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COORONG TO OUTBACK: OBSERVATIONS OF A BANDED STILT BREEDING COLONY AT LAKE TORRENS, SOUTH AUSTRALIA, MAY 2010

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In early 2010, heavy rain fell across the outback region of South Australia. Later that year the Coorong population of Banded Stilts (*Cladorhynchus leucocephalus*) left their usual coastal habitat, prompting an aerial search for the breeding birds across the vast salt lakes of northern SA. The search resulted in the discovery of one of the largest breeding colonies of Banded Stilts ever recorded at an isolated island in Lake Torrens National Park. A field surveillance team travelled to the island to observe the colony and, if required, to minimise the impact of Silver Gulls on the breeding birds. In this paper we provide an overview of past Banded Stilt breeding events in Australia. We describe the climatic conditions leading up the 2010 mass breeding event, the techniques used to discover the colony and the results of aerial and field-based observations, including observations on any impacts of Silver Gulls. We also provide information from follow-up observations, including the discovery of a second smaller colony at Lake Torrens in the same year. Using a conservative method that attempted to account for mortality, we estimate that more than 190,000 chicks departed the island after the initial breeding attempt. Subsequent breeding on the same island and in the secondary colony would have added substantially to this number. The mass breeding event is likely to contribute significantly to the long term viability of the Banded Stilt population in southern Australia.

INTRODUCTION

The Banded Stilt (*Cladorhynchus leucocephalus*) is a unique endemic Australian wader. The species is well known for its remarkable behavioural and physiological adaptations to the erratic rainfall patterns of the Australian outback. In early 2010, the world Banded Stilt population was estimated at between 206,000 and 260,000 individuals (Delany & Scott 2006, Geering *et al.* 2007). The species is listed as 'Vulnerable' under the South Australian *National Parks and Wildlife Act 1972*. The International Union for Conservation of Nature (IUCN) recognises the Banded Stilt as a species of 'Least Concern' given its broad range and the lack of a significant population reduction in the past decade (Birdlife International 2011). However, their dependence on spasmodic inland rainfall events and the significant impacts of Silver Gulls (*Chroicocephalus novaehollandiae*) on recent breeding attempts (Minton *et al.* 2000, Baxter 2003), suggest the species may be susceptible to sudden declines that could potentially threaten long-term population viability (Baxter 2003).

Large non-breeding flocks of Banded Stilts are commonly observed at estuarine and salt marsh habitats along the coastline of southern Australia (Marchant & Higgins 1993, Baxter 2003). However, knowledge of their breeding behaviour and movement patterns is incomplete because of the infrequent occurrence of suitable climatic conditions, the remoteness of preferred nesting areas and the speed with which breeding events occur. Large flocks of Banded Stilts are known to depart their non-breeding coastal habitats, setting down to nest close to the water on the exposed sand-spits and islands of ephemerally flooded inland salt lakes of inland southern Australia, including southern Western Australia, within days of their departure (Burbidge & Fuller 1982, Bellchambers & Carpenter 1992, Marchant & Higgins 1993, Gosbell & Christie 2006). Breeding pairs are thought to mate en-route as the first eggs are laid almost immediately following their arrival at chosen colonial nesting sites (Robinson & Minton 1989). Breeding coincides with the emergence of small crustaceans (mostly Brine shrimp (*Parartemia sp.*)) that provide the breeding stilts with an abundant and reliable food source (Jones 1945a,b, Williams *et al.* 1998, Gosbell & Christie 2006). The remoteness of the breeding islands, combined with the protection afforded by the surrounding salty water, provide an ideal refuge for the birds and protection from native and introduced terrestrial predators (Robinson & Minton 1989, Bellchambers & Carpenter 1992).

Banded Stilt nests are shallow earth scrapes, often adorned with a small amount of vegetation (Marchant & Higgins 1993). Clutches typically consist of 3-5 large eggs, which are continuously incubated by both parents and hatch within 19-21 days. The chicks are large (~30g) and immediately active and alert (Robinson & Minton 1989, Williams *et al.* 1998). Soon after hatching the chicks are led to the lake, dispersing vast distances (up to 100km from the colony) and independently feeding on brine shrimp (Williams *et al.* 1998). Chicks are fully feathered at 6-weeks (Gosbell & Christie 2006) and once the previous brood has departed, and if conditions are suitable, the nesting adults will remain and mate for a second time. Complete or partial breeding colonies will sometimes move to different islands for subsequent breeding attempts (Robinson & Minton 1989, Williams *et al.* 1998).

Prior to the 2010 breeding event reported in this paper, approximately thirty-two Banded Stilt breeding

events had been documented across southern Australia (see Table 1). The first confirmed breeding events were at Lake Grace in southern Western Australia (WA) in 1930 and Lake Callabonna in South Australia (SA) (Figure 1) in 1930. The most recent breeding events occurred at Lake Ballard, WA, in 1995, and more recently at Lake Eyre North National Park, SA (Figure 1) in 2000. Since the first South Australian record, only seven further breeding events have been recorded in the state (Table 1).

Silver Gulls have been identified as a key predatory threat to the success of Banded Stilt breeding events and the long-term population viability of the species (Minton *et al.* 2000, May 2000, Baxter 2003). Although native to Australia, the gull population has been artificially increased by access to human food resources (Smith & Carlile 1992, Kingsford & Norman 2002). Silver Gulls also flock to inland salt lakes when they fill with water, often breeding in close proximity to Banded Stilt colonies and aggressively attacking and eating stilt eggs and chicks (Robinson & Minton 1989, Bellchambers & Carpenter 1992). Towards the end of the breeding event at Lake Torrens in 1989, Robinson & Minton (1989) estimated that 99.5% of chicks and eggs were taken by Silver Gulls. In 2000, at Lake Eyre North, Banded Stilts attempted to breed at Hughes Island. The first two breeding attempts failed due to unremitting Silver Gull predation. Fearing serious impacts on the stilt population, the Department of Environment and Natural Resources (DENR) intervened, culling a significant number of the culprit Silver Gulls. Following DENR's intervention, the Stilts attempted to breed for a third time, successfully producing approximately 50,000 chicks (Baxter 2003).

Widespread rainfall and cool conditions across Australia during 2010 led to the coolest year for a decade, and South Australia's third wettest year on record (BOM 2011a). In February and April of 2010 several low pressure troughs triggered heavy rainfall across much of outback South Australia, including over the catchments of Lakes Eyre, Torrens, and Callabonna and Lake Frome (BOM 2011b), previous breeding locations for Banded Stilts. In particular, rainfall of between 31-156 mm fell across the northern half of the Lake Torrens catchment in February and April. The heaviest of the April rain fell on the 9th (85-124mm), with less significant falls on the 6th (18-32mm) and 21st (19-38mm). The north-west quarter of the Lake Torrens catchment area received the heaviest falls; Andamooka and Roxby Downs Pastoral Stations received between 155-165 mm each (BOM 2011b). The April 9th rainfall flowed into the north-western section of the lakebed, and was detectable from satellite imagery within days (Modis 2010). Realising the potential for a significant breeding event and the serious threat posed by Silver Gulls, local amateur birdwatchers and DENR staff worked together to document the event and discover more about this enigmatic bird species.

This paper: 1) describes the methods used to locate and survey the Banded Stilt breeding colony at Lake Torrens; 2) presents results of observations made during a field expedition to the island in May 2010, including the impact of Silver Gulls; and 3) provides information from follow-up visits to the colony, including the discovery of a smaller secondary breeding colony at Lake Torrens. These findings are discussed in the context of previous studies and broader implications for the conservation of the species.

METHODS

Locating the breeding stilts – aerial surveys

Banded Stilts were observed at the Coorong, just south of Hacks Lagoon up until the 5th April, 2010 after which time they were not seen. To confirm that the stilts were not present at the Coorong, an opportunistic aerial survey of the Coorong was conducted by DENR on the 29th April. The survey began at the Murray Mouth, tracking south along the western shoreline to Stonywell Island, returning northwards along the eastern shoreline (Figure 1). Aerial surveillance focused on the backs of islands and embayments and on sites known for stilts, such as "The Needles" and "Parnka Point" (P. Wainwright *pers. comm.*). No Banded Stilts were recorded during the survey, providing justification for a broad-scale aerial survey of the outback salt lakes in South Australia (Figure 1).

A comprehensive survey of these lakes was proposed, with Lake Torrens National Park identified as the most likely breeding location on the basis of previous breeding records (Table 1). An aerial survey of the lakes was conducted by DENR on the 4th May. The survey began at Lake Frome, tracked north-east to Lake Callabonna, and then north-west to Lake Gregory, before returning along the western shoreline of Lake Torrens (Figure 1). Each salt lake was surveyed at a minimum of 60 metres (200 feet) altitude. Attention was given to islands within each lake, with persistent scanning for the presence of a "white and black moving surface". Lake Eyre was not surveyed because DENR Ranger staff had surveyed it on the 3rd May, reporting no sign of breeding Banded Stilts.

The survey team found no evidence of breeding colonies at Lakes Frome, Callabonna, or Gregory despite a thorough search. However, along the western shoreline of Lake Torrens several hundred stilts were seen feeding in the shallow water. As the plane tracked south along the eastern shoreline of Andamooka Island a small island with a nesting colony of densely packed Banded Stilts was spotted 3 km from the western shoreline of Lake Torrens. The island was later named 'Arduous Island' for future reference.

Table 1. Recorded Banded Stilt breeding events, 1904-2010.

Date	Location	No. Pairs/Nests	Comments	Reference
1904	Lake Cowan, WA	*	Unconfirmed - large colony	Whitlock 1932, Jones 1945a,b
1923	Quinn's Find, WA	At least 100 birds	Unconfirmed - but very likely	Jones 1945a,b
1929	near Menzies, WA	*	Unconfirmed - thousands of dead chicks	Glauert & Jenkins 1931, Jones 1945a,b
1930	Lake King, WA	*	"tens of thousands of adults and countless chickens"	Glauert & Jenkins 1931
1930	Lake Grace, WA	40,000 nests	No comment	Glauert & Jenkins 1931, Carnaby 1946
1930-31	Lake Callabonna, SA	27,000 nests	Colony covered an area of 3,640m^2. An estimated 81,000 eggs were produced.	McGilp & Morgan 1931, Minton *et al.* 2000
1936	Lake Callabonna, SA	*	Thousands of adults observed on an island - one egg observed - no further information available	SAOA 1937
1937	Seepage Swamp, Lake Torrens, SA	*	Unconfirmed - but likely	Cain 1938
1945	Lake Grace, WA	*	No comment	Carnaby 1946
1946	Lake Grace, WA	500 nests	No comment	Carnaby 1946, Burbidge & Fuller 1982
1960	Wagga Wagga Lake, WA	40-50 nests	Colony abandoned before egg laying commenced	Burbidge & Fuller 1982
1963	Lake Ballard - Menzies District, WA	*	1,400 chicks walked through town	Minton *et al.* 1995
1971	Lake Disappointment, WA	*	Probably bred, an adult & juvenile were spotted nearby, but the breeding colony was not observed.	Clarke *et al.* 2004
1973	Lake Ballard, WA	*	No comment	ODX EIS 2009
1974	Lake Ballard, WA			
1975	Lake Ballard, WA			
1975	Lake Marmion, WA	2,500-25,000 nesting pairs	25,000 breeding pairs in March, reducing to 2,500 nesting pairs in May.	Burbirdge & Fuller 1982, Kolichis 1976
1980	Lake Barlee, WA	178,835 (± 34,843) nests	High nest density likely due to successive waves of birds laying within the colony. Colony later abandoned due to falling water levels (est. 255,000 addled eggs & dead chicks). A large number of chicks (possibly around 350,000) are thought to have fledged prior to abandonment.	Burbidge & Fuller 1982
1980	Lake Goongarrie, WA	*	No comment	ODX EIS 2009
1980	Esperance, WA			
1981	Lake Ballard, WA			
1984	Lake Eyre NP, SA	*	Probably at Lake Eyre	Minton 1989, Minton *et al.* 2000, Baxter 2003
1986	Lake Ballard, WA	*	No comment	ODX EIS 2009
1988	Lake King, WA	*	No comment	ODX EIS 2009
1989	Lake Torrens NP, SA.	50,000 breeding pairs	Est. 50,000 pairs nested across 3 islands in the southern Lake Torrens NP.	Minton 1989, Robinson & Minton 1989, Bellchambers & Carpenter 1992
1992	Lake Barlee, WA	*	No comment	ODX EIS 2009
1992	Lake Giles, WA			

Table 1 continued. Recorded Banded Stilt breeding events, 1904-2010.

1995	Lake Ballard, WA	35,000+ nests	Multiple colonies. 20,000 nests at main colony & 15,000 at second major colony. 70,000-175,000 eggs may have been produced.	Minton *et al.* 1995
1997	Lake Eyre (North) NP, SA	*	No comment	Baxter 2003
2000 (Feb-April)	Lake Eyre (North) NP, SA	18,000 nests (9,000 occupied)	Stilts tried to breed at Hughes Island, but aggressive Silver Gull predation of eggs & chicks caused the failure of almost 9,000 nests (potential 27,000 eggs & chicks). Only 322 chicks were observed successfully departing the colonies.	Minton *et al.* 2000, Baxter 2003
2000 (May)	Lake Eyre (North) NP, SA	4,000 nests (abondoned)	Stilts nested again in late May at Hughes Island. Approx. 4,000 nests produced, but were abandoned by 31st May due to incessant gull predation	Baxter 2003
2000 (July)	Lake Eyre (North) NP, SA	18,000 breeding pairs	18,000 breeding pairs successfully bred to produce est. 50,000 chicks at Ibis Island in July. Following extensive Silver Gull control by NPWSA.	Baxter 2003
2000 (July - August)	Lake Eyre (North) NP, SA	2,000 breeding pairs	Nests abandoned in early August due to receding water levels, nearest water to Ibis Island was 8km.	Baxter 2003
2004	Lake Disappointment, WA	*	Breeding colony not visited. Approx. 750 chicks found dead scattered around the Lake. Some evidence to suggest some chicks successfully fledged.	Clarke *et al.* 2004
2006	Coorong, South Lagoon, SA	*	2 major nesting sites located with a combined potential to produce 2300 - 3100 chicks, but only 1006 juveniles were observed	Gosbell & Christie 2006
2010 (April - July)	Lake Torrens NP, SA	150,000 birds	The number of birds was calculated from aerial photos and ground measurements. Refer to Methodology section	(current study)
2010 (May)	Lake Eyre (North) NP, SA	4,500-5,000 nests	Small colony discovered mid-May by Trevor Wright. Subsequent aerial survey by DENR SA confirmed est. 4500-5000 nests present on Ibis Island (counted from aerial photo). Est. 6-7,500 eggs may have been produced.	T Wright *pers. comm.*, A. Clarke *pers. obs.*

* information not available or not recorded

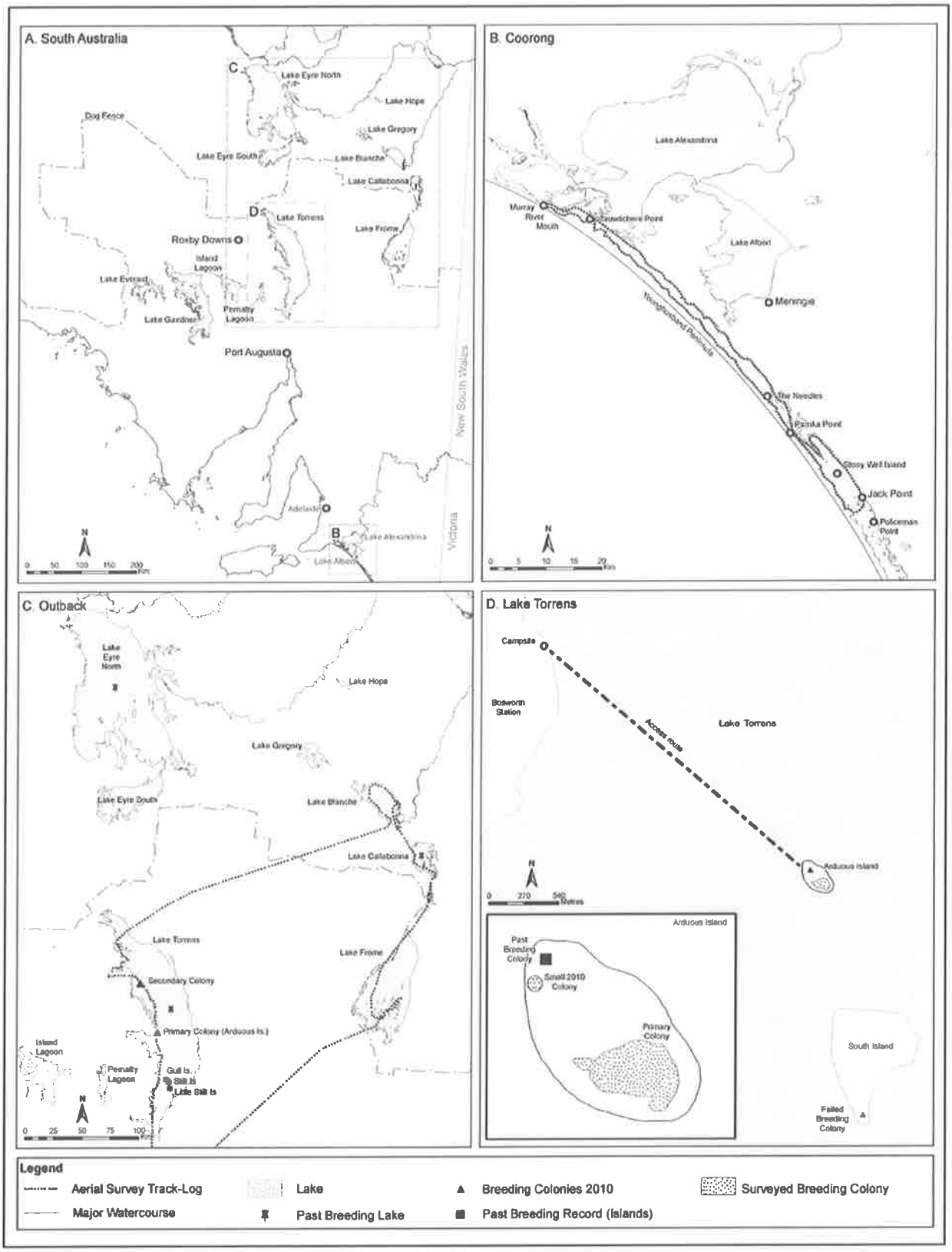


Figure 1. Map of the study area showing: A) locations in South Australia, B) flight path at the Coorong, C) flight path over the outback salt lakes, previous breeding locations and the location of the primary and secondary colonies in 2010, and D) the access route to Arduous Island, the failed breeding colony at "South Island" and (inset) the location and extent of the documented and past breeding colonies on Arduous island.

Site description and access

Arduous island is oval in shape, approximately 250 metres north-south and 100 metres east-west. It is a protrusion of the gibber pavement, which dominates the landscape adjacent to the nearby western edge of the lake, and rises to a maximum of 2.5-3.0 meters above the lake surface. A layer of loamy sand, vegetated with low chenopod shrubland, covers the gibber over much of the island. Where the gibber is exposed, in a relatively small portion of the northern half of the island, only sparse (<10% cover) Samphire (*Tecticornia* sp.) occurs. On the 20 metre wide shelf around the island perimeter there is even more sparse Sea-heath (*Frankenia* sp.), in some parts fringed with Pop Saltbush (*Atriplex holocarpa*). Plant species diversity and density is poorer in the area of the Banded Stilt breeding colony at the southern end of the island, where Bladder Saltbush (*Atriplex vesicaria* ssp.) is dominant.

Access to the site was gained through Bosworth Station. Once at the western shore of Lake Torrens, kayaks or wading were used to cross the knee-deep water between the island and the mainland camp. The island lay approximately three kilometres from the western shoreline of Lake Torrens (Figure 1D). The majority of the nesting birds were located on the southern end of the island while a much smaller colony of an estimated 250 nests was located near the northern tip.

Aerial estimates of colony population size

Aerial photographs of the primary colony at Arduous Island were used to rapidly assess the size of the breeding population prior to the field visit. High resolution images were captured using a Canon 1D digital camera while flying between 60 m and 90 m altitude. The plane was tilted onto its side while passing over the colony, providing the greatest field of view possible to capture both close-up and broad-scale images.

A rough initial estimate of the colony size was 70,000 birds. We considered it important to be able to rapidly assess colony size from the aerial surveys as detailed field visits to colonial bird breeding sites are often not be possible due to resource constraints, limited access or remoteness. To estimate colony size, a combination of close-up and broad-scale images was used. Initially, a broad-scale image of the entire colony was printed and a regular 5mm x 5mm grid superimposed over the image. The total number of grid cells overlapping the colony was counted and summed. Cells at the edge of the colony had on average half the number of birds compared with interior cells and these were counted as half cells.

Five of the best quality close-up images were then used to determine the number of birds present on the ground. These were scaled relative to the broad-scale image by comparing the dimensions of vegetation features common to images at both scales. Using this method, an approximate scale of 1:5 was calculated, indicating that cells with dimensions of 25 mm x 25 mm in the close-up images contained the same number of birds as the 5 mm x 5 mm cells in the broad-scale image. Counting the entire colony was not possible due to the resolution of the photos and the time required to do this. Instead, the number of birds present in 13 sample cells across the five close-up images was counted, and the mean number of birds per sample cell calculated. This number was then multiplied by the total number of occupied cells from the broad-scale (colony) image to derive an estimate of total population size. The estimate conservatively assumes that both adult birds were present at the nest at the time of the photograph.

Field observation methods

The breeding colony was observed for six consecutive days from 10th May – 15th May 2010, coinciding with the peak departure of chicks from the island. Surveyors were present at the colony between 1-2 hours after dawn to 1 hour before dusk. Care was taken to disturb the colony as little as possible. However, in the absence of large numbers of Silver Gulls, a low level of disturbance was deemed acceptable. Variables recorded included clutch size, scrape / nest densities, group size and colony departure rates, offshore group counts and chick mortality. Demographic and behavioural observations at the breeding colony as well as assumptions for estimation techniques are summarised in Table 2. A large amount of high definition video footage of breeding behaviour was also recorded at the colony for future use.

RESULTS

Estimate of colony population size

The total number of adult stilts in the primary colony was estimated from aerial photographs to be 135,100 birds. It was assumed that all birds observed from the air were breeding pairs, hence the number of nests was calculated to be half this number (i.e. 67,550 nests). Colony size was also estimated by multiplying the mean number of scrapes per quadrat (i.e. 9.50 / m^2 - see below) by the area of the colony from the GPS track log (i.e. 7,726m^2). This gave a total of 73,397 nests, a similar number to the aerial estimate.

Scrape density and clutch size

Scrape density ranged from six to 13 scrapes per square metre, with a mean density of 9.50 scrapes (Table 3). The mean number of eggs and/or chicks per scrape ranged from 0 - 5, with a mean of 2.85 (Table 3). A high proportion (75%) of all clutches had three eggs or chicks (Figure 2).

Figure 2. Distribution of clutch size.

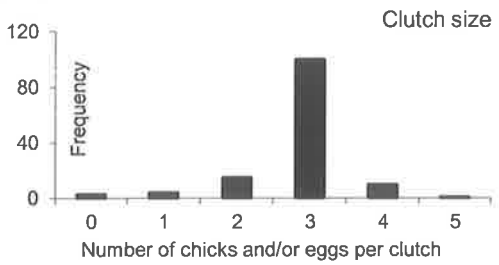


Table 2. Demographic and behavioural observations made at the breeding colony, methods used and assumptions made.

Observation	Method	Comments/ assumptions
Colony area	GPS track-log function used to create a polygon that was later used to determine area with ArcGIS software	Slight buffer from edge of colony to avoid undue disturbance to nesting birds
Clutch size	Combination of opportunistic visual counts (including photographs) at different parts of the colony and formal quadrat counts (see below)	The number of quadrats (n = 14) was minimised to reduce disturbance to the breeding birds
Scrape/Nest density	Photographs of 1m x 1m quadrats randomly placed at different locations within the colony (n = 14)	Photographs inspected later to determine number of scrapes / m^2
Group size counts & departure rates	Timed counts of the number of chicks and adults departing the island at different times of the day and standardised according to time spent counting	Counts included loose groupings of chicks and adult birds
Offshore group counts	The number of adults/chicks in groups swimming on the water surface >100m offshore from the island	Assumes that family groups have separated at >100m from the shoreline
Chick mortality rate	Approximate mortality rate calculated by comparing mean clutch size counts with mean offshore group size	Assumes that all chicks from each nest are led away from the island by one or both parents once offshore (i.e. >100m).
Vegetation information	Vegetation communities and plant species identified	None
Silver Gull numbers and behaviour	Daily gull count and record of predatory behaviour	None
Other predators	Daily count of other predators and opportunistic observation of predator behaviour	None
Other vertebrate species	Opportunistic records of other vertebrate species	Results not reported here
Aquatic	Water depth, sampling of aquatic invertebrate communities	Results not reported here

Table 3. Scrape density and clutch size counts.

	Mean (±SE)	Range	Sample size (n)
Scapes per m^2	9.50 (0.49)	6 - 13	14
Eggs and / or chicks per scrape	2.85 (0.06)	0 - 5	133

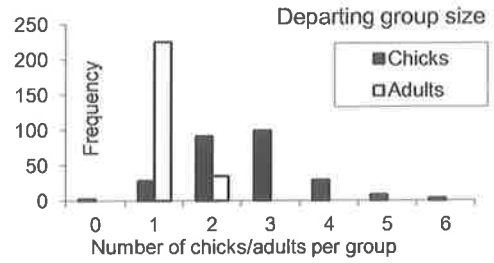
Table 4. Size of groups (adults and chicks) moving from the breeding colony to the water.

	Mean (±SE)	Range	Sample size (n)
Adults	1.57 (0.03)	0 - 9	707
Chicks	4.21 (0.09)	0 - 24	707

Group size and rate of departure

Groups of adults and chicks were observed moving from the colony to the water at points around the perimeter of the island, although the majority of departures occurred at the southern tip of the island. Departing groups contained up to nine adults and 24 chicks, however mean group size was 1.57 adults and 4.21 chicks (Table 4). The majority of these groups comprised one adult bird with two or three chicks (Figure 3).

Figure 3. Group size of departing birds.



Large groups of birds congregated loosely in the shallow water at the shoreline prior to departing the island. As the groups of birds moved offshore, they again separated into smaller groups with a mean of 1.13 adults and 2.62 chicks, typically one adult bird leading two or three chicks (Table 5).

Variation in departure rate appeared to be dependent on the time of day and prevailing weather conditions (Table 6). At the peak of activity, more than 2,800 chicks per hour were observed departing the island. At other times, departure rate was as low as 12 chicks per hour. Times of low departure rate appeared to coincide with inclement weather and maximum departure rates were commonly observed during the middle of the day (Table 6).

Predation

Silver Gulls were the main predators observed on the island. Gull numbers were variable during the survey period, with a maximum of 37 birds observed on the 13th May (Table 7). There were low levels of gull predation on Banded Stilt eggs and chicks and no gull breeding behaviour was observed on or around the island. The only evidence of gulls breeding in the outback in 2010 was a small nesting colony (only a few hundred birds) detected at Lake Eyre during aerial reconnaissance.

Opportunistic sightings of other predators included low numbers of Australian Raven (*Corvus coronoides*), flying to and from the colony on most days. A Wedge-

Table 5. Size of groups (adults and chicks) once > 100m offshore.

	Mean (±SE)	Range	Sample size (n)
Adults	1.13 (0.02)	1 - 2	260
Chicks	2.62 (0.06)	0 - 6	260

Table 6. Departure rates of chicks at different times during the field survey in 2010.

Sample ID	Date	Survey time/ duration	Departure rate (chicks/hr)	Weather conditions
1	12/5	12:16-12:46	1,362	Fine, sunny, warm, light wind
2	12/5	15.02-15.32	342	Fine, sunny, mild, light wind
3	13/5	10.31-11.01	2,842	Fine, clear, mild, still
4	13/5	13.06-13.36	744	Fine, clear, warm, still
5	14/5	11.01-11.11	1,266	Fine, clear, mild, light wind
6	14/5	12.15-12.25	282	Fine, clear, mild, light wind
7	14/5	13.30-13.40	174	Fine, overcast, mild, light wind
8	15/5	09.00-09.10	12	Fine, overcast, cool, moderate wind
9	15/5	10.00-10.10	18	Fine, overcast, cool, moderate wind
10	15/5	11.07-11.17	18	Fine, overcast, cool, moderate wind
11	15/5	12.00-12.10	204	Fine, overcast, mild, moderate wind

tailed Eagle (*Aquila audax*) was observed on the island once, after it was disturbed from the ground on the edge of the northern colony. A single Black Kite (*Milvus migrans*) was observed on one occasion circling over the colony.

Chick mortality

Mortality rate, determined by comparing mean clutch size on the island ($\bar{x}$ = 2.85) with mean offshore group size ($\bar{x}$ = 2.62) was estimated at 8.1%. This was used to calculate the number of chicks that successfully departed the island, based on an overall breeding colony size of 73,397 nests. Using this method, it was estimated that 192,000 chicks left from Arduous island. This figure does not take into account the number of surviving chicks from the subsequent breeding attempts or from the secondary breeding colony.

Other important field observations

One adult stilt with an orange overyellow banding flag was observed during the survey, confirming the presence of birds from the Coorong population (see Gosbell & Christie 2006).

Evidence of two earlier breeding events or attempts was found in the area. One was a recently abandoned attempt on the southern tip of a separate larger island less than a kilometre south of the active breeding colony (Figure 1D inset), and the other was a much older nesting site underlying the small active breeding colony on the north-western corner of Arduous Island (Figure 1D inset). At the former colony, many of the nest scrapes still contained eggs, whilst other eggs were scattered loosely around the area. Approximately 150 dead adult birds were scattered throughout and around the colony with little evidence of predation.

Follow-up after the initial visit

During an aerial survey on the 21st May, a secondary Banded Stilt breeding colony was discovered on an island approximately 50kms to the north of the original colony at Lake Torrens (Figure 1C). A conservative estimate of 15,000-20,000 nesting individuals was made from the aircraft. The birds appeared to be sitting on eggs and there were no chicks visible in the water surrounding the island. Silver Gull presence appeared to be higher at this colony. On the same day, an aerial survey of Lake Eyre (on advice from Trevor Wright) uncovered a Banded Stilt breeding colony of around 4,500-5,000 birds incubating their eggs on Ibis Island, the site of a previous breeding event in 2000. Silver Gull presence at this colony was deemed to be low. Subsequent observations of the Banded Stilt breeding colony at Arduous Island following the initial survey period are summarised in Table 8.

DISCUSSION

Our observations of the Banded Stilt clutch size and scrape density are similar to those of previous field-based studies (e.g. Burbidge & Fuller 1982, Robinson & Minton 1989, Bellchambers & Carpenter 1992). The maximum chick departure rate from Arduous Island exceeded that documented by Minton *et al.* (1995) for a smaller breeding colony in Western Australia. Our observation of groups of chicks departing from the island closely associated with a single parent or (pair of adults) concurs with the findings of Minton *et al.* (1995) who noted no true crèching behaviour.

Table 7. Silver Gull numbers observed daily at Arduous Island from 10th – 15th May 2010.

Date	Number of Silver Gulls
May 10	7
May 11	12
May 12	30
May 13	37
May 14	21
May 15	20
Mean (±SE)	21.2 (± 4.5)

Table 8. Observations of the Arduous Island breeding colony following the initial survey period.

Date	Survey type - participants	Estimated colony size (adult birds)	Silver Gull estimate	Comments
21st May	Aerial - Alex Clarke and Scott Dickery	40-60,000	30	• Thought to be incubating second clutch of eggs
4th June	Field - Alex Clarke	50-60,000 (75% still incubating eggs)	35-40	• Low numbers of chicks departing • Many nests and eggs abandoned • Evidence of recent dingo visitation • Water level reduced by 20-30% since May • Limited courting/mating behaviour
8th July	Aerial and Field – Alex Clarke	0	150-200	• Both colonies completely disbanded with no evidence of further breeding. • Water level low with lakebed exposed in some areas. • Signs of dingos • Thousands of juvenile stilts (most fully fledged) spread across the lake very few adult stilts present

*Observations of the same colony were also made by the VWSG and are reported elsewhere

Many questions regarding the stilt breeding behaviour remain unanswered. In particular, little is known about the different role played by adult male and female birds during breeding as they are difficult to distinguish in the field. Extensive high definition video footage and photographs captured as part of this study including of mating behaviour could be reviewed in more detail to potentially yield further insights into breeding behaviour and parental roles.

The success of breeding events following irregular inland flooding is linked closely to the conservation status and population viability of the Banded Stilt (Minton *et al.* 2000, Baxter 2003). Silver Gull predation was surprisingly low compared with previous events in South Australia (e.g. Robinson & Minton 1989, Bellchambers & Carpenter 1992). Although predation was apparent, the small number of gulls meant that the impact was low relative to the size of the stilt colony and gull control measures were not necessary. Increases in gull activity / predation were not observed when the stilts were disturbed from their nests and the birds appeared to resettle quickly. Disturbance to the breeding birds to collect data was deemed acceptable because of the low levels of predation. The reason for the lower than anticipated number of gulls is uncertain. However, it is possible that gull control measures (e.g. oiling and egg pricking) at nearby Roxby Downs in recent years have reduced gull numbers in the region.

A number of previous breeding events had occurred at Arduous Island and surrounding islands at different times in the recent past. The active smaller colony to the north of the island appeared to have started before the main colony, as most eggs had hatched and all adult birds had vacated the area by the morning of 13th May. The unsuccessful breeding colony on the southern island suggests that an even earlier group of birds arrived - the reason for the demise of this colony is uncertain but it is possible that the adult birds began nesting before sufficient aquatic invertebrate food sources were available. There was also evidence that a small number of stilts had nested on Arduous Island in previous years. This most likely coincided with widespread heavy rainfall in mid-January 2007 (R. Peddler *pers. comm.*). At this time Andamooka, approximately 100 kilometers to the north-west recorded rainfall of 48 mm over five days (17/1/2007 to 21/1/2007) and Pernatty Station, 45 kilometers to the south-west of the breeding site, recorded 73 mm over three days (18/1/2007 to 20/1/2007) (BOM 2011b).

The unexpected success of the breeding event documented in this study is likely to have resulted in a significant increase to the Banded Stilt population in Australia. Follow-up observations confirmed that breeding continued until late June, suggesting that some birds nested at Arduous Island for a second and possibly even third time, resulting in an even greater number of chicks successfully departing the colony. Although it is not possible to estimate the number of chicks that progressed to maturity, opportunistic aerial and field observations of large numbers of juvenile stilts have been documented in South Australia and it is likely that the sheer size of the breeding event, coupled with the relatively low chick mortality at the island has improved the long-term viability of the population.

Despite the success of this breeding event, we recommend that future events continue to be closely monitored for Silver Gull predation. Decisions by government about whether to protect and monitor future Banded Stilt colonies may depend on accurate and timely estimates of breeding colony size. The scale-based aerial estimation method used for this study proved to be consistent with field-based estimates and therefore suitable for future use. Where appropriate, gull control measures should be implemented in accordance with the Banded Stilt Action Plan (DENR 2009). This will aid in the ongoing management of predation and disturbance to nesting colonies. The monitoring and collation of data from this survey has provided a baseline to measure trends in occurrence and abundance over time from which future assessments and reviews of the species' conservation status can be based. Considering the dependence of the species on significant inland rainfall events and predictions for drier and warmer conditions under climate change scenarios for inland

southern Australia (Steffen & Hughes 2013), ongoing monitoring is recommended to ensure the long term viability of the population and to increase our knowledge of the breeding biology of the species.

ACKNOWLEDGEMENTS

We thank Iain Stewart, Keith Bellchambers and David Dadd for providing crucial information in early 2010 that lead to the discovery of the Banded Stilt colony. We also wish to thank members of the AWSG, VWSG and Friends of Shorebirds SE for their support during the breeding event. We are grateful for the support and resources provided by the Department for Environment and Natural Resources – without DENR, much of the biodiversity conservation work that occurs in South Australia would not be possible. We especially wish to thank Paul Wainwright, Peter Copley, Anthony Freebairn, Clare Manning, Simon Oster and Reece Pedler for their advice and support during the breeding event. We would like to thank an anonymous reviewer for comments on an earlier draft of this manuscript.

REFERENCES

Baxter, C. I. 2003. Banded Stilt *Cladorhynchus leuocephalus* Breeding at Lake Eyre North in year 2000. *South Australian Ornithologist* 34: 33-56.

Bellchambers, K. & G. Carpenter. 1992. Sudden Life on Stilt Island. *Natural History* 4: 42-48.

BirdLife International. 2011. *Cladorhynchus leucocephalus*. In: IUCN. (2011). IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>.Accessed: 22 November 2011.

Bureau of Meterology (BOM). 2011a. Australian rainfall patterns during El Niño events. Online Report, Available Online: http://www.bom.gov.au/climate/enso/ninocomp.shtml, Accessed: 21/7/2011.

Bureau of Meterology (BOM). 2011b. Monthly Climate Statistics. Online Report, Available Online: http://www.bom.gov.au/climate/data/index.shtml?bookmark=200, Accessed: 20/7/2011.

Burbidge, A.A. & P.J. Fuller. 1982. Banded Stilt breeding at Lake Barlee, Western Australia. *Emu* 82: 212 – 216.

Cain, W. 1938. Holiday Notes on North-Western Swamps. *South Australian Ornithologist* July 185- 187.

Carnaby, I.C. 1946. A Further Nesting Record of the Banded Stilt. *Emu* 46: 156–158.

Clarke, A., B. Muir, S. Elscot & J. Lane. 2004. Banded Stilt breeding attempt at Lake Disappointment. *Stilt* 46: 39.

Delany, S. & D. Scott. 2006. Waterbird Population Estimates (Fourth edition). Wetlands International, Australia.

Department of Environment and Natural Resources (DENR). 2009. Draft Banded Stilt (*Cladorhynchus leucocephalus*) Action Plan to Reduce Silver Gull Predation at Inland Salt Lakes. Unpublished internal report.

Geering, A., L. Agnew & S. Harding. 2007. Shorebirds of Australia. CSIRO Publishing, Victoria.

Glauert, M. L & C.F.H. Jenkins. 1931. Notes on the Banded Stilt (*Cladorhynchus leuocephalus*) with a description of its eggs. *Journal of the Royal Society of Western Australia* XVII: 1-7.

Gosbell, K. & M. Christie. 2006. The Breeding of Banded Stilt and Red Necked Avocet in the Coorong, South Australia: December 2005 – February 2006. *Stilt* 50: 277-284.

Jones, J. 1945a. The Banded Stilt (Part 1 and 2). *Emu* 45: 1–36.

Jones, J. 1945b. The Banded Stilt (Part 1 and 2). *Emu* 45: 110–118.

Kingsford R.T. & F.I. Norman. 2002. Australian waterbirds – products of the continent's ecology. *Emu* 102: 47-69.

