AUSTRALIAN NATURAL HISTORY SERIES

HERONS, EGRETS AND BITTERNS

Their biology and conservation in Australia

Neil McKilligan

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To my family

Preface and acknowledgments

The aim of this book is to make Australian herons, egrets and bitterns better understood and more appreciated by bird watchers, students and indeed anyone who has a particular admiration for these striking members of our avian fauna and a concern for their long-term survival. Unless otherwise indicated, in what follows 'heron' will collectively refer to all three of these members of the family Ardeidae. This book is certainly overdue. In fact, it is more than 30 years since, at the first campout of the Queensland Ornithological Society (now Birds Queensland), Dr Doug Dow alerted me to the need for monographs on Australian bird families. Since then some excellent field guides and beautifully illustrated bird books have been published and there is a wealth of detailed technical information on many of our bird species in the volumes of the Handbook of Australian, New Zealand and Antarctic Birds (HANZAB) (Marchant and Higgins 1990 and subsequent authors). However, there is still a dearth of books that focus on families of Australian birds with the aim of making the facts and principles of their biology and conservation accessible to a wide readership. It seems the germ of the idea of writing such a book lay dormant in my mind all these years, but now, after decades of research into the Cattle Egret and shorter forays into the field studying other species of herons, I feel I have sufficient depth and breadth of knowledge to be comfortable with the idea of producing a book that looks comprehensively at the Australian members of the family Ardeidae. Nevertheless I am very conscious of my limited field experience of many of our ardeids and gratefully make use of what others have published and told me, while accepting the reality that a number of our heron species have hardly been studied at all.

The book starts with worldwide and Australian perspectives on the heron family, outlining the herons' habits and habitats, origin and biogeography, classification and relationships. It then describes their distinctive physical characteristics, and their importance to humans. It goes on to compare and contrast aspects of the biology of Australian herons, looking at their distribution and movements, feeding and breeding. It reviews species numbers, the loss of much habitat and the need to protect, enhance and indeed restore shallow wetlands. Finally a separate 'thumbnail sketch' is given for each of the 14 heron species resident in Australia and briefer accounts of the six species that are very occasional visitors to Australian territory.

A good deal of general biology can be learnt through the study of birds and the opportunity is also taken here to expand on certain topics as they relate to herons. Recognising that some of these topics will be familiar to some readers I've included them as separate 'boxes' so they don't disrupt the flow of the main text and may be read at your leisure.

My wish is that this book should be read with enjoyment and lead the reader to more satisfying 'heron-watching'. Also that the challenges of preserving heron habitats will be better understood and pursued more vigorously. Finally, it would be excellent if this book encouraged bird enthusiasts to undertake research on the ardeids, especially on those species whose biology is presently poorly understood.

Inevitably a book of this sort draws on the work of many people. I have accessed this mostly through conventional literature searches, but where I have made direct requests to researchers I have been very thankful for the speed and helpfulness of their replies. The Australian Bird and Bat Banding Scheme provided heron recovery data that gives banding and recovery locations, distance travelled and age of death.

I am especially appreciative of the comments on a draft of the text made by Greg Baxter, Roger Jaensch, Max Maddock and Harry Recher, whose research has given them a different perspective on these birds from my own. The book is also greatly enhanced by the use of illustrations from *The New Atlas of Australian Birds* (Barrett et al. 2003) and *Waterbird Breeding Colonies in the Top End of the Northern Territory* (Chatto 2000).

Closer to home, I must thank the University of Southern Queensland and especially the technical staff, past and present, in biology, computing and media services for their support over many years. Thanks also to the many local naturalists and bird watchers who have performed a sterling service by counting egret nests in Lockyer Valley (south-east Queensland) swamps year after year. Birds Queensland kindly provided heron images from their slide library and my request to use these met with universal agreement from the photographers. Regrettably I could not use all of their very high-quality slides.

Nick Alexander and his staff at CSIRO Publishing have very efficiently executed the technical processes, largely a mystery to me, needed to bring this project to fruition. Carol Stephens drew some very nice line drawings and last but by no means least, my wife Helen has always been there for me, encouraging and actively supporting my efforts.

Introduction

Some of our herons are very familiar to us. They are large, elegant, eye-catching birds that are easily observed as they feed in open landscapes or aggregate in large colonies for roosting and nesting. Others, however, are secretive in their habits, preferring the cover of reed beds and other dense vegetation on the edges of lakes, rivers and estuaries, and live a more solitary existence.

From a narrow, utilitarian point of view herons might seem to be of little value to humans, with the probable exception of the Cattle Egret that eats Cattle Ticks and large numbers of grass-eating insects. Their flesh feeds very few people (if any), their feathers are no longer a fashion item and they are not known to be an important source of medicines. Nor are their wastes (guano) easily harvested for fertiliser, as is the case with some colonial seabirds. Some fish farmers see them as pests when they raid their ponds, although their economic impact tends to be exaggerated.

On deeper consideration, however, it is apparent that herons can make a large contribution to the quality of human lives in a variety of ways. Their beauty inspires artists and charms ordinary folk. The presence of different heron species in a wetland gives us an immediate insight into its biodiversity. Herons may also be bioindicators, in the sense of revealing the presence of toxic materials in their habitats. This is because, as top predators, certain pollutants may concentrate in their bodies causing death or illness or low breeding success. Consequently a study of a heron population could give early warning of problems that, if not checked, would eventually impact on human health.

Conservation of our natural wetlands is synonymous with the conservation of many heron species but not any water-body will do. They must have shallow water, as virtually all herons that feed in water are restricted to wading in order to find their prey. The wading depth is limited by the length of the bird's lower leg so potential prey in water deeper than 20–30 cm (depending on the size of the bird) is not accessible to wading birds. Exceptions do occur and remarkably, quite a few heron species, including the Great Egret, have been observed diving off a perch into deep water to catch a fish (H. Recher, pers. comm.).

Wetlands used by heron species include freshwater marshes and the margins of lakes and rivers, estuaries and coral reefs. Some herons like the Cattle Egret, so called because it feeds with grazing stock, are very dependent on the

resources of dry-land prey such as grasshoppers. Heron feeding habitat requirements are varied, diverse and complex, so if we are to preserve or re-establish local populations we need a good understanding of their feeding ecology.

Herons also need safe places to roost and nest and most often use vegetation occurring on or adjoining wetlands for this purpose. Many species have similar roosting and nesting requirements and are found sharing these resources in large colonies.

The health and persistence of shallow wetlands are important for a number of reasons: they have high biodiversity; bring economic benefits to rural communities; and provide environmental services. Such wetlands are the homes of so much of the world's unique plant and animal life that when we lose a wetland we lose a myriad of species, including herons. Marshes and lagoons catch floodwaters, releasing them slowly and consequently reducing the risk of downstream flooding. The wetland's complex ecological processes involving decomposition, regeneration and the transfer of nutrients among many species, has the very valuable effect of purifying the water before it flows on into larger streams and impoundments.

Australasian Bittern habitat near Leeton, New South Wales. Across the world, heron habitats are under assault as wetlands are filled or drained for a variety of domestic, industrial and agricultural uses.

Across the world, heron habitats are under assault as wetlands are filled or drained for a variety of domestic, industrial and agricultural uses. Other wetlands have been saved from this fate only to be converted into deep-water storages by dam construction, leaving only the shallow margins to meet the needs of foraging herons. It is obvious that the great majority of heron species have been disadvantaged by these human-made changes to their environment, as have many other waterbirds and water life generally. As a result of habitat loss the numbers of some heron species are in serious decline or even at risk of extinction.

Worldwide there are about 60 species of herons and 14 of them are resident in Australia. An additional six species are vagrants to Australia or its island territories.

The Australian continent is a vast, chequered tapestry of landscapes, some very attractive to herons, some not at all. Much of coastal and sub-coastal Australia has wetlands that support seasonal nesting by herons. In the south the rainfall mostly occurs in the cooler months and in the north there are heavy falls in late summer into autumn and dry conditions for the rest of the year. At in-between latitudes in eastern Australia rainfall is more evenly distributed across the year. Over the last 50 years there has been a worrying trend towards reduced annual rainfall in this region.

Australia also has extensive regions with very 'stop-go' rainfall regimes, providing feeding and breeding opportunities for herons as a series of irregular and unpredictable events in time and space. About 70% of the continent is considered arid, receiving on average less than 200–500 mm of rain annually. The wetlands of arid and semi-arid regions are actually dry lands most of the time. Heavy rain falls at irregular intervals and the watercourses burst their banks, spilling floodwaters over the plains and filling the ephemeral swamps. These floodwaters can persist for months or even years, providing protected nest sites and an abundance of food for waterbirds. Taken over this whole dry region, floods are frequent although unpredictable in their occurrence, consequently at any one time there are likely to be suitable wetlands somewhere in the region available to birds capable of travelling the huge distances to find them. Recent surveys have shown that arid Australia supports 'extraordinary numbers of waterbirds'. We are only starting to gain insights into the importance of arid Australia to our species of herons.

In recent times there have been major assaults on heron breeding and feeding habitats in southern Australia, resulting most noticeably in a gross depletion of heron numbers at major colonies on the Murray–Darling River System. This has made inland and northern heron populations, such as those of the Channel Country and Top End, even more valuable. The key to their conserva-

tion is to ensure that adequate natural river and overland flows remain available to sustain the biodiversity values of wetlands.

The 14 heron species resident in Australia include conspicuous and cryptic species occupying a diversity of wetland habitats, where they play important roles in the functional dynamics of aquatic food-webs. The success of most heron species is synonymous with the persistance and health of shallow freshwater wetlands but regrettably these have been under seige in this country for the last 200 years.

1
Herons of the world

The term 'heron' covers all the birds in the Family Ardeidae, including those called 'egrets' (the white herons) and 'bitterns'. Many herons are diurnal and can be easily located and identified in the field. However, the bitterns and night herons, who are active at night, are harder to observe as they have camouflage plumage and feed in dense, swamp vegetation. Some herons are very conspicuous at their roosting and nesting sites (heronries) where there can be tens of thousands of birds of the one species, or a mixture of species, forming a close-packed, noisy, and it must be said, smelly, colony. Others are less gregarious, such as the bitterns and some day herons, and have well-dispersed nesting territories.

Herons typically share a suite of distinctive characteristics such as long legs and necks and sharp pointed bills that enable them to prey on the smaller animals of shallow water-bodies, marshes and pastures. Collectively the habitats used by herons are so high in biodiversity and structural diversity that each species may occupy its own ecological niche and cohabit with others without undue competition for food. As herons have evolved in response to the demands of their various environments and inter-species competition each species has developed its own unique body form, habitat preference and foraging behaviour. They may preferentially forage in open or weedy freshwater, in shallow seas, estuaries or marshes, or in wet or dry pastures; and may prey on fish, crustaceans, insects or some other type of small animal.

The ecological result of such evolutionary specialisation is known as 'habitat partitioning', whereby different species exploit different subsets of the available resources. It must be said, however, that heron species display a good deal of overlap in their choice of prey and nest sites and in times of shortage of these resources some inter-species competition might be expected.

Origin and biogeography

Biogeography is the study of past and present geographical distributions of plants and animals and attempting to understand these in the context of past climatic and geological events and species' dispersive processes. Unfortunately, fossil records of ancient bird species are relatively limited. In contrast to the bones of other vertebrates, those of birds are fragile and are more likely to disintegrate before the slow process of fossilisation can take place.

