

MOVEMENT PATTERNS OF GREAT, INTERMEDIATE AND LITTLE EGRETS FROM AUSTRALIAN BREEDING COLONIES

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The current state of knowledge about the movements of Great, Intermediate and Little Egrets from Australian breeding colonies is reviewed using published work, data provided by the Australian Bird and Bat Banding Scheme and the records of Project Egret Watch at the Shortland Wetlands Centre. The limited data available suggest that the three egret species undertake movements to all points of the compass but that inland birds tend to move north towards Queensland and New Guinea. Data from the coastal colonies in New South Wales indicate that fledglings disperse to foraging and night roosting locations on the floodplain where the colony is situated, before embarking on long-distance migration. Long-distance movements (up to 3 000 km) soon after fledging have been recorded from colonies in coastal and inland New South Wales and Western Australia. There is some evidence that a seasonal migration between nesting colonies and wintering locations may take place for at least some birds originating from coastal colonies.

INTRODUCTION

Until recently, little was known about the movements of egrets within Australia. The migratory pattern of the Cattle Egret *Ardeola ibis* throughout south-eastern Australia and to New Zealand, and the mechanisms assisting the migration, are now reasonably well understood (Maddock 1990; Maddock and Bridgman 1992; McKilligan *et al.* 1993; Maddock and Geering 1993, 1994; Bridgman *et al.* 1997). There is, however, little information on the movement of other species of egrets in Australia with references indicating that the movements are 'poorly understood' or 'poorly known' (Marchant and Higgins 1990).

Migratory patterns have been identified for all three egret species in the northern hemisphere. Young Great Egrets *Egretta alba* in northern Europe may be recovered up to 400 km in any direction from their natal heronries in August and September. There is a seasonal migration between September and November from northern Europe to Mediterranean countries, with some birds reaching Africa. Birds return to the nesting colonies from February to April (Voisin 1991). A southward migration has been identified for the species in United States of America and in Asia, from Japan and Korea to the Philippines (Hancock and Kushlan 1984). Little Egrets *E. garzetta* in Europe are regarded as being mainly migratory, but with a substantial part of the population wintering in their breeding range. Migratory routes for this species have been identified from southern France to Spain, to Italy and then southwards to Africa (Voisin 1991). The Intermediate Egret *E. intermedia* in Asia moves from northern Japan to the Philippines in winter, while African movements, some of which may be migratory

(Hancock and Kushlan 1984), appear to depend on local conditions.

In Australia, Marchant and Higgins (1990) refer to the Great Egret as dispersive, with some regular seasonal movements, and as eruptive in New Zealand; and the Intermediate Egret as being sedentary in some areas, but dispersive and perhaps migratory in other areas. Referring to an Intermediate Egret which was banded at Campbell Island New South Wales in 1975 and recovered at Mapur, New Guinea, Mees (1982) stated that this was proof that Australian Intermediate Egrets make long distance movements, but 'whether Australian birds are truly migratory (directed seasonal movements), or the recovery listed is just an example of extreme wandering, is uncertain'.

The Little Egret appears to undertake most of its movements over short distances but the species is dispersive when necessary. Most northern Australian populations apparently move short distances between wet season breeding sites and dry season refuges on the coast (Marchant and Higgins 1990). The Little Egret appears to be a regular visitor to New Zealand during winter (Falla *et al.* 1975; B. Heather, pers. comm.) and to New Guinea (Beehler *et al.* 1986).

The conclusions reached for the movement patterns of egret species in Marchant and Higgins (1990) are based mainly on single recoveries of banded birds and reports of population fluctuations. This paper reviews the current state of knowledge collated from: the results of Project Egret Watch, based at Shortland Wetlands Centre in Newcastle, New South Wales; the work of Halse and Pearson in Western Australia; as well as other published and unpublished reports on

egret movements. The Project Egret Watch data includes some repeated sightings of birds which were individually identifiable by patagial tags.

METHODS

In the 1983–84 breeding season nestling egrets were marked using colour bands at the Shortland colony, Newcastle, New South Wales (32°53'S, 151°42'E). In 1985 patagial tags were fitted to the wings of nestlings at the Shortland colony and a colony at Seaham (32°38'S, 151°43'E), 30 km north of Shortland. Since then marking of nestlings has continued at seven breeding colonies in coastal northern New South Wales: Shortland, Seaham, Boambee (30°20'S, 153°04'E) near Coffs Harbour, Junction Hill (29°38'S, 152°55'E) and Lawrence (29°30'S, 153°06'E) near Grafton, Ballina (28°51'S, 153°32'E), Murwillumbah (28°21'S, 153°25'E); two in inland New South Wales: Bora Channel (30°42'S, 147°31'E) and Wilgara/Sandy Camp (30°55'S, 147°44'E) in the Macquarie Marshes; and four in southern Queensland: Bracken Ridge (27°18'S, 153°02'E) near Brisbane; Skyring Creek (26°22'S, 152°45'E) near Gympie; Ten Mile Lane (24°54'S, 152°12'E) and Bullyard (25°54'S, 152°05'E) near Bundaberg.

Independently, Halse and Pearson tagged a total of 189 Great Egrets at colonies at Corio Swamp (32°33'S, 115°53'E), Australind Nature Reserve (33°18'S, 115°42'E), McCarleys Swamp (33°36'S, 115°30'E) and Needonga Lake (31°24'S, 116°06'E) in Western Australia in 1989 and 1990 (Storey *et al.* 1993).

Networks of observers throughout southern Queensland, New South Wales, Victoria, Tasmania, South Australia, Western Australia and New Zealand reported sightings of marked birds as well as fluctuations in numbers and movements of egret populations. Intensive observations were carried out at and around the breeding colonies and in wintering locations throughout south-eastern Australia and New Zealand.

