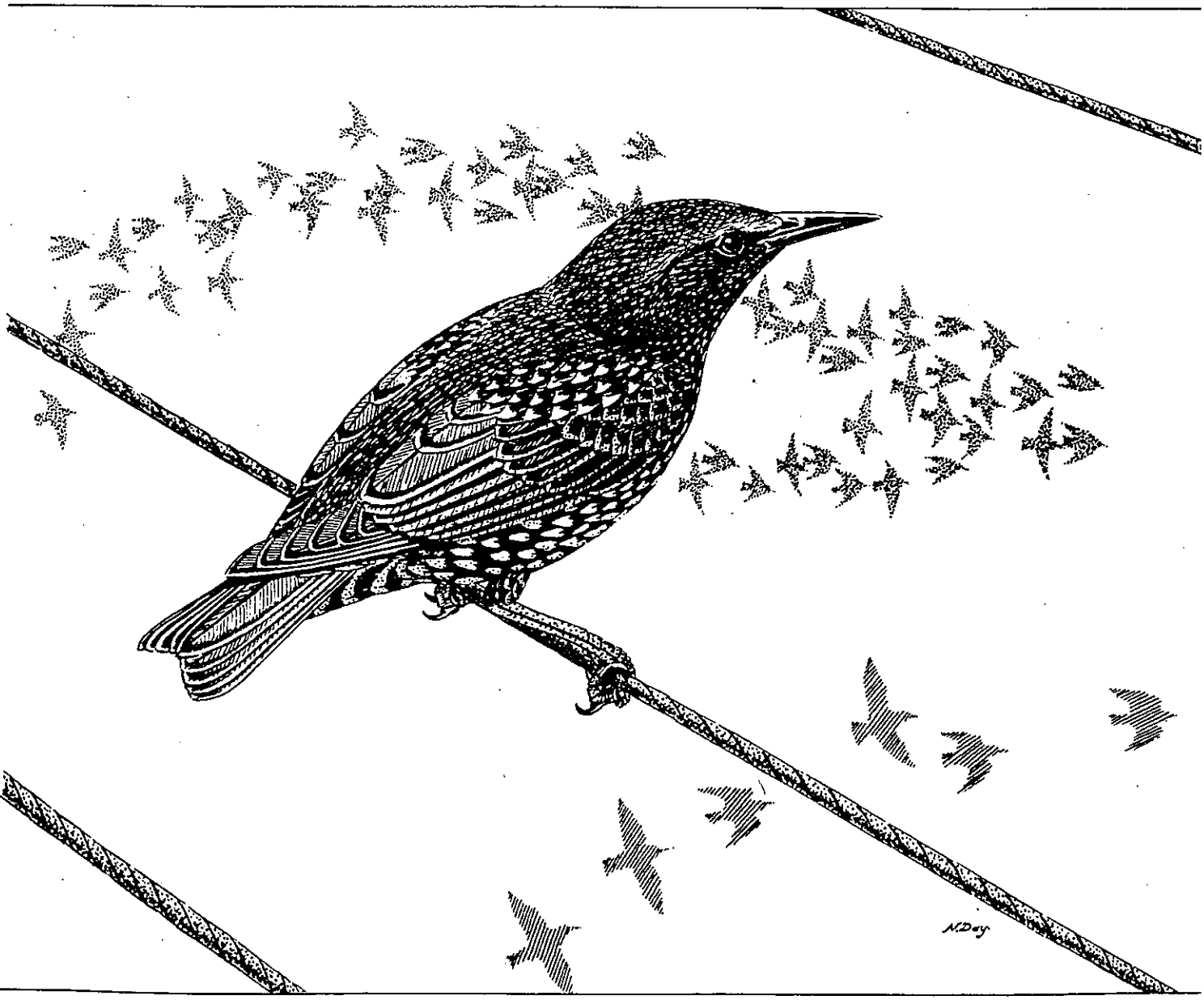
DISTRIBUTION AND MOVEMENTS OF POST-BREEDING FLOCKS OF THE COMMON STARLING, STURNUS VULGARIS LINN., IN THE CANBERRA AREA.

Isobel Crawford



CANBERRA ORNITHOLOGISTS GROUP INC. JANUARY 1990

Contents

Abstract

Acknowledgements

1 Introduction
  1.1 Introduction and dispersal in Australia
  1.2 The starling as a pest in Australia
  1.3 Aims of the project

2 Study area and methods
  2.1 Study area
  2.2 Methods
      2.2.1 Distribution
      2.2.2 Dispersal
      2.2.3 Fidelity to a location and/or to a flock
      2.2.4 Survey techniques

3 Results
  3.1 Distribution and abundance of starlings in the ACT
  3.2 Survey results
      3.2.1 Major feeding flocks
      3.2.2 Major roosting flocks
      3.2.3 Minor suburban roosts
  3.3 Dispersal
      3.3.1 Daily dispersal distance
      3.3.2 General dispersal data from ACT banding recoveries
  3.4 Fidelity to a location and/or to a flock
  3.5 Survey techniques

4 Discussion
  4.1 Distribution and abundance
      4.1.1 Distribution of feeding flocks
      4.1.2 Distribution of roosting flocks
  4.2 Dispersal
  4.3 Fidelity to a location and/or to a flock
  4.4 Survey techniques

5 Management options
  5.1 Reducing the food supply
  5.2 Parkwood Eggs
  5.3 The Garema Place roost
  5.4 Future survey work
      5.4.1 Trapping, tracking and marking methods
      5.4.2 Baits

6 Conclusions

7 Effectiveness of the project

8 Appendices

Appendix 1. Food and feeding behaviour
Appendix 2. Roosts and roosting behaviour
Appendix 3. a) Data card
            b) Explanatory sheet given to observers
Appendix 4. Bibliography of starling survey techniques

9 References

List of figures

Figure 1. Distribution of starlings in Australia (after Blakers et al. 1984) a) historical maps
b) field atlas records 1977-81.
Figure 2. Map of study area.
Figure 3. Major feeding flocks observed in Canberra area Feb.-June 1989.
Figure 4. Major roosting flocks observed in the Canberra area Feb.-June 1989.

List of tables

Table 1. Largest flocks of starlings recorded in the ACT 1979/80-1986/87.
Table 2. Major feeding flocks observed in the Canberra area Feb.-June 1989.
Table 3. Major roosting flocks observed in the Canberra area Feb.-June 1989.
Table 4. Minor roosts observed in 6 Canberra suburbs June 1989.
Table 5. Trapping and netting results.
Table 6. Daily dispersal distance from roost to feeding area.
Table 7. ACT banding recoveries.
Table 8. Conclusions on the fidelity of post-breeding starlings to a roost and/or a feeding site, or a flock.

Distribution and movements of post-breeding flocks of the Common Starling, Sturnus vulgaris Linn., in the Canberra area.

Abstract

Roosting and feeding sites used by post-breeding flocks of one hundred or more starlings were located to determine distribution. Nineteen birds were colour-marked to assess i)their daily dispersal distance and ii)fidelity to a location and/or to a flock. Extra data on local dispersal distances were obtained from the Australian Bird and Bat Banding Scheme. Insufficient birds were marked to provide the information sought, but the English and North American literature revealed that starlings i) fly up to 80 km daily from roosts to feeding areas, and ii) are not always faithful to a nocturnal roost, but do return to the same general feeding area each day. These movement patterns reflect the general opportunism of starlings, and mean that even localised control of starlings would have no long term impact, because replacement birds would be expected to move in quickly, assuming that Australian birds behave similarly to northern hemisphere birds of the same race.

Acknowledgements

I thank S. Ambrose, C. Davey, N. Hermes and W. Osborne for help with project methods;
R. Allen, S. Ambrose, R. Bennett, G. Cottsell, C. Davey, V. Kowalski, M. Lewis, T. Marples, W. Martin, R. McCulloch, D. Purchase, M. Skipper and J. Wright for field assistance;
C.O.G. members for collecting data on major flocks, and C. Davey, D. Purchase, M. Skipper and V. Kowalski for collecting data on minor flocks;
J. Voosterman for access to Parkwood Eggs and L. Taylor for access to Belconnen Tip;
M. Braysher, M. Lintermans, W. Osborne, R. Saillard and K. Williams of A.C.T. Parks and Conservation Service for useful discussions and/or equipment;
S. Ambrose, M. Clayton, and R. McCulloch for equipment;
M. Clayton for permission to use his banding data, and the Australian Bird and Bat Banding Scheme for searching their records;
N. Day for the cover drawing;
J. Prance, B. Staples and P. White for literature searching and library facilities;
I. Taylor for data input and analysis;
M. Braysher, C. Davey, T. Howard, W. Osborne, I. Taylor and P. Veerman for helpful comments on the draft reports;
P. Veerman for a synopsis of Garden Bird Survey data;
The Canberra Ornithologists Group for organising the project and the Bureau of Rural Resources, via the ACT Parks and Conservation Service, for funding it.