Fossils of the first known feathered animal, and therefore by definition a bird, *Archaeopteryx*, are dated as being from the late Jurassic period, about 150 million years ago. Herons are a very ancient family of birds. Thirty-four fossil heron species have been discovered and the oldest of these dates back to the Lower Eocene, about 55 million years ago. Some of the present-day genera are quite ancient. For example, fossils thought to be of the genus *Ardea*, one that is still well represented among the herons today, have been discovered in Miocene deposits aged about 7 million years.

At about the time that the Ardeidae were differentiating from earlier forms of birds, the ancient landmasses that were to become Australia and New Guinea were separating from Antarctica. For millions of years their surrounding oceans were barriers to organism dispersal and this genetic isolation would have promoted the evolution of a unique fauna. After eons of drifting northwards, the Australian plate is today less than 500 km from Indonesia, presenting no obstacle to new heron species that might invade from Asia. Indeed it is suggested in Chapter 8 that the Cattle Egret, *Ardea ibis*, has done just that in quite recent times.

Herons have considerable dispersive powers. For example, Cattle Egrets apparently flew 2900 km across the Atlantic from West Africa to colonise South America in the late 19th century and, more recently, a bird banded in Australia was recovered 2500 km away at the most southern tip of New Zealand. Of course, these journeys almost pale into insignificance when compared to the much longer journeys undertaken each year by our small wading birds on their seasonal migrations between the northern and southern hemispheres.

Taken as a group, present-day herons occur in all temperate and tropical lands, but are absent from the coldest regions of the earth and where there are few suitable water-bodies to sustain them, such as the arid Sahara and Arabian

deserts. Some species have a circumscribed geographical range whereas others are very widespread. The New Guinea Tiger Heron, *Zonerodius heliosylus*, for example, is found only in New Guinea and on a few islands off its west coast. By contrast, two of the six most widespread non-marine bird species that breed on every continent except Antarctica are herons: the Great Egret, *Ardea alba*, and the Cattle Egret. Herons are evidently most numerous and diversified in warmer climes. For example: in Central America (Belize to Panama) there are 20 heron species; the USA has 15; Canada nine; and Greenland only five, none of which breed there.

Classification

The relationships of herons to other bird species and to one another have been strongly debated among bird taxonomists. This section is based on the system of classification of Christidis and Boles (1994), which draws on the traditional classification and the more recent findings from DNA analyses (see Sibley and Ahlquist, 1990). Because of the large standard errors associated with the measurement of DNA-DNA hybridisation distances, Christidis and Boles (1994) conclude that this technique 'is useful for demonstrating what is related to what, but not necessarily at what taxonomic level'.

The herons comprise the Family Ardeidae in the Order Ciconiiformes. Also placed in this order are the ibises (Family Threskiornithidae) and storks (Family Ciconiidae). In Australia there are three species of ibis and one stork: the Straw-necked Ibis, *Threskiornis spinicollis*; the Australian White Ibis, *T. molucca*; the Glossy Ibis, *Plegadis falcinellus*; and the Black-necked Stork, *Ephippiorhynchus asiaticus*.

There is ongoing debate among taxonomists about what other families of birds should be put in the Order Ciconiiformes; how many genera there should be in the Ardeidae, and the allocation of species to genera. If at this stage you are getting confused with the jargon of classification, the box, 'Taxonomy and classification', on page 5 may be helpful.

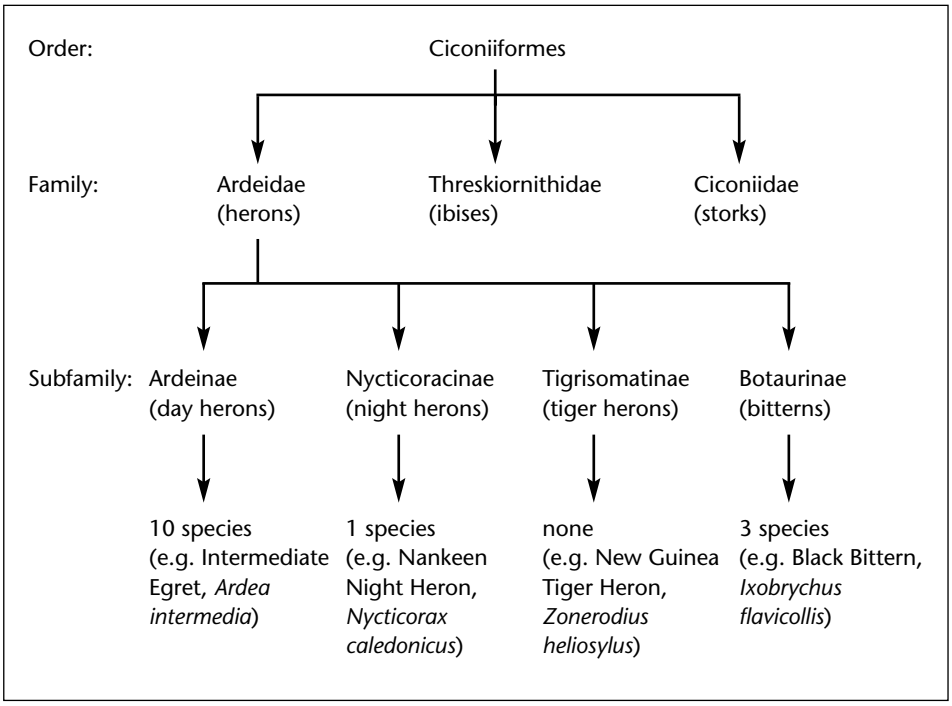
Christidis and Boles' system of classification recognises four main subdivisions (subfamilies) within the Ardeidae (see Figure 1.1). These are the day herons, night herons, tiger herons and bitterns. The day herons, subfamily Ardeinae, comprise the most species and are the best known. Many have conspicuous, bright plumage and, as their name suggests, they are active during the day. The night herons, subfamily Nycticoracinae, are more heavily built birds that typically feed at low light intensities. The tiger herons, subfamily Tigrisomatinae, so called because of their striped plumage, have not been recorded in Australia. They tend to be secretive and solitary and may be the most primitive members of the Ardeidae. The bitterns, subfamily Botaurinae,

also tend to be nocturnal and generally restrict their foraging to thick reed-beds and thickly vegetated margins of lakes and rivers.

Many heron species are further subdivided into subspecies or races. This is appropriate for widespread species and especially those that have colonised remote oceanic islands where a lack of near neighbours prevents interbreeding. Most notable in this regard is the Striated Heron, *Butorides striatus*, with its 36 subspecies, giving rise to the descriptor 'super species'.

Not withstanding the Striated Heron's numerous subspecies, it is possible there has not been as much genetic divergence among some herons as we would expect. In his book on bird speciation, Ian Newton writes, 'It is perhaps partly because of the dispersive powers of wetland birds that … several taxonomically undifferentiated species breed on two to four different continents.' Newton specifically mentions the Great Egret as an example of this, but even this species has five subspecies. Obviously geographic barriers are not the whole story and the likelihood of genetic divergence will also vary among heron species depending on behavioural factors such as their tendency to be sedentary or migratory.

Figure 1.1 Classification of the Order Ciconiiformes. The number of resident Australian species is shown for each subfamily and one example is given for each.



Taxonomy and classification

Taxonomy, the science of classifying organisms, involves first deciding which organisms comprise a single species and then putting species into categories according to how closely the taxonomist considers them to be related. Thus within the inclusive category of Living Things, there follows Kingdom, then Phylum, Class, Order, Family, Genus and Species, in descending order of size. Intermediates may also be invented such as Suborder and Subfamily.

The Species is a special category because it alone can be given an unambiguous biological definition – namely a 'group of interbreeding or potentially interbreeding organisms that can produce fertile offspring'.
The evolutionary significance of this is that there is a reproductive barrier between species that preserves their genetic integrity.

With the 'binomial system' of classification, devised by Carl Linnaeus, a species' name consists of two parts, the genus followed by the species. However, a species may show enough regional variation to warrant it being further subdivided into subspecies. In naming subspecies the one that is first described, called the 'nominate' subspecies, gets a third name which is the same as the species name, whereas subspecies described at a later date get a different third name. Thus, the nominate subspecies of the Cattle Egret is *Ardea ibis ibis* but in Australia we have the later described subspecies *Ardea ibis coromanda* (abbreviated as *A. i. coromanda*).

Traditionally taxonomists inferred genetic relationships from visible features, such as anatomy and behaviour that were (correctly) assumed to have a genetic basis. However genes may not be solely responsible for these features which might also be shaped by the birds' rearing environment. Or similar structures may owe their similarity to the process of convergent evolution rather than common ancestry.

Molecular biology now allows for direct comparison of the genes of individuals using the techniques of DNA-DNA hybridisation and protein electrophoresis. Proteins are a good substitute for genes because the DNA encodes their structure.

Taxonomy and classification are enormously important because they organise our view of nature. Each species is given a unique binomial and a place in the classification system. There should then be no confusion of identity; accessing information on a species or group in the biological literature becomes easy; and when confronted by a new organism, simply knowing its classification gives an immediate insight to its form and function. Ideally the classification will also closely reflect the species' evolutionary relationships, giving an organic foundation to what would otherwise be a system of grouping things on somewhat arbitrary criteria.

Australia's herons

Herons are well represented on continental Australia, where there are 14 resident species (23% of the world total). Among these are 10 species of day herons, one species of night heron and three species of bitterns (see Table 1.1).

In addition to the 14 resident species there have been rare sightings in Australia of six other identified species. These are the Black-crowned Night Heron, *Nycticorax nycticorax*, the Malayan Night Heron, *Gorsachius melanolophus*, the Yellow Bittern, *Ixobrychus sinensis*; the Cinnamon Bittern, *Ixobrychus cinnamomeus*, the Schrenck's Bittern, *Ixobrychus eurhythmus*, and the Grey Heron, *Ardea cinerea*. An unidentified species of pond heron, *Ardeola* spp., has also been sighted on Christmas Island as recently as November 2003.

Elsewhere in Oceania, there are six heron species in New Zealand, all of which also occur in Australia, 15 species in Irian Jaya and Papua New Guinea, and eight are found on various Pacific islands.

Table 1.1 Resident Australian herons

CLASS AVES, ORDER CICONIIFORMES, FAMILY ARDEIDAE		
Subfamily	**Species name**	**Common name**
Ardeinae (day herons)	*Ardea ibis*	Cattle Egret
	Ardea pacifica	White-necked Heron
	Ardea sumatrana	Great-billed Heron
	Ardea alba	Great Egret
	Ardea pictata	Pied Heron
	Ardea intermedia	Intermediate Egret
	Egretta novaehollandiae	White-faced Heron
	Egretta garzetta	Little Egret
	Egretta sacra	Eastern Reef Egret
	Butorides striatus	Striated Heron
Nyctocoracinae (night herons)	*Nycticorax caledonicus*	Nankeen Night Heron
Botaurinae (bitterns)	*Ixobrychus minutus*	Little Bittern
	Ixobrychus flavicollis	Black Bittern
	Botaurus poiciloptilus	Australasian Bittern

2
What makes herons different?

The world's largest heron is Africa's Goliath Heron, *Ardea goliath*, (140 cm long and 2600 g in weight) and the smallest, found in Australia and the Old World (Europe, Asia and Africa), is the Little Bittern, *Ixobrychus minutus* (minimum length 25 cm, weight 85 g). The large day herons are particularly elegant birds, with their slim body and long neck and legs; whereas some of the smaller day herons, and the night herons and bitterns have a more compact build. Male and female herons generally have a very similar appearance. An exception is the Little Bittern where the female's brown, streaky plumage distinguishes it from the more immaculate black-and-brown male. Heron females tend to be smaller and lighter than males of the same species, but in some the largest females exceed the smallest males. Extreme size dimorphism occurs in the Australasian Bittern with the males weighing in at about 1400 g compared with the 900 g females.

