothriocloa macra* was present in one crop in April. Four unidentified seeds were present in small numbers in 5 crops.

At Wallangra crop seeds were also eaten throughout the year (Fig. 40b); but seeds from native and modified grassland were much more abundant in these 'crops' than at Swan Vale. Sorghum was eaten in March and from May to September, comprising 42.7% of diet by weight. Wheat, barley and oats were consumed from sowing in June/July and in October and November, comprising 23.2% of diet by weight. Seeds from the thistles (*Cirsium vulgare* and *Silybum marianum*) dominated modified seed intake. Other seeds identified in 'crops' were those of *Hypochoeris* sp., *Setaria* sp., *Amaranthus retroflexus*, *Phalaris*? sp., *Rumex* sp., and four small < 2 mm unidentified seeds (Plate 4). The native seeds *Bothriocloa macra* and *Alternantha nana* were present in May and August. Throughout the year seeds of modified and native plants formed an important part of the diet of the Galah, being 55.7% by weight.

At two sites 20 and 40 km north-west of Wallangra 15 Galahs shot

FIGURE 40

MONTHLY SEED COMPOSITION OF GALAHS 'CROPS' AT

a. SWAN VALE and b. WALLANGRA.

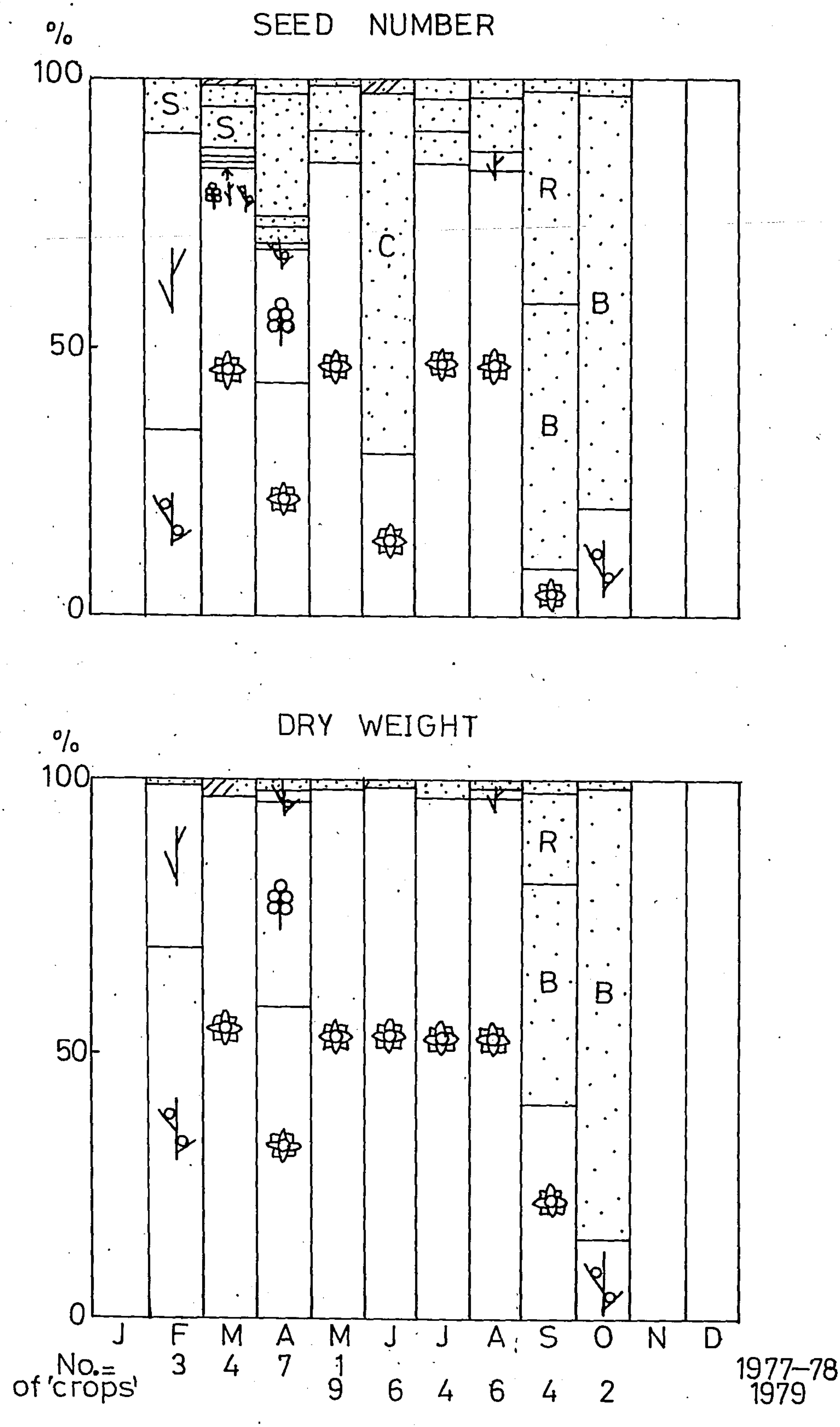
Proportions by:

1. numbers of seeds
2. dry weights of seeds

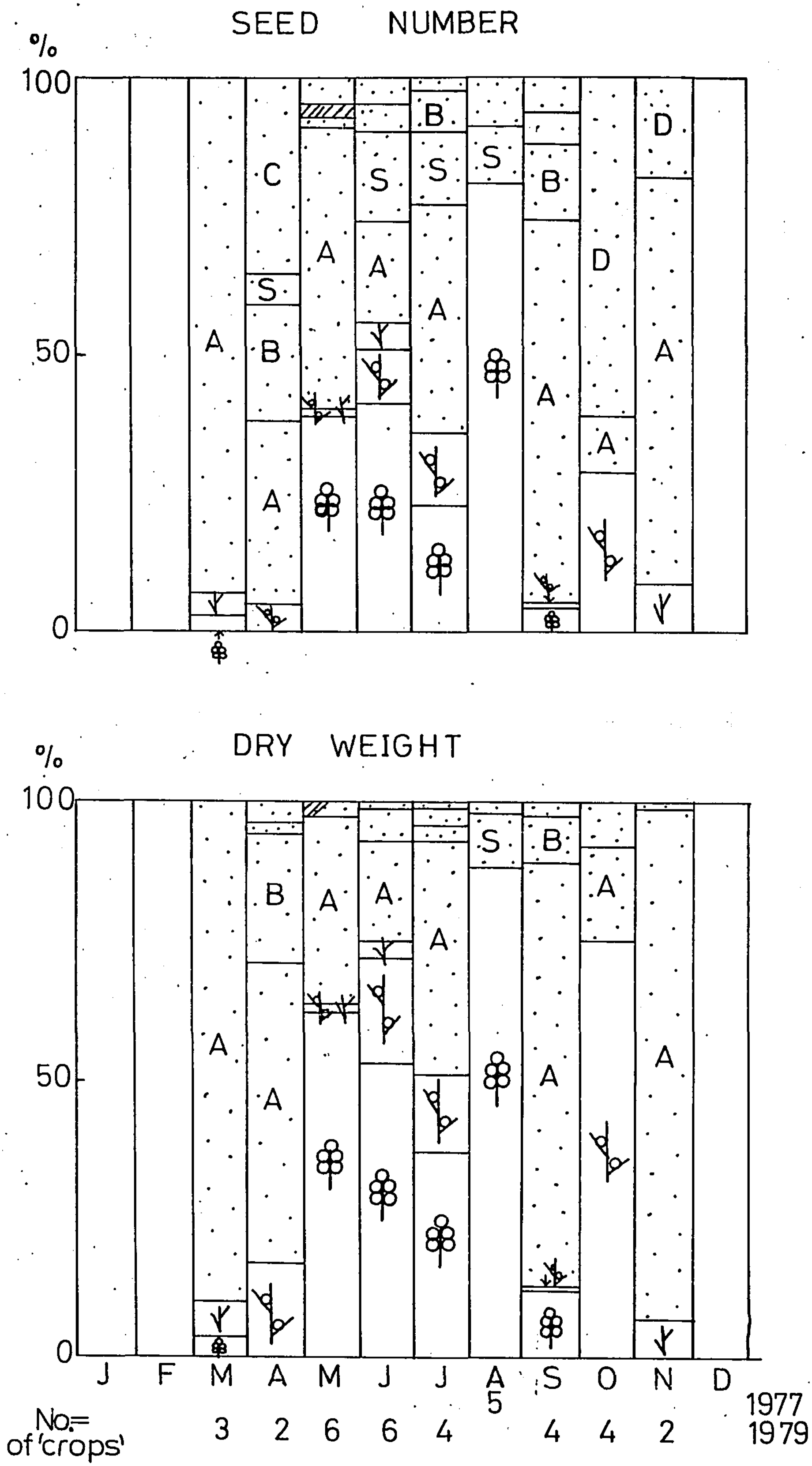
LEGEND

	sunflower
	sorghum
	wheat/barley
	oats
A	thistle *Silybum marianum*
B	thistle *Cirsium vulgare*
C	?catsear ?canary grass *Hypochoeris* sp. *Phalaris* sp.
D	catsear/dandelion *Hypochoeris/Taraxacum* spp.
	modified seed
	native seed
R	dock *Rumex* sp.
S	pigeon grass *Setaria* sp.

a. SWAN VALE


SEED NUMBER
%
100
50
0
S
S
C
R
B
B
DRY WEIGHT
%
100
50
0
R
B
B
J F M A M J J A S O N D
No.= 3 4 7 1
of 'crops' 9 6 4 6 4 2
1977–78
1979

b. WALLANGRA


SEED NUMBER
%
100
50
0
A
B
C
D
S
DRY WEIGHT
%
100
50
0
J F M A M J J A S O N D
5
No= of 'crops'
3 2 6 6 4 4 4 2
1977
1979

in August contained sorghum, sunflower and oat crop seeds (comprising 63% of diet by weight). The remaining 37% contained seeds of *Setaria* sp., *Hypochoeris* or *Taraxacum* sp., *Alternantha nana* and three unidentified seeds.

SECTION C

THE WHITE COCKATOO AND GALAH -
COMPARATIVE BEHAVIOUR AND ECOLOGY, AND PEST STATUS

CHAPTER 11

COMPARATIVE BEHAVIOUR AND ECOLOGY

11.1 COMPARISONS BETWEEN THE WHITE COCKATOO, GALAH AND OTHER COCKATOOS

Much of the individual and social behaviour of the White Cockatoo is very similar to that of the Galah (Table 20); and these behavioural patterns may be used to infer their taxonomic relationships with other parrots (see Appendix B). Patterns of maintenance, locomotion and preening are the same, as are displays of threat and alarm (Table 20). However, in long flights Cockatoos glide and flap, whereas Galahs never glide. Cockatoos commonly feed in trees, but Galahs rarely do so. The Galah appears to be aggressive in certain intra- and inter- specific encounters more frequently than the Cockatoo. Other minor differences occur in reproductive behaviour. Unlike Cockatoos, Galahs chew bark on the trunk of nest trees, line their nest with leaves and appear not to clean occupied nests. The mean clutch size of the Galah is larger than that for Cockatoos, and incubation and nestling periods shorter. Breeding success at least in north-east New South Wales appears comparable at about 1 fledgling per pair each season.

The daily routines of White Cockatoos and Galahs are very similar. Aggregation and dispersal of flocks follow a similar pattern throughout the day. At both field areas throughout the year Cockatoos and Galahs often fed together, such "mixed" flocks comprising 39% of all feeding flocks observed (N = 500). Of these mixed flocks, 72% were

TABLE 20

BEHAVIOURAL COMPARISON OF THE GALAH AND WHITE COCKATOO

SIMILARITIES	DIFFERENCES		
CHARACTER	CHARACTER	GALAH	WHITE COCKATOO
INDIVIDUAL BEHAVIOUR			
Self-preening			
Branch-lopping			
Rain-bathing			
Panting			
Drinking			
Feeding (most aspects)	Feeding site	ground, rarely trees	ground, trees
Resting			
Sleeping			
Defäecation			
Landing, take-off			
Most locomotion	Long flights	flap	flap, glide
Alarm			
SOCIAL BEHAVIOUR			
INTRA-SPECIFIC			
Movement toward			
Beak gape			
Beak thrust(method)	frequency	frequent	infrequent
Beak fence(method)	frequency	frequent	infrequent
Flight-chase			
INTER-SPECIFIC			
Wing-spread			
Hover	Hover	more frequent small & large flocks	less frequent small flocks
Mobbing	Mobbing	"	"
REPRODUCTIVE BEHAVIOUR			
No elaborate courtship			
Pairs allopreen all year			
No courtship feeding			

TABLE 20 (Cont'd)

SIMILARITIES	DIFFERENCES		
CHARACTER	CHARACTER	GALAH	WHITE COCKATOO
REPRODUCTIVE BEHAVIOUR			
Copulation			
Nest inspection			
	Bark chewing	Trunk, hole	Hole
	Nest lining	Eucalypt leaves	Wood-chips
	Nest sanitation	Nil - putrid maggots	Present - reasonaby clean, no maggots
Both sexes incubate			
	Clutch size	2-6($\bar{X}$=3.3)	2-3($\bar{X}$=2.5)
	Incubation	3-4 weeks	30 days
Nestling calls*			
Nest-mates different ages			
Both sexes feed young			
When young fed 2 X day			
When older fed 1 X day			
	Hatch to fledge	6-7 weeks	9½ - 10½ weeks
	Breeding success	1 fledgling/pr.	0.78 - 1.22/pr.