Kolichis, N. 1976. New breeding records of the Banded Stilt in Western Australia. *Western Australian Naturalist* 13: 114-119.

Marchant, S. & P.J. Higgins. 1993. Handbook of Australian New Zealand and Antarctic Birds Vol. 2: (Raptors To Lapwings). Oxford University Press, Melbourne.

May, I. 2000. Banded Stilts – the conclusion. *Galah* 46: 8.

McGilp. J. N. & A.M. Morgan. 1931. The nesting of the Banded Stilt (*Cladorhynchus leucopephalus*). *South Australian Ornithologist* 11: 37-53.

Minton, C. 1989. Banded Stilts do breed. *RAOU Newsletter* 80: 3.

Minton, C., R. Jessop & P. Collins. 2000. Visit to Banded Stilt breeding colony on Hughes Island, Lake Eyre North. Unpublished Report to NPWSA, Department for Environment and Heritage, Adelaide.

Minton, C., G. Pearson & J. Lane. 1995. History in the mating. Banded Stilts do it again. *Wingspan* 5: 13-15.

Modis 2010. Modis Satellite Imagery (NASA Earth Data). Tingana Tingan image. Online Data, Available Online: http://rapidfire.sci.gsfc.nasa.gov/subsets/index.php?subset=AERONET_Tinga_Tingana. Accessed: 15/6/2011.

Olympic Dam expansion Environmental Impact Statement (ODX EIS). 2009. *Review of potential effects of the expanded tailings retention system on shorebirds*. Olympic Dam Expansion Environmental Impact Statement. Arup Pty/ Ltd on behalf of BHP Billiton written by Brett Lane and Associates Pty. Ltd. Appendix N11. 225-230. BHP Billiton, Australia.

Robinson, T. & C. Minton 1989. The enigmatic Banded Stilt. Lasting Impressions of exciting field experiences. *Birds International* 1: 72-85.

South Australian Ornithological Association (SAOA). 1937. Bird Notes. *South Australian Ornithologist* 14: 104.

Smith, G. C. & N. Carlile, N. 1992. Methods for population control within a silver gull colony. *Wildlife Research* 20: 219-225.

Steffen, W. & Hughes, L. 2013. *The Critical Decade 2013: Climate change science, risks and response*. Commonwealth of Australia (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education), Canberra.

Whitlock, F. L. 1932. The Nesting of the Banded Stilt. *Emu* 31: 271-272.

Williams, W.D, P.D. Deckker & R.J. Shiel. 1998. The limnology of Lake Torrens, an episodic salt lake of central Australia, with particular reference to unique events in 1989. *Hydrobiologia* 384: 101-110.

Stilt

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MISSION STATEMENT

To ensure the future of waders and their habitats in Australia through research and conservation programmes, and to encourage and assist similar programmes in the rest of the East Asian–Australasian Flyway.

OBJECTIVES

- To monitor wader populations through a programme of counting and banding in order to collect data on changes on a local, national and international basis.
- To study the migrations of waders through a programme of counting, banding, colour flagging and collection of biometric data.
- To instigate and encourage other scientific studies of waders such as feeding and breeding studies.
- To communicate the results of these studies to a wide audience through *Stilt*, the *Tattler*, other journals, the internet, the media, conferences and lectures.
- To formulate and promote policies for the conservation of waders and their habitat, and to make available information to local and national governmental conservation bodies and other organisations to encourage and assist them in pursuing this objective.
- To encourage and promote the involvement of a large band of amateurs, as well as professionals, to achieve these objectives.

MEMBERSHIP OF THE AUSTRALASIAN WADER STUDIES GROUP

Membership of the AWSG is open to anyone interested in the conservation and research of waders (shorebirds) in the East Asian–Australasian Flyway. Members receive the twice yearly bulletin *Stilt*, and the quarterly newsletter *Tattler*. Please direct all membership enquiries to the Membership Manager at BirdLife Australia, Suite 2-05, 60 Leicester St, Carlton Vic 3053, AUSTRALIA.
Ph: 1300 730 075, fax: (03) 9347 9323.
Email: membership@birdlife.org.au

Annual Subscriptions:	Australia & New Zealand	A$40.00
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	Institutions	A$50.00

Published in November 2013

EDITORIAL

Welcome to the combined the issue of *Stilt* 63 and 64. I would like to start by taking the opportunity to thank Andrew Dunn, who retired from the position of production editor of *Stilt* early in 2013. He commenced in this role in April 1996, along with the new editor Mike Weston. In the 17 plus years that have elapsed since then, he has presided over the production of increasingly better quality issues of *Stilt* and has helped raise the profile of the journal to that of a widely recognised repository for the publication of scientific material on waders. We all thank him heartily for his huge contribution over nearly two decades.

This issue contains updates on activities and data from New South Wales and Western Australia, as well as several contributions from Indonesia where our counterparts have been busy again with continued wader monitoring. We also have several contributions on our resident species, which makes a interesting change to the usual migratory wader reports. The first is from Stuart Collard and his colleagues at the South Australian Department for Environment and Natural Resources, who report on the Banded Stilt breeding event at Lake Torrens in 2010. The second is brought to us by Mike Newman, reporting on his intensive observations of brood capture by Australian Pied Oystercatchers in Tasmania. The third is thanks to Michael Murphy's survey work in the Pillaga Forest in northern NSW. This issue also includes a review of the Action Plan for Australian Birds by Graham Fulton. The latest percentage juvenile paper plus the last NWA expedition report by Clive Minton and colleagues are also included.

For those readers wondering why *Stilt* 63 never arrived in the post, unfortunately insufficient contributions were received in time to produce a full issue. I was very disappointed about this and wish to avoid this happening again in the future. I again encourage all readers to send in their contributions, whether they are working on a full research article or wish to provide a short report on their group's activities. Readers are welcome to contact me first if they are uncertain about the appropriateness of their material for publication.

I am pleased to announce a major change to the *Stilt* editorial team, which will greatly benefit the journal. This is the formation of an editorial board, which will be responsible for various functions from coordinating reviews, providing advice in relation to specific contributions, and presiding over dispute resolutions and other publication issues. I welcome Danny Rogers (Arthur Rylah Insitute for Environmental Research), Marcel Klaassen (Deakin University), Phil Battley (Massey University) and Zhijun Ma (Fudan University).

I would also like to welcome Nancy Van Nieuwenhove, who has taken over as the new production editor for *Stilt*. She joins myself, Yaara Rotman and the editorial board members to make a sound editorial team. We have also been greatly assisted by Margaret Cameron, Doris Graham and Linda Patrick with proof reading. Thanks also to the many reviewers that have helped with improving manuscripts for publishing.

I remind readers that *Stilt* now includes Instructions to Authors, which can be found at the end of this issue. Please familiarise yourselves with this document if you are planning to submit an article for publication

The AWSG committee held its Annual General Meeting on 9 October at Birdlife Australia's Head Office in Melbourne. Following the editorial is a report from the new chair, Alison Russell-French, which summarises the major activities of the AWSG since her commencement and highlights strategic directions for the AWSG. The annual Treasurer's report follows.

I hope you enjoy this issue of *Stilt* and I am looking forward to publishing the next one, which promises more interesting contributions from around the flyway.

Birgita Hansen
Editor

NEWS FROM THE CHAIR

This is my first report since becoming Chair of the AWSG in October 2012. I would like to first of all extend my appreciation on behalf of AWSG to the previous Chair Dave Milton for his support and leadership of AWSG over the period of his tenure as Chair.

The plight of waterbirds across the Flyway continues to be one of major concern with ongoing declines in populations. Much of this is the result of the loss of staging sites in the Flyway, particularly in the Yellow Sea, with ongoing major reclamation and development of tidal flats. This was highlighted (again) by David Melville at the recent Meeting of the Flyway Partners in June 2013 and at the International Wader Study Group meeting in October 2013. He presented a report on a survey he had undertaken with Chinese researchers of many important areas of the Chinese coastline from Shanghai to Yalu Jiang, and the outlook from the expanding rate of reclamation and development is very bleak indeed.

This highlights the importance of having the best available science to inform decisions about land use and appropriate conservation options. With this as a driving force, the work of the AWSG has focused over the last 12 months on a number of priority areas.

AWSG activities nationally

Leg Flagging and Banding Databases

The previous edition of *Stilt* included the very sad news of the sudden death of Heather Gibbs, Leg Flag and Banding Database Manager for the AWSG and the Victorian Wader Studies Group (VWSG). Heather's loss was a terrible blow to us all. She was such a committed member of AWSG and a very long-standing member of Birds Australia, and her loss has reverberated in many ways.

We have faced a critical situation with respect to the future of the databases that Heather managed. These were very much Heather's creation and the contribution she made to the data amassed by AWSG on banding and leg flags was quite unique. The databases are a vital source of information on shorebird movements in the Flyway that must be maintained.

We have been very fortunate to have one of our volunteers, Roger Standen, pick up the very challenging task of reviewing the databases with the view of providing recommended ways forward for AWSG to consider on the future of the databases. A small sub-committee of AWSG has been over sighting the task, led by Roger. This is still a work in progress and I hope to be able to report on where we will be going with this in my next report.

Monitoring

Monitoring under the MYSMA project in northern Australia has continued, with the project running for another year. A good team has been built for the project and some funding was also obtained from Western Australian Marine Science Institution to support analysis and publication of monitoring efforts. Owing to very efficient budget management, there will be carry-over funds to cover the costs of summer surveys in November and December 2013. We are particularly fortunate to have a very dedicated team (including Chris Hassell, Adrian Boyle and George Swann) that has offered to undertake the counts for free this year. However, this highlights the ongoing issues surrounding funds that are needed for this critical project and other AWSG activities. I shall return to that issue later in this report.

Shorebirds 2020

The Population Monitoring Program has been nurtured by AWSG for almost 35 years. It is through the database that we are able to study the trends in the decline of shorebird species in Australia. The current phase of the program was commenced in 2008 when Shorebirds 2020 was adopted as a key program of Birds Australia. Sadly funding for this important program has not been continued by the Australian Government in the latest round of Caring for our Country grants. However, BirdLife Australia will continue this very successful program in a reduced capacity and guided by different priorities. It is seeking input from Shorebirds 2020 volunteers to an online survey to assist in planning the future of the program. There has also been a change of staff responsibilities at BirdLife Australia as a result of the funding situation. Golo Maurer who has been the Shorebirds 2020 Project Manager is moving to the position of Business Development Manager. He will stay involved with Shorebirds 2020 but the role of Project Manager will be taken by Dan Weller. We wish them both well and a big thank-you to Golo for his enthusiastic support of the project and AWSG generally.

Global Flyway Network

AWSG also works closely with Chris Hassell in his work with the Global Flyway Network (GFN). The work that GFN is doing in Bohai Bay (China) is providing a vitally important insight into the situation affecting shorebirds across the Yellow Sea and Chris provides regular information on the work of GFN. He is also a very strong advocate for shorebirds and has a strong presence in the local media.

Banding

Banding activities have been actively pursued over the 12 months. Almost 500 geolocators have now been placed on waders at a cost of almost $100,000 (provided from a number of sources). The geolocator program on waders is a major one and Australia is probably leading the activity globally. This work is primarily being done by the volunteer efforts of the AWSG, VWSG and Friends of Shorebirds SE, the Queensland Wader Studies Group and the GFN with some support from Deakin University.

As well, satellite transmitters will be put on Little Curlew in the 2013 November Broome expedition. Very little is known about Little Curlew migration and the satellites will hopefully provide much needed data. The terrific contribution by Clive Minton and volunteers, both financially and with commitment of their time, needs to be recognised as a hugely important element in the success of the banding activities.

AWSG Scientific Committee

The Scientific Committee of AWSG is considering future research directions and has, as a major exercise at present, the development of a position paper that will focus on the priorities that researchers need to undertake to support shorebird conservation in the Flyway. This is being considered in the context of "How do Shorebirds react to Habitat Loss?" The Scientific Committee has actively collaborated with Richard Fuller and his team from Queensland University who are conducting the three year ARC-funded project that is examining Flyway-wide trends in the abundance of waders and the extent of their habitat.

AWSG engagement internationally

East Asian – Australasian Flyway Partnership (EAAFP)

The EAAFP Meeting was held in Alaska in June 2013. AWSG was represented by Ken Gosbell in his role as Chair of the Shorebird Working Group, with a very challenging number of issues presented including David Melville's assessment of tidal flat habitat loss along the Chinese coastline. Phil Straw, Vice President of AWSG, participated in the Communication, Education and Public Awareness (CEPA) Working Group that is looking to bring together case studies from different sites to enhance education and learning about management of important sites. As Chair of AWSG, which is one of the Partners of the Flyway Partnership, I represented AWSG on behalf of BirdLife Australia across the broader range of issues and discussion.

The meeting was hosted by the US Government Department of Fisheries and Wildlife Services and the program offered a number of opportunities to consider what is being done (and not done) in the Flyway to address the state of migratory shorebirds and their habitat across the Flyway.

Prior to the Partnership meeting, meetings were held with the Commonwealth Department to discuss the agenda of the meeting and possible areas of cooperation for positions.

There were a number of significant elements in the program that reflected the need to address shorebird and shorebird habitat conservation. These were (a) the report which listed and prioritised important sites in the Flyway providing guidance and tools to assist in the nomination of high priority sites not yet listed, (b) a Science Workshop led by Dr Richard Fuller of Queensland University and assisted by Dr Judit Szabo, the new Science officer of the Partnership. This workshop focused on issues ranging from population collapse in migratory shorebirds in Australia, new methods of assessment of tidal flat losses in the Yellow Sea, understanding migration routes through use of geolocators to cost / benefit of habitat loss, and (c) a number of sessions on the importance of and threats posed to Yellow Sea shorebird habitat.

The Partnership meetings offer an opportunity to exchange information and practical experience in what is being done to address shorebird conservation. However, the dynamics of meetings are also very challenging with the multi-lingual representation of Partners and a very full agenda only on a 1-2 year basis. The Partnership now has 30 Partners including national governments (15), inter-government organisations (4), NGOs (10) and the international business community (1). Three new partners were welcomed at the meeting – Malaysia, the Conservation of Arctic Fauna and Flora (Arctic Council) and the Wildlife Conservation Society.

AWSG has been elected to the EAAFP Management Committee that advises the Partnership Secretariat and we will work to provide guidance and assistance to the Secretariat based on our experience, knowledge and research on migratory shorebirds. We certainly should not under-estimate the challenges that face the Partnership in meeting its objectives when faced with the range of social and economic pressures arising from land-use and development action in the Flyway. These are the root cause of many of the problems facing migratory shorebirds and make it imperative that good science is as the base of decisions about land use and conservation of shorebirds' habitat.

AWSG administrative issues

Structural issues following the formation of BirdLife Australia

AWSG is now a Special Interest Group of BirdLife Australia following the merger of Birds Australia and Bird Observation & Conservation Australia. As this required new Rules of Operation for AWSG, the opportunity was taken to include in the new Rules the flexibility to co-opt up to four additional members to be able to formally take advantage of a broader range of skills and expertise. We have done so with the addition of Dave Milton, Maureen Christie, Jon Coleman and Penny Johns as the current four co-opted members. Arthur Keates took on the role of Treasurer after the resignation of Brian Speechley and has made sterling efforts in the management of AWSG funds as well as taking responsibility for drafting the new Rules of Operation. The Board of BirdLife Australia approved the new Rules early in 2013.

AWSG is building a stronger working relationship with BirdLife Australia and this was enhanced by Ken Gosbell giving a presentation on AWSG to BirdLife Australia staff, many of whom are new to the organisation. We are keen to work with the new BirdLife CEO, Paul Sullivan, who has shown interest in achieving a strong working relationship between AWSG and BirdLife Australia. This is particularly important in the context of funding which is a fundamentally important

issue for both. BirdLife Australia is working to build a more secure financial base for the organisation as a whole and AWSG will be part of this effort. Funding for wader research, the databases and ongoing monitoring and banding are our critical areas of funding needs, and we have discussed options for these with BirdLife Australia including the new role that Golo Mauer as Business Development Manager. We have already had the Board approve funding support for the initial work on the databases.

Conservation

Following the resignation of Dr Joan Dawes after two solid years of hard work in the national conservation position, we are currently looking at measures to both fill the national conservation position and work more cohesively within the BirdLife Australia conservation framework to maximise efforts to manage the wader conservation agenda. On behalf of AWSG I extend particular thanks to Joan for all her hard work and dedication in the conservation work she undertook during her time in the position. Joan will continue with her conservation work in NSW.

A number of meetings were also held with the Department over the 12 months to discuss a range of issues associated with migratory shorebirds and their conservation. The meetings were attended by Ken Gosbell, Joan Dawes, Doug Watkins and I. Samantha Vine, BirdLife Australia's Manager of Conservation, also attended meetings when able to.

AWSG Membership

As readers of *Stilt* will have seen editor Birgita Hansen has been doing a fantastic job and she is always keen for submissions to come her way. She has also taken on responsibility for AWSG membership as we are very keen to increase our membership base. It is through our members that we can much more effectively raise the profile of migratory and resident shorebirds, their ecological importance, and the threats that are facing them. The local voice can be very powerful and I urge members to take up the cause locally and nationally to conserve our waders with the community, industry and governments.

We are also seeking members' support in encouraging those who are interested in shorebirds to join AWSG. It is likely to be increasingly important to get local people involved with the conservation of their local sites and the shorebirds that use them.

Where to from here?

2014 Shorebirds Conference

The next Shorebirds Conference will be held in September, 2014 in Darwin. Professor Stephen Garnett of Charles Darwin University is leading the organizing committee which is well into the planning of the Conference. More information on the Conference will be forthcoming in the near future.

Mark Barter Award

AWSG has taken steps to put in place an Award that will celebrate the outstanding contribution by Mark Barter to migratory waterbird conservation in the East Asian – Australasian Flyway. Mark did much to raise the awareness globally about the importance of protecting and maintaining migratory waterbird populations. His on-ground banding and counting efforts in China, Japan and the Republic of Korea and mentoring of young researchers and community members was truly inspirational.

The Committee has agreed that the long term nature of the Award will need to be developed but as a first step and in recognition of Mark's emphasis on training and education, it agreed that it would be most fitting to approve funds to cover the costs of attendance and some specific training in Australia post the Conference for a young person from either China or Korea with the emphasis on the Yellow Sea.

Conclusion

I would like to thank all of the Committee members for their enthusiasm and support for AWSG and its activities. Being on the Committee is a very rewarding experience and I encourage any people interested to contact me if you would like to discuss how you might join us. There are many actions that can be done including data analysis by those skilled in this area. Being part of ASWSG and the Committee is both fun and rewarding so I encourage you to become involved with AWSG.

Alison Russell-French
Chair

Johnstone, R.E., Burbidge, A.H. & Darnell, J.C. (2013). *Birds of the Pilbara region, including seas and offshore islands, Western Australia: distribution, status and historical changes.* Records of the Western Australian Museum, Supplement 78:343-441.

Only pages 343, 383-384, 389 reproduced here. These are the Abstract and Introduction and the sections concerning Banded (& Black-winged) Stilt, Avocet and Silver Gull.

Particularly relevant observations include numbers and movement of BaSt to and from Port Hedland Saltworks, age groups, c.60,000 BaSt in Dec 1992, Mandora Marsh and Halse *et al.* (2005).

Banded Stilt, Black-winged Stilt, Avocet, Silver Gull extracts

Records of the Western Australian Museum, Supplement 78: 343–441 (2013).

21/4/2014

Birds of the Pilbara region, including seas and offshore islands, Western Australia: distribution, status and historical changes

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Abstract – The geographic range, status and breeding season are documented for 325 bird species known to occur in the Pilbara, Western Australia, since the first records were made in 1699. The fauna is a mixture of Torresian, Eyrean and Bassian components, along with a variety of seabirds, migratory wading birds and Asian vagrants. The region lies entirely within the arid zone and the overall harshness of the environment means that few species are resident. The richness of the total avifauna (resident and non-resident) is due mainly to the diversity of habitats, especially those on or near the coast. The region is an important refugial destination for a variety of Australian species and includes a range of endemic subspecies and colour morphs. The area from Eighty Mile Beach to Port Hedland saltworks is of international importance for shorebirds and, following cyclonic rains, Mandora Marsh and Fortescue Marsh are of continental importance for waterbirds. The 204 breeding species are mapped, and each species is assessed for possible changes in distribution or abundance since 1900.

Keywords – Pilbara birds, ecological status, relative abundance, breeding, movements, taxonomy

INTRODUCTION

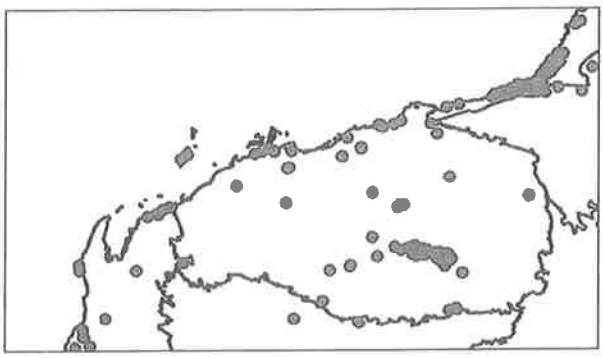
The Pilbara region of Western Australia (WA), with internationally significant mineral deposits, is of considerable importance to the Australian economy but the region also contains significant, but inadequately documented, conservation values (e.g. McKenzie *et al.* 2009). As a contribution to assessing these values, we set out to provide an up-to-date summary of the bird fauna of the Pilbara, with particular reference to historical data and the distribution of individual species. Ecological patterns in bird occurrence across the region were explored in a previous paper (Burbidge *et al.* 2010).

The Pilbara coast was one of the first parts of Australia discovered by Europeans and is the site of some of the earliest references to Australian birds by early English navigators. On 22 and 31 August 1699 (early September in the modern [Gregorian] calendar [George 1999]), William Dampier landed on islands in the Dampier Archipelago (naming one island Rosemary Island) and noted 'some Cormorants, Gulls, Crab-catchers, &c a few small Land Birds, and a sort of white Parrots, which flew a great many together' (p. 10, Whittell 1954). The white parrots were Little Corellas which still occur on these islands. On 28 August 1699 he also recorded some 'Boobies and Noddy-birds'; based on his description the latter were Bridled Terns. He also noted 'The Land-fowls that we saw here were Crows (just such as ours in England), small hawks and Kites; a few of each sort; But here are plenty of small Turtle-Doves, that are plump, fat and very good Meat. Here are 2 or 3 sorts of smaller Birds, some as big as Larks, some less; but not many of either sort. The Sea-Fowl are Pelicans and Boobies, Noddies, Curlews, Sea-pies, &c. and but few of these neither' (p. 10, Whittell 1954). Unfortunately, Dampier made no collections of birds, or at least no specimens survive.

Brief observations and collections were made by the French expedition under the command of Nicolas Baudin (1800–1804) including a visit

Recurvirostridae

Himantopus himantopus leucocephalus Gould, 1837
Black-winged Stilt



Throughout the region, north to Sandfire and Mandora Marsh and east to Marble Bar, Roy Hill and Newman. Nomadic, principally drought-driven. Scarce to locally very common in wet years. Usually in ones, twos or small parties, occasionally flocks of many hundreds, and rarely large or huge aggregations of many thousands (e.g. estimates of over 10,000 at Mandora Marsh in June 1997 and around 180,000 and 220,000 birds there in Aug. 1999 and 2000, respectively). Large numbers are attracted to the region after cyclonic rains, especially when drought is extensive elsewhere in Australia. Even when drought conditions are not so extensive or severe it is apparent that as the productivity of their inland breeding sites declines some birds may move into this region regardless of local conditions. This type of movement could account for the regular influxes noted at Port Hedland Saltwork ponds which are now of an essentially migratory pattern. Recorded from a wide range of habitats but mainly inundated samphire flats, claypans, grass flats, also river pools and saltwork (saline and hypersaline), sewage and mining ponds. The extent of immigration can be seen from counts from Mandora Marsh, resulting from the combination of a transient flood event there and extensive, prolonged drought conditions over much of inland eastern Australia. With flooding but no co-incident drought conditions the populations there are significantly lower, and in dry years the Mandora Marsh does not flood and no birds are present. The origin of these vast numbers (180,000–220,000) is not known. The estimate of such concentrations out of the total Australian population of this scattered widespread breeder is problematic and numbers will vary according to prevailing conditions. The peak numbers recorded there represent a significant percentage of the total Australian population, estimated at 266,000 (HANZAB). The situation at Port Hedland Saltworks is quite different. There permanent conditions have resulted in a regular movement to and from this location, although again the origin of these birds, none breeding here, is unknown. Some birds remain throughout the year but the highest numbers, around 800–1,200 occur in Aug. to Feb.–March. Unfortunately no records corresponding to the peak years at Mandora Marsh are available. In contrast to Banded Stilt (*q.v.*) these new arrivals comprise typical proportions of adults and juveniles, with some still behaving as family groups. Breeding recorded from Jan.–Sept. usually in areas where temporary flooding is prolonged, e.g. Mandora Marsh (following the March 2000 flooding *ca.* 3,500 pairs bred in June) (Halse *et al.* 2005).

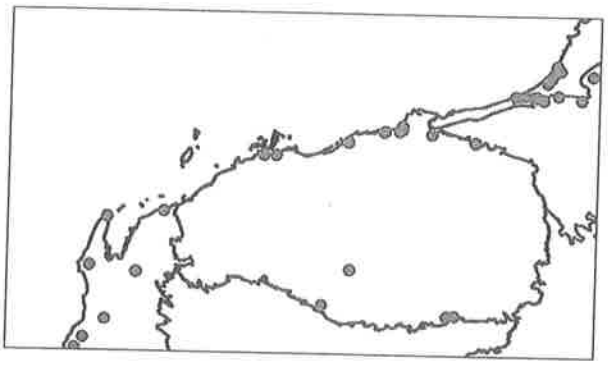
Cladorhynchus leucocephalus (Vieillot, 1816)
Banded Stilt

Northern coastal plains from Mandora south-west to Mundabullangana, accidental or vagrant on Barrow Is., rarely at Fortescue Marsh. Nomadic. Uncommon to very common visitor (Sept.–May) usually in small flocks, occasionally large flocks or aggregations (up to 60,000). Flooded samphire flats and saltwork ponds. Although locally regular and common (occasionally abundant) at Port Hedland Saltworks, over most of the region it is scarce to uncommon, its appearances being erratic. In contrast with the Black-winged Stilt (*q.v.*) the movements of this species seem to be only little influenced by local rains and flooding. When such events extend into more southerly and central parts of the State, i.e. affect the inland lakes within their breeding range, however, few birds remain here, returning later, as these dry out or as the food resources dwindle. The origin of local birds is not known. Possibly the irregular groups may contain (at least an element) of Australia-wide origin especially when drought is widespread. Although not continuously present at Port Hedland Saltworks, small numbers frequently remain between annual influxes, Aug.–Sept. to Feb.–April. The timing of their arrival and departure (particularly the latter) is much less fixed or regular than that of the northern hemisphere waders. This seems to correlate to those cyclonic events that bring heavy rainfall (with ensuing flooding) into the mid-central regions of WA. The Port Hedland Saltworks birds usually depart shortly after such an occurrence. Typically this late spring–summer influx comprises 800–1,700 birds, with the peak numbers occurring shortly after the first wave of arrivals which contains a very high percentage, about 90%, of juvenile first year birds, although this imbalance is restored by later arrivals. The

chicks gather into crèches and remain until fledged. Observations at Port Hedland Saltworks suggest that such groups may well depart from their natal areas independently and ahead of the adult breeding birds. The wintering population normally comprises 20–40 birds. This regular pattern is occasionally disrupted by the arrival of far greater numbers, during late spring–summer, but only once did such an arrival coincide with that of the regular birds. By far the largest such group comprised *ca.* 60,000 in Dec. 1982. Numbers built up rapidly, the birds remained for a short period and almost just as rapidly moved on, leaving behind what appeared to be the regular group. Such flocks appeared independent and their movements were superimposed on those of the local or regular birds. These massed flocks appear to have a more normal balance of adult and juvenile–first year birds.

At Mandora Marsh the situation is quite different. This wetland is not permanent and so no regular movement is possible or has developed, and sometimes even when favourable flooding events occur the species may not be present, e.g. Aug. 1999. On other occasions, e.g. Aug. 2000, flocks of 2,600 have occurred (Halse *et al.* 2005). Such utilisation gives the impression of being opportunistic or irregular. Unfortunately no data corresponding to this peak is available for the Port Hedland Saltworks site. It is interesting to note that unlike the situation at Port Hedland Saltworks, this large flock amounted to just 1% of the corresponding Black-winged Stilt numbers. These sites illustrate markedly differing usage patterns. Port Hedland Saltworks, with a seasonally cyclic, but annually relatively constant regime (food source), has resulted in the development of a regular movement of this species, similar to that occurring on the coastal plains of south-west WA. Mandora Marsh, a temporary irregular source, is used by nomadic flocks that disperse towards the coast when drought conditions prevail inland and augment the numbers at Port Hedland Saltworks. Apart from the large numbers recorded from the above two locations, those from nearby even adjacent sites are minimal (only 23 birds were recorded in 18 years in the Port Hedland-Cape Keraudren area). There are no breeding records.

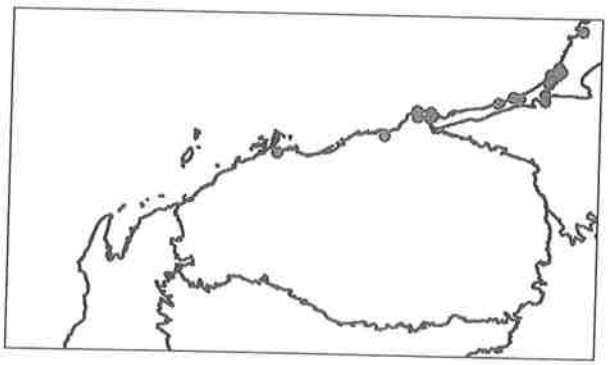
Recurvirostra novaehollandiae Vieillot, 1816
Red-necked Avocet



Throughout the region, north to the Mandora Marsh and east to Newman. Nomadic, rare to common, usually in ones, twos or small parties, occasionally in flocks (of many hundreds) and rarely in larger aggregations under drought conditions (of several thousand, e.g. estimate of over 3,500 at Mandora Marsh in Aug. 1999). Inundated samphire flats and claypans, brackish near-coastal lagoons, saltwork and sewage ponds and roadside puddles. Breeding in March–April.

Charadriidae

Vanellus miles miles (Boddaert, 1783)
Masked Lapwing



Nomadic. Formerly a rare or infrequent visitor (presumably from Kimberley) to far northern coastal plain, now locally and seasonally varying from rare to moderately common. Usually in pairs or small parties, occasionally larger aggregations, e.g. 60 at Mandora Marsh in June 2000, increasing to 1,170 individuals at the same site in Aug. 2000 (C. Hassell). Its status in the region is significantly distorted by flooding events at Mandora Marsh and the origin of these birds is unknown. Mainly flooded samphire flats, river pools, claypans, sport ovals, sewage ponds and bore overflows. Breeding recorded by G. Lodge on De Grey R. in May 2007, the first breeding record for the region. Appears to be expanding its range and abundance. Prior

flights is the South Polar Skua, *C. maccormicki*, which migrates from Antarctic areas to the higher latitudes of both the Pacific and Atlantic Oceans, probably mainly or only as immature birds. The status of this species in the Indian Ocean is poorly known but since Brown Skuas rarely range beyond the Tropic of Capricorn, any *Catharacta* skua seen in tropical waters should be carefully examined.

Stercorarius pomarinus (Temminck, 1815)
Pomarine Skua

One record, an adult light morph in non-breeding plumage observed at Finucane Is. in Feb. 1982 shortly after passage of a cyclone. Probably a rare but regular non-breeding visitor over summer as it has been regularly reported from Kimberley seas during Ashmore Reef pelagic surveys. The latter records fall between late Sept. and early Nov., the limiting period for these surveys. Occasional distant sightings of *Stercorarius* skuas from the Pilbara in Oct.–Feb., always of single birds, could apply to this species or the Arctic Skua.

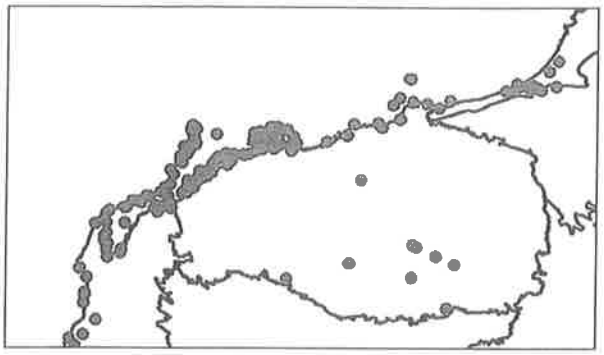
Stercorarius parasiticus (Linnaeus, 1758)
Arctic Skua

Rare winter visitor from northern hemisphere but the few records probably underestimate its true status. One immature dark phase observed at Cape Keraudren in Oct. 1980, two (one dark and one intermediate phase) at Finucane Is. in Feb. 1989, just before and one the day following a cyclone. Also one adult dark phase at Shay Gap in Jan. 1984, a bird driven inland overnight by cyclonic winds, seen at first light the following day with a mixed party of Silver Gulls, Crested Terns and various shorebirds and a Lesser Frigatebird holding position in updraft of an adjacent hill—as the wind abated the group moved back towards the coast. Has been fairly regularly recorded (although not as frequently as Pomarine Skua) in the Ashmore Reef region in Sept.–Nov. Almost certainly some unidentified skuas seen off the Pilbara coast would be this species and the Long-tailed Skua, *Stercorarius longicaudus*, which has been recorded from the Ashmore Reef region and would almost certainly occur here.

Larus pacificus georgii King, 1826
Pacific Gull

Former visitor (presumably from the Shark Bay region) to the far south-west coast of Pilbara region. Tom Carter observed some at the former whaling station near Point Cloates on 6 Sept. 1913. He believed that they were attracted to the hundreds of dead whales that lay along the beach from Point Maud to North West Cape in 1913. No recent records.

Larus novaehollandiae novaehollandiae
Stephens, 1826
Silver Gull



All coasts, as well as Mandora Marsh and many islands as far offshore as Bedout, Legendre, the Montebello Is and oil platforms up to 150 km offshore. Uncommon to common about islands and on mainland at towns, saltwork and sewage ponds and at Mandora Marsh (when flooded), elsewhere scarce or uncommon. Mainly coasts and sheltered seas, occasionally extending inland to freshwater pools on lower courses of rivers and to flooded near-coastal samphire flats, e.g. Mandora Marsh, Pardoo Flats and about 75 birds on Fortescue Marsh in Aug. 1999. Also a rare visitor from south-eastern Australia to fresh waters of the interior, e.g. one collected from a flock of four at Newman sewage ponds on 5–6 Nov. 1981 was from the far south-east of Australia (Johnstone 1982). Origin of birds at Mandora Marsh in June and Aug. 2000 (230 and 240 birds, respectively) not known but may have come from south-eastern Australia. Breeding reported on islands in Dampier Archipelago, Montebello Is, Lowendal Is and islands off Barrow Is., mainly in summer and autumn.

Larus pipixcan Wagler, 1831
Franklin's Gull

Rare vagrant from North America. An adult in non-breeding plumage observed and photographed by C. Surman 20 km SW of Barrow Is. on 11 Nov. 2005 and one photographed by N. Waugh at Dampier on 17 Feb. 2008.

Larus sabini Sabine, 1819
Sabine's Gull

Rare visitor or vagrant from northern hemisphere. An immature observed at Finucane Is. on 23 Feb. 1989 and a non-breeding adult at same location on 28 Jan. 1990. Both records followed cyclonic events.

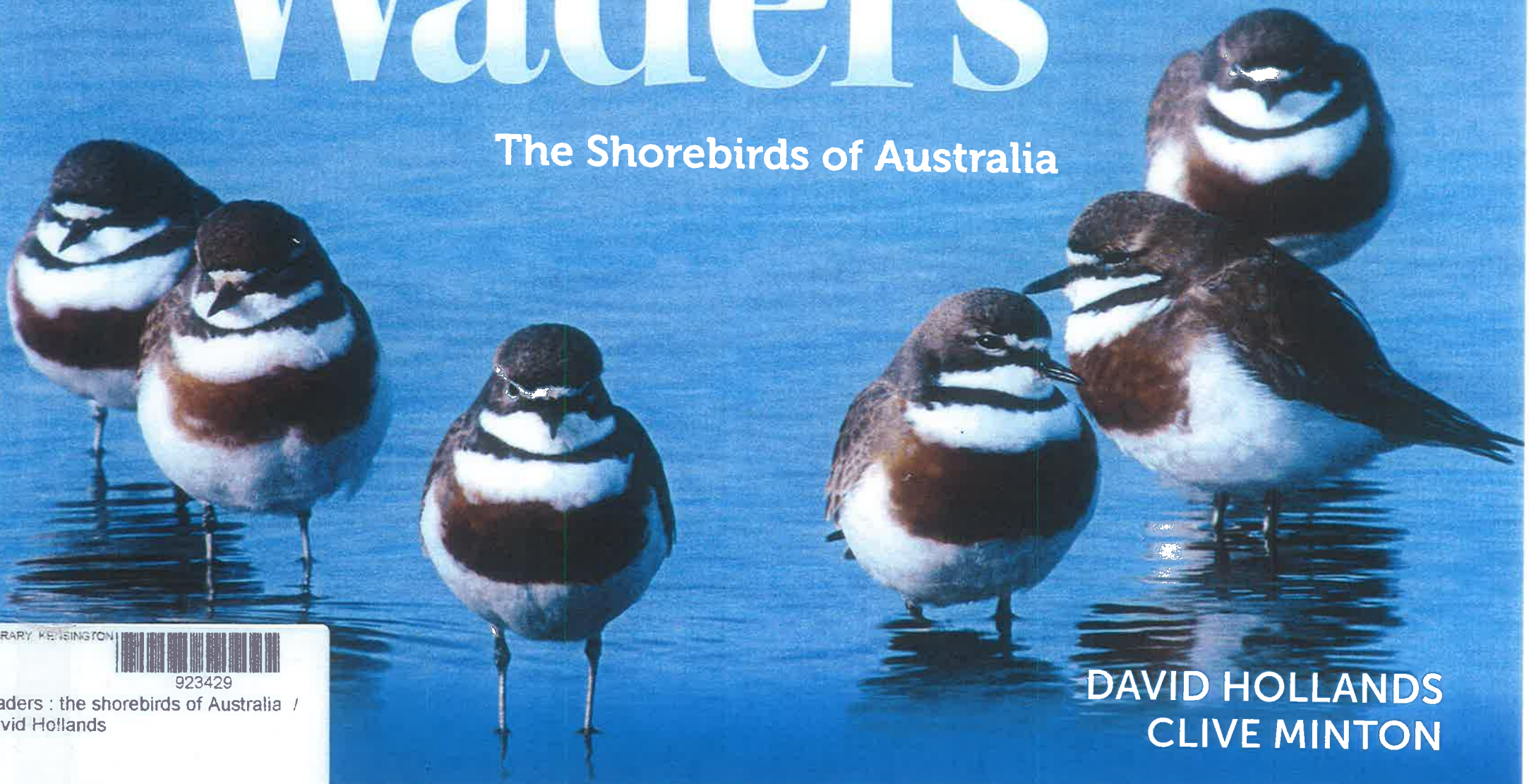
Other *Larus* species

Other northern hemisphere gulls have been

Extracts regarding BaSt from: Hollands, D. & Minton, C. (2012). *Waders: the shorebirds of Australia. Blooming* Books, Melbourne. Contains extensive descriptions and many photos of BaSt breeding events including lake Ballard in 1995.