Juveniles can often be readily identified from adults by their plumage. In the case of the Nankeen Night Heron, the juvenile's overall streaky brown plumage is quite different from the well-defined pattern of black, rufous and white of the adult. Some species of herons are polymorphic, which means that adult birds can have markedly different plumages. The Eastern Reef Egret, for example, occurs as white and black morphs, in both sexes. It is a puzzle as to why the black morph predominates in the southern parts of its range and the white in the north, with both morphs common at in-between locations.

When flying, the heron flaps its wings continuously with a slow, strong beat. The neck is flexed into an 'S' shape, bringing the head back towards the body. This shape readily distinguishes it from cormorants or ibises that fly with their necks outstretched. Being flappers rather than gliders herons have a short wingspan relative to wing depth. This proportional measurement is

Aspect ratio and wing aerodynamics

The shape of a bird's wing has an important bearing on its aerodynamic properties. Wing proportion is expressed numerically as 'aspect ratio', a value obtained by dividing total wingspan by mean wing chord (see Figure 2.1). Consequently a bird such as a heron with a relatively short, broad wing will have a lower aspect ratio than one whose wing is long and narrow.

A low aspect ratio lends itself to flapping flight with high maneuverability in the air due to a low stalling speed. Flapping flight requires a large expenditure of energy. The House Sparrow, *Parus major*, is a flapper and has an aspect ratio of 5.

Gliding birds have long, narrow wings and hence a high aspect ratio. The Wandering Albatross, *Diomedea exulans*, is a glider par excellence with a wingspan of 300 cm and the very high aspect ratio of 25. This wing shape minimises the drag of the air against the wing's surface. Low drag reduces the energy cost of flight but the narrower wing brings with it the penalty of a high stalling speed, which explains the dramatic crash landings of albatrosses and boobies when their speed drops below the critical level.

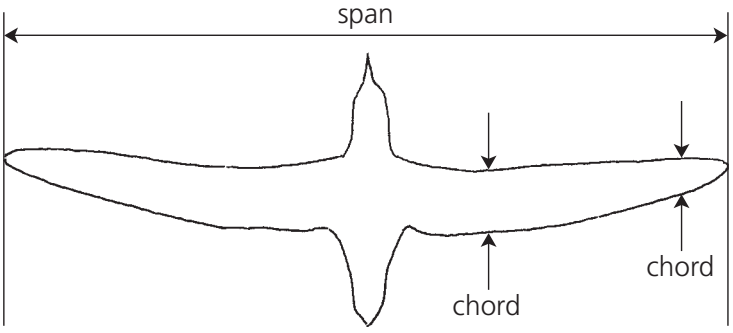


Figure 2.1 The aspect ratio of a bird's wing is the value obtained by dividing the total wingspan by the mean chord. Wing chord is the width of the wing, measured along the direction of flight. It varies at different points along the span. Adapted from Pennycuick 1989.

termed the bird's 'aspect ratio' (see box, 'Aspect ratio and wing aerodynamics', opposite). The tail feathers are short.

With the exception of the deep bill of the Boat-billed Heron, *Cochlearis cochlearis*, of South America, herons' bills are slender, straight, sharp-pointed and moderately long, but not as extreme in length as that of the ibis. Their mandibles often have a finely serrated edge to help secure slippery prey.

The extended neck of herons may be seen to have a noticeable kink in it about one-third of the way down. This corresponds to the position of the modified 5th, 6th and 7th vertebrae. These elongated vertebrae have special points of articulation for numerous long and short muscles and tendons, which allow the retracted neck to unfold in an instant, producing a rapier-like thrust of the bill towards the prey.

Herons have four toes, the first of which is directed backwards: this is called the 'anisodactyl' foot. The three forward-directed toes have vestigial webbing between them. A characteristic of the heron family is the serrated edge of the claw of each third (= middle) toe. This claw is described as 'pectinate' and is used as a comb by the bird in feather maintenance (see Figure 2.2). Like other birds herons walk on the flat of their toes with the rest of the foot raised off the ground. The long toes distribute the heron's weight when walking on mud or floating vegetation. Bitterns use their long, strong claws to grasp reeds as they clamber through marshy terrain.

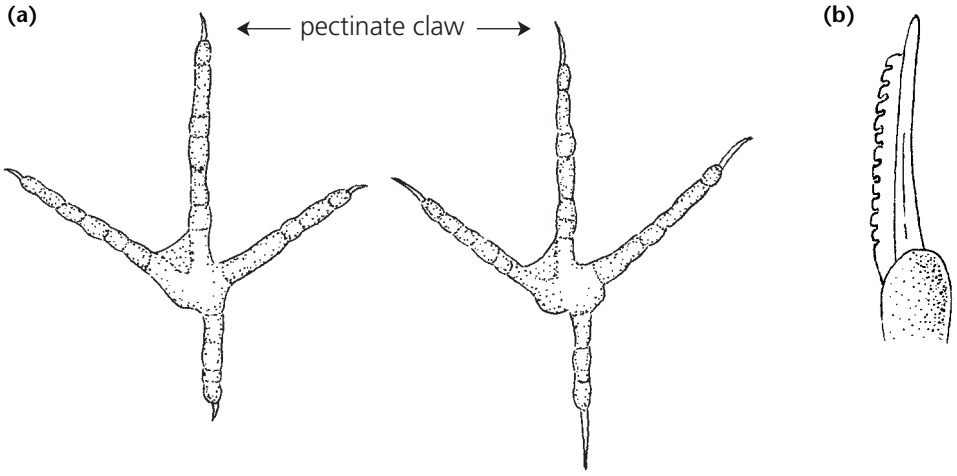


Figure 2.2 (a) The bittern (right) has noticeably longer claws than the day heron (left) (b) The pectinate claw of the Little Egret showing its serrated edge. (a) from Romer and Parsons 1986, (b) drawn by C. Stephens from a specimen.

Vision

Herons are visual predators and like other birds they have very large eyes in proportion to their head size. Their eyes have two remarkable properties. The first is a very wide visual field that is almost panoramic on the vertical plane and encompasses about 320 degrees on the horizontal plane. The 40-degree 'blind spot' is behind the head but this can be reduced to only 10–20 degrees by the bird diverging its eyes, albeit at the expense of the arc of binocular vision at the front. The second property, not unique to herons, is its 'bifocal vision' whereby the lower part of the visual field can be focused on the ground in front of its feet when the upper part is focused on more distant surroundings. Thus it can be searching for food close by and also scanning further afield for anything that might threaten it. Birds have colour vision.

Display plumage

Birds have three basic types of feathers that serve different functions (see box, 'Feather structure', opposite). The heron's plumage is loose and the feathers are typically moulted twice a year. A partial moult takes place just prior to nesting and a complete moult, when all the feathers are replaced, follows closely after nesting. Indeed some Cattle Egrets start moulting while still feeding advanced young and for a period appear very 'scraggy'. Most (and perhaps all) herons have a pre-nuptial moult and then grow special nuptial feathers, called plumes, that are very showy in some but quite inconspicuous in others.

Feather colouring ranges from all white through various combinations of contrasting colours to more subdued, sometimes non-descript, greys, browns and tans. Bright plumage is a feature of many of the colonial day herons and self-advertisement probably helps bring them together at roosts and heronries and facilitates clumping or dispersing on the feeding grounds as necessary to best exploit the available prey. By contrast the more solitary bitterns may benefit from concealment rather than advertisement when nesting and feeding and their nondescript plumage, sometimes with a disruptive (broken) pattern, provides a good camouflage.

Feathers are a conspicuous part of the bird's appearance so they inevitably serve to advertise its physical condition and motivational tendencies such as aggressiveness or readiness to mate. The showy plumes are very elongated, modified body feathers that sprout from the head, neck, breast or back. There are two types: lanceolate plumes, which have a long shaft but a very narrow vane; and aigrette plumes, which have long shafts and long barbs that are not linked so that instead of forming a vane they spread out, fluffy and diaphanous. A heron's plumes are most often the same colour as its

Feather structure

Flying birds typically have three basic feather types: contour, down and filoplumes. The contour feathers are the vaned feathers that form the contours of the body and provide the expansive wing area needed in flight. The fluffy down feathers lie under the contour feathers and trap an insulating layer of air. The tiny filoplumes, which you may have noticed as a light fuzz on a plucked bird, move when the larger feathers are dishevelled and this stimulates sensory cells that send signals to the brain, alerting the bird to the need to do some preening.

Contour feathers have a shaft bearing a series of side branches called 'barbs' on each side of it. Each barb also has a row of branches on each side called 'barbules' that hook up with the barbules of adjoining barbs. Collectively these linkages form the vane, which is like a continuous membrane. As you will know from stroking a feather the 'wrong way', these linkages are easily broken, but the barbules are easily re-linked by stroking the feather the right way and the bird does this with its bill while preening.

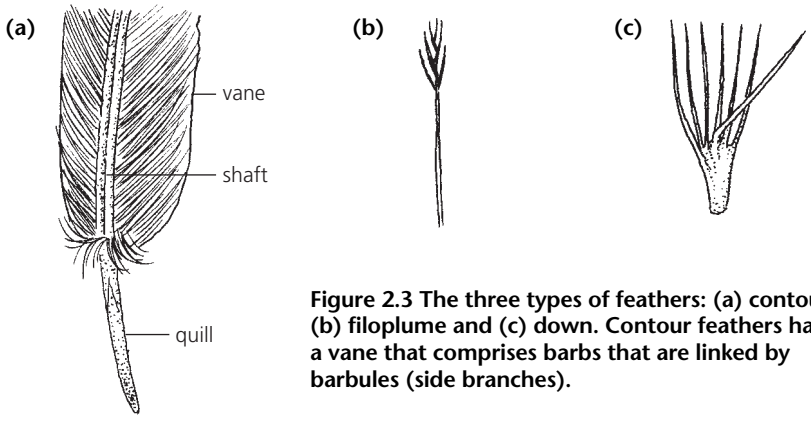


Figure 2.3 The three types of feathers: (a) contour, (b) filoplume and (c) down. Contour feathers have a vane that comprises barbs that are linked by barbules (side branches).

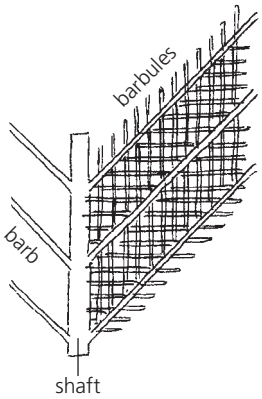


Figure 2.4 Schematic representation of a small part of a contour feathers showing the interlocking barbules (after Romer and Parsons 1986).

background feathers but the orange-buff plumes of the Cattle Egret contrast strongly against its white body feathers.