*J.E. Courtney pers. comm.; pers. obs.

Data from - pers. obs.; Pidgeon 1970

"major feeding"; mixed "minor feeding" flocks were less common (28%). Both species ate crop seeds throughout the year, although Galahs consumed a wider variety and larger quantity of seed from modified and native grassland. The two species often perched together before, during and after feeding, although Galahs generally began and finished "major feeding" earlier than Cockatoos. Midday resting flocks were rarely mixed and communal roost sites were always separate. Even in mixed flocks, individuals of the two species maintained a distance of at least one to two body-lengths from each other. The smaller Galah was usually passive and submissive in encounters, although these were rare. During the breeding season, however, either species was capable of driving the other away from its nest. Nests of the two species were sometimes as close as 20 metres.

The population fluctuations each year were similar for both species. Numbers were highest and flocking tendencies strongest in late summer, autumn and winter; fewer numbers and smaller flocks were characteristic of spring and early summer when both species bred.

The social organization of the Galah in New South Wales and Western Australia (according to Pidgeon 1970 and Rowley 1974, 1976, respectively) is similar to that I have inferred here for the White Cockatoo. In both species sedentary populations (cores) of breeding and non-breeding birds occupy a fixed home range. Other birds (juveniles, immatures and perhaps non-breeding adults) join these core populations in the non-breeding months. The movements and habitats of these mobile birds during the breeding season are unknown as they were absent from the study area during this period. Members of adjacent core populations may temporarily move to other occupied home ranges to feed in non-breeding months.

The social organizations of the Little Corella (*Cacatua sanguinea*) in northern Western Australia, and the Funereal or short-billed White-tailed Black Cockatoo (*Calyptorhynchus funereus latirostris*) in south-west Western Australia, are comparable to those of the above species. In the Little Corella, there is again a core population of breeding and non-breeding birds ("static sub-flock") and a mobile "roving flock", although these two components may intersperse (Beeton 1977a). Roving flocks amalgamate to form the "static super-flock" which posed the major threat to farm crops.

The population structure of the Funereal Cockatoo is similar to the other cockatoos although this species inhabits forests and plantations, feeding on seeds from native Proteaceous shrubs and exotic pines (Saunders 1979). At the end of the breeding season (December - January) small breeding flocks amalgamate as they move towards the coast (C.S.I.R.O 1972, 1974). There they wander in search of food in large aggregations throughout the non-breeding season, returning to their breeding grounds in June or July in small flocks. Adults return to the same area each year, sometimes using the same nesting hollows. Juveniles do not return to the breeding area until they are ready to breed in their fourth year.

In all these cockatoos breeding adults are believed to pair for life, breeding in the same area each year and sometimes using the same nesting hollow. Not all adults breed. Breeding success appears to be relatively low in all four of the above species, ranging from 0.3-0.6 in the Funereal Cockatoos to about 1.2-1.5 fledglings per pair each year in the Little Corella. However, in 15 nests of the Long-billed Corella (*Cacatua tenuirostris*) examined by Saunders (1977b) in south-west Western Australia, only 2 failed and the rest produced 28 young i.e. a mean of 1.9 fledglings per pair. In the breeding season flock sizes of cockatoos are smaller than in non-breeding months when large aggregations occur. Breeding adults of the Funereal Cockatoo wander up to 50 km from their breeding areas in the non-breeding months, but in the White Cockatoo and Galah such birds appear to be sedentary. Juvenile and immature cockatoos of all species appear to be very mobile, wandering throughout the year until they are old enough to breed and presumably join the sedentary and/or breeding populations.

The White Cockatoo has a more restricted distribution than the Galah and Little Corella; and avoids arid environments. Owing to probably more specialized habitat requirements it occurs in localized "colonies". The species is therefore more manageable as a pest, but at the same time its populations are probably more "fragile" than in the other species. Of the two field areas it is more common at Wallangra where large stands of *Callitris* still remain. It is conceivable that before alteration of the habitat, White Cockatoos were more arboreal, feeding on the fruits and seeds of *Callitris*, *Angophora* and other trees. Several species of Australian cockatoos are somewhat specialized in this way. The Glossy Black Cockatoo (*Calyptorhynchus lathami*) with its very broad bill feeds almost exclusively on the seeds of many *Casuarina* species (Forshaw 1969; H.L. Bell pers. comm.); though not uncommon, its distribution in south-east Australia is patchy. Similarly, the Long-billed Corella with its long tapering bill, is currently regarded as a rare and declining species in south-eastern Australia (Forshaw 1969). Its food requirements have not been studied in detail, although its present diet may have altered or become more generalized with the clearing of this region. Saunders (1977a) found that the Funereal Cockatoo has a lower breeding success and slower development of nestlings in cleared agricultural land than in uncleared land. He attributes this to the patchiness of food in cleared areas. Most cockatoos require large old trees in which to nest, and such trees are frequently felled for agricultural or forestry purposes.

11.2 COMPARISON OF THE WHITE COCKATOO AND GALAH WITH OTHER AUSTRALIAN PARROTS.

Brereton (1963a, 1971) suggested that there is a relationship between the social organization of Australian parrots and their ecology and environment. He showed for four species of parrots that those inhabiting the mesic coastal regions form small flocks, while inland species form larger flocks. He also postulated that social organization reached its most complex form in moderately predictable environments and most simple in unpredictable environments. Flock size, age and sex dimorphism and vocal repertoire were used as measures of the social complexity of each species.

The Eastern and Crimson Rosellas (*Platycercus eximius* and *P. elegans*) of the eastern tablelands and slopes live in a relatively predictable environment where food is probably reliable. Both have complex social systems consisting of two population units: a core population of high status birds breeding pairs and a subsidiary population of low status birds, mostly non-breeding adults and immatures. This latter population inhabits suboptimal areas, although these birds intersperse with those from the core during the non-breeding season (Brereton 1971, Aslin 1978). The rosellas have a large repertoire of calls and marked to moderate age and sex differences in plumage (Table 21). On the opposite end of the continuum, the inland Budgerigar (*Melopsittacus undulatus*) inhabits an environment with less predictable resources. Its social organization is simple, vocal signals are few and there is little age or sex dimorphism (Brereton 1971, Wyndham 1978, 1980) (Table 21).

The White Cockatoo and Galah also fit into the continuum of social complexity. They reach their highest densities in semi-arid regions, so are roughly midway between the Eastern Rosella and the Budgerigar

TABLE 21

SOCIAL CONTINUUM IN SOME AUSTRALIAN PARROTS

Data from: Brereton 1971* #

Aslin 1978* #

Cameron 1968*

Zann 1965*

Barclay 1976#

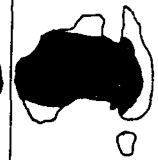
Pidgeon 1970* #

Wyndham 1978, 1980#

pers. obs.#

* cage study

\# field study

	KING PARROT	CRIMSON ROSELLA	EASTERN ROSELLA	MALLEE RINGNECK	RED-RUMP PARROT	WHITE COCKATOO	GALAH	COCKATIEL	BUDGERIGAR
DISTRIBUTION									
HABITAT	rainforest sclerophyll	sclerophyll	savannah woodland	open savannah woodland	open savannah woodland	savannah woodland sclerophyll	open savannah woodland	grassland	grassland
FEEDING SITE	arboreal/ ground	arboreal/ ground	ground/ arboreal	ground/ arboreal	ground/ arboreal	ground/ arboreal	ground/ arboreal	ground	ground
FOOD	canopy seed fruit	canopy seed fruit	canopy herb seed	canopy herb seed	canopy herb seed	herb seed canopy roots	herb seed roots	herb seed	herb seed
NO. OF VOCAL SIGNALS	4	22	25	16	15	13	11	8	8
NO. OF VISUAL SIGNALS	?	+++	+++	?	++	+	+	?	+
SEXUAL DIMORPHISM (degree)	+++	+	++	++	+++	+	+	++	+
AGE DIMORPHISM(degree)	++	++++	+++	++	++	+	++	+	+
GREGARIOUSNESS (degree)	+	++	++	++	+++	+++	+++	+++	++++
POPULATION STRUCTURE	?	sedentary breed core; subsidiary non-breed	as for C. Rosella	?	as for W. Cockatoo	sedentary breed & non-breed core; mobile non-breed	as for W. Cockatoo	?	nomadic breed & non-breed
RESOURCES	relatively predictable →							→	unpredict-able
SOCIAL ORGANIZATION	less complex?	← most complex →						→	less complex

in distribution. They have fewer vocal signals than the rosellas or the Red-rumped Parrot (*Psephotus haematonotus*) (Table 21). Sexual dimorphism is weak and there is little or no difference between juveniles and adults in plumage. However, the population units of these cockatoos are more reminiscent of the social organization of rosellas than of Budgerigars.

Figure 41 combines information on sizes of flocks for four species of parrots from Brereton (1971) with similar data for four other species which have been subsequently studied. Some problems with the overall model are evident. Firstly many of the species in this analysis overlap considerably in their geographical distributions, so it is difficult to accurately fit them into a moisture gradient; for example, the White Cockatoo occurs in both mesic and semi-arid environments. Secondly, one species (the Bluebonnet, *Psephotus haematogaster*) appears not to conform at all to the expected pattern. There are no obvious reasons for this apparent anomaly (Hawes 1979). Nevertheless, flock sizes of the White Cockatoo and Galah are almost identical,and are intermediate between those of the mesic rosellas and the arid Cockatiel-Budgerigar type.

A comparison of the social organization of different populations of a single species of parrot along a climatic gradient,would probably illustrate the influence of local environments on social organization more convincingly than inter-specific comparisons. For instance, White Cockatoos in coastal areas appear to form smaller flocks than their inland counterparts. These coastal birds inhabit denser habitats and appear to be more arboreal in feeding habits than those further inland (pers. obs.).

FIGURE 41

FLOCK SIZES OF EIGHT SPECIES OF AUSTRALIAN PARROTS IN THREE ACTIVITIES (FLYING, PERCHING AND FEEDING), ARRANGED IN RELATION TO THE ARIDITY OF THEIR ENVIRONMENT.

