

# METEOROLOGICAL CONDITIONS AND CATTLE EGRET MIGRATION: AN UPDATE

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## ABSTRACT

The migration pattern of Cattle Egrets in 1990 and 1991 and its relation to meteorology are presented to extend initial results covering 1987-1989 (Maddock & Bridgman 1992). Cattle Egrets migrated to Victoria and Tasmania in waves during March and April in northerly air flow (western side of a high pressure system) in a series of stages, with periods of rest in between. Major staging points seemed to be Windsor (NSW), Nowra (NSW), and Bairnsdale (Vic). Return migrations (October and November) appeared faster, with fewer and shorter rest stops, and were in southerly airflow. Staging points were Werribee (Vic), Nowra (NSW), and Wyong (NSW). Migrations to and from New Zealand were much more limited than in previous years due to adverse weather conditions, especially winds.

KEYWORDS: meteorology, Cattle Egret, migration, Australia, New Zealand

## INTRODUCTION

The migratory movements of the Cattle Egret (*Bulbulcus ibis*) and related meteorology in 1987-1989 were described by Maddock & Bridgman (1992). A second phase of research, which began in 1990 using an expanded observation network, developed a better understanding of the migration patterns. This paper presents the results of research for 1990 and 1991 and suggests an improved way to track migrating egrets in the future. It deals with the Tasman Sea area from Southern Queensland to Tasmania and across to New Zealand (Figure 1). Background information on bird migration habits and problems were included in Maddock & Bridgman (1992) and will not be repeated here.

## REVIEW OF RESULTS: INITIAL STUDY

Maddock & Bridgman (1992) established the following features of the migratory pattern:

1. Cattle Egrets migrate by five potential pathways, depending on the weather:
  - a. from the Hunter Region to Tasmania behind the centre of a high pressure system in northerly airflow;
  - b. from the Hunter Region to New Zealand around the northern boundary of a weakening low pressure system, in westerly airflow;
  - c. from the Hunter Region to Tasmania around the western side of a high, and then continuing across the Tasman Sea to New Zealand with south-westerly or westerly airflow, probably after resting in Tasmania;

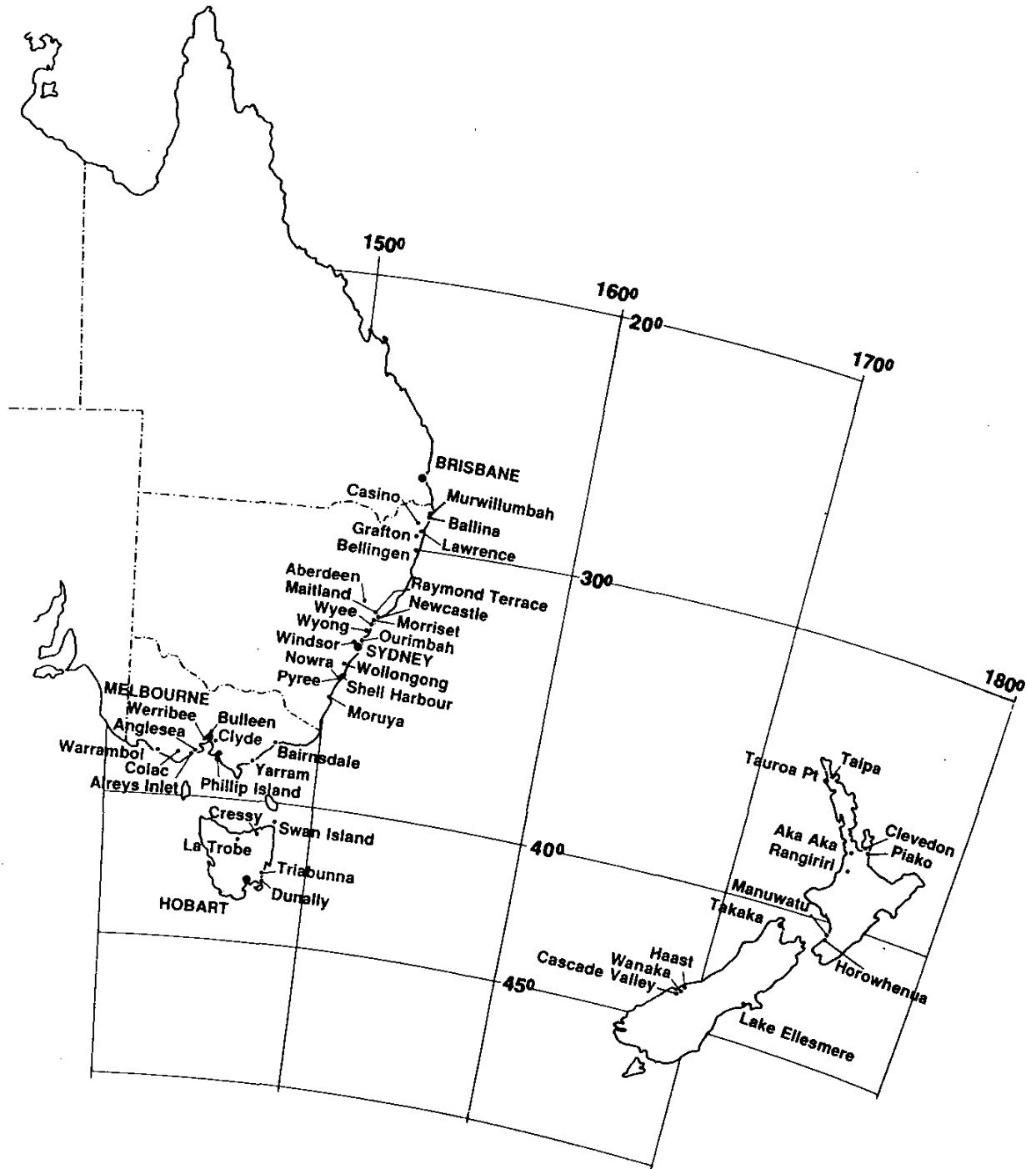


FIGURE 1 – Area of Cattle Egret migration research in SE Australia and New Zealand and location of the observation network