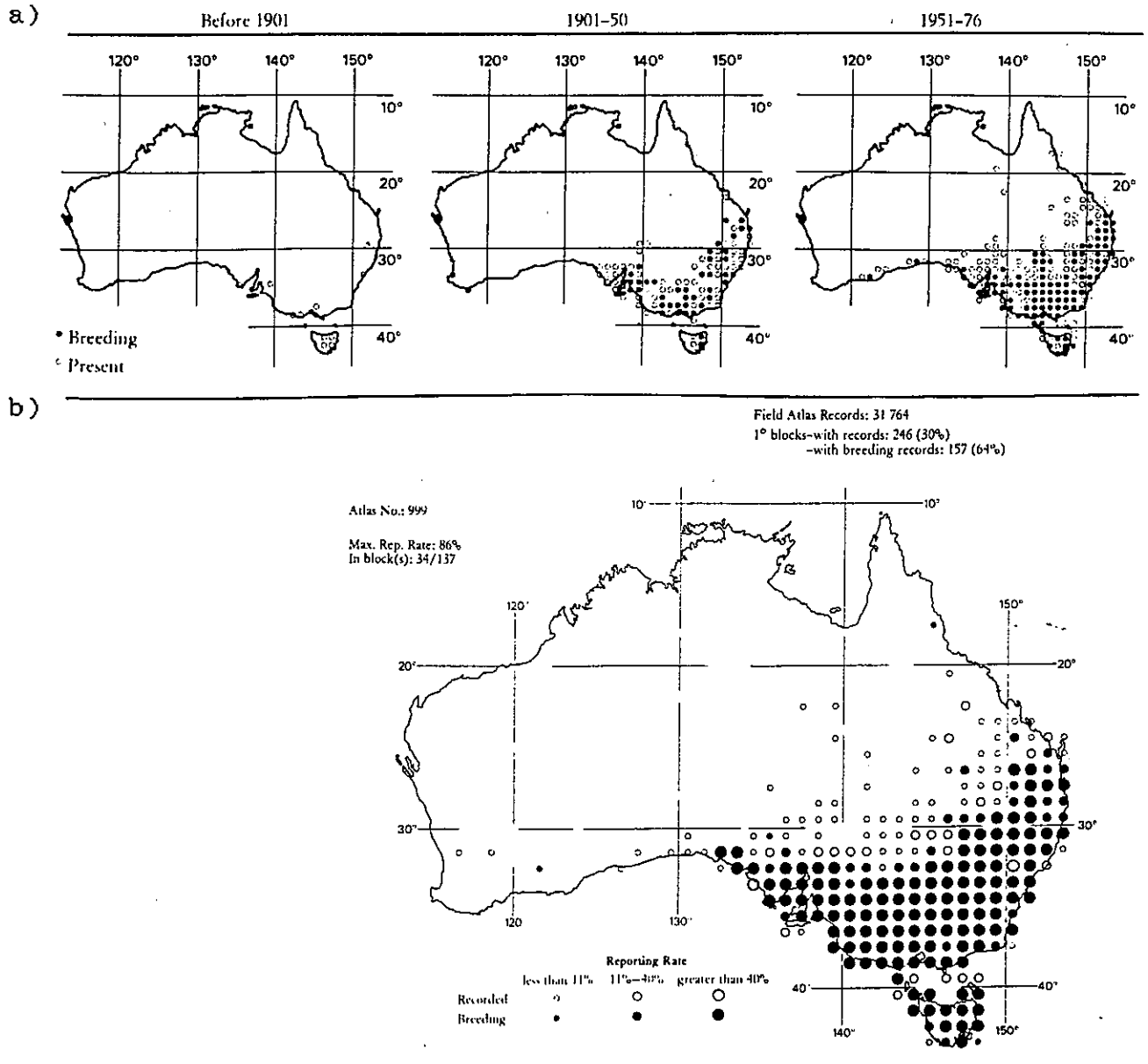
1 Introduction

1.1 Introduction and dispersal in Australia

The Common Starling, Sturnus vulgaris L., (referred to hereafter simply as 'starling') is a gregarious passerine which congregates in flocks from the end of one breeding season to the beginning of the next (post-breeding flocks). It was introduced from England into Melbourne in the late 1850's and was established in Victoria by 1862 (Bamford 1978). In New South Wales, Chisholm (1926) recorded that by the early 1920's starlings had spread into all of the settled parts of the state. They are now established in all of the agricultural and urban areas of south-eastern Australia (Blakers et al. 1984) (Fig. 1). A dependence on fresh water (Long 1981; Emison et al. 1987), and the control activities of the Western Australian Agricultural Protection Board, slow their further expansion.

The birds introduced into Australia are of the nominate race, vulgaris (Peters 1962).

Figure 1. Distribution of starlings in Australia (after Blakers et al. 1984) a) historical maps
b) field atlas records 1977-81.



1.2 The Starling as a pest in Australia

As Roots (1976) has pointed out, an introduced animal's ability to adapt to a new area is largely dependent on 'pre-adaptations' evolved in its former environment. The starlings introduced into Australia were already adapted to the agricultural practices and urban and rural settlements which greeted them here: their new environment not only offerred prime nesting, feeding and roosting sites, but also an increasingly large area of such suitable habitat. Another advantage which starlings enjoyed was the lack of either a closely related species (Goodwin 1978), or a native species able to exploit as successfully the new niches created by European settlement.

Starlings possess 14 of the 21 ecologically important variables of bird pests (Wiens & Johnston 1977): of these the major ones are communal roosting, flock feeding, food opportunism, high population turnover and the ability to migrate from higher latitudes in winter. These factors have combined to ensure that a species already seen as a pest in England when exported to Australia (Roots 1976), became an even more successful pest in the more temperate climates prevailing here.

Starlings are considered to be a major pest for the following reasons: autumn-winter roosting flocks can foul buildings and pavements, and harm vegetation (Kessell 1957; Roots 1976; Tate 1987; Wynne-Edwards 1929); nesting pairs compete with other hollows-nesters (Pizzey 1980; Emison et al. 1987; Kentish and Peace 1987); feeding flocks may damage fruit crops (Tahon 1980), and take animal food if allowed access to feeding areas (Feare 1984). These activities are aggravated by the role of starlings as potential vectors of diseases of humans and other animals (Weber 1979; Feare 1980; Summers et al. 1983; Feare 1984).

In the Canberra area starlings are a particular problem in Garema Place in the City, where they roost at night from late summer to early winter, and in Parkwood Eggs' battery hen sheds at Macgregor, where they feed and roost. Concern about the fouling of public areas and about the possible spread of bird and human diseases by starlings prompted the present study.

1.3 Aims of the project

The project had three aims initially:
1) to determine the distribution of starlings in the ACT by recording the location and size of the major feeding and roosting flocks;
2) to determine the daily dispersal distance from feeding and roosting sites, and to obtain longer term dispersal data from banding recoveries;
3) to ascertain if individuals were faithful to a feeding and/or a roosting area, and/or to a flock, particularly in relation to Garema Place and to Parkwood Eggs at Macgregor.

During the course of the study, it became apparent that starlings are difficult to trap, so the following aim was also addressed:
4) to obtain information on survey methods: trapping, tracking and marking techniques, and baits attractive to starlings.

Extra information on food and feeding behaviour, and roosts and roosting behaviour, has been included as appendices 1 and 2.

2 Study area and methods

2.1 Study Area

The study area was the woodlands and grasslands of rural ACT and the urban area of Canberra (Fig.2).

2.2 Methods

2.2.1 Distribution

Background information on distribution and abundance was obtained from the ACT Avifauna Database, the Annual Bird Reports and the Garden Bird Surveys of the Canberra Ornithologists Group. Further distribution information was obtained from members of COG who recorded observations of major feeding and roosting flocks: details of post-breeding flocks of 100 or more birds were recorded from February to June 1989. A copy of the data card and the information sheet given to observers is appended (App. 3).

Six suburbs were surveyed over two weeks in June to ascertain: i) the number of suburban roosts with fewer than 100 birds, and ii) how many birds were using each roost. Observers surveyed on foot different parts of their area, at times when starlings were likely to be entering or leaving roosts. The location of roosts and the number of birds in them were recorded for the first twelve days of the survey. Over the last two days, all of the known roost sites were re-visited and their populations totalled.

2.2.2 Dispersal

Birds were colour-marked (see below for method) to collect data on daily dispersal. Further information was obtained from the literature. Details of recoveries of locally banded starlings were obtained from the Australian Bird and Bat Banding Scheme of the Australian National Parks and Wildlife Service, to obtain data on longer term dispersal.

2.2.3 Fidelity to a location and/or to a flock

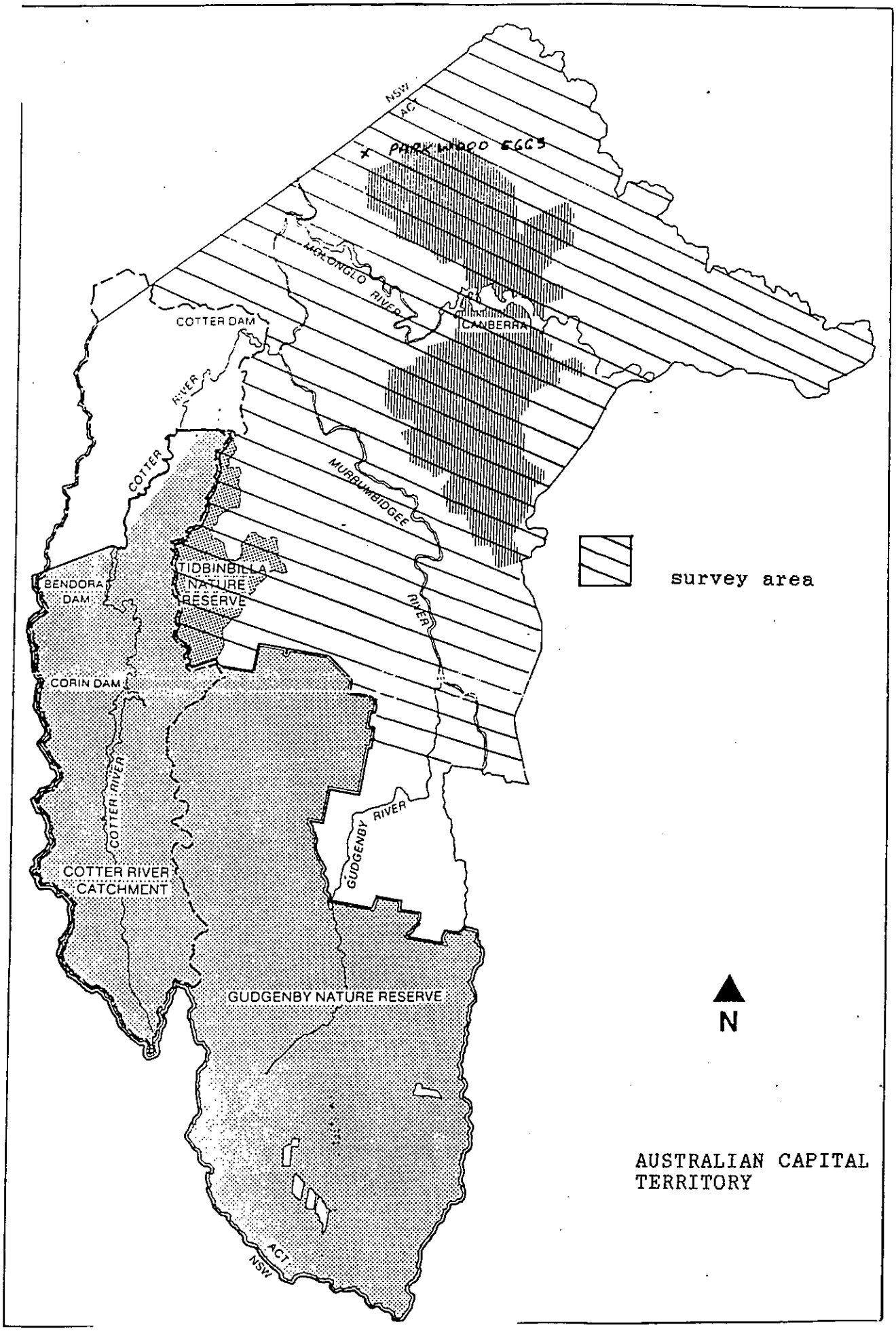
At five sites, traps and/or nets were put out to catch birds for colour-marking. The following trapping methods were used:
i) funnel traps (1500x850x600 mm) at feeding and watering sites (Belconnen Tip; Jerrabomberra Wetlands; O'Connor - Dryandra St x old Weetangera Rd);
ii) net over roost at Kambah (5x5x5x3 m^2);
iii) mist nets at roosts (1 net at Kambah; a row of 9 nets in an air-conditioning vent at Parkwood Eggs) and at a feeding site (5 and 6 nets around dung heaps at Parkwood Eggs).