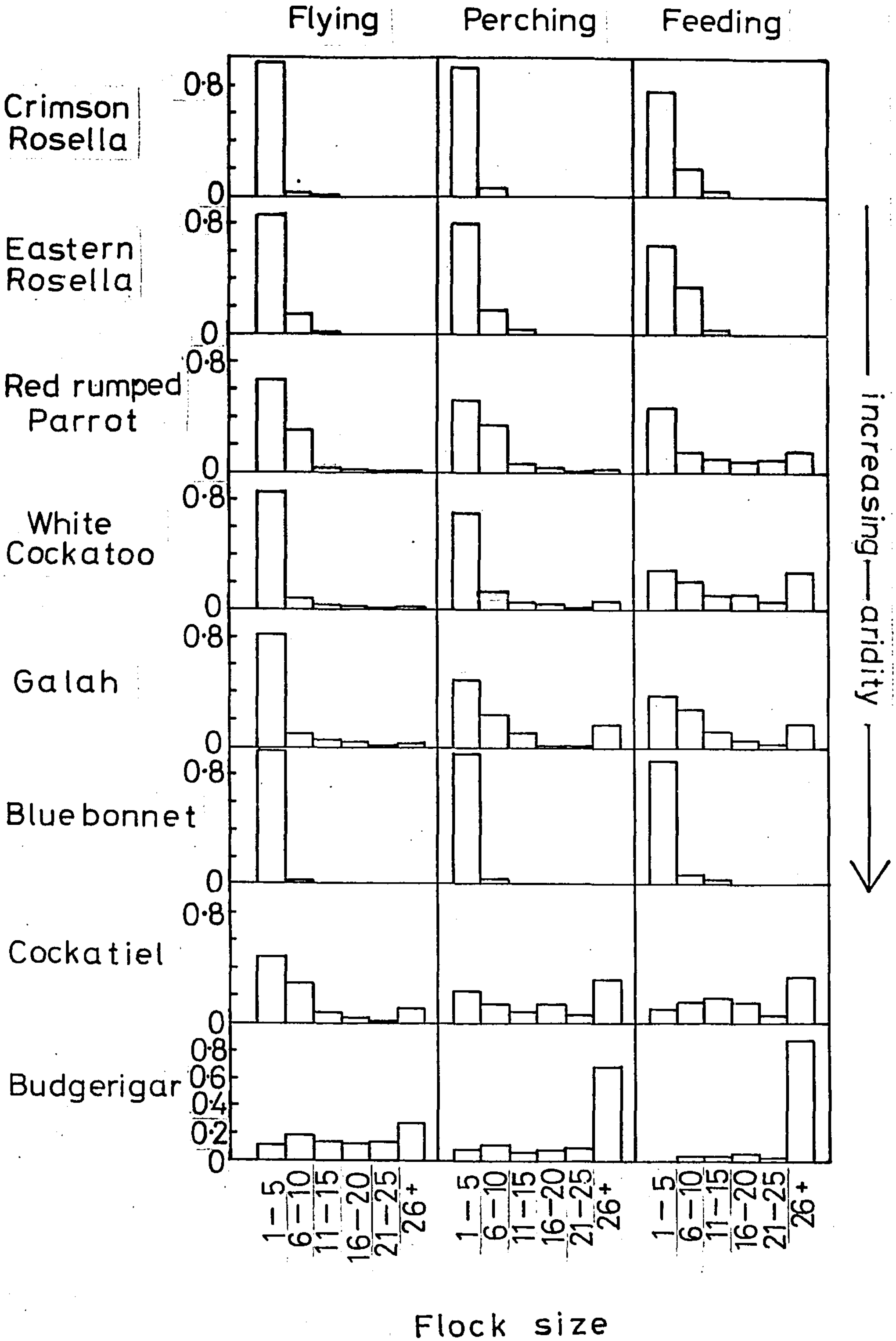
Data from: Brereton 1971

Barclay 1976

Aslin 1978

Hawes 1979

personal observation



Flying
Perching
Feeding
Crimson Rosella
Eastern Rosella
Red rumped Parrot
White Cockatoo
Galah
Bluebonnet
Cockatiel
Budgerigar
0·8
0·6
0·4
0·2
0
increasing—aridity
1–5
6–10
11–15
16–20
21–25
26+
Flock size

11.3 ENVIRONMENT, SOCIAL ORGANIZATION AND POTENTIAL PEST STATUS

The tendency for social organization to change in relation to the environment has been noted in other groups of animals (reviewed in Wilson 1975, Davies and Krebs 1978). Species inhabiting forests tend to be solitary and territorial, while those living on open plains are generally gregarious with large home ranges. The weaver finches (Ploceidae) of Asia and Africa, like the Australian parrots, are more social in open than in dense habitats (Crook 1964). The forest-dwelling species are monogamous and defend territories, whereas the savannah species are usually polygynous and nest colonially. The Australian parrots are perhaps exceptional, of the groups studied, in that although the open country species live in flocks their social behaviour appears very simple. However, comparisons of the degree of complexity and simplicity of social organization are necessarily somewhat subjective.

Two major reasons are used to explain the increase in sociality from forests to open country, and both have some support (Crook 1964, Bertram 1978). Firstly, animals in open country are more exposed and therefore susceptible to predation; by contrast forest-dwellers tend to rely on inconspicuousness to avoid predators. In open country distant predators could be sighted by any member of a group and the remainder of the group warned, intentionally or inadvertantly. Lone Wood Pigeons (*Columba palumbus*) are more likely to be taken by a goshawk than members of flocks (Kenward 1978), chiefly because hawks were detected at a greater distance by flocks than single birds. Although I never witnessed an instance of natural predation, White Cockatoos and Galahs in feeding flocks were extremely adept at detecting birds of prey and humans.

The second advantage of belonging to a group is that of locating food. When food is evenly distributed there is little advantage to be gained from following or observing conspecifics. In fact there may be the disadvantage of competition. However, when food is patchy or localized, unsuccessful foragers would gain from following and watching more successful foragers (Crook 1964, Ward and Zahavi 1972). Thus, flocking benefits the individual and enables efficient exploitation of patchy food by the group.

Seeds are more likely to be clumped in distribution than insects, and seed-eating birds such as weavers and parrots typically feed in flocks, although exceptions exist. Flocking therefore, should be correlated with patchiness of food but not necessarily environment, though dense forests appear to have more dispersed food and open country more localized food sources. If this was correct one would expect animals feeding on clumped food sources in dense forests to also occur in flocks. The gregarious feeding of many lorikeets and fruit-pigeons in rainforest suggests this is true (Terborgh and Diamond 1970).

In some species the degree of flocking changes seasonally in response to the distribution and abundance of food. Quelea form large flocks in the dry season when food is unevenly distributed, but during the wet season, when food is evenly distributed (either abundant or scarce) flocks are smaller (Ward 1965). Similarly the degree of flocking by Rooks (*Corvus frugilegus*) is greatest in winter when the distribution of food is patchy, and lowest in summer when it is more even (Feare *et al.* 1974).

The flocking tendencies of White Cockatoos and Galahs were strongest during autumn and winter at which times native food seems scarcest (pers. obs) though not necessarily patchy. Yet grain crops provide an unevenly distrubuted but abundant food source at this critical time. Flocks are smaller in spring and summer when native food is more abundant and more evenly distributed, although crops provide an additional food source. At this time mobile flocks leave many permanent home ranges and presumably disperse throughout the region or concentrate on areas of abundant native or crop seed elsewhere.

Communal roosting may facilitate communal feeding and thus the efficient exploitation of localized food (Zahavi 1971). The Rook exhibits its greatest degree of communal roosting (and feeding) in winter when food is localized and in short supply (Feare *et al.* 1974). The winter roost assisted individuals in discovering food patches in unfamiliar surroundings when snow rendered food in usual feeding areas unavailable. In Sarawak, Fogden (in Ward and Zahavi 1972) found that the Long-tailed Parakeet (*Psittacula longicauda*) which exploited patchily distributed food formed large communal roosts. The sympatric Blue-rumped Parrot (*Psittanus cyanurus*) on the other hand, exploited a more evenly distributed food source and did not roost communally.

The communal roosts of White Cockatoos and Galahs might also act as "information centres" for efficient location of food. White Cockatoos and Galahs vacated roosts in a similar fashion to Quelea (Ward 1965). Some flocks flew straight to a known food source while others perched for a while and joined later waves of birds flying to the food source. As feeding flocks of White Cockatoos increased in numbers so did the numbers of birds at a roost site. Sedentary and mobile birds apparently roosted and fed together. Galahs often had more than one roost area at one time at each site . Accordingly flocks of Galahs fed in several areas.

Feeding parties of White Cockatoos may attract Galahs and *vice versa*. The white plumage of White Cockatoos possibly serves as a social signal, attracting conspecifics as well as congeners (i.e. Galahs). Armstrong (1970) and Kushlan (1977) regarded the white plumage of seabirds and herons, respectively, to be a social signal indicating to other individuals areas of abundant ephemeral food. However, the application of this hypothesis to terrestrial birds is doubtfully valid considering the number of gregarious species which are not white. It is likely that vocalizations are of greater importance in social signalling of such species.

Flocking in White Cockatoos and Galahs appears to be significant in the efficient exploitation and location of a food source. Birds belonging to the mobile component of the population gain from the experience and local knowledge of the sedentary population within their home range. When a relatively permanent and predictable food source such as a crop of sunflower or sorghum is located, the birds continually return to that source to feed. Communal feeding and roosting, and possibly white plumage may facilitate the efficient exploitation of food.

The agricultural pests discussed in this thesis are direct competitors of man for food. As most pests are appreciably smaller than man it is obvious that they need to occur in relatively large numbers to be significant. Agriculture provides localized, rich food sources for herbivorous, especially granivorous birds. Thus species which in their natural state flocked to exploit patchily distributed food are preadapted to become pests. Weavers, finches and sparrows, pigeons and, in Australia, parrots and cockatoos, are the major groups which show extensive flocking to exploit such patchy rich food sources. They include the major granivorous pests. Studies on some of these species, for example Wood Pigeons (Murton *et al.* 1963, 1966, 1974) and Quelea (Ward 1965), have indicated that their populations are limited by the availability of food. The same could be true of Australian parrots, at least in arid areas (Brereton 1971). However, when additional food is provided in agricultural areas a population increase occurs. Such increases will cease only when other factors such as nest-sites or food abundance at other times of the year become limiting.

In temperate areas with one growing season, most bird pests are limited by a period of food scarcity outside this season (e.g. Wood Pigeons, Murton *et al.* 1966; Rooks, Feare 1974; Bullfinches, Newton 1972). Shooting of these pests before this period rarely reduced the population below the levels expected from mortality due to the natural food shortage (Feare 1974, Murton *et al.* 1974).

In Australia the major pests to grain crops are cockatoos. In the Ord River area of Western Australia the Little Corella is the major pest, exhibiting its strongest tendencies to flock during periods of native food shortage that coincide with sorghum maturation (Beeton 1977a). In the same area, Galahs flock mainly during periods of native seed availability and are not major pests to grain crops in the Ord. However, in south-west Western Australia, the largest flocks of Galahs occur when native seed is scarce but cereal wheat crops are maturing. Similarly in north-east New South Wales Galahs and White Cockatoos show their greatest tendencies to flock when the more valuable crops of sunflower and sorghum are available. Galahs and Cockatoos are thus major pests in these areas. In north-east New South Wales there are usually both winter and summer crops within the range of cockatoos. Galahs and Cockatoos feed on both types of crop although they do most damage to the summer crops of sunflower and sorghum.

Because food is rarely limiting one might expect populations of these cockatoos to increase for a prolonged period unless controlled, for instance, at the reproductive stage. In fact it seems that less than 50% of the sedentary population of White Cockatoos and Galahs breed each year, and only about one fledgling is produced by each pair owing to natural and human predation at nests. According to Rowley (1976) one in ten juvenile Galahs survive to breed in south-west Western Australia. Mortality in the mobile flock component of the cockatoo populations is probably high. Most of the cockatoos shot while feeding on summer crops are young birds which are inexperienced and perhaps naturally "doomed". Thus in the long term, although the potential for population increase is high as food is rarely limiting, the actual rate of increase is modest and likely to be very gradual due to the low reproductive rate and low survival rate of juveniles.

The White Cockatoo in north-east New South Wales appears to have more specific habitat requirements than the Galah, and often occurs in dense "colonies". It is also more wary of human presence and interference such as shooting and scaring, than the Galah. These characteristics, along with its more localized distribution render it potentially more "manageable" than the ubiquitous Galah. Specific management techniques are discussed in the following chapter.

CHAPTER 12

THE WHITE COCKATOO AND GALAH AS PESTS TO GRAIN CROPS IN NORTH-EAST NEW SOUTH WALES

12.1 CROP DAMAGE

12.1.1 Crop Selection

White Cockatoos and Galahs ate seed from crops throughout the year at both field areas. Sunflower and sorghum were eaten in autumn and winter; and wheat, barley and sometimes oats in spring and summer.

The establishment of feeding flocks of Cockatoos and Galahs on a crop occurred gradually. Initially individual scouts located a crop and only small numbers fed there. After days or weeks numbers escalated depending on the total population present in the home range (Fig. 42).

Galahs were apparently more catholic than Cockatoos in their selection of crops on which to feed. At Swan Vale the majority of Cockatoos fed on sunflower crops. The largest numbers of Cockatoos seen on sorghum were on a crop adjacent to the permanent roost site. However, Galahs were seen feeding on most sorghum crops as well as sunflower at Swan Vale each year (Fig. 43). Similarly, at Wallangra both species fed on sorghum crops, but the majority of Cockatoos fed on one crop, while Galahs fed on several crops in the area (Fig. 43b). Only one or two crops of wheat/barley/oats were used by Cockatoos at both field areas, but again, Galahs used several each year.