Powder-down and self-maintenance

The feathers of all birds are soft to touch but the feathers of adult herons have a silky softness due to a coating of a talc-like powder. This powder comes from paired patches of highly modified feathers termed 'powder-down' on the breast, and rump, and in the subfamily Ardeinae on the inguinal region as well. The powder-down patch is a low furry mat of short feathers that are not moulted but continuously grow and disintegrate to a powder. The heron uses its head and bill to wipe the powder over its feathers to clean them. Most other birds lack powder-down and instead use oil secreted by the uropygial gland on their rump to clean and waterproof their feathers. This gland is small in the herons, appearing as a fleshy eminence at the base of the dorsal (upper) side of the tail feathers.

Like other birds, herons spend a good deal of time preening. This serves many purposes: it keeps them clean of debris, removes some ectoparasites, tidies their feathers that may have become dishevelled and restores the linkages between the feather barbs to maintain the integrity of the vane (see box, 'Feather structure', on page 11). They use their toe nails, especially the large middle toe with its pectinate claw, to preen the head and upper neck, which are hard to access with the bill.

When it is hot, herons thermo-regulate by panting. In doing this the mandibles are opened slightly and there is an easily visible, rapid fluttering of the gular membrane of the upper throat. Other self-maintenance behaviours are fluffing out their feathers and loosening their wings while vigorously shaking their bodies, and simultaneously stretching the wing and leg on one side of the body and then on the other.

Brightly coloured bare parts

Unfeathered body surfaces in herons are the bill, the lore (skin between the bill and the eyes) and the skin of the lower leg and foot (from the mid-tibia down). In non-breeding herons all of these bare areas tend to be dull in colour, for example grey-green, grey-yellow or grey-black but with the onset of breeding they can change dramatically. Thus in those Australian species described in HANZAB, at the onset of breeding the iris changes from yellow to bright red; the lore becomes red or green or blue depending on the species; the bill becomes mostly red or all black; and the tibia becomes red. The red colouring of the tibia extends down onto the tarsus and toes of some, but this varies considerably among individuals.

The most intense expression of these colours typically lasts only a few weeks, fading to something closer to their non-breeding colour when the mates settle down to incubate the eggs. These bright nuptial colours are likely to be important sexual signals and probably develop to some extent in all species. At the start of nesting the egrets in particular have an exotic beauty, with their long plumes and brightly coloured bare parts. In some Cattle Egrets that are nesting for the first time, the plumes are sparse or absent but the bare part colours are as vivid as those of Cattle Egrets with well-developed plumes.

Aspects of field identification

Many day herons are immediately recognisable in the field from their plumage colours. Juvenile Nankeen Night Herons and bitterns have a nondescript colouration that might result in misidentification. The Little Bittern is, however, very much smaller than the others.

The egrets with their all-white plumage can be difficult to distinguish. Although there are considerable differences in their sizes, this is only a useful measure if they are standing side by side. Accurate identification of these is best based on skin colour, behaviour and body proportions.

The bright skin colours that distinguish breeding egret species are only helpful during a limited period over the few weeks of the early breeding season. Some colour differences, however, are evident all year round. For example, the Little Egret's bill is always black, which immediately distinguishes it from the non-breeding Intermediate Egret with its yellow-coloured bill.

Behaviour is often a good indicator. For example, the tendency of the Little Egret to dash around in the shallows after its prey helps to distinguish it from the Great Egret a much more sedate forager.

Among certain heron species, body proportions are noticeably different. In trying to decide at a distance whether the bird is, for example, a Great Egret or an Intermediate Egret, the disproportionately long neck and legs of the Great Egret are very useful clues. These different body proportions are the result of a developmental phenomenon known as allometry or allometric growth (see box, 'Animal shapes and allometric growth', on page 14).

Why are there different types of herons?

Species of herons most obviously differ in body size, habitat choice and foraging behaviour. These, and less obvious features, have evolved through the process of adaptive selection that promotes the spread in a population of genes for novel traits that ultimately enhance reproduction. Chance may exert a powerful influence for good or ill. For example, the phenomenon of genetic drift may increase the frequencies of genes for non-adaptive traits in small populations.

Animal shapes and allometric growth

Body proportions in animals are strongly influenced by a developmental phenomenon called 'allometric growth', which determines that the growth of certain body parts is faster than the others. Very often there is faster rate of growth of the extremities of the body, such as the neck and legs, than more central parts.

In the case of herons, the larger the heron the disproportionately longer its neck and legs. We humans are also influenced by allometric growth, as is evidenced by the markedly long noses, chins and digits of very tall people. Allometry turns out to be very useful in identifying some egrets. On first acquaintance with the Intermediate Egret the observer would be struck by its very long neck (equal to its body length) but when looking at the larger Great Egret he or she would be even more impressed by its almost bizarrely long, thin neck (about 1.5 times its body length).

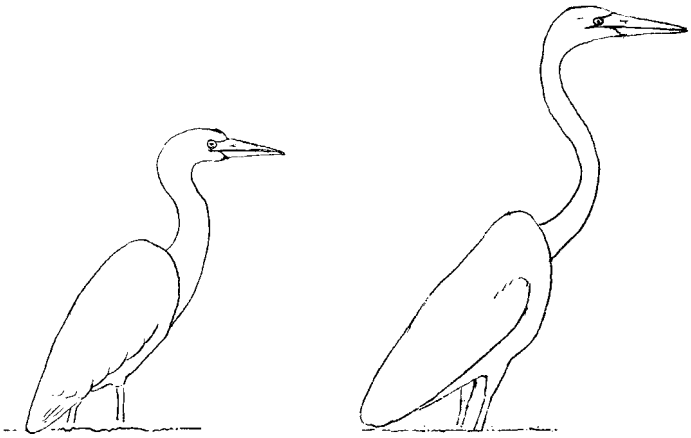


Figure 2.5 The body proportions of the Intermediate Egret, *Ardea intermedia*, (left) and the Great Egret, *Ardea alba*, (right) are strikingly different.

Obviously efficient feeding is of paramount importance and much of heron diversity can be understood in the light of species-specific adaptations for feeding. The driving force for adaptive change in the equipment and behaviours for feeding might simply be the challenge of obtaining enough food to maintain body condition in times of scarcity or of successfully taking on the extra burden of feeding chicks. Evolution may also be forced by the pressure of numbers of birds competing for the same resources.

Harry and Judy Recher's research in 1980 found that heron diversity in the USA coincided with resource diversity and that species feeding in the same

Great Egrets and Royal Spoonbills feed in the shallow margins of a water storage.

habitats partitioned the available food resources, thus increasing their foraging efficiency and reducing the scope for inter-species competition. The Recher's thesis is that there are different kinds of herons because there are different kinds of prey. For example, the large bodied species of herons seemed most efficient at exploiting large prey and the small species, small prey. Where there is a mixture of prey sizes in the shared habitat one might expect directional selection to act on some of the heron species to shift their average body size towards the larger (or smaller) end of the size spectrum.

The heron does not 'live by food alone', however, and undoubtedly, traits that serve to differentiate present-day species have evolved to enhance the bird's abilities to obtain a mate, raise a brood, avoid predation and resist various malentities.

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3
The importance of herons

It is rare to visit an art gallery that doesn't display at least one painting of a watery landscape with herons (usually egrets, the white ones). Artists obviously find their grace and elegance irresistible subject matter. For anyone sensitive to beauty and interested in the natural world it is a moment of enchantment to chance upon a Great Egret hunting its prey: a tall, white bird standing stock-still, peering into the shallows of a limpid pool, its slender form reflected in the glassy water and framed by the greenery of the shore.

The Great Egret was once of great interest to the fashion industry when ladies coveted its exotic plumes as decoration for their hats. The wholesale slaughter of the Great Egret for its plumes in the 19th and early 20th centuries in southern USA, for example, reduced its populations to dangerously low levels, and in 1902 nearly 1.5 tons of these feathers were sold to London milliners. Fortunately public outrage succeeded in discrediting the fashionable trend, hunting of the bird was banned, and population numbers returned to sustainable levels.

Because many herons are very visible as they access the food resources of open waters or grasslands, the bird watcher can get considerable satisfaction from observing them feeding. Methods of hunting vary among the heron species (see Chapter 5). For example, the Great Egret will stand very still for an interminable length of time before striking with lightening speed as some

unsuspecting frog or fish comes within range; in contrast, the Little Egret dashes through the shallows in active pursuit of fishes. Then, there are the more dry-footed herons, who search out their prey by walking and peering in potential hiding places among sedges and grasses.

Herons as bioindicators

Bioindicators are detectible biological parameters, such as organisms, populations or communities, which provide reliable measures of a changing environmental condition. They are used by scientists for types of changes that are difficult to measure directly, for example the deterioration in the quality of a wetland. To be useful, the bioindicator must be so closely coupled with the condition of interest that its occurance is a reliable indicator of the condition. As an example, since waterbirds need quality wetlands, monitoring waterbird communities might reveal changes in wetland availabilty and biodiversity. This was proven to be effective in the Florida Everglades where downward trends in the numbers of herons, ibises and Wood Storks, *Mycteria americana*, were said to be some of the first indications that a major system deterioration had begun. Such insights into fundamental changes in the health of a wetland may require bird population data gathered over a long period of time. This data may be collected for reasons unrelated to its eventual use as a bioindicator. Fortunately, bird enthusiasts simply enjoy surveying bird numbers and nowadays in Australia they are organised to do so in a systematic way in national, regional and local projects, so the data collected can be used for scientific purposes.

To understand how heron diversity might be coupled with the complexity of the wetland we need to understand the concept of biodiversity. A healthy wetland will generally support a highly diverse community of animals. This diversity comes from the varied conditions of its topography, hydrology, soil type and vegetation. Typically a wetland will support not just one type of heron but a suite of species, each one exploiting somewhat different subsets of the food made available by the mosaic of habitats that form the wetland. The biodiversity of a wetland is a measure of the diversity of species present and their proportional contributions to the economy of the wetland system. A wide diversity of primary producers (plants) and consumers (small and large herbivores) and their predators translates ultimately into feeding opportunities for a variety of the top predators such as the herons. Given the large size and the high visibility of the day herons at least, this group might be expected to be very suitable bioindicators of the biodiversity and therefore the health of the wetland.

Herons and environmental contaminants

Almost everything used and disposed of on dry land will find its way eventually into some body of water. Environmental contaminants that may be present in heron habitats and in the bodies of herons include organochlorine compounds, organophosphorus insecticides, trace elements and petroleum. (For details on the significance of contaminants to heron populations see Custer in Kushlan and Hafner (2000).)

DDT and dieldrin are organochlorine insecticides that at one time were used widely in agriculture. DDT breaks down to the compound DDE and high concentrations of DDE and dieldrin have been found in the brains of herons in the USA and DDE in herons of Europe. These contaminants are implicated in the deaths of adult birds but at lower concentrations they may affect heron eggs and chicks in ways that are more subtle and less easily detected.

DDE was first associated with eggshell thinning in Britain in 1967 in the Grey Heron, *Ardea cinerea*, whose eggs were up to 16% thinner than those collected in the pre-DDT era. Grey Herons did not, however, suffer a decline in numbers as a result of this thinning, possibly because they produced replacement eggs. A plot of eggshell thickness against DDE concentrations in eggs of the Black-crowned Night Heron, *Nycticorax nycticorax*, in the USA shows a significant negative correlation between the two (see Figure 3.1). A thin shell is more likely to suffer accidental breakage, allowing infection to enter and kill the embryo.