Waders

The Shorebirds of Australia



DAVID HOLLANDS
CLIVE MINTON

Waders

The Shorebirds of Australia

Text and Photographs **DAVID HOLLANDS**

Foreword and Specialist Chapters **CLIVE MINTON**

With some additional contributed photographs

For Margaret and Pat
Who have both supported and suffered this book for a very long time.

And for the small army of volunteers, who have braved heat, cold, rain, wind, sand, mud, thirst and, sometimes, near starvation to further the interests of the waders of Australia.

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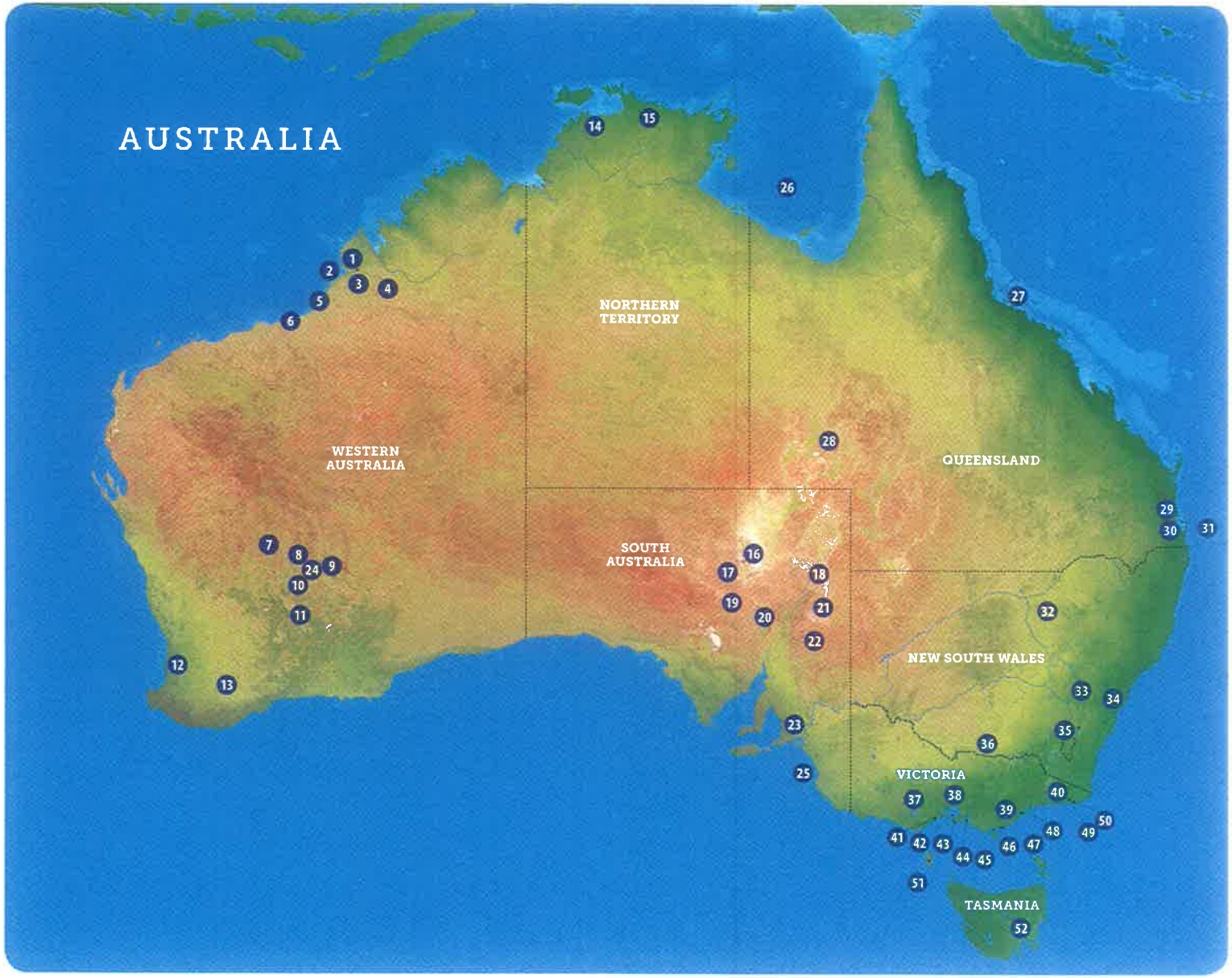

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Banded Stilt *Cladorhynchus leucocephalus*

Among the many remarkable wader lives, the Banded Stilt's must go close to being the most bizarre and unexpected of all. Alone among the world's waders, it nests in huge, closely packed colonies and, unlike any of them, it is not a regular annual breeder, with years sometimes passing without a single bird attempting to nest anywhere in Australia. As it is an Australian endemic, these are years when there is no breeding anywhere in the world.

The Banded Stilt is a conspicuous bird, similar in size to the Black-winged but slightly stockier and with marginally shorter legs. It is a much whiter bird than the Black-winged, completely white above apart from black wings, which have broad white trailing edges. The underparts are also pure white except for a broad chestnut breast band, absent in juveniles, and black wing tips. If the bill of the Black-winged Stilt is a stiletto, the Banded Stilt's is even finer, an unbelievably slender, black needle, narrowing at its tip to a point. The legs are pink.

Adult Banded Stilt, a stockier bird than the Black-winged but with an even finer bill.

The Banded Stilt's habit is to congregate in large or huge flocks and it was soon noticed by the early ornithologists. Vieillôt named and described the species in 1816, some 20 years before John Gould, but nobody could find a nest and little else was discovered for over 100 years. A.J.Campbell thought that he had some answers and in 1899, in his *"Eggs and Nests of Australian Birds"*, described the nest and eggs in detail, basing it on a clutch which had been sent to him by Mr. Lindsay Clark from Booligal in the Riverina. However, he was somewhat premature. Fifteen years later, A.J.North, writing in *"Nests and Eggs of Birds Found Breeding in Australia and Tasmania"*, referred to an egg from the same clutch as being that of a Black-winged Stilt, adding that he had received a letter from Mr. Clark saying that he had wrongly identified a Black-winged Stilt nest as being that of a Banded.

A hundred years elapsed from Vieillôt's description, still without a nest being found and it was not until 1930 that a Mrs Cannon finally made the discovery at Lake Grace, a salt lake in Western Australia, where she found not one nest but thousands, crowded on a sandy spit of the lake. Interestingly, later that same year, a colony of some 27,000 pairs was found at Lake Callabonna in South Australia, another ephemeral salt lake. In the light of this new knowledge, people started to think back, recalling chicks walking through the main street of Menzies, north of Kalgoorlie in Western Australia, in 1929 and even, possibly, a large breeding colony as far back as 1904 at Lake Cowan, also in Western Australia.

The biggest question in the mystery had been answered. No detailed studies were done at any of these colonies but a few facts had become clear. The stilts breed in huge colonies; they breed only after flood rains fill the inland salt lakes and, as a result of this, they breed only in the occasional years when conditions are right.

For the next 65 years, there were sporadic reports of Banded Stilts breeding. At Lake King in Western Australia, there were tens of thousands of adults and chicks in 1930 and again in 1988. In Menzies, the sight of chicks walking through the street became almost commonplace and happened in 1963, 1981 and 1986. The breeding colony had to have been on nearby Lake Ballard, 60km long and with its closest point some 10km from Menzies, a considerable hike for a still flightless chick. At Lake Marmion in Western Australia, there were 50,000 breeding pairs in 1976 while, at Lake Barlee, further to the west, there were 179,000 nests in 1980. Breeding colonies were also reported from salt lakes in South Australia but the impression was that these were less successful.

By now, there was enough knowledge to appreciate that this was a very unusual bird and there was a pressing need for a detailed breeding study. In 1989, the first of these opportunities came, when 400mm of rain fell in the Flinders Ranges of South Australia. Pouring out of the mountains, the water rapidly filled the great salt lakes to the north-east, Lakes Blanche, Callabonna and Frome, while Lake Eyre also held significant water. An initial aerial search failed to find any stilts but it had been confined to those three lakes and, when Ian May from South Australian Parks extended the next search west of the ranges to take in Lake Torrens, the birds were there.

Two species of stilt together, Banded in front and Black-winged behind.

This was a very big colony and Clive Minton went straight to it, travelling the last 20km by boat to spend a few hours there and take the first ever pictures of Banded Stilts at the nest. Within six weeks of the rain there were chicks and Clive went back for a follow-up visit. Even as he arrived, it was clear that there was a major problem with Silver Gulls and, despite the hatching of large numbers of chicks, the colony had shrunk greatly in size. Over the next few days this continued, due entirely to the marauding gulls, which succeeded in destroying the last 300 nests in their entirety. Despite this, there were large crêches of half-grown young and the breeding had been at least partly successful.

The same could not be said for the study, which had been severely restricted by lack of time and difficulty of access. The Goldfields Region of Western Australia, where most of the known breeding events had occurred, seemed likely to be the area where a good opportunity would eventually arise.

The Goldfields Region has a harsh environment. Centred on Kalgoorlie, it is a desiccated land of scorched earth and sparse vegetation, where the infrequent rain barely has time to wet the ground before it is gone, while the few creatures which choose to live there generally go about their business far away from human sight. Very occasionally this can change and February 1995 was such a time, when the remnants of what had been Cyclone Bobby soaked the district with nearly 400mm of flooding rain. Overnight, all roads became impassable, dry gullies turned into foaming rivers and empty salt pans were transformed into brimming lakes.

Far from Kalgoorlie, this event did not pass unnoticed. The Banded Stilts knew at once and reacted as quickly, disappearing en masse from their many haunts around the Western Australian coast. Much further away in Melbourne, Clive also knew about it and realised that this could be the trigger for the long-awaited breeding of the stilts. Almost as quickly as the birds, he too was in Western Australia, travelling by light plane in a low-flying search over the salt lakes. With scores of lakes and a myriad small islands, it was an arduous task

but he did have the advantage of history and the knowledge of the sites of earlier breeding.

Lakes Barlee and Marmion were both full but deserted. They flew on to Lake Ballard and at last, in the confusion of land and water, began first to see swimming stilts and then, on a tiny island, the white smudge of a great congregation of them, packed closely together in what was clearly a big breeding colony. It was a mere 16 days since the cyclone but already the birds had had time to appreciate the opportunity, react to it, fly around 1,000km, choose a site, find a mate and begin the process. From the air, it appeared that there were already about 2,000 nests with eggs, the first known attempt since the failed one in South Australia six years before. Clive had no time to lose.

Three days later, with two companions, he flew into the site by helicopter, landing on an adjacent island and completing the journey on foot. They arrived to a scene of frenetic activity. Everywhere there were nest sites being scraped and eggs laid. Birds were squabbling over partners and territories, while everywhere there was copulation. Sitting at the edge of the colony, Clive could always see up to 20 couplings taking place at any one time and there was no discrimination about where it took place; sitting, standing, swimming, in the midst of the colony or away from it, on the land or in the water. With no birds flagged or banded, it was impossible to know if the unions were monogamous or indiscriminate but it seems most likely that any female was available to any taker.

The nests were packed together so closely that it might have been the last piece of available land on earth; ten nests to the square metre, which was just far enough apart to keep each sitting bird out of pecking range from its neighbours. On that first day, there were already 2,000 nests but, by the end of March, this had expanded to 20,000 and three more satellite colonies had also appeared in the lake, the largest of these only four kilometres away and with 4,500 nests.

Of necessity, Clive's first visit was only fleeting but this was to be a major study and, two weeks later, he returned for a protracted stay, bringing with him a team from ABC Television. They came in by amphibious ~~military DUKW~~, the only means of getting anywhere near the colony other than by helicopter,

Banded Stilts on the saline Gippsland Lakes, Vic. February 2008. With a minimum possible age of eight years, all these birds are in adult plumage.

and from then until breeding ended, there was always at least one observer at the colony.

In their haste to reach their new nirvana, not all the stilts had had time to moult. About two thirds were in mature breeding plumage with rich chestnut breast bands but many others were only half way there, while some had totally white underparts and no sign of any breeding plumage. It seemed not to affect their breeding capabilities at all, with white-breasted birds appearing to be doing every bit as well as those in full plumage. Most birds were sitting on clutches of three or four eggs but some clutches were smaller, while a few nests held five. Amid the chaos of the colony, it seemed quite possible that these could have been produced by more than one female.

The question of Banded Stilt plumage is an intriguing one. Is the chestnut breast band part of breeding plumage or is it the sign of a fully adult bird? I suspect that it is the latter. In 2002, I photographed Banded Stilts at Werribee, many of which had completely white underparts, although they had pink legs, not the black

Banded Stilts feeding on the edge of The Coorong. February 2006.

legs of juveniles. The youngest Banded Stilts in Australia at that time would have been two years old, the offspring of the 2000 breeding colony at Lake Eyre. In 2003, I again photographed Banded Stilts, this time at Port Hedland in Western Australia. With the youngest possible birds now being three years old, none had completely white underparts but many were just acquiring chestnut breast bands, which were still incomplete. Subsequently, I again photographed sizeable flocks of birds in 2006 and 2008, all of which were at least six or eight years old respectively and none of which would breed until at least 2010. To a bird, every one had the full chestnut breast band, which has always been assumed to be part of breeding plumage. I suspect that this is not so, that birds only acquire the chestnut breast band at the age of three and that those with smudgy or incomplete breast bands are between two and three years old and just going into adult plumage.

By April 3rd, eggs were beginning to hatch. As with all waders, the chicks began to walk as soon as they were dry but they would not walk very far as one parent from each family led them to the lake's edge to set sail on the water. Within a day or two, many of them were three or four kilometres from the colony, herded together in groups with each group in the care of a number of adults. Whether or not these groups were made up of intact families, still with one or both parents, was a question which was impossible to answer.

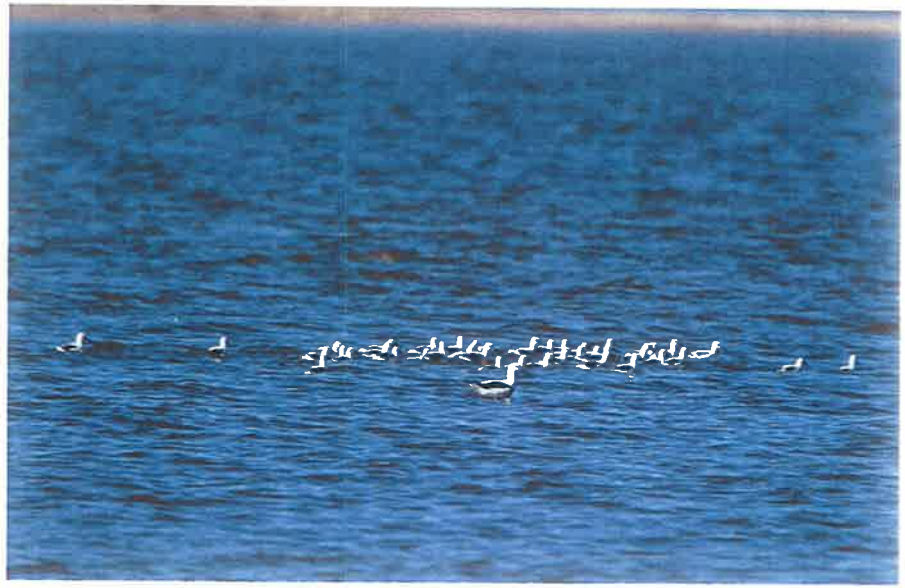
This water-borne departure from the colony is, to the best of my knowledge, unique among land birds and I know of no comparable behaviour anywhere in the bird world. On reflection, however, it is entirely logical. With other colonial nesters, terns, penguins, bee-eaters, swifts or anything else, the newborn chicks are more or less immobile and the parents must hunt for them, travelling widely in their search for food before returning with it to the colony. With the stilts it is the other way round. Not at any time are the chicks fed by the adults. From the day that they are hatched, they must find all their own food without any help from their parents and it is they who must do the travelling. Thousands of young appear almost at once and, if they stayed around the island to feed, stocks of their vital diet of brine shrimps would surely be rapidly depleted, leading to starvation and failure for the stilts amid a sea of plenty further afield. In 1989, at Lake Torrens in South Australia, chicks had floated up to 100km. from their birthplace within days of hatching.

As with so many desert species, success or failure is balanced on a knife edge. Be they pelicans feeding on fish in Lake Eyre or Letter-winged Kites taking Long-haired Rats in the Simpson Desert, the flush of plenty is as brief as the blooming of desert flowers. When the food supply is exhausted, the birds must move and any that cannot yet fly will be left behind. With the Banded Stilts, all depends on brine shrimps and the same rules apply. There have been numerous instances of the adults having to abandon the flightless young, leaving them, like an army of refugees, to set off on foot in search of a better place.

It has long been assumed that, with all the salt lakes drying up together, there is no such thing as a better place and that most chicks which set out to walk simply starve or succumb for other reasons along the way. Certainly there are stories of great numbers walking along roads and through towns, there to be crushed in their hundreds by vehicles. However, Clive Minton has suggested that these walks are not necessarily death marches. Young Black-winged Stilts, faced with the drying up of the wetlands where they were hatched, frequently survive on what they can pick up from the dry ground through the bush. Certainly, they are never in the same numbers as a great phalanx of young Banded Stilts but, until more research is done, it cannot be assumed that these troupes of young Banded Stilts are simply trudging to their deaths.

On Lake Ballard at least, very few eggs or chicks were lost to predation. A few crows took to loitering around the colony but they seemed to take only chicks that were already dead and there was no sign of Silver Gulls, the scourge of many other stilt colonies. The most obvious wastage was through lost and abandoned eggs and these soon littered the colony in profusion, rapidly declaring themselves as they went rotten and exploded in the hot sun.

Up to this time, almost nothing was known about Banded Stilt movements and one of the most important tasks for Clive's team was to band as many young as possible. At first, this was done by trying to catch a complete family of chicks as they swam with a parent, which he suspected was always the male. With



almost any other species of wader, this intrusion would have provoked a protective response from the parent; calling, flying round and round, doing the "broken wing" trick or even attacking. The adult stilts did none of these things, simply abandoning the young and disappearing. This did not augur well but the problem was solved by catching all but one of a brood, whereupon the adult was usually quite content to stay with the single chick until the others were returned and the remaining one could then be banded too. (10 by Clive)

A total of 800 chicks was banded and, although most have never been seen again, there have been enough reports to throw doubt on one old theory. Conventional belief has long held that there are two quite discrete Banded Stilt populations, one each in Western Australia and South Australia, and that they do not mix. This became no longer tenable when three of the banded Lake Ballard stilts were recovered in the year 2000 at Lake Eyre in South Australia, evidence that at least some birds move from one population to the other.

With such big numbers of birds nesting and chicks fledging, ideas that the

Releasing young Banded Stilts after leg-flagging. The young stilts, not yet quite ready to fly, congregated in offshore crèches, guarded by one or more adults. February 2006. The Coorong.

species could be vulnerable or threatened seemed hardly credible. The events of 2000 suggest otherwise.

In February of that year, cyclonic rains across the top of Australia sent a huge surge of water down the northern rivers into Lake Eyre. There seemed every chance that it would create the right conditions for stilts to breed. The ever-resourceful Clive was overseas but, on his return, managed to hitch a flight with the proprietor of the William Creek Hotel on the western side of the lake, putting in a low flying reconnaissance on the way. It was only two weeks since the rain but already, far out in the lake, there was a big stilt colony, sharing a small island with a colony of pelicans. In the shallow lake, approach by boat was impossible and the only feasible way seemed to be by helicopter, an expensive proposition. By the time finance could be organised it was the first week in April.

The moment that Clive and his team set foot on the island, it was clear that the stilts were in great trouble. From an initial estimate of 30,000 pairs, the colony had shrunk to around 10,000. They were under siege from Silver Gulls and it was all too clear that the gulls were winning. They had established a very large colony themselves and a milling, predatory throng of them was moving among the stilts with brutal efficiency. It was pure carnage and the stilts had no chance. The gulls worked in teams and, as an adult stilt faced up to one gull, other gulls would sneak in behind it, smashing eggs and dismembering young. It was a sickening sight and there was nothing that Clive could do to help. So total was the slaughter that there was hardly a stilt chick which made it to the water and, in the four days that Clive was there, the colony was reduced from 10,000 to 2,000 pairs. Two days later it was abandoned altogether.

This was a disaster. The first South Australian breeding attempt for 11 years had ended in total failure. It could well be another 11 years before the right conditions came round again and it would not take many more episodes like that to occur for the species to become extinct. For millions of years, the stilts must have been coming here to breed and they would not have survived if the gulls had

Lake Corangamite. August 2006. D.H. preparing to board Norman Tann's helicopter to survey the Banded Stilts.

Lake Corangamite. The glistening outline of 90,000 Banded Stilts, packed shoulder to shoulder in the shallow water.

As the helicopter came over for the first time,
the stilts took off as one in a vast, swirling mass.

been there too. Something must have changed dramatically and, in this modern world, this usually means something caused by man. It did not take very much research to work out what it was.

Prior to European settlement, Lake Eyre was separated from the coast by nearly 500km of inhospitable country. There was almost no water, very little for gulls to eat and certainly nowhere for them to settle down and breed. Now, with a chain of towns, rubbish tips and man-made lakes, there is a conduit into Australia's dry heart and the gulls have made good use of it. Lake Eyre, for aeons a safe haven for the Banded Stilts, has become a death trap.

Nobody knew when the stilts would try again but Clive was not prepared to stand by and wait. He at once contacted the South Australian Parks to set out the position and it is to their great credit that they understood the seriousness of the situation and acted at once to authorise a comprehensive cull of Silver Gulls, should the occasion arise again. At the time, nobody realised just how soon that would be.

Even while Clive was talking with the South Australian Government, the stilts were trying again, using the same place on the same island. Authority for a cull was not yet in place and the attempt was doomed even as it began. Lindsay Cupper, a well-known wildlife film-maker, had bought his own hovercraft to travel to the island and he was there as the disaster unfolded. From the very start, the gulls began their depredations again, not only by day but continuing right on through the hours of darkness. For a few days, the stilts tried to persist but they were being overwhelmed. The end came suddenly in the middle of the night when Lindsay, asleep in his camp, heard a roar of wings as several thousand stilts took off at once. In the morning, the colony was totally deserted.

It seemed that, despite all Clive's efforts, the authorisation had come too late. Lake Eyre was drying up rapidly, together with the supply of brine shrimps, which are vital for the stilts successful breeding. Then fate took a hand. Down the Georgina and Diamantina Rivers came a fresh surge of water, the result of monsoonal rains in north-east Queensland. The stilts were ready and moved to a different island, nearer to the new influx of water. The gulls came with them but now the Parks Authorities were also ready and they came too.

Chloral Hydrate is a long-established and safe human sedative but for gulls it is lethal. Straightaway, the parks authorities put out thousands of baits, pieces of bread spread with a mixture of butter and chloral, and the effect was dramatic. The gulls swarmed onto the baits and died in their thousands, so many that it was impossible to bury them on the island and the carcasses had to be transported back to land for disposal there. There were no other birds there which would take bread and chloral does not cause secondary poisoning, making its action quite specific for gulls. Almost overnight, the gull problem was solved and, freed from predation, the stilts had an extraordinarily successful breeding, producing about 40,000 chicks from a total of 55,000 eggs. Through quick thinking, swift government response and a stroke of good luck, a total breeding failure had been transformed into a resounding success, a triumph for Clive and the South Australian Parks.

Against the odds, the stilts had had an excellent breeding year but the inevitable question arose, "Where to next time?" It had been one thing to eliminate Silver Gulls on a remote and isolated island but to do that all the way to the coast would be a huge task and might well elicit opposition from the public. It seems highly unlikely that this will be attempted, making it almost certain that any future breeding attempt will also bring in the gulls, making their elimination essential. This may have to continue in perpetuity. Whether there will be the political will to do this remains to be seen. Fortunately at least, there has never, so far, been a gull problem at Western Australian colonies, where there is even less human presence and not the number of refuse tips to lead gulls into the interior.

That should have been the end of the Banded Stilt story but, in 2005, there came a new development, again the result of human activity. It concerned stilts along the Coorong, the saline lagoon, 130km long, which extends south-east from the mouth of the River Murray, separated from the sea only by the sand dunes. Banded Stilts have always visited there, often for prolonged periods, but, although there are brine shrimps, the concentrations have always been too low to stimulate the stilts to breed. In recent years, low flows in the river have resulted in a steady rise in the Coorong's salinity, causing great harm to fish stocks, water plants and bird life. Not every species has suffered however, and these changes

Second pass. The stilts quickly came to realise that the helicopter was not a threat and allowed us to come directly overhead.

The expedition wends its tortuous way across the stony desert to the edge of the lake.

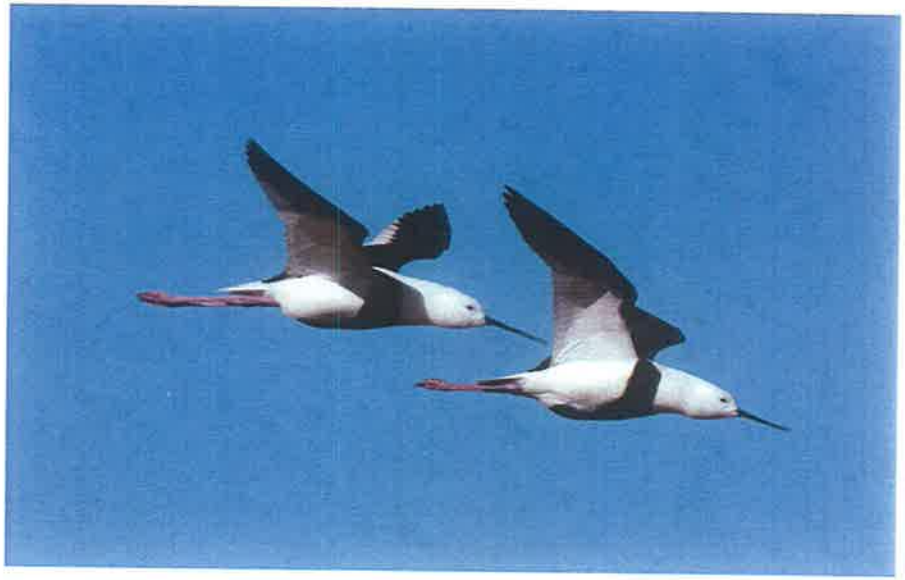
suit brine shrimps. By extension, they also suit Banded Stilts and, in the winter of 2005, a vast throng of some 100,000 of them congregated there.

Despite this, nobody ever expected that the stilts would breed there. Stilts breed on salt lakes far inland. They had never been known to try to breed near the coast and there was no expectation that they ever would. Consequently there was nobody on the look-out for nests and it was not until January 2006, when swimming young began to appear, that anyone realised that the stilts were actually breeding. By that time most of the eggs had probably hatched and an aerial search failed to find the colony. Possibly there were several small colonies rather than a single one, for a small number of nests was subsequently found on the eastern shore. By Banded Stilt standards, this was a small breeding event, with a March count for the whole Coorong finding just over a thousand chicks but it was highly significant, the first time that the stilts had ever been known to breed near the coast. Even the Silver Gulls seem to have been taken unawares and it appears unlikely that they caused any appreciable harm.

I arrived there in early February. It was the week-end of the annual Coorong

Late afternoon light and the first sight of the stilt nesting island with the faint outlines of the Flinders Ranges in the bachground.

Top: *Lake Torrens, 6th May 2010. Paul Wainwright's aerial reconnaissance discovered the vast breeding colony on a tiny island in the lake. Photo Paul Wainwright.*



wader count but there were also plans to band young stilts and I joined one of the teams. Scattered round the Coorong's shores were flocks of Banded Stilts, ten thousand here, a thousand there, a few hundred somewhere else. It was easy to pick out the chicks, smaller in size and always in little knots and swimming, often slightly further from the shore than the adults. The idea was to herd them ashore and then run and catch them with a net but this plan was rapidly abandoned when we found that the baby stilts could run infinitely faster than we could. The alternative was to pursue them in the water and this worked better. The chicks tended to stay together and, as long as the water was fairly shallow, it was usually possible to overhaul them on foot and scoop them up with a hand net. By this method, over a hundred chicks were caught, banded and flagged, a tiny fraction of the population but one which might just bring in a subsequent sight record.

In the hand, the baby stilts evoked much that was similar to the Red-necked Avocets, which were also present on the Coorong. They were still only half-sized and with rudimentary feathers but their legs were disproportionately big, well-grown, powerful and clearly adapted for the long swims and marches which they would be called on to do. It was interesting to see too that, like the avocets, the feet were webbed, a feature which is almost lacking in the Black-winged Stilt.

Will Coorong breeding becomes a regular feature of the Banded Stilt's life? Only time will tell. Since 2000, there has never been enough water in South Australia's inland salt lakes to trigger a breeding event there and, with its increased salinity, the Coorong has shown that it can now hold enough brine shrimps to support at least a small breeding colony. However, writing now in 2010, there has been no evidence that this has yet occurred.

In August 2006, the Banded Stilts produced a new surprise, neither in the Coorong nor at Lake Eyre but at Lake Corangamite, a moderate-sized salt lake in western Victoria. When full, the lake is about 35km long but drought had contracted its edges and concentrated the salt. At the beginning of the month came reports that large numbers of Banded Stilts had appeared in the lake, far out from the shore. A kilometre-wide surround of soft mud made even the water's

The first morning and the expedition prepares to head for the island.

As we approached the island, we began to see flying stilts.

First sight of the breeding colony, a packed throng of sitting, standing and flying birds.

edge inaccessible and it was quickly clear that the only way to get a good look at these birds would be from the air. On August 10th, with the generous help of Norman Tann, a local helicopter pilot, Clive and I headed off over the lake. It was a memorable flight, which I committed to paper as soon as we were back on the ground.

"For the unpracticed eye, the scene from the air is not easy to interpret. The height seems to flatten the already smooth landscape, grey water merging with brown mud as we approach the lake against the light, the only prominent features being areas of white around the shore. Perhaps these are the stilts but, as we come closer, they reveal themselves as patches of crystallised salt. It is only when we are approaching an apparent muddy island, far out from the shore, that we see that this is not mud but a vast assembly of stilts, packed shoulder to shoulder in a huge tear-shaped flock which we estimate to be 300 metres long. As we come overhead, still 500 feet up, they take off in a chaos of flailing wings, a chaos which is in our eyes alone, for, amid the apparent frenzy, not one wing touches another. The helicopter moves on and, within moments, the whole flock is settling back in the same spot.

Now we are approaching with the light behind and the flock takes on an entirely new aspect, a glistening island of silver in the now blue water. We have dropped down lower but slightly to the side of the birds and already they seem to have realised that we are a harmless intrusion, unlike the situation a few days before when a distant observer had seen the whole flock stay airborne for half an hour at the advent of a Peregrine. The lake is so shallow that all the birds are standing in water, absolutely evenly spaced and all facing the same way, like a great army of soldiers on parade. The numbers are immense. An earlier observer had guessed at a quarter of a million. This is clearly excessive but Clive has a rough guess at over 90,000. Hopefully, our photographs will give us a better idea.

We circle the flock several times, dropping steadily lower until we are down to 50 feet. By now the birds are ignoring us and we watch the changing effects of the light on the flock. Against the light, it is an island of black in the water, then, with side lighting, it becomes almost invisible until, with the light behind us, it is transformed again into a sparkling jewel."

Would they stay and try to breed? It was impossible to know but Clive thought that the terrain looked very similar to that on Lake Eyre, where they had bred ten years before. However, Lake Corangamite is tiny alongside Lake Eyre and it was hard to think that such a small area could produce food for this great army of birds. To add to this, Silver Gulls were already nesting around the lake's shores and would certainly try to wreak havoc if the stilts begin to nest. It promised some intriguing watching.

The watching did not have to continue for long. Three weeks later, the stilts had disappeared en masse, their destination unknown. In the middle of the worst drought ever recorded in south-eastern Australia, they had certainly not gone anywhere to breed. Perhaps they had gone all the way to Western Australia, where, in early 2007, there were flooding cyclonic rains but, if they had, nobody knew where. There is a lot more yet to learn before the riddle of the Banded Stilt comes anywhere near to being understood. Eventually, these birds made their way back to the Coorong and were still there three and a half years later.

2010 arrived and another year had passed without the Banded Stilts breeding. Again there were large numbers of Banded Stilts around the Coorong, now even saltier than three years before, but there was no evidence of nesting. Early in 2009, monsoonal rain had sent water all the way to Lake Eyre. Around the lakes of the inland, pelicans, herons, cormorants and ibis bred in profusion and there was hope that there would be enough water to trigger the Banded Stilts into breeding. There was not. Some stilts did arrive at the lake but there was no attempt at nesting. Next year would be the eleventh year since the last significant breeding of Banded Stilts. Probably there have been such gaps before but I wondered just how long the species is able to survive without any recruitment of new blood.

Then it happened!

The start came in late February 2010 with flooding rains in North Queensland, which then moved south, inundating huge areas of the inland and setting the rivers of the Channel Country flowing towards and into Lake Eyre. The rains continued and, from April 6th-9th, it was the turn of the Flinders Ranges in South Australia. Water poured out of both sides of the mountains, into Lakes Blanche, Callabonna

In the breeding colony. Every scrap of open ground was covered with eggs, chicks and adult birds.

and Frome to the east and Lake Torrens to the west. On April 14th, with all four salt lakes starting to fill, Iain Stewart, who has long followed the fortunes of the stilts, alerted the South Australian authorities that a breeding opportunity for the stilts might be developing. He was not the only one to realise this. By that time, the stilts had come to the same conclusion and were on their way.

At the start of April, an estimated 150,000 Banded Stilts were living in the Coorong and were seen to be still there on the 5th. Three weeks later, however, an aerial survey revealed that every single one had gone. They were indeed long gone and, by that date, the first eggs were close to hatching. But where?

On April 21st, an initial aerial survey of Lakes Blanche, Callabonna and Torrens found nothing, but the plane was probably flying too high and, on May 6th, a lower level reconnaissance by Paul Wainright, from South Australian Parks, now known as the Department of Environment and Heritage (DEH), found it, a tightly-packed colony of some 140,000 stilts, squeezed onto a tiny island on the western side of Lake Torrens. Four days later, a field team from DEH, headed by Alex Clarke, reached the site. It found a thriving, teeming colony of stilts, already with many thousands of eggs hatched and an insignificant presence of Silver Gulls. On one afternoon, a watch at the water's edge recorded 2,000 chicks per hour entering the water. Even if the eggs had only commenced hatching that day it would, with an incubation period of 22 days, have set laying at April 18th, but, with so many already hatched, it seems certain that some were laid even earlier, when the rains which filled the lake had scarcely finished falling. How the stilts knew that conditions were right and on which lake is a mystery which no one has yet solved.

By May 19th hatching was complete and an estimated 190,000 chicks had got away from the island, by far the biggest Banded Stilt breeding event that had ever been recorded. By that time too, adult stilts were mating again and it was clear that there was going to be a second laying, albeit a much smaller one than the first. There is no means of telling one stilt from another and whether these latter birds were having a second brood, had lost their first clutch or were merely late arrivals in the colony is a question which is impossible to answer. Eventually

The floor of the nesting colony, a litter of incubated nests, abandoned eggs and chicks. Some eggs, discarded for no obvious reason, had been swept together like unwanted refuse.

In the colony. An adult is trying to steer its three newly-hatched chicks through the throng of decidedly hostile sitting birds.

the second colony numbered some 10-12,000 birds and I was lucky to be one of a seven member team to go in and study it.

On June 14th, our vehicles made their tortuous way in towards the lakeside and I could well appreciate why it had taken so long to find that first ever recorded Banded Stilt colony. It took us nearly three hours to negotiate the last 30km of broken gibber, following the route which Alex Clarke had reconnoitred the month before. Finally, we found ourselves at the muddy shoreline of Lake Torrens, looking east across 30km of water to the outlines of the Flinders Ranges. Much closer to us, a low hummock out in the lake was all that we could see of the tiny island where the stilts were breeding. Darkness was not far away and we would leave our first visit there until the morning. The night became still and cold but not quite silent. From 2½km away across the lake came the distant babel of a great host of voices, the sounds of the Banded Stilts.

The next morning, we set out for the island; Ken Gosbell, Maureen Christie

The Silver Gull, arch enemy of the Banded Stilt. A gull lands in the colony, seizes a chick and flies with it to the lake to dismember it in the water.

Enemy No 2! Footprints of a fox, which came once to the colony, killing adults, burying some and causing a sizeable section of the colony to desert.

and Iain Stewart from the VWSG, Simon Oster, Chris Thompson and Clare Manning from DEH and myself. There was only one way to get there and that was to wade. The water was less than knee deep but was intensely cold and, in those circumstances, 2½km is quite a long hike. To transport our considerable gear, we had three kayaks and some large plastic containers, wedged inside the inflated inner tubes of truck tyres. As we waded through the clear water, we could just make out the tiny brine shrimps, almost translucent and barely 2-3mm long. Without them, there would have been no stilt breeding event.

As we neared the island, we started to see stilts, adults flying to and from the colony and little parties of tiny swimming chicks, each party in the care of anything from one to a dozen adults. There was no sign of any of the chicks which had hatched five to six weeks before. If observations from earlier colonies were anything to go by, they could be over 100km away by now, not quite ready to fly and still living on the huge lake.

We landed on the little island, just 500m x 300m in size. The stilts were on the far side, out of sight in dead ground from where we stood but evidence of the size of the first colony was all around; empty scrapes, broken eggshells and the occasional dead chick. We crested the low crown of the island and the colony was in front of us, a spectacular scene of noise, colour and activity. The ground was made up of clumps of saltbush with bare sand in between and, on the sandy patches, the sitting birds were packed shoulder to shoulder, ten to the square metre. The noise was constant, a chorus of musical yelps, melding together into a single sound and mingled with lower clucking calls and the squeaking of newly-hatched chicks. The colony was quite small as Banded Stilt colonies go, only about 150m in diameter, but into that space was packed what we estimated to be some 6,000 nests. Banded Stilts do not need much space when conditions are right.

Down to the water. As soon as the chicks are dry and able to walk, their parents lead them down to the lake and into the water.

We walked a little closer and the nearest thousand birds rose in the air in a hubbub of sound. It was only a momentary alarm and they were hardly in the air before they were landing again but now a few metres back from their nests. They hit the ground running and, within moments, all were back at their nests and settling onto their eggs again. This is the way of a Banded Stilt colony. Their nerves are on a constant hair-trigger, ever ready to leap into the air at the slightest threat, be it real or merely perceived but they are not shy and, as long as I kept quite still, I could sit within a few metres of them, while they went about their lives and ignored me. Whether, after each alarm, every bird returned to the same nest, I had no means of knowing. To me, one egg looked just like any other and there were thousands of them but no doubt the stilts have powers of recognition which are lacking in me. One adult stilt also looks just like another but, among them, Clare spotted and photographed one wearing the orange and yellow leg flag of the Coorong, one of the birds which we had caught as a chick four years before.