At Swan Vale, Cockatoos seemed to favour sunflower crops which were away from well-used roads, and close to trees. Two crops (Fig.43a A)

FIGURE 42

ESTABLISHMENT OF WHITE COCKATOOS ON

TWO SUNFLOWER CROPS IN 1977

AT SWAN VALE

LEGEND

X - standing crop

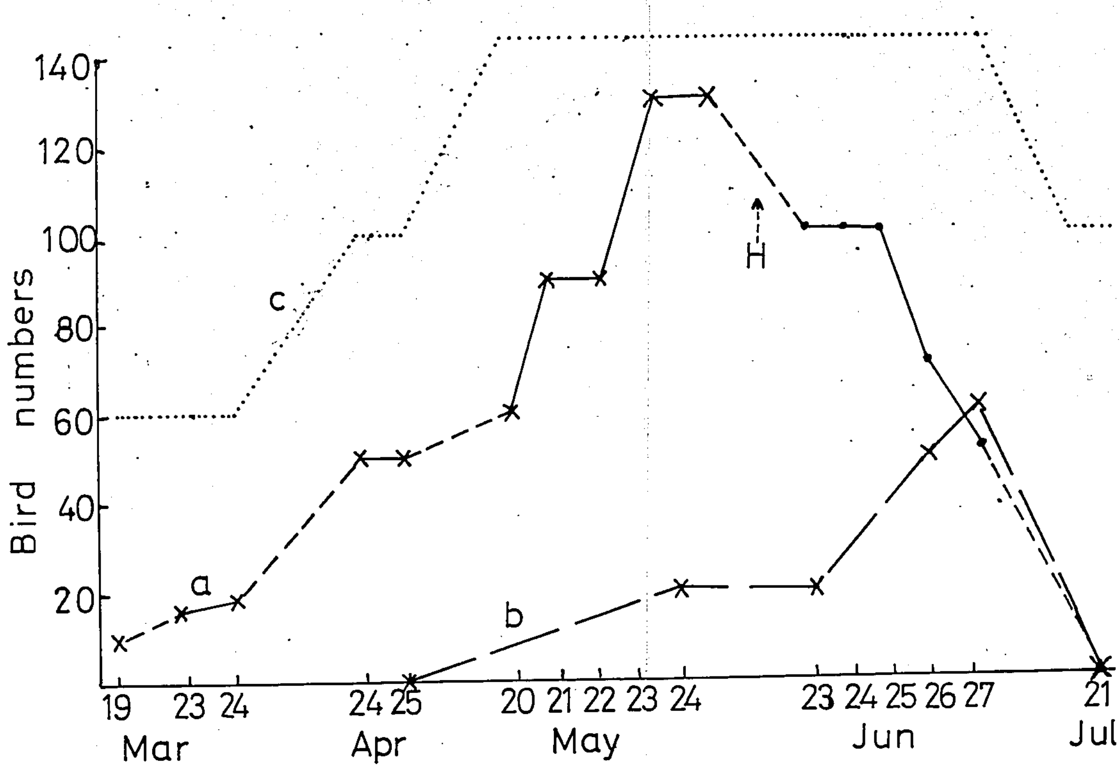
● - stubble

H - harvest

a - good crop (A in Fig. 43)

b - poor crop not harvested
(G in Fig. 43)

c - total population in home range



140
120
100
80
60
40
20
Bird numbers
c
a
b
H
19
23
24
24
25
20
21
22
23
24
23
24
25
26
27
21
Mar
Apr
May
Jun
Jul

FIGURE 43

SELECTION OF CROPS BY WHITE COCKATOOS AND GALAHS AT

a. SWAN VALE and b. WALLANGRA EACH YEAR

- sunflower

- sorghum

- wheat/barley

- main road

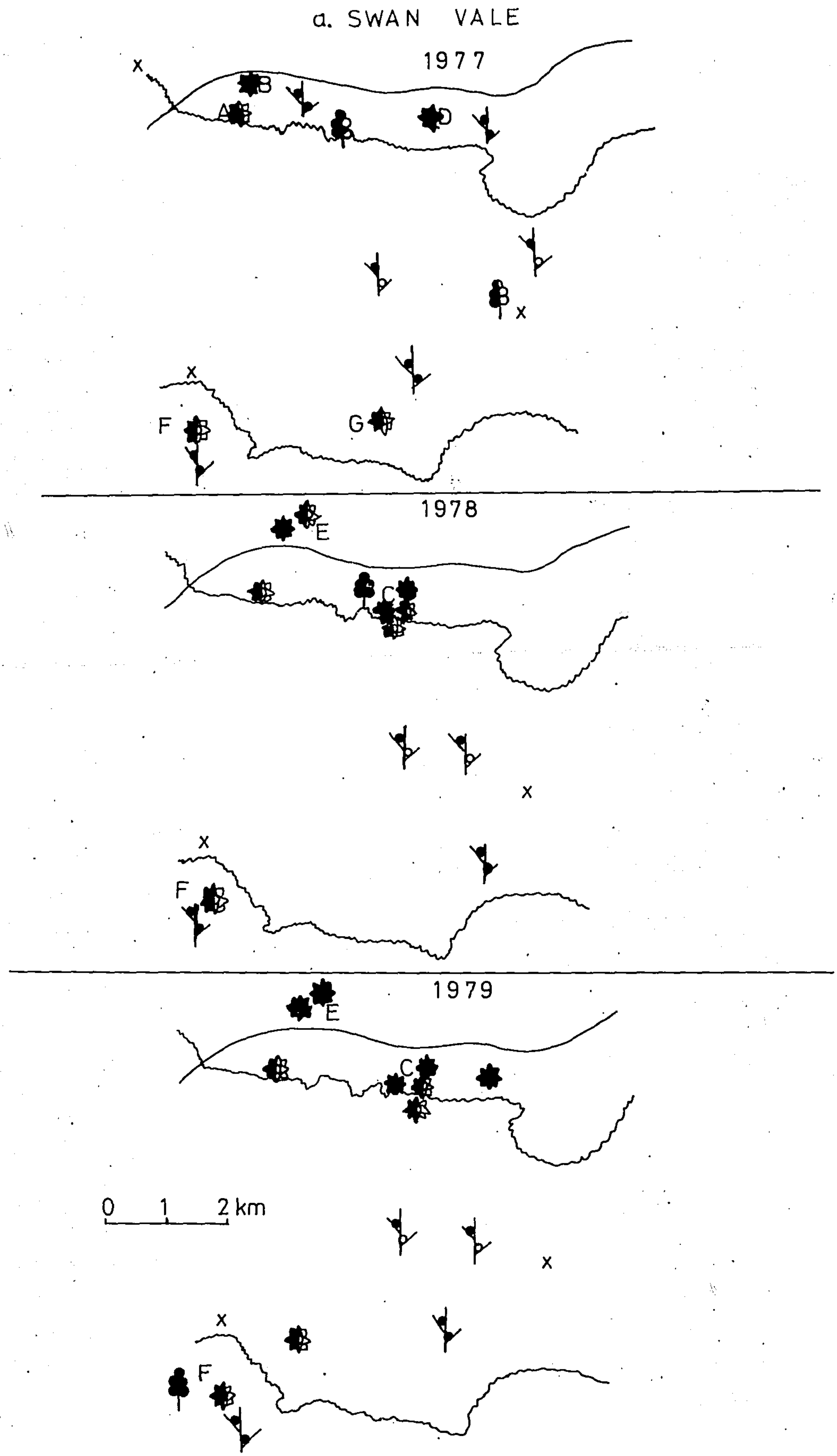
- creek/river

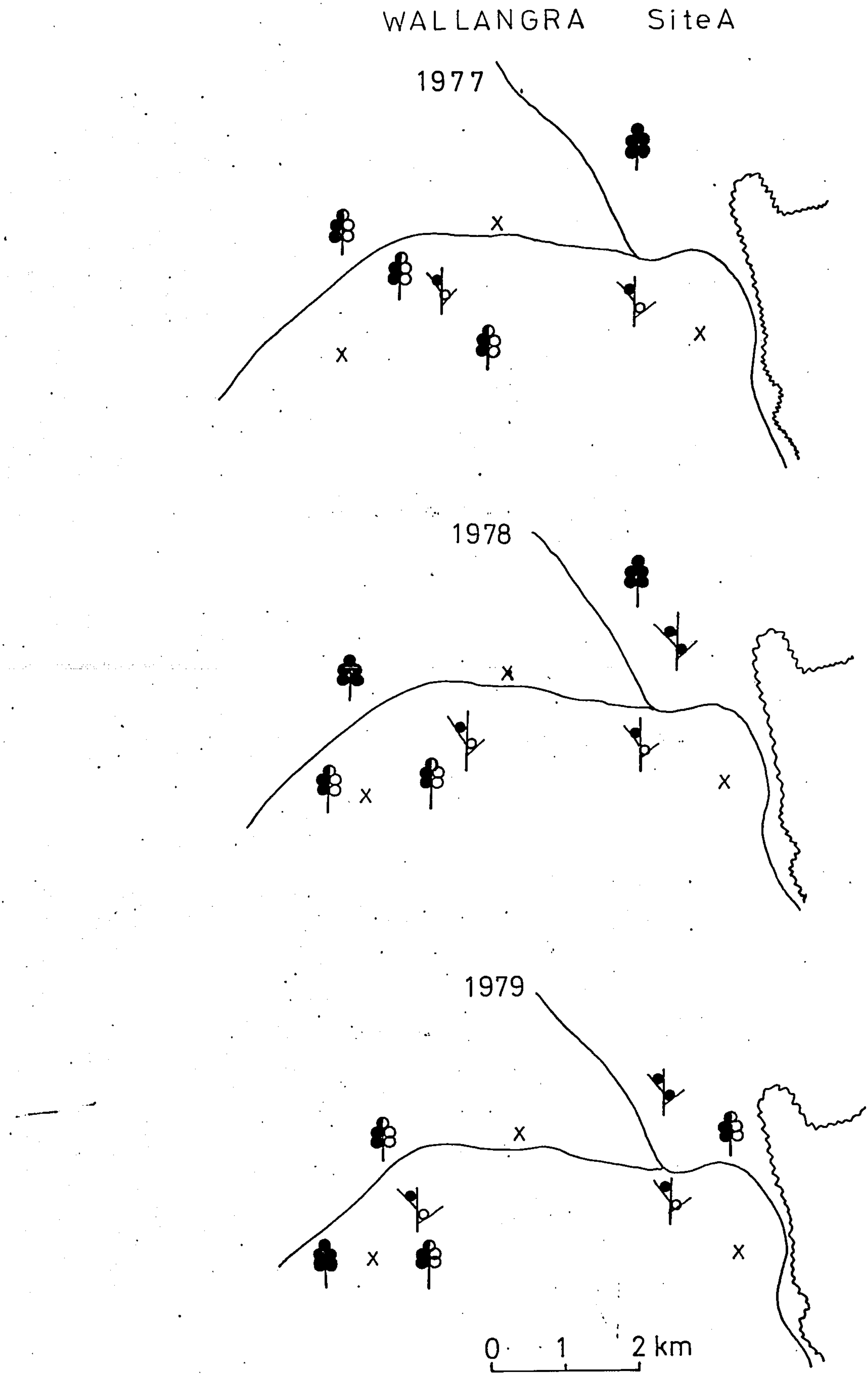
half closed symbols - feeding by White Cockatoos and Galahs

closed symbols - feeding by Galahs only

X - roost

see text for letters


a. SWAN VALE
1977
A
B
D
F
G
1978
E
C
F
1979
E
C
F
0 1 2 km


WALLANGRA Site A
1977
1978
1979
0 1 2 km

on Swan Brook lined with White Gums and River Oak attracted large flocks of Cockatoos and Galahs each year, but another adjacent crop on the highway (B) was damaged by Galahs but not Cockatoos. Each year one to four sunflower crops were grown in the Swan Brook valley (C) between the favoured creekside crops (A) and the permanent roost. These crops were near a road,and were not used by many Cockatoos although large numbers of Galahs fed there.

Some evidence suggests that poor (sparse) crops with short stems and small heads, were avoided to some extent by Cockatoos. In 1977 such a crop (Fig. 43b D) was damaged by Galahs, but remained largely untouched by Cockatoos. In 1978, a large crop (E) of tall plants and medium heads, attracted Galahs and Cockatoos from Swan Vale and another population to the north, but in 1979 a poor crop with short plants and small heads, in the same location (E) was damaged by Galahs, but not Cockatoos (Plate 10). A large isolated sunflower crop in Kings Creek valley (F) attracted large numbers of Cockatoos and Galahs each year. The area supported tall plants with large heads and was adjacent to a tree-lined creek and suitable roosting habitat.

12.1.2 Patterns of crop damage

Cockatoos and Galahs typically selected parts of a crop nearest to perching sites such as trees and fences. Zones adjacent to stands of foliaged and dead trees, both within and along the edge of the crop, were destroyed, often in waves extending inward from the trees. Shaded areas of a crop were often selected in late spring and summer months. The source direction of birds was another determinant of feeding position within a crop; birds often chose an area close to their approach path (Broome 1979, pers. obs.).

Plate 10

SUNFLOWER CROP FEEDING BY COCKATOOS

a. Galah feeding *in situ* on a sunflower head

b. White Cockatoo damage to a sunflower head - head felled and pith and seed ripped off head a

b

De la Motte (1977) found that birds preferred tall sunflower plants to short ones. Such tall perches gave birds all-round vision. There was no significant correlation between damage to sunflower, and crop density or the size of seed heads (de la Motte 1977).