- d. from Tasmania back to the Hunter Valley with the southerly airflow ahead of an advancing high pressure system (behind a cold front);
  - e. from New Zealand on return to Australia around the northern edge of a high pressure system with south-easterly to easterly airflow.
2. The most likely altitude of flight is between 1 to 2 km (900 to 850 hPa pressure altitude), with higher altitude flights unlikely because of differing wind directions and wind speeds, and wind shear problems (Maddock & Bridgman 1992)
  3. Migration takes place as a series of waves and not all Cattle Egrets migrate beyond the flood plain surrounding the breeding colonies.
  4. The speed of flight might average 50 km/h with a following wind with perhaps 90 km/h possible for short periods of time. Except for flights across the Tasman from Australia to New Zealand, continuous flights are unlikely.

### METHODS

The use of radar or satellite tracking suggested in Maddock & Bridgman (1992) was not feasible. We therefore relied on ground observations from the Project Egret Watch network (Maddock 1990), which was enlarged and made more efficient during 1990 and 1991. Project Egret Watch observers were alerted to record the arrival dates of migrating flocks and tagged birds during the autumn and early winter of 1990 and 1991.

This approach was successful for assessing the southward migration patterns from the Hunter Region in March and April 1990 and 1991 to both Tasmania and New Zealand. Arrival dates for flocks were much more accurate than those obtained in 1987-1989, which enabled a chronological succession of flock sightings as they moved away from the breeding colonies toward their winter ranges to be reported.

We were also able to incorporate some observations of birds arriving from breeding sites in northern NSW and Queensland to join the migratory flocks from the Hunter. Information on the return of the egrets to the Hunter during October to December was more limited, obtained from the arrival dates of tagged birds.

Based on information on bird movements from the ground observation team, we obtained weather maps from the Bureau of Meteorology for 900 - 850 hPa for the five day period before the dates of movement. Movement patterns were related to pressure systems and winds shown on these maps.

### RESULTS

#### **Migration to Victoria and Tasmania, 1990 and 1991**

The observation network in 1990 and 1991 established that Cattle Egrets migrate across the Australian continent in a series of stages, with rest stops of a few days between stages. The timing of migration to Tasmania was different in each year. The first major departure from the Lower Hunter

TABLE 1 – Observed migration timing of Cattle Egrets from NSW in 1990  
(for locations see Figure 1)

Date	Movement	Meteorological Comments
2 Mar	First Lawrence (Grafton, NSW) bird observed in Hunter	N-NNE airflow on western of high, approx 20 km/h, good transport
6 Mar	First arrivals Wyong (first wave?)	High pressure system maintained, good transport in N airflow
11,22 Mar	2nd, 3rd Lawrence bird in Hunter	High pressure established over Western Tasman Sea, good transport in northerly airflow
26 Mar	First wave arrived Pt Fairy, Vic	Clear transport corridor S on back side of high for 4 days
30 Mar	Big exodus from Hunter (second wave)	Airflow weak E or NE behind trough. Transport OK for next few days
4 Apr	First arrivals Pyree, NSW	Airflow SE along coast, birds must fly crosswind
12 Apr	Second arrivals Pyree	Birds arrive ahead of front, NW airflow
11-14 Apr	Tagged birds arrived Hunter from Grafton, Ballina NSW (3rd wave)	Front dissipated, good transport in northerly airflow
15 Apr	3rd wave arrived Cattai (Windsor) NSW	Arrival before weak trough passes
16 Apr	1st wave arrived Werribee, Vic	Winds weak and variable in ridge over Victoria (62 birds)
18 Apr	2nd wave arrived Bairnsdale, Vic	Winds weak E-ESE along coast, crosswind transport probable (2 birds)
22 Apr	3rd wave arrived Pyree 2nd wave group to Bairnsdale	3-day period of N-NW winds behind high - arrive ahead of front (500 birds)
26 Apr	3rd wave arrived Bairnsdale (?)	Possible transport on 25th in N-NW airflow, strong front passes through on 26th, winds strong SSW
5 May	First sightings, Cressy, Tas	Good transport in N-NW winds behind high since 3 May (14 birds)

TABLE 2 – Observed migration timing of Cattle Egrets from NSW, 1991 (for locations, see Figure 1)