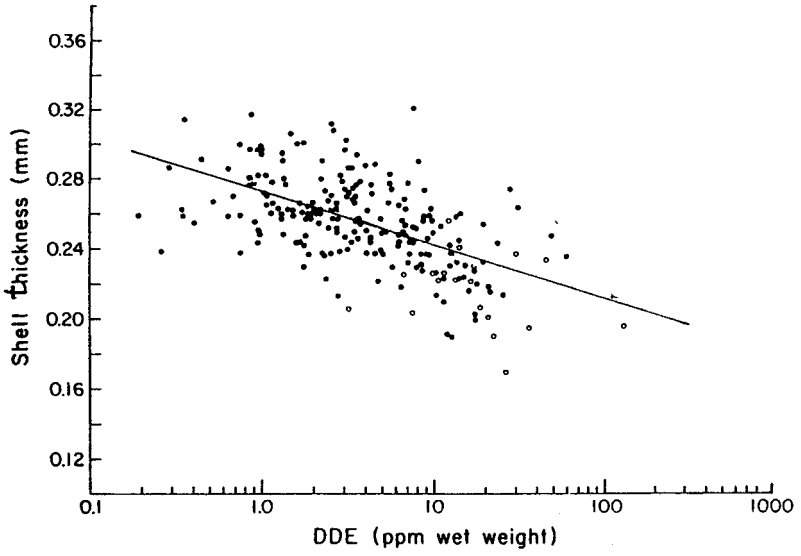


Figure 3.1 The relationship between eggshell thickness and the level of DDE residues in the Black-crowned Night Heron (adapted from Kushlan and Hafner 2000).

Generally the evidence for DDE reducing heron numbers is circumstantial and is limited to the above mentioned study of the Black-crowned Night Heron in the USA, and that of the Cattle Egret of the Nile Delta and Suez Canal Zone. The Egyptian study showed that Cattle Egret numbers reduced after farmers started using DDT on cotton but have recovered since DDT use has been discontinued. The alarming reductions in the number of raptors such as the Peregrine Falcon, *Falco peregrinus*, in several countries have, however, been convincingly attributed to DDE-induced eggshell thinning. In some parts of Australia, populations of raptors probably suffered local breeding failure and population disruption due to DDE contamination but Peregrine Falcon eggshell thickness has returned to normal here and overseas since the ban on DDT. Similarly dieldrin is now banned in this country, as it has been for many years in the USA and Britain.

Poisons coming from industrial sources, such as PCBs and dioxins, have been associated with abnormalities in heron embryos. They may also be associated with lower than average reproductive success, although studies so far suggest these effects are localised.

Other contaminants such as organophosphorous and carbamate pesticides, trace elements and petroleum do not seem to have had a significant impact on heron populations.

Herons and aquaculture

Some species of heron largely subsist on fish and the crowded environment of an aquaculture pond provides them with an easy source of prey. Conflict between fish-eating birds, such as herons, ibises, darters and cormorants, and aquaculturalists has often led to drastic consequences.

Captive fish are subject to many different malentities. Among these are poor water quality, low oxygen level, disease organisms and, much further down the scale of importance, predation. Bacteria and parasites, in particular, can take a heavy toll of farmed fish but they may be hard to detect. By contrast a bird is very visible to the fish farmer who may become quite apoplectic on seeing a heron in the act of taking a fish. However, this strong emotional response may by quite out of proportion to the dollar cost of the fish taken. Of course every situation is different and at some farms the birds may significantly impact on an enterprise's profitability.

There is disturbing evidence about the slaughter of birds species because of their perceived threat to the aquaculture industry. In some instances herons have been shot and poisoned on a massive scale. In the Danube Delta between 1949 and 1953, entire colonies of fish-eating birds were destroyed, and in 1956, 106 340 such birds were killed there. Not so long ago, in what

might be thought to be more enlightened times, such large-scale slaughter was still being carried out. For example, in Denmark each year to 1979, 25% of the autumn population of herons (4000–7000 birds) was killed. There are now laws protecting these birds in Europe and the USA but unfortunately they are often flouted.

In Australia, herons are identified among the many potential predators of fish and crustaceans in coastal and inland ponds. According to one fish hatchery the Nankeen Night Heron was said to take advantage of the easy pickings for a time, unnoticed under the cover of darkness.

One cannot blame a fish farmer for taking steps to protect his/her livelihood. But there are two questions to be answered before the extreme step of killing birds is taken: 1) How much money are the birds actually costing the farmer? and 2) What is the cost and effectiveness of exclusion measures? It is only in recent years that well-planned studies have shed light on the economic impact of such birds on particular enterprises. Because these are highly dynamic systems, the size of the problem varies from one location to the next and from one year to the next. In Europe the proportion of fish taken by a wading bird such as the Grey Heron in the natural environment can be as much as 76% or as low as 6.5%. In artificial habitats, studies suggested losses to herons ranging between 0.3 and 36%, but below 5% for the great majority. These figures must be contrasted with huge losses due to other malentities.

Even if the herons are deemed to be a sufficient pest to warrant taking action against them, there are a variety of non-lethal strategies that can be implemented. Generally the success of these comes from having a good understanding of the species' feeding behaviour and predatory capabilities. Guaranteed to work, although at some cost, is simply netting ponds to exclude the birds. An understanding of heron's social behaviour might be exploited. For example, in Europe, the individual Grey Heron defends an exclusive feeding territory and if the territory holder is tolerated it may exclude non-territorial herons that would consume considerably more than it does. There are also scaring devices, but as with grain and fruit farmers, the fish farmer will probably soon discover that a hungry bird is not easily scared.

Australian aquaculturalists that are suffering heavy losses see total exclusion of bird predators by netting off the pond as the only practical solution. However, netting against birds is expensive and considerable thought has to be put into the choice of materials and its erection if it is to be durable and effective. In their book, *Australian Fish Farmer*, John Mosig and Ric Fallu provide an example of a cost-benefit analysis for bird exclusion at a hypothetical yabby (freshwater crayfish) farm. In this example, where without protection a 3 tonne per hectare yabby crop might be reduced to 500 kg by birds, an

expenditure of $10 000 per hectare on exclusion could save the farmer between $50 000 to $75 000 over 5 years. More typically, losses are likely to be affordable and the fish farmer can avoid considerable angst by adopting the sanguine attitude of an old-timer grain farmer of my acquaintance who was content 'to grow some for the birds' on his southern Queensland farm.

From a global viewpoint, serious damage to a fish farm from herons is likely to be a rarity. Furthermore, given that aquaculture enterprises are on the increase worldwide and that coastal wetlands are favoured sites for pond construction, the serious damage is more likely to be that inflicted on heron populations as a result of the loss of their mangrove, mudflat and swamp habitats.

4

Distribution, movements and longevity

Thanks largely to the efforts of about 7000, mostly amateur, bird observers, comprehensive and up-to-date information about the distribution of birds across most of Australia is contained in *The New Atlas of Australian Birds*. The atlas is a remarkable compilation of a long-term survey: from 1998 to 2002, where volunteers submitted 279 000 survey forms from 149 000 locations throughout Australia, including 12 400 wetlands. This sort of community-based survey inevitably produces regionally biased data, because, no matter how systematically undertaken, most observations are made in the higher rainfall coastal regions where most bird recorders live. Consequently, there is a paucity of data about heron species in certain remote parts of Australia. This chapter draws together distribution data compiled for the atlas and various other surveys or scientific research projects, including the important discoveries of large mixed-species heronries in the Top End of the Northern Territory by Ray Chatto in the 1990s.

Distribution of Australian herons

Nine important heron areas in Australia have been identified (see Figure 4.1), although there are significant differences in the numbers of herons among them. For example, there are considerably fewer herons in the south-west of Western Australia than in the Top End. Furthermore the vast, difficult to

Figure 4.1 Important heron areas in Australia: (1) South-western Australia drainage basin (2) Western Australia/Northern Territory wetlands (3) Darwin/Kakadu floodplain (4) Gulf of Carpentaria tidal wetlands (5) Cooper Creek system ephemeral lakes (6) Paroo River ephemeral wetlands (7) Murray–Darling Basin (8) Bool and Hacks lagoons, South Australia (9) Eastern coastal plain (adapted from Maddock in Kushlan and Hafner 2000).

access, inland is still poorly known, but may be more important to herons than we have previously thought based on recent surveys which show that arid Australia supports a large population of waterbirds.

Non-breeding distribution

There are striking differences in the distributions of different heron species. The White-necked Heron, White-faced Heron, Nankeen Night Heron and the Great Egret, are the most widespread although infrequently recorded in the most arid regions. The Little Egret and Intermediate Egret also occur widely, but are even scarcer in arid regions than the above four and the Intermediate Egret is absent from the entire south-western area of WA. The Cattle Egret is most abundant in the higher rainfall, coastal and sub-coastal pasturelands of the NT and the eastern Australian seaboard. The Eastern Reef Egret and Striated Heron are strictly coastal but widespread, except that the Striated Heron is absent from our most

A pair of Intermediate Egrets at their nest site in a tree canopy. The Intermediate Egret occurs widely, but is scarce in arid regions and absent from south-west WA.

southern shores. The Pied Heron and Great-billed Heron are found on the coastal and sub-coastal zones of north-eastern and northern Australia. In south-east Australia the Little Bittern and Australasian Bittern occur from the coast to the inland as far as the lower Murray–Darling Basin and the Little Bittern also has isolated populations in north-east Queensland and the NT. The Black Bittern by contrast is not found so far south or so far inland, but has a more or less unbroken distribution up the east coast and across the top of the continent. All three bitterns are found in the south-west of WA.

Tasmania has relatively few herons, although nine species have been recorded there: the White-necked Heron, White-faced Heron, Nankeen Night Heron, Cattle Egret, Great Egret, Little Egret, Intermediate Egret, Eastern Reef Egret and the Australasian Bittern; however, the Intermediate Egret, Eastern Reef Egret and Nankeen Night Heron were not sighted for the new atlas.

Breeding distribution

During the breeding season there is a massive contraction in the ranges of colonial heron species as they converge onto the traditional heronries. The largest heronries may accommodate tens of thousands of herons and typically they have several different heron species vying for nest sites. Among these traditional heronries are the large coastal heronries at the Top End of the NT, the smaller heronries on the eastern edge of the Gulf of Carpentaria and, best known, those on coastal eastern Australia from south-east Queensland to just south of Newcastle in New South Wales. In some years, large heronries are established west of the Great Dividing Range on the Murray–Darling River system and, although not well known, intermittent nesting occurs further west on the floodplains of the Cooper Creek and the Paroo, Diamantina and Georgina rivers, which discharge into the interior of the continent. For example, in 2000 in south-west Queensland, a 'huge' heronry was established after the Diamantina River flooded, during which herons were observed feeding on freshwater crabs and yabbies (Julian Reid pers. comm.). There are small colonies in the most southern regions of eastern and western Australia.

As might be expected the solitary nesters have a breeding distribution that corresponds to their general distribution. There is a paucity of observations for some species: the new atlas gives only three breeding locations for the Great-billed Heron and none for the Australasian Bittern!