12.1.3 Crop seed intake

To estimate basal metabolism and cost of flight of White Cockatoos and Galahs I used several formulae for the energetics of non-passerine birds, constructed from Northern Hemisphere studies (Table 22). The rates of energy use were calculated for the four basic daily activities of the birds, *viz.* sleep, day resting, feeding and flying. No additional energetic costs were allowed for moult, seasonal and photoperiod changes, temperature regulation, effects of wind and rain, or reproductive activities. The nutritional requirements of the birds were not considered in calculations.

The basal metabolic rate (BMR) or rate of energy use by organs and tissues of animals at complete rest, furnished a reference base for the use of coefficients to estimate energy costs of other activities. Thus sleep was calculated at 0.8 x BMR (Kendeigh, Dol'nik and Gavrilov 1977), alert day rest at 1.35 x BMR and feeding at 3.0 BMR (King 1974)(Table 23). The energetic cost of flight was calculated using two formulae (see Table 22). The proportions of an average day spent in each of these four activities were estimated using data for White Cockatoos from Table 9. Sleeping was estimated to comprise about 44% of an average day (mean of 10.5 hours): the value for flying was reduced to 5%, being greatly overestimated in Table 9. Feeding comprised about 36% of an active day (about 20% of the 24 hour day), with resting activity being allotted the remaining 31%.(Table 23). I calculated that the daily energy requirements for a Cockatoo and Galah were 156 Kcal/day and 78 Kcal/day, respectively (Table 23).

To translate the daily energy requirements into the amount of food consumed per day, it is important to know the calorific value of the food

TABLE 22

METABOLIC REQUIREMENTS OF WHITE COCKATOOS AND GALAHS FOR CERTAIN ACTIVITIES

Activity rate	Source	Formula+	Metabolic Requirements* White Cockatoo	Galah
Basal Metabolic Rate	Lasiewski and Dawson 1967	$78.3m^{0.723}$ Kcal/day (m = Kg)	71.39	36.28
"	Tucker 1973	$3.73m^{0.723}$ Watts (m = Kg)	70.21	35.68
"	Aschoff and Pohl 1970	$3.60w^{0.734}$ Kcal/hr (w = Kg)	78.66	39.56
"	Kendeigh *et al.* 1977	$0.5224w^{0.7347}$ Kcal/day (w = g)	76.09	38.24
MEAN			74.09	37.44
Flight Rate	Berger and Hart 1974	$45.5w^{0.73}$ Kcal/day (w = Kg)	41.45	20.92
Flight Rate	Tucker 1973	$55.7w^{0.78}$ Kcal/hr (w = Kg)	50.41	24.29
MEAN			45.93	22.61

+ m and w = body weight of bird

Mean body wt. of White Cockatoo = 880g (N = 26)

Mean body wt. of Galah = 345g (N = 34)

* Basal metabolic rate = Kcal/day

Flight rate = Kcal/hr

TABLE 23

DAILY METABOLIC REQUIREMENTS OF WHITE COCKATOOS AND GALAHS

ACTIVITY	FORMULA FOR METABOLIC RATE	METABOLIC RATE FOR EACH ACTIVITY Kcal/day		APPROX. % OF 24 HR DAY IN EACH ACTIVITY FOR BOTH SPP.	METABOLIC REQUIREMENTS FOR EACH ACTIVITY Kcal/day	
		COCKATOO	GALAH		COCKATOO	GALAH
Sleep	0.8 x BMR*	59	30	44	26	13
Rest	1.35 x BMR	100	51	31	31	16
Feed	3 x BMR	222	112	20	44	22
Fly	+	1102	543	5	55	27
				Daily Energy Requirements	156	78

*BMR (Basal Metabolic Rate) for White Cockatoo = 74.09 Kcal/day
for Galah = 37.44 Kcal/day (see Table 22)

+Flight Rate for White Cockatoo = 45.93 Kcal/hr (1102 Kcal/day)
for Galah = 22.61 Kcal/hr (543 Kcal/day) (see Table 22)

and the efficiency with which food is digested, absorbed and utilized. This metabolizable energy varies with food type, temperature, seasonal state and the bird species. Kendeigh *et al.* (1977) show that different granivorous species metabolize from 40 to 90% of food intake. As such information on cockatoos is unavailable I assumed that White Cockatoos and Galahs assimilated the various crop seeds at the same rate as poultry, for which there is an abundance of information. The metabolizable energy content of seeds of sunflower (family Compositae) was 6.0 Kcal/gram (D.J. Farrell pers. comm.), which was high compared with those of sorghum, wheat, barley and oats (family Gramineae), 3.65, 3.45, 3.07 and 2.85 Kcal/gram, respectively (AEC 1978). Using these values I estimated that a Cockatoo requires 26 g (dry weight) of sunflower, 43 g of sorghum, 45 g of wheat, 51 g of barley or 55 g of oats to fulfill its daily energy requirements; a Galah requires 13 g of sunflower, 21 g of sorghum, 23 g of wheat, 25 g of barley or 27 g of oats (Table 24).

The calculated daily requirements of sorghum for Cockatoos agrees approximately with the dry weights of their full 'crops'(Table 25). Requirement values for sunflower are greater than weights of full 'crops' of Cockatoos and less than weights of full 'crops' of Galahs. Broome (1979) calculated food intake using estimates of damage on a decoy crop, numbers of cockatoos and the time they spent feeding on the crop; estimated daily intake of sunflower seed (wet weight) for a White Cockatoo and Galah was 54.8 g and 36.8 g respectively. To convert my dry weight estimates of sunflower intake into wet weights, I assumed sunflower seeds have a moisture level of 15% at harvest. My metabolic calculations of wet weight were much lower than those of Broome (1979), Cockatoos requiring 30 g of sunflower and Galahs 15 g.

For the following section I converted all dry weight values of seed intake to wet weight, using the maximum moisture level of 15% acceptable at harvest (Table 26). As oats are rarely harvested as

TABLE 24

DAILY CROP SEED INTAKE (Dry Weights)

OF WHITE COCKATOOS AND GALAHS

Crop Seed	Metabolizable* Energy (Kcal/g) of Seed	Food Intake (g/day)	
		White Cockatoo	Galah
Sunflower	6.0	26	13
Sorghum	3.65	43	21
Wheat	3.45	45	23
Barley	3.07	51	25
Oats	2.85	55	27

*Data from AEC 1978, D.J. Farrell pers. comm.

TABLE 25

DRY WEIGHTS OF COCKATOO 'CROPS' FULL OF PURE CROP SEED

Species	Seed	N	Range (g)	Mean + S.D. (g)	Daily Intake (g) (Mean x 2)
White Cockatoo	Sorghum	8	13-35.10	22.44 + 8.08	45
White Cockatoo	Sunflower	6	9.81-12.59	10.56 + 1.44	21
Galah	Sunflower	2	7.3 - 9.0	8.15 + 1.20	16

Probably underestimates of food intake as some seed passed from 'crop' into alimentary tract.

TABLE 26

DAILY CROP SEED INTAKE (g/day AT 15% MOISTURE)
OF WHITE COCKATOOS AND GALAHS
(from metabolic calculations)

Crop Seed	White Cockatoo	Galah
Sunflower	30	15
Sorghum	50	24
Wheat	52	27
Barley	59	29

commercial grain at the two field areas, this crop is not included in the discussion of crop damage. The similar winter crops of wheat and barley are considered the one crop type in further discussion.

12.1.4 Degree of crop damage by White Cockatoos and Galahs

Figure 44 shows the estimated amount of grain eaten from standing crops each month at both field areas. This is calculated from daily intake for individual White Cockatoos and Galahs, multiplied by bird-days spent feeding on the crop. At Swan Vale White Cockatoos and Galahs consumed about equal amounts of grain, but at Wallangra White Cockatoos ate more. At Swan Vale damage occurred throughout much of the year, although most damage was done in autumn and early winter; sunflower and sorghum were the most affected crops. At Wallangra however, the pattern was more predictable, owing to a more regular cropping cycle and the presence of only a few large farms within the birds' ranges. Very little or no damage occurred during late winter and early spring.

Estimates of the quantity of economic grain consumed by birds from standing crops each growing season, were compared with the potential yields of damaged crops (Table 27). The maximum damage to sunflower crops, by both White Cockatoos and Galahs at Swan Vale each year, was only about 1% (2% overall). Damage to sorghum was greater (about 4 to 17%), as the birds concentrated on a self-sown crop near the Cockatoo roost site. At Wallangra Cockatoos damaged up to about 2.5% of sorghum crops, but Galahs less than 0.7% each year. Damage to wheat/barley crops each year was consistently low, being less than 0.5% at Swan Vale and less than 3% at Wallangra, each year.

The above calculations are based on grain needed to satisfy the bird's energy requirements. However, White Cockatoos harvest whole seed heads, rip off chunks of pith and seed, and discard much seed (Plate 10b); this too needs to be included. By examining damage on a decoy crop of sunflower,

FIGURE 44

AMOUNT OF CROP SEED EATEN FROM STANDING CROPS

BY WHITE COCKATOOS AND GALAHS AT

a. SWAN VALE and b. WALLANGRA

ASSUMPTIONS:

Seed consumption by birds is at 15% moisture (see Table 26)

Minimum consumption each month = Days in month x total no. birds x g/day intake x % of feeding hours on the crop

Maximum consumption each month = Days in month x total no. birds x g/day intake

Data sources:

Total no. of birds from Fig. 12.

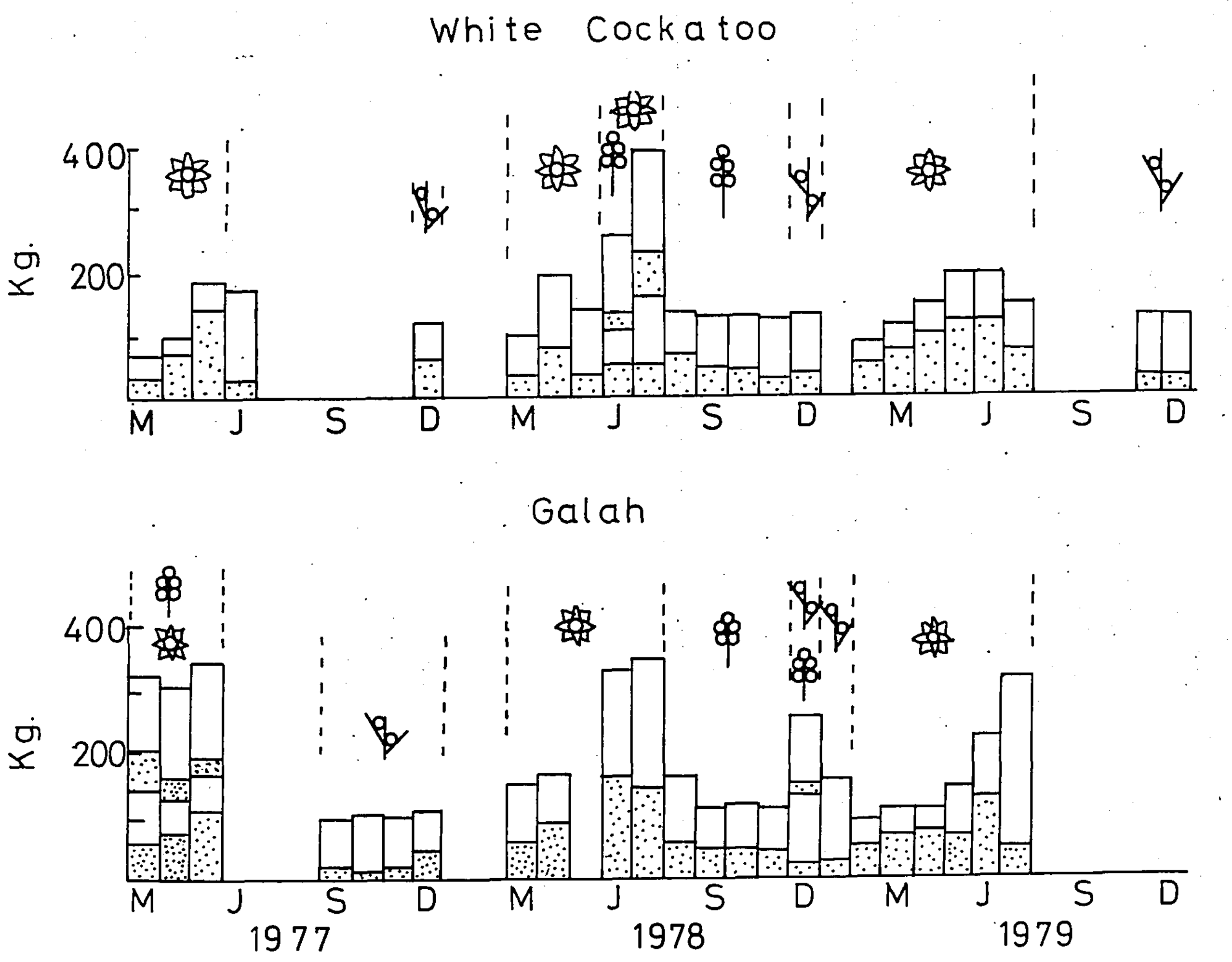
G/day seed intake from Table 26.