Date	Movement	Meteorological Comments
15 Feb	First major exit from Grafton (exits continue until 26th)	Winds NW - 45-55 km/h, low off E. Victoria coast
19 Feb	First wave departed from Hunter	High over SE Australia & Western Tasman, N flow over NSW coast area
20 Feb	60 egrets arrived at Windsor	E-NE airflow along coast. Crosswind transport (60 birds)
27 Feb	First observation, Wollongong, NSW	Good N airflow behind blocking high for 6 days (3 birds)
4 Mar	Egrets moved to Shell Harbour, NSW	N airflow behind high re-established on 3 March (3 birds)
6 Mar	Major exit from Grafton; bird 403 last seen in Hunter	Winds weak and variable along coast, NW inland
8 Mar	Egrets moved to Nowra	Winds NW ahead of approaching front (3 birds)
12 Mar	Bird B90/674 (Ballina) last seen in Hunter	Winds E-NE behind existing high, crosswind transport
17 Mar	First flock arrived, Bairnsdale, Vic	N airflow behind high since 13 March, winds weak & variable in Victoria
26 Mar	Arrival in Triabunna, Tas	Strong W-NW airflow at all levels, 55 km/h below 850 hPa (4 birds)
2 Apr	B90/674 observed at Nowra	Winds weak and variable over eastern NSW, high moves east
9 Apr	First observation, Don, Latrobe, Tas; bird SE300 observed in Hunter	NW winds behind ridge oriented NW-SW. Good transport (5, 15 birds)
15 Apr	Birds observed Swan Island, Tas	Airflow in Victoria W on south side of approaching high (40-55 km/h), Transport OK

Region in 1990 was in early March. The second was on 30 March (Table 1). In 1991 (Table 2), the first major departure occurred in mid-February, approximately two weeks earlier than in 1990.

Tables 1 and 2 clearly show the migratory waves and that the birds migrate in stages, with stopovers of two to several days between movements. Southward movement was always under favourable meteorological conditions of northerly winds on the western side of a high. An example of the meteorological conditions facilitating staged migrations for 1990 is shown on Figure 2. Occasionally movements seemed to use easterly crosswinds. Transport during good weather did not occur if the birds were still resting or were ahead of an approaching cold front. The passage of fronts and the shift of winds to the south always blocked travel until conditions improved. Flight was most likely at about 900 hPa pressure altitude (up to 1 km) as the stronger winds often existing at 850 hPa are not needed to assist the birds on short flights.

In 1990, the arrival of birds from Lawrence (near Grafton, NSW, Figure 1) to the Hunter established probable times for migratory departure. Table 1 shows three possible waves, although the first sightings in early March are less clearly defined and may have been forerunners. The major waves began on 30 March and 14 April, with each taking about two weeks to arrive in eastern Victoria. After about a month, some egrets arrived in Tasmania. Major staging points identified were Windsor, NSW; Nowra, NSW; and Bairnsdale, Vic..

This pattern of migration and the timing of the transport from the Hunter to Tasmania/Victoria is further confirmed by the observations for 1991 (see Table 2), although the wave pattern is somewhat less well-defined. In this case, the birds from Grafton, NSW arrived just before a major exit of egrets from the Hunter Region on 19 February. The birds were tracked to Windsor, Wollongong area, Nowra and Bairnsdale from 20 February to 17 March, with the first sightings in Tasmania on 26 March. Figure 3 shows the transport pattern and meteorological conditions associated with the first wave in 1991.

The existence of waves is further confirmed by the sightings of three individually tagged birds. On 12 March, B90/674 (from Ballina) was last seen in the Hunter, and on 2 April it was seen at Nowra. On 9 April, SE300 (Seaham) was last observed in the Hunter, to be seen again at Werribee, Victoria on 5 May. The bird taking the longest to move south was SE403 (Seaham), last seen in the Hunter on 6 March, and observed again at Phillip Island, Vic, on 11 April.

### **Migration to New Zealand, 1990 and 1991**

Table 3 presents the details of migrations between eastern Australia and New Zealand in 1990 and 1991. The frequency of sightings and the number of locations was lower than in Australia, particularly in 1990. Comments in a letter from an Egret Watch observer in the Waikato, suggest a reason for the lack of observed birds (Jardine, pers. comm.). Instead of the normal westerly winds of varying strength, the circulation pattern resulted in mainly easterly airflow, alternating with periods of calm. Only one significant group

TABLE 3 – Observed migration pattern of Cattle Egrets to New Zealand from eastern Australia, 1990 and 1991 (for locations see Figure 1)

Date	Movement	Meteorological Comments
<b>1990</b>		
16 Apr	1 bird seen at Aka Aka	Direct transport possible in NW flow ahead of front. Transport only possible over less than 48 hours from NSW
18 Apr	2 birds seen Lake Horowhenua.	SW winds strong across Tasman behind front - transport from Tasmania possible
28 Apr	30 birds seen at Aka Aka	Passage of low and front across Tasman - transport around top of low and ahead of front possible since April 25
<b>1991</b>		
23 Mar	First sighting Piako	NW flow from NSW across Tasman ahead of front. Possible start 21 March
30 Mar - 1 Apr	Sighting Taipa	NW flow from NSW directly to New Zealand
4 Apr	8 birds arrived Aka Aka; first arrivals Rangiriri	24-36 hour transport in WSW-W airflow from NSW
9 Apr	Observations at Clevedon	No transport possible across Tasman since 7 April. Probable local transfer
19 Apr	70 birds arrived at Aka Aka; observations at Rangiriri; Tag Sh322 from Hunter seen at Tauroa Pt	Since 17 April big ridge over all of Australia. Westerly airflow direct from Tasmania 20-40 km/h. Situation holds until 20 April
21 Apr	Birds arrived Manuwatu; on South Island at Wanaka, Haast, Cascade Valley	Trough cuts off transport source but movement ahead of trough OK