Throughout the colony, the ground was thick with abandoned eggs. Some of these were still in discrete clutches of one, two and three, sitting in their nest scrapes but others were scattered haphazardly everywhere, sometimes in great clusters of 20 or more. Why so many eggs had been left is hard to know, although a fox had visited the island a week before, wreaking considerable mischief. Its footprints were still on the sand, one corner of the colony had been abandoned completely and here there were not only thousands of deserted eggs but also many dead chicks and numerous adult corpses, some of which the raider had tried to bury with varying degrees of success. Fortunately, it seemed that it had not returned and, with a long swim to reach the island, we felt it unlikely that it would try again.

Despite these losses, the colony was thriving and eggs were hatching at a considerable pace. From a hide, I watched a number of newly hatched families of chicks being led by a parent to the water. For the chicks, it was a harrowing introduction to the world which they had just entered. As they followed their parents through the colony, the chicks were being assaulted and stabbed by the stiletto-fine bills of every sitting adult which could reach them. Many were knocked over and, under continuous attack, struggled to regain their feet without falling behind. Others were rolled completely onto their backs under multiple

As soon as they reach the lake, the adults take the chicks under their wings and briefly submerge them in the water. Then they have to negotiate the menacing ring of Silver Gulls.

assaults and, even if they did manage to get up, their siblings had gone, following on behind a parent who seemed quite unconcerned by the misfortunes of some of its offspring. Once on their own, they seemed unlikely to reach the water and, of the many dead chicks throughout the colony, some were surely victims of this strange and, to human eyes, callous behaviour.

At the edge of the saltbush, there was a stretch of bare sandy mud leading down to the water. Here, each adult, with its band of tiny chicks, paused before making the final dash. This was where the chicks were most vulnerable but I never saw one taken or even attacked here. Then they reached the water and the Silver Gulls were waiting. On our first day at the colony, there were only around 30 there but, within three days, this had swelled to more than 100. They were certainly having an impact and were doing most of their grisly work in the colony itself, landing among the nesting stilts and stalking around until they could snatch a poorly defended hatchling. In two hours on the last day, I saw five chicks taken and it was only fortunate that not enough gulls had found the colony to become a significant problem. Unknown to us at the time, a smaller breeding colony of stilts had formed on Lake Eyre and this was later reported to have been completely destroyed by Silver Gulls, a repeat of the events of 2000.

Once in the water, the adult stilts seemed to become much more capable of defending their young than they had been on land. The first requirement was to introduce the chicks to a life afloat and, as they entered the water, an adult would stand over one or two of them, covering them with part-open wings and then appearing to push them briefly under water. This was not an ongoing protective tactic as used by grebes and jacanas but a brief, single initiation practice. What purpose it served is hard to say but, light as gossamer, it may have helped to dampen the chicks down and prevent them sailing uncontrollably away on the ever-present breeze. After this, clustered closely together, they set off to breach the cordon of gulls, each little flotilla guarded by at least one, but sometimes up to a dozen adults. Many times I watched a gull advancing menacingly towards chicks but always there was an adult stilt to turn, face it and drive it away and, unlike Clive's experience at Lake Eyre, I never saw the gulls working as a team to overpower the stilts' defences.

Out in the broader lake, the chicks seemed free of further gull attack. Each little group, with its guardian adults, stayed more or less together, tending to drift away downwind, even though, with their strong, webbed feet, the chicks were well able to make headway against the breeze, a skill which they brought into play when trying to avoid the attentions of the banding team. Of the earlier hatching of stilts four to six weeks before there was no sign and these were likely to be far away with many of them already capable of flight.

One of the main purposes of our expedition was to band and flag chicks. Very little is known about stilt movements and nothing at all about their longevity. After ten years without breeding, were they likely to start dying without reproducing themselves or can they live on for much longer than this? There was an imperative to find out but putting the requirement into practice was not easy. To catch newly-hatched chicks in the colony was not an option as this would certainly have caused widespread disruption and desertions. However, within hours, these same chicks swim far away out into the lake so that the only practical option was to catch them soon after they entered the water. We set off in pursuit.

Two parties of chicks had recently left the shore, one of nine and one of seven, each guarded by three adults. As we closed in on them from two sides, they came together and closed ranks, adults on the outside and chicks in the centre, like a beleaguered platoon of soldiers. Finally the adults' courage failed and they flew, while, left alone, the chicks tried to scatter. It was too late and, with a hand net, it was quite easy to catch them, taking all but two in the hope that the adults would stay to guard their diminished crêche. Two of the adults did stay close by but we had to be quick, for there was always the concern that they too would fly off, leaving the banded chicks unprotected and at the mercy of the gulls. It was slow work but we got the chicks back in the water while the adults were still there and they drifted away as a compact party. Over the three days, we only managed to process 60 chicks but it was a start and, hopefully, some of these birds will be seen in the future to help solve some of the mysteries of the species.

We had only three days at the island but, even in that short time, fresh patches of mud were appearing, it was clear that the lake was drying out rapidly and we wondered

Catching and flagging the Banded Stilt chicks. They are quite easy to round up and scoop from the water with a net.

about the fate of the little chicks which we had just been watching. HANZAB states that it takes 50 days before a young Banded Stilt can fly, which seems excessively long but, even if they took only the 28-32 days of the Black-winged Stilt, there was clearly the risk that the lake would be dry before the young were able to fly, With floating brine shrimp their sole source of food there, some of these birds were certainly going to move beyond the lake to find food and might, in fact, never survive to fly.

On July 8th, three weeks after we left, Alex Clarke did a final helicopter reconnaissance over the lake. He found extensive mudflats appearing in the lake, while the island site of the colony was now completely deserted, as was a second colony 50km to the north, which had been established some time after the first one. There were still about 200 Silver Gulls at the first colony site and they had completely devoured all the abandoned eggs and dead chicks which they had previously ignored. There had also been a return visit by a fox and there were new adult stilt carcasses on the ground. Why these agile and powerful flyers were unable to avoid being caught is something which I cannot explain.

A Banded Stilt aquaplanes across the water as it returns to its newly-flagged chicks.

There were also ample signs of success and, spread across the lake, there were many thousands of stilt chicks, no longer accompanied by parents and either capable of flight or very close to it. Twelve weeks after the first broods had hatched, it seemed highly likely that these were chicks from the second attempt and that they too might get away before the lake went dry. The largest Banded Stilt breeding event ever recorded had also been a highly successful one and the future of the species, at least for the next few years, seems to be assured.

That might have been the end but, in a period which has seen repeated episodes of soaking inland rainfall, that end may even yet not be in sight. In February 2011, the remnants of tropical Cyclone Yasi brought over 100mm of rain to the Flinders Ranges, Lake Torrens filled once more and, within days, the Banded Stilt were breeding again, this time in two colonies, one of 20,000 pairs and one of 5,000. Silver Gulls were not a problem but rapid drying out of the lake was and few if any chicks fledged from the larger colony. At the smaller colony, the water persisted for longer and a considerable number of chicks were, when last seen, close to fledging. Here in miserable conditions, the indefatigable Maureen Christie and a stoical team were able to catch and flag 332 chicks, a sterling effort.

Finally, in June 2011, Lake Eyre was the site of yet another Banded Stilt breeding colony, this time of an estimated 80-85,000 birds. Here though, the Silver Gulls had set up a breeding colony too and, while the authorities were still deliberating about when they should take action, the stilts decided that they had had enough and deserted without raising a single chick. With their voracious appetites, it seems that the presence of any breeding Silver Gulls should be the trigger to take action against them.

In just over 12 months, Banded Stilts had bred three times, or even five if the two sets of twin colonies on Lake Torrens are counted. Even with the failure of the Lake Eyre colony, the number of chicks which left the breeding islands was enough to more than double the previous Banded Stilt population. Not all of these will survive to become adults but, nevertheless, this has been a remarkably successful time for the species, which should ensure its health for many years to come.

Footnote:

The Banded Stilt has produced many surprises but it seems that there are always more to come.

In April 2012, satellite transmitters were attached to six adult birds nesting at Lake Eyre, part of a large breeding colony which was totally destroyed by Silver Gulls. These six remained in the same area until the end of the month but then two of them left. Both headed straight to Western Australia, one flying non-stop for 1500km, the other making two stops at salt lakes along the way. If any further proof had been needed that Banded Stilts all belong to a single population, then this was it.

33 Further Reading

Australasian Wader Studies Group, *Stilt, The Journal for the East Asian-Australasian Flyway*, Numbers 1-60, AWSG

Australasian Wader Studies Group *Tattler, Newsletter for the Asia Pacific Flyways* Numbers 1-19, AWSG

Chatto, R. *The Distribution and Status of Shorebirds Around the Coast and Coastal Wetlands of the Northern Territory*, Parks and Wildlife Commission of the Northern Territory 2003

Geering, A., Agnew, L. and Harding, S. *Shorebirds of Australia*, CSIRO Publishing, Melbourne, 2007

Hayman, P., Marchant, J. and Prater, T. *Shorebirds. An Identification Guide* Houghton Mifflin, Boston, Massachusetts, USA 1986

Higgins, P.J. and Davies, S.J.J.F. *Handbook of Australian, New Zealand and Antarctic Birds*, Vol 3, Oxford University Press, Melbourne, 1996

Lane, B. *Shorebirds in Australia*, Nelson Publishers, Melbourne, 1987

Marchant, S. and Higgins, P.J. *Handbook of Australian, New Zealand and Antarctic Birds*, Vol 2, Oxford University Press, Melbourne, 1993

Matthews, G.V.T. *Bird Navigation*, Cambridge University Press, 1968

Nethersole-Thompson, D. *The Dotterel*, William Collins, Glasgow, 1973

Nethersole-Thompson, D. *The Greenshank* Collins, London, 1951

Paton, D.C. *At the End of the River* ATF Press, Adelaide, 2010

Pizzey, G. and Knight, F. *The Field Guide to the Birds of Australia*, 7th Edition, Harper Collins *Publishers*, 2003

Pringle, J.D. The National Photographic Index of Australian Wildlife, *The Shorebirds of Australia* Angus and Robertson, North Ryde, NSW, 1987

Rogers, D.I., Piersma, T., Lavaleye, M., Pearson, G.B. and de Goeij, P. *Life Along Land's Edge*, Department of Conservation and Land Management, Western Australia, 2003

Thomson, A. Landsborough. *Bird Migration*, H.F.& G.Witherby, London, 1936

van de Kam, J. *Invisible Connections*, Wetlands International, 2008

van de Kam, J., Ens, B., Piersma, T. and Zwarts, L. *Shorebirds An Illustrated Behavioural Ecology*, KNNV Publishers, Utrecht, The Netherlands, 2004

Victorian Wader Study Group, *VWSG Bulletin*, Numbers 1-33, VWSG

White, Gilbert. *The Natural History of Selbourne*, 1788

STILTS AND AVOCETS
Genera *Himantopus, Cladorhynchus* and *Recurvirostra*

Three species. All resident.

Tall, delicate-looking, mostly black and white waders with long, spindly legs and long fine (Stilts) or upturned (Avocets) bills. 7 species world-wide.

BLACK-WINGED STILT *Himantopus himantopus*

Identification 33-38cm. **A striking, tall, black and white wader with extremely long, slender red legs.** Frequents many habitats – fresh and saltwater marshes, wet meadows, saltfields, sewage farms, mudflats, estuaries. **Breeding and non-breeding** Similar. **Adults** Upperparts **Distinguished from Banded Stilt by black nape and upper neck and slimmer build**. Rest of head and base of neck white. Wings black. Underparts All white. Eye black. Bill long, needle-like, black. Legs bright pink **In flight** Upperwings and upper back black. Lower back, rump and tail white. Axillae white. Rest of underwing black. Toes not webbed. Legs trail far behind tail in flight. **Juveniles and Immatures** lack black nape and have varying amounts of dark grey or black on crown and smudgy black around eye.

Voice A short barking yelp, almost dog-like in character.

Breeding Opportunistic and may breed any time when conditions are right but, in southern Australia, mainly in spring. Numerous sites including in or around shallow lakes and ephemeral wetlands, sewage farms. **Nest** variable. On dry ground may be simple trampled hollow, sometimes with a thin lining of grasses, but many nests in shallow water are solid constructions, made from water plants and built-up from the lake bed into a cone-shaped nest. **Eggs** Usually 3-4. **Incubation** c.25days. Young leave nest within a few hours of hatching, swimming if necessary.

Status and Distribution Occurs throughout Australia inc. Tas. where conditions suitable. May congregate in 100s or 1000s on ephemeral wetlands and then disperse without breeding. Occurs all continents except Antarctica. Generally resident but mainly summer migrant above Tropic of Cancer.

BANDED STILT *Cladorhynchus leucocephalus*

Identification 35-43cm. A medium-large, endemic wader, associated exclusively with salt water, and with a unique and remarkable life history. Slightly larger than Black-winged Stilt with fractionally longer bill but significantly shorter legs. **Adult** Whole of head and neck, back, **centre of rump, tail and upper breast white. Broad chestnut band across lower breast**, tapering rapidly along belly to end in point at vent. Remainder of belly and under tail white. Eye black. Bill even finer than Black-winged Stilt, black. Legs pink. Toes webbed. **In flight** upper wings black, which extends back in a point onto rump and almost meets. This plumage used to be regarded as breeding plumage but is now recognised as being acquired with age. **Juvenile and Immature** What used to be described as non-breeding plumage is now known to be juvenile and immature. Juveniles have breast and belly completely white with legs black. Chestnut breast-band is acquired gradually over an unknown period of time. Some records of birds breeding in juvenile plumage.

Voice A soft bark which can sound like a pack of hounds from a large flock in flight.

Breeding The ultimate in opportunistic breeders and the right conditions for this may not occur for years. Needs large, inland salt lakes which have flooded after cyclonic rains and have just the right salinity to trigger explosive breeding of brine shrimps. Nests on islands, packed closely together in huge colonies (Largest recorded estimated at 150,000 birds). **Nest** a shallow scrape on soft ground but no nest at all on hard ground. Sometimes adds a little dry vegetation. **Eggs** Eggs usually 3-4 but occasional bigger clutches. **Incubation** 19-21 days. Huge losses of eggs and chicks due to predation, adverse weather, depletion of food source or unexplained desertion. Silver Gulls a particular problem and sometimes whole colony destroyed and abandoned without a chick surviving.

Status and Distribution Total estimated population of just over 200,000 birds hides a complex and vulnerable state. Two populations, one in WA, one in SA, previously thought to be distinct but now shown to intermingle. Breeding events sporadic, often with years in between and either population will usually form only one breeding colony in a favourable season. This enormous limitation of breeding opportunity clearly makes the whole population highly vulnerable, with any failure having serious portents for the species survival. Non-breeding birds frequent salt lakes, salt pans, saltworks and estuaries in s.w. WA, north to about Port Hedland, and southern SA east to Victoria. **Fledging** of estimated 190,000 birds Lake Torrens in 2010 has hugely increased population.

RED-NECKED AVOCET
Recurvirostra novaehollandiae

Identification 40-48cm. Unmistakable. A medium-large black and white wader of saltpans, salt lakes, estuaries and sewage farms with **chestnut head and neck and long, fine, conspicuously upswept bill.** Whole of head and upper neck chestnut, ending abruptly in lower neck. Back, rump, tail, breast and belly white. Scapulars white. Rest of folded wing black. Eye black with narrow white eye ring. Bill black. Legs long, bluish-grey. Toes webbed. **In flight**, striking pattern of black and white with wing tips, broad wing-band and narrow strip along inner scapulars black. Remainder white. Underwing white with tips black. Feet project well beyond tail. **Breeding and non-breeding** Similar. **Juveniles** have duller head and neck with many brownish feathers.

Voice Barking call, very similar to Black-winged Stilt.

Breeding Opportunistic. Singly or in loose colonies. Mainly Aug.–Dec. in inland regions from:– 1. Northern Vic and eastern SA north through western NSW to south-east Q and southern NT. 2. Inland s.w. WA. **Nest** Scrape with sparse lining sticks or vegetation. Usually near water, close to bush or on small hummock surrounded by water. **Eggs** 4. **Incubation** c.23-25 days. Young leave nest soon after hatching.

Status and Distribution Nomadic and opportunistic. Widespread but patchy distribution across much of Australia, excluding Arnhem Land, northern Cape York, western deserts and s.e. coastal regions.

PLOVERS, DOTTERELS, LAPWINGS
Genera *Pluvialis, Charadrius, Elseyornis, Thinornis, Erythrogonys* and *Vanellus*

21 Species. Seven resident. 14 migratory, seven of these vagrant.

This large group of waders encompasses a wide range of colours, sizes and lifestyles, while retaining a more or less characteristic shape and common features throughout. Sizes range from the 38cm Masked Lapwing down to the 14-16cm Red-capped Plover. All have short bills and high foreheads, with a rounded head shape, well-rounded bodies, long wings, fairly short necks and legs and lack a hind toe. Some are migratory and others resident. World-wide, there are 65 species.

GREY PLOVER *Pluvialis squatarola*

Other Name Black-bellied Plover

Identification 28-31cm. Largest Australian migratory plover. A pale grey plover of sea coasts, noticeably bigger than Pacific Golden Plover and with diagnostic black axillae in flight. **Non-breeding** Rather nondescript. Forehead, crown dark grey. Indistinct pale grey supercilium. Back and wings dark grey with feathers edged pale grey. Underparts Off white with breast streaked lightly dark grey. Eye black. Bill short but heavier than Pacific Golden Plover, black. Legs dark grey. **In flight** Pale white wing bar and rump. **Conspicuous black axillae in all plumages**. **Breeding** Very similar pattern to Pacific Golden Plover but upperparts blackish, heavily flecked with white instead of gold. In Australia this plumage seen most commonly in post-breeding birds arriving back. Rarely moults into breeding plumage prior to leaving Australia but does this at one of the staging points during migration.

Voice A very characteristic triple whistle, "Klee-oo-ee", the middle note lower than the similarly pitched first and third.

Habitat Entirely coastal in Australia, beaches, rocky shores, tidal mudflats, saltmarsh.

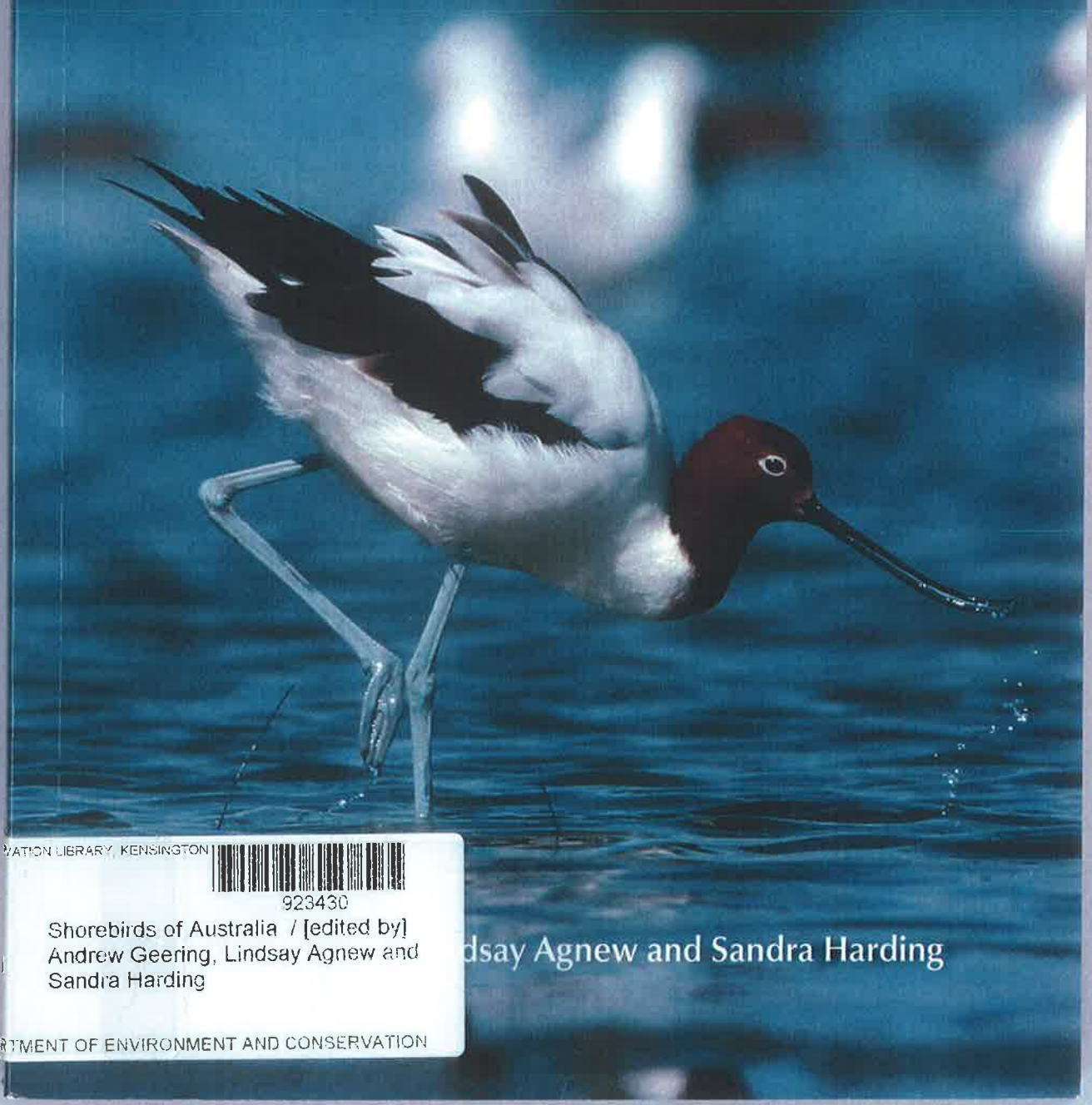
Breeding Circumpolar breeder on arctic tundra of Russia, Siberia, Alaska and Canada but not Greenland or Scandinavia. Non-breeder in Australia.

Distribution Thinly distributed summer migrant around coastal Australia, Tas. and offshore islands.

Extracts regarding BaSt from: Geering, A., Agnew, L. & Harding, S. (2007). *Shorebirds of Australia.* CSIRO Publishing. Topics covered include: breeding areas, salinity, 'Red-capped Plover are known to drape their damp bellies over their eggs (Rogers & Eades 1997)', a 'summary of the breeding ecology' of BaSt (including modal clutch size' of 3-4 eggs, 'incubation period' of '19-21, 28 days', 'age of first flight' of '50 days'), creche formation, predators, Silver Gulls, 'Nest Record Scheme' and moults.

Note in particular the reference (a copy is below, at 1998): Williams, W.D., De Deckker, P. & Shiel, R.J. (1998). *The limnology of Lake Torrens, an episodic salt lake of central Australia, with particular reference to unique events in 1989.* Hydrobiologia 384:101-110.

SHOREBIRDS of AUSTRALIA



dsay Agnew and Sandra Harding

SHOREBIRDS *of* AUSTRALIA

Shorebirds of Australia brings together the latest information about the evolution, ecology and behaviour of shorebirds and how they are distributed in Australia.

Complete with colour photos and up-to-date distribution maps, it provides descriptions and tips to assist with the identification of all species of shorebird in Australia, which comprise about ten per cent of Australia's total avifauna. In addition to information about their habitats, the most significant threats to their existence are mentioned, as well as actions in place to help conserve these birds.

The book is a valuable reference for a broad range of people, from birdwatchers and field naturalists to professional ornithologists and land managers entrusted with the responsibility of protecting Australia's natural resources, especially its wetlands and coastal regions.

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SHOREBIRDS *of* AUSTRALIA

Andrew Geering, Lindsay Agnew
and Sandra Harding

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Red-necked Avocet, Werribee, Victoria. Photograph by Rohan Clarke.
Back cover (from left)
Wood Sandpiper, Werribee, Victoria. Photograph by Peter Fuller.
Masked Lapwings, Townsville, Queensland. Photograph by Graeme Chapman.
Red-necked Stint. Photograph by Peter Fuller.

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Cont

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thousands of kilometres away and are usually closer to the coast where the rainfall is more reliable. For some species, breeding opportunities may not occur every year. Among the many mysteries of shorebird movements is the unanswered question of what triggers these nomadic movements – how do non-breeding birds at the coast know that conditions are favourable for breeding in central Australia with enough confidence to undertake the journey?

Where do shorebirds breed?

On a broad scale, the breeding areas of most migratory species are linked to vegetation zones, which in turn, reflect climatic zones. The Calidridinae sandpipers, tundra plovers and turnstones breed in the arctic- or sub-arctic tundra, whereas the majority of shanks (*Tringa* spp.) breed in the belt of boreal forest south of the tundra. The steppes and deserts of the middle latitudes are home to fewer species but Marsh Sandpiper, Greater Sand Plover and Oriental Plover breed here. This natural latitudinal zoning of breeding areas is interrupted on the coast and along the major rivers, where some species may penetrate both north and south.

Distribution maps of migratory shorebirds in most field guides give a false impression of the extensiveness of a breeding area, as in reality, each area is a mosaic of different habitats, each supporting different shorebird species. For example, Broad-billed Sandpiper nest on tussock islets in very shallow swamps, which are often almost dry by the time the chicks hatch. Many species breed only in mountainous areas. Great Knot are restricted to dry alpine plateaus above the tree-line, while Red-necked Stint prefer a gentle slope with a damp, mossy cover. Both tattler species breed along small braided rivers that descend from the mountains. Other species need a combination of habitats for successful breeding. For example, Grey Plover nest on raised dry tundra but upon hatching, broods move to marshes containing short, sparse vegetation.

Regions of the Northern Hemisphere breeding grounds with the greatest diversity of habitats support the greatest diversity of shorebird species but not necessarily the greatest densities of breeding shorebirds. At least 25 species breed in the northern part of the Chukotsky Peninsula, north-east Siberia, where there is a combination of tundra plain, mountains and the coast. Breeding densities are generally lowest in mountainous and drier areas and highest in fertile river deltas such as the Yukon-Kuskokwim Delta in Alaska (Table 2.1).

The breeding distribution of most Australian-breeding shorebirds is patchy throughout most of their range and for some species, their breeding distribution in any one year is dictated by the distribution of suitable habitat and not all species necessarily breed every year. Australian Pratincole do not breed throughout their range but migrate from the Australian breeding areas to northern Australia and adjacent islands. Other species exploit ephemeral breeding opportunities, then retreat to permanent water or coastal areas. These include Banded Stilt, the western population of Hooded

Table 2.1 Breeding densities of shorebird species in north-east Siberia and Alaska

Species	Site	Density (per km²)	Source
Wandering Tattler	SW Alaska	< 0.1 nests	65
Ruddy Turnstone	Chukotsky Peninsula	1.5 pairs	66
		1–4 pairs	67
Red-necked Stint	NE Chukotsky Peninsula	4.1–6.1 nests, up to 28 nests in best habitats	67
Long-toed Stint	Kamchatka Peninsula	0.2–15.3 pairs	68
Pectoral Sandpiper	Northern Slope, Alaska	4–40 males	69
		1–33 nests	69
	N Siberia	1–36 nests	69
Sharp-tailed Sandpiper	Indigirka R. Siberia	10.2–12.5 males	70
		7.3–9.2 females	70
Dunlin	N Alaska	15 pairs	71
	Yukon R. delta, W Alaska	c. 75 pairs	71
	NE Chukotsky Peninsula	4.1–23.4 nests	67
Western Sandpiper	Yukon R. delta, W Alaska	330–750 pairs	72
	NE Chukotsky Peninsula	3.9–5.3 nests, up to 32 nests in best habitats	67
Curlew Sandpiper	N Taimyr	7–31 males	267
		0.5–18 nests	267
	S Taimyr	0–2.4 nests	267
Red Knot	N Taimyr	0.1–2.0 pairs	73
Great Knot	Alpine area of inland Chukotka	4.7–10.3 males	74
Grey Plover	Alaska	1.0–2.9 pairs	75
	Wrangel Island	5 pairs	76
	Chukotsky Peninsula	1.0–2.5 pairs	77

Plover, Red-necked Avocet and Australian Painted Snipe. Even the species that nest in terrestrial habitats such as grasslands and woodlands are sometimes forced to move in response to drought and fire. Thus, as for Arctic-breeding shorebirds, breeding distribution maps tend to overestimate the occurrence of actual breeding in any one year. Nevertheless, shorebirds have adapted to breed in almost every part of the continent.

Australian-breeding shorebirds breed in a broad variety of habitats (Table 2.2). Some, such as the oystercatchers, the eastern population of Hooded Plover, and Beach Stone-curlew breed along the coast. Terrestrial wetlands of all types, whether

permanent or ephemeral, are used by at least one species of shorebird for breeding: freshwater (e.g. Comb-crested Jacana), brackish (e.g. Black-winged Stilt), saline (e.g. Banded Stilt) and even hypersaline (e.g. the western population of Hooded Plover). Some of these species can exploit a variety of wetland types.

Some Australian-breeding shorebirds do not nest in wetlands but nevertheless, still need to be within a few kilometres of water. One example is Australian Pratincole, which can breed in arid areas but probably requires water for drinking. Other Australian-breeding shorebirds use water to help thermoregulate their clutch; in extreme heat, Red-capped Plover are known to drape their damp bellies over their eggs[21]. Remarkably, Bush Stone-curlew, Inland Dotterel and Plains-wanderer have limited, if any, dependence on water and occur in the most terrestrial of habitats: grasslands, woodlands and arid plains. Australian-breeding shorebirds range from breeding habitat generalists (e.g. Masked Lapwing) to habitat specialists (e.g. the rocky ocean coast-dwelling Sooty Oystercatcher) and there can also be regional variation in breeding habitat. For example, the eastern population of Hooded Plover almost without exception breeds on ocean beaches and associated dunes, whereas the western population also breeds on salt-lakes, sometimes hundreds of kilometres from the coast.

Habitat change by humans has affected the breeding range of some shorebird species. The clearing of forests for farmland, especially along the Amur and Lena rivers in eastern Siberia, is thought to be a reason for the northward extension of the Marsh Sandpiper's breeding range. The increased survival of Ruff and Long-billed Dowitcher in their non-breeding areas seems to explain the recently recorded expansion of their breeding range[22]. In Australia, breeding habitat has been destroyed through wetland reclamation, degradation and water diversion[23]. Even woodland and grassland breeders have suffered from the processes that degrade or eliminate habitat, such as the clearing of woodland and the replacement of native with introduced grasses for pastures. Some of these processes have led to two Australian-breeders, Australian Painted Snipe and Plains-wanderer, being classified as nationally threatened. Even where habitats remain intact, habitat quality is declining because of factors such as disturbance (see page 206). Global warming resulting from the emission of 'greenhouse gases' will likely affect the breeding range of many shorebird species[24]. In particular, the predicted rise in sea-level potentially poses a major problem to coastal-breeding endemic species, such as Beach Stone-curlew, the eastern population of Hooded Plover and oystercatchers[25].

When do shorebirds breed?

Those shorebirds that breed in the Arctic normally arrive at their breeding grounds as the snow cover is disappearing, which generally occurs between late May and early June (Table 2.3). However, in some years, snow cover can still be extensive at these times, forcing the birds to concentrate near human settlements, at the edge of cliffs

Table 2.2 Summary of the breeding ecology of Australian-breeding shorebirds. The main sources of data are Marchant & Higgins[16] and Weston[38]; much of the data require confirmation by scientific study.

Species	Australian Pratincole	Banded Lapwing	Banded Stilt	Beach Stone-curlew
Typical breeding habitat	Open plains, grasslands, agricultural land; near water	Open grasslands, agricultural land, open savannah	Saline and hypersaline terrestrial wetlands	Ocean coast
Permanence of breeding habitat	Ephemeral and permanent	Ephemeral and permanent	Ephemeral	Permanent
Breeding distribution	Australia, mostly in the south-east	Throughout range	A small number of non-coastal lakes†	Throughout range
Dispersion when breeding	Dispersed or loose colonies	Dispersed	Usually colonial	Dispersed
Season (eggs)	All months except March, June, July and August	All months	All months except February, July, October and November	All months except April, May and June
Mating system	Monogamy	Monogamy	Unknown	Monogamy
Sexual dimorphism	None	None	None	None
Parental care	Biparental	Biparental	Biparental	Biparental
Nest site	On ground	On ground	On ground	On ground
Material overhanging nest	Not recorded	Not recorded	Not recorded	Sometimes
Modal clutch size	2	4	3–4	1
Incubation period (days)*	20–21	26–28	19–21, 28	30+
Young fed by parents?	Yes	No	No	No
Defence of young	Distraction displays	Distraction displays and aggression	Limited aggression	Aggression
Age of first flight (days)	20–25	Unknown	50	84

*Excludes infertile eggs and small clutches. † There has been a new, extraordinary breeding event in the Coorong, South Australia (see p.181 for details).

parents normally depart several days before the chicks fledge[3]. Among Australian-breeding shorebirds, it is generally thought that parental care continues at least until the young are capable of flight. For territorial species with the opportunity to lay another nest (e.g. Hooded Plover), young may be aggressively evicted from the territory; only exceptionally do they remain until the subsequent clutch is laid[47]. Other species associate with their young for longer periods: Sooty Oystercatcher young may remain with their parents up to nine months after fledging and Beach Stone-curlew young may remain more than 12 months[48]. Banded Stilt chicks form crèches as the young swim and forage on salt-lakes; one crèche moved, wind-assisted, 130 km in six days[49]. Although the role of the parents in attending the crèches is unknown, it seems possible that some parents diminish or cease their paternal duties once their young join a crèche. Some Australian-breeding shorebirds are occasionally forced to abandon their young if the ephemeral habitat in which they are breeding dries out or becomes unsuitable, presumably with fatal consequences.

Predation

Predation is generally considered to be the most important factor influencing the reproductive success of shorebirds. Lemmings (*Lemmus* spp. and *Dicrostonyx* spp.) and other microtine rodents such as voles (*Microtus* spp. and *Clethrionomys* spp.) are extremely important components of the tundra ecosystem and fluctuations in their abundance can have a large bearing on the reproductive success of Arctic-breeding shorebirds. In some years, lemmings are very abundant but after these peak years, populations usually crash. Many lemming populations fluctuate cyclically, with a 3–4 year periodicity over extensive tracts of land that are not dissected by large rivers or mountain ranges (e.g. the Taimyr Peninsula in north-central Siberia). Where mountain landscapes predominate (e.g. Chukotka in north-east Siberia), peaks in lemming numbers are often localised and irregular in timing.

Several Arctic predators such as Snowy Owl (*Nyctea scandiaca*) and Pomarine Skua (*Stercorarius pomarinus*) are rodent specialists and breed predominantly in years of high lemming abundance. Other predators like Arctic Fox (*Alopex lagopus*), Ermine (*Mustela erminea*), Long-tailed Skua (*S. longicaudus*) and Rough-legged Buzzard (*Buteo lagopus*) have a preference for lemmings and only occasionally take eggs from shorebird nests in good lemming years. However, when lemming numbers collapse, shorebirds and their offspring become the main food source for these predators[50, 51]. Hungry Arctic Fox are especially persistent in searching for birds' nests, sometimes even swimming to small islands in lakes or climbing up cliffs. In years when lemming numbers collapse, shorebirds produce very few, if any, young. This is reflected in the low proportion of juvenile birds which arrive on the non-breeding grounds in Australia[52].

Australia also has its complement of predators that prey upon breeding shorebirds, their eggs and young. Native mammalian predators include Dingo (*Canis lupus*

dingo), quolls, Tasmanian Devil (*Sarcophilus harrisii*) and rodents such as Water-rat (*Hydromys chrysogaster*). Native reptilian and avian predators (e.g. goannas, gulls, ravens and raptors) also abound. However, in the last 200 years, introduced predators have emerged as a prominent force in Australian ecologies and doubtlessly have a major influence on shorebird reproductive success. Domestic dogs and in particular, cats, have established huge feral populations and introduced rodents often reach plague proportions. The introduced Red Fox (*Vulpes vulpes*) is a major predator of nesting shorebirds and young throughout mainland Australia: foxes have been observed to cause the failure of up to 30% of Hooded Plover nests in eastern Australia (depending upon the region)[53] and one fox stomach examined in Western Australia contained the remains of about 38 Red-capped Plover chicks (R. Johnstone, personal communication). Fox-free islands have become strongholds for some species, such as Bush Stone-curlew[54]. Some native predator/scavengers, such as Silver Gull (*Larus novaehollandiae*) and ravens, are at artificially high

Fig. 2.8 Shorebirds chicks have to cope with predators, extreme temperatures and the challenge of finding prey. Cryptic plumage and behaviour and a high tolerance to fluctuations in body temperature allow chicks, such as these Pacific Golden Plover **(upper left)**, Great Knot **(upper right)**, Sanderling **(bottom left)** and Hooded Plover **(bottom right)**, to grow rapidly and fly within a few weeks of hatching. Photographs: Pavel Tomkovich, except for Hooded Plover (Michael Weston).

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Fig. 2.9 Banded Stilt chicks are able to swim and form large crèches, which may move hundreds of kilometres in a few days. Photograph: Graham Carpenter and Keith Bellchambers.

densities, as human wastes provide rich and abundant food allowing populations to become superabundant. The breeding event of Banded Stilt in Lake Torrens in 1989 terminated well before the lake had dried and the food resource disappeared as a result of predation by Silver Gull[55]. While Australian-breeding shorebirds have evolved in the face of predator-pressure, this pressure is probably at historically unprecedented levels.

What defence do shorebirds have against predators? Only the bigger or more aggressive shorebird species are able to chase off some predators from the vicinity of their nests or chicks and these birds are not necessarily well camouflaged (e.g. Grey Plover, Ruddy Turnstone, Bush Stone-curlew and Masked Lapwing)[56,57]. Masked Lapwing will attack potential predators using the spurs on their wings as weapons[16]. Non-aggressive species may find protection by associating with larger, more aggressive species or by forming brood aggregations[58-60]. Australian-breeding shorebirds show a remarkable tendency to breed in colonies, with reports of colonial breeding for half of these species (Table 2.2). This colonial nesting behaviour may confer protection against predators but also probably reflects the localised nature of resources (e.g. suitable breeding sites, water and food). Arctic-breeding shorebirds generally do not form colonies, possibly because of the dispersed nature of their food resources. The exception is the Ruddy Turnstone, which occasionally forms loose colonies.