Recoveries from the banding of 791 Great, 1 432 Intermediate and 416 Little Egrets, obtained from the Australian Bird and Bat Banding Scheme, have been used in conjunction with patagial tag sightings to evaluate the movements of the three egret species. It should be noted that a large proportion of the Australian Bird Banding Scheme data were birds patagial tagged by Project Egret Watch.

RESULTS

A total of 168 Great Egrets, 662 Intermediate Egrets and 76 Little Egrets, (compared with 6 658 Cattle Egrets), were patagial tagged as nestlings during the 1985/86 to 1993/94 breeding seasons in the coastal colonies. An additional 62 Great Egrets, 602 Intermediate Egrets and 10 Little Egrets were tagged in the Macquarie Marshes in 1993/94. A total of 189 Great Egrets were tagged in the Western Australian colonies. Ninety-eight per cent of recoveries of Great Egrets were first year birds as were 87 per cent of Intermediate Egrets and 90 per cent of Little Egret recoveries. Only

four birds of each species have been reported more than once.

Three observers have regularly reported appearances of single, unmarked, Great Egrets in autumn and departures in spring at very specific locations over several years (P. Reilly; G. Soderland; E. Briggs, pers. comm.). One bird, identified by its behaviour of coming to the observer's home to be fed, has repeated this pattern at Point St. Clare (New South Wales) for 15 years (E. Briggs, pers. comm.). A similar pattern of seasonal arrival and departure was reported for Little Egrets on the east coast of Tasmania (N. Tresize, pers. comm.).

Sightings of tagged birds (5 Great Egrets, 10 Intermediate Egrets and 6 Little Egrets) were made in the Hunter River floodplain area up to three months after fledging from the nearby Shortland breeding colony (Table 1). Of egrets which originated in eastern Australia and which were reported at a distance greater than 50 km from the banding place, 18 Great Egrets, were reported from 19 locations; 28 were Intermediate Egrets, reported from 29 locations; and 14 were Little Egrets, reported from 14 locations (Table 2, Figs. 1–3). In Western Australia, 26 Great Egrets were reported from 23 locations (Table 3, Fig. 4) and another tagged bird (tag number not deciphered) was seen in 1991 at Gascoyne Junction, 700 km north of the banding site. The longest recorded movement for each of the three egret species is in excess of 3 000 km for each bird. Each of the egrets was banded in Australia and recovered in Papua New Guinea or Irian Jaya.

The mean distance for movements of more than 50 km by Great Egrets was 273 km ($n = 44$, range = 56–3 333 km, $SD = 491$); for Intermediate Egrets, 1 020 km ($n = 30$, range = 63–3 990 km, $SD = 990.9$); and for Little Egrets, 1 502 km ($n = 14$, range = 52–3028, $SD = 1 298$). There was a significant difference between the mean distance moved by the Great Egret and the Intermediate Egrets ($t = -3.8$, $p < 0.0002$) and the Great Egrets and the Little Egrets ($t = -3.46$, $p < 0.002$) but there was no significant difference between the Intermediate Egrets and the Little Egrets ($t = -1.23$, $p < 0.23$). The mean distance for the longest recovery for all three species was for birds originating from colonies in the Murray-Darling Basin (Table 5).

Recovery data (Tables 2 and 3) indicates that long-distance movement of juveniles from the natal colony can occur soon after fledging, highlighted by the following examples:

- Intermediate Egret at Kurnell, New South Wales, 1 month 11 days after banding at Shortland, New South Wales, a distance of 133 km;
- Great Egret at Cooloonup Lake, Western Australia, 1 month 27 days, McCarley's Swamp, 191 km;
- Great Egret at Port Germain, South Australia, 2 months 1 days, Narrung, South Australia, 297 km;
- Intermediate at Belmore River, New South Wales, 2 months 3 days, Lawrence, New South Wales, 177 km;

TABLE 1

Lower Hunter River floodplain sightings of Great Egrets *Egretta alba*, Intermediate Egrets *E. intermedia* and Little Egrets *E. garzetta* banded at Shortland, New South Wales (32°53'S, 151°42'E).

Banding date	Recovery location	Distance from banding site	Recovery date	Notes
Great Egret				
Jan. '86	Seaham	28 N	Sept. '86	Tag only found
1988/89	Maitland	17 NW	Mar. '89	
1988/89	Tomago	6 N	Apr. '89	
Nov. '89	Maitland	18 NW	Mar. '90	Multiple sightings
1992/93	Kooragang Island	4 E	May '93	Multiple sightings
Nov. '89	Raymond Terrace	15 N	Jan. '91	Multiple sightings
Intermediate Egret				
1985/86	Seaham	28 N	May '86	
1987/88	Maitland	15 N	Mar. '88	
1987/88	Nelsons Plains	15 N	Mar. '88	
Feb. '87	Cedar Hill Drive	8 W	Mar. '88	
Feb. '88	Cedar Hill Drive	8 W	Mar. '88	Multiple sightings
Nov. '88	Maitland	18 NW	Feb.-Mar. '89	Multiple sightings
Dec. '88	Raymond Terrace	15 N	Feb.-Mar. '89	Multiple sightings
Dec. '88	Tarro	8 N	Feb. '89	
1993/94	Seaham	28 N	Mar. '94	
Little Egret				
Jan. '86	Shortland	2 SW	Apr. '86	Multiple sightings #
Nov. '88	Bolwarra	21 NW	Mar.-Apr. '89	Multiple sightings *
Nov. '88	Kooragang Island	4 E	Mar. '89	
	Raymond Terrace	15 N	Apr. '89	**
Dec. '89	Seaham	28 N	Feb. '90	
	Bolwarra	21 NW	Apr. '90	
Dec. '90	Maitland	18 NW	Mar.-Apr. '91	Multiple sightings
	Seaham	28 N	Apr. '91	Killed by fox
Feb. '94	Seaham	28 N	Mar. '94	Killed by fox

#Later found shot. *Seen at Numbaa, NSW; Oct. '89, 240 S. **Seen at Joskleigh, Qld; July '89, 1056 N.