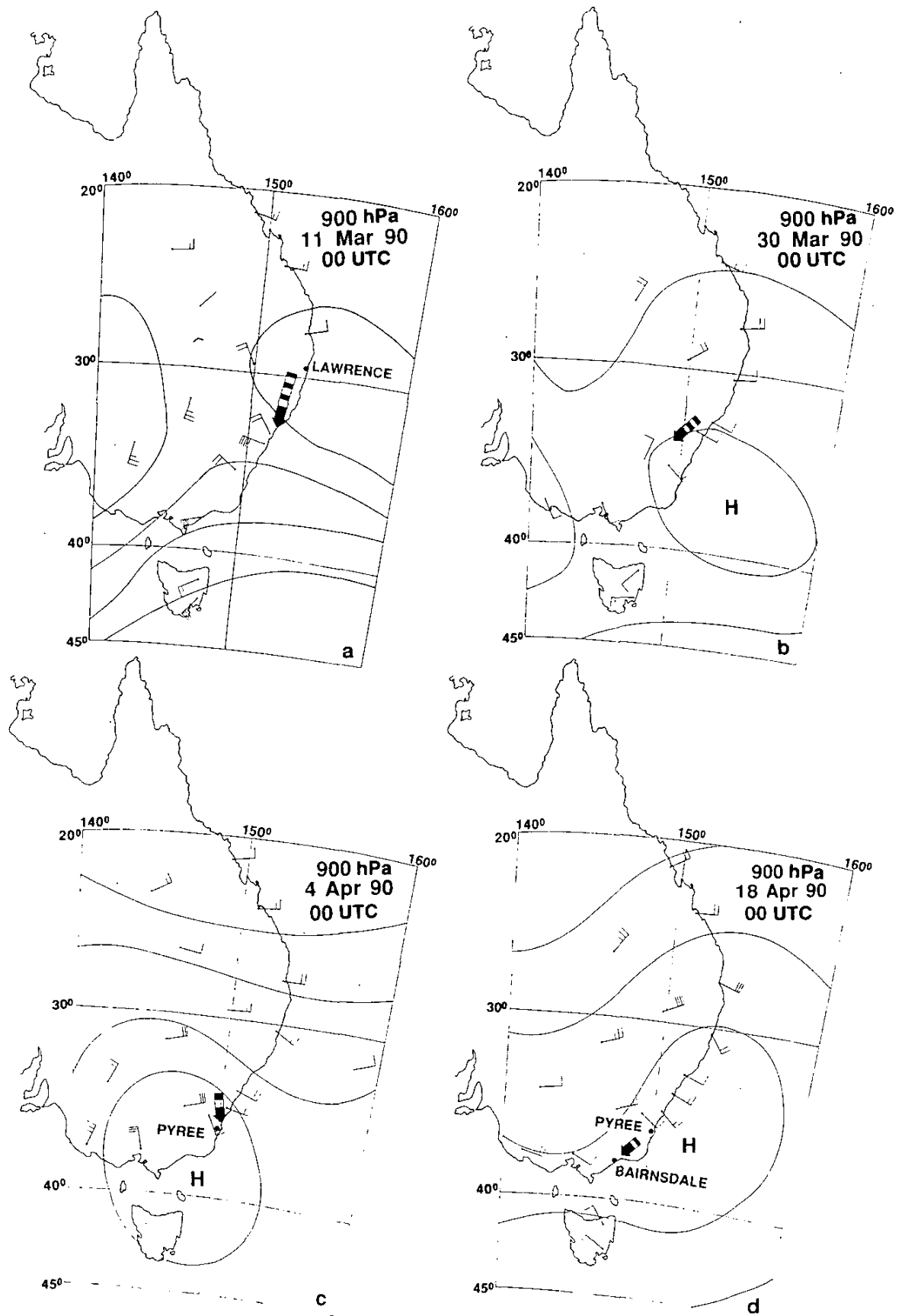


FIGURE 2 – An example of staged migrations used by Cattle Egrets in 1990 between the Hunter Region and Victoria. The arrows indicate the general direction of movement by the egrets