Long-distance movements

Long-distance movements characterise the life histories of many herons. Such movements require a considerable expenditure of energy and may bring the bird into unfamiliar terrain where it is exposed to considerable risks. These

long journeys are, however, driven by one of two forces: the need to find food when it becomes scarce locally; or the urge to return to traditional nesting sites. Interestingly, a study of the Cattle Egret suggests that the younger members of the population may tend to travel the farthest.

Long-distance movements of bird populations may be categorised as migration or dispersion. Migration is directed seasonal movement between a breeding and non-breeding region, and can involve extraordinary distances. Sometimes only a proportion of the population is forced to move and this is called partial migration. On the other hand, dispersive movements are not tied to a particular season or direction.

Whichever the reason, long-distance travel is an integral part of the life strategy of those Australian heron species whose survival and reproductive success requires them to locate widely separated wetlands across a continent

Marking and tracking herons

The traditional way of collecting data about the movements and survival rates of birds is to apply a metal band around the lower leg of adults or fledglings and then wait for someone to find and return the band. The metal band is very durable and bears an inscription that identifies its owner and a return address. The disadvantage of this method is the birds need to be held in order to read or remove the band, and this limits the rate of retrieval of information. For a number of decades now, in addition to the metal band, coloured plastic leg bands or inscribed wing tags have been used to gather more information. Bands in different colour combinations are visible at a distance and distinguish the banding site, year of banding and may even identify the individual. Plastic tags secured by various methods to the patagial membranes of the wings of herons can be read up to 400 m away through a telescope and have been retained for up to 12 years (Max Maddock pers. comm.). The wing tags do not seem to cause discomfort but one study of the Cattle Egret suggested they were a slight handicap to the bird, which means the data must be used with caution since it might underestimate the birds' natural capacity for long-distance travel and their survival rates. Satellite tracking has been tried with two Cattle Egrets and this method shows great promise for gathering detailed information in the future.

In Australia the Federal Government's Australian Bird and Bat Banding Scheme coordinates the activities of bird banders and collects and documents the recovery records. In the absence of banding data from the scheme, clues to heron movements may come from observing complementary changes in their numbers at different locations. The data submitted for *The New Atlas of Australian Birds* gives circumstantial evidence of possible mass relocations.

This Cattle Egret chick carries a metal leg band on its right tarsus and coloured-plastic leg bands on its left tibia and tarsus.

notorious for its irregular episodes of drought and flood. The study of heron movements has been very uneven with respect to the species and regions targeted. Virtually no marking studies have been undertaken in Northern Australia and those that have been done in the south have targeted the chicks of colonially nesting species (mostly egrets) since these are easy to access and process in large numbers. For more about the methods used for tracking movements of herons see box, 'Marking and tracking herons' on page 27.

Heron banding commenced on a large scale in Australia in the late 1970s with the banding of mostly Cattle Egret chicks at heronries in south-east Queensland and north-east NSW. Project Egret Watch, a 1980s initiative based at the Shortlands Wetland Centre near Newcastle, NSW, extended the banding

Wing tags have been used on Cattle Egrets to track long-distance movements. The coloured plastic tags are attached to the patagial membrane (left) and are inscribed with a visible identification number (right) (Photo by Ray Viljoen).

and wing tagging to other egret species and other NSW heronries, including the Macquarie Marshes west of the Great Dividing Range. As part of the project, members of the public from many parts of NSW were recruited to report sightings of the banded and tagged egrets. Then in the late 1980s, banding of Great Egrets in WA got underway.

The long-distance movements of the Cattle Egret are the best understood of all herons, thanks to the banding and tagging of thousands of fledglings. On leaving the breeding area in autumn, adults and juveniles migrate along the eastern seaboard, and recoveries show that most have flown south. Of all of Australia's birds it appears that only the Cattle Egret migrates south for the winter! The majority spend the winter on the coastal plains of south-east Australia, but some go further to South Australia, Tasmania and New Zealand (see Figure 4.2). The longest distance recorded for a banded Cattle Egret was for one banded at its heronry in Gatton in south-east Queensland and recovered 2500 km away on Stewart Island, off the southern end of New Zealand's South Island. These remarkable flights across the Tasman Sea are apparently aided by prevailing winds and it is likely that the birds first discovered New Zealand by accident when they were blown out to sea from the Australian mainland. The Cattle Egret does not nest in New Zealand and it is probable, but not yet proven, that they return to Australia to nest.

Much less is known about the movements of other herons due to the small number that have been banded and recovered. The following information summarises the recovery records up to mid-2004 from the Federal Department of Environment and Heritage's Australian Bird and Bat Banding Scheme.

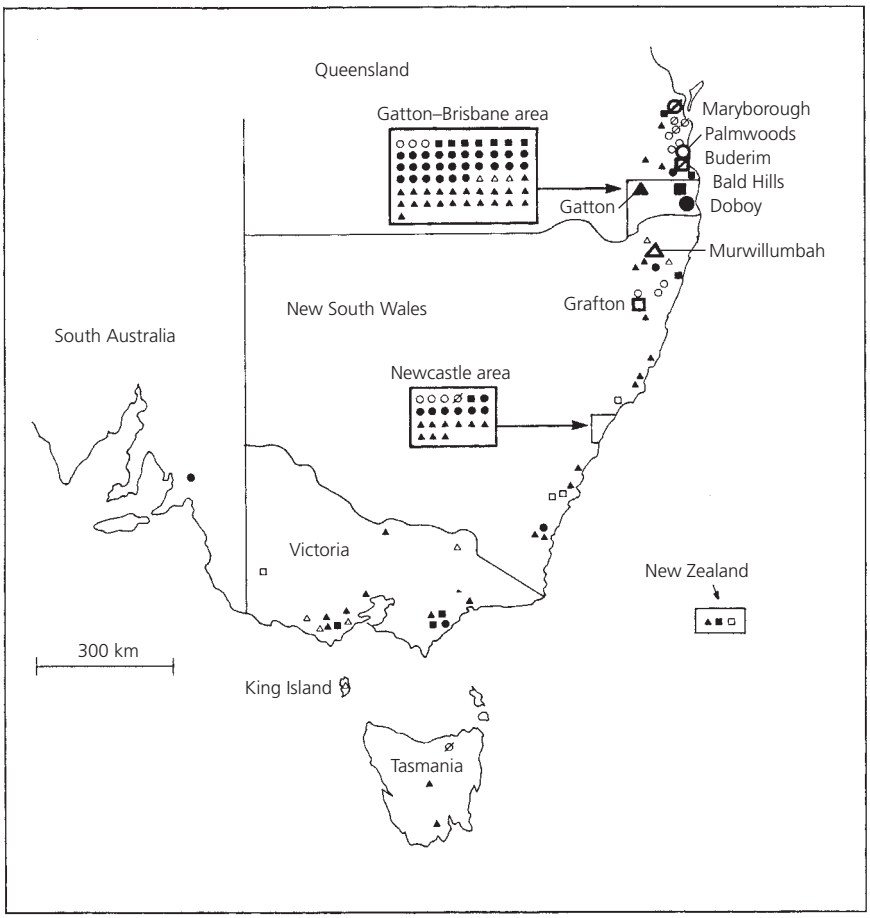


Figure 4.2 Recovery locations of Cattle Egrets marked as fledglings between 1979 and 1985. Each of the different types of large symbols represent a banding heronry (there are eight) and the corresponding small ones represent the recovery of a bird banded at that particular heronry. For example, the Grafton heronry is represented by the large white square and birds from that heronry that are recovered elsewhere are represented by a small white square, such as the one marked in New Zealand. Noticeably, the egrets are recovered south of their respective heronries, illustrating their southerly migration pattern. Recoveries at banding heronries are not shown. (From McKilligan et al. 1993.)

In south-west WA, the Great Egret disperses in a variety of directions after fledging. The longest recovery distance is only 280 km from the natal heronry, perhaps because the surrounding deserts inhibit more distant travel. In eastern Australia, the Great Egret, Intermediate Egret and Little Egret similarly show dispersive rather than migratory movements. It appears that many of them remain in Australia but members of each species have turned up in Papua New Guinea and Irian Jaya, over 3000 km from their natal heronry. The Little Egret has also been recovered in New Zealand.

Some band-recovery data are also available for the Nankeen Night Heron, White-faced Heron, Eastern Reef Egret, White-necked Heron and Pied Heron (1 record only!). The Nankeen Night Herons were mostly recovered close to their place of banding. One however was recovered 2992 km distant in Papua New Guinea. Nankeen Night Herons banded on Raine Island, in the Coral Sea near the tip of Cape York Peninsula, were recovered in Papua New Guinea, a relatively short crossing across the Torres Strait.

White-faced Herons and White-necked Herons have all been recovered within 300 km of the banding place, suggesting somewhat sedentary populations. In northern Australia, White-necked Heron and Pied Heron numbers increase markedly at coastal locations, such as Darwin, during the dry season and some Pied Herons continue north and are found in large numbers in Papua New Guinea and Indonesia during the dry winter period. These movements are quite regular and are driven by the seasonal drying out of inland wetlands.

There is circumstantial evidence of some large-scale movement patterns of heron species in eastern Australia. Analysis of seasonal data from *The New Atlas of Australian Birds* indicates gross regional differences in sighting frequencies. These suggest that the White-faced Heron, Little Egret, Intermediate Egret, Great Egret, White-necked Heron and Nankeen Night Heron undertake long-distance migrations north up through the inland and along the coast to spend the cooler months in tropical northern Australia. Many then vacate the north during the wet season.

Some overseas populations of the Little Bittern are described as migratory and this may also be the case for the Little Bittern in Australia. On the other hand, our Black Bittern and Australasian Bittern are probably sedentary. Nevertheless bittern numbers at a locality can fluctuate greatly and this is probably due to them suddenly leaving drying swamps or arriving en masse at a wetland to capitalise on a flooding event. These type of fluctuations are described as 'irruptive' movements.

We would expect the Striated Heron, Eastern Reef Egret and Great-billed Heron to be more sedentary than some of the freshwater herons because they probably have a more constant food supply. The longest recovery distance of an Eastern Reef Egret was 540 km from the banding location. A Top End survey of Eastern Reef Egrets suggested small scale local movements to feed on the seasonal hatching of young Flatback Turtles, *Natator depressus*. Pairs of Great-billed Herons are said to defend their nesting territories all year round.

Longevity and life expectancy

Longevity cannot be reliably measured from the few recoveries available for most herons in Australia. For example, of the 80 recoveries of Great Egrets in Australia the oldest was 7 years 1 month, yet this species is known to attain 22 years in the USA. We are on more certain ground with the Cattle Egret, where the oldest recovered in Australia was a dead individual aged 13 years 11 months, about the same as the oldest record for this species in South Africa. The oldest Nankeen Night Heron was 10 years 8 months and Eastern Reef Egret 14 years 11 months, both of which were found dead at their banding place.

Of course maximum longevity bears only a general relationship to average life expectancy. After banding, the mortality rate of Cattle Egret's in their first year is 40.6% and the mean life expectancy of the juvenile is only 2.6 years. The life expectancy is actually higher (3.1 years) among one-year-old birds. Although this seems strange at first, as one would expect life expectancy to progressively reduce with age, it is a general phenomenon among birds and mammals and is explained by the greater hazards that face the newly independent bird. Compared to the more experienced older birds the juvenile is more at risk of succumbing to many life-threatening factors. Cattle Egret survival values in eastern Australia are very comparable with those for the species in South Africa. While the 40.6% first-year mortality rate among juvenile Cattle Egrets may seem high it is in fact quite low compared with the 76% mortality of ringed first-year Great Egrets in America and the 79% and 54% recorded for the Little Egret before and after World War II respectively, in the Camargue in the south-west corner of France. The survival of this Little Egret population, which would have been unable to maintain itself with a 79% loss of first-year birds, was, in the short term, only achieved by the arrival of immigrant birds.