% feeding time on the crop from Figs. 27 and 39.

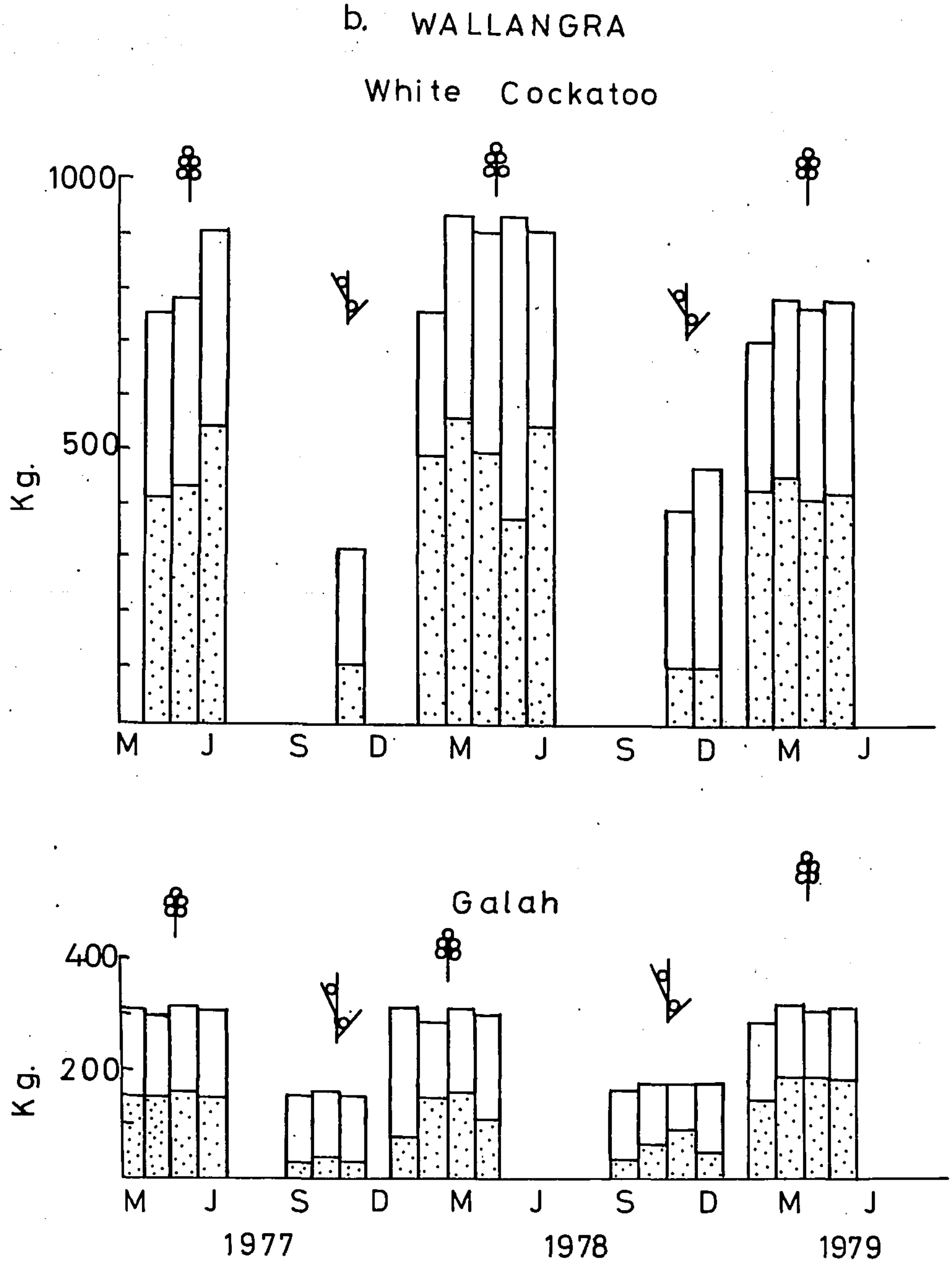
- sunflower

- sorghum

- wheat/barley


White Cockatoo
Kg.
400
200
M J S D M J S D M J S D
Galah
Kg.
400
200
M J S D M J S D M J S D
1977
1978
1979

a. SWAN VALE



b. WALLANGRA
White Cockatoo
1000
500
Kg.
M
J
S
D
M
J
S
D
M
J
Galah
400
200
Kg.
M
J
S
D
M
J
S
D
M
J
1977
1978
1979

TABLE 27

CROP DAMAGE POTENTIAL OF WHITE COCKATOOS AND GALAHS AT SWAN VALE AND WALLANGRA

a. SWAN VALE

	1977		1978		1979	
	WC	G	WC	G	WC	G
SUNFLOWER						
Min. consumed (tonnes at 15% moisture)	.28	.31	.21	.44	.52	.30
Max. consumed	.53	.79	.71	1.02	.82	1.0
$ loss (min. - max.)	124 - 277		140 - 365		170 - 385	
$ loss assuming WC damage extra 50%	153 - 333		159 - 438		277 - 468	
Total crop area (ha)	90		120		130	
Area of damaged crops (ha)	72	85	100	115	90	100
Yield of damaged crops (1 tonne/ha) (tonnes)	72	85	100	115	90	100
% of yield eaten - Min.-	.39	.36	.21	.38	.58	.30
- Max.-	.74	.93	.71	.89	.91	1.00

TABLE 27 (Cont'd)   a. SWAN VALE

	1977		1978		1979	
	WC	G	WC	G	WC	G
SORGHUM						
Min. consumed (tonnes at 15% moisture)		.16	.30	.24	Sorghum grown only in south-west corner of field area - insufficient data	
Max. consumed (" " " ")		.74	1.13	1.28		
$ loss (min.-max.)	12 - 56		41 - 181			
$ loss assuming WC damage extra 50%	12 - 56		52 - 233			
Total crop area (ha)	50		40			
Area of damaged crops (ha)		50	5	40		
Yield of damaged crops (1.5 tonnes/ha) (tonnes)		75	7.5	60		
% of yield eaten - Min. -		.21	4.0	.40		
- Max. -		.99	15.1	2.13		
WHEAT OR BARLEY						
Min. consumed (tonnes at 15% moisture)	.06	.10	.02	.04	.04	.03
Max. consumed (" " " ")	.14	.52	.13	.31	.25	.30
$ loss (min.-max.)	12 - 50		5 - 33		5 - 41	
$ loss assuming WC damage extra 50%	14 - 55		5 - 38		7 - 51	
Total crop area (ha)	210		206		200	
Area of damaged crops (ha)	90	150	90	140	90	120
Yield of damaged crops (1 tonne/ha) (tonnes)	90	150	90	140	90	120
% of yield eaten - Min. -	.07	.07	.02	.03	.04	.03
- Max. -	.16	.35	.14	.22	.28	.25

TABLE 27 (Cont'd) b. WALLANGRA

	1977		1978		1979	
	WC	G	WC	G	WC	G
SORGHUM						
Min. consumed (tonnes at 15% moisture)	1.37	.62	2.43	.45	1.70	.70
Max. consumed (" " " ")	2.40	1.23	4.36	1.22	2.97	1.22
$ loss (min.-max.)	149 - 272		216 - 419		180 - 314	
$ loss assuming WC damage extra 50%	201 - 362		307 - 582		244 - 426	
Total crop area (ha)	330		400		330	
Area of damaged crops (ha)	80	120	120	200	200	260
Yield of damaged crops (1.5 tonne/ha) (tonnes)	120	180	180	300	300	390
% of yield eaten - Min. -	1.14	.34	1.35	.15	.57	.18
- Max. -	2.00	.68	2.42	.41	.99	.31
WHEAT OR BARLEY						
Min. consumed (tonnes at 15% moisture)	.10	.05	.21	.17	Insufficient data	
Max. consumed (" " " ")	.35	.53	.92	.69		
$ loss (min.-max.)	11 - 66		29 - 121			
$ loss assuming WC damage extra 50%	15 - 79		36 - 155			
Total crop area (ha)	200		200			
Area of damaged crops (ha)	50	80	50	80		
Yield of damaged crops (1 tonne/ha) (tonnes)	50	80	50	80		
% of yield eaten - Min. -	.20	.06	.40	.21		
- Max. -	.70	.66	1.84	.86		

TABLE 27 (Cont'd)

WC - White Cockatoo

G - Galah

Data on Max. and Min. consumed by birds calculated from Fig. 44.

Data based on 15% moisture - the maximum acceptable at harvest time, thus maximizing bird consumption figures and making them comparable to the conservative yield values.

Grain is stored at maximum of 10 - 11% moisture.

Although damage values are only approximate they indicate the degree of damage potentially caused by White Cockatoos and Galahs in each field area.

Broome (1979) estimated that one Cockatoo eats 54.8 g in a day and destroys an additional 28.4 g, i.e., it wastes about half as much as it eats. Including this additional damage to crops by Cockatoos, overall crop damage, according to my calculations, is still not excessively high, being less than or equal to 4% in all cases each year; (excluding damage to the self-sown sorghum crop at Swan Vale which would have suffered about 25% damage - the farmer did not intend this crop to be a commercial one).

I calculated the maximum financial losses due to bird damage using a mean value of \$210/tonne for sunflower and \$75/tonne for wheat and sorghum (Frame 1978a, b)(Table 27). Gross monetary losses due to bird consumption and Cockatoo destruction each growing season, were highest for sunflower at Swan Vale, with an average loss of \$296 (range of \$153-\$468) per season; losses for sorghum at Swan Vale were \$86 (\$12-\$233), and for wheat/barley \$28 (\$5 - \$55). At Wallangra monetary losses were higher for sorghum, with an average of \$354 (range of \$201-\$582); wheat/barley losses averaged \$71 (range of \$15-\$155) per season. However, these losses vary from one farm to another in each field area. Each growing season the birds damaged one or more crops to varying degrees within their home range. At Swan Vale in 1977 four crops of sunflower were damaged on three farms; in 1978 three crops on three farms and in 1979 five crops on five farms suffered damage. At Wallangra each year two to three sorghum crops on two properties suffered the most damage. Thus average losses to all crops amounted to about \$410 (\$170-\$746) spread amongst three to five farms at Swan Vale, and \$425 (\$216-\$737) shared by two farms at Wallangra. Individual farms therefore lose an average of around \$82 - \$137 per year from White Cockatoos and Galahs at Swan Vale, and about \$213 at Wallangra.

Bennett's (1978) postal survey of farmers in north-east New South Wales, revealed that farmers' estimated average sunflower losses of approximately 21% ± 21 (standard deviation) (N = 72) of potential yield, and sorghum losses of 5% ± (N = 52) of potential yield. Broome (1979) estimated damage ranging from 0.06 - 80% of the area of individual sunflower crops. The proportion of damage on sunflower crops is inversely related to crop size; small crops suffer the greatest degree of damage. The area damaged does not vary greatly between crops, ranging from 0.16 - 4.15 ha (Broome 1979), but the impact on gross profits are proportionally higher for smaller crops (ranging from $16 to $800 for single crops). Large monocultural farms are better able to cope with the financial losses due to bird damage than small mixed farms.

12.2 CONTROL OF CROP DAMAGE

In this section I discuss various control measures which have been implemented, and suggest others in view of the behaviour and ecology of the White Cockatoo and the Galah. The biological feasibility of such methods are examined with no particular regard to their economic viability.

A variety of methods has been suggested and used to relieve damage caused by birds to grain crops. Beeton (1977a), de la Motte (1977) and Easdown (1978a) reviewed control methods used overseas (particularly in North America) and in Australia. These range from shooting, trapping and poisoning to more sophisticated aids such as the use of "white noise", electric shock, stupefying baits, bird repellent chemicals, bird resistant crops and reproductive inhibitors. In Britain an ecological approach to the problem was developed: control methods were formulated after consideration of the behaviour and ecology of the birds as well as farm management and agronomy.

At present many farmers at Swan Vale use scare guns to deter birds from feeding on sunflower crops. However, this method is generally ineffective unless combined with occasional shooting, as birds eventually become habituated to the sound of scare guns. As White Cockatoos are particularly wary of humans in agricultural areas, mechanical scarecrows or stationary vehicles from which shots have been fired may be effective temporary measures. However, the expense of operating such scaring devices make them uneconomic in relation to the actual damage caused by birds to the crop. Shooting/scaring also leads to some wastage as a Cockatoo invariably drops the whole seed head or portion it is holding and chooses a new head on its return. Moreover, overall consumption may increase in such cases because birds compensate for energy expended in flight when frightened.