Various breads and grains were used as bait in the funnel traps. Captured birds had oil-based paint sprayed onto both sides of their tail feathers. A different colour was used at each site so that movements of marked birds could be noted. Observers were asked to record all sightings of colour-marked birds, regardless of flock size.

2.2.4 Survey techniques

Because the above methods caught fewer birds than were required, the literature was searched for details of trapping and marking techniques, to facilitate any future studies of starlings.

Figure 2. Map of study area.



3. Results

3.1 Distribution and abundance of starlings in the ACT

In the ACT Avifauna Database, which has been recording species, but not their abundance, since September 1986, starlings were recorded in all of the open woodland and grassland areas of the ACT (I. Taylor pers. comm.).

Following the 1978-82 drought, the Canberra starling population declined (Annual Bird Reports of the Canberra Ornithologists Group, 1979/80 to 1986/87). The largest flocks recorded during this period are tabled below (Table 1). It is noteworthy that all were post-breeding flocks, observed from late summer to winter.

Table 1. Largest flocks of starlings recorded in the ACT 1979/80-1986/87 (data from the Annual Bird Reports of C.O.G.).

Year	Month	Flock size	Activity	Location
1979/80	April	1 000	feeding	Lake Burley Griffin East
"	April	2 000	"	O'Connor Oval
"	June	3 000	"	O'Connor Oval
1984/85	July	1 000	"	Lake Burley Griffin East
"	Feb.	1 500	"	Lake Burley Griffin East
"	April	6 000	roosting	Civic
"	June	3 000	"	Civic
1985/86	May	4 000	"	Civic
"	May	10 000	"	Civic
"	regular max.	1 100	feeding	Lake Burley Griffin East

Data collected from July 1981 to June 1988 for the Garden Bird Survey, conducted by the Canberra Ornithologists Group, indicated that the starling was the most abundant species (i.e. largest numbers recorded), but not the most commonly recorded (which was the more conspicuous and evenly distributed Australian Magpie). Fluctuations in numbers of starlings recorded throughout the year were regular: numbers were lowest in October and highest following breeding, in summer and autumn, from December to April. October numbers were 25-50% lower than the post-breeding peak (P. Veerman pers. comm.). For methods, see Taylor (1983).

3.2 Survey results

3.2.1 Major feeding flocks

Ten major (more than 100 birds) feeding flocks were each estimated to have had 500-2 000 starlings, and 27 to have had fewer than 500 (Table 2; Fig. 3). There were 24 observations of rural flocks, and 13 of urban flocks. The unshaded area on figures 3 and 4 has been categorised as rural. The largest flocks were feeding in rural areas, either on the 'wet garbage' (i.e. food scraps) at the rubbish tips, or in open paddocks. Short, well watered lawns and grass, and the sewage filtration works at Fyshwick also attracted these major feeding flocks (Table 2; Fig.3).

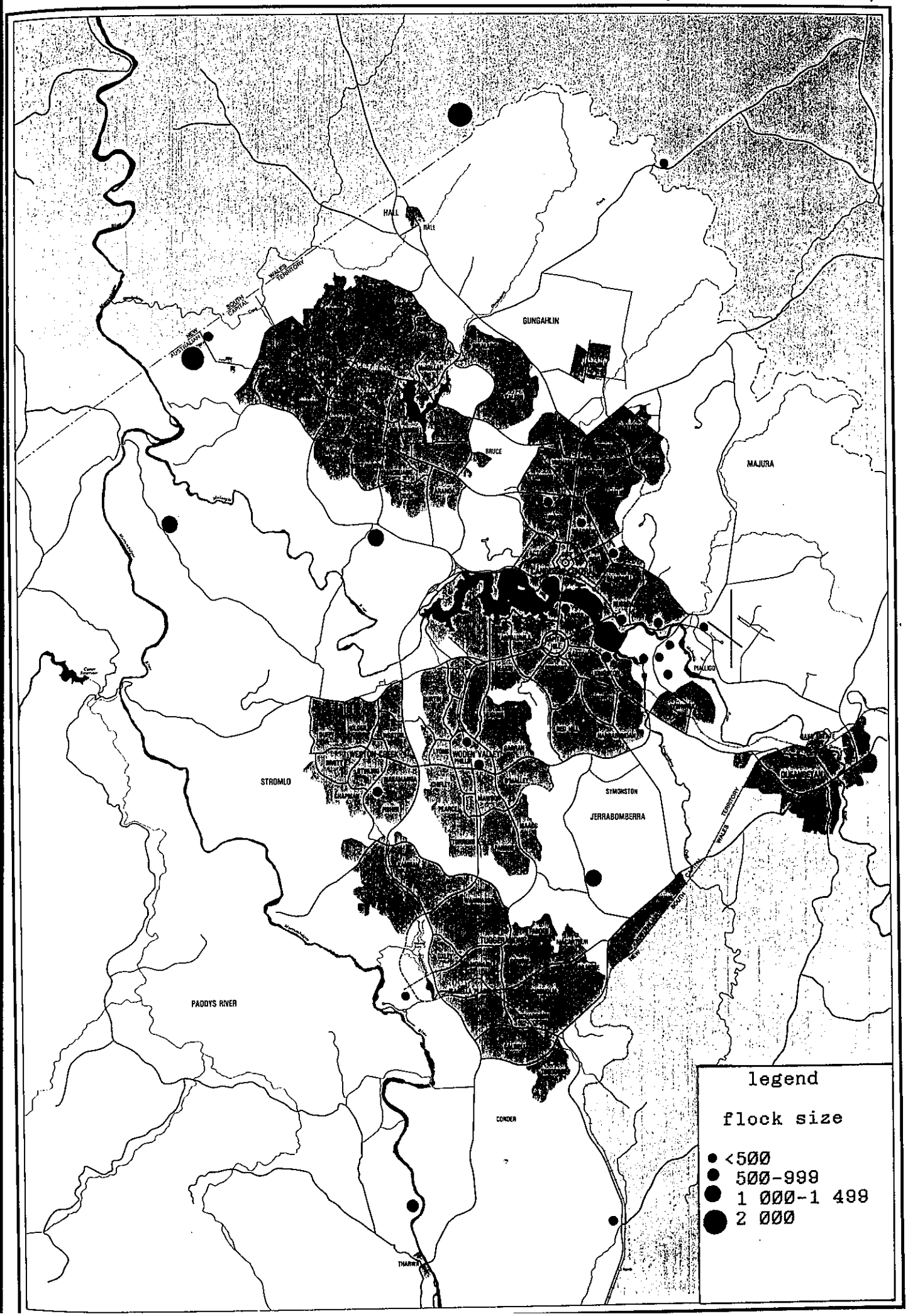
Smaller flocks of up to 30 birds were observed feeding on fruit crops (cherries, figs and grapes in particular) and on lawns.

The largest feeding flocks (2 000 birds) recorded in 1989 were smaller than the largest feeding flock of 3 000 birds, recorded in June 1980, during a drought (Table 1).

Table 2. Major feeding flocks observed in the Canberra area Feb.-June 1989.

Location	Flock size	Date	Substrate
rural areas			
Belconnen Tip	2 000	3, 12/3	'wet garbage'
" "	2 000	12/5	" "
" "	800	29/4	" "
" "	500	16/2	" "
" " - top dam	300	17/2	dam wall
'Braeside' - 5 km NE Hall	2 000	29/3	paddock
Coppins Cr. Rd x Wm Hovell	1 000	8/3	paddock
Fairbairn	100	5/4	paddock
Guise's Ck x Monaro Hway	150	7/5	paddock
Gundaroo Rd 1.5 km N border	200	3/6	paddock
'Huntley' - Uriarra Rd	1 000	5/4	paddock
Jerrabomberra Wetlands	300	14/4	mudpuddle
- sewage ponds	180	26-28/2	paddock
" "	120	27/4	paddock
- filtration tower	300	12/5	?invertebrates
- MacDonald's farm	100	23/3	paddock
'Lanyon' - 2 km N Tharwa	500	5/5	paddock
Macgregor - Parkwood Eggs	300	7/4	dung heaps
" " "	200	9/4	(dung beetles)
" " "	120	22/4	
Mugga Lane Tip	1 000	17/4	'wet garbage'
" " "	1 000	16/5	" "
" " "	200	27/4	" "
Tuggeranong - W of Hyperdome	150	14/4	open paddock
North Canberra			
Braddon - Merici College	150	19/2	lawn
Campbell High School	100	10/3	lawn
Duntroon Golf Course	400	1/4	turf
O'Connor - North Oval	120	19-28/1	lawn
Russell - Constit x King's A.	200	19/2	mown grass
South Canberra			
Kingston - Aquatic Ecol. Lab.	200	12/3	mown grass
Parkes - Treasury lawns	400	24/5	lawn
Weston Creek			
Weston Ck High School	300	6/6	lawn
Woden Valley			
Phillip College	400	1/2	lawn
" "	300	14/2	lawn
" "	100	March	lawn
Phillip Oval	300	May	lawn
Woden Cemetery	300	May	short grass

Figure 3. Major feeding flocks observed in the Canberra area Feb.-June 1989. (the largest flock observed at each site is recorded)