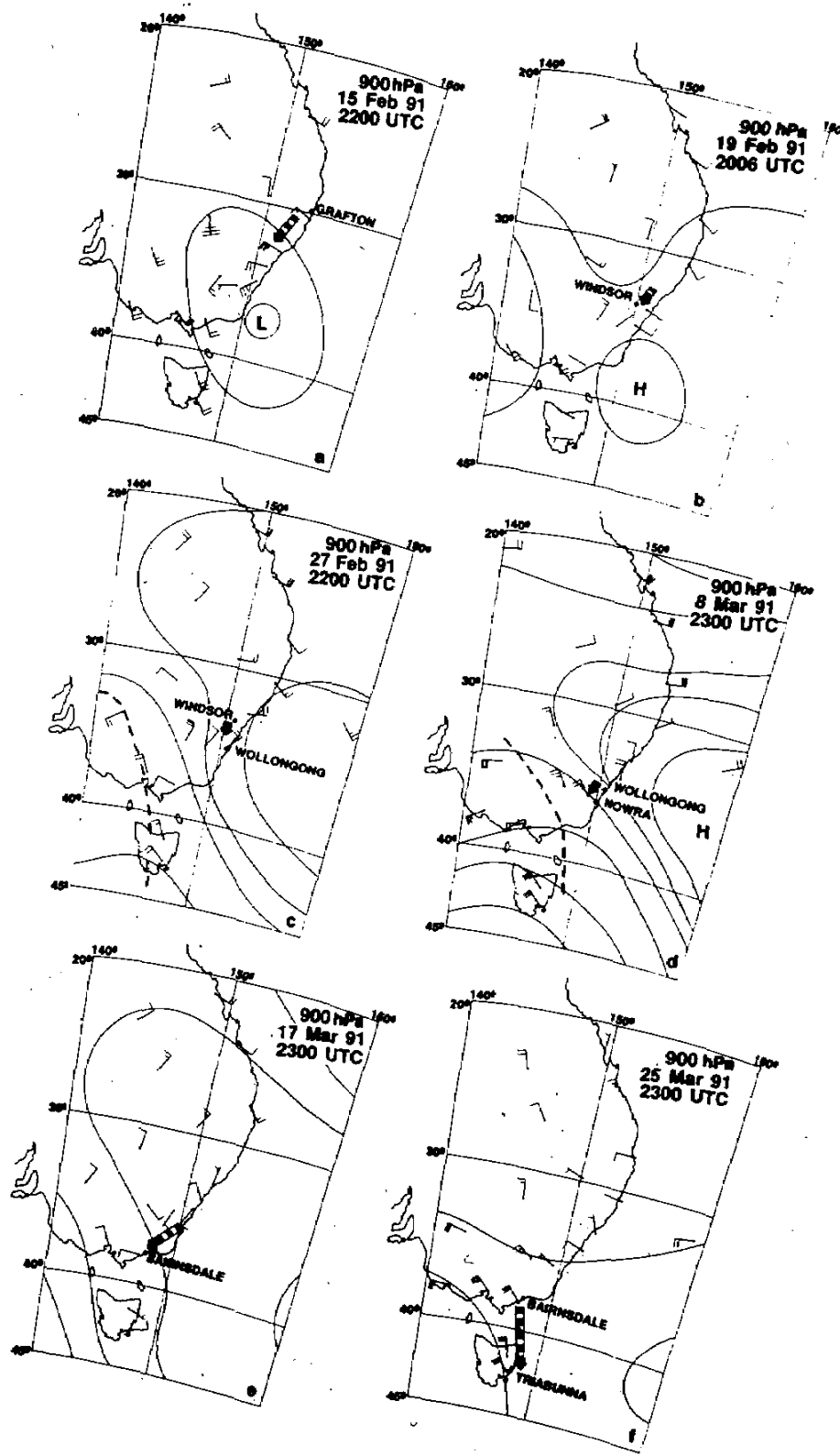


FIGURE 3 – An example of staged migrations used by cattle Egrets in 1991 between the Hunter Region and Tasmania. The arrows indicate the general direction of movements by the egrets

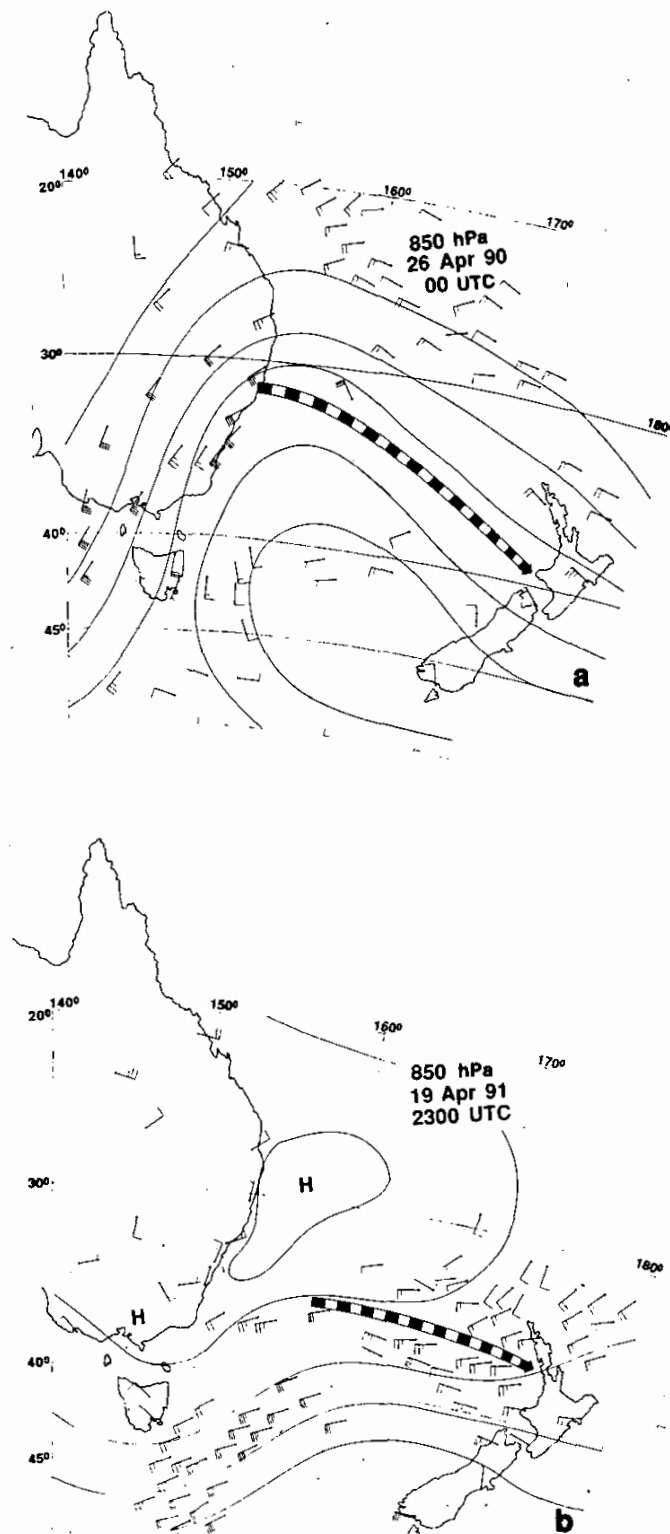


FIGURE 4 – Examples of migration tracks used by Cattle Egrets between SE Australia and New Zealand, (A) 1990 and (b) 1991