- Intermediate at Landsborough, Queensland, 2 months 3 days, Lawrence, New South Wales, 300 km;
- Little Egret at Newlands, New Zealand, 2 months 11 days, Red Bank Weir in New South Wales, 2 440 km;
- Intermediate near Townsville Queensland, 3 months 1 day, Macquarie Marshes, New South Wales, 1 262 km;
- Intermediate at Alice Springs, Northern Territory, 3 months 12 days, Shortland, New South Wales, 2 015 km.

In eastern Australia, tagged birds of all three species have been found to return to their natal colonies during the breeding season and nesting has been confirmed for five Great, two Intermediate and one Little Egret (Table 4). One Intermediate Egret, tagged in the Macquarie Marshes, was reported back in the vicinity of the breeding colonies in the Marshes in the 1994–95 season one year after tagging (R. Jones, pers. comm.). A tagged Intermediate Egret was observed in the Gingham Channel colony (Gwydir Valley, New South Wales) during the 1995–96 breeding event (W. Johnson, pers. comm.). This bird had been tagged at

the Lawrence colony, near Grafton, New South Wales (350 km east), at least two years previously. In Western Australia, five Great Egrets were recorded breeding at their natal colony at three or four years of age.

DISCUSSION

The number of recoveries of banded or tagged Great, Intermediate and Little Egrets to date is relatively small. Nevertheless, there is sufficient data to present a preliminary picture of the movements of all these species which can form the basis for further research. Movement away from the natal colony can occur soon after fledging for all three egret species (Tables 1 and 2). Maddock and Geering (1994) reported similar rapid dispersal for some juvenile Cattle Egrets although movement after fledging was usually to night roosts centred in foraging areas within the floodplain area surrounding the breeding colony. A further migration usually took place several months after fledging (Maddock and Geering 1994). Adult Cattle Egrets show the same general pattern of migrations. Some Cattle Egrets, however, used the local floodplain as a permanent winter range, without further migration.