3.2.2 Major roosting flocks

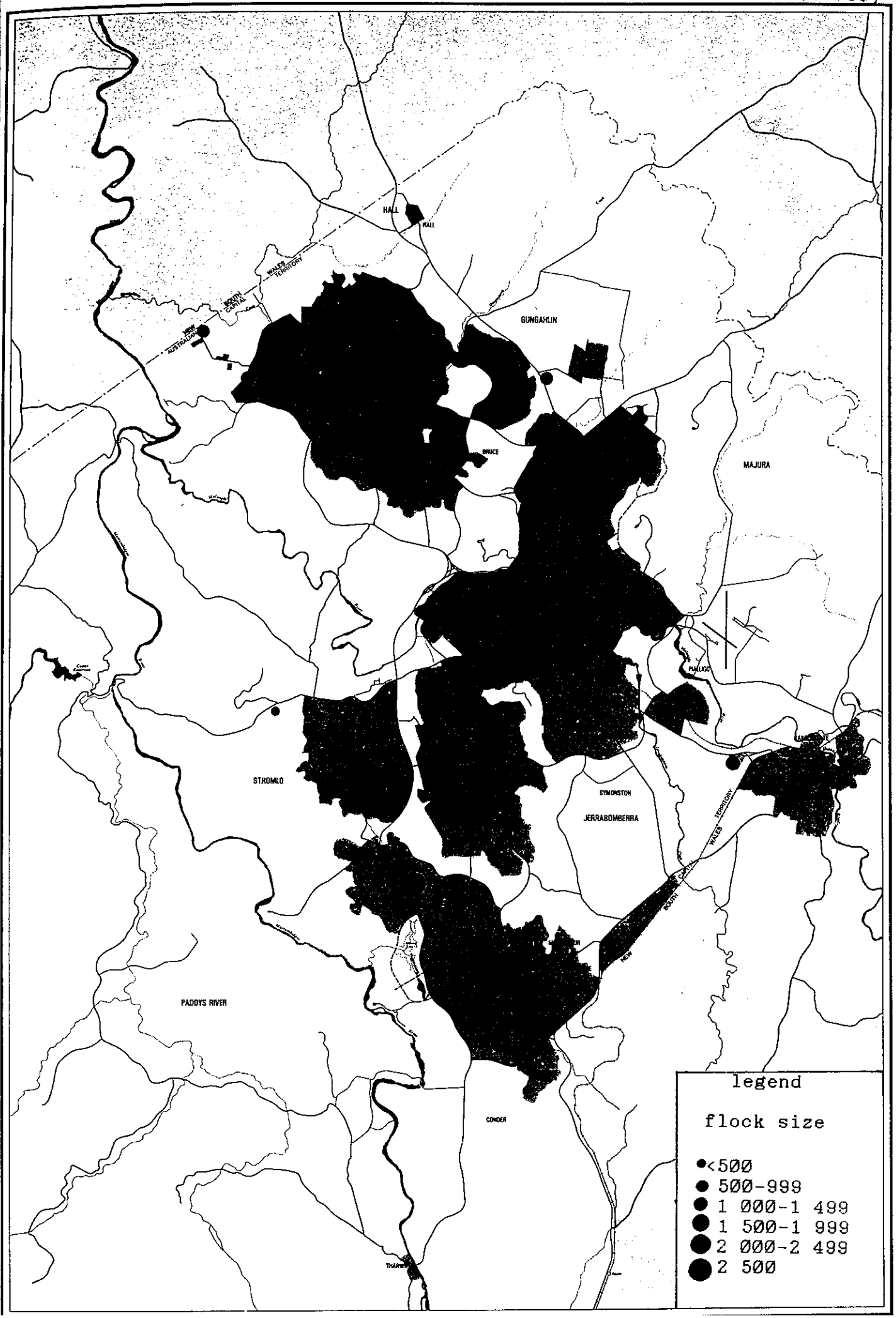
Sixteen major (more than 100 birds) roosting and pre-roosting flocks were each estimated to have had 500-2 500 starlings, and 30 to have had fewer than 500 (Table 3; Fig. 4). As with feeding flocks, the largest roosting flocks recorded during the survey period were smaller than those of 3 000-10 000 recorded in earlier years (Table 1). There were 10 observations of rural flocks, and 36 of urban flocks (Table 3; Fig.4.)

Plants favoured for roosting typically had very dense foliage, as noted in North America by Jumber (1956): pampas grass, bamboo, cypresses, blue gums, Typha 'reed' beds, and creepers or climbers intertwined with other plants. Plane Trees were the most frequently used plant, by flocks of all sizes, by day as well as by night (pers. obs). In 1989, the Garema Place trees did not lose their leaves until mid June. The roost had already been vacated, with only 40 birds remaining on June 10. Power lines were the most frequently used pre-roosting site.

Table 3. Major roosting flocks observed in the Canberra area Feb.-June 1989 (* pre-roosting flock)

Location	Flock size	Date	Roost plant or structure
rural areas			
'Bibaringa', Cotter Rd	200*	2/4	power lines
Gungahlin CSIRO Wildlife	600	25/3	Pampas Grass
" " & Ecology	300	2?/?4	" "
" "	200*	22/5	power lines
" "	130*	1/5	" "
" "	120*	20/3	in flight
" "	100*	8/5	" "
Macgregor - Parkwood Eggs	617	26/4	sheds - air
" " "	546	29/4	conditioning vents
" " "	330	23/4	" " " "
Belconnen			
Belconnen Golf Course	500*	20/2	water soak
Cook - Dwyer St	120	16/6	Bamboo thicket
" Lyttleton x biketrack	100	7/6	yellow cypresses
" " " "	100	7/6	rose in E. nicholli
Evatt - Brebner St and	1 000	9/2	power lines
" Ginninderra Dr.	600*	11/2	" "
Higgins - De Baun Cres	100	May	Hakea sp.
" Bundy St	100	May	blue gums
Page - Keartland St	150	21/6	Ivy over tree
Macgregor - Cotter Pl.	300*	27/4,3/5	eucalypts
North Canberra			
City - Garema Place	1 500	28/4	Plane Trees
" " "	1 000	2/3, 3/6	" "
" " "	770	31/3	" "
" " "	550	10/5	" "
" - Alinga St.	400*	3/5	" "
" - Garema Place	300	10/5	" "
" " "	200	1-9/6	" "
" - Mort x Alinga Sts	200	28/3	Plane trees
Hackett - 4 Dunn Place	100	22/3	
Lyneham-lane Earle-Mackennal	500	10/4	yellow cypress
South Canberra			
LBG - N of Water Police HQ	2 000	8/3	Typha reedbed
" " " " "	1 000	3/3	" "
" " " " "	300	1/3	" "
" - Yarramundi Reach	150	7/5	Typha reedbeds
Parkes-opp. Ed. Barton bldg	200	15/5	Cedars of Leb.
" - Kings x Macquarie	2 000*	31/3	in flight
Symonston - Harman/Bonshaw	1 100	23/5	Pencil Pines
" " "	300	19/3	" "
" " "	300	1/3	" "
Tuggeranong			
Kambah - Mackenzie St	2 500	25-27/2	ivy, willows
" " "	200	18/3	" "
Woden Valley			
Phillip College	300*	14/2	trees
" - Launceston St	200	17/2	"
" " "	100*	Mar.	"
Weston Creek			
Duffy Oval	200	12/3	yellow cypress
Fisher - Kalgoorlie Cres.	100	18/3	tall eucalypts

Figure 4. Roosting flocks observed in the Canberra area Feb.-June 1989. (the largest flock observed at each site is recorded)



3.2.3 Minor suburban roosts

Thirty minor (<100 birds) roosts, containing a total of 656 starlings, were found during a search of 6 suburbs (3.48 km^2) in June. They held 189 roosting birds/km^2, or 1.89 birds/ha (Table 4). Numbers of birds per roost ranged from 6 to 50. There were major roosts within 2 km of each of these smaller ones (Fig. 4). All of the small roosts were in dense trees, shrubs or clumps of bamboo.

Birds in the same pre-roosting flock were observed to fly to different nocturnal roosts and to fly over some roosts on the way to others (C. Davey pers. comm.).

Table 4. Minor roosts observed in 6 Canberra suburbs June 1989.

Suburb	Area (km^2)	No. of roosts	Roosts/ km^2	No. of birds	Birds/ km^2
Cook	0.25	4	16.0	63	252
Higgins	0.41	2	4.9	50	122
Holt	0.97	13	13.4	390	402
Kambah	0.58	4	6.9	102	176
Melba	0.85	0	0.0	0	0
Turner	0.42	7	7.0	51	121
totals	3.48	30	8.6	656	189

3.3 Dispersal

Nineteen birds were colour-marked at Kambah and Parkwood (Table 5). However these marked birds were not seen subsequently, so no new data on movements of starlings (dispersal distance or fidelity to a location and/or a flock) were obtained.

In two outer suburbs, Cook and Holt, small flocks of starlings (<100 birds) were observed flying out to feed in the adjacent paddocks in the morning, and returning at night (C. Davey pers. comm.; pers. obs.).

Table 5. Trapping and netting results.

Trap type	Location	Dates	Birds marked
funnel traps	Belconnen Tip top dam	17-25 Feb.	-
" "	O'Connor - Dryandra x Old Weetangera Rd	25 Feb. - 9 Mar.	-
" "	Jerrabomberra Wetlands	10-22 Mar.	-
mist nets	Parkwood dung heaps	7 Apr.	4
" "	" " "	9 Apr.	2
" "	" shed 4 airvent	29 Apr.	11
" "	Kambah McKenzie St	7 Apr.	2
" "	" " "	10 Apr.	-
net over roost	" " "	6 Mar.	-

3.3.1 Daily dispersal distance

Estimates made in other studies of daily dispersal distance from roost to feeding area are summarised in Table 6.

Table 6. Daily dispersal distance from roost to feeding area.

Distance (km)	Country	Reference
4	NZ	Coleman (1977)
4 & 8 (means, 2 roosts)	USA	Morrison & Caccamise (1985)
8-24, to a maximum of 40	England	Wynne-Edwards (1929)
16, to a maximum of 32	England	Eastwood *et al*. (1962)
18	USA	Bray *et al*. (1975)
28 maximum	England	Peach & Fowler (1989)
30	Belgium	Laguesse (1986)
48	England	Marples (1934)
80 maximum	USA	Hamilton & Gilbert (1969)

Eastwood *et al*. (1962) used radar to track starlings, and Hamilton & Gilbert (1969) suggested that 16-32 km may be an underestimate reflecting the limitations of radar in picking up the thinning ranks of dispersing flocks. The estimates in Table 6 all relate to post-breeding flocks, except for that of Eastwood *et al*. (1962) who collected data from August 1958-February 1961.