Shorebirds have developed other methods of predator avoidance. Whimbrel, Curlew Sandpiper and a range of plovers leave their nest at the first sign of an approaching

Fig. 2.10 Predators of shorebirds.
Upper left: an Arctic Fox patrols the Siberian tundra in search of prey such as rodents, shorebirds, their eggs and young. Photograph: Michael Weston.
Upper right: a Silver Gull waits for an opportunity to snatch an unattended egg or chick from breeding Banded Stilt on Stilt Island, southern Lake Torrens, South Australia, in 1989. Photograph: Graham Carpenter and Keith Bellchambers.
Bottom: a dead Hooded Plover, a victim of a free-roaming domestic cat. Photograph: Michael Weston.

predator, relying on the cryptic nature of their eggs or motionless chicks. The breeding plumage of tattlers and knots provides a perfect camouflage and they remain on the nest until the last moment, after which they perform various distraction displays to draw the predator away, such as feigning injury, mimicking a badly flying chick or fleeing rodent and false brooding[61-63]. Although initial responses to a terrestrial predator may differ, nearly all shorebird species exhibit one or several distraction displays if the predator comes too close to the chicks, even when they are nearly fully grown.

Most shorebird species breeding in the northern parts of the tundra have greenish-grey mottled eggs similar in colour to the lichens that smother the rocks. The eggs of more southerly breeding species are usually more richly coloured but they still blend in well with the surrounding vegetation. Pectoral Sandpipers have eggs with big brown patches on a light background, matching the dead leaves and branches of dwarf birch and willow. The eggs of Sharp-tailed Sandpiper are more uniformly coloured brownish-olive and are practically invisible in sedge-covered depressions in the tundra. Australian-breeding shorebirds also have highly cryptic nests and eggs, for example, Hooded Plover eggs blend well with the sandy substrate of an ocean beach and little nest material is used, presumably to maximise camouflage. Red-kneed Dotterel often place their nests under vegetation or even under a raised walkway.

Comb-crested Jacana may sink their floating nest beneath the water to camouflage it when unattended and Australian Pratincole have been recorded covering their eggs when they leave the nest. There are even reports of Australian Pratincole and Beach Stone-curlew moving their nests short distances when disturbed[16].

Downy chicks also blend in well with the surrounding environment. Chicks of most species breeding in the northern parts of the tundra are lightly coloured. Chicks inhabiting sparsely vegetated, mossy areas in southern parts of the tundra are yellowish-tawny (e.g. Red-necked Stint and Pectoral Sandpiper) or greenish-yellow in the case of all species of golden plover. Chicks inhabiting wet marshes or swamps (e.g. Broad-billed Sandpiper and Sharp-tailed Sandpiper) are dark brown. In Australia, as for the Arctic, chicks are highly cryptic within their habitats. For example, the crouching chicks of Bush Stone-curlew resemble the characteristic fallen timber which is common in woodlands.

Some shorebirds have developed other anti-predatory strategies to help protect their young. Comb-crested Jacana and Bush Stone-curlew have been recorded carrying their young under their wings, either away from danger or to cover[16]. The young of some species often dash to protected sites before crouching and freezing, for example Hooded Plover chicks run and hide beneath boulders and in rock crevices. Australian Pratincole chicks hide in rabbit burrows, in cracks in the ground and under

Fig. 2.11 While most species of shorebird are solitary breeders, some form dense breeding colonies consisting of thousands of birds. Banded Stilt is an example of a colonial breeder, here shown breeding on Stilt Island, southern Lake Torrens, South Australia, in early May 1989. Photograph: Graham Carpenter and Keith Bellchambers.

Table 2.5 A crude index of the study effort directed at Australian-breeding shorebirds to date

Species	NRS sheets*	Published papers†	Published papers on breeding‡	Effort index§
Australian Pratincole	69 (1.3%)	0	0	0.0
Banded Lapwing	451 (8.5%)	0	0	0.0
Banded Stilt	0 (0.0%)	8	3	NA
Beach Stone-curlew	17 (0.3%)	5	1	3.1
Black-fronted Dotterel	303 (5.7%)	4	1	0.2
Black-winged Stilt	619 (11.6%)	2	1	0.1
Bush Stone-curlew	86 (1.6%)	5	2	1.2
Comb-crested Jacana	49 (0.9%)	4	2	2.2
Hooded Plover	169 (3.2%)	36	7	2.2
Inland Dotterel	0 (0.0%)	0	0	NA
Masked Lapwing	1844 (34.6%)	2	0	0.0
Painted Snipe	15 (0.3%)	7	4	14.2
Pied Oystercatcher	639 (12.0%)	14	5	0.4
Plains-wanderer	9 (0.2%)	5	0	0.0
Red-capped Plover	618 (11.6%)	4	3	0.3
Red-necked Avocet	174 (3.3%)	3	1	0.3
Sooty Oystercatcher	147 (2.8%)	7	0	0.0

*The number of sheets (i.e. breeding attempts) in Birds Australia's Nest Record Scheme (NRS). Bracketed figures are the percentage of all NRS sheets for Australian-breeding shorebirds (5329). These figures can be assumed to reflect the relative ease with which eggs or young can be detected.

†Number of published papers derived from a search of the Ornithological Worldwide Literature database. It is recognised that not all papers are contained in this database but it is assumed that the results provide a relative measure of the actual number of publications.

‡Those papers that were specific for a species and dealt with at least one component of breeding ecology or mating systems.

§The index is the ratio of the number of papers on breeding that have been published (study output) divided by the percentage of Nest Record Scheme sheets available for each species (an index of the relative ease of locating breeding events). The higher the index, the greater the study effort.

that looks almost identical to the non-breeding plumage, undergo a partial moult before they breed. There is much to be learned about the pre-breeding moults of resident shorebirds, especially those living in the arid inland, such as Banded Stilt and Inland Dotterel. These species breed opportunistically in response to rainfall and for at least Banded Stilt, there is evidence that they can commence breeding while in non-breeding plumage – which makes one wonder why they bother with different breeding and non-breeding plumages in the first place!

Juvenile and sub-adult

Shorebirds hatch with a covering of short fluffy down (see Fig. 2.8, page 26). This natal down is intricately patterned with complex streaks and spots and although it looks attractive when viewed against a plain background, it provides amazingly good camouflage on the breeding grounds. The pattern of the downy plumage differs from species to species, so any chick can be identified with experience. The patterns are also a useful guide to the phylogeny of shorebirds and have provided important insights in shorebird taxonomy[217, 218].

In the period before fledging, a complete moult occurs, whereby the natal down is replaced by juvenile plumage. This is the first plumage of 'true' feathers and in migrants, is generally held through the first southward migration. The feathers of the juvenile plumage are often slightly smaller and narrower than those of the adults, possibly reflecting the rapidity in which they were formed. As a rough generalisation, the juvenile plumage resembles breeding plumage in the upperparts and non-breeding plumage in the underparts. In most species, there are also unique characteristics that set this plumage apart, for example buff tips or dark subterminal markings to some feathers.

Juvenile plumage is only held for a few months and is replaced by the first immature non-breeding plumage. The post-juvenile moult in which this occurs includes the body feathers and some wing-coverts. In some species, such as Latham's Snipe, this moult is more extensive and also includes the flight feathers. The resultant plumage appears similar to the adult non-breeding plumage and in many cases, is only distinguishable at close quarters. However, post-juvenile moult takes several weeks and in migratory species, occurs a month or two after the post-breeding moult of adults. As a result, plumage can be a useful ageing guide in the austral spring. In early spring (about September–October), first-year birds will generally be in complete juvenile plumage, while adults have replaced much or all of their breeding plumage with non-breeding body plumage. Later in spring (about November), when adults have completed body moult, first-year birds still retain identifiable traces of juvenile body plumage. For example, young Red-necked Stint still have many juvenile scapulars through November. Identifying these remnants requires some thought though, as by then, the fringes to these feathers have faded and lost their initial rufous tinges. However, the dark centres to these feathers remain and they appear to merge to form broad streaks above the base of the wings. The timing of the post-juvenile

Banded Stilt

Cladorhynchus leucocephalus

A medium sized shorebird with long, slender, straight bill, long legs and pied plumage. Highly gregarious, found in small to dense flocks mainly on salt-lakes. Sexes similar.

Length 35–43 cm. World population estimate: 206 000; Australian population estimate: 206 000.

Adults, the Coorong, South Australia, 8 December 2005. Peter Fuller.

Adult breeding: Mostly white except for black scapulars and upperwing and broad, chestnut, U-shaped band across lower breast, which merges into black patch at centre of belly. Bill black. Iris black-brown. Legs and feet dark pink to pink-red.

Adult non-breeding: Varies greatly, some similar to adult breeding plumage but breast-band narrower and slightly duller; dullest birds have underpart markings reduced to brown smudges on upper belly, while those intermediate in plumage have a patchy chestnut, brown and white breast-band. Legs duller pink than in adult breeding plumage, sometimes with grey tibiotarsal joint.

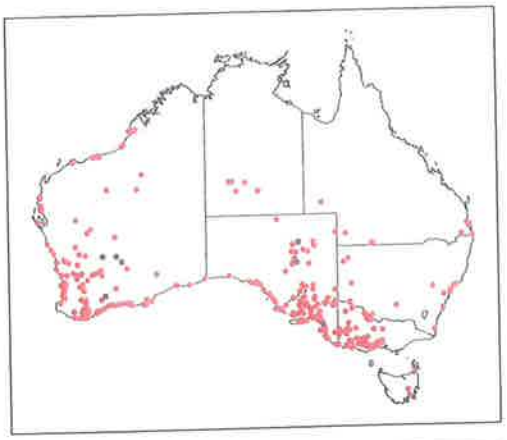
Juvenile: Similar to adult non-breeding plumage but lores and forehead grey when fresh; scapulars and upperwing-coverts black brown with narrow white fringes. Underparts wholly white (lacks breast-band). Legs and feet dark grey.

Flight: Head and upperbody white; upperwing black with white secondaries and tips of inner primaries forming a broad white trailing edge. Underwing mostly white with dark grey outer primaries and primary coverts forming dark wing tip. Chestnut breast-band conspicuous on breeding birds. Feet project well beyond end of tail.

Voice: Individuals make soft, reedy, barking calls but can sound loud when emanating from large, dense flocks. Also gives plaintive whistle.

Range: Endemic. Breeds on large inland salt-lakes of South and Western Australia after rare flooding events; disperses widely

Adult, Bush Bay, Western Australia, March 1976. Graeme Chapman.



within Australia at other times, though most common in southern regions, west of the Great Dividing Range. Breeding recorded at Lakes Callabonna, Eyre and Torrens and the Coorong in South Australia and Lakes Ballard, Barlee and Marmion in Western Australia.

Habits: Intensely gregarious, feeding in very large flocks, often in the company of Red-necked Avocet. Feet partly webbed and birds swim well, often far from shore. Breeding behaviour is unique amongst shorebirds; almost always nests on islands in inland salt-lakes immediately after flooding by major rainfalls. Such events are rare and Banded Stilt may go for years without even attempting to breed. When conditions are suitable, the adults disappear from their non-breeding sites, flying inland to sites that may be hundreds of kilometres away – nobody knows how the birds know that the inland sites have just flooded. Many thousands of adults congregate in small areas, nesting in extraordinarily dense colonies and immediately re-nesting if conditions remain suitable. As the salt-lake dries out, the birds disperse, often to coastal habitats including salt-marshes, salt-works and sewage farms.

In 2006, Banded Stilt were observed breeding in the south lagoon of the Coorong, the first coastal breeding record for this species (K. Gosbell, personal communication). This record most probably reflects increasing

Juvenile, Bush Bay, Western Australia, March 1976. Graeme Chapman.

salinity in the upper reaches of the Coorong due to reduced flows from the Murray River, resulting in brine shrimp flourishing, which in turn, has triggered breeding of the birds.

Similar species: Unmistakable in breeding plumage. Dull non-breeding and juvenile plumage similar to that of juvenile Black-winged Stilt but calls differ. Furthermore, white head and white trailing edge to wings are diagnostic. Banded Stilt is also stockier and has shorter legs (juvenile Black-winged Stilt are slender and have very long pale pink legs with a yellow tinge).

END

Endnotes

1. Lane 1987
2. Byrkjedal, Thompson 1998
3. Hoyo, Elliott, Sargatal 1996
4. Paton, Haddrath, Baker 2002
5. Paton, Baker, Groth, et al. 2003
6. van Tuinen, Waterhouse, Dyke 2004
7. Dyke, van Tuinen, 2004
8. Ericson, Envall, Irestedt, et al. 2003
9. Thomas, Wills, Székely 2004a
10. Paton, Baker 2006
11. Thomas, Wills, Székely 2004b
12. Higgins, Davies 1996
13. Parker 1982
14. Christidis, Davies, Westerman, et al. 1996
15. Piersma, van Gils, Wiersma 1996
16. Marchant, Higgins 1993
17. Joseph, Lessa, Christidis 1999
18. Hayman, Marchant, Prater 1995
19. Christian, Christidis, Schodde 1992
20. Chernov 1985
21. Rogers, Eades 1997
22. Tomkovich 1992
23. Olsen, Weston 2004
24. Zockler, Lysenko 2000
25. Chambers, Hughes, Weston 2005
26. Morrison 1975
27. Tomkovich, Zharikov 1997
28. Morrison, Davidson 1990
29. Soloviev, Tomkovich 1997
30. Morrison, Davidson, Piersma 2005
31. Klaassen, Lindström, Meltofte, et al. 2001
32. Piersma, Jukema 1993
33. Tomkovich, Soloviev 2001
34. Holmes, Pitelka 1968
35. Myers, Pitelka 1979
36. Schneider, Harrington 1981
37. Lank, Butler, Ireland, et al. 2003
38. Weston 2000
39. Székely, Reynolds 1995
40. Pierce 1989
41. Pitelka, Holmes, MacLean Jr 1974
42. Oring, Lank 1984
43. Tomkovich, Soloviev 1994
44. Weston 2005
45. Weston, Kraaijeveld-Smit, McIntosh, et al. 2004
46. Weston, Elgar 2005b
47. Whitelaw, Whitelaw, Weston 2005
48. Clancy 1986
49. Phillipps 1990
50. Summers 1986
51. Summers, Underhill, Syroechkovski 1998
52. Minton, Jessop, Hassel 2003
53. Weston 2003
54. Gates, Paton 2005
55. Williams, De Deckker, Shiel 1998
56. Larsen 1991

209. Rijke 1987
210. Burrt Jr 1986
211. Burrt Jr, Ichida 1999
212. Watson 1963
213. Howell, Corben, Pyle, et al. 2003
214. Dolnik, Gavrilov 1979
215. Hedenström 1998
216. Murphy 1998
217. Fjeldså 1977
218. Jehl 1968
219. Meltofte, Piersma, Boyd, et al. 2004
220. Barrett, Silcocks, Barry, et al. 2003
221. Rogers, Hance, Paton, et al. 2005
222. Kam, Ens, Piersma, et al. 2004
223. Morrison, Ross, Niles 2004
224. Baker, González, Piersma, et al. 2004
225. Kingsford 2000
226. Asmal, Jain, et al. 2000
227. Yuan 2001
228. YRCC 2000
229. Gosbell, Grear 2006
230. Tobai 1997
231. Moores 1999
232. Miller 1997
233. Spalding, Blasco, Field, 1997
234. Parish 1987
235. Harty 2004
236. Saintilan, Rogers 2002
237. Jennerjahn, Ittekkot 2002
238. Lee 2005
239. Li, Lee 1998
240. Straw, Saintilan 2004
241. Noor, Andalusi 1997
242. Li, Mundkur 2004
243. Anonymous 2000
244. Evans, Moon 1981
245. Shaw, Connell 1982
246. Anonymous 2001
247. Nielsen, Pedersen, Trai, et al. 1998
248. Taylor 1995
249. Stillman, West, Goss-Custard, et al. 2003
250. West, Goss-Custard, McGrorty, et al. 2003
251. Zharikov, Skilleter 2004 a
252. Baird, Dann 2003
253. Weston, Elgar 2005a
254. Alley, Berntsen, Bindoff, et al. 2007
255. Kattsov, Källén 2005
256. McBean 2005
257. Austin, Rehfisch 2005
258. Callaghan, Bjorn, Chernov, et al. 2004
259. Galbraith, Jones, Park, et al. 2002
260. Rehfisch, Crick 2003
261. Dye 2002
262. Smith, Sheng, MacDonald, et al. 2005
263. Weston, Fendley, Jewell, et al. 2003
264. Anonymous 2005
265. Anonymous 2004
266. Melville 1997
267. Tomkovich, Soloviev 2006
268. Bamford, Watkins, Beacroft, et al. 2007
269. Garnett, Crowly 2000
270. Watkins 1993
271. Wetlands International 2006
272. Blakers, Davies, Reilly 1984
273. Pereira 2005
274. Yang, Wang, Saito, et al. 2006

Bibliography

Alerstam T, Gudmundsson G A (1999) Bird orientation at high latitudes: flight routes between Siberia and North America across the Arctic Ocean. *Proceedings of the Royal Society of London Series B-Biological Sciences* **266**, 2499–505.

Alerstam T, Gudmundsson G A, Green M, Hedenström A (2001) Migration along orthodromic sun compass routes by arctic birds. *Science* **291**, 300–03.

Alley R, Berntsen T, Bindoff N L, et al. (2007) 'Climate change 2007: the physical science basis. Summary for policymakers'. (International Panel on Climate Change: Geneva, Switzerland).

Anonymous (2000) 'PRC National Report for the preliminary transboundary diagnostic analysis of the Yellow Sea large marine ecosystem (PDF-B)'. (United Nations Development Programme: New York, USA).

Anonymous (2001) 'Discover the waterways of South-east Queensland: waterways health and catchment management in South-east Australia'. (South East Queensland Regional Water Quality Management Strategy: Brisbane, Australia).

Anonymous (2004) Fact sheet – Australia's Ramsar Sites. http://www.deh.gov.au/water/wetlands/publications/.

Anonymous (2005) The Ramsar Convention on Wetlands. http://www.ramsar.org/.

Asmal K, Jain L C, et al. (2000) 'Dams and development – A new framework for decision-making, the report of the World Commission on Dams'. (Earthscan Publications Ltd: London and Sterling, VA).

Austin G E, Rehfisch M M (2005) Shifting nonbreeding distributions of migratory fauna in relation to climatic change. *Global Change Biology* **11**, 31–8.

Baird B, Dann P (2003) The breeding biology of hooded plovers, *Thinornis rubricollis*, on Phillip Island, Victoria. *Emu* **103**, 323–8.

Baker A J, González P M, Piersma T, et al. (2004) Rapid population decline in red knots: fitness consequences of decreased refuelling rates and late arrival in Delaware Bay. *Proceedings of the Royal Society of London Series B-Biological Sciences* **271**, 875–82.

Baker M C (1979) Morphological correlates of habitat selection in a community of shorebirds (Charadriiformes). *Oikos* **33**, 121–6.

Bamford M, Watkins D, Bancroft W, Tischler G, Wahl J (2007) 'Migratory shorebirds of the East Asian-Australasian Flyway; population estimates and internationally important sites'. (Wetlands International – Oceania: Canberra, Australia).

Barbosa A (1995) Foraging strategies and their influence on scanning and flocking behaviour of waders. *Journal of Avian Biology* **26**, 182–6.

Barrett G, Silcocks A, Barry S, Cunningham R, Poulter R (2003) 'The New Atlas of Australian Birds'. (Birds Australia: Melbourne, Australia).

Barter M A (1987) Are Curlew Sandpipers sexist – and if so, why? *The Stilt* **11**, 14–7.

Barter M A (1990) Morphometrics of the Eastern Curlew *Numenius madagascariensis*. *The Stilt* **16**, 36–42.

Barter M A (2002) 'Shorebirds of the Yellow Sea: importance, threats and conservation status'. Wetlands International Global Series 9, International Wader Studies 12. (Wetlands International: Canberra, Australia).

Barter M A, Tonkinson D, Tang S X, Yuan X, Qian F W (1997) Staging of Great Knot *Calidris tenuirostris*, Red Knot *Calidris canutus* and Bar-tailed Godwit *Limosa lapponica* at Chongming Dao, Shanghai: jumpers to hoppers? *The Stilt* **31**, 2–11.

Battley P F (1997) The northward migration of Arctic waders in New Zealand: departure behaviour, timing and possible migration routes of Red Knots and Bar-tailed Godwits from Farewell Spit, North-West Nelson. *Emu* **97**, 108–20.

Battley P F, Piersma T, Dietz M W, Tang S, Dekinga A, Hulsman K (2000) Empirical evidence for differential organ reductions during trans-oceanic bird flight. *Proceedings of the Royal Society of London Series B-Biological Sciences* **267**, 191–5.

Battley P F, Piersma T, Rogers D I, Dekinga A, Spaans B, Van Gils J A (2004) Do body condition and plumage during fuelling predict northwards departure dates of Great Knots *Calidris tenuirostris* from north-west Australia? *Ibis* **146**, 46–60.

Battley P F, Rogers D I, Piersma T, Koolhaas A (2003) Behavioural evidence for heat-load problems in Great Knots in tropical Australia fuelling for long-distance flight. *Emu* **103**, 97–103.

Battley P F, Rogers D I, van Gils J A, Hassell C J, Boyle A, Hong-Yan Y (2005) How do Red Knots *Calidris canutus* leave northwest Australia in May and reach the breeding grounds in June? Predictions of stopover times, fuelling rates and prey quality in the Yellow Sea. *Journal of Avian Biology* **36**, 494–500.

Bednekoff P A, Lima S L (2002) Why are scanning patterns so variable? An overlooked question in the study of anti-predator vigilance. *Journal of Avian Biology* **33**, 143–9.

Biljlsma R G, Roder F (1991) Foraging behaviour of Terek Sandpipers *Xenus cinereus* in Thailand. *Wader Study Group Bulletin* **61**, 22–6.

Blakers M, Davies S J J F, Reilly P N (1984) 'The Atlas of Australian Birds'. (Melbourne University Press: Carlton, Australia).

Botton M L, Loveland R E, Jacobsen T R (1994) Site selection by migratory shorebirds in Delaware Bay, and its relationship to beach characteristics and abundance of horseshoe crab (*Limulus polyphemus*) eggs. *The Auk* **111**, 605–16.

Burrt E H Jr (1986) 'An analysis of physical, physiological and optical aspects of avian coloration with emphasis on wood-warblers', Ornithological Monographs no. 38. (American Ornithologists' Union: Washington DC, USA).

Burrt E H Jr, Ichida J M (1999) Occurrence of feather-degrading bacilli in the plumage of birds. *The Auk* **116**, 364–72.

Butler R W, Williams T D, Warnock N, Bishop M A (1997) Wind assistance: a requirement for migration of shorebirds? *The Auk* **114**, 456–66.

Byrkjedal I, Thompson D B A (1998) 'Tundra plovers: the Eurasian, Pacific and American Golden Plovers and Grey Plover'. (T & A D Poyser: London, UK).

Callaghan T V, Bjorn L O, Chernov Y, et al. (2004) Responses to projected changes in climate and UV-B at the species level. *Ambio* **33**, 418–35.

Chambers L E, Hughes L, Weston M A (2005) Climate change and its impact on Australia's avifauna. *Emu* **105**, 1–20.

Chernov Y I (1985) 'The Living Tundra' (transl. from Russian). (Cambridge University Press: Cambridge, UK).

Christian P D, Christidis L, Schodde R (1992) Biochemical systematics of the Australian dotterels and plovers (Charadriiformes: Charadriidae). *Australian Journal of Zoology* **40**, 225–33.

Christidis L, Davies K, Westerman M, Christian P D, Schodde R (1996) Molecular assessment of the taxonomic status of Cox's sandpiper. *The Condor* **98**, 459–63.

Clancy G P (1986) Observations on nesting Beach Thick-knees *Burhinus neglectus* at Red Rock, New South Wales. *Corella* **10**, 114–8.

Congdon B C, Catterall C P (1994) Factors influencing the Eastern Curlew's distribution and choice of foraging sites among tidal flats of Moreton Bay, south-eastern Queensland. *Wildlife Research* **21**, 507–18.

Dann P (1987) The feeding behaviour and ecology of shorebirds. In 'Shorebirds in Australia', B A Lane (Ed), pp. 10–20. (Nelson Publishers: Melbourne, Australia).

Dann P (1999a) Foraging behaviour and diets of Red-necked Stints and Curlew Sandpipers in south-eastern Australia. *Wildlife Research* **27**, 61–8.

Dann P (1999b) Feeding periods and supratidal feeding of red-necked stints and curlew sandpipers in Western Port, Victoria. *Emu* **99**, 218–22.

Dodd S L, Colwell M A (1998) Environmental correlates of diurnal and nocturnal foraging patterns of nonbreeding shorebirds. *The Wilson Bulletin* **110**, 182–9.

Dolby A S, Grubb T C Jr (1998) Benefits to satellite members in mixed-species foraging groups: an experimental analysis. *Animal Behaviour* **56**, 501–9.

Dolnik V R, Gavrilov V M (1979) Bioenergetics of molt in the chaffinch (*Fringilla coelebs*). *The Auk* **96**, 253–64.

Dorogoy I V (1997) The fauna and distribution of waders in North-East Asia. In 'Species Diversity and Population Status of Waterbirds in North-East Asia' [in Russian], pp. 53–87. (North-East Science Center, Russian Academy of Sciences: Magadan, Russia).

Driscoll P (1997) The distribution of waders along the Queensland coastline. In 'Shorebird Conservation in the Asia-Pacific Region'. Proceedings of the Australasian Wader Studies Group Symposium, 16–17 March 1996, Brisbane, Australia, P Straw (Ed), pp. 80–122. (Birds Australia: Melbourne, Australia).

Driscoll P V, Ueta M (2002) The migration route and behaviour of Eastern Curlews *Numenius madagascariensis*. *Ibis* **144**, E119–E130.

Dye D G (2002) Variability and trends in the annual snow-cover cycle in Northern Hemisphere land areas, 1972–2000. *Hydrological Processes* **16**, 3065–77.

Dyke G J, van Tuinen M (2004) The evolutionary radiation of modern birds (Neornithes): reconciling molecules, morphology and the fossil record. *Zoological Journal of the Linnean Society* **141**, 153–77.

Emlen S T, Oring L W (1977) Ecology, sexual selection, and the evolution of mating systems. *Science* **197**, 215–23.

Ens B J, Esselink P, Zwarts L (1990) Kleptoparisitism as a problem of prey choice: a study on mudflat-feeding curlews, *Numenius arquata. Animal Behaviour* **39**, 219–30.

Ericson P G P, Envall I, Irestedt M, Norman J A (2003) Inter-familial relationships of the shorebirds (Aves: Charadriiformes) based on nuclear DNA sequence data – art. no. 16. *BMC Evolutionary Biology* **3**, 16.

Esselink P, Zwarts L (1989) Seasonal trend in burrow depth and tidal variation in feeding activity of *Neris diversicolor. Marine Ecology Progress Series* **56**, 243–54.

Evans P R, Moon S J (1981) Heavy metals in shorebirds and their prey in North-East England. In 'Heavy Metals in Northern England: Environmental and Biological Aspects', P J Say, B A Whitton (Eds), pp. 181–90. (University of Durham, Department of Botany: Durham, UK).

Fasola M, Biddau L (1997) An assemblage of wintering waders in coastal Kenya: activity budget and habitat use. *African Journal of Ecology* **35**, 339–50.

Ferns P N, Siman H Y (1994) Utility of the curved bill of the Curlew *Numenius arquata* as a foraging tool. *Bird Study* **41**, 102–9.

Finn P G, Catterall C P, Driscoll P V (2007) Determinants of preferred intertidal feeding habitat for Eastern Curlew: a study at two spatial scales. *Austral Ecology* **32**, 131–44.

Finn P G, Driscoll P V, Catterall C P (2002) Eastern Curlew numbers at high-tide roosts versus low-tide feeding grounds: a comparison at three spatial scales. *Emu* **102**, 233–9.

Fitzpatrick S, Bouchez B (1998) Effects of recreational disturbance on the foraging behaviour of waders on a rocky beach. *Bird Study* **45**, 157–71.

Fjeldså J (1977) 'Guide to the Young of European Precocial Birds'. (Skarv Nature Productions: Tisvildeleje, Denmark).

Fleischer R C (1983) Relationships between tidal oscillations and Ruddy Turnstone flocking, foraging, and vigilance behaviour. *The Condor* **85**, 22–9.

Flint V E (1977) Distraction displays: ecological and ethological aspects (waders as an example). In 'Adaptive Peculiarities and Evolution of Birds' [in Russian], V D Ilychev (Ed), pp. 109–19. (Nauka Publication House: Moscow, Russia).

Flint V E, Tomkovich P S (1982) Ecological and ethological isolation in the Pectoral Sandpiper and the Sharp-tailed Sandpiper. In 'Ornithological Studies in the USSR', V M Gavrilov, R L Potapov (Eds), pp. 241–61. (Zoological Institute, USSR Academy of Sciences: Moscow, Russia).

Galbraith H, Jones R, Park R, Clough J, Herrod-Julius S, Harrington B, Page G (2002) Global climate change and sea level rise: potential losses of intertidal habitat for shorebirds. *Waterbirds* **25**, 173–83.

Garnett S T, Crowley G M (2000) 'The Action Plan for Australian Birds 2000'. (Environment Australia: Canberra, Australia).

Gates J A, Paton D C (2005) The distribution of Bush Stone-curlews (*Burhinus grallarius*) in South Australia, with particular reference to Kangaroo Island. *Emu* **105**, 241–7.

Gill R E Jr, Handel C M (1981) Shorebirds of the Eastern Bering Sea. In 'Eastern Bering Sea Shelf; Oceanography and Resources', D W Hood, J A Calder (Eds), pp. 719–38. (Office of Marine Pollution Assessment. NOAA. Distributed by University of Washington Press: Seattle, Washington, USA).

Gill R E, McCaffery B J, Tomkovich P S (2002) Wandering Tattler *Heteroscelus incanus*. In 'The Birds of North America No. 642'. (The Birds of North America Inc: Philadelphia, USA).

Gill R E, Piersma T, Hufford G, Servranckx R, Riegen A (2005) Crossing the ultimate ecological barrier: evidence for an 11000-km-long nonstop flight from Alaska to New Zealand and eastern Australia by Bar-tailed Godwits. *The Condor* **107**, 1–20.

Gochfield M (1984) Antipredator behavior: aggressive and distraction displays of shorebirds. In 'Behavior of Marine Animals. Vol. 5. Shorebirds: Breeding Behavior and Populations', J Burger, B L Olla (Eds), pp. 289–377. (Plenum Press: New York, USA).

Goede A A (1993) Longevity in homotherms, the high lifespan and lifespan energy potential in Charadriiformes. *Ardea* **81**, 81–8.

Gosbell K, Grear B (2006) The importance of monitoring shorebird utilisation of the Coorong and surrounding wetlands in South Australia. In 'Status and Conservation of Shorebirds in the East Asian-Australasian Flyway', Proceedings of the Australasian Shorebirds Conference, 13–15 December 2003, Canberra, Australia, P Straw (Ed), pp. 52–61. Wetlands International Global Series 18, International Wader Studies 17. (Wetlands International: Sydney, Australia).

Goss-Custard J D (1980) Competition for food and interference among waders. *Ardea* **68**, 31–52.

Goss-Custard J D, Jones R E (1976) The diets of Redshank and Curlew. *Bird Study* **23**, 233–43.

Grant P, Mullarney K (1989) 'The New Approach to Identification'. (Peter Grant: Ashford, UK).

Guglielmo C G, Haunerland N H, Hochachka P W, Williams T D (2002) Seasonal dynamics of flight muscle fatty acid binding protein and catabolic enzymes in a migratory shorebird. *American Journal of Physiology-Regulatory Integrative and Comparative Physiology* **282**, R1405–R1413.

Guglielmo C G, Haunerland N H, Williams T D (1998) Fatty acid binding protein, a major protein in the flight muscle of migrating Western Sandpipers. *Comparative Biochemistry and Physiology B-Biochemistry & Molecular Biology* **119**, 549–55.

Hale W G (1980) 'Waders'. (Collins Press: London, UK).

Harty C (2004) Planning strategies for mangrove and saltmarsh changes in Southeast Australia. *Coastal Management* **32**, 405–15.

Hayman P, Marchant J, Prater T (1995) 'Shorebirds: An Identification Guide to the Waders of the World'. (A & C Black (Publishers) Ltd: London, UK).

Hedenström A (1998) Aerodynamics of moult in birds: effects of wing gaps on flight performance. In 'Proceedings of the 22nd International Ornithology Congress', Durban, South Africa, N J Adams, R N Slotow (Eds), pp. 536–43. (BirdLife South Africa: Johannesburg, South Africa).

Hedenström A, Alerstam T (1998) How fast can birds migrate? *Journal of Avian Biology* **29**, 424–32.

Hedenström A, Weber T P (1999) Gone with the wind? A comment on Butler et al. (1997). *The Auk* **116**, 560–2.

Hegyi Z, Sasvari L (1997) Costs and benefits of interspecific coloniality in breeding waders. *Folia Zoologica* **46**, 303–14.

Higgins P J, Davies S J J F (1996) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipes to Pigeons'. (Oxford University Press: Melbourne, Australia).

Holmes R T (1970) Differences in population density, territorality, and food supply of Dunlin on arctic and subarctic tundra. In 'Animal Population in Relation to their Food Resources', A Watson (Ed), pp. 303–19. (Blackwell Science Publications: Oxford & Edinbourgh, UK).

Holmes R T (1971) Density, habitat, and the mating system of the Western Sandpiper (*Calidris mauri*). *Oecologia* **7**, 191–208.

Holmes R T, Pitelka F A (1968) Food overlap among co-existing sandpipers on Northern Alaskan tundra. *Systematic Zoology* **17**, 305–18.

Holmes R T, Pitelka F A (1998) Pectoral Sandpiper (*Calidris melanotos*). In 'The Birds of North America, No. 348', A Poole, F Gill (Eds). (The Birds of North America Inc: Philadelphia, USA).

Hotker H (1999) What determines the time-activity budgets of Avocets (*Recurvirostra avosetta*)? *Journal für Ornithologie* **140**, 57–71.

Howell S N G, Corben C, Pyle P, Rogers D I (2003) The first basic problem: A review of molt and plumage homologies. *The Condor* **105**, 635–53.

Hoyo J del, Elliott A, Sargatal J (1996) 'Handbook of the Birds of the World. Vol. 3. Hoatzin to Auks'. (Lynx Edicions: Barcelona, Spain).

Jehl J R Jr (1968) Relationships in the Charadrii (shorebirds): A taxonomic study based on color patterns of the downy young. *San Diego Society of Natural History Memoir* **3**, 1–54.

Jennerjahn T C, Ittekkot V (2002) Relevance of mangroves for the production and deposition of organic matter along tropical continental margins. *Naturwissenschaften* **89**, 23–30.

Jenni L, Jenni-Eiermann S (1998) Fuel supply and metabolic constraints in migrating birds. *Journal of Avian Biology* **29**, 521–8.

Jenni-Eiermann S, Jenni L, Kvist A, Lindström Å, Piersma T, Visser G H (2002) Fuel use and metabolic response to endurance exercise: a wind tunnel study of a long-distance migrant shorebird. *Journal of Experimental Biology* **205**, 2453–60.

Jessop A E (1987) Foraging strategies of the family Recurvirostridae. *The Stilt* **10**, 15–8.

Joseph L, Lessa E P, Christidis L (1999) Phylogeny and biogeography in the evolution of migration: shorebirds of the *Charadrius* complex. *Journal of Biogeography* **26**, 329–42.

Kam J van de, Ens B, Piersma T, Zwarts L (2004) 'Shorebirds: an illustrated behavioural ecology'. (KNNV Publishers: Utrecht, The Netherlands).

Kattsov V, Källén E (2005) Future climate change: modelling and scenarios for the Arctic. In 'Arctic Climate Impact Assessment', C Symon, L Arris and B Heal (Eds), pp. 99–150. (Cambridge University Press: Cambridge, UK).

Kelsey M G, Hassall M (1989) Patch selection by dunlin on a heterogeneous mudflat. *Ornis Scandinavica* **20**, 250–4.

Kennish M J (2002) Environmental threats and environmental future of estuaries. *Environmental Conservation* **29**, 78–107.

Kingsford R T (2000) Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. *Austral Ecology* **25**, 109–27.

Klaassen M, Lindström Å, Meltofte H, Piersma T (2001) Ornithology – Arctic waders are not capital breeders. *Nature* **413**, 794.

Kondratyev A Y (1982) 'Biology of Waders in Tundras of North-eastern Asia' [in Russian]. (Nauka Publication House: Moscow, Russia).

Kretchmar A V, Andreev A V, Kondratyev A Y (1991) 'Birds of the Northern Plains' [in Russian]. (Nauka Publication House: Leningrad, Russia).

Lanctot R B, Gill R E Jr, Tibbitts T L, Handel C M (1996) Brood amalgamation in the Bristle-thighed Curlew *Numenius tahitiensis:* process and function. *Ibis* **137**, 559–69.

Landys M M, Piersma T, Visser G H, Jukema J, Wijker A (2000) Water balance during real and simulated long-distance migratory flight in the Bar-tailed Godwit. *The Condor* **102**, 645–52.

Lane B (1987) 'Shorebirds in Australia'. (Nelson Publishers: Melbourne, Australia).

Lank D B, Butler R W, Ireland J, Ydenberg R C (2003) Effects of predation danger on migration strategies of sandpipers. *Oikos* **103**, 303–19.

Larsen T (1991) Anti-predator behaviour and mating system in waders: aggressive nest defence selects for monogamy. *Animal Behaviour* **41**, 1057–62.

Larsen T, Sordahl T A, Byrkjedal I (1996) Factors related to aggressive nest protection behaviour: a comparative study of holarctic waders. *Biological Journal of the Linnean Society* **58**, 409–39.

Lee S Y (2005) Exchange of organic matter and nutrients between mangroves and estuaries: myths, methodological issues and missing links. *International Journal of Ecology and Environmental Science* **31**, 163–75.

Li M S, Lee S Y (1998) Carbon dynamics of Deep Bay, eastern Pearl River Estuary, China. I: A mass balance budget and implications for shorebird conservation. *Marine Ecology Progress Series* **172**, 73–87.

Li Z W D, Mundkur T (2004) 'Numbers and distribution of waterbirds and wetlands in the Asia-Pacific region. Results of the Asian Waterbird Census: 1997–2001'. (Wetlands International: Kuala Lumpur, Malaysia).

Lobkov E G (1986) 'Breeding Birds of the Kamchatka Peninsula' [in Russian]. (Far-Eastern Science Centre, USSR Academy of Sciences: Vladivostok, Russia).

Marchant S, Higgins P J (1990) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 1: Ratites to Petrels'. (Oxford University Press: Melbourne, Australia).

Marchant S, Higgins P J (1993) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings'. (Oxford University Press: Melbourne, Australia).

Marsh R L (1981) Catabolic enzyme activities in relation to premigratory fattening and muscle hypertrophy in the gray catbird (*Dumetella carolinensis*). *Journal of Comparative Physiology* **141**, 417–23.

McBean G (2005) Arctic climate: past and present. In 'Arctic Climate Impact Assessment'. C Symon, L Arris, B Heal (Eds), pp. 21–60. (Cambridge University Press: Cambridge, UK).

McNeil R, Diaz O D, Linero I A, Rodriguez J R S (1995) Day- and night-time prey availability for waterbirds in a tropical lagoon. *Canadian Journal of Zoology-Revue Canadienne De Zoologie* **73**, 869–78.