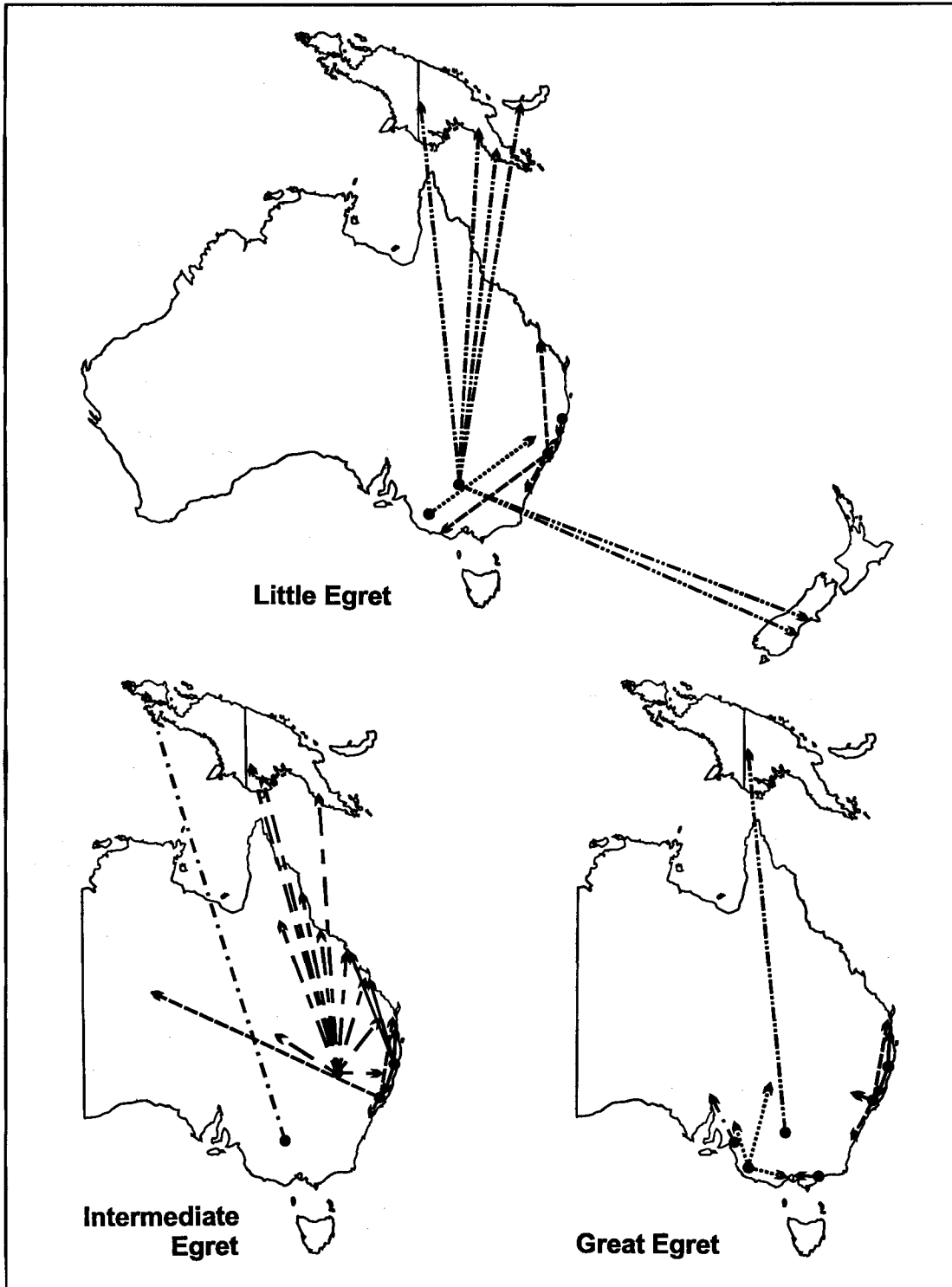


Figure 1. Movements of Great, Intermediate and Little Egrets from location of banding/tagging site at Eastern Australian breeding colonies to point of sighting or recovery. The lines do not represent actual movement paths nor numbers of movements but show direction and relative distance from the natal colony to recovery site.

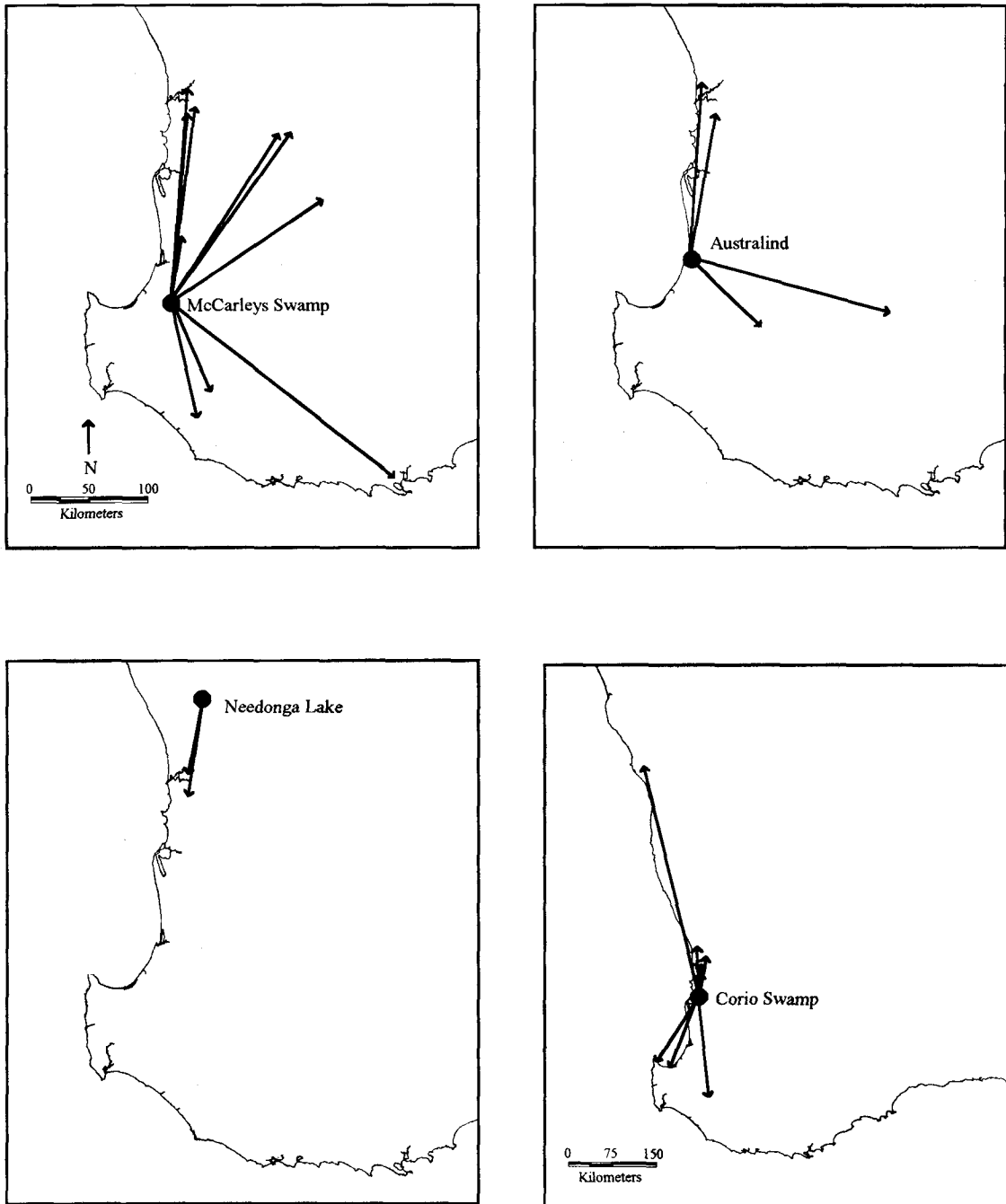


Figure 2. Movements of Great Egrets from breeding colonies in south-western Western Australia. The lines do not represent actual movement paths nor numbers of movements but show direction and relative distance from the natal colony to recovery site.

TABLE 2

Long distance movements of Great Egrets *Egretta alba*, Intermediate Egrets *E. intermedia* and Little Egrets *E. garzetta* banded in eastern Australia.