The size of the home range of an individual bird is relevant to daily dispersal distance. The following estimates have been made of home range size by radio-tracking starlings in North America: 33 km^2 and 49 km^2 (Morrison & Caccamise 1985), and 39.6 km^2 (Bray *et al*. 1975).

3.3.2 General dispersal data from ACT banding recoveries

Records from the Australian Bird and Bat Banding Scheme revealed 21 recoveries of starlings which had been found from 1 to 32 km from where they were banded in the suburb of Kaleen, up to 3 years and 15 days after being banded (Table 7). The average distance from trap site to recovery point was 5 km, and the average time elapsed was 11 months and 11 days. Median values were 2 km and 3 months respectively. The recovery rate was approximately 0.21%.

Table 7. ACT banding recoveries.

Recovery site	Distance (km)	Elapsed time	Age at banding
Giralang	1	<1 day	juvenile
Kaleen	1	11 months	+1
Giralang	2	11 days	juvenile
Gungahlin Hill	2	2 yrs 10 months	+1
Gungahlin Hill	2	2 yrs 10 months	+1
Gungahlin Hil	2	2 yrs 9 months	1
Kaleen	2	3 yrs 15 days	+1
Kaleen	2	30 days	+1
Kaleen	2	1 yr 4 months	+2
Kaleen	2	1.5 months	juvenile
Kaleen	2	23 days	juvenile
Downer	4	1 month 29 days	1
Downer	4	5.5 months	juvenile
Kaleen	4	3 months	1
Kaleen	4	3 months	1
Gungahlin	5	2 months	juvenile
Melba	5	4.5 months	juvenile
M.L.C. City	7	7 weeks	juvenile
Braddon	7	3 months	"
Lyons	14	6 weeks	"
'Lakelands' Bungendore	32	2 yrs 10.6 months	1 yr

3.4 Fidelity to a location and/or to a flock

As none of the colour-marked starlings was subsequently seen, no new data were collected on this topic. Relevant data from other studies have been summarised in Table 8.

Table 8. Conclusions on the fidelity of post-breeding starlings to a roost and/or a feeding site, or a flock.

Conclusion	Method	Comment	Location	Season	Reference
faithful to roost	-	no data or reference given.	-	-	Jumber (1956)
	banding	based on 9 retraps from 9284 birds (Ø.Ø1% retrap rate) within 5Ø km of roost.	Pennsylvania USA	winter	Fankhauser (1966)
faithful to roost & general feeding site	radio-track.	8 radiotracked birds from a roost of 8ØØØ starlings returned to the 16 ha roost, but not always to the same part. Mean radius of daily feeding area = Ø.8 km. Mean dist. between feeding areas on subsequent days = 4.8 km.	Oregon USA	winter	Bray et al. (1975)
not faithful to roost	banding	169 retraps from 1872 birds (9% retrap rate) at the roost.	Michigan USA	winter	Thompson & Coutlee (1963)
	radio-track.+ leg tags	estimated 30% nightly turnover of starlings at roost over 8 nights.	USA	winter	Heisterberg et al. (1984)
faithful to roost flock but not to a site	observ. at dusk	diff. locations used on consec. nights (Ø.6-2.Ø km apart). Did not follow indiv. birds so inconclusive	Edinburgh Scotland	winter	Brodie (1976)
faithful to a feeding site or general feeding area	-	no data or reference given.	-	-	Wynne-Edwards (1929)
	'Saflag' wing tags	95% of sightings of indiv. marked birds were <4ØØ m from trapping site.	Norfolk England	winter	Feare (198Ø)
	radio-track.	birds more faithful to 'diurnal activity centres' than to roosts	New Jersey USA	summer-autumn	Morrison & Caccamise (1985)

From the above studies, it would appear that starlings in post-breeding flocks return each day to a general feeding area, of varying size, and that they are not always faithful to a roost site. The most reliable work has been done by radio-tracking (Bray et al. 1975; Morrison & Caccamise 1985), or by individually colour-tagging (Feare 1980), or by both (Heisterberg et al. 1984).

3.5 Survey techniques

Starlings were observed to be very reluctant to go into funnel traps and to shy away from mist nets. It was difficult to find locations suitable for mass trapping, especially at feeding sites as these tend to be out in open areas. Starlings were also very easily dissuaded from using a roost by any human activity: pruning roost plants, presence of nets (furled or unfurled) or of observers at dusk. Birds were very readily disturbed by observers at night, even at a suburban roost where no trapping had been done.

Grain-based baits were not successful in attracting starlings into traps.

Spraying the tail feathers with enamel paint clogged the pinnae and could therefore impair the bird's ability to fly. This, along with increased conspicuousness could render the bird more vulnerable to predation.

Appendix 4 is a list of references on trapping, tracking and marking techniques, plus papers detailing successful techniques in their methods section.

4 Discussion

4.1 Distribution and abundance

Local observers commented that the large post-breeding flocks typical of late summer through to winter had not formed during the survey period, February to June 1989 (M. Clayton, C. Davey, V. Kowalski and D. Purchase pers. comm.). The unusually wet and mild autumn may have contributed to this by ensuring a readily available supply of soil and above ground invertebrates, forced to the surface by flooding, for starlings to feed on. Hamilton & Gilbert (1969) recorded that flooding increased food availability for starlings in California. As sharing of knowledge on food sources is the main reason suggested for the formation of communal roosts (Hamilton & Gilbert 1969; Feare 1984; Morrison and Caccamise 1985), the abundance of food during the survey period may have delayed flock formation, or have discouraged the formation flocks as large as some of those recorded over the previous decade (Tables 1-3).

It would be useful to collect comparable data on feeding and roosting flocks in subsequent years. Such data would be more useful if the study area were systematically searched so that areas not frequented by starlings were also recorded.

During the drought of the late 197Ø's and early 198Ø's the starling population may have formed larger feeding and roosting flocks to exploit the available food resources, and more birds may have fed in the urban area because of drought induced food shortages in rural areas. These factors may explain the higher numbers of starlings recorded in the Garden Bird Survey during this period. Annual nationwide censuses conducted by the British Trust for Ornithology indicated that the populations of most breeding birds were more or less stable, despite some fluctuations (Flegg 198Ø). The starling population here could therefore be expected to vary with fluctuating food availability, within the limits set by the present carrying capacity of the study area. Further clearing of forest for agriculture or other purposes would increase this carrying capacity. In the US a 19.4% increase in the starling population was noted over the decade 1966-76, and was attributed to land use changes favourable to starlings (Dolbeer & Stehn 1979).

4.1.1 Distribution of feeding flocks

The larger number of feeding flocks recorded in rural areas and their much larger size agrees with the observation of Goodwin (1978) that even starlings which roosted in towns in England preferred to feed out in the country, rather than in town. Given the smaller amount of time spent by observers in rural areas, the number of rural flocks could have been under-recorded.

There are extensive areas of suitable starling feeding habitat in rural and urban ACT: cleared farming land, urban grasslands and lawns provide the soil and ground invertebrates most favoured by starlings. The drying out of the ground in summer, which diminishes the availability of these organisms, usually coincides with the ripening of fruit and grain crops. Food intended for pets and livestock is a more or less constant food source for starlings, along with the 'wet garbage' at the major tips, and ?invertebrates at the sewage treatment works.

The distribution of feeding flocks of starlings in the study area is determined by the occurrence of suitable habitat. The extensive amount of such ideal feeding habitat is one reason that starlings are so successful in the Canberra region.

4.1.2 Distribution of roosting flocks

The smaller number of records of rural roosts may reflect lack of rural observers, or that starlings prefer to roost in town. Murton (1971) considered that towns were favoured for roosts because of the generally higher temperatures and greater protection from predators.

The roosts were very small compared to northern hemisphere roosts recorded to hold up to 2 million birds (see appendix 2).

The preference for roosting in plants, rather than buildings, and in certain species of plants, suggests that the establishment of new roosts may be minimised by not planting those species favoured by starlings (Table 3).

Suburban roosts tended to be small and numerous. The presence of just under 2 starlings per hectare, using small suburban roosts, may be a reflection of the milder autumn-winter weather in 1989. The main advantage of flocking is the sharing of information about food sources (Feare 1984), and as there was abundant food available during the study, more birds may have stayed in smaller flocks than would have in harsher years. As there are no earlier data to compare, it is not possible to know how many smaller roosts there have been in past years. As no attempt was made to estimate the total number of birds using major and minor roosts on the same night, no comparison of roost preference is possible.

It seems that starlings may prefer to roost in trees, where there is a choice. Macpherson (1928 in Marples 1934) considered that it was their increasing population which pushed starlings into roosting in buildings. That they roost in trees until the leaves fall in London (Goodwin 1978) could be seen as evidence for this. The only roost so far found in a building in the study area (Parkwood Eggs) has the extra attraction of freely available high-protein food, and water, as well as warmth and shelter. Starlings at Parkwood Eggs are roosting in the warm current of air from the air-conditioning system, a situation favoured by flocks elsewhere (Kalmbach 1932).

Perhaps the birds introduced into Australia were continental European migrants to England, as such birds are recorded still to prefer roosting in trees, even when wintering in England (Thompson & Coutlee 1963).

4.2 Dispersal

Daily dispersal distance was recorded in California to increase with the size of the roost (Hamilton & Gilbert 1969). As the winter roost which Hamilton and Gilbert were observing held up to 2 million birds which dispersed up to 80 km from the roost each day, birds from the much smaller roosts in the study area could be expected to disperse shorter distances than this.

ACT banding recoveries indicated that starlings in the study area do not disperse widely from year to year and season to season, and it could be assumed that the daily dispersal distance would not be any greater than the longer term dispersal distances revealed by banding recoveries (median distance 2 km) (Table 7).

Variation in daily dispersal distance (Table 6), and in home range size, may relect differring climates and food availability.

4.3 Fidelity to a location and/or to a flock

As with the above disparity in daily dispersal distances, the varying conclusions presented in Table 8 on the fidelity of starlings to a location and/or to a flock may indicate that there are regional behavioural differences, perhaps triggered by food availability. Migratory and non-migratory sectors of the population might behave differently (Kessell 1957; Potts 1967).

Different survey techniques may produce different results too (section 4.4).