Meire P M (1996) Using optimal foraging theory to determine the density of mussels *Mytilus edulis* that can be harvested by hammering oystercatchers *Haematopus ostralegus*. *Ardea* **84A**, 141–52.

Meltofte H, Piersma T, Boyd H, et al. (2004) Vulnerability of Arctic shorebirds to climate variability and change. In 'ACIA International Symposium on Climate Change in the Arctic'. Reykjavik, Iceland. (Cambridge University Press: Cambridge, UK).

Melville D S (1997) Threats to waders along the East Asian-Australasian flyway. In 'Shorebird Conservation in the Asia-Pacific region'. Proceedings of the Australasian Wader Studies Group Symposium, 16–17 March 1996, Brisbane, Australia, P Straw (Ed), pp. 15–34. (Birds Australia: Melbourne, Australia).

Mendes L, Piersma T, Lecoq M, Spaans B, Ricklefs R E (2005) Disease-limited distributions? Contrasts in the prevalence of avian malaria in shorebird species using marine and freshwater habitats. *Oikos* **109**, 396–404.

Mercier F, McNeil R (1994) Seasonal variations in intertidal density of invertebrate prey in a tropical lagoon and effects of shorebird predation. *Canadian Journal of Ecology* **72**, 1755–63.

Metcalfe N B (1984) The effects of habitat on the vigilance of waders: is visibility important? *Animal Behaviour* **32**, 981–5.

Miller G (1997) 'Wader site data collection and survey project for south-east Queensland'. (Queensland Department of Environment: Brisbane, Australia).

Minton C (2000) Waders roosting on mangroves. *The Stilt* **37**, 23–4.

Minton C, Jessop R, Hassel C (2003) Variations in apparent annual breeding success of Red-necked Stints and Curlew Sandpipers between 1991 and 2001. *The Stilt* **43**, 30–3.

Mlodinow S G (2001) Possible anywhere: Sharp-tailed Sandpiper. *Birding* **August**, 330–41.

Moores N (1999) 'Internationally important wetlands, especially as waterfowl habitat. Korean Wetlands Alliance', National NGO Wetlands Report, Ramsar, Brisbane, Australia. (Korea Wetlands Alliance).

Moreira F (1995) The winter feeding ecology of Avocets *Recurvirostra avosetta* on intertidal areas. II. Diet and feeding mechanisms. *Ibis* **137**, 99–108.

Morrison R I G (1975) Migration and morphometrics of European Knot and Turnstone on Ellesmere Island, Canada. *Bird-Banding* **46**, 290–301.

Morrison R I G, Davidson N C (1990) Migration, body condition and behaviour of shorebirds during spring migration at Alert, Ellesmere Island, NWT. In 'Canada's Missing Dimension. Science and History in the Canadian Arctic Islands', C R Harrington (Ed), pp. 544–67. (Canadian Museum of Nature: Ottawa, Canada).

Morrison R I G, Davidson N C, Piersma T (2005) Transformations at high latitudes: Why do Red Knots bring body stores to the breeding grounds? *The Condor* **107**, 449–57.

Morrison R I G, Ross R K, Niles L J (2004) Declines in wintering populations of Red Knots in southern South America. *The Condor* **106**, 60–70.

Murphy M E (1998) Energetics and nutrition of moulting. In '22nd International Ornithology Congress'. Durban, South Africa, N J Adams, R N Slotow (Eds), p. 311. (Ostrich).

Myers J P, Pitelka F A (1979) Variations in summer temperature patterns near Barrow, Alaska: analysis and ecological interpretations. *Arctic and Alpine Research* **11**, 131–44.

Nebel S, Lank D B, O'Hara P D et al. (2002) Western sandpipers (*Calidris mauri*) during the nonbreeding season: spatial segregation on a hemispheric scale. *The Auk* **119**, 922–8.

Nebel S, Thompson G J (2005) Foraging behaviour of western sandpipers changes with sediment temperature: implications for their hemispheric distribution. *Ecological Research* **20**, 503–7.

Nielsen S S, Pedersen A, Trai L T, Thuy L D (1998) 'Local use of selected wetland resources of Cua Day Estuary, Red River Delta, Vietnam'. (ZMUC and Wetlands International: Kuala Lumpur, Malaysia).

Noor Y R, Andalusi N (1997) Hunting of shorebirds on the north coast of West Java. In 'Shorebird Conservation in the Asia-Pacific region'. Proceedings of the Australasian Wader Studies Group Symposium, 16–17 March 1996, Brisbane, Australia, P Straw (Ed), pp. 44–52. (Birds Australia: Melbourne, Australia).

Norris K (1999) A trade-off between energy intake and exposure to parasites in oystercatchers feeding on a bivalve mollusc. *Proceedings of the Royal Society of London Series B-Biological Sciences* **266**, 1703–9.

Norris K, Johnstone I (1998) Interference competition and the functional response of oystercatchers searching for cockles by touch. *Animal Behaviour* **56**, 639–50.

Ntiamoa-Baidu Y, Piersma T, Wiersma P, Poot M, Battley P, Gordon C (1998) Water depth selection, daily feeding routines and diets of waterbirds in coastal lagoons in Ghana. *Ibis* **140**, 89–103.

Nudds R L, Bryant D M (2000) The energetic cost of short flights in birds. *Journal of Experimental Biology* **203**, 1561–72.

Olsen P, Weston M (2004) The state of Australia's birds 2004: water, wetlands and birds. http://www.deh.gov.au/biodiversity/publications/birds-04/threats.html. (Birds Australia: Melbourne, Australia).

Orians G H, Wittenberger J F (1991) Spatial and temporal scales in habitat selection. *The American Naturalist* **137**, S29–S49.

Oring L W, Lank D B (1984) Breeding area fidelity, natal philopatry, and the social systems of sandpipers. In 'Behavior of Marine Animals. Vol. 5. Shorebirds: Breeding Behavior and Populations', J Burger, B L Olla (Eds), pp. 125–325. (Plenum Press: New York, USA).

Parish D (1987) Conservation of wader habitats in East Asia. In 'The Conservation of International Flyway Populations of Waders', N C Davidson, M W Pienkowski (Eds), Wader Study Group Bulletin No.49 Suppl./IWRB Special Publication No.7: 4–14.

Parker S A (1982) A new sandpiper of the genus *Calidris*. *The South Australian Naturalist* **56**, 63.

Paton D C, Ziembicki M, Owen P, Heddle C (2000) Disturbance distances for water birds and the management of human recreation with special reference to the Coorong region of South Australia. *The Stilt* **37**, 46.

Paton T A, Baker A J, Groth J G, Barrowclough G F (2003) RAG-1 sequences resolve phylogenetic relationships within Charadriiform birds. *Molecular Phylogenetics and Evolution* **29**, 268–78.

Paton TA, Baker AJ (2006) Sequences from 14 mitochondrial genes provide a well-supported phylogeny of the Charadriiform birds congruent with the nuclear RAG-1 tree. *Molecular Phylogenetics and Evolution* **39**, 657–67.

Paton T, Haddrath O, Baker A J (2002) Complete mitochondrial DNA genome sequences show that modern birds are not descended from transitional shorebirds. *Proceedings of the Royal Society of London Series B-Biological Sciences* **269**, 839–46.

Paulson D R (1995) Black-bellied Plover (*Pluvialis squatarola*). In 'The Birds of North America, No. 186', A Poole, F Gill (Eds). (The Academy of Natural Sciences: Philadelphia, and The American Ornithologists' Union: Washington DC, USA).

Paulson D R, Erckmann W J (1985) Buff-breasted Sandpipers nesting in association with Black-bellied Plovers. *The Condor* **87**, 429–30.

Pereira S L, Baker A J (2005) Multiple gene evidence for parallel evolution and retention of ancestral morphological states in the shanks (Charadriiformes: Scolopacidae). *The Condor* **107**, 514–26

Pfister C, Harrington B A, Lavine M (1992) The impact of human disturbance on shorebirds at a migration staging area. *Biological Conservation* **60**, 115–26.

Phillipps H (1990) The stilt, the shrimp and the scientist. *Australian Natural History* **23**, 322–9.

Pienkowski M W (1983a) Changes in the foraging pattern of plovers in relation to environmental factors. *Animal Behaviour* **31**, 244–64.

Pienkowski M W (1983b) Surface activity of some intertidal invertebrates in relation to temperature and the foraging behaviour of their shorebird predators. *Marine Ecology Progress Series* **11**, 141–50.

Pierce R J (1989) Breeding and social patterns of Banded Dotterels (*Charadrius bicinctus*) at Cass River. *Notornis* **36**, 13–23.

Pierce R J (1999) Regional patterns of migration in the Banded Dotterel (*Charadrius bicinctus*). *Notornis* **46**, 101–22.

Piersma T (1987) Hop, skip or jump? Constraints on migration of arctic waders by feeding, fattening and flight speed. *Limosa* **60**, 185–94.

Piersma T (1997) Do global patterns of habitat use and migration strategics co-evolve with relative investments in immunocompetence due to spatial variation in parasite pressure? *Oikos* **80**, 623–31.

Piersma T (2002) When a year takes 18 months: evidence for a strong circannual clock in a shorebird. *Naturwissenschaften* **89**, 278–9.

Piersma T (2003) 'Coastal' versus 'inland' shorebird species: interlinked fundamental dichotomies between their life- and demographic histories? *Wader Study Group Bulletin* **100**, 5–9.

Piersma T, De Goeij P, Tulp I (1993) An evaluation of intertidal feeding habitats from a shorebird perspective: towards relevant comparisons between temperate and tropical mudflats. *Netherlands Journal of Sea Research* **31**, 503–12.

Piersma T, Drent R, Wiersma P (1991) Temperate versus tropical wintering in the world's most northerly breeder, the Knot: metabolic scope and resource levels restrict subspecific options. In 'Acta XX Congressus Internationalis Ornithologici', pp. 761–72. (Christchurch, New Zealand).

Piersma T, Gill R E (1998) Guts don't fly: Small digestive organs in obese Bar-tailed Godwits. *The Auk* **115**, 196–203.

Piersma T, Gudmundsson G A, Lilliendahl K (1999) Rapid changes in the size of different functional organ and muscle groups during refueling in a long-distance migrating shorebird. *Physiological and Biochemical Zoology* **72**, 405–15.

Piersma T, Jukema J (1990) Budgeting the flight of a long-distance migrant: changes in nutrient reserves levels of Bar-tailed Godwits at successive staging sites. *Ardea* **78**, 315–37.

Piersma T, Jukema J (1993) Red breasts as honest signals of migratory quality in a long-distance migrant, the Bar-tailed Godwit. *The Condor* **95**, 163–77.

Piersma T, Rogers D I, Gonzalez P, Zwarts L, Niles L J, de Lima Serrano do Nascimento I, Minton C D T, Baker A J (2005) Fuel storage rates in Red Knots worldwide: facing the severest ecological constraint in tropical intertidal conditions? In 'Birds of Two Worlds: the Ecology and Evolution of Migratory Birds', P P Marra, R Greenburg (Eds), pp. 262–74. (John Hopkins University Press: Baltimore, USA).

Piersma T, van Aelst R, Kurk K, Berkhoudt H, Maas L R M (1998) A new pressure sensory mechanism for prey detection in birds: the use of principles of seabed dynamics? *Proceedings of the Royal Society of London Series B-Biological Sciences* **265**, 1377–83.

Piersma T, van Gils J, de Goeij P, van der Meer J (1995) Holling's functional response model as a tool to link the food-finding mechanism of a probing wader with its spatial distribution. *Journal of Animal Ecology* **64**, 493–504.

Piersma T, van Gils J, Wiersma P (1996) Family Scolopacidae (sandpipers, snipes and phalaropes). In 'Handbook of the Birds of the World, Vol. 3: Hoatzin to Auks', J del Hoyo, A Elliot, J Sargatal (Eds), pp. 444–533. (Lynx Edicions: Barcelona, Spain).

Pitelka F A, Holmes R T, MacLean S F Jr (1974) Ecology and evolution of social organization in Arctic sandpipers. *American Zoologist* **14**, 185–204.

Placyk J S, Harrington B A (2004) Prey abundance and habitat use by migratory shorebirds at coastal stopover sites in Connecticut. *Journal of Field Ornithology* **75**, 223–31.

Puttick G M (1981) Sex-related differences in foraging behaviour of Curlew Sandpipers. *Ornis Scandinavica* **12**, 13–7.

Raffaelli D, Balls P, Way S, Patterson I J, Hohnmann S, Corp N (1999) Major long term changes in the ecology of the Ythan estuary, Aberdeenshire, Scotland: how important are physical factors. *Aquatic Conservation: Marine and Freshwater Ecosystems* **9**, 219–36.

Reading C J, McGrorty S (1978) Seasonal variations in the burying depth of *Macoma balthica* (L.) and its accessibility to wading birds. *Estuarine and Coastal Marine Science* **6**, 135–44.

Rehfisch M M, Crick H Q P (2003) Predicting the impact of climate change on Arctic-breeding waders. *Wader Study Group Bulletin* **100**, 86–95.

Ribeiro P D, Iribarne O O, Navarro D, Jaureguy L (2004) Environmental heterogeneity, spatial segregation of prey, and the utilization of southwest Atlantic mudflats by migratory shorebirds. *Ibis* **146**, 672–82.

Riegen A C (1999) Movements of banded Arctic waders to and from New Zealand. *Notornis* **46**, 123–42.

Rijke A M (1987) The water repellency of water-bird feathers. *The Auk* **104**, 140–2.

Robert M, McNeil R (1988) Comparative day and night feeding strategies of shorebird species in a tropical environment. *Ibis* **131**, 69–79.

Rogacheva H (1992) 'The Birds of Central Siberia'. (Husum Druck- und Verlagsesellschaft: Husum, Germany).

Rogers D I (2003) High-tide roost choice by coastal waders. *Wader Study Group Bulletin* **100**, 73–9.

Rogers D I, Battley P F, Sparrow J, Koolhaas A, Hassell C J (2004) Treatment of capture myopathy in shorebirds: a successful trial in northwestern Australia. *Journal of Field Ornithology* **75**, 157–64.

Rogers D I, Eades D W (1997) Belly-soaking and egg-cooling behaviour in the Red-capped Plover *Charadrius ruficapillus*. *The Stilt* **30**, 53–4.

Rogers D, Hance I, Paton S, et al. (2005) The breeding bottleneck: breeding habitat and population decline in the Australian Painted Snipe. In 'Status and Conservation of Shorebirds in the East Asian–Australasian Flyway', Proceedings of the Australasian Shorebirds Conference, 13–15 December 2003, Canberra, Australia, P Straw (Ed), pp. 15–23. Wetlands International Global Series 18, International Wader Studies 17. (Wetlands International: Sydney, Australia).

Rogers K G (1995) Eastern Curlew biometrics: based on bivariate separation of the sexes. *The Stilt* **26**, 23–34.

Rojas L M, McNeil R, Cabana T, Lachapelle P (1999) Diurnal and nocturnal visual capabilities in shorebirds as a function of their feeding strategies. *Brain, Behavior and Evolution* **53**, 29–43.

Saintilan N, Rogers K (2002) The declining saltmarsh resource. In 'Proceedings of the Coast to Coast 2002 National Coastal Conference', 4–8 November 2002, Tweed Heads, New South Wales, pp. 410–3. (Coastal CRC: Brisbane, Australia).

Schneider D C (1983) The food and feeding of migratory shorebirds. *Oceanus* **26**, 38–43.

Schneider D C, Harrington B A (1981) Timing of shorebird migration in relation to prey depletion. *The Auk* **98**, 801–11.

Shaw G R, Connell D W (1982) Factors influencing the concentrations of polychlorinated biphenyls in organisms from an estuarine ecosystem. *Australian Journal of Marine and Freshwater Research* **33**, 1057–70.

Simmons K E L (1955) The nature of the predator-reactions of waders towards humans, with special reference to the role of the aggressive-, escape- and brooding-drives. *Behaviour* **8**, 130–73.

Smith L C, Sheng Y, MacDonald G M, Hinzman L D (2005) Disappearing Arctic lakes. *Science* **308**, 1429.

Soloviev M Y, Tomkovich P S (1997) Body mass changes in waders (Charadrii) in a High Arctic area at Northern Taimyr, Siberia. *Journal für Ornithologie* **138**, 271–81.

Soloviev M Y, Tomkovich P S (1998) The phenomenon of brood aggregations and their structure in waders in northern Taimyr. *International Wader Studies* **10**, 201–6.

Spalding M D, Blasco F, Field C D (1997) (Eds) 'World Mangrove Atlas'. (The International Society for Mangrove Ecosystems: Okinawa, Japan).

Speakman J R, Bryant D M (1993) The searching speeds of foraging shorebirds: redshank (*Tringa totanus*) and oystercatcher (*Haematopus ostralegus*). *The American Naturalist* **142**, 296–319.

Stillman R A, Goss-Custard J D, Caldow W G (1997) Modelling interference from basic foraging behaviour. *Journal of Animal Ecology* **66**, 692–703.

Stillman R A, West A D, et al. (2003) An individual behaviour-based model can predict shorebird mortality using routinely collected shellfishery data. *Journal of Applied Ecology* **40**, 1090–101.

Straw P, Saintilan N (2004) Shorebird habitat management in Australia – the threat of mangroves. In 'Status and Conservation of Shorebirds in the East Asian-Australasian Flyway', Proceedings of the Australasian Shorebirds Conference, 13–15 December 2003, Canberra, Australia, P Straw (Ed), pp. 87–91. Wetland International Global Series 18, International Wader Studies 17. (Wetlands International: Sydney, Australia).

Summers R W (1986) Breeding production of Dark-bellied Brent Geese *Branta bernicla bernicla* in relation to lemming cycles. *Bird Study* **33**, 105–8.

Summers R W, Underhill L G, Syroechkovski E E (1998) The breeding productivity of dark-bellied brent geese and curlew sandpipers in relation to changes in the numbers of arctic foxes and lemmings on the Taimyr Peninsula, Siberia. *Ecography* **21**, 573–80.

Székely T, Reynolds J D (1995) Evolutionary transitions in parental care in shorebirds. *Proceedings of the Royal Society of London Series B-Biological Sciences* **262**, 57–64.

Taylor I R (1995) 'Clam harvesting and the conservation of wading birds in Tasmania'. Johnstone Centre of Parks, Recreation and Heritage, Albury, Australia.

Thomas G H, Wills M A, Székely T (2004a) Phylogeny of shorebirds, gulls, and alcids (Aves: Charadrii) from the cytochrome-b gene: parsimony, Bayesian inference, minimum evolution, and quartet puzzling. *Molecular Phylogenetics and Evolution* **30**, 516–26.

Thomas G H, Wills M A, Székely T (2004b) A supertree approach to shorebird phylogeny – art. no. 28. *BMC Evolutionary Biology* **4**, 28.

Thompson J (1990) The sex and age-related distribution of bar-tailed godwits in Moreton Bay, Queensland, during the northward migration. *Emu* **90**, 169–74.

Thompson J (1992) Spatial and temporal patterns of wader habitat utilisation in Moreton Bay, Queensland. PhD Thesis, The University of Queensland.

Thompson J J (1993) Shorebirds as indicators of habitat type and biodegradation. In 'Birds and their Habitats: Status and Conservation in Queensland', C P Catterall, P V Driscoll, K Hulsman, D Muir, A Taplin (Eds). (Queensland Ornithological Society: Brisbane, Australia).

Thompson J J (1998) Interseasonal changes in wader habitat specialisation in Moreton Bay, Australia. *Emu* **98**, 117–26.

Tobai S (1997) Habitat loss and alteration in Japan – a history of large scale destruction. In 'Shorebird conservation in the Asia-Pacific region', Proceedings of the Australasian Wader Studies Group Symposium, 16–17 March 1996, Brisbane, Australia, P Straw (Ed), pp. 35–43. (Birds Australia: Melbourne, Australia).

Tomkovich P S (1992) Breeding-range and population changes of waders in the former Soviet Union. *British Birds* **85**, 344–65.

Tomkovich P S (1995) Wader competition on non-breeding grounds – or why are Australian Red Knots so small? *The Stilt* **27**, 34–5.

Tomkovich P S (2001) Breeding biology of the Great Knot, *Calidris tenuirostris* [in Russian]. *Bulletin of Moscow Society of Naturalists, Biological Division* **106, Part 4**, 13–22.

Tomkovich P S, Soloviev M Y (1994) Site fidelity in high arctic breeding waders. *Ostrich* **65**, 174–80.

Tomkovich P S, Soloviev M Y (1996) Distribution and biometrics of knots *Calidris canutus* on Taimyr, Siberia. *Ardea* **84**, 85–98.

Tomkovich P S, Soloviev M Y (2001) Social organization of the Sanderling at Taimyr, Siberia. *Ornithologia* **29**, 125–36.

Tomkovich P S, Soloviev M Y (2006) Curlew Sandpipers *Calidris ferruginea* on their breeding grounds: schedule and geographic distribution in the light of their breeding system. *International Wader Studies* **19**, 19–26.

Tomkovich P S, Sorokin A G (1983) The bird fauna of Eastern Chukotka [in Russian]. *Archives of the Zoological Museum of Moscow State University* **21**, 77–159.

Tomkovich P S, Zharikov Y V (1997) Wader breeding conditions in the Russian tundras in 1996. *Wader Study Group Bulletin* **83**, 26–36.

Triplet P, Stillman R A, Goss-Custard J D (1999) Prey abundance and the strength of interference in a foraging shorebird. *Journal of Animal Ecology* **68**, 254–65.

Tulp I, McChesney S, De Goeij P (1994) Migratory departures of waders from north-western Australia: behaviour, timing and possible migration routes. *Ardea* **82**, 201–21.

Turpie J K, Hockey P A R (1996) Foraging ecology and seasonal energy budgets of estuarine Grey Plovers *Pluvialis squatarola* and Whimbrels *Numenius phaeopus* at the southern tip of Africa. *Ardea* **84**, 57–74.

Urfi A J, Goss-Custard J D, Lev Dit Durell S E A (1996) The ability of oystercatchers *Haematopus ostralegus* to compensate for lost feeding time: field studies on individually marked birds. *Journal of Applied Ecology* **33**, 873–83.

van Gils J A, De Rooij S R, Van Belle J, Van der Meer J, Dekinga A, Piersma T, Drent R (2005) Digestive bottleneck affects foraging decisions in red knots *Calidris canutus*. I. Prey choice. *Journal of Animal Ecology* **74**, 105–19.

van Gils J A, Dekinga A, Spaans B, Vahl W K, Piersma T (2005) Digestive bottleneck affects foraging decisions in red knots *Calidris canutus*. II. Patch choice and length of working day. *Journal of Animal Ecology* **74**, 120–30.

van Tuinen M, Waterhouse D, Dyke G J (2004) Avian molecular systematics on the rebound: a fresh look at modern shorebird phylogenetic relationships. *Journal of Avian Biology* **35**, 191–4.

Velasquez C R, Hockey P A R (1992) The importance of supratidal foraging habitats for waders at a south temperate estuary. *Ardea* **80**, 243–53.

de Vlas S J, Bunskoeke E J, Ens B J, Hulscher J B (1996) Tidal changes in the choice of *Nereis diversicolor* and *Macoma balthica* as main prey species in the diet of the oystercatcher *Haematopus ostralegus*. *Ardea* **84A**, 91–104.

Watkins D (1993) 'A national plan for shorebird conservation in Australia. RAOU Report No. 90'. (Australasian Wader Studies Group, Royal Austalasian Ornithologists' Union and World Wide Fund for Nature: Melbourne, Australia).

Watson G E (1963) The mechanism of feather replacement during natural moult. *The Auk* **80**, 486–95.

Weimerskirch H, Martin J, Clerquin Y, Alexandre P, Jiraskova S (2001) Energy saving in flight formation – Pelicans flying in a 'V' can glide for extended periods using the other birds' air streams. *Nature* **413**, 697–8.

West A D, Goss-Custard J D, McGrorty S, Stillman R A, Durell S, Stewart B, Walker P, Palmer D W, Coates P J (2003) The Burry shellfishery and oystercatchers: using a behaviour-based model to advise on shellfishery management policy. *Marine Ecology Progress Series* **248**, 279–92.

Weston M, Fendley M, Jewell R, Satchell M, Tzaros C (2003) Volunteers in bird conservation: insights from the Australian Threatened Bird Network. *Ecological Management and Restoration* **4**, 205–11.

Weston M A (2000) The effect of disturbance on the breeding biology of Hooded Plovers. PhD Thesis, The University of Melbourne.

Weston M A (2003) 'Managing the Hooded Plover in Victoria: a review of existing information'. (Parks Victoria: Melbourne, Australia).

Weston M A (2005) A sex-specific display in the sexually monomorphic Hooded Plover. *Thinornis rubricollis*. *Corella* **29**, 11–12.

Weston M A, Elgar M A (2005a) Disturbance to brood-rearing Hooded Plover *Thinornis rubricollis*: responses and consequences. *Bird Conservation International* **15**, 193–209.

Weston M A, Elgar M A (2005b) Parental care in Hooded Plovers (*Thinornis rubricollis*). *Emu* **105**, 283–92.

Weston M A, Kraaijeveld-Smit F J L, McIntosh R, et al. (2004) A male-biased sex-ratio in non-breeding Hooded Plovers on a salt-lake in Western Australia. *Pacific Conservation Biology* **9**, 273–7.

Wetlands International (2006) 'Waterbird population estimates – Fourth edition'. (Wetlands International: Wageningen, The Netherlands).

Whitelaw A, Whitelaw J, Weston M A (2005) Delayed dispersion of a juvenile Hooded Plover from its natal territory. *The Stilt* **48**, 10–2.

Whitfield P (1990) Individual feeding specializations of wintering turnstone *Arenaria interpres*. *Journal of Animal Ecology* **59**, 193–211.

Wiersma P, Piersma T (1994) Effects of microhabitat, flocking, climate and migratory goal on energy expenditure in the annual cycle of Red Knots. *The Condor* **96**, 257–79.

Williams W D, De Deckker P, Shiel R J (1998) The limnology of Lake Torrens, an episodic salt lake of central Australia, with particular reference to unique events in 1989. *Hydrobiologia* **384**, 101–10.

Wiltschko W, Weindler P, Wiltschko R (1998) Interaction of magnetic and celestial cues in the migratory orientation of passerines. *Journal of Avian Biology* **29**, 606–17.

Yang Z, Wang H, Saito Y, Milliman JD, Xu K, Qiao S, Shi G (2006) Dam impacts on the Changjiang (Yangtze) River sediment discharge to the sea: the past 55 years and after the Three Gorges Dam. *Water Resources Research* **42**, W04407.

Yasue M, Quinn J L, Cresswell W (2003) Multiple effects of weather on the starvation and predation risk trade-off in choice of feeding location in Redshanks. *Functional Ecology* **17**, 727–36.

Yates M G, Goss-Custard J D, McGrorty S, et al. (1993) Sediment characteristics, invertebrate densities and wader densities on the inner banks of the Wash. *Journal of Applied Ecology* **30**, 599–614.

Yates M G, Stillman R A, Goss-Custard J D (2000) Contrasting interference functions and foraging dispersion in two species of shorebird (Charadrii). *Journal of Animal Ecology* **69**, 314–22.

Yesou P, Triplet P, Dubois P J (1995) Winter site-fidelity in the Black-winged Stilt *Himantopus himantopus*. *Wader Study Group Bulletin* **76**, 39.

YRCC (2000) 'Lower Yellow River flood control planning. Reconnaissance, Planning and Design Institute, Yellow River Conservancy Committee, April 2000'. (Ministry of Water Resources: Beijing, China).

Yuan J (2001) 'Yellow Sea Ecoregion: reconnaissance report on identification as important wetland and marine areas for biodiversity conservation, Volume 1: China'. WWF-Japan, Supchi wa Sei and Wetlands International China Programme.

Zeffer A, Johansson C, Marmebro Å (2003) Functional correlation between habitat use and leg morphology in birds (*Aves*). *Biological Journal of the Linnean Society* **79**, 461–84.

Zharikov Y, Skilleter G A (2003) Nonbreeding eastern curlews *Numenius madagascariensis* do not increase the rate of intake or digestive efficiency before long-distance migration because of an apparent digestive constraint. *Physiological and Biochemical Zoology* **76**, 704–15.

Zharikov Y, Skilleter G A (2004a) Potential interactions between humans and non-breeding shorebirds on a subtropical intertidal flat. *Austral Ecology* **29**, 647–60.

Zharikov Y, Skilleter G A (2004b) Why do eastern curlews *Numenius madagascariensis* feed on prey that lowers intake rate before migration? *Journal of Avian Biology* **35**, 533–42.

Zockler C, Lysenko I (2000) 'Water birds on the edge. First circumpolar assessment of climate change impact on Arctic Breeding Water Birds. WCMC Biodiversity Series No.11'. (World Conservation Monitoring Center: Cambridge, UK).

Zwarts L (1981) Habitat selection and competition in wading birds. In 'Birds of the Wadden Sea', C J Smith, W J Wolf (Eds), pp. 271–9. (Balkema: Rotterdam, The Netherlands).

Zwarts L (1985) The winter exploitation of fiddler crabs *Uca tangeri* by waders in Guinea-Bissau. *Ardea* **73**, 3–12.

Zwarts L, Blomert A-M (1992) Why knot *Calidris canutus* take medium-sized *Macoma balthica* when six prey species are available? *Marine Ecology Progress Series* **83**, 113–28.

Zwarts L, Ens B J, Kersten M, Piersma T (1990) Moult, mass and flight range of waders ready to take off for long-distance migrations. *Ardea* **78**, 339–64.

Zwarts L, Wanink J H (1991) The macrobenthos fraction accessible to waders may represent marginal prey. *Oecologia* **87**, 581–7.

Zwarts L, Wanink J H (1993) How the food supply harvestable by waders in the Wadden Sea depends on the variation in energy density, body weight, biomass, burying depth and behaviour of tidal-flat vertebrates. *Netherlands Journal of Sea Research* **31**, 441–76.

Index

Extracts regarding Banded Stilt (especially p.206) from '*Ernest Hodgkin's SWANLAND: estuaries and coastal lagoons of South-western Australia'* by Anne Brearley (2005).

The Banded Stilt stuff draws heavily on materials provided to Brearley by JL for this book.

Ernest Hodgkin's SWANLAND

Estuaries and Coastal Lagoons of South-western Australia

Anne Brearley

Peel-Harvey Bernard Hilt extract.

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A special place for birds

The Peel–Harvey, together with the Yalgorup, McLarty and Mealup Lakes, is recognised as a significant waterbird habitat and a Wetland of International Importance under the Ramsar Convention. More than eighty species have been recorded in the area including twenty-seven species listed in the Japan Australia Migratory Birds Agreement (JAMBA) and the China Australia Migratory Bird Agreement (CAMBA). In 1977 more than 100,000 birds were recorded on the estuary. Each year in summer around 20,000 migratory birds visit the estuary to feed on the rich pickings of the sandy flats before flying off to breed in the following Northern Hemisphere summer. The area is also important for species resident in Australia such as pelicans, swans, ducks, grebes, stilts and avocets. (See **Box 1.10 Global travellers: living a double summer life—transequatorial migrant birds** and **Box 3.5 Types of birds using the Peel–Harvey.**)

The Peel–Harvey environment with its wide sandy shallows, low-lying fringing marshes, and abundant food supply has been a waterbird haven. Although extensive areas remain undisturbed, the increasing urban development along the northern and western shores at Mandurah and Dawesville and the recent subdivisions to the east are increasing the fragmentation of suitable habitat and disturbance to bird populations.

The greatest numbers of birds occur in the north-central and south-eastern areas (Austin and Robert Bays) of the Peel Inlet and the southern part of the Harvey Estuary. The southern part of the Harvey is a particularly important refuge for waterfowl that congregate on the lower reaches of the river and the extensive delta. While the eastern shores and outer delta are reserved for nature conservation with a narrow reserve for 'drainage and conservation' on both banks of the lower river, most of Harvey Estuary is not officially protected as a waterfowl refuge area. Land to the west is privately owned, and the population is increasing as farmland is subdivided on both sides of the estuary.

The continuing value of the area for birds is unclear. The fringing vegetation, at the limits of physical tolerance, is particularly vulnerable to higher tides and more saline water. Since the Dawesville Channel was opened, some trees and shrubs appear to be showing signs of stress, the paperbarks are paler and more yellowish in late summer–autumn with some dead branches and a few trees have died. River salinities also appear to be increasing.

Box 3.5 TYPES OF BIRDS USING THE PEEL–HARVEY

The main types of birds using the Peel–Harvey and other estuaries in south-western Australia are:

- migratory waders (e.g. sandpipers, plovers and stints), which feed on benthic invertebrates in the intertidal areas at low tide
- resident waders (e.g. Banded Stilts, Black-winged Stilts, Red-necked Avocets and Red-capped Plovers). Banded Stilts are usually found in shallow inland non-tidal wetlands and rarely in estuaries with marked tidal influence
- long-legged waders (herons, egrets, ibises and spoonbills), which feed on fish and benthic invertebrates in shallow waters
- fish-eating birds (pelicans, cormorants, darters and terns), which occur all year round and fish in deeper water than waders, along with grebes that also feed on invertebrates
- waterfowl (ducks, swans, coots and swamphens). Black Swans feed mainly on large aquatic plants (especially the seagrass *Ruppia* and some species of macroalgae) and are found all year round providing there is access to low-salinity water for drinking
- gulls, which are omnivorous scavengers.

Most of these groups roost on the sandy spits and cays, or in the fringing vegetation (salt marsh and trees) of estuaries. Only a few species breed in estuaries: pelicans, swans, Pacific Black Ducks and Grey Teal, which usually build their nests on low-lying islands in undisturbed fringing vegetation, and Australian Shelducks (Mountain Ducks), which generally breed in trees.

Adapted from D. A. Lord & Associates, 1998.

Ultimate vagabonds

In general, birds are highly mobile, typically using the estuary as a feeding ground and breeding elsewhere, for example in the nearby swamps or the distant Arctic tundra. Numbers may vary greatly from year to year depending on breeding success and conditions in other parts of their range, as well as changes in the estuarine environment of the Peel–Harvey or similar water bodies throughout the South-West. At least 44,939 birds were present on the estuary during surveys in 1998–1999, the most common being Red-necked Stints with 16,436 birds recorded (Table 3.6).

Australian resident species such as pelicans and cormorants are present in varying numbers all year round, while migratory waders arrive in spring and stay through summer. The resident waders such as the Banded Stilt are more characteristically found in non-tidal lakes (Fig. 3.24). It has been suggested that their presence in Peel–Harvey during 1976–1977 was linked to a recent, inland breeding event and the small tidal influence in the pre-channel era (Table 3.7). (See **Box 3.6 The Banded Stilt**.)

TABLE 3.6 *Forty most common species of birds recorded in surveys in the Peel–Harvey 1996–1997 and 1998–1999.*
Source: Lane et al., 2002a & 2002b.

Species	1996–1997	1998–1999
Red-necked Stint*	14,672	16,436
Grey Teal	12,612	4,581
Banded Stilt	6,954	186
Australian Shelduck	4,527	3,890
Silver Gull	4,405	3,383
Red-necked Avocet	2,443	1,399
Black-winged Stilt	2,293	1,400
Little Pied Cormorant	1,665	1,693
Little Black Cormorant	1,368	2,636
Sharp-tailed Sandpiper*	1,285	1,322
Pied Cormorant	1,096	727
Black Swan	1,052	1,130
Red-capped Plover*	876	1,754
Pacific Black Duck	749	693
Whiskered Tern	736	337
Australian Pelican	641	774
Australasian Shoveler	501	100
Common Greenshank*	314	319
Curlew Sandpiper*	313	566
Bar-tailed Godwit*	307	137
Fairy Tern	262	167
Hoary-headed Grebe	220	NR
Caspian Tern	180	298
White-faced Heron	134	126
Grey Plover*	116	81
Great Egret	114	88
Crested Tern	112	121
Darter	95	79
Little Egret	89	78
Australian White Ibis	48	70
Pacific Golden Plover*	54	29
Great Cormorant	39	30
Red Knot*	39	34
White-fronted Chat	33	28
Black-tailed Godwit*	28	NR
Pied Oystercatcher	27	20
Great Knot*	26	37
Eastern Curlew*	19	24
Little Grassbird	15	22
Musk Duck	4	48

** denotes transequatorial migrant species; NR–not recorded in survey.*

As bird numbers naturally fluctuate from year to year, the effects of the new environment created by the channel are difficult to assess. Larger tides will alter some roosting, feeding and breeding areas but will potentially create similar conditions elsewhere. Disturbance is potentially a greater threat due to increased urban development, access and the popularity of boating.

Little Egrets *Egretta garzetta* have become more numerous and widespread around the estuary than in 1976–1977 when a major survey was conducted, reflecting a general increase in numbers of this species in south-western Australia in the past twenty-five years. Small numbers (ten to twenty) of Eastern Curlews *Numenius madagascariensis*, rarely observed elsewhere in the southern half of Australia, are still present particularly around the northern end of the Peel Inlet. Curlew Sandpiper *Calidris ferriginea* are now less abundant due to

Box 3.6 THE BANDED STILT

For a time in the mid-1970s, Banded Stilts *Cladorhynchus leucocephalus* were the most abundant waterbirds on the Peel–Harvey (Tables 3.6 and 3.7). Their presence was probably due to the low tidal amplitude and extensive area of shallow water available for feeding and roosting. Generally they are more common on non-tidal wetlands, particularly saline lakes of the coast or interior. Numbers can fluctuate greatly: 8,800 were recorded in December 1976, increasing to 63,000 in the following February and decreasing to only 27 in June 1977. The largest numbers have been found in the eastern and southern sides of Peel Inlet and in the Creery marshes, with few in Harvey Estuary. Although stilts were not as abundant in the same survey areas in 1996–1997, there were still quite large numbers on other parts of the estuary.

The number of stilts in the area also varies over shorter time scales, for example, more than 2,000 birds were found in Creery Wetland in summer 1995 but most birds had departed by March. Similar departures have been observed on Rottnest Island. A count in the middle of March 1983 recorded 3,000 birds, with another count 24 hours later recording only 200. This sudden drop in numbers is now known to be a response to the filling of the saline lakes of the arid interior following exceptionally heavy rain. When the lakes fill the bird's main food source, the brine shrimp *Parartemia*, hatch from drought resistant eggs and the birds congregate to breed. Although the birds were first scientifically named in 1816, their nesting habits eluded investigators until 1930 when nesting was first observed at Lake Grace.

TABLE 3.7 *Numbers of Banded Stilt on the Peel–Harvey.* Source: Lane et al., 2002a & 2002b; Lane & Pearson, 2002.

Year	Aug	Oct	Dec	Feb	Apr	June
1976–77	761	1,503	8,806	63,000	5,948	27
1996–97	–	124	760	6,954	–	–
1998–99	–	58	15	186	–	–

– indicates no survey at this time.

Three to four eggs, chalky fawn to pure white with black to dark brown twisted lines or blotches, are laid on the ground. The young are covered with pure white down, an unusual colour for young wading birds. Young birds in the first year of life lack the chestnut band across the chest.