5
Feeding and food

Herons feed in the sub-littoral and littoral zones of marine and freshwater habitats, where the water is shallow and suitable for wading, or where they can clamber through or over aquatic plants. This includes coral reefs at low tide, mangrove-lined estuaries, exposed mudflats, and marshes and lakes. Within these habitats herons exploit the resources of open water-bodies: shallows with sparse floating and emergent vegetation; the thick vegetation of marshes; and rafts of floating plants where these provide a sufficiently strong platform to support the foraging bird's weight. A smaller number of species choose to feed in wet and dry pastures and the Cattle Egret in particular has learned to find food in freshly ploughed paddocks, young crops under irrigation and lawns. The high mobility of herons allows them to access food resources over a wide area.

Each of the heron species has a unique combination of physical and behavioural adaptations that enable them to efficiently exploit different subsets of the available food resource, not withstanding some overlap in the prey taken. Typically they wade in water only up to the edge of the feathering on their tibia and obviously the longer-legged species can wade into deeper water than can the smaller species. The day herons cannot penetrate dense reed beds, but the bitterns, with their short, strong legs and long toes and claws, can easily clamber through the reeds in search of prey.

For some heron species the water depths they forage in increases with greater leg length. Table 5.1 supports this, showing that, for a number of species, the mean tarsus length correlates with the average water depth in which a bird prefers to spend its time foraging. This association doesn't apply to all of them. For example, it is not evident for the Intermediate Egret and White-faced Heron, medium to large herons that prefer to feed in the shallows. These data for the short-legged Striated Heron indicates a preference for deeper water (>50 mm) but I have often seen it foraging on mudbanks exposed at low tide.

Table 5.1 Per cent of time spent foraging at different depths of water

	WATER DEPTHS (MM)	TIME SPENT (%)
Great Egret	100–149	0.8
Mean tarsus = 152 mm	150–199	72.8
	200–250	26.4
White-necked Heron	0–1	14.3
Mean tarsus = 133 mm	1.1–49	17.1
	50–99	56.1
	100–149	11.4
Intermediate Egret	0–1	32.3
Mean tarsus = 96 mm	1.1–49	39.9
	50–99	25.8
	100–149	1.9
Little Egret	1.1–49	24.9
Mean tarsus = 99 mm	50–99	68.9
	100–149	4.4
	150–199	1.6
White-faced Heron	0–1	9.9
Mean tarsus = 97 mm	1.1–49	56.2
	50–99	19.9
	100–149	14.1
Striated Heron	0–1	3.6
Mean tarsus = 53 mm	1.1–49	8.3
	50–99	54.7
	100–149	33.5

Source: Recher et al. 1983

Feeding times and territory

Day herons feed alone or in small flocks and are typically diurnal in their feeding. The Eastern Reef Egret's foraging is tide dependent as it mainly exploits the resources of marine shallows that are inaccessible to it at high tide. If there is sufficient moonlight they will feed at night. While waiting for the tide to ebb most bide their time roosting on trees along the shore but a few scavenge under the nests of other birds. The Striated Heron accesses tidal pools and

mudflats at low tide, night or day. The Nankeen Night Heron and bitterns are active under lower light intensities, at dusk and dawn, and also during the night if there is enough light for them to see the prey.

Individuals of some species defend a feeding territory. The Great Egret uses a display called 'supplanting flight' to chase off a competitor. I have seen one flying in pursuit of an intruder over several hundred metres, during which the pursuer occasionally threatened its adversary by extending its neck towards it and giving a guttural croak. Individual Eastern Reef Egrets defend feeding territories when breeding, and paired White-faced Herons defend well-spaced feeding territories throughout the year.

Foraging behaviour

Although each heron species tends to have its characteristic feeding method they can vary this considerably depending on their circumstances. Table 5.2 summarises the known behaviours used by Australian herons. The Eastern Reef Egret has been relatively well studied and uses 18 of the 22 feeding behaviours listed. Many of the blank spaces in the table are due to a lack of knowledge of the species: for example, only one behaviour, 'Stand and wait', is shown for the Great-billed Heron but it logically has a larger repertoire than this.

Feeding is mostly characterised by three locomotory states: 'Stand and wait', 'Walk slowly' or 'Walk quickly'. Therefore the heron is usually on its feet when feeding and not flying or swimming. There are also other less commonly used methods: the Pied Heron has been seen feeding while hovering; Striated Herons sometimes dive off low perches to catch fish; and the Great Egret is known to alight on deep water in order to catch its prey.

The standing heron may assume a fully erect or crouched posture. Its specialised neck anatomy allows it to very rapidly stab with its bill to seize the prey between its mandibles or, less often, spear it. Small prey animals are swallowed live. Large items are killed or stunned before being swallowed whole.

'Stand and wait' is a passive feeding strategy that is used for making a surprise attack on an aquatic animal as it unsuspectingly comes within reach. It is the most widespread feeding tactic among Australian herons. The Great Egret spends much of its time using 'Stand and wait' but also uses 'Walk slowly'. In the southern rice fields of New South Wales, the egret is at first able to walk and forage among the newly planted rice fields, but as the rice crop grows taller and denser and presumably harder to walk through, it spends more time in standing and waiting than in more active feeding. The much smaller Striated Heron is also a 'Stand (or crouch) and wait' and 'Walk slowly' feeder.

'Walk slowly' is commonly used by the Intermediate Egret. The slow pace allows for methodical searching for cryptic prey in floating plants, in the emer-

gent vegetation of marshes and at the edges of lagoons. The bird may be selecting prey that rely more on camouflage than a speedy exit for their survival. The Intermediate Egret (and others) will occasionally stop and peer closely at the foliage moving its head slowly from side to side. This behaviour is called 'Head swaying' and its purpose may be to enhance the bird's stereoscopic vision and thereby improve its estimation of prey distance and the accuracy of its strike. An alternative action is swaying the neck laterally with the head kept still. This could potentially distract the prey from the bird's bill.

Pied herons use 'Walk quickly' on land and in water, making rapid pecks at low vegetation as they move in order to glean small prey items.

	Australasian Bittern	*Black Bittern*	*Little Bittern*	*Nankeen Night Heron*	*Striated Heron*	*Eastern Reef Egret*	*Intermediate Egret*	*Little Egret*	*Great Egret*	*Cattle Egret*	*Pied Heron*	*White-faced Heron*	*White-necked Heron*	*Great-billed Heron*
Stand and wait	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Crouch and wait		✓	✓	✓	✓	✓		✓	✓		✓			
Gleaning						✓				✓	✓	✓	✓	
Walk slowly	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Scan					✓	✓		✓	✓		✓	✓		
Walk quickly					✓	✓		✓	✓	✓	✓	✓	✓	
Running						✓		✓				✓		
Hopping						✓								
Leapfrog feeding						✓	✓	✓		✓				
Peering			✓				✓		✓		✓	✓	✓	
Foot stirring						✓	✓	✓			✓	✓		
Foot raking												✓	✓	
Foot paddling						✓						✓		
Hovering								✓			✓			
Dipping											✓			
Foot dragging						✓								
Plunging					✓			✓						
Diving					✓	✓								
Rob nests				✓	✓									
Piracy						✓			✓		✓			
Feed at night	✓	✓	✓	✓	✓	✓								✓
Feed during day		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wing flicking						✓		✓						
Canopy feeding						✓		✓						

Source: Mostly from Recher et al. 1983, with additional information from Moon 1988, Marchant and Higgins 1990 and the author.

Table 5.2 Comparative foraging behaviour of Australian herons

The Little Egret uses all three feeding methods mentioned already but its 'Stand and wait' behaviour may be designed to scan for distant prey rather than to ambush them. In pursuit, it runs, dashing hither and thither through the shallows, flapping its wings to maintain its balance. During 'Walk slowly' the Little Egret and some other Australian herons periodically stir the bottom mud with a foot to flush prey. The Old World subspecies of the Little Egret has bright-yellow toes that upon suddenly appearing in the turbid pond water may scare prey out of their hiding places.

The glare of light reflected off the water's surface could be a problem for some herons. The Little Egret and Eastern Reef Egret occasionally use 'Canopy feeding', also known as 'Double-wing feeding', where the bird partially unfolds both wings and raises them level with its lowered head to make a canopy that casts a small blanket of shade over the water. The shade produced by canopy feeding may also serve to attract fish to within seizing distance. Other herons use different strategies, for example the White-faced Heron is said to forage away from the sun to avoid glare.

Symbiosis

Herons feeding in marsh and grassland habitats may closely follow larger animals of a different species, using them as 'beaters' to scare the prey out of its hiding place. This symbiosis is best understood for the Cattle Egret. It keeps close to its host cow and snaps up small animals disturbed in the grass. Cattle Egrets following cattle have been shown to have a higher feeding success than egrets feeding independently nearby. Relative status will influence where the

Cattle Ticks form part of the diet of the Cattle Egret with the bird feeding directly off the host animal. Small animals disturbed out of the grass by the cow are, however, the main attractions here.

birds position themselves: an alpha Cattle Egret feeds near the head of the cow and generally has more success than a lower ranking one taking up the rear.

The feeding relationship between the egret and its host may be mutualistic because the bird will feed on Cattle Ticks (*Boophilus microplus*) found on the host animal, thereby removing these disease-carrying parasites.

The Little Egret feeds with cormorants, *Phalacrocorax* spp., catching fish driven into the shallows by them, and also associates with feeding spoonbills and Australian White Ibises. The White-faced Heron also follows White Ibises and although no feeding benefit to the heron has been demonstrated, such a benefit is strongly implied by its aggressiveness towards others that get too close. The Great Egret and White-faced Heron have also been recorded feeding with Royal Spoonbills.

Kleptoparasitism

Given the opportunity, herons will steal food from another bird. Eastern Reef Egrets attack Noddy Terns, *Anous stolidus*, at their nest sites, causing them to regurgitate food. They also pursue other Reef Egrets and the Silver Gull, *Larus novaehollandiae*, for their food. A case of pirates preying on pirates!

Learning

Learning may play a large part in the acquisition of effective foraging behaviours. In Europe the Little Egret has been observed feeding in flocks in the early morning in order to exploit dense aggregations of mosquito fish, but feeding solitarily later in the day when the fish were dispersed and less visible in weedy waters. Different individuals in a population may show a learned preference for different feeding habitats. Among a population of Grey Herons, *Ardea cinerea*, in Europe, some fed only in an estuary, others only in streams and birds in a third group switched between those two habitats. A striking example of heron learning, albeit in an unnatural situation, is the Striated Heron at the Miami Seaquarium that improved its fishing success by dropping pellets of bread into the water to attract fish. Of the Australian herons, the Australasian Bittern is said to bait fish using small pieces of grass, presumably a learned behaviour. Overseas studies suggest that young herons learn by experience to avoid unpleasant-tasting prey.