4.4 Survey techniques

The ease with which birds are temporarily frightened away from roosting sites by the presence of people, or by trapping activities, suggests that it may be very difficult to obtain accurate data on fidelity to a roost site. Lack of retraps at the original trapping/netting site may reflect the wariness of the birds rather than lack of fidelity to the site.

The same argument may apply to trapping at a feeding site, but it is interesting to note that none of the studies examined attempted to trap starlings at a feeding site. This is presumably because of the difficulty of finding suitable trapping sites in the open areas where the birds typically feed.

5 Management Options

5.1 Reducing the food supply

Food is often the factor limiting the further increase of a bird population (Lack 1966), so reducing the food supply in the study area should lower its carrying capacity. Putting extra pressure on the population at the time of year when high quality food (i.e. soil and ground invertebrates) is most difficult to obtain, (summer and autumn), would be the most effective way to decrease the population.

Ways to reduce the summer-autumn food supply:
i) less watering and mowing of public and private grasslands and lawns, to diminish populations of soil invertebrates;
ii) dumping of food wastes at the tips at night, and/or liming the surface layer;
iii) encouraging the hygienic (i.e. not accessible to vertebrates) composting of food scraps;
iv) excluding birds from areas where stock and poultry are fed.

The implementation of these measures is recommended as they would act to reduce populations of starlings and other vertebrate pests (e.g. rodents, Silver Gulls and House Sparrows), and the last one is an excellent method for minimising the impact of starlings in particular areas.

However, the basic problem is that over the last 100 years, European settlement has extended the area of woodland and grassland habitat suitable for starlings, especially in rural parts of the study area, and this is where the largest flocks appear to be feeding (section 3.2.1). In South Africa, the spread of starlings into rural areas followed the construction of European dwellings (Long 1981), and may have coincided with changes to the vegetation similar to those which occurred here. In the study area, unless the woodland and grassland are converted to forest, and this is impracticable, no major impact will be made on the starling population.

So although reducing the food supply could decrease starling numbers, no major population reduction could be expected.

5.2 Parkwood Eggs

The starlings in the sheds at Parkwood Eggs are seen as a pest because they take food intended for the hens, and, probably more importantly, because they may carry disease to and/or from the hens.

There are at least two ways to respond to this:
i) to try to scare away or kill the starlings, or
ii) to prevent their access to the sheds.

The first is not recommended because it does not work. Starlings are very wary birds, capable of deserting a roost for the duration of attempted trapping, and so killing all of the birds in one location may not be possible. Scaring is effective in the short term, but is not a permanent solution. Even if it were possible to kill all of the birds in one location, replacements would be expected to come in from elsewhere, because there is movement of starlings between different feeding and roosting sites (section 3.4)

Feare et al. (1981) killed 50% (n=449) of the starlings feeding at a diary farm in Norfolk UK over a 3 day period, using alphachloralose 1% and quinalbarbitone sodium 0.5%. (Most birds were found alive and then killed.) Within a week the local population was back to its original level.

The second approach, to make the sheds inacessible to starlings, would achieve the desired result of preventing the damage they cause. It would be expensive, and to ascertain whether it would be worth doing, a cost-benefit analysis should be done at sites such as Parkwood Eggs by the relevant industries comparing the costs of killing and replacing infected and exposed stock, plus loss of production, with the cost of damage evasion tactics, such as effective bird-proofing.

It is recommended that building regulations in all states be amended to ensure that commercial poultry businesses such as Parkwood Eggs have buildings which are inaccessible to other animals, especially birds and rodents, which have been implicated in the spread of avian disease. Pressure should also be brought to bear on insurance companies not to insure against avian transmitted disease, when the species implicated in transmitting the disease is/are not effectively kept out.

5.3 The Garema Place roost

Starlings roost in the Plane Trees in Garema Place in large flocks from late summer to early winter. They are seen as a pest because of the odour and mess from their faeces, and their possible role in transmitting disease to people.

Possible courses of action are:
i) regular daily cleaning of pavements when the large flocks are roosting there;
ii) lopping or removing the Plane Trees in Garema Place may appear to be a way of removing starlings from the area, but the most likely result of this would be the establishment of another roost in nearby Plane Trees, or in nearby buildings where the droppings would be much more difficult, and hence expensive, to clean up;
iii) moving the roost: Laguesse (1986) suggested designing and constructing an alternative roost site on one of the flight lines to an existing problem roost, and then encouraging the birds to transfer to the new site (by judicious frightening). If unpleasantness (of faeces) were the only problem caused by starlings, this potential solution may be worth trying. But if a more important problem is the spread of human diseases, then simply moving a problem roost may not help;
iv) controlling the population by scaring or killing: attempts to reduce the population, by frightening or attempting to kill part or all of the population, do not work with starlings because other individuals come in and replace the original birds (section 5.2). Even if it were possible to kill more than 50% of the birds each year, which is the proportion necessary if human inflicted mortality is to exceed natural mortality, the economic and ecological costs could be high (Murton 1971).

As with the Parkwood Eggs site, it is recommended that a realistic cost-benefit analysis of any suggested solutions should be done to avoid wasting public money. The only workable solutions will be those aimed at reducing the impact of the

birds, rather than reducing their numbers.

5.4 Future survey work

5.4.1 Trapping, tracking and marking methods

If accurate movement data on starlings in the study area is required for future management of this species, the use of radio-tracking is recommended, as only individual, observable, marking provides reliable information on dispersal distances and on fidelity to locations and/or flocks. It could be useful to colour mark birds being radio-tracked. Plastic leg-streamers (Guarino & Woronecki 1967) or plastic wing tags (Hester 1963; Parry 1967; Peach & Fowler 1989) may be more suitable than painting the tail feathers, for short term colour-marking.

Radar is not recommended as a method for ascertaining movement data because it does not permit the identification of individual birds within the flock. A limitation on its use in following flocks is that the thinning ranks of dispersing birds may be lost from the radar screen before the birds have stopped flying, and their total distance travelled underestimated (Hamilton & Gilbert 1969).

General observation of movements of flocks (e.g. Brodie (1976) who observed from vantage points) can not provide precise movement data, because of the difficulty of assessing the activities of individual birds.

Mass trapping, banding and re-trapping is not recommended as a method, even if roosting or feeding locations suitable for mass trapping were found, for the following reasons:
i) banding recovery rates are notoriously low (Table 8);
ii) birds are easily scared away from a trapping site (Kalmbach 1932; Thompson & Coutlee 1963; Green 1965; pers. obs.), and this may distort any data collected (i.e. are birds unfaithful to a site, or are they being scared away by the presence and/or activities of trappers?).

If mass banding is still preferred, setting up a permanent feeding station where traps could safely be left, in a location already frequented by feeding flocks, is suggested. An open area on the periphery of Canberra, on a flight line from a roost to a rural feeding area, would be likely to attract starlings.

Trapping at roosts may be a better way of mass trapping. Green's (1965) success in plucking birds off a roost in Oatlands, Tasmania, was because a 'natural trap' had been created by the roof of an old building. Thompson & Coutlee (1963) took nearly 2 000 starlings from a tower roost in Detroit, and Kalmbach (1932) caught 4 500 starlings in church tower roosts. All of these sites had in common being dark, so that trappers were not silhouetted and therefore visible to the birds. No such site has yet been found in the study area.

For any projects requiring the capture of small numbers of birds (e.g. for radio-tracking), the use of nest traps (nest boxes with spring-loaded doors (Johnson & Glahn 1983; Kessell 1957)), or of funnel traps placed where starlings are already accustomed to feed, are recommended.

Starlings are difficult to trap in large numbers, and in any future work involving mass trapping, it is recommended that greater resources (people and equipment) be made available than were allocated to the present study.

5.4.2 Baits

To attract starlings into funnel traps, a bait containing meat or fat in any form (Coleman 1977; Goodwin 1978) is recommended. Devon sausage mashed with spaghetti is usually an effective bait (V. Kowalski pers. comm.) Open compost heaps with good populations of soil invertebrates are good sites for tunnel traps.

6 Conclusions

i) Distribution

The largest feeding flocks were in rural areas, feeding on food scraps at the garbage tips, or out in open paddocks. The largest flocks, of 2 ØØØ birds, were observed at the Belconnen Tip and at 'Braeside', 5 km north-east of Hall. Smaller flocks, of fewer than 1ØØ birds, were seen feeding on fruit crops (section 3.2.1), and were observed flying from outer suburbs to open paddocks to feed (section 3.3).

One of the reasons for flocking is that information on food sources is shared, and the largest flocks are formed when food is scarce. The unusually mild and wet autumn would have ensured adequate food for starlings, and this may account for the lack of large flocks during the survey (section 4.1).

The study area contains extensive areas of ideal starling feeding habitat (section 4.1.1). Therefore it would be unrealistic to expect to be able to diminish the population significantly, although various measures are suggested which would limit numbers slightly (section 5.1).

The largest roosting flocks were in urban areas, roosting in densely foliaged (usually introduced) plants. The largest flock, of 2 5ØØ birds was in Kambah (section 3.2.2). Only one roost was found in a building rather than a plant: at Parkwood Eggs, where food, water and warmth are available. Minor roosts surveyed in 6 suburbs accounted for just under 2 birds per hectare (section 3.2.3).

The largest feeding and roosting flocks recorded during the survey were smaller than the largest ones recorded over the last decade in Canberra (sections 3.2.1-2), and considerably smaller than some northern hemisphere roosts of up to 2 million birds (appendix 2).

ii) Movements

Estimates made in other studies of daily dispersal distance from roost to feeding area varied from 4 to 8Ø km. Estimates of home range size varied from 33 km^2 to 49 km^2 (section 3.3.1). Daily dispersal distance was recorded to increase with the size of the roost (section 4.2). ACT banding recoveries indicated that starlings travelled 2 km from the banding site, and that the elapsed time was 3 months (median values) (section3.3.2).

iii) Fidelity to a location and/or a flock

Northern hemisphere data on the fidelity of a flock to a location and/or to a flock indicated that starlings returned to the same general feeding area each day, but that they were not always faithful to a roost site (section 3.4).

Lack of retraps at a trapping site should be interpreted with caution, as they may reflect the wariness of the birds rather than lack of fidelity to that site (section 4.4).

Variations in both daily dispersal distance, and in fidelity of birds to a location and/or to a flock, may reflect different climates and food availability (sections 4.2-4.3).