TABLE 4 – Dates of observed arrivals in the Hunter Region in 1990 and associated meteorology

Dates of Arrival	Meteorology and Comments
2 October	Direct transport from Victoria possible in S winds behind trough, beginning on 1 Oct.
19 October	Transport only possible on 17-18 Oct. across a WSW prevailing wind, 45-55 km/h. Frontal approach on 18 Oct. shifts airflow NW
21 October	Transport across WSW airflow, 40-55 km/h on 20 Oct.
25 October	Low at 30°S in western Tasman encouraged SE to S winds along SE Australian coast from 22-24 Oct., probable weather interference from rain and wind >55 km/h except on 24 Oct.
2 November	Transport pathway from Victoria/Tasmania open after frontal passage. Winds 45-55 km/h
4-7 November	Transport from New Zealand likely on the north side of a ridge extending NW-SE from Australia across the Tasman. Wind direction ESE, 40-55 km/h, weaker late in period
10-11 November	Direct transport route from Victoria/Tasmania behind frontal passage in SW airflow. Winds light and variable along coast
14 November	Possible transport in SE flow from New Zealand on 12 Nov., otherwise no transport in strong NW airflow
21 November	Direct transport from Tasmania possible on 16-19 Nov. Poor weather on first two days. Winds NW ahead of approaching front on 20-21 Nov.

of egrets was sighted, at Aka Aka on 28 April. The transport pattern likely to have encouraged migration is shown in Figure 4a, suggesting movement around the northern margin of a weakening low located in the central Tasman Sea.

Fewer egrets were seen in New Zealand in 1991. Both the likely migration patterns from the Australian continent (Maddock & Bridgman 1992) were in operation. In March and early April, NW airflow ahead of an approaching trough or cold front extended across the Tasman, providing a direct transport route to New Zealand from New South Wales. The major sightings on 19 and 21 April were probably associated with transport from Tasmania in the SW airflow during the days before, as shown in Figure 4b. This time period links in well with major sightings in Tasmania and southern Victoria in the two weeks before, and so the southern migration route after a period of rest in Tasmania is a strong possibility. At least two sightings confirmed this: on 29 April 1991, seven Cattle Egrets were seen 60 km southeast of Tasman Island, and in May 1991, two birds were seen 200 km offshore from Tasmania.

### **Return Migrations to the Hunter, 1990 and 1991**

In 1990, Cattle Egrets returned to the Hunter Region between the end of September and 20 November. Aside from dates of first sightings, information about their movements and probable routes is less detailed than for outgoing migrations (Table 1). Table 4 presents the dates of observed arrivals in the Hunter and the associated comments on the meteorology. As in previous years, the Hunter was a major break point for many egrets in their migration to nesting areas further north, such as Grafton and several locations in Queensland.

Return trips to the Hunter from Victoria and Tasmania were probably more direct, with less chance for rest stops than during trips south. Although this could be explained by the meteorological conditions, another reason could be the need to nest in season. Assessment of the weather associated with the arrival dates listed in Table 4 suggests seven possible periods for migration from Victoria/Tasmania and only one period when migration from New Zealand was feasible. A typical example of the weather pattern favouring migration is shown in Figure 5a.

Dates for movement from Victoria/Tasmania were 1-2, 17-18, 20-21, 24-25, October and 2, 10-11, and 16-18 November. Migration was probably limited on 17-18 and 20-21 October because the birds would be required to fly in fairly strong cross-winds (westerlies). In two other periods, 24-25 October and 16-18 November, poor flight conditions limited visibility, and precipitation may have restricted bird movements. The migration period was shorter than in previous years and the number of observed arrivals was fewer.

The only period of likely return migrations from New Zealand was between 4 and 7 November 1990. During this period, a ridge extended NW-SE from south-eastern NSW across the Tasman Sea to New Zealand (see Figure 6a). The airflow along the northern side of the ridge was ESE with speeds up to 60 km/h, allowing a direct flight between New Zealand and the Hunter in 24-48 hours. Few Cattle Egrets arrived in New Zealand in 1990 (see Table 3). Consequently few birds would have been available to make this trip.

In 1991, returns to the Hunter occurred later than in 1990, between 27 October and 14 December. A drought in eastern Australia may partially explain this. A bushfire and the drought diminished the wetland habitat at the Wetlands Centre at Shortland and few egrets were seen in the breeding colonies before rainfall in December. Further north, however, at Seaham Swamp, observers provided a much more detailed record than in 1990. As in 1990, conditions were rarely favourable for return flights from New Zealand and were of short duration. The records from Victoria/Tasmania suggest that in 1991 egret flocks made rest stops at least in the Werribee (Vic.), Nowra (NSW) and the Wyong/Ourimbah (NSW) areas before reaching the Hunter. Observations at Grafton also linked birds moving through the Hunter to nesting areas further north.