Banded Stilts are also known as Rottnest Snipe. In the early colonial days, when Rottnest Island was used as the Governor's summer residence, shooting parties were a favourite entertainment. Bush brakes were erected around the lakes and prisoners used as beaters to move the birds towards the shooters. Today the summer flocks are a great attraction as they swim and feed on the brine shrimps or crowd into 'rafts' for resting. With increasing development along the coast, the shores of the Rottnest lakes are likely to become even more important for large groups of Banded Stilts.

Sources: Lane et al., 1997; Saunders & de Rebeira, 1985; Serventy & Whittell, 1962; Coate & Johnstone, 2003.

FIG. 3.24 *Banded Stilts.* A. G. Wells Collection, Courtesy CALM.

year to year variation in numbers migrating to Australia from the Arctic, a longer term decline in abundance in Australia or change in the Peel–Harvey.

Although not popular, the cormorants are an important part of the estuary system. As fish feeders, their numbers in part reflect the abundance of fish such as the small hardyheads and the health of the system. In the mid 1970s Little Black Cormorants roosted in single flocks of several thousands birds on the sandbars of Herron Point Ford and thousands of Pied Cormorants roosted on high points of a low sand cay north of Point Birch and on Nirimba Cay.

Pelicans

Increased water levels and disturbance are quite likely to affect the pelicans that historically have nested on low-lying islands such as Nirimba Cay, Creery, Channel, Boodalan and Boundary Islands and an unnamed island in Boggy Flat. Nesting has often failed due to human interference, vandalism, fox predation or flooding of nesting sites. (See **Box 3.7 The Pelican.**)

Box 3.7 THE PELICAN

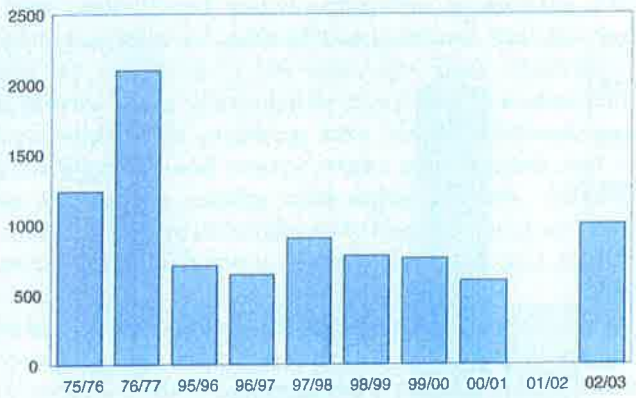
The Australian Pelican *Pelecanus conspicullatus* regularly nests at eight or nine locations in Western Australia. Most nesting sites are located in the northern part of the state, between Shark Bay and the east Kimberley. A few also breed in the south in the Peel–Harvey at Nirimba Cay since 1962, Boodalan and Boundary Island in the Peel–Harvey, on Green Island in Oyster Harbour, Albany since 1985, and more recently in Shoalwater Bay on Penguin Island since 1998, and Seal Island since 2001.

Pelicans nest in colonies, generally on small low islands near the coast and around inland lakes. The nests are placed pecking distance apart and are typically simple scrapes in the ground, often without nesting material, although they are sometimes lined with plant material. The two to three eggs are white, elliptical in shape, and the young hatchlings are featherless. In recent times, nesting in the Peel–Harvey has been most successful on Boundary Island, although the ongoing success is doubtful due to disturbance from boats using the channel, its jetty access and status as a recreation reserve.

Boundary Island, created in 1987 from spoil dredged out of the natural outlet channel, is now an important bird habitat as many of the traditional shallow grounds have been altered or are no longer quiet due to increased people pressure. The first nesting of pelicans was recorded in 1989, but the numbers of successful hatching are unknown. Since the channel was opened there have been four periods of breeding varying from four to eleven months between July 1994 and July 1997 producing 500–700 young. These numbers are probably sufficient to maintain pelican populations, but there is no clear relationship between the number of pelicans counted on Peel–Harvey and the number of young fledglings from Boundary Island. The fluctuating numbers are typical of this highly mobile species. Many newly fledged young probably dispersed to other water bodies, like the older pelicans that use a variety of water bodies and breeding grounds.

Source: Abbott, 2001; Lane et al., 1997; Lane et al., 2002a & b.

FIG. 3.25 *Pelicans at Falcon on the Peel–Harvey, July 1983.* E. P. Hodgkin Collection.



GRAPH 3.7 *Numbers of pelicans on the Peel–Harvey, February 1975 – May 1977 and October 1995 – February 2003. No counts were made in January 2001.* Courtesy J. Lane, CALM.

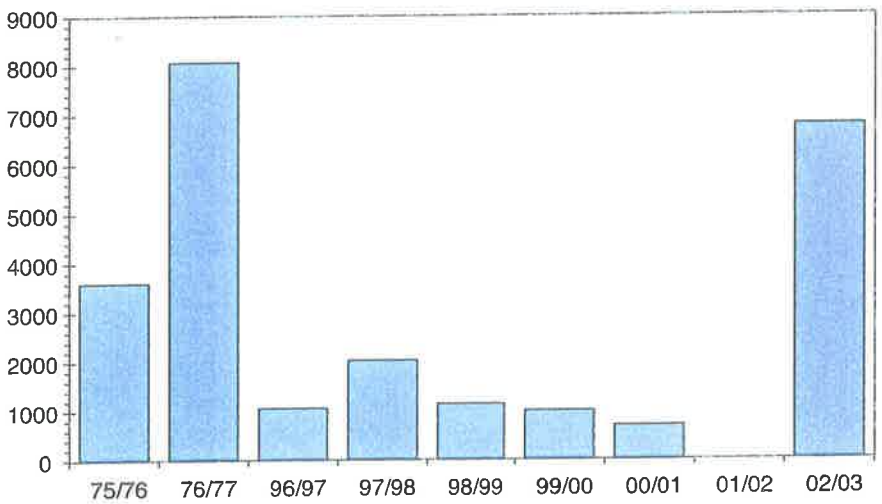
Australian pelicans are most abundant in the south-western estuaries in summer–autumn, and least abundant in winter–spring. Leg banding and monitoring of breeding colonies indicate numbers vary as adults leave to breed in the northern part of the state in winter, and with the return of both adults and young birds in summer. Birds staying in the South-West all year are either non-breeders, or in the case of the Peel–Harvey non-breeders and resident breeders (Fig. 3.25).

Counts of pelicans in the Peel–Harvey between 1995 and 2003 ranged from 268 in October 1995 to 998 in February 2003. These numbers are similar to those recorded from February to November 1975, but much lower than numbers recorded from October 1976 to March 1977 (Graph 3.7). The very high numbers of pelicans in 1976–1977 have been be linked to the filling of Lake Eyre in 1974. The Lake Eyre event supported a large breeding population that may have persisted into 1975–1976. As the waters receded and salinity increased, fish died and thousands of pelicans flew in search of food to other parts of the continent and New Guinea, possibly reaching the west coast including the Peel–Harvey. As 1976 was a drier than average year in the South-West, this would have also been an influence contributing to the high bird numbers in the permanent coastal waters.

Swans

The Peel–Harvey is also one of the most significant habitats for Black Swan in Western Australia. Populations fluctuate between years and throughout the year as swans range over a wide area of the South-West, but numbers appear to have declined since the late 1970s (Graph 3.8). This decline may be a short-term trend rather than a long-term change as numbers observed in the surveys of 1975 were similar to those in 1996–1997. Reasons for the decline are not known but could include differences in breeding success between years, of water habitat available across the South-West and possibly across the whole continent, food and differences in disturbance. A census in December 2002 at the height of an Australia-wide drought revealed a dramatic increase in swan numbers on Peel–Harvey, almost matching that of October 1976. (See **Chapter 2 The Swan–Canning Estuary: Recreating Swanland—bringing back the Black Swans.**)

Swans are abundant in the shallow areas of the Peel–Harvey, particularly over seagrass *Ruppia* sp. on the eastern and southern sides. The highest number recorded was 8,100 in October 1976. In some years they congregate in the southern part of Harvey Estuary in late summer and autumn where they have access to fresh drinking water that flows all year from the Harvey River. Small numbers also breed on the nearby freshwater wetlands and lead



GRAPH 3.8 *Numbers of Black Swans on the Peel–Harvey, February 1975 – June 1977 and October 1996 – February 2003. No counts were made in January 2001.* Courtesy J. Lane, CALM.

their young to the permanent waters of the estuary where they are reared. Other birds leave the area in winter to breed elsewhere on the Swan Coastal Plain or further inland, returning in summer as inland waters recede.

Like pelicans, swans are sensitive to disturbance from boats, and people or dogs wading in the shallows. They are particularly vulnerable for a period of four to six weeks when they undergo their annual moult of flight feathers. During this time they cannot fly and need large areas of undisturbed permanent open water with assured food supplies and fresh water for drinking.

As well as having great aesthetic appeal, swans are also an important component of the estuary food web playing a major role in cycling of nutrients. They graze extensively on submerged aquatic plants, particularly the seagrass *Ruppia*, hence the alternative name of swan grass. Their feeding also affects the distribution and composition of the plant community and the nutrient status of the sediments.

What of the future?

Problems in the Peel–Harvey emerged slowly as each of the small changes came together to create a huge effect, sending an ecosystem into distress in less than 150 years. The questions remain. Do the cures work? Do we like the result of our cures? Are they cures? And the most important question: have we learnt from the mistakes? The story of the Peel–Harvey is echoed throughout Swanland, throughout the state, the continent and the world: it was just larger, more visible in the Peel–Harvey being close to urban centres, and the cures more drastic and expensive.

If we had the chance to start again, we would probably go down much the same pathway. The land would have to be cleared, the watertable would rise, drains would be dug and we would add fertilisers to promote the pastures to feed the large animals we have added to the landscape. But there are some things we could do differently.

The first is probably accepting that small mistakes can add to a large whole and, conversely, adopting the idea that small remedies can make a difference. The birth of the Landcare movement and development of a stewardship for the land by communities as well as farmers has facilitated many small remedies through planting trees and revegetation of streamlines that buffer erosive water flows and filter nutrients, as well as creating a more pleasant landscape. The scale, however, is difficult to visualise. In 1995 an estimated 150 kilometres of the waterways had been revegetated, but there are about 2,000 kilometres of similar drains on the coastal plain.

Alternative types of fertilisers and reduced application rates will gradually reduce phosphorus stores and losses from the land. Certainly some of the land should never have been cleared, and clearing went on into the 1980s. Fertiliser use on farms has received most of the attention but the rivers flowing off the scarp are not those of 200 years ago, their flows having been impounded to provide water demanded by more distant communities. When the phosphorus application problems were being addressed, point source pollution from piggeries and sewage works commenced, and the growing population around the estuary used septic systems. Although some of the point source polluting industries have been 'cleaned up', some have become diffuse polluters with more intensive land use and stocking densities.

The waters flowing to the estuary still contain high concentrations of nutrients and these, together with those stored in the sediment, are the fuel for algal blooms that now plague the river reaches instead of the main estuarine basins. Then there are the acid sulfate soils that are likely to exacerbate problems. Although the masses of macroalgae have decreased, seagrasses along with algal epiphytes now grow profusely in the shallow well-lit waters indicating that nutrients are still abundant (Fig. 3.26). It is

interesting that problems in the New Peel–Harvey continue to fuel political argument as they did in the 1970s and 1980s.

Today we have more knowledge at our disposal, and we should use it. Land clearing is no longer necessary: we have enough land, although it may not be in a state to make full use of its potential. The landscape needs to be viewed as a whole composed of many pieces. Large-scale engineering works have large downstream impacts, and we need to consider what these are or might be. We can use new products, or modify our practices. Drain flows can be regulated to accommodate irrigation and prevent flooding, but perhaps we do not need so many and perhaps they do not need to be so large or deep. It is in our own interests to maintain a healthy system, be it for the view (who wants to look only at buildings?), for the fishing (we all want to fish), for fun (there is no doubt that it is best to walk and swim in clean healthy water), or for the birds as they revive our spirits and show us that an environment is healthy and functioning.

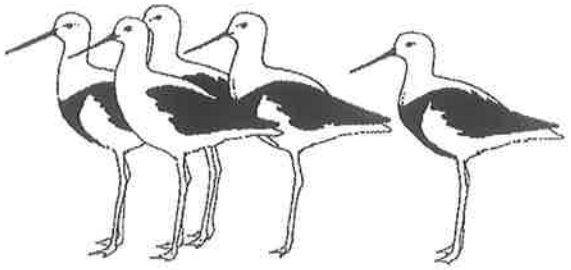
FIG. 3.26 *Could this happen again? Ernest Hodgkin examining algae removed from the beach at Coodanup, June 1981.* E. P. Hodgkin Collection.

Clarke, A., Muir, B., Elscot, S. & Lane, J. (2004). *Banded Stilt breeding attempt at Lake Disappointment.* The Stilt 46:39.

Records ACl and BM's observations on 23rd August 2004.

Makes reference to dead chicks, predation, cats, dog/dingo, 'anostracan shrimps and ostracods', BaSt feeding, did not locate BaSt nesting island, BaSt at Coral Bay (CDTM), previous records of breeding at or near Lake Disappointment (Butler in 1971, Percival Lakes, 'Kolichis (1976)').

Alan Clarke's original report (06/09/2004) to JL and SE on these 23/8/2004 observations is also here and has more detail.



Stilt 46 - October 2004
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Printed 24/4/2014

BANDED STILT BREEDING ATTEMPT AT LAKE DISAPPOINTMENT

ALAN CLARKE[1], BILL MUIR[1], SUE ELSCOT[2] AND JIM LANE[2].

Department of Conservation and Land Management. [1] PO Box 51, Wanneroo, Western Australia, 6065. [2] 14 Queen Street, Busselton, Western Australia, 6280.

On 23 August 2004, two of the authors (A.C. and B.M.) visited Lake Disappointment in central Western Australia. At the northernmost access point to the main lake, between Wells No. 20 and No. 21 on the Canning Stock Route, a large (3 km x 5 km), banana-shaped embayment was found to be mostly dry with the exception of two small, shallow (1-2 cm deep) ponds of water at the base of a dune on the north-eastern edge of the lake. The remainder of the lake floor was covered with a thin salt crust which was broken through to reveal damp to wet sediment. A total of 220 juvenile Banded Stilt *Cladorhynchus leucocephalus* were found lying dead both around and within the two remaining areas of water. A few were scattered further away from the waters edge and two were found on the dune adjacent with evidence of predation. A third, similarly-sized pool with only a film of surface water was located approximately 1 km to the east-southeast of the access point and an additional 10 dead Banded Stilt were found there. The dead Banded Stilt found in the embayment appeared to be close to fledging. None had chest-band markings and they were noticeably smaller than adult Banded Stilt. The birds appeared to have been dead for around two weeks. A series of strand lines around the shore of the embayment had a light spread of white feathers. Small, dead, salt-preserved frogs were collected from the pools.

A second part of the main lake was accessed from a track off the Canning Stock Route located 5 km south of the turnoff to Well No. 20. Here approximately 40 dead juvenile Banded Stilt were found both within and around a small, very shallow pool on the lake surface, just below the samphire line. The dead stilts at this site appeared to be smaller than those found 10 km further north although all were fully feathered with no down visible. At this site, the lake edge had been eroded by runoff from a recent major rainfall event and some of the resultant erosion gullies still contained water.

The lake was also accessed where Savory Creek enters Lake Disappointment. The creek system leading into the lake was deep (about 1.5 m) and there was evidence that the creek had recently flooded and broken its banks. Where the creek entered the main lake basin, it opened out into a fan with a main body of water that became progressively shallower and was dry approximately 1 km from the creek mouth. Larger, very shallow pools of water were scattered further into the lake for some kilometres. At this site, more dead juvenile Banded Stilt were seen than at the previous two sites. Approximately 500 dead birds were scattered over an area of about 1 km^2 and there was evidence of predation of live young by cats. Dog/dingo tracks were also evident. Sixteen Banded Stilt without chest bands were observed feeding in shallow water in the lake, approximately 200 m from the entrance of Savory Creek. Both anostracan shrimps and ostracods were observed in the water where the birds were feeding. Other birds feeding in the vicinity were 10 Avocet *Recurvirostra novaehollandiae*, 60 Red-capped Plover *Charadrius ruficapillus*, two Red-necked Stint *Calidris ruficollis* and 11 Sharp-tailed Sandpiper *Calidris acuminata*. More dead stilts were seen upstream along Savory Creek for at least 3 km.

Although several large islands were visible further out into the lake, the exact location of the Banded Stilt breeding site could not be located, due to the distance and difficulty of access.

During 6-9 September 2004, two weeks after the dead Banded Stilts were recorded at Lake Disappointment, Clive Minton (pers. comm.) recorded 28 Banded Stilt, all juveniles, using a small, ephemeral saltmarsh lagoon located about a kilometre from Coral Bay, 1,000 km west of Lake Disappointment. This sighting suggests that some birds may have successfully fledged from Lake Disappointment.

Banded Stilt have previously been recorded breeding at or near Lake Disappointment. In August 1971, W.H. Butler recorded both adult and juvenile Banded Stilt using a claypan 30 km south of Durba Spring on the Canning Stock Route, and others using a claypan 4 km north of Well No. 11 (Kolichis, 1976). He collected an immature specimen that was thought to have come from a presumed nesting attempt at Lake Disappointment, which had filled in May of that year (ibid.). In 1975, the Western Australian Museum received fragments of Banded Stilt eggs which were found partly buried in clay in the Percival Lakes, to the north-east (ibid.). The eggs were still pigmented and were evidently of recent age.

REFERENCE

Kolichis, N. 1976. New breeding records of the Banded Stilt in Western Australia. *Western Australian Naturalist* 13:114-119.

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BY ALAN CLARKE[1], BILL MUIR[1], SUE ELSCOT[2] AND JIM LANE[2].

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REFERENCE

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"FW Banded Stilt at Lake Disappointment" ("Outlook Item")

Lane, Jim Emailed 24/4/2014 JR

From: Lane, Jim
Sent: Monday, 23 April 2007 4:05 PM
To: Elscot, Susan
Subject: FW: Banded Stilt at Lake Disappointment

-----Original Message-----
From: Clarke, Alan
Sent: Tuesday, September 07, 2004 9:31 AM
To: Lane, Jim; Elscot, Susan
Cc: Pearson, Grant
Subject: Banded Stilt at Lake Disappointment

Jim and Sue,

Please call me to discuss any further information that you require regarding this event. I have recorded everything from my notes, but further questions may prompt additional information.

AC

Alan Clarke
Senior Technical Officer
Science Division
Woodvale Wildlife Research Centre
Department of Conservation and Land Management
Ph 08 94055141

Department of Conservation and Land Management
CALM**Science** Division
Woodvale Research Centre
Wildlife Place (off Ocean Reef Road) Woodvale Western Australia
PO Box 51 Wanneroo Western Australia 6065
☎ (08) 9405 5101 🖷 (08) 9306 1641

To:	Sue Elscot
	Jim Lane
From:	Alan Clarke
Date:	September 6, 2004
Subject:	Lake Disappointment Banded Stilt Breeding event 2004

Observations made by Alan Clarke and Bill Muir, Senior Technical Officers, while investigating new Directory of Important Wetlands sites and adding additional information to current sites in the Little Sandy Desert. Lake Disappointment was visited on August 23, 2004. Access to the western shore of Lake Disappointment is via The Canning Stock Route. Vehicle access to the lake can be made at four places.

The first of these visited was the northern most access point where the Track intersects the lake between Well 21 and Well 20. The coordinates for this site are GDA94, S 23 14.482 E 122 42.089 UTM Zone 51 469463 E 7497280 N. At this site a banana shaped embayment sweeping to the northwest from the main lake was mostly dry. Two small, shallow (1-2 cm See photos) areas of water remained on the northeast edge of the lake where a dune protected the water from drying northeast wind. The water bodies did not contain any aquatic invertebrates visible to the eye. The remaining lake surface was dry with a thin salt crust. This crust could be broken through to reveal damp/wet soil. A total of 220 dead Banded Stilt young lay around and in the two bodies of water. A few were scattered further south along the shore progressively away from the water. Two stilt were found near the top of the dune adjacent to the water bodies with evidence of predation. A third similarly sized water body, which had only a film of water, was 1 kilometer to the ESE in the main body of the lake. An additional 10 dead Stilt lay around this area. None of the Stilt had chest bands, but were close to fledging, although noticeably smaller than adult birds (Stage 3). A few birds had been predated, but there was no evidence of a struggle in the mud. The birds seem to have been dead for approximately two weeks. Dog tracks were observed through the area. The majority of birds seemed to be unmarked by physical trauma. A series of wash lines (Debris from higher water levels) had only a light spread of white, Stilt ?, feathers. No Anostraca bodies were observed on these wash lines. Small frogs, dead and preserved in salt, were collected in the middle of the embayment that contained the dead Stilt. They were common in an area traversed from the main lake across the embayment on the dry salt crust. 8 specimens were collected.

The second site heading south involves taking a track heading east off the CSR at a point 5km south of the turnoff to Well 20. The track leads into the main lake body. Once again dead Stilts were observed around the edges of the lake just below the samphire line. The highest concentration of dead birds was in and around a small, very shallow pool on the lake surface. Approximately 40 dead birds in total with the average size noticeably smaller than the previous site, which is 10km further north via a straight line. The birds were fully feathered with no down visible. The lake edges had been eroded by significant rainfall runoff causing deep rutting and small creeks feeding into the lake. Some of these recently created drainage lines were deep enough to still contain water.

The third site visited to the south was the entry point of Savory Creek into Lake Disappointment. The creek system leading into the lake was deep (1.5m) and filled the drainage line, but scars of a recent high water flow braking its banks were evident. The creek opened out into a delta system with a main body of water that progressively became shallower and dry 1km from the creek entrance. Larger very shallow areas of water were scattered further into the lake for some kilometers out and along the main lake area. The dead Stilt were scattered in higher concentrations than the previous two sites. Most of the Stilt bodies had been predated resulting in severed heads and or wings. Evidence of cats chasing and catching young Stilt (see photos) and dog tracks were seen in the mud. 500 dead Stilt were estimated to be at this site over an area of 1km square. More dead Stilt were seen upstream along Savory Creek for 3 kilometers where we crossed the creek and headed south. 16 Banded Stilt were feeding in water connected to the creek 200m into the lake from the Creek entrance at a depth of 0.3m. The coordinates for this site are GDA94 23 21.441 S 122 39.855 E or UTM Zone 51 465682 7416881. Anostraca and small Ostracoda were observed in the water at the site where the Stilt were feeding.

water samples and aquatic invertebrate sweeps were collected at this site for analysis in the laboratory. None of these birds had any breast band markings at all. They were observed flying strongly when approached. Other birds feeding at or adjacent to this area were 10 Red-necked Avocet, 60 Red-capped Plover, 2 Red-necked Stint and 11 Sharptailed Sandpiper. Three low, small 'islands', which had been covered by the recent flood event, each had a nest scrape. One had an eggshell with coloring consistent with that laid by Banded Stilts. Large islands could be seen further out into the lake. The site or sites for the breeding event/s were not located because of the lack of appropriate transport. A forth and southern most access point was not visited. Access to this point is via a track heading east from the Stock Route 18 kilometers south of Well 19.

Alan Clarke

'*Breeding ecology and conservation of the Banded Stilt*' (SPP 1999/0013) extract (pp.83-84) from WA Dept. of Conservation & Land Management (CALM) Science Division's 'Annual Research Activity Report: July 2003 – June 2004'.

ANNUAL RESEARCH ACTIVITY REPORT

July 2003 – June 2004

Science Division

Discovering the nature of WA
http://www.naturebase.net/science/science.html

Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

of the species as outlined in its Recovery Plan (Pearson and Jones 1997).

Summary of progress and main findings
- Translocation of captive stock to Favourite Island (total 130 skinks) appears to have been successful with recaptures of released animals and the capture of a neonate indicating breeding.
- Reports on progress of Lancelin Island Skink Recovery Team to Corporate Executive.

Management implications
- The establishment of a second wild population of the skink will greatly improve its conservation status
- Captive breeding research indicates that the species is long lived and can be bred easily in captivity.

Future direction(s)
- Monitoring of Favourite Island translocated population and Lancelin Island population in Nov and Dec 2004. No further releases of captive-bred skinks contemplated but a direct transfer of individuals from Lancelin Island may be undertaken in the future to provide more genetic diversity in the translocated population.
- Publication of results of captive breeding and translocation to Favourite Island.

CALM Region
Midwest.

IBRA Region
Geraldton Sandplains.

Breeding ecology and conservation of the Banded stilt
SPP # 1999/0013

Team members
J Lane (0.05), G Pearson, A Clarke; Total (0.05).

Aim
- To identify principal breeding locations of Banded Stilt in Western Australia.
- To develop improved understanding of breeding biology.
- To quantify factors governing breeding success.
- To identify threats.
- To disseminate knowledge to ensure conservation.

Summary of progress and main findings
- An aerial survey of 2 lakes in the Eastern Goldfields is proposed for June 2004, following heavy rains earlier in the year and subsequent sightings of adults and young.
- Report on previous breeding activity was not prepared, due to priority being given to other work.

Management implications
- Discovery of new nesting locations (lakes and/or islands) has implications for mining and other potentially disturbing activities, for establishment of a comprehensive, adequate and representative conservation reserve system in the goldfields, and for conservation of the Banded Stilt.

Future direction(s)
- Rainfall reports from the Eastern Goldfields (main breeding range of Banded stilt in WA) will continue to be monitored.
- Following exceptional rainfall events and reports of flooding, aerial surveys will be conducted to locate and monitor breeding colonies.
- Colonies will be photographed from the air and, if feasible, visited on the ground to determine number of breeding pairs, nesting and fledging success, water depths, water chemistry and food availability.

- Chicks will be banded and leg-flagged to obtain information on movements and longevity.
- A report on previous breeding activity will be prepared.

CALM Region
Goldfields.

IBRA Region(s)
Great Victoria Desert, Murchison.

Ground parrot recovery

SPP # 2000/0002

Team members
AH Burbidge (0.05), J Rolfe (0.02) B Barrett (1.0); Total (1.07).

Aim
- To develop an understanding of habitat requirements, including response to fire.
- To create management prescriptions that will increase the survival chances of the Ground Parrot and increase its total population size.

Summary of progress and main findings
- All contemporary and historical records brought into a digital environment, and accuracy validated, for use in a GIS, to facilitate planning of specific management actions.
- In collaboration with regional staff, discussion paper concerning fire management at Waychinicup–Manypeaks presented at workshops on the South Coast.
- Obtained significant NHT funding.
- Recovery Plan developed.
- Protocol being developed for translocation.
- Major systematic survey conducted in Fitzgerald River National Park.
- Monitoring surveys carried out in Cape Arid National Park and at Waychinicup.
- Surveys conducted in collaboration with the Friends of the Western Ground Parrot.
- Numerous media releases and presentations to community groups and the public.

Management implications
- Improved basis for decision-making concerning management, especially in relation to fire, in major conservation reserves on the South Coast.

Future direction(s)
- Develop monitoring protocol.
- Analyse data from monitoring program.
- Finalize Recovery Plan.
- Implement Recovery Plan where funds permit (including monitoring and a trial translocation).

CALM Region(s)
South Coast, Warren.

IBRA Region(s)
Esperance Plains, Jarrah Forest, Warren.

Probait trials: phase 2

SPP # 2000/ 0014
(includes 99/ 0018)

'*Breeding ecology and conservation of the Banded Stilt*' (SPP 1999/0013) extract (pp.69-70) from WA Dept. of Conservation & Land Management Science Division's 'Annual Research Activity Report: June 2002 – June 2003'.

ANNUAL RESEARCH ACTIVITY REPORT

June 2002 – June 2003

Science Division

Discovering the nature of WA
http://www.naturebase.net/science/science.html

Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Implementation of the Lancelin Island skink Recovery Plan

SPP # 1999/0011

Team member
D Pearson (0.1), Perth Zoo - captive breeding; Total (0.1).

Aim
To ensure the survival of the Lancelin Island skink through strategic research, monitoring and translocation of the species as outlined in its Recovery Plan (Pearson and Jones 1997).

Summary of progress
- The Lancelin Island skink is known only from Lancelin Island (7.6 ha) and a single location on the adjacent mainland. Further surveys have failed to find any other individuals on the mainland.
- Two translocations undertaken to Favourite Island (total 90 skinks) after 12 months monitoring of the existing lizard populations. First translocation of a lizard in WA and one of the few translocations of reptiles worldwide.
- Ongoing collaborative work with Perth Zoo in maintaining captive colony (monitoring condition, selecting breeding stock, measuring and sexing neonates and selection of individuals for translocation).
- Reports on progress of Lancelin Island Skink Recovery Team provided to Dennis Hockey and Corporate Executive.

Future direction(s)
- Monitoring of Favourite Island translocated population and Lancelin Island population in Dec 2003 and March 2004. Further release of captive-bred skinks and direct transfer of Lancelin Island wild stock proposed for Dec 2003.
- Publication of results of captive breeding and translocation to Favorite Island.
- Report to Recovery Team and Corporate Executive.
- Supervision of student (Z Hamilton, UWA) examining genetics of sympatric skinks on Jurien Bay islands.
- Analyse collected genetic material to examine reproductive dynamics of captive colony.

DCLM Region
Midwest.

IBRA Region
Geraldton Sandplains.

Breeding ecology and conservation of the Banded stilt

SPP # 1999/0013

Team members
J Lane, G Pearson, A Clarke; Total (0.0).

Aim
- To identify principal breeding locations of Banded stilt in Western Australia.
- To develop improved understanding of breeding biology.
- To quantify factors governing breeding success.
- To identify threats.
- To disseminate knowledge to ensure conservation.

Summary of progress
- No field work was undertaken during 2002-03, due to annual rainfall in Eastern Goldfields being insufficient to warrant aerial inspections for Banded stilt breeding activity.
- Report on previous breeding activity was not prepared, due to priority being given to other work.

Future direction(s)
- Rainfall reports from the Eastern Goldfields (main breeding range of Banded stilt in WA) will be monitored.
- Following exceptional rainfall events and reports of flooding, aerial surveys will be conducted to locate and monitor breeding colonies.
- Colonies will be photographed from the air and, if feasible, visited on the ground to determine number of breeding pairs, nesting and fledging success, water depths, water chemistry and food availability.
- Chicks will be banded and leg-flagged to obtain information on movements and longevity.
- A report on previous breeding activity will be prepared.

DCLM Region
Goldfields.

IBRA Region
Murchison.

Ground parrot recovery
SPP # 2000/0002

Team members
A Burbidge (0.05), J Rolfe (0.02); Total (0.07).

Aim
- To develop an understanding of habitat requirements, including response to fire.
- To create management prescriptions that will increase the survival chances of the Ground parrot and increase its total population size.

Summary of progress
- All contemporary and historical records brought into a digital environment, for use in a GIS, to facilitate planning of specific management actions.
- In collaboration with regional staff, discussion paper developed concerning fire management at Waychinicup–Manypeaks.
- In collaboration with regional staff, options have been developed for fire management for the major population in Fitzgerald River NP.
- Monitoring at Cape Arid NP has led to the rediscovery of the species at this location.
- NHT funding proposal developed in collaboration with regional staff; high likelihood of being funded.

Future direction(s)
- Validate accuracy of all location records using GIS framework.
- Develop monitoring protocol.
- Analyse data from monitoring program.
- Write Recovery Plan.
- Implement Recovery Plan where funds permit (including monitoring and a trial translocation).

DCLM Region(s)
South Coast, Warren.

IBRA Region(s)
Esperance Plains, Jarrah Forest, Warren.

Probait trials: phase 2
SPP # 2000/ 0014 (includes 99/ 0018)

Team members
N Marlow (0.35), A Williams (0.4); Total (0.75).

Printout (05/08/2003) from CALM website of 'Science Project Plan Summary: SPP 1999/0013. *Breeding ecology and conservation of the Banded Stilt*'. Note the start (15/03/1995) and finish (15/03/2005) dates of this SPP.

Science Project Plan Summary

SPP Number: 1999/013

Title: **Breeding ecology and conservation of the Banded Stilt.**

Staff:

Supervising scientist	Lane J (15%)
Technical officer	Pearson G (25%)
Technical officer	Clarke A (5%)
Associated scientist	Chapman A (5%)
External Collaborators:	Dr CDT Minton (Australian Wader Study Group), ABC Natural History Unit.

Associated SPPs: 1999/014

Aims:

· Determine the principal breeding locations of Banded Stilt in Western Australia and their relative importance.
· Develop an improved understanding of their breeding biology.
· Quantify key environmental factors (e.g. hydrological regime, salinity) governing breeding success;
· Identify any significant human-induced threats to nesting colonies and habitats.
· Obtain and disseminate knowledge needed to ensure conservation of the species.

Commenced: 15/03/1995

Finishes: 15/03/2005

Location of project:

SID Section:	Species Conservation
Dept Program:	Nature Conservation and Wildlife Management
Region(s):	Goldfields
District(s):	Kalgoorlie

Methods:

Phase 1 (1995-2000): Conduct aerial survey of Lakes Barlee & Ballard following Cyclone Bobby (Feb 1995) to locate breeding colonies. Establish base camp on Lake Ballard. Establish quadrats in nesting areas for daily monitoring (photographs) to determine laying rate, clutch size, incubation period and hatching success. Collect adults and chicks to determine diet. Conduct macro-invertebrate (standardised sweeps) to monitor food availability. Install continuous recorder to monitor lake water level. Sample water chemistry. Develop safe method of catching chicks. Band / leg flag

chicks. Conduct additional aerial surveys to monitor fledging success. Analyse results. Prepare for publication. Publish.

Phase 2 (1999-2005): Rainfall in the main breeding range of the Banded Stilt (in WA) will be monitored using daily rainfall data obtained by the Bureau of Meteorology. Following exceptional rainfall events (approx 3-7 year intervals) and reports of flooding, aerial surveys will be conducted to locate and monitor breeding colonies. Colonies will be photographed from the air and, if feasible, visited on the ground to determine number of breeding pairs, nesting and fledging success, water depths, water chemistry and food availability. Chicks will be banded and leg-flagged to obtain information on movements and longevity. Standard statistical techniques will be used where appropriate.

Science Intranet Home | Structure | Projects | Staff | Key Documents | Bibliography
Databases | Libraries | News | Links | Search | Feedback | Science Internet Home

CALMweb HOME

Projects

Science Division Science Project Plans (WASPP) are available online using the WASPP database.

Biological Information Group

- Collections Management
- Regional Information Network
- Bioprospecting
- Information Systems Administration
- Information Systems Research and Development
- Descriptive Taxonomy and Biosystematics
- Forest Region Flora
- Regional Forest Assessment

Biodiversity Conservation Group

- Western Shield - Fauna Recovery
- Western Shield - Introduced Predator Control
- Western Everlasting - Flora Recovery
- Carnarvon Basin Biological Survey
- Marine Fauna Conservation and Management
- Aquatic Ecosystems Conservation
- Salinity Action Plan
- Monitoring Rabbit Calicivirus Disease
- Disturbance Management Ecology
- Remnant Vegetation Reconstruction
- Monitoring River Health
- CAR Reserve System

Forests and Tree Crops Group

- Ecologically Sustainable Forest Management
- Forest Microbiota Management
- Forest Fire Management
- Genetics and Tree Breeding
- Western Bluegum Plantations
- Tropical Plantations
- Sandalwood Ecology and Management
- Dryland Tree Crops
- Softwood Plantations
- Vegetation Health Service

Astronomical Services Group

- Astronomical Research
- Astronomical Education
- Astronomical Information

CALMweb HOME

Biodiversity Conservation Group

CALM Science

Aquatic Ecosystems Conservation

PROJECT LEADER

Jim Lane

SCIENCE PROJECT PLANS / CORE FUNCTIONS

- 1993-013: Affect of Dawesville Cut on adjacent estuary vegetation
- 1993-058: Lake Clifton nutrient inputs
- 1993-059: RAMSAR Wetlands Monitoring Guidelines
- 1993-060: Monitoring wetlands in WA conservation reserves
- 1993-062: Busselton wetland disturbances & Black Swan breeding
- 1993-093: Conservation Biology of Vulnerable Frogs
- 1993-162: Aquatic invertebrate surveys and atlas
- 1998-008: Taxonomy and zoogeography of aquatic oligochaetes of Western Australia
- 1999-012: Silver Gull monitoring
- 1999-013: Breeding ecology and conservation of the Banded Stilt
- 1999-014: Directory of important wetlands - third edition
- 1999-015: Tropical inter-tidal benthic invertebrate communities
- 1999-016: Affect of Dawesville Cut on adjacent estuary waterbirds
- 1999-017: Assessment of vegetation and current use of Vasse-Wonnerup estuary by waterbirds
- TBA: Assessment of biota and physico-chemistry of Byenup-Muir wetlands

STAFF

Staff	Location	FTE

Email (24/7/2000) from Peter Copley (NPW SA) to JL making reference to HANZAB [Vol.2, pp.780-790] treatment of BaSt populations and movements. Seeks JL's comments on conservation status of BaSt and asks about Silver Gull numbers in inland WA.

22.

To: Jim Lane@buss.sid@CALM
From: "Copley, Peter (DEH)" <pcopley@deh.sa.gov.au>
Cc:
Subject: Banded Stilts
Attachment:
Date: 24/Jul/2000 4:16 PM

Hi Jim

I gather Andrew Burbidge has forwarded an e-mail request to you from me earlier today concerning the current whereabouts of Banded Stilts other than at Lake Eyre. I'd be very interested to know what the "WA population" is doing at present and how many birds are at what general localities to compare with current SA data. The treatment about Banded Stilts in HANZAB seems rather equivocal about how large the population(s) is (are), and which birds move from where to breeding colonies on inland salt lakes during such events.

At my 'kite-flying' suggestion to Andrew B that perhaps these Stilts are a species that may warrant listing as 'conservation dependant' because of the need to protect any future breeding events from gull predation, Andrew pointed out that "most breeding has been on remote WA salt lakes and there have been plenty of successful breeding events without any management". What is your impression on this point? What is happening with Silver Gull numbers in the inland areas of WA following lake flooding events?

Hope you can assist.

Regards

Peter Copley
Senior Ecologist, Species Conservation
Biodiversity Conservation Programs
National Parks & Wildlife SA
Department for Environment, Heritage and Aboriginal Affairs

Email: pcopley@dehaa.sa.gov.au
Phone: +61 8 8204 8781
Fax: +61 8 8204 8889

Article (The Weekend Australian, May 20-21, 2000, p.5) regarding recent partial filling of Lake Eyre. Has a photo of 'Lake Eyre shrimp'.

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Shallow delight: Lake Eyre 60 per cent full after recent heavy rains is no place for boating

Pictures: NICK CUBBIN

Spectacular Lake Eyre a sailor's mirage

ASA WAHLQUIST

THE flood waters that have transformed Lake Eyre have brought with them tourists, wildlife and ... just a little disappointment.