7 Effectiveness of the project

The effectiveness of the project is evaluated in terms of its four aims:

i) Location and size of the major feeding and roosting flocks

As noted in section 4.1 this could be better addressed in future if the study area were systematically searched, so that areas not frequented by starlings could also be accurately recorded. In the present survey, absence of a record may reflect lack of observers and/or lack of birds. It could be useful also to collect data throughout one year, and also to record smaller flocks, of fewer than 100 birds, to obtain a more accurate picture of how starlings behave.

However, within the constraints of time and funding allowed for this survey, the method used was effective, except that rural flocks may have been under-recorded.

iia) Daily dispersal distance from roost to feeding site

This was not effectively answered because the method employed (mass trapping and colour marking) would only have produced results if hundreds of birds had been marked and some re-sighted the next day. Because starlings are hard to trap en masse, radio-tracking would be a more effective and efficient way to obtain this information. Northern hemisphere research did provide some interesting information, but local birds may behave differently.

iib) Longer term dispersal data from ACT banding recoveries

This was effectively done and could usefully be extended in any future work to include other Australian data.

iii) Fidelity of birds to a location and/or to a flock

See iia above: the same comments apply.

iv) Survey techniques

Although this was not part of the original brief for the project, the need for such information became apparent, and much useful information has been gathered.

The project would have been even more effective had its aims been much more narrowly defined. In any future work, it is recommended that the aims be discussed by all individuals involved so that the exact requirements are known, and so that pertinent survey techniques may be employed and adequate funding allocated.

Further work could be done on fidelity to a location and /or a flock, and on dispersal distance, by radiotracking. However, research into ways of diminishing the impact made by starlings ('damage control') would be of more value than more work based on the premise that this pest species can be managed by controlling its numbers.

8 Appendices

Appendix 1. Food and feeding behaviour

Starlings are predominantly ground-feeding and omnivorous, but their preferred food is invertebrates from the soil surface or just below (Murton 1971; Feare 1984). They search for food by 'open-bill probing' (Beecher 1978). This efficient and effective strategy allows starlings to locate insects, often dormant in grassland in colder months (Feare 1984).

Short-cropped pastures (Dunnett 1956; Bray et al. 1975; Coleman 1977; Emison et al. 1987), and mown grass (Morrison & Caccamise 1985) are ideal feeding areas for starlings as the birds are able to see prey items readily, and also to watch for predators. When populations of soil invertebrates diminish, or are less accessible as the ground dries out in the summer and autumn, (Dunnett 1956), starlings, especially juveniles, will feed on fruits (Brown 1974; Tahon 1978) and seeds (Morrison & Caccamise 1985). Rubbish dumps and sewage treatment works are also frequented, especially in very cold weather (Taitt 1973; Laguesse 1986).

Starlings prefer food containing fat or meat in any form (Goodwin 1978) and are unable to digest large amounts of cellulose (Feare 1984). In his study of the food and feeding behaviour of New Zealand starlings, Coleman (1977) concluded that although omnivorous, they did have distinct dietary preferences and were not generalist feeders. They feed in bouts, which allows time for preening, watching for predators and checking nest hollows (Feare 1984).

In Australia starlings are recorded to have eaten the following: a 10 cm lizard and grasshoppers (Green 1965); beetles and other ground insects, fruit and cutworms; soft fruits, berries, grapes, pasture [invertebrates] (Pizzey 1980). The detailed information on the food of Australian starlings in Barker & Vestjens (in prep.) indicates a strong preference for insects and other small animals (pers. comm. R. Barker).

Advantages of feeding in flocks

Feare (1984) saw the advantages of feeding in flocks to be
i) an increased rate of feeding: the larger the flock, the less time each individual has to spend watching for predators;
ii) predator swamping: it is harder for a predator to pick on one bird out of a large flock than on a single bird;
iii) feeding by 'local enhancement': birds flying over respond to a feeding starling and fly down to share in the food. Localised and transient patches of food may thereby be exploited (Morrison & Caccamise 1985).

Appendix 2. Roosts and roosting behaviour

The gregariousness of starlings is most apparent in the large roosting flocks formed at the end of the breeding season, from late summer through to winter. The largest recorded Australian starling roosts are of 25 ØØØ birds on a Hobart bridge (Blakers et al. 1984) and of 5Ø ØØØ birds at Riverside on the Tamar River in Tasmania (Liddy 1968). Roosts of up to 2 million starlings have been recorded in the northern hemisphere (Hamilton & Gilbert 1969; Bray et al. 1975; Peach & Fowler 1989).

Pre-roost assemblages are made up of smaller flocks which join forces before converging on the nocturnal roost. Pre-roost sites may come to be used as roost sites and birds may depart from the same pre-roost site for two different nocturnal roosts (Clergeau 1983).

The ability of starlings to adapt to urban living is illustrated by two behavioural changes adopted within the last 15Ø years: i) from roosting only in rural areas to also using urban sites, and ii) from using only plants to also using buildings and other structures.

The first urban roosts were in Dublin, in 184Ø (Feare 1984) and London, in 1894 (Fitter 1943 in Delvingt 1959). In the early 19ØØ's they were recorded in the USA (Kalmbach 1932), Belgium and France, but have remained relatively uncommon in continental Europe (Feare 1984). Urban roosts in Britain contained mainly resident birds, and rural roosts mainly migrants from continental Europe (Potts 1967). The generally higher temperatures in towns and the greater protection afforded from nocturnal predators are explanations suggested for this change.

Buildings were first used for roosting in 1913 in London (Parker 1941 in Delvingt 1959) and in 1922-23 in New York (Kalmbach 1932). North American and British birds came to prefer to roost in buildings (Murton 1971), whereas continental European birds continued to prefer trees and vines, even when wintering in England (Thompson & Coutlee 1963).

The same roosting site may be re-occupied year after year: a reedbed roost in Devon had been in use for 185 years (Feare 1984). Of 247 roosts surveyed by Marples (1934) in Britain, 1Ø7 had been in use for more than 1Ø years and 19 for more than 4Ø years. A Pennsylvanian roost investigated by Jumber (1956) had been in use for 15 years.

Advantages of communal roosting

Information on new food sources is made available to other starlings through the use of communal roosts, and was the most important reason for this behaviour (Hamilton & Gilbert 1969; Feare 1984; Morrison & Caccamise 1985). Reduction of nocturnal predation (Feare 1984; Morrison & Caccamise 1985) and protection from wind (Feare 1984) are pertinent, but less important.

Appendix 3a. Data card

C.O.G. STARLING PROJECT DATA CARD

OBSERVER:.....´PHONE NO. (a.h.):.....

DATE(S):.....TIME:.....

COLOUR-MARKED BIRDS:.....FLOCK SIZE.....

LOCATION, OR DIRECTION OF FLIGHT:

FEEDING.....
.....
FLYING.....
.....
PRE-ROOSTING.....
.....
ROOSTING.....
.....

REMARKS:.....

Appendix 3b. Explanatory sheet given to observers

CANBERRA ORNITHOLOGISTS GROUP STARLING PROJECT

The aim of this project is to record the main feeding and roosting sites of the introduced Common Starling, Sturnus vulgaris, and the movements of birds between these sites, in the open northern and eastern parts of the A.C.T.. It will run from February until July 1989.

As part of this project, I am planning to trap and colour mark 1ØØ or more birds at three or four main feeding sites, and I seek the assistance of C.O.G. members to :

1) help with trapping and colour marking;
2) collect data on flock size, direction of flight, and feeding and roosting sites of marked and unmarked birds.

DATA CARDS.

Please send in records of any colour marked birds, and/ or of flocks of more than 1ØØ starlings. The following notes are intended to explain the filling in of data cards.

Observer: please print name
Telephone no.: please include an 'after hours' number
Date(s): write month e.g. 2 Mar.
Time: 24 hour notation is preferred.
Colour-marked birds: e.g. 1 yellow
Flock size: PLEASE SEND IN DATA CARDS ONLY FOR FLOCKS OF MORE THAN 1ØØ STARLINGS, OR FOR COLOUR-MARKED BIRDS REGARDLESS OF FLOCK SIZE.
Location and/or direction of flight: Insert details alongside relevant action(s):
Feeding: e.g. O'Connor Oval
Flying: e.g.'Towards Gungahlin', or 'N' for direction of flight.
Pre-roosting: This refers to the gradual build-up of numbers at a preliminary roosting site, prior to moving to another roost for the night. e.g. M.L.C. Building.
Roosting: Refers to a nightlong roost. e.g. Garema Place.
Remarks: any extra information deemed relevant to flocking or to movements.

If the same flock is seen feeding and in flight, use one data card. Conversely, for different flocks, use separate cards.

If identical information is collected on more than one day, indicate this on the 'date(s)' and/or 'remarks' lines.

RETURNING DATA CARDS.

As it is important for me to have your data quickly, please mail cards within a fortnight of the observation, or, if a C.O.G. meeting intervenes, bring them to a meeting. Cards may also be delivered to one of the listed addresses.

Any help which you may be able to give, trapping and colour marking, and/or data recording, will be most appreciated. I may be contacted by 'phone on 375155 (before 8 a.m. is a likely time), or you may leave a message with Robyn McCulloch on 512ØØ3.

Isobel Crawford
Co-ordinator
Feb. 1989.

Appendix 4. Bibliography of Starling Survey Techniques

Eastwood, E., Isted, G. A., and Rider, G. C. (1962). Radar ring angels and the roosting behaviour of starlings. Proc. R. Soc. Lond. B Biol. Sec. 156, 242-267. (note caveat from Hamilton & Gilbert (1969) on limitations of method)

Ennion, E. (1959). The House on the Shore: the Story of Monks' House Bird Observatory. (Routledge & Kegan Paul: London).

Green, R. H. (1965). Mass banding of the Common Starling. Aust. Bird Bander 3, 27-31.

Guarino, J. L. (1968). Evaluation of a coloured leg tag for starlings and blackbirds. Bird-Banding 39, 6-13.

Guarino, J. L., and Woronecki, P. P. (1967). Color marking to trace Blackbird and Starling movements. West. Bird Bander 42, 26-27.

Heisterberg, J. F., Knittle, C. E., Bray, O. E., Mott, D. F., and Besser, J. F. (1984). Movements of radio-instrumented blackbirds and European starlings among winter roosts. J. Wildl. Manage. 48, 203-9.

Hester, A. E. (1963). A plastic wing tag for individual marking of passerine birds. Bird-Banding 34, 213-17.