Food

The food of herons has been sampled by analyses of their stomach contents, from their regurgitates and by observation of the feeding bird. When alarmed by an intruder, older chicks conveniently regurgitate pellets that mostly comprise undigested prey items. The concentration of food studies on regurgitates has

resulted in us having a much better knowledge of the food of the advanced heron chick in summer, than that of other life stages or seasons.

Regurgitates literally rain down from chicks in their tree-top nests, landing on researchers and for several metres distant. This raises two questions: (1) Why do chicks that are not immediately threatened waste so much food? and (2) Why is it mostly undigested items in the pellets? (Given the heron's ability to digest its food completely within a few hours). Regarding the first, these chicks are big enough to flee the nest and their regurgitates may distract a predator long enough to allow them to escape. But it seems an exaggerated response to a remote threat nevertheless. Alternatively, but improbably, jettisoning food may make them lighter and more mobile!! We know the answer to the second from the dissection of adult Cattle Egrets newly returned from their feeding grounds. This revealed most of the food packed into their oesophagus where it had not been exposed to digestive juices; hence it was undigested (and easy to identify). The smaller portion of the food was in the stomach and showed advanced digestion.

Do herons eat anything that moves?

Herons eat a wide variety of small animals – invertebrate and vertebrate. Plant material has been recorded in the food of the Nankeen Night Heron, Australasian Bittern, Cattle Egret and Intermediate Egret. Studies have found the seeds of Awnless Barnyard Grass, *Echinochloa colonum*, in the stomachs of the adult Nankeen Night Heron, and melaleuca leaves and grass blades comprised up to 3% by weight of boluses collected directly from advanced egret chicks at a NSW heronry. The chicks may have accidentally ingested these plants when they scavenged for food on the ground below their nests.

It is likely that most or all of the Australian herons are very opportunistic feeders. Thus a 'fishing' heron will most probably ingest a variety of aquatic invertebrates in addition to fish and indeed will take virtually any small animal that comes within reach. The diet of the 'habitat generalist', the White-faced Heron, has been recorded for a population whose members fed on intertidal mudflats, salt marsh, freshwater marsh, cultivated pastures, drainage depressions, residential lawns and intertidal rocky shores. Stomach contents of White-faced Herons feeding in intertidal habitats mostly contained shrimps and crabs with a smaller number of fish whereas the stomachs of those feeding in pastures contained insects, shield shrimps (presumably Order Notostraca from brackish water or freshwater), worms and snails. By contrast the Great-billed Heron, more of a habitat specialist, has only been recorded eating fish, but further study would almost certainly show that it also eats other vertebrates and intertidal invertebrates.

In addition to the wide taxonomic diversity among prey there is a huge range in prey sizes. The Cattle Egret takes prey weighing from less than 0.1 g (flies and spiders) up to 50 g (skinks). The prey need not be moving to be recognised as food. The White-necked Heron, for example, eats mussels.

Generally, the larger the heron the larger the average prey size, but there are some exceptions. The Little Egret, for example, a medium-sized heron, is described in Europe as specialising on very small prey, which it can collect in large numbers due to its swift movements and long slender bill.

More data are needed for many species. Comparisons of the prey taken by a heron species at different locations sometimes reveals significant regional differences but this seems more likely to reflect the uniquely different composition of each region's prey biota than a difference in the birds' food preferences.

Prey to avoid

Despite their catholic tastes herons do have to be somewhat selective in what they eat. Prey must be within a certain size range, give the best nutritional return for the effort of catching them and not be noxious. The Great Egret in the Northern Territory is said to favour fish less than 12 cm long, which they can swallow easily and quickly before it is stolen by a raptor. Catfish, *Neosilurus* spp., usually present a problem for them due to their large dorsal spine.

I have, however, seen a Great Egret swallow a 20 cm long Freshwater Catfish, *Tandanus tandanus*. It may be significant that there was no 'pirate' in sight. This particular bird had been using a 'Stand and wait' hunting strategy in a shallow (about 15 cm deep) freshwater pool. When first seen it was holding its head high and its neck straight, but progressively it lowered its head, kinking its neck, but occasionally lifting its head slightly before lowering it even further, and all the while staring into the weedy water. It then struck and lifted out the large catfish festooned in weed. The bird carried its prize to a dry area of a creek bed and repeatedly lowered it onto the mud and picked it up again. The weed fell off and each time it repositioned its bill behind the head until, after about five minutes, it swallowed it head first. I wasn't able to observe the position of the catfish's spine.

Certain noxious prey seemed to be avoided. Analyses of Cattle Egret chick regurgitates, for example, contained no millipedes and very few centipedes although both were present in the egret's feeding pastures in south-east Queensland. Given this, it is somewhat surprising that small Cane Toads, *Bufo marinus*, were common in these chicks' regurgitates despite the juvenile toads having poison glands.

What do herons eat in winter?

A heron's diet may be different in winter compared with summer. Cattle Egrets in South Africa and New Zealand eat many earthworms in winter but these are a minor food for the birds during the summer, at least in South Africa. This seasonal difference could be due to a shortage of insects when the weather is cold and the wet conditions in winter making earthworms more available than in other seasons. Perhaps this is why the Cattle Egret migrates south in winter when all other birds are flying north!

Is there competition for food between species?

A comparison of the taxa eaten by heron species nesting together reveals considerable overlap. Studies of the food of Cattle Egrets and Intermediate Egrets from heronries in NSW showed about an 80% correspondence in the classes and orders of prey taken. This does not, however, imply a dietary equivalence since the former ate mostly grasshoppers, locusts and crickets and the latter depended most heavily on fish (see Table 5.3). At the same heronries, the prey of the Cattle Egret, Intermediate Egret and Great Egret was found to be sufficiently different to preclude inter-species competition for food and this may have been the result of the different feeding habitats favoured by these species. When food is scarce the heron will probably eat animals it might normally ignore. Consequently an unweighted list of prey items will give the impression that the species is more of a generalist in its feeding than is actually the case. What a heron eats, where and when, and how it captures its prey are all-important dimensions of a species' feeding niche (see box, 'The niche concept', on page 42).

Table 5.3 A comparison of the diets of the Cattle and Intermediate Egrets at the same heronry. Adapted from Baxter and Fairweather 1989

	Cattle Egret	Intermediate Egret
Prey category	**% weight**	**% weight**
Mammals	0.7	<0.1
Birds	0.1	<0.1
Frogs	3	2.6
Lizards	9.7	8.2
Fish	9.3	**58**
Orthopteran Insects	**66.2**	22.4
Other insects	5.4	2.9
Shrimps	0	<0.1
Spiders	3.3	2.3
Vegetable	2.3	1.9

The niche concept

Similar species may depend on the same resources. This raises the question – How can similar species co-exist? Surely superior competition by one would eliminate the other. The niche concept may explain this apparent paradox. Alternatively, their resources may not be limiting so there is little competition.

Niche can refer to a subdivision of habitat or the role of a species in a community (or both). The differences in the physical and behavioural attributes of heron species, although seemingly small, may mean that each has its own unique feeding niche. The combination of a heron hunting in a particular way, in a particular habitat at a preferred time of day and accessing a particular subset of potential prey, defines its feeding niche. The species' suite of niche adaptations is the product of evolutionary processes over a long period of time. The result of this specialisation is probably reduced inter-species competition and achieving the most favourable 'rate of return' for the time and energy invested in feeding.

The disadvantage of specialisation is that the species may not be able to quickly adapt to natural or man-made changes to its habitat, placing it more at risk of extinction than a species that is more of a generalist in its use of resources. Contrasting examples are the White-faced Heron, one of our most widespread and numerous herons, which has been described as a 'habitat generalist'; and the Great-billed Heron, one of our rarest herons, which has a very circumscribed habitat. Figure 5.2 illustrates partitioning of pasture and freshwater foraging locations among egret species, some of whom prefer wetter and others drier locations.

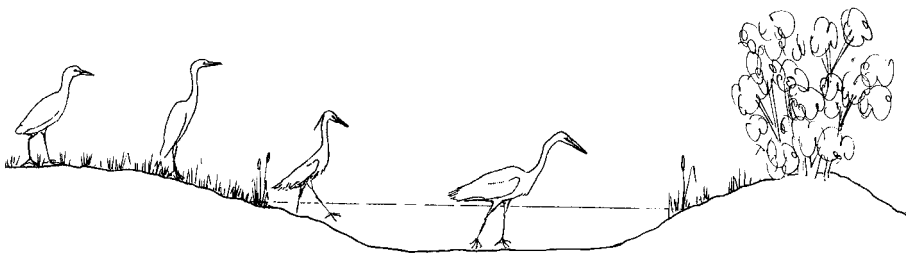


Figure 5.1 Different heron species prefer different feeding situations, from dry habitats to wet habitats of increasing water depth. From left to right: the Cattle Egret and Intermediate Egret prefer drier locations; the Little Egret shallow water and the Great Egret deeper water. (Drawing by C. Stephens.)

6
Breeding

In Australia, herons nest at all latitudes: from temperate Tasmania (possibly only the White-faced Heron nowadays) to the tropical north and across the continent from west to east, including even the most arid regions where they exploit ephemeral floodwaters. Some heron species are dependent on marine and estuarine resources and have a coastal breeding distribution; others exploit freshwater habitats and for them rainfall is the key factor that influences the timing, location and magnitude of their breeding. In the south of the continent most rain falls in winter whereas in the north it is monsoonal and falls from summer to autumn. The climatic regions along the central part of the eastern seaboard have a more even distribution of rain over the year but somewhat wetter summers. Inland areas, such as the Channel Country of south-west Queensland, depend largely on summer and autumn monsoonal rainfall in their headwaters to create the flood conditions attractive to waterbirds, but benefit from occasional local falls too.

In the tropical north herons typically nest from about mid-summer (January) through to autumn or early winter. The exception is the Eastern Reef Egret, which apparently responds to different environmental cues as it nests from late winter (August) to December.

In coastal and sub-coastal areas of southern Australia heron nesting occurs fairly reliably during the warmer, wetter months of the year (October to

March approximately). The White-faced Heron differs in that it may start nesting as early as July, with its young fledging by September. The Eastern Reef Egret that inhabits the southern part of the Great Barrier Reef has a more extended season than its conspecifics in the north, nesting from late winter to late autumn.

Some herons nest at sites scattered across inland Australia. In these environments the timing of breeding varies with seasonal conditions. Birds may breed at any time if suitable conditions arise, but most often this occurs after summer–autumn floods, in the years when such floods eventuate. Heavy local rainfall or heavy falls possibly hundreds of kilometres upstream fill the creeks and ephemeral wetlands, producing abundant food and nesting opportunities for herons and other waterbirds. Conditions conducive to breeding generally persist for only a few months after floods peak, but on rare occasions it will be many months or even several years until the waters dry out. These conditions can support colonies of thousands of birds, but many years may elapse between nesting events.

A pair of Cattle Egrets at their nest site. The male is returning with a stick for the nest.

Herons are almost without exception socially monogamous, with both parents undertaking the task of rearing the young. A known exception is the Eurasian Bittern, *Botaurus stellaris*, where the male can have several females nesting in his territory. He does not assist in incubation or in chick rearing. It is not known if the Australasian Bittern shares this behaviour.

Breeding herons communicate using calls and a variety of visual displays. In a crowded colony the heron must be able to instantly identify the source and meaning of a display. The posture of the body contributes to the signal