Banding location	Banding date	Recovery location	Recovery date	Distance moved (km) and direction	Time elapsed	Source
Great Egret						
Gunbower Island (Vic)	19-01-61	Kiunga Oktedia R (PNG)	05-10-62	3 333 N	1yr 8mth 16day	ABBBS
Narrung (SA)	29-01-63	Port Germain (SA)	30-03-63	304 N	2mth 1day	ABBBS
Bool Lagoon (SA)	20-12-64	Menindee Lake (NSW)	00-09-71	553 N	7yr 8mth	ABBBS
Bool Lagoon (SA)	20-12-64	Blanchetown (SA)	23-05-65	322 NW	5mth 3day	ABBBS
Bool Lagoon (SA)	20-12-64	Gazette Penthurst (Vic)	30-06-65	158 E	6mth 10day	ABBBS
Bool Lagoon (SA)	08-01-65	near Geelong (Vic)	10-04-65	337 E	3mth 2day	ABBBS
Narrung (SA)	30-12-67	Mile End South (SA)	19-08-68	87 W	7mth 20day	ABBBS
Dowds Morass (Vic)	1988/89	Mount Mathavic (Vic)	21-05-89	192 W	6mth	ABBBS
Lawrence (NSW)	1988/89	near Casino (NSW)	?	63 N	?	PEW
Shortland (NSW)	30-11-89	Gympie (Qld)	21-10-90	747 N	10mth 21day	PEW
Lawrence (NSW)	20-12-89	Shorncliffe (Qld)	24-04-90	243 N	4mth 4day	PEW
Lawrence (NSW)	26-12-89	Wards River (NSW)	12-05-90	320 S	4mth 17day	PEW
		Seaham (NSW)	05-11-90	374 S	10mth 10day	PEW
Junction Hill (NSW)	15-01-91	Innesplain (Qld)	00-07-91	163 N	6mth	PEW
Shortland (NSW)	09-02-93	Wards River (NSW)	26-03-93	77 N	1mth 14day	PEW
Shortland (NSW)	09-02-93	Armidale (NSW)	01-06-93	265 N	3mth 23day	PEW
Shortland (NSW)	18-02-93	Merriwa (NSW)	22-06-93	150 NW	4mth 4day	PEW
Shortland (NSW)	18-02-93	Berry (NSW)	19-05-93	230 S	3mth 1day	PEW
Intermediate Egret						
Campbells Island (NSW)	04-01-75	Desa Mapur (IJ)	?	3 990 N	?	ABBBS
Booby Island (Qld)	28-03-88	Lake Murray (PNG)	02-11-89	401 N	1yr 7mth 5day	ABBBS
Shortland (NSW)	28-11-88	Kurnell (NSW)	09-01-89	133 S	1mth 11day	PEW
Lawrence (NSW)	03-02-89	Raymond Terrace (NSW)	05-03-90	382 S	1yr 1mth 2day	PEW
		Shortland (NSW)	31-10-90	399 S	1yr 8mth 28day	PEW
Lawrence (NSW)	20-02-89	near Casino (NSW)	12-12-90	63 S	9mth 8day	PEW
Shortland (NSW)	05-03-92	Muswellbrook (NSW)	18-04-92	78 W	1mth 13day	PEW
Lawrence (NSW)	1991/92	Seaham (NSW)	16-04-92	374 S	?	PEW
Lawrence (NSW)	26-02-92	Rockhampton (Qld)	14-01-95	727 NW	2yr 10mth 19day	PEW
Lawrence (NSW)	07-03-92	Dyers Crossing (NSW)	04-06-92	297 S	2mth 28day	PEW
Lawrence (NSW)	07-03-92	Upper Belmore (NSW)	10-05-92	179 S	2 mth 3day	PEW
Lawrence (NSW)	07-03-92	near Sarina (Qld)	07-08-94	975 NW	2yr 5mth	PEW
Lawrence (NSW)	07-03-92	Landsborough (Qld)	10-05-92	300 N	2mth 3day	PEW
Lawrence (NSW)	07-03-92	Landsborough (Qld)	05-07-92	300 N	3mth 28day	PEW
Lawrence (NSW)	10-03-92	near Balnagowan (Qld)	08-11-94	1 011 NW	2yr 7mth 29day	PEW
Lawrence (NSW)	?	Gingham Watercourse (NSW)	00-01-96	368 W	?	PEW
Shortland (NSW)	?	Toorbul (Qld)	20-02-94	695 N	?	PEW
Shortland (NSW)	11-02-93	Alice Springs (NT)	23-05-93	2 015 NW	3mth 12day	PEW
Macquarie Marshes (NSW)	08-01-94	Lightning Ridge (NSW)	17-02-94	268 N	1mth 9day	PEW
Macquarie Marshes (NSW)	08-01-94	Laloki (PNG)	27-05-94	2 400 N	4mth 19day	PEW
Macquarie Marshes (NSW)	09-01-94	Lake Daviambu (PNG)	08-05-94	2 671 N	3mth 30 day	PEW
Macquarie Marshes (NSW)	22-01-94	near Mackay (Qld)	16-08-94	1 082 N	6mth 25day	PEW
Macquarie Marshes (NSW)	22-01-94	Yeppoon (Qld)	22-09-94	914 N	8mth	PEW
Macquarie Marshes (NSW)	22-01-94	Thargomindah (Qld)	09-10-94	501 NW	8mth 17day	PEW
Macquarie Marshes (NSW)	23-01-94	near Townsville (Qld)	24-04-94	1 262 N	3mth 1day	PEW
Macquarie Marshes (NSW)	23-01-94	Tinaroo Dam (Qld)	21-05-94	1 545 N	3mth 29day	PEW
Macquarie Marshes (NSW)	1993/94	Dalby (Qld)	27-03-94	~521 NE	~3mth	PEW
Macquarie Marshes (NSW)	1993/94	Georgetown (Qld)	02-04-94	~1 468 N	~3mth	PEW
Macquarie Marshes (NSW)	1993/94	Fly River (PNG)	03-12-94	~2 650 N	~11mth	PEW
Macquarie Marshes (NSW)	1993/94	Fly River (PNG)	03-12-94	~2 650 N	~11mth	PEW
Macquarie Marshes (NSW)	1993/94	Armidale (NSW)	00-05-94	384 E	~4mth	PEW
Little Egret						
Red Bank Weir (NSW)	02-01-60	Kulipi (PNG)	09-06-60	2 923 N	5mth 17day	ABBBS
Red Bank Weir (NSW)	15-12-62	near Oamaru (NZ)	09-05-63	2 597 SE	4mth 25day	ABBBS
Red Bank Weir (NSW)	15-12-62	Talasea (PNG)	06-06-63	3 291 N	5mth 22 day	ABBBS
Red Bank Weir (NSW)	14-12-63	Boset Village (PNG)	13-12-64	3 028 N	11mth 29day	ABBBS
Red Bank Weir (NSW)	14-12-63	Wairavanua (PNG)	02-09-64	2 805 N	8mth 18day	ABBBS
Red Bank Weir (NSW)	14-12-63	Newlands (NZ)	25-02-64	2 620 SE	2mth 11day	ABBBS
Bool Lagoon (SA)	13-12-64	Cessnock (NSW)	17-05-65	1 081 NE	5mth 4day	ABBBS
Shortland (NSW)	23-11-88	Numbaa (NSW)	12-10-89	240 S	10mth 19day	PEW
Shortland (NSW)	28-11-88	Forster (NSW)	23-02-89	108 NE	2mth 25day	PEW
Shortland (NSW)	28-11-88	Hawks Nest (NSW)	15-01-91	52 NE	2yr 1mth 18day	PEW
Shortland (NSW)	28-11-88	Joskleigh (Qld)	31-07-89	1 056 N	8mth 3day	PEW
Shortland (NSW)	22-12-89	Chittaway Point (NSW)	17-03-91	56 S	1yr 2mth 23 day	PEW
Shortland (NSW)	?	Warnambool (Vic)	13-04-87	1 045 SW	?	PEW
Boambee (NSW)	24-12-93	Port Macquarie (NSW)	16-07-94	122 S	6mth 23 day	PEW