More significantly the frightening of birds from a crop will probably be successful only if suitable alternative food sources exist (such as 'decoy crops' discussed later); in many cases one farmer's solution becomes his neighbour's problem. Partial eradication of pest species by shooting at roosts or by indiscriminate poisoning may be equally ineffective in the long term, as well as dangerous to other species and the environment.

Improved farm management might provide a more permanent solution to the problem of bird damage. Retention of non-commercial summer crop or stubble areas for birds, particularly where they are regular visitors could relieve damage to maturing winter crops. At Swan Vale Cockatoos and Galahs were attracted to a small self-sown sorghum crop rather than standing wheat and barley crops about 200 metres away. Paddocks of sunflower and sorghum stubble, which were left unploughed and were prohibited to stock during spring and early summer, also attracted birds away from standing winter crops.

Conversely, the retention of wheat and barley stubble, especially in areas where birds had previously been feeding might delay birds becoming established on standing sunflower or sorghum crops. Two or three times each year farmers at Swan Vale ploughed wheat and barley stubble fields where birds were feeding. If ploughing had been delayed damage to sunflower might have been reduced. Similarly, establishment of birds on late sunflower crops could be delayed or reduced by retaining stubble areas of earlier crops.

Beeton (1977a) found that Little Corellas preferred to feed on sorghum stubble if it was slashed. He suggested slashing of stubble on the edges of crops nearest the source direction of birds and leaving these areas solely for birds. At Wallangra I noticed that standing sorghum stubble was often very dense and leafy, and was less attractive to Cockatoos and Galahs than standing crops or even ploughed stubble. Although it is not practised at Swan Vale or Wallangra, slashing of selected areas of sorghum or sunflower stubble, with the possible addition of trash grain to the area, would provide an attractive feeding area for Cockatoos and Galahs. This might detract them from other standing crops, particularly if the area chosen for slashing was an established feeding area, and the birds were left to feed undisturbed.

In north-east New South Wales bird damage is greatest to sunflower crops. The sunflower industry is still relatively new in Australia; it faces many agronomic, technological and farm management problems. There is a need for better seed varieties and grading, for improved soil preparation and more adequate farm machinery (Easdown 1978b). The industry also requires better seed germination and evenness of plant maturation. Precision planters and new harvesting equipment that would improve sunflower yields are expensive and, like aerial dessication and mechanical dryers, beyond the income of individual farmers.

Easdown (1978b) suggested feasible practices for reducing bird damage to sunflower crops, involving changing the time of planting. An early sunflower crop (planted in October or November) may mature quickly and avoid the worst period for crop damage (April to July) when numbers of birds are greatest. Early planting is more feasible on the North-west Plains than the Slopes where weeds are a major problem in early crops (Easdown 1978b). However, two crops planted in November/ December at Swan Vale were harvested in April and avoided severe bird damage; while crops planted in January and harvested from May to July suffered the most damage each year. Having crops which matured evenly and quickly, and were suited to aerial dessication or to premature harvest and mechanical drying, would also reduce the period of susceptibility to damage from seed set to harvest (Easdown 1978b).

However, the present climate of sunflower growing necessitates more immediate methods of controlling damage. De la Motte (1977) suggested that decoy crops (i.e. low cost sunflower crops planted specifically for birds) may be one such solution; and the viability of this was investigated by Broome (1979), who grew decoy sunflower crops in three areas of north-east New South Wales in 1979. Some decoy crops were successful in attracting birds away from the main sunflower crops, but others failed to do so. She suggested that decoys could be planted at the same time as main crops if the decoy was in an area favoured by birds, and if the main crops were protected by scare guns and shooting. If a decoy was overexploited before main crops were harvested, it could be slashed and trash grain added to maintain the interest of the birds. Small decoys of 2-4 ha planted along the flight paths of cockatoos between roost areas and main crops were suggested. White Cockatoos and Galahs preferred decoys in open country with good all-round vision and nearby perches, while smaller parrots appeared to prefer decoys nearer woodland (Broome 1979).

Decoy crops of sunflower (a preferred food of cockatoos) should ideally be planted before the main economic crop and placed strategically to attract birds. This involves some knowledge of the movements and habits of the birds in a locality. The White Cockatoo is more predictable in this regard than the Galah. Finally a decoy crop must be large enough to provide seed throughout the growing period of the main crop, but not so large as to be an economic liability.

Cooperation between individual farmers in all endeavours to control crop damage by birds is of paramount importance. White Cockatoos and Galahs live within areas that may encompass many farms. One farm may receive most or even all the bird damage in a local area; attempts by the owner to discourage birds from his own crops often succeed only in shifting the birds to his neighbours' crops. Thus a control programme of cooperation between farmers is essential. Such programmes might include the management of stubble fields and the planting of decoy crops, to provide uneconomic grain for birds. Attempts should be made to reduce the period of crop susceptibility to damage, to plant summer crops as early as possible to avoid the period of greatest bird flocking, to coordinate the growing of main crops and if necessary, to use scaring methods on main crops; all these tasks should be a local cooperative concern.

The Macintyre Development Unit 2000 is a body of local citizens concerned about the management and conservation of the natural resources in the Macintyre Valley region,which includes Swan Vale and Wallangra. Although the need for regional authorities composed of local residents is obvious, a smaller scale of planning than that envisaged by the MDU 2000 may be necessary for bird pest management, governed by the size of the home ranges of the birds and the areas over which mobile flocks move. At Swan Vale and Wallangra, apparently resident populations of Cockatoos and Galahs live within an area of about 20 to 45 square kilometres. However, there are records of Galahs moving up to 256 kilometres (Pidgeon 1970).

CHAPTER 13

CONCLUSIONS

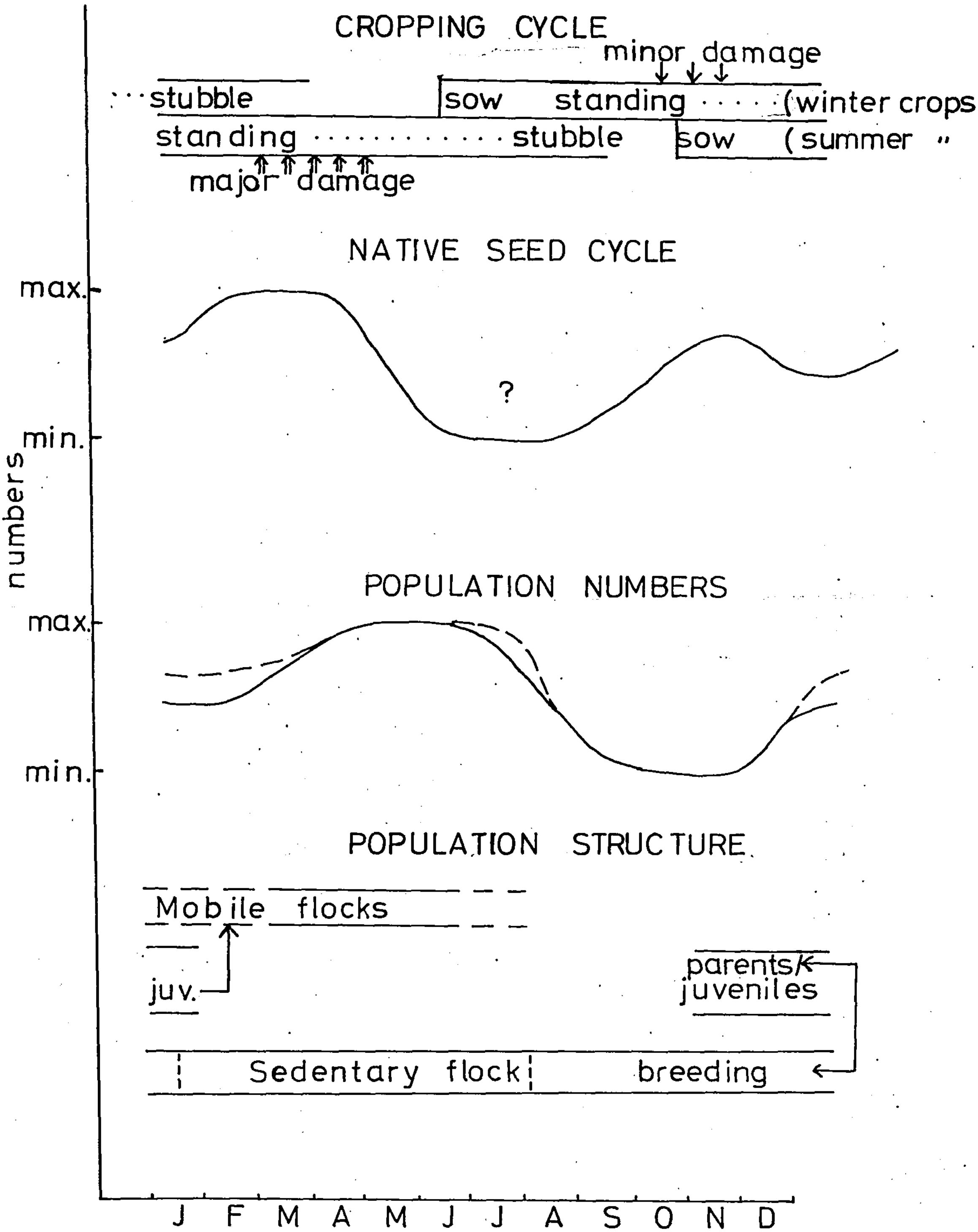
Figure 45 summarizes the White Cockatoo and Galah pest problem in agricultural areas of north-east New South Wales. White Cockatoos and Galahs differ from most species of bird pests in other parts of the world in that they are almost entirely granivorous. Many other pests rely on insects or leaves of plants during the breeding season, to gain energy and nutrients to breed, and to feed their young. Also unlike most areas of the world where birds are agricultural pests, north-east New South Wales has two growing seasons so that some form of crop seed is available throughout the year (Fig. 45). In autumn and winter when cockatoos form the largest flocks and native food is at its scarcest, the summer crops of sunflower and sorghum are available. In spring and summer, cereal crops of wheat and barley are available. Both species of cockatoo depend to a large extent on crops, although seeds of native and exotic plants are also eaten, mostly in spring and summer when they are most abundant (Fig. 45).

Many pest species breed colonially, having strict breeding synchronization, rapid development of young, multiple broods and large clutches. They have a high reproductive output and population turnover is rapid (Pinowski and Kendeigh 1977). White Cockatoos and Galahs however, have a low reproductive output. Only a relatively small proportion of the overall population breeds each year, assuming mobile birds do not breed, and only about 50% of the sedentary birds breed. Only about one fledgling is produced per pair each season. Cockatoos are also single brooded, and the development of young is slow (about 10

FIGURE 45

PATTERNS OF BIRD NUMBERS, POPULATION COMPOSITION, CROPPING AND NATIVE SEED CYCLES, WITHIN A PERMANENT HOME RANGE OF WHITE COCKATOOS AND GALAHS IN NORTH-EAST NEW SOUTH WALES.

There may be fluctuations around these trends graphed, and also variations within home ranges from year to year and place to place.



CROPPING CYCLE
minor damage
stubble
sow standing (winter crops
standing stubble
sow (summer "
major damage
NATIVE SEED CYCLE
max.
min.
?
numbers
POPULATION NUMBERS
max.
min.
POPULATION STRUCTURE
Mobile flocks
juv.
parents/
juveniles
Sedentary flock
breeding
J F M A M J J A S O N D

weeks for White Cockatoos). Goannas probably account for some losses, while in some areas humans take a substantial proportion of the nestlings. Mortality is probably high among juveniles and immatures in mobile flocks, although provision of crop seed year-round in some areas may ensure their survival. However, once it becomes an established adult member of a sedentary population (core), a cockatoo may live for many years.

White Cockatoos and Galahs are opportunistic seed-eaters, which flock while roosting and feeding, and show mobility of some of their population. These factors predispose them to becoming pests. Cockatoos concentrate to feed in large numbers in a relatively small area of their overall range. Crops provide rich localized areas of food, and seed is available for long periods either on standing plants or as stubble. Economic losses of a local nature, often affecting one or a few farmers in an area may be high. The small farmer is not only less able to cope with the financial burden of bird damage, but less able to control it, than large monocultural concerns.

Some knowledge of the behaviour and movements of a pest population of cockatoos in a locality is necessary for planning efficient methods of damage control. Grain from uneconomic stubble or decoy crops can be used to attract birds away from the economic standing crops. These and other passive methods advocated in the last chapter,should alleviate damage as well as ensure the survival of local populations of these cockatoos. Clearly the success of control programmes depends on cooperation between farmers and coordination of activities within the home ranges of the pest populations.