Most of those who have travelled inland have been dazzled by the spectacle of the expanse of water and the wildlife. But those who brought boats and dinghies, expecting to sail on Australia's largest inland lake, have been thwarted. The water is shallow and it is evaporating quickly.

"The water is so far away from the shoreline and even when you get to the edge of the water it is shallow for a long time," said John Watkins, a manager with National Parks and Wildlife SA.

"The surface of the lake is treacherous and we wouldn't recommend that anybody attempts to put a boat out there."

Specimens: Lake Eyre shrimp

But he does recommends flying over the lake. "It really is fantastic from the air."

The big question for locals, and those flocking to take in the sight, has been whether the lake will fill.

Mr Watkins's colleague, Albie Zepf, who flew over the site yesterday, said the lake was starting to dry up after being about 80 per cent full.

"It is down to about 60 per cent," Mr Zepf said. "The water is so shallow and the evaporation rate is so high. But it is very impressive."

Mr Watkins said the general feeling of the local community is that it is highly unlikely that the waters from Cooper Creek, usually a major source of water, will reach Lake Eyre.

"But the Warburton is still flowing strongly, so there is still a significant amount of water coming down. The Diamantina flows into the Warburton, which flows into Lake Eyre. There is still a significant amount of floodwater coming down." He also pointed out that the lake can appear more full at different times. "It really depends which way the wind is blowing and how hard it is blowing, because that does move the water around a fair bit," he said.

Just add water — Magazine, F age 24

It has been a busy season at the tiny, remote settlements of William Creek and Marree, with tourists flocking to catch a glimpse of the lake alive with prehistoric-looking shield shrimp and tiny fish — including hardy heads, spangled grunters and desert goby. Pelicans are massing in the area and breeding, and birds are flocking not just to feast on the riches of the lake but on the grasses that have flourished in the wake of the summer rains.

Mr Watkins said he was not surprised by the tourist numbers. "It is what we would expect. We haven't had a really significant flooding event in Lake Eyre for some time."

In THE AUSTRALIAN next week

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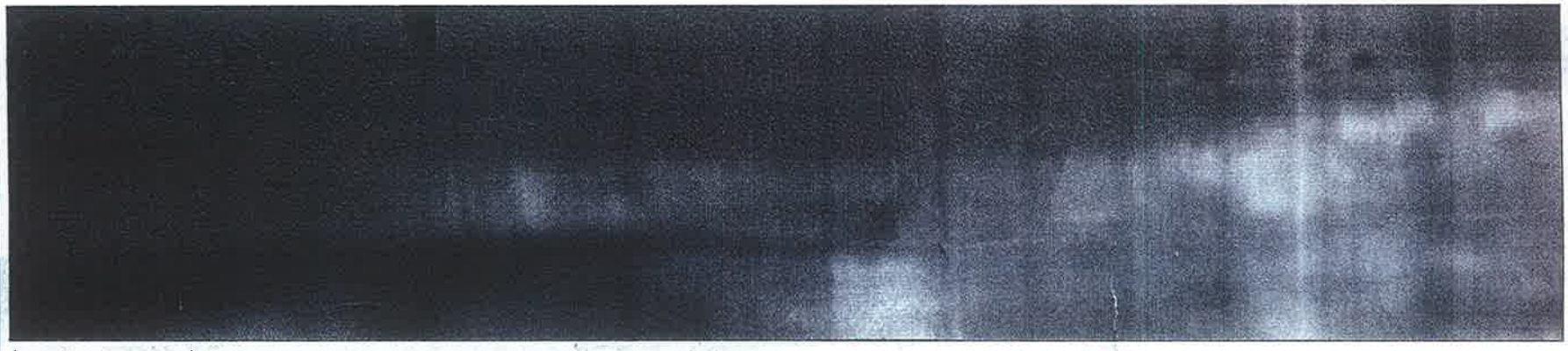

Shallow delight: Lake Eyre 60 per cent full after recent heavy rains is no place for boating

Pictures: NICK CUBBIN

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"THE WEEKEND AUSTRALIAN" MAY 20-21, 2000 Page 5.

Copy of Minton, Jessop & Collins (2000). *Visit to Banded Stilt breeding colony on Hughes Island, Lake Eyre North, 1st – 5th April 2000* and covering letters recommending that '[Silver Gull] control measures be prepared now and implemented when the next Banded Stilt breeding event occurs in South Australia'. Received by GBP and JL in electronic format (as CLIEYRE3.doc).

14.

To: ALAN CLARKE@WOOD.SID@CALM,Jim Lane@BUSS.SID@CALM
From: Grant Pearson@WOOD.SID@CALM
Originated by: "Rosalind Jessop" <rosj@penguins.org.au>
Cc:
Subject: fwd: Lake Eyre Report
Attachment: CLIEYRE3.doc
Date: 19/Apr/2000 2:33 PM

Jim
Attached copy of Minton report as discussed.

Grant Pearson
Department of Conservation and Land Management
WA Wildlife Research Centre
Wildlife Place
Woodvale WA 6026
Tel:(8) 9405 5163, Fax: (8) 9306 1641
Email: grantp@calm.wa.gov.au
--------- Original Text ---------

From: "Rosalind Jessop" <rosj@penguins.org.au>, on 19/04/2000 5:59 AM:
To: iSMTP@CALM.COMO.1@Servers["Sandra Harding" <joyceh@dragon.com.au>],iSMTP@CALM.COMO.1@Servers["Phil Straw" <pstraw@mpx.com.au>],iSMTP@CALM.COMO.1@Servers[<john.read@wmc.com.au>],iSMTP@CALM.COMO.1@Servers[<donald.coventry@birdsaustralia.com.au>],Grant Pearson@WOOD.SID@CALM

To: Jim Lane@BUSS.SID@CALM
From: Grant Pearson@WOOD.SID@CALM
Cc:
Subject: re: fwd: Lake Eyre Report
Attachment:
Date: 19/Apr/2000 2:47 PM

I think i have word 7 and it extracts without any problem. Do you get a prompt asking how to extract it? If so tell it to extract in whatever is later than 6 if you can. I'll fax a copy anyway.
gp

Grant Pearson
Department of Conservation and Land Management
WA Wildlife Research Centre
Wildlife Place
Woodvale WA 6026
Tel:(8) 9405 5163, Fax: (8) 9306 1641
Email: grantp@calm.wa.gov.au
---------- Original Text ----------

From: Jim Lane@BUSS.SID@CALM, on 19/04/2000 2:44 PM:

Which format is the attachment in? It looks weird. Did you have to convert it?

I am using "Word for Windows Version 6" at the moment, but will be updating to Office 2000 in a week or so.

From: Grant Pearson@WOOD.SID@CALM, on 19/Apr/2000 2:33 PM:

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printed 28/11/00
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Lake Eyre Visit

Clive Minton, Rosalind Jessop, Peter Collins

We thought that you would like a copy of this report which we have prepared following our recent visit to Lake Eyre.

This report was primarily written for the South Australian National Parks and Wildlife Service and for those who financially supported us but it contains detail which we hope you will find of interest.

We were particularly pleased with the reception which our verbal report to the District Manager and Head Ranger at Port Augusta received. They indicated enthusiasm for the immediate preparation of an action plan for control of Silver Gulls at future Banded Stilt breeding events in South Australia.

A copy of the letter sent to SANPWS is attached

Address for correspondence 165 Dalgetty Road, Beaumaris. Vic. 3193.

(email: mintons@ozemail.com.au).

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Visit to Banded Stilt breeding colony on Hughes Island, Lake Eyre North

1st - 5th April 2000.

Dr. Clive Minton[1], Dr. Rosalind Jessop[2] and Peter Collins[2]

[1]165 Dalgetty Road, Beaumaris. Vic. 3193. (email: mintons@ozemail.com.au).
[2]RMB 4009, Cowes. Vic. 3922.

Executive Summary

Heavy rains in central Australia in the middle of February facilitated major breeding activity by Banded Stilt, Australian Pelican, Silver Gull and Caspian Tern on Hughes Island in the centre of Lake Eyre North.

A five day visit to the island in early April 2000 found that large scale predation of Banded Stilt eggs and young was being carried out by Silver Gulls. The net result was that the estimated 18,000 pairs of Banded Stilt, the majority of the South Australia/Victoria population, produced very few young. If such low breeding success continues in future there will be a major reduction in the population.

It is strongly recommended that control measures be prepared now and implemented when the next Banded Stilt breeding event occurs in South Australia.

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It is strongly recommended that control measures be prepared now and implemented when the next Banded Stilt breeding event occurs in South Australia.

Introduction

The Banded Stilt is an endemic species of Australian wader which requires ephemeral salt lakes in inland South Australia and Western Australia for breeding. Breeding opportunities therefore only occur at irregular intervals following major rain events.

The Banded Stilt populations of South Australia/Victoria and Western Australia are thought to be largely separate, with a total estimated population of at least 100,000 individuals.

During the last 20 years Banded Stilts are only known to have nested in South Australia four times - in 1984 (probably at Lake Eyre), 1989 (Lake Torrens), 1997 (Lake Eyre North) and now in 2000 (again at Lake Eyre North).

Maintenance of population numbers in a bird which can breed only irregularly is dependant on a high adult survival rate and good breeding success. However detailed studies at Lake Torrens in 1989 by SANPWS staff indicated exceptionally high nest failure due to predation by Silver Gulls. By contrast similar studies at Lake Ballard in Western Australia in 1995 showed no gull predation and reproductive success was extremely high. Photographs taken at Lake Callabonna in South Australia in 1930 clearly show that Silver Gull predation was not a problem then.

The principle purpose of this visit was to obtain up to date information on Silver Gull predation at South Australian Banded Stilt breeding events since this potentially affects the long term viability of this part of the Australian Banded Stilt population.

Field Work

Major rains fell in the northern parts of South Australia in February. On the 12/13th February some 150+ mm fell in the area of Lake Eyre and to the north and west of there, causing severe local flooding. A week later a further 50 mm of rain fell over a wider area.

Experience at Lake Ballard in 1995 showed that Banded Stilts were capable of laying eggs within 1 to 2 weeks of a major rain event. CDTM travelled to William Creek at the beginning of March and made fixed wing aerial surveys over Lake Eyre on 2nd and 3rd March. A nesting colony of 2-3,000 Banded Stilts was located on Hughes Island in the middle of Lake Eyre North. 1,200 Pelican nests and 1,000 Silver Gull nests were also present on the same island.

CDTM, REJ and PCC returned to William Creek on 30th March and carried out a fixed wing aerial survey on 31st March. They were then deposited on Hughes Island by hired Jet Ranger helicopter from April 1st to 5th. A further fixed wing aerial search for Banded Stilt chicks was carried out over the lake on 6th April.

A detailed census of all the birds encountered on Hughes Island was undertaken. Also prolonged observations were made of Silver Gull predation at the Banded Stilt colony over the 5 day period.

Results

a) Banded Stilts

On the 1st April it was estimated that there were 9,000 occupied Banded Stilt nests at the colony located about half way along the western side of the island (which was about 2 km long by 250 metres wide, with the long axis running in a north/south direction).

The original colony located on 2/3 March, which had apparently subsequently doubled in size (per local air tour operators), had already been vacated. Furthermore a segment of the new colony had also already been recently vacated.

Measurements of the total areas covered by the colonies, nest densities (up to 10 per square metre) and the area of the colony occupied by nests gave an estimate of 4,500 nests for the original colony and 13,500 nests for the 'new colony' giving a total estimated breeding population of 18,000 pairs.

A brief incursion into one end of the colony indicated that the majority of nests contained 3 eggs, with some with 2 or 4 eggs. The average clutch size will be calculated once the photographs taken at the time have been developed. But it is clearly similar to the average clutch size of 3 eggs recorded in the Lake Ballard colony.

b) Australian Pelican

The island contained 4,714 Pelican nests located in 12 separate colonies/subcolonies. The majority were on the southern half of the island. Most colonies favoured areas with small (half metre high) bushes around the perimeter of the island but some colonies were on bare ground in the centre of the island.

Full details of the nest contents are given in Table 1. Two eggs was clearly the dominant clutch size (92.6%) with 3.2% having laid 3 eggs and 4.2% laying 1 egg.

Hatching in some southern parts of the colony appeared to have commenced a few days prior to the census and on the 2nd April 625 of the nests (13%) contained at least one hatched young.

Table 1. Contents of the 4714 Australian Pelican nests on Hughes Island on 2 April 2000.

1 egg	**2 eggs**	**3 eggs**	**4 eggs**	**(abandoned eggs)**
164	3793	131	1	(53)

1 young	**2 young**	**3 young**
33	348	9

1 egg/1 young	**1 egg 2 young**	**2 eggs/1 young**
222	8	5

Total breeding pairs = 4714

c) *Silver Gulls*

Silver Gulls nests were spread over approximately 400 metres at the northern end of the island. On 2nd April 2,152 nests were counted. Nest contents are detailed in Table 2. The most common clutch size was 3 eggs (62%), followed by 2 eggs (28%). Some of the anomalous nest contents were due to roaming chicks temporarily crouching in other nests because of our presence.

Hatching was in progress with some chicks up to 10 days old. On 2nd April 37% of the nests had hatched at least one chick.

Table 2. Contents of the 2152 Silver Gull nests on Hughes Island on 2 April 2000.

1 egg	**2 eggs**	**3 eggs**	**4 eggs**	**5 eggs**	**6 eggs**
116	360	785	7	3	1
1 young	**2 young**	**3 young**	**4 young**	**5 young**	
111	176	100	9	1	
1 egg/1 young	**1 egg/2 young**	**1 egg/3 young**	**1 egg/7 young**		
104	79	18	1		
2 eggs/1 young	**2 eggs/2 young**	**2 eggs/3 young**			
159	18	5			
3 eggs/1 young	**3 eggs/2 young**	**3 eggs/4 young**			
23	7	1			
abandoned eggs	**predated eggs**	**dead chicks**	**empty nests**	***runners**	
6	16	24	68	95	

* (young not attached to nests).

Total estimated breeding pairs = 2152.

d) *Caspian Tern*

Only two Caspian Terns were seen on 2/3 March but by 1st April a large colony had formed on a sand bank close to the gull colony on the north end of the island. A census on 3rd April showed 114 nests and 36 scrapes indicating a breeding population of 150 pairs (Table 3). Two nests contained newly hatched chicks.

Two eggs was the most common clutch size (51%) followed by 3 eggs (37%).

Because the Silver Gulls were occupying the higher ground on the northern end of the island, which was used by the Caspian Terns in 1997 (CDTM per. obs.), the terns appeared to have been forced to nest on this lower bank which had been submerged immediately after the mid-February rains. They could thus be vulnerable to flooding when the next pulse of water reaches Lake Eyre in late April from the Georgina/Diamantina/Warburton River system.

Table 3. Contents of the 150 Caspian Tern nests on Hughes Island on 3 April 2000.

1 egg	**2 eggs**	**3 eggs**	**1 egg/1 young**	**2 eggs/1 young**	**empty nests**	**Total**

					(new)	
12	56	44	1	1	36	150

e) Other Species.

At least 12 pairs of Red-capped Plover were nesting on the island.

A single Gull-billed Tern was regularly seen and on two occasions behaved as if nesting. However no nest was found.

Five pairs of Orange Chat were present and breeding. Budgerigars, Zebra Finches and Little Button Quail were also seen but not thought to be breeding.

At least 200 Sharp-tailed Sandpipers were seen feeding on the salt flats around Hughes Island an most days. Their 'fat profile' suggest that they had already accumulated large fat reserves and were ready for departure. About 100 Red-necked Stints (some in breeding plumage) and a single Curlew Sandpiper (non-breeding) were also seen.

No raptors were seen. However a Wedge-tailed Eagle had been reported visiting the island a few days before our arrival. Wedge-tailed Eagles had apparently bred on the island, on the ground, in 1997. Remains of their prey, including several Bearded Dragons, were seen at several locations.

An old dingo scat was also found.

There was evidence of two active rabbit burrows on the island but no rabbits were seen.

Silver Gull Predation

a) Banded Stilt

Thirteen hours of systematic observations of Silver Gull predation at the Banded Stilt colony were made between 1st and 5th April. Observations were made from a distance of 80 metres by two observers with the aid of binoculars and a telescope.

Marauding Silver Gulls were present throughout the Banded Stilt colony at all times - day and night. Counts made at 15 minute intervals showed that numbers varied between 25 and 162 with typically 80 to 100 present at one time (Figure 1). Five and fifteen minute counts of gulls newly arriving at the Banded Stilt colony from the Silver Gull colony to the north ranged between 3 and 12 per minute with an average of 6.5 per minute. This suggests that during daylight hours, on average 390 visits were made by Silver Gulls each hour to the Banded Stilt colony. This equates to around 4,875 visits each day. If Silver Gulls visited the colony at the same rate during the night as observed close to dawn/dusk then an additional 4,100 visits would have been made making a total of around 9,000 visits each 24 hours.

Silver Gulls patrolled on foot within the colony seeking every opportunity to seize an unguarded egg or chick. Sometimes several gulls appeared to be working together in concert and on occasions gulls were even seen to pull at adult Banded Stilts in order to try and drag them off their nests. Other gulls would hover over nests and drop into the colony causing a disturbance which created opportunities for predation of eggs and /

or young by a number of gulls. On one occasion a low flying Pelican caused disturbance leading to the contents of 40 or so nests being lost.

Whenever it was possible to identify that an egg or a chick had been taken by a Silver Gull this was recorded. In many cases predation was followed by a melee of up to ten gulls fighting for the egg or chick. Eggs were often eaten on the ground close to the nest. However chicks were often carried away to be eaten, resulting a chase by up to 10 other gulls in aerial pursuit. Sometimes the chick was dropped and then retrieved by a different bird.

Inevitably the number of eggs/chicks predated was under recorded as it was often difficult to tell if all the contents of a clutch were taken. Also when the egg/chick was consumed rapidly and no melee or chase resulted the predation event may have been missed.

Predation was already at a high level at first light (about 0600) and continued at the same level until mid-morning (Figure 2). There was some reduction in the rate of predation in the middle of the day, especially on hot days, when the gulls appeared to seek shade or stand in the water. However heavy predation resumed again from mid-afternoon and was still continuing when it became too dark to see (around 1830). Predation appeared to continue during darkness judging by the sounds emanating from the colony and gulls appeared to be arriving and departing from the colony all night. Night time predation was also recorded at the Lake Torrens Banded Stilt colony in 1989.

The number of chicks recorded as being predated averaged 1.85 per minute during daylight hours. 51% of the predation events involved chicks and 49% eggs (28% one egg and the remainder clutches of eggs). It was not possible to quantify night predation rates but judging by the noticeable reduction in the size of the colony between dusk and dawn the following day it must have been very significant.

The recorded daytime predation rate equates to a loss of 1,350 eggs/chicks per day. However during the five day period the colony was under observation it decreased from an estimated 9,000 to 3,000 nests. This is equivalent to around 18,000 eggs/chicks. However over the same period only 322 chicks were seen to successfully depart from the colony (escorted by protective adults) for the relative safety of the open lake.

It therefore appears that most of these 6,000 nests failed due to predation. The combination of unmeasured night-time predation and the under recording of day-time predation meant that the actual predation losses were more than twice the recorded level i.e. around 3,000 eggs/chicks per day.

It was also notable that the extent and effectiveness of gull predation increased as the Banded Stilt colony decreased. This was particularly because massive gull predation became more possible as open areas appeared in the colony allowing greater gull access. Similar observations were made at Lake Torrens in 1989 when the final 3,000 nests were totally destroyed by Silver Gull predation. At Hughes Island there was a further reduction in the colony size to only 1,500 nests by the morning of the 6th April (fixed wing aerial survey) - equivalent to the loss of 4,500 eggs/chicks in only about 20 hours). It is estimated that the colony will have been empty by 8th April.

b) Australian Pelican

The Silver Gulls were not attempting to predate either Pelican eggs or newly hatched chicks. However they were increasingly depriving the young Pelican chicks of food by stealing the partially digested fish regurgitated by the adult Pelican prior to feeding the small chicks.

While large chicks can take food from within the Pelican's beak/crop, small chicks have to be fed by the adult with small pieces of fish held in the bill. To achieve this the adult Pelican regurgitates a large portion of its crop contents onto the ground and it is then that the adult gulls working in concerted packs of 8 to 10 birds were observed stealing up to 90 % of the regurgitant. With the imminent termination of the Banded Stilt colony as a source of food for Silver Gull adults and chicks, it is likely their attention will turn even more onto the predation of Pelicans in the future. This presumably could have a detrimental effect on the survival of young Pelican chicks.

c) Caspian Terns

There was no evidence of current predation by Silver Gulls at the tern colony even though their colonies were adjacent. However previous experience elsewhere has shown that Silvers Gulls can be a major predator of Caspian Tern eggs and chicks. Gull predation may therefore increase in the future.

d) Red-capped Plover

Two young chicks were seen to be taken by Silver Gulls.

Other Activities

Banding

No banding was undertaken because so few young birds were successfully leaving the colony and because of the risk of associated further gull predation opportunities.

An exciting discovery however was the presence of a yellow leg flagged breeding adult bird in the colony. This bird had been banded as a chick at the Lake Ballard, Western Australia, colony in 1995. This is the first evidence of any interchange between the South Australian and Western Australian Banded Stilt populations.

b) Blood Sampling.

Blood samples from 14 dead Banded Stilt chicks were collected for DNA analysis. These were chicks accidentally dropped by gulls during aerial chases or collected from beside nests in the Silver Gull colony (one Silver Gull nest had 10 dried chicks in it).

These blood samples will be sent to Professor Allan Baker at the University of Toronto for use in his wader classification studies. (he is the world expert in wader classification using DNA techniques). They will also be used to see if any DNA characteristics have yet developed to separate the Banded Stilt populations of South Australia and Western Australia (from where blood samples already exist).

c) Photography

A detailed photographic record was obtained of all aspects of the breeding waterbirds on Hughes Island. The gull predation in the Banded Stilt colony was also photographed extensively.

Conclusions and Recommendations

The exceptional mid- February rains in central Australia put sufficient water in Lake Eyre North to trigger a major breeding event for Banded Stilts, Australian Pelicans, Silver Gulls and Caspian Terns. However the breeding success of the Banded Stilts has been limited by massive predation of eggs and chicks at the colony by Silver Gulls. In due course the breeding success of Pelicans and Caspian Terns is also likely to be adversely affected by Silver Gull predation.

It is too late for any remedial action to be taken to improve the breeding success of this particular Banded Stilt breeding event. However it is strongly recommended that SANPWS prepare a plan for the intensive control of Silver Gull numbers at and immediately adjacent to, any future Banded Stilt colony in South Australia. Unless such remedial action is taken to greatly reduce the massive predation by Silver Gulls in the future it is likely that there will be a major reduction in the Banded Stilt population.

Proven methods exist for gull control, including the use of bread soaked in alpha-chloralose. This has proved effective in extensive gull control programs carried out in Western Europe and North America over the last 30 years.

The appropriate approvals need to be obtained well in advance and control methods and the necessary products decided upon and purchased. An appropriate budget allocation needs to be made also. This is because it will be necessary to act very quickly after a future rain event not only to locate the Banded Stilt colony but also to implement control measures within 10 to 14 days of the rain event occurring. These measures will need to be sustained for a period of 4 to 6 weeks to ensure that the expected continual inflow of gulls is controlled and that all the Banded Stilts get an opportunity to hatch young successfully and get them to the relative safety of open water.

It is also recommended that SANPWS endeavour to carry out an extensive aerial survey of Lake Eyre North during the next two weeks (before April 20th) to determine just how many young are successfully produced to fledging by the 18,000 pairs of Banded Stilt that nested on Hughes Island and to try and ascertain the breeding success of Pelicans and Caspian Terns.

The expected further inflow of water from Queensland should sustain the water levels long enough for these to successfully complete breeding. It is even possible it may stimulate renewed breeding activities by the Banded Stilts, especially in view if their poor breeding productivity at the first attempt. This would enable an immediate testing of the effectiveness of gull control measures in limiting predation activities.

Acknowledgments.

The visit to Hughes Island would not have been possible without the generous support of an anonymous donor ($8,000), the BBC Natural History Unit ($5,000) and the Norman Wettenhall Trust ($4,000) who provided the most of the funds for the helicopter transportation to the island ($20,000).

We are also extremely grateful to the proprietors of the William Creek Hotel for accommodation at reduced rates and for flying CDTM up to William Creek from Melbourne on March 2nd.

Wrightsair based at William Creek were also most generous in taking us on 3 aerial surveys over Lake Eyre at reduced rates, as well as providing regular information on bird numbers at Hughes Island obtained during their scenic flights.

SANPWS staff at Port Augusta are thanked for their assistance in many ways, including permission to visit the National Park, permission to land a helicopter on Hughes Island, and the provision of a portable radio.

We also thank Keith Bellchambers and Nicky du Prue and Wally and Betty Klau for accommodation during our journey to and from William Creek.

Figure 1. The average number of Silver Gulls present in the Banded Stilt colony during daylight hours, Hughes Island, Lake Eyre, 1st to 5th April 2000.

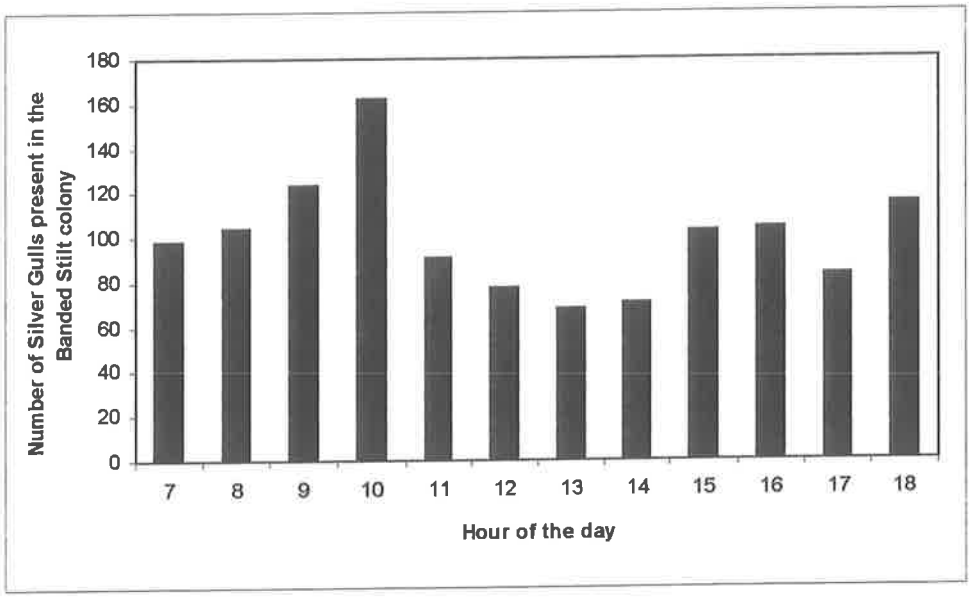
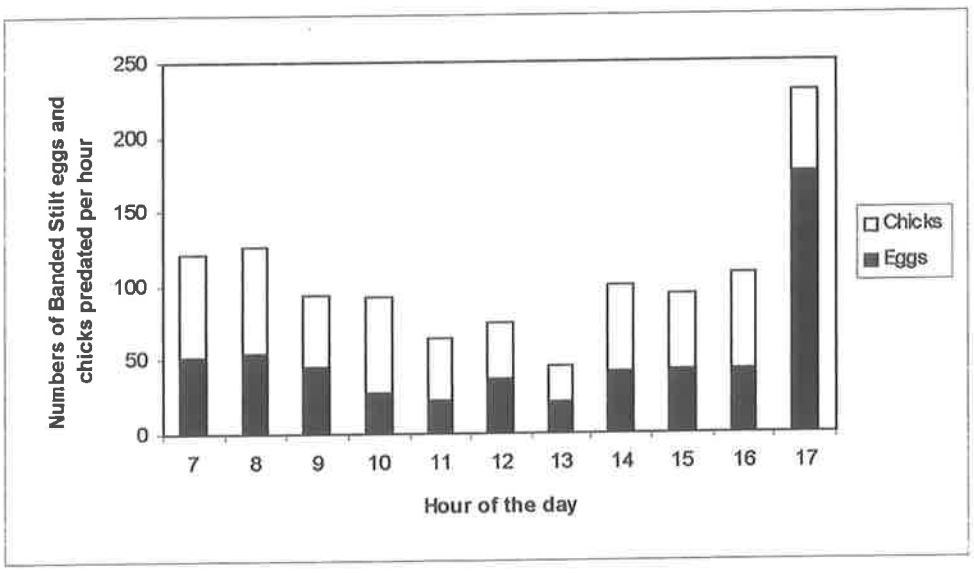


Figure 2. The average number of Banded Stilt eggs and chicks predated by Silver Gulls, Hughes Island, Lake Eyre, 1st to 5th April 2000 (note the large number of eggs taken at 17.00 hours was due to an overflight by an Australian Pelican which disturbed the Banded Stilts allowing the Silver Gulls to predate the eggs and chicks).



Australasian Wader Studies Group

Lindsay Best
Acting Director SANPWS
GPO Box 1047
Adelaide
SA 5001

Recommendations for Silver Gull Control at Banded Stilt Colonies.

Dear Mr. Best,

We attach a copy of a report we have prepared after our recent visit to Hughes Island in Lake Eyre North where we observed massive predation at the Banded Stilt colony by Silver Gulls. The data collected supports earlier information collected by the South Australian National Parks and Wildlife Service during the Banded Stilt breeding event at Lake Torrens in 1989.

We consider that there will be a major reduction in the Banded Stilt population in South Australia and Victoria if drastic measures are not taken to restore a reasonable level of breeding success at Banded Stilt breeding events in South Australia in the future.

We recommend that SANPWS immediately make appropriate preparations to implement a Silver Gull control programme at, and near, future Banded Stilt colonies in South Australia, whenever and wherever these infrequent breeding opportunities occur.

We have already verbally presented our findings and recommendations to John Watkins and Pearce Doherty at Port Augusta and were most pleased at their generally supportive reactions.

We would be most grateful if you would please accept this report and consider initiating action on the recommendations as a matter of urgency.

Yours Sincerely
Dr. Clive Minton
Dr. Rosalind Jessop
Peter Collins

Address for correspondence 165 Dalgetty Road, Beaumaris. Vic. 3193.

(email: mintons@ozemail.com.au).

Letter (20/7/1999) from Mary E. White, D.Sc., to JL seeking BaSt photos for a book she is writing. JL recommended she contact CDTM. Also see her letter of 27/4/1999 below.

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Mary E. White D.Sc.

34 Beatty Street
Balgowlah
NSW 2093
ph. 02 99485269
20th July, 1999

Mr Jim Lane
CALM
14 Queen Street
BUSSELTON
WA 6280

Dear Mr Lane,

I wrote to you in April hoping that you might be able to supply me with a photograph of banded stilts. As I have had no reply and I am getting close to finishing my book, I am writing again to find out if you could be kind enough to direct me to someone else who might have a slide I could use, if you are unable to help me.

I can have the slide professionally copied and return the original promptly so that the time taken for publishers to return material does not cause any inconvenience.

I am sorry to be a nuisance. I know everyone is so busy these days, and I am grateful for an help you can give me.

Yours sincerely,

M E White.

J Lane or Caroline

Would you please ring Dr White and recommend she contact Dr Clive Minton 165 Dalgetty Rd, Beaumaris, Victoria, 3193 Ph and Fax (03) 9589 4901. done. Thanks.

3/8/99

Fax (02/8/1999) from JL to GBP replying to CDTM's 23/7/1999 fax to GP in which he wrote: 'I would like to put a brief note in Tattler re the final outcome of the [1999] Banded Stilt breeding attempt' and asked a number of questions related to BaSt breeding activity and movements in WA in 1999.

Check for / obtain copy of resultant article.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

14 QUEEN STREET, BUSSELTON WA 6280

PHONE – (08) 9752 1677 FAX – (08) 9752 1432

FACSIMILE TRANSMITTAL SHEET

TO:	Grant Pearson	FROM:	Jim Lane
COMPANY:		DATE:	2/8/99
FAX NUMBER:		TOTAL NO. OF PAGES INCLUDING COVER:	(4)
PHONE NUMBER:		SENDER'S REFERENCE NUMBER:	
RE:		YOUR REFERENCE NUMBER:	

NOTES/COMMENTS: Please send the CDTM

FAXED

appreciated please.

Best wishes,

Clive 03-9589-4901

Answer: ① No

② No

③ Don't know

(didn't return to Vasse-Wonnerup (by end of June '99))

Also – see attached article by Kevin Coate in May 1999 issue of "The Naturalist News" (W.A.)

23/7/1999 12/01/2004

Fax to Grant Pearson, CALM 08-9306-1641 23/7/99

I would like to put a brief note in Tattler re the final outcome of the Banded Stilt breeding attempts. What can you tell me please?

I remember that the colony found by Kevin Coate aborted soon after. (1) Were any other colonies located (or suspected?)? (2) Has anyone seen young around? (3) Have the adults now returned to traditional non-breeding areas such as Rottnest?

A brief response by return would be appreciated please.

Best wishes,

Clive 03-9589-4901

Answer: (1) No

(2) No

(3) Don't know.

didn't return to Lake Warmenup (by end of June '99)

Also — see attached article by Kevin Coates in May 1999 issue of "The Naturalist News" (W.A.)

pillars of cemented laterite pebbles somewhat reminiscent of the Pinnacles. There was little evidence left of the Cobb & Co Staging Post which had been built nearby. The Main Road through the area had skirted the western side of the Valley.

We lunched in a pleasant Eucalypt woodland down by the Lake. Several of our party left leaving six to return to base and home on Tuesday.

Of course the botanists and the birdoes had their eyes open on all the outings. Several birds sighted were not on the Station or Park lists and also several plant species. 32 flowering plant specimens were collected, most yet to be identified. Many Euros were sighted. Dragon lizards were everywhere and tadpoles and frogs were evident around the soak areas. The wet conditions had brought up a lot of fungi even including mushrooms at the mallee fowl mound. Kevin will tell you about the birds including his adventures on Lake Goongarrie, in a separate account.

In spite of the disappointing Mallee fowl mound sweep, the excursion was most successful. The recent heavy rain had filled many scenic lakes providing us with opportunities to observe many species of waterbirds. The country has its fascination with its Acacia, Mallee and mixed woodlands, Eremophilas and other shrubs in flower dotted here and there, the compact shapes, colours and textures of the Gimlets and many Casuarina cristata (Black oak) and the almost exotic appearance of the occasional Brachychiton gregorii and Callitris preisii ssp. verrucosa. These generally reflect the underlying soil types, red loam flats, pinkish residual granitic sandy country including sand ridges, breakaways with many colours and forms, the lakes and clay pans, the granite outcrops and the soaks. Thanks to Daphne for a well organised Excursion and to CALM for the use of their excellent facilities.

Gilbert Marsh

"The Naturalist News"
May 1999

BIRD NOTES FOR THE EASTER CAMPOUT AT GOONGARRIE STATION.

Some Club members travelled directly to Goongarrie Station, while others with more time took alternative routes. On the Mt Jackson road Lake Deborah and small ephemeral lakes were full and attracting all kinds of waterfowl, including Pink-eared Duck and Australian Shoveller. Several Australian Shelduck and Maned Wood Duck were seen in forested areas, obviously seeking nesting hollows. Two Major Mitchell Cockatoo were seen 30kms north of Lake Deborah.

On the 2nd April 1999, Banded Stilt were discovered breeding on a very isolated low island in Lake Goongarrie by following their distant sounds carried on a strong easterly wind. Initially it was thought the breeding colony at a conservative estimate, consisted of about 3,000 birds with about the same number feeding out in the lake away from the breeding area. (The shallow water had an abundance of Brine Shrimps.) However, after looking at photographs taken at the time, it is possible there could be up to 10,000 birds.

It appeared as if they had all suddenly gone down to nest after Cyclone Elaine. During Cyclone Vance in March thousands of eggs were abandoned after being covered with sand, blown into piles or washed down the slope into the lake.

Since Cyclone Vance the colony has restructured and breeding is continuing with many fresh scrapes and newly laid eggs. It is expected that the breeding colony of Stilt will increase rapidly over following weeks as hundreds of copulating pairs were to be seen on the lake. However, the depth of water covering the lake was low and unless there is more follow up rain in the area within the next month, it could well be that the colony will be abandoned. Due to the isolated nature and difficult access to areas where these birds breed, there have been less than 25 breeding records in Australia since white settlement.

Shield Shrimp and Brine Shrimp were plentiful in ephemeral lakes close to Goongarrie Station homestead and others we visited on the way to Goongarrie National Park. Black Swan, Hoary-headed Grebe, Australian Shelduck, Grey Teal (up to 96 on one lake), a single Australian Shoveller, Red-necked Avocet and White-faced Heron were recorded.

On our early morning bird walks from the homestead, interesting birdlife included about six Hooded Robin. Red-capped Robin were reasonably plentiful and there was a lot of courting behaviour going on between pairs. Splendid Wrens, Southern Whiteface, Chestnut and Yellow-rumped Thornbill were also reasonably common. Horsfield's Bronze-Cuckoo were seen and heard. Spiny-cheeked Honeyeater were common and Crested Bell Bird heard often. The Owlet Nightjar calling at dawn near the shed close to the homestead possibly had a roost there. After our unsuccessful hot walk in formation along grid lines to monitor Mallee Fowl, it was gratifying next day to find distinctive fresh tracks near an unused nest mound not far from the grid line area. While doing this walk Shy Heath Wren, Mulga Parrot, White-fronted Honeyeater and White-eared Honeyeater were seen.

On Lake Wangine near Siberia, there were considerable numbers of Black Swan, Grey Teal, Australian Shelduck and Eurasion Coot to be seen. Returning to Perth, near Northam we stopped to view a Barn Owl sitting on a road sign.

Kevin Coate

YOUNG NATURALISTS EXCURSION

A BUGS LIFE

And it certainly was a bug's life. Rather unwittingly, over thirty junior and senior Naturalists ventured into a world of assassins and poisons of adventure.... and cockroaches. Saturday, 7th March, a heated morning on Wireless Hill, Applecross was the scene, Eric McCrum our man. While the main focus was insects, we were still able to view the swift and deadly accurate male Darter, and a magnificent sparrow hawk, showing her beauty from high in the sky. Also, the celebrity reptile of the day - a Bobtail Skink found by David and its attached ticks that completed the pack. At 38cm in length and 810g this bobtail provided the group with a chance to touch, hold and watch her devour a supply of apple. The ticks were extracted from the earhole and back region, and we were able to view these squeamishly fascinating arachnids from a close range.

Jim Lane.

Jim

Do you wish to respond? I can pass
him to Nic Dunlop if you prefer.

Cheers

Grant

23/7/1999 12/04/2014

Fax to Grant Pearson, CALM 08-9306-1641 (23/7

I would like to put a brief note in Tattler re. the final outcome of the Banded Stilt breeding attempts. What can you tell me please?

I remember that the colony found by Kevin Coate aborted soon after. (1) Were any other colonies located (or suspected?)? (2) Has anyone been around? (3) Have the adults now returned to traditional non-breeding areas such as Rottnest?

A brief response by return would be appreciated please.

Best wishes,

Clive 03-9589-4900