ABBBS — Australian Bird & Bat Banding Scheme. PEW — Project Egret Watch.

TABLE 3
Long distance movements of Great Egrets banded in Western Australia.

Banding location	Band date	Recovery location	Recovery date	Distance moved (km)	Time elapsed	Source
McCarley's Swamp	14-11-89	Middlesex (WA)	08-03-90	99	2mth 25day	Halse & Pearce
	14-11-89	Grosnells (WA)	03-04-90	178	3mth 17day	
				178	1yr 1mth 30day	
	14-11-89	Grosnells (WA)	07-07-90	178	7mth 23day	
	14-11-89	Regans Ford (WA)	07-07-90	280	7mth 23day	
	09-01-90	Cooloonup Lake (WA)	08-03-90	191	1mth 27day	
	09-01-90	Cuballing (WA)	20-04-90	183	3mth 11day	
	09-01-90	Belmont (WA)	08-09-91	190	7mth 30day	
	09-01-90	Forestdale Lake (WA)	24-02-93	169	2yr 1mth 15day	
	13-12-90	Albany (WA)	14-02-91	269	2mth 1day	
	13-12-90	Beverley (WA)	17-03-91	196	3mth 4day	
	13-12-90	Belmont (WA)	10-04-91	190	3mth 28day	
	13-12-90	near Pemberton (WA)	16-04-91	109	4mth 3day	
	13-12-90	Wokalup (WA)	16-05-91	69	5mth 3day	
	Corio Swamp	01-11-89	Cannington (WA)	08-01-91	56	1yr 2mth 7day
01-11-89		Bridgetown (WA)	26-04-91	179	1yr 5mth 25day	
01-11-89		Brusselton (WA)	09-08-91	131	1yr 9mth 8day	
17-11-89		Lake Mealup (WA)	20-01-90	136	2mth 3day	
17-11-89		Jandabup Lake (WA)	26-02-90	89	3mth 9day	
17-11-89		Helana River (WA)	29-06-90	72	7mth 12day	
Australind NR	20-12-89	Midland (WA)	16-03-90	156	2mth 27day	
	29-12-89	Katanning (WA)	13-03-90	177	2mth 15day	
	19-12-90	Boyup Brook (WA)	07-05-91	83	4mth 19day	
	19-12-90	Nicholson Road (WA)	20-01-92	128	1yr 1mth 1day	
Needonga Lake	20-12-90	Cloverdale (WA)	01-05-91	65	4mth 12day	
	20-12-90	Forestdale (WA)	20-01-92	85	1yr 1mt	
Ballajura Lakes	09-01-90	near Cuballingwa (WA)	20-04-90	158	3mth 11day	ABBBS

TABLE 4
Breeding activity of individually marked Great Egrets *Egretta alba*, Intermediate Egrets *E. intermedia* and Little Egrets *E. garzetta*.