In general, if a bird species incurs an economic cost to man the possible benefits are ignored or deleted from any cost-benefit analysis (Weins and Dyer 1977). The aesthetic and recreational values of such birds are abstract qualities, difficult to weigh against quantitative evidence of bird depredations. Yet some pest species are beneficial to man, in consuming seeds of weeds or pest insects at certain times of the year. White Cockatoos and Galahs eat large quantities of thistle seeds, and Galahs especially eat the seeds of many other noxious weeds.

Several other workers (e.g. Beeton 1977a and de la Motte 1977) have commented on the possible economic gain and alleviation of damage to be derived from legalized export of non-endangered species such as the White Cockatoo and Galah. However, as Cockatoos and Galahs do not readily breed in captivity (Forshaw 1979, J.E. Courtney pers. comm.), uncontrolled export might (through increased incidence of nest-robbing) place excess strain on natural populations. Individual cockatoos may live many years and if a significant proportion of a local population is old it may "crash" quite suddenly (Forshaw 1979). Many Australian cockatoos and parrots are already in some danger from the depredations of man through nest-robbing and habitat alteration.

Long-term monitoring of bird numbers and distributions, and of the patterns and economics of crop damage and its control, are essential. There is a need for more information on the population dynamics of the cockatoos, and it would be most useful to know more about the movements of mobile flocks. One shortcoming of this thesis is the lack of precise information on the movements of individual White Cockatoos. A long-term study by a team of workers using an efficient trapping and marking scheme would provide such information.

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APPENDIX A.

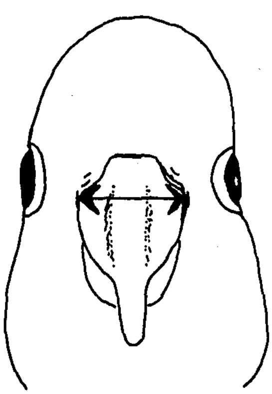
a. SEXUAL DIMORPHISM IN SOME MORPHOLOGICAL FEATURES OF THE WHITE COCKATOO

Feature	♂ $\bar{X}$	♀ $\bar{X}$	t-value	df	Significance levels
Body weight (g)	926.25	826.50	4.78	16	$P < 0.001$
Bill width* (cm)	2.29	2.12	4.86	29	$P < 0.001$
Bill length' (cm)	4.44	4.14	5.58	19	$P < 0.001$
Eyeskin + dimensions (cm)	3.90	3.29	2.85	17	$P < 0.01$

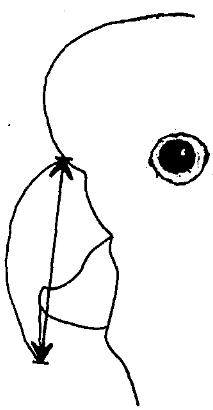
b. SEXUAL DIMORPHISM IN SOME MORPHOLOGICAL FEATURES OF THE GALAH

Feature	♂ $\bar{X}$	♀ $\bar{X}$	t-value	df	Significance levels
Body weight (g)	361.15	333.86	2.79	33	$P < 0.01$
Bill width* (cm)	1.53	1.47	3.46	55	$P < 0.001$
Bill length' (cm)	2.48	2.37	3.03	31	$P < 0.001$

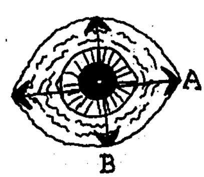
* bill width



' bill length



+ eyeskin dimensions - A x B



APPENDIX A (Cont'd)

c. AGE AND SEX CHARACTERISTICS OF WHITE COCKATOO

Age	Sex	Iris colour	Eyeskin colour	Eyeskin texture	Plumage
NESTLING	?	black	blue-white	smooth	yellow down. some with grey feathers in wing, head, crest
JUVENILE	?	black	blue-white	smooth	some with grey feathers in wing, head, crest
IMMATURE	♀	dark brown	white	smooth	" "
	♂	black	white	smooth	" "
ADULT	♀	red	white	increasingly wrinkled and large with age	no grey feathers
	♂	black	white	" "	" " "

d. AGE AND SEX CHARACTERISTICS OF GALAH

Age	Sex	Iris colour	Eyeskin colour	Eyeskin texture	Plumage
NESTLING	?	brown, grey	pink blue tinge	smooth	pink down grey breast band grey crest
JUVENILE	?	brown, grey	pink	smooth to lightly pimpled	grey breast band grey crest
IMMATURE	♀	pale brown pink tinge	pink	lightly pimpled to lightly warted	grey in breast and crest pale pink breast
	♀	dark brown	pink	"	"
ADULT	♀	pink	pink to red	light to heavy warting with age	deep pink breast
	♂	dark brown	pink to red	medium to very heavy warting with age	"

Data - J.E. Courtney pers. comm. and banding data; pers. obs. of shot+caged birds.

APPENDIX A (Cont'd)

e. PATTERNS OF MOULT IN WHITE COCKATOOS AND GALAHS SHOT AT BOTH FIELD AREAS

NUMBER OF WHITE COCKATOOS IN MOULT EACH MONTH

Moulting parts	J	F	M	A	M	J	J	A	S	O	N	D
No moult	-		-	-	1	7	2	4	3	2	-	
Crest	-		8	1	1	-	2	2	1	1	2	
Body	1		9	1	2	2	1	2	-	1	4	
Wing	-		2	1	1	-	-	2	-	-	2	
Tail	1		3	1	1	1	1	7	-	1	3	
Total number of birds	1	0	10	1	3	9	4	13	4	4	4	0

MOULT COMBINATIONS IN WHITE COCKATOO

	CREST	BODY	WING	TAIL	BODY & TAIL
Crest	2	7	0	0	2
Body		4	0	3	2
Wing			0	2	2
Tail				6	
Wing & crest		0		0	4

NUMBER OF GALAHS IN MOULT EACH MONTH

Moulting parts	J	F	M	A	M	J	J	A	S	O	N	D
No moult			2	2	6	8	7	6	4	1	-	
Body			3	-	9	2	-	-	2	1	-	
Wing			-	-	-	-	-	-	-	3	1	
Tail			-	-	-	-	-	-	1	2	1	
Total number of birds	0	0	5	2	15	10	7	6	7	5	1	

MOULT COMBINATIONS IN GALAH

	BODY	WING	TAIL
Body	15	0	1
Wing	0	2	2
Tail			1

APPENDIX B

A Taxonomic Comment

Pidgeon (1970) used behavioural characteristics to infer taxonomic relationships between nine species of parrot (1 - 9 inclusive in the following Table). His findings were consistent with those of Watters (1968) who examined mainly morphological characters using numerical taxonomy. The White Cockatoo (10 in the following Table) is almost identical to the Galah (9) and Little Corella (11) in the behavioural characters tabulated. However, the Galah differs somewhat morphologically from the others (Watters 1968) and has periodically been assigned to a separate monotypic genus (*Eolophus*). Watters (1968) argues that it is intermediate between White Cockatoos (*Cacatua*) and Black Cockatoos (*Calyptorhynchus*).

LEGEND TO FOLLOWING TABLE

No.	Parrot Species		Country	References
1.	*Agapornis* Spp.	lovebirds	Sth. Africa	Pidgeon (1970)
2	*Loriculus galgulus*	Hanging Parrot	Malaya	Pidgeon (1970)
3	*Brotogeris jugularis*	Parakeet	Sth. America	Pidgeon (1970)
4	*Melopsittacus undulatus*	Budgerigar	Australia	Pidgeon (1970)
5	*Platycercus eximius*	Eastern Rosella	Australia	Pidgeon (1970)
6.	*Platycercus elegans*	Crimson Rosella	Australia	Aslin (1978)
7.	*Psephotus haematonotus*	Red-rumped Parrot	Australia	Pidgeon (1970)
8	*Nymphicus hollandicus*	Cockatiel	Australia	Pidgeon (1970)
9	*Cacatua roseicapilla*	Galah	Australia	Pidgeon (1970) & pers. obs.
10	*Cacatua galerita*	White Cockatoo	Australia	pers. obs.
11	*Cacatua sanguinea*	Little Corella	Australia	Beeton, pers.comm.

Behavioural characteristics common to all species 1 - 11 inclusive:

Husk/ingest grain

Drink - ingest with tongue

Wing-leg stretch, wing arch, body shake etc.

Bill preening movements

Rest, sleep upright

Defaecation movements

Hole nesters.

APPENDIX B (Cont'd)

SOME IMPORTANT COMPARATIVE BEHAVIOURAL CHARACTERISTICS

CHARACTERISTICS	SPECIES										
	1	2	3	4	5	6	7	8	9	10	11
Use feet in feeding	0	X	0	0	X	0	0	0	X	X	X
Tilt head back to drink	X	0	0	0	X	X	X	X	X	X	X
Wing-whirring*	X	X	X	X	0	0	X	0	0	0	0
Tail wagging - comfort*	X	X	-	0	0	0	X	X	0	0	0
Tail wagging - threat	0	0	-	0	X	X	X	0	0	0	0
Ruffle only preen area	0	0	-	0	X	X	X	0	X	X	X
Allopreen*	X	0	X	X	0	0	X	X	X	X	X
Foot under wing to scratch*	0	0	0	0	0	0	0	0	X	X	X
Foot over wing to scratch	X	X	X	X	X	X	X	X	0	0	0
Bathe by splashing	X	X	-	X	X	X	X	0	0	0	0
Rain-bathe	X	X	-	0	0	0	0	X	X	X	X
Rest, sleep upside-down	0	X	-	0	0	0	0	0	0	0	0
Beak-chew before sleep	0	0	0	0	0	0	0	X	X	X	-
No. of intra-specific threat signals	4-5	10	8	7	8	-	9	5	4	4	-
Simple courtship	X	-	0	0	X	-	0	0	X	X	X
Courtship feed	X	X	X	X	X	X	X	0	0	0	0
Simple pre-copulation	0	-	0	0	0	-	-	X	X	X	X
♂ mount with both legs	X	-	0	X	X	X	X	X	X	X	X
♂ displays during copulation	X	-	0	X	-	-	X	X	0	0	0
♀ tail elevated in copulation solicitation	X	-	X	X	X	X	X	0	0	0	0
Nest termite mounds	X	0	X	0	0	0	0	0	0	0	0
Nest in hollow limbs	X	X	0	X	X	X	X	X	X	X	X
Line nest	X	X	0	0	0	0	0	0	X	X	X
Line nest with leaves	X	0	0	0	0	0	0	0	X	0	0
Both sexes incubate	0	0	-	0	0	0	0	X	X	X	X

* of phylogenetic importance (Pidgeon 1970) X Character present
0 Character absent - Unknown

APPENDIX C

DISTRIBUTION OF HOURS SPENT COLLECTING WRITTEN DATA IN THE FIELD (FROM MARCH 1977 TO MARCH 1979)

	SWAN VALE									WALLANGRA								
HOUR OF DAY	AUTUMN		WINTER		SPRING		SUMMER		TOTAL	AUTUMN		WINTER		SPRING		SUMMER		TOTALS
	1977	1978	1977	1978	1977	1978	1977–78	1978–79		1977	1978	1977	1978	1977	1978	1977–78	1978–79	
0400–0500														2	3	2	2	9
0500–1600					2	2	1	2	7					2	2	3	2	9
0600–0700	5	8	6	2	5	3	2	3	34	2	4	2	5	3	4	3	3	26
0700–0800	7	9	7	8	6	5	3	4	49	2	3	3	5	3	4	3	3	26
0800–0900	7	9	9	8	8	8	6	4	59	2	4	3	6	4	4	3	3	29
0900–1000	7	9	9	8	8	8	6	4	59	2	4	3	6	4	4	2	3	28
1000–1100	5	8	9	7	8	8	4	4	53	2	4	3	5	4	3	2	2	25
1100–1200	1	4	7	5	8	5	3	2	35	1	3	2	3	3	2	1	2	17
1200–1300	1	2	2	2	5	3	1	3	19	1	3	2	3	3	2	1	2	17
1300–1400	1	4	2	3	4	3	2	2	21	1	2	3	2	3	3	1	2	17
1400–1500	3	4	7	4	5	3	2	2	30	1	2	4	2	2	3	3	2	19
1500–1600	6	9	9	9	8	6	4	4	55	2	4	4	4	3	5	3	3	28
1600–1700	6	11	9	9	10	6	6	6	63	2	4	4	5	5	5	3	3	31
1700–1800	7	11	9	8	10	6	6	6	63	2	4	4	5	5	5	3	3	31
1800–1900	2	8	2		10	7	6	6	41	2	3	3	2	5	5	3	3	26
1900–2000	1						2	6	9	1	1			2	4	3	2	13
	59	96	87	73	97	73	54	58	597	23	45	40	53	53	57	39	41	351
	155		160		170		112			68		93		110		80		