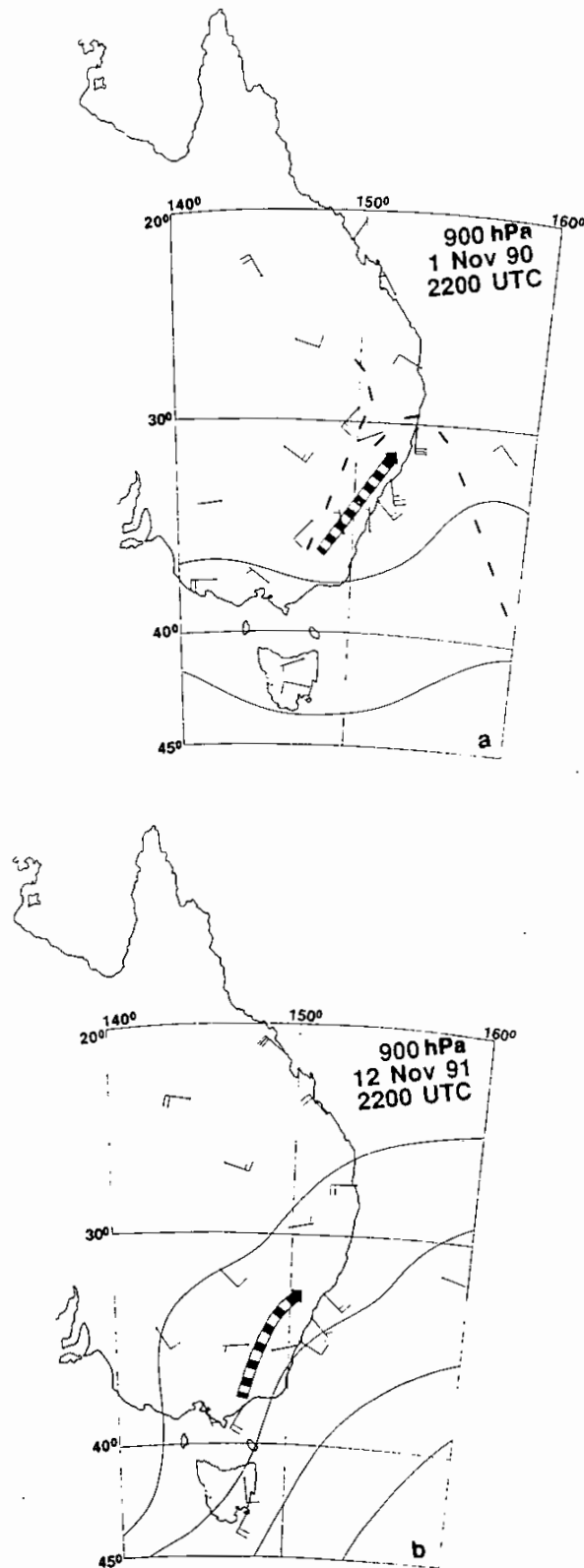


FIGURE 5 – Examples of return migration tracks used by Cattle Egrets between Victoria or Tasmania and the Hunter Region, (a) 1990 and (b) 1991

TABLE 5 – Examples of first sightings of tagged Cattle Egrets at Seaham, Hunter Valley, (or Grafton \*) NSW in 1991, and appropriate meteorology. (See Figure 1 for locations)

Arrival Dates	Tags Seen at Seaham (* or Grafton)	Comments
4 Nov	9/275 from Grafton	Good migration situation begins in S airflow behind front
6 Nov	9/335 1/144 (?)**. 9/216 from Ourimbah	Winds W over SE Australia, 30-40 km/h, limited crosswind transport?
10 Nov	9/230, 9/284, 9/286, 9/417 1/102, all(?)	Weak trough moves up coast, winds weak and variable, short hop transport likely
12 Nov	9/250, 1/252, 1/259 all (?)	High in Bass Strait, SE wind along coast, transport from S possible
13 Nov	21/011, 20/006 from Nowra	As above, high further east
15 Nov	9/210, 1/191, 1/200, 1/311, 20/179 all (?)	Trough passage, transport from S behind
16, 17 Nov	9/308, 1/244, 9/285, 9/320 (?). 1/127 from Victoria	Weak low off Australian coast, winds weak and variable, weather problems?
20 Nov	9/208, 9/331, 20/009 all (?)	Trough moves through long coast, winds N along coast, no transport
22 Nov	9/217, 9/390, 1/205 from Victoria	As above, migration limited
26 Nov	9/300 from Werribee, * 20/270 from Seaham at Grafton	From frontal passage, some transport possible in irregular S flow
27 Nov	9/263, 9/376, 9/445 all (?) 9/446 from Moruya	SE or NE winds dominate, 20-30 km/h, poor transport
4 Dec	21/226 from Nowra	SW winds behind frontal passage on 3 Dec., transport possibility good
11 Dec	1/291 from Nowra	Ridge over Tasmania, W-E orientation, first direct link to New Zealand, migrations possible on north side of high, 75 km/h ESE winds onshore in SE Australia

Origin of bird (tag prefix code): 1 = Shortland, 9 = Seaham, 20 = Lawrence (Grafton), 21 = Junction Hill (Grafton). (?)\*\* Starting point of bird is unknown