Hollom, P. A. D. and Brownlow, H. G. (1968). Trapping methods for Ringers. BTO Field Guide no. 1. (Brit. Trust for Ornithology: London).

Johnson, R. J. and Glahn, J. F. (1983). Starlings. in Prevention and Control of Wildlife Damage. (ed. Timm, R. M.) pp.E53-65. (Dep. For. Fish. Wildl., Uni. Nebraska: Lincoln, Nebr.).

Kessell, B. (1957). Study of the breeding biology of the European Starling (Sturnus vulgaris L.) in North America. Am. Midl. Nat. 58, 257-331.

Laguesse, M. (1986). Déplacements journaliers des étourneaux (Sturnus vulgaris L.) entre les dortoirs urbains et les gagnages ruraux en région liègeoise. Alauda 54, 81-99.

Liddy, J. (1968). An analysis of recoveries from starlings banded at Riverside, Tasmania. Aust. Bird Bander 6, 27-34.

McClure, H. E. (1984). Bird Banding. (Boxwood Pr.: Pacific Grove, Ca.).

Marion, W. R. and Shamis, J. D. (1977). An annotated bibliography of bird-marking techniques. Bird-Banding 48, 42-61.

Mitchell, R. T. (1963). The floodlight trap/ a device for capturing large numbers of blackbirds and starlings at roosts. US Fish Wildl. Serv. Spec. Sci. Rep. - Wildlife no. 77.

Parry, V. A. (1967). The patagial method for tagging birds. Aust. Bird Bander 5, 73.

Peach, W. J. and Fowler, J. A. (1989). Movements of wing-tagged Starlings Sturnus vulgaris from an urban communal roost in winter. Bird Study 36, 16-22.

Richison, G. (1984). A new marking technique for birds. N. Am. Bird Bander 9, 4.

Ricklefs, R. E. (1973). Tatooing nestlings for individual recognition. Bird-Banding 44, 63.

Rowley, I. (1964). Use and limitations of colour bands. Aust. Bird Bander 2, 69-78.

Underhill, L. G. and Underhill, G. D. (1987). The zap net: an elastic-propelled variation of the cannon net. Safring News 16, 21.

9 References

Bamford, R. (1978). Early introduction of birds to Victoria. Aust. Bird Watcher 7, 237-48.

Barker, R. D. and Vestjens, W. J. M. (in prep.). The Food of Australian Birds. Pt II Passerines. (CSIRO: Melbourne).

Beecher, W. J. (1978). Feeding adaptations and evolution in the starlings. Bull. Chic. Acad. Sci. 11, 269-98.

Blakers, M., Davies, S. J. J. F., and Reilly, P. N. (1984). The Atlas of Australian Birds. pp.608, 669. (MUP: Melbourne).

Bray, O. E., Larsen, K. H., and Mott, D. F. (1975). Winter movements and activities of radio-equipped starlings. J. Wildl. Manage. 39, 795-801.

Brodie, J. (1976). Flight behaviour of Starlings at a winter roost. Br. Birds 69, 51-60.

Brown, R. G. B. (1974). Bird damage to fruit crops in the Niagara Peninsula. Can. Wildl. Serv. Rep. Ser. 27, 1-57.

Canberra Ornithologists Group. (1981-88) Annual Bird Report 1979/80-1986/87. (published in its Canberra Bird Notes).

Chisholm, E. C. (1926). Birds introduced into New South Wales. Emu 25, 276-79.

Clergeau, P. (1983). Quelques aspects des comportements hiverneaux des étourneaux rejoignant leurs dortoirs nocturnes. Alauda 51, 124-147.

Coleman, J. D. (1977). Foods and feeding of starlings in Canterbury. Proc. N.Z. Ecol. Soc. 24, 94-109.

Delvingt, W. (1959). Sur l'origine des dortoirs urbains d'Etourneaux sansonnets, Sturnus vulgaris Linné. Bull. Inst. Agron. Stn Rech. Gembloux 27, 412-17.

Dolbeer, R. A. and Stehn, R. A. (19779). Population trends of blackbirds and starlings in North America, 1966-76. US Fish. Wildl. Serv. Spec. Sci. Rep. - Wildlife no. 214.

Dunnet, G. M. (1956). The autumn and winter mortality of starlings, Sturnus vulgaris, in relation to their food supply. Ibis 98, 220-30.

Eastwood, E., Isted, G. A., and Rider, G. C. (1962). Radar ring angels and the roosting behaviour of starlings. Proc. R. Soc. Lond. B Biol Sec. 156, 242-267.

Emison, W. B., Beardsell, C. M., Norman, F. I., and Loyn, R. H. (1987). Atlas of Victorian Birds. (Dept of CFL and RAOU: Melbourne).

Fankhauser, D. P. (1966). Movements of starlings in relation to a roost near Hanover, Pennsylvania. Bird-Banding 37, 200-3.

Feare, C. J. (1980). Local movements of starlings in winter. Int. Ornithol. Cong. Acta XVII, 1331-6.

Feare, C. J. (1984). The Starling. (OUP: Oxford).

Feare, C. J., Isaacson, A. J., Shepphard, P. A., and Hogan, J. M. (1981). Attempts to reduce starling damage at dairy farms. Prot. Ecol. 3, 173-181.

Flegg, J. J. M. (1980). Biological factors affecting control strategy. in Bird Problems in Agriculture. (eds Wright, E. N. and Inglis, I. R.) pp. 7-19. (Brit. Crop Prot. Council:London).

Goodwin, D. (1978). Birds of Man's World. (Uni. Qld Pr. and BMNH: St. Lucia).

Green, R. H. (1965). Mass banding of the Common Starling. Aust. Bird Bander 3, 27-31.

Guarino, J. L., and Woronecki, P. P. (1967). Color marking to trace Blackbird and Starling movements. West. Bird Bander 42, 26-27.

Hamiltom, W. J., and Gilbert, W. M. (1969). Starling dispersal from a winter roost. Ecology 50, 886-98.

Heisterberg, J. F., Knittle, C. E., Bray, O. E., Mott, D. F., and Besser, J. F. (1984). Movements of radio-instrumented blackbirds and European starlings among winter roosts. J. Wildl. Manage. 48, 203-9.
Hester, A. E. (1963). A plastic wing tag for individual marking of passerine birds. Bird-Banding 34, 213-17.
Johnson, R. J. and Glahn, J. F. (1983). Starlings. in Prevention and Control of Wildlife Damage. (ed. Timm, R. M.) pp. E53-65. (Dep. For. Fish. Wildl., Uni. Nebraska: Lincoln, Nebr.).
Jumber, J. F. (1956). Roosting behavior of the starling in central Pennsylvania. Auk 73, 411-26.
Kalmbach, E. R. (1932). Winter starling roosts of Washington. Wilson Bull. 44, 65-74.
Kentish, B., and Peace, H. (1987). Nest Record Scheme: where, when and what are the starlings doing in Australia? RAOU Newsl. 73, 7-9.
Kessell, B. (1957). Study of the breeding biology of the European Starling (Sturnus vulgaris L.) in North America. Am. Midl. Nat. 58, 257-331.
Lack, D. (1966). Population Studies of Birds. (OUP: Oxford).
Laguesse, M. (1986). Déplacements journaliers des étourneaux (Sturnus vulgaris L.) entre les dortoirs urbains et les gagnages ruraux en région liègeoise. Alauda 54, 81-99.
Liddy, J. (1968). An analysis of recoveries from starlings banded at Riverside, Tasmania. Aust. Bird Bander 6, 27-34.
Long, J. L. (1981). Introduced Birds of the World. (Reed: Sydney).
Marples, B. J. (1934). The winter starling roosts of Great Britain, 1932-1933. J. Anim. Ecol. 3, 187-203.
Morrison, D. W., and Caccamise, D. F. (1985). Ephemeral roosts and stable patches? A radiotelemetry study of communally roosting starlings. Auk 102, 793-804.
Murton, R. K. (1971). Man and Birds. (Collins: London).
Parry, V. A. (1967). The patagial method for taging birds. Aust. Bird Bander 5, 73.
Peach, W. J. and Fowler, J. A. (1989). Movements of wing-tagged Starlings Sturnus vulgaris from an urban communal roost in winter. Bird Study 36, 16-22.
Peters, J. L. (1962) Checklist of Birds of the World. 15, 107-8. (Museum of Comparative Zoology: Cambridge, Mass.).
Pizzey, G. (1980). A Field Guide to the Birds of Australia. (Collins: Sydney).
Potts, G. R. (1967). Urban Starling roosts in the British Isles. Bird Study 14, 35-42.
Roots, C. (1976). Animal Invaders. (David & Charles: Newton Abbot).
Summers, R. W., Pritchard, G. C., and Brookes, H. B. L. (1983). The possible role of starlings in the spread of TGE in pigs. Proc. Bird Control Semin. 9, 301-6.
Tahon, J. (1978). L'Etourneau sansonnet (Sturnus vulgaris). Biologie, dortoirs, protection des cultures. E.P.P.O. (Eur. Mediterr. Plant Prot. Organ.)Publ. Ser. B, no. 84, 83-153.
Tahon, J. (1980). Attempts to control starlings at roosts using explosives. in Bird Problems in Agriculture, (eds Wright, E. N., and Inglis, I. R.) pp. 56-68. (Brit. Crop Prot. Council: London).
Taitt, M. J. (1973). Winter food and feeding requirements of the Starling. Bird Study 20, 226-36.
Tate, A. (1987). When starlings come home to roost. New Sci. 114, 71.
Taylor, I. (1983). Annual bird report: 1 July 1981 to 30 June 1982. Canberra Bird Notes 8, 5-11.

Thompson, W. L., and Coutlee, E. L. (1963). Biology and population structure of starlings at an urban roost. Wilson Bull. 75, 358-72.
Weber, W. J. (1979). Health Hazards from Pigeons, Starlings and English Sparrows. (Thompson: Fresno, Ca.).
Wiens, J. A. and Johnston, R. F. (1977). Adaptive correlates of granivory in birds. in Granivorous Birds in Ecosystems. (eds Pinowski, J. and Kendeigh, S. C.) pp. 301-40. IBP Programme 12. (CUP: Cambridge).
Wynne-Edwards, V. C. (1929) The behaviour of starlings in winter: an investigation of the diurnal movements and social roosting-habit. Br. Birds 23, 138-53, 170-80.