Individual	Tagged	Colony	Date sighted	Activity
Great Egret				
Lawrence 003	Dec. '88	Junction Hill *	Dec. '92	Courting blush
Lawrence 004	Dec. '88	Junction Hill *	Dec. '90	Incubating — failed
Lawrence 009	Jan. '89	Lawrence	Feb. '90	Carrying sticks
		Junction Hill *	Dec. '90	Present only
		Lawrence	Feb. '92	Fledged young
Lawrence 037	Jan. '90	Lawrence	Feb. '92	Courting flush
Lawrence ??? #	?	Lawrence	—	Building
Shortland ??? #	?	Shortland	—	Raised young
Shortland ??? #	?	Shortland	—	Incubating
McCarleys JB	Nov. '89	MaCarleys Swamp	Oct. '93	?
McCarleys JC	Nov. '89	MaCarleys Swamp	Oct. '93	?
McCarleys HF	Nov. '89	MaCarleys Swamp	Oct. '93	?
McCarleys HH	Nov. '89	MaCarleys Swamp	Nov. '93	?
McCarleys 67	Dec. '90	MaCarleys Swamp	Nov. '93	?
Intermediate Egret				
Lawrence 049	Feb. '89	Shortland **	Nov. '90	Present only
Lawrence 056	Feb. '89	Junction Hill *	Feb. '91	Incubating
Lawrence 065	Feb. '89	Lawrence	Feb. '91	Courting flush
Lawrence ??? #	?	Gingham Watercourse ***	Jan. '95	Present only
Shortland 140	1988/89	Shortland	1990/91	Raised young
Shortland 141	1988/89	Shortland	1990/91	Present only
Shortland 154	1988/89	Shortland	Nov. '90	Present only
Little Egret				
Shortland 025	1988/89	Shortland	1990/91	Raised young
Shortland 027	1988/89	Shortland	Nov. '90	Present only

*30 km from natal colony. **375 km from natal colony. ***368 km from natal colony. #Tag number not able to be read.

Activity listed is that confirmed by observation, birds present or in courting flush may not have successfully established nests.

TABLE 5

Mean recovery distances of Great Egrets *Egretta alba*, Intermediate Egrets *E. intermedia* and Little Egrets *E. garzetta* from the natal colony.

Breeding area	n	Mean distance (km)	SD
Great Egret			
SW Western Australia	26	157.0	80.9
Gippsland, Victoria	1	192.0	—
Murray River	7	727.7	1 158.3
Coastal NSW	9	285.4	195.0
Overall*	44	272.8	491.0
Intermediate Egret			
Murray-Darling	14	1 593.3	1 116.3
Coastal NSW	15	527.6	509.3
Overall	30	1 020.1	990.9
Little Egret			
Murray River	7	2 620.0	720.2
Coastal NSW	7	382.7	460.4
Overall	14	1 501.7	1 298.3

*Overall figure includes one bird banded on Booby Island (Qld) (see Table 2). n = number of recoveries. SD = standard deviation.

Limited data obtained from patagial tagged Great, Intermediate and Little Egrets tagged at the Shortland, Lawrence and Junction Hill breeding colonies indicate that many juveniles exhibit behaviour similar to that of Cattle Egrets; they move from the natal colony to forage and establish night roosts on the floodplain surrounding the natal colony. Tagged juveniles (50% of all the recoveries in the first four months after banding) have been located in such areas within the Hunter Valley.

Unlike Cattle Egrets, no Great, Intermediate or Little Egret has yet been found to spend the entire winter in the region around the nesting colony. This suggests that a subsequent post-nesting migration has occurred for these species. However, the lack of over-wintering birds in the local floodplain may be an artefact of the small sample size. Cattle Egrets from the coastal New South Wales and southern Queensland breeding colonies have been shown to migrate in all compass directions, but with a major southern bias (Maddock 1990; Maddock and Geering 1993; McKilligan *et al.* 1993; Maddock and Geering 1994).

The recovery data for Great, Intermediate and Little Egrets, although limited, suggests that all three species of egret may also undertake long distance movements in any direction from the natal colony. However, the location of the natal colony may play an important role in influencing direction of movements. While the seven recoveries of Great Egrets (Fig. 1) banded in the Murray area (Gunbower Island, Victoria; Bool Lagoon and Narrung, South Australia) show an apparent northward bias, eight birds wing-tagged on the New South Wales coast (Shortland, Junction Hill and Lawrence) were recovered, or seen alive, to the north and south. A similar pattern exists for Intermediate Egrets (Fig. 1). Seven Little Egrets (Fig. 1) banded in the

Murray area (Red Bank Weir, New South Wales and Bool Lagoon, South Australia) undertook movements, all in excess of 1 000 km, to the north and south-east while six tagged at Shortland, New South Wales and one at Boambee (near Coffs Harbour) were sighted to the north, south and south-west.

Differences between movement patterns of birds originating from the Murray and/or Macquarie Marshes and coastal New South Wales colonies are also reflected in the 'mean distance of movements' as demonstrated in Table 3. Less extreme climatic variation and a more predictable environment in coastal areas may result in generally shorter movements than in the inland. Egrets originating from less stable inland wetlands, where longer, more severe droughts have a greater impact, may initiate more extensive movements. The movement data for Great Egrets from Western Australia supports this suggestion. Although some 40 per cent of the state is arid with erratic low rainfall (Lane and McComb 1988), the nesting colonies are in an area with a very predictable, higher rainfall climate.

The movements by an Intermediate Egret from Shortland to Alice Springs and a Little Egret from the same colony to Joskleigh in Queensland, however, indicate that some birds originating from coastal colonies may undertake extensive movements. It should, however, be noted that tag sightings do not necessarily represent the end point of a particular migration, but may be a staging, or rest point en route, as has been reported for Cattle Egrets. For example, Maddock and Geering (1994) reported that in the Shoalhaven Valley on the south coast of New South Wales many tagged Cattle Egrets were present for only a few days before moving elsewhere. Care must, therefore, be taken when interpreting these distance records.

The data strongly suggests that Little and Intermediate Egrets (mean distances of 1 020 km and 1 502 km respectively) may regularly undertake movements that are longer than those of Great Egrets (mean distance 269 km). There is, however, a reported movement of 3 333 km for a Great Egret, but it is difficult to draw a firm conclusion for the species as a whole, given the small number of recoveries.

Large numbers of Intermediate and Great Egrets have been reported migrating across Torres Strait at Booby Island (A. Taplin, pers. comm.), with both diurnal and nocturnal movements being recorded. This suggests that regular movements do occur between Australia and New Guinea. This is further supported by reports of four tagged Intermediate Egrets from the Macquarie Marshes recovered in Papua New Guinea, while a further five birds were reported over 900 km to the north of their natal colony in central and north Queensland.