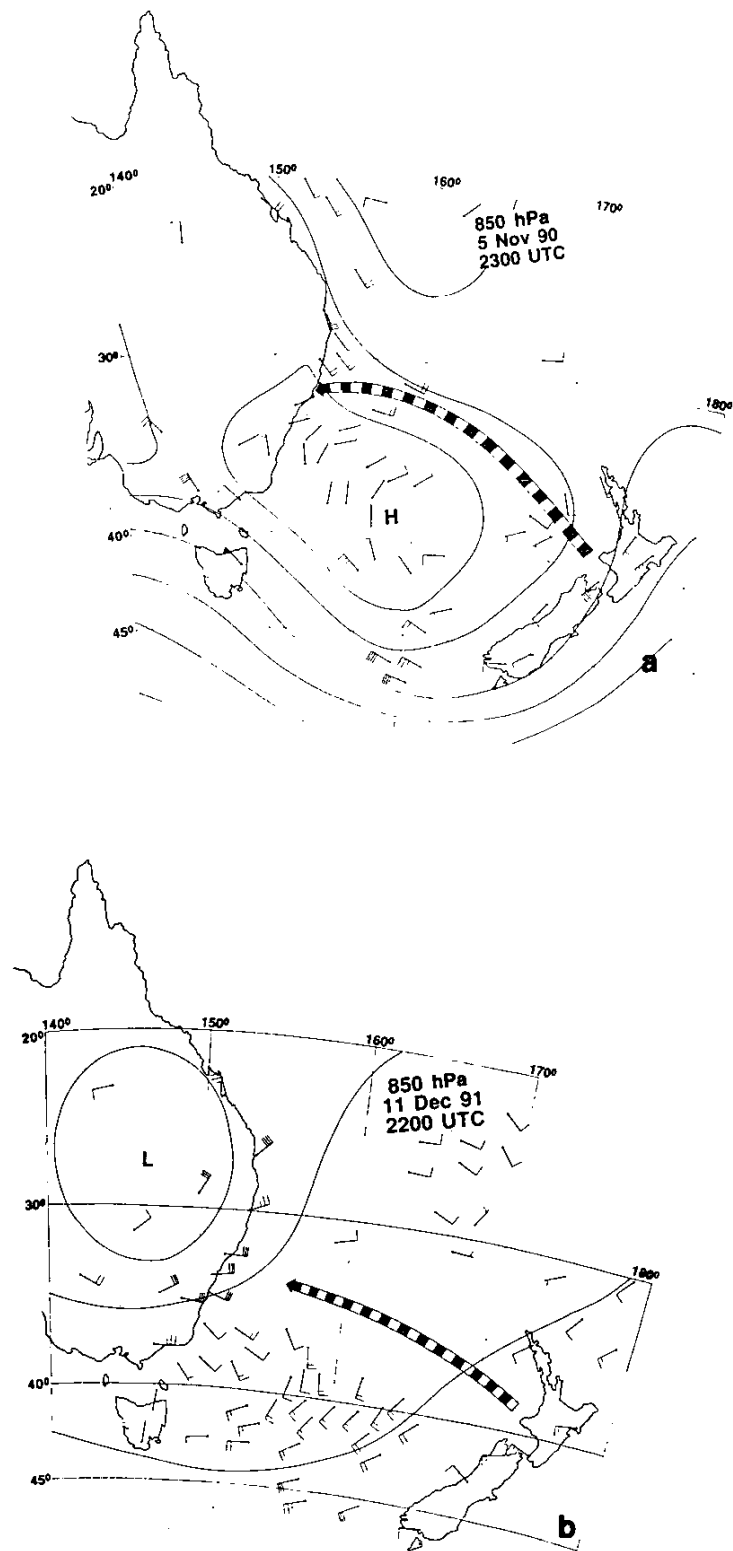


FIGURE 6 – Examples of possible return migration tracks used by Cattle Egrets between New Zealand SE Australia, (a) 1990 and (b) 1991

Nesting began on October 30. Table 5 shows that individual Cattle Egrets at Seaham were arriving throughout November. Only on a few of those days was the weather appropriate for extended migration, but for most of this period, shorter hops were possible. Figure 5b shows weather conditions on a reasonable transport day, 19 November. It seems likely that the return migration was again faster than the preceding autumn migration. However the many short-term variations in the weather patterns suggest that direct flights from Victoria and Tasmania to the Hunter Region were unlikely.

The lack of favourable weather conditions for return migrations from New Zealand is significant. Autumn 1991 was a reasonable year for migrations to New Zealand. However, only twice between 29 October and 9 December were the conditions appropriate to allow following winds (SE) across the Tasman Sea along the northern side of a high. On both these days, 14 and 29 November, the corridor shut off in less than 24 hours, and wind speeds tended to be less than 40 km/h. Migration at these times would have been very difficult. Only at the very end of the survey period, 14 December, was a direct meteorological link with New Zealand established, as a ridge oriented NW-SE extended from SE Australia to New Zealand and winds on the Australian coast were SE (onshore) at speeds up to 80 km/h (Figure 6b).

### CONCLUSION

The results of this analysis confirm those of Maddock & Bridgman (1992) and provide further information for 1990 and 1991. Cattle Egret migration from the Hunter Region to Victoria and Tasmania was in a series of waves. Travel was not direct but in stages with several rest stops. Major staging points seemed to be Windsor (NSW), Nowra (NSW), and Bairnsdale (Vic). Migratory flight was always in northerly airflow along the western side of a high pressure system, with occasional flights in an easterly crosswind. The passage of fronts and the shift of winds to the south always prevented migratory flight.

The migration pattern to New Zealand was less well defined. Fewer egrets were seen in 1990 and 1991 in New Zealand than in previous years, with dominant easterly winds associated with unusual weather patterns considered responsible. Flights directly from NSW, or from NSW via Tasmania in south-westerly airflow, were both possible.

Return migration to the Hunter from Tasmania and Victoria also in stages, was more direct, with fewer and shorter rest stops. Major staging points were Weribbee (Vic), Nowra (NSW), and the Wyong area (NSW). Flight occurred in southerly airflow. Returns from New Zealand were not directly observed, but the weather records suggest that only one return period in each year was possible, 4-7 Nov, 1990, and after 14 Dec, 1991.

The approximate times of arrival and departure highlight the limitations of a ground-based observer network for tracking migrating egrets. During 1994 it has become possible to conduct a pilot study on satellite tracking with the assistance of Australian Research Committee Small Grant funding. A new light-weight (30 grams) satellite transmitter, developed in late 1993, was mounted on the back of two Cattle egrets released at Richardsons Swamp,