The circumstantial evidence of seasonal appearances and disappearances of unmarked birds in specific locations, linked with a limited number of recoveries of birds returning to their natal colonies for the breeding season suggests that a seasonal migratory pattern may be in operation, at least for some birds. Based on their 1994 study of waterbirds in the Fly River floodplain of Papua New Guinea, Halse *et al.* (1996), suggested that Australia is the most probable source of migrants of most waterbird species found in the Middle Fly River. They also suggest that the decline in the number of Intermediate Egrets found between their December and April surveys indicated a return of breeding adults to Australia. Sightings of tagged individuals at both breeding and wintering locations are needed to confirm these conclusions. To date relatively few wing-tagged Great, Intermediate or Little Egrets have been found breeding (Table 2) and these have involved birds returning to the natal, or a nearby colony.

Only one Great Egret has been reported from a breeding colony outside the floodplain area of the natal colony although breeding was not confirmed for this bird (Table 2). One case has been recorded for an Intermediate Egret originating from a coastal colony (Lawrence) sighted in an inland colony (Gingham channel) during the 1995–96 nesting season, although no nest was located for this bird (Table 2). A similar pattern was described by Maddock and Geering (1993) for wing-tagged Cattle Egrets, the birds generally returning to the natal colony to breed although some nesting occurred at nearby colonies and to a lesser extent at more distant colonies.

FUTURE RESEARCH

Research on the Cattle Egret has been successful in determining movement patterns for the species (Maddock 1990; Maddock and Bridgman 1992; McKilligan *et al.* 1993; Maddock and Geering 1993, 1994). The success is due to a large number of patagial tagged birds (nearly 7 000) and over 20 000 sight

records of these birds. The regular movement of migratory flocks, which are highly visible, has occurred through well populated farming areas where a network of over 200 volunteer observers has been established.

By comparison, the number of the other species tagged is considerably smaller (Great Egrets, 419; Intermediate Egrets, 1 264; Little Egrets, 86). There have been far fewer sightings for these species, both in absolute numbers and in proportion to the numbers tagged, and no comparable flock movements have been identified. The three species depend on wetlands for foraging, many of which are in sparsely populated areas or on private property not accessible to regular observers. The birds also tend to forage alone or in small groups.

Because of the importance of identifying habitat along migration routes and the relationship of such habitat to the conservation of egrets, it is important that the current programme of individually marking birds be continued and the observer network be expanded to more remote areas. In the 1993/94 and 1996/97 breeding seasons the Project was extended to include colonies within the Macquarie Marshes. It is hoped that tagging at such colonies will provide a comparison with the behaviour of egrets from coastal colonies, identify critical migration routes, staging points *en route*, wintering destinations, and determine whether there is interchange between inland and coastal colonies.

The results of a pilot study into the use of satellite tracking Cattle Egrets conducted in 1994 (Bridgman *et al.* 1997), provided more detailed information on movements than hitherto available by ground observations of marked birds. It was thus demonstrated that this technology would be of value if applied to further Great and Intermediate Egret research. Extending satellite technology to Little Egrets is dependent upon technology providing a smaller transmitter. Satellite tracking provides additional information which can be used in conjunction with the more traditional patagial tagging, and is of greatest value where the birds frequent remote inland wetlands, mostly on private property, where few if any ground observers are available.

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BOOK REVIEW

Australian Grass Parrakeets — The *Psephotus* and *Northiella* Genera

S. Sindel and J. Gill. 1996. Singil Press, Austral, Australia. 203 pp. \$A45.00

This is the fourth book in the planned series of six aviculture specialist books covering the Australian Psittaciformes. The previous three dealt with Australian lorikeets, cockatoos and the small *Neophema* grass parrots and all have previously been reviewed in *Corella*.

Stan Sindel and Jim Gill between them have acquired in excess of 80 years experience of Australian parrots in the field and aviary. They both have exceptional avicultural skills and are highly respected in their field both within Australia and overseas. Jim Gill is also widely acclaimed as a leading avian veterinarian.

This book follows the same successful format as the earlier publications with chapters on housing, diet and management of birds and a chapter on the diseases which may afflict *Psephotus* parrots. A chapter is devoted to each of the five *Psephotus* species and two chapters to *Northiella* — the Naretha Blue Bonnet is afforded species status as *N. narethae* and the other three subspecies are dealt with under *N. haematogaster*. These species accounts provide information on such subjects as classification; early reports of the species; range; habitat and field notes, including breeding in the wild; avicultural history; sexing; display; avicultural nesting requirements; incubation and development of the young and information on avicultural mutations. Each species chapter also includes a distribution map and numerous colour photographs to illustrate development of the young, plumage stages and mutations. An interesting photograph is included of a Naretha Blue Bonnet with an acquired red suffusion, which is thought to be age related, over most of its body.

This is another good reference book which should be essential reading for all who keep these parrots in aviaries. It not only imparts an immense amount of knowledge about the do's and don'ts for the subject species in aviculture, but also raises an appreciation for the birds in their natural environment. Lessons are to be learned from the demise of the Paradise Parrot and the current threats to the Golden-shouldered Parrot, which are both well documented in this book.

The earlier books in this series have become standard texts for serious aviculturists and I am sure that this volume will achieve the same high status. I am also sure that those who may not wish to keep birds in captivity would also find this book quite interesting.

This is a limited edition publication, which is not available through retailers, it can only be purchased through avicultural societies or direct from the publisher Singil Press, P.O. Box 9, Austral, New South Wales 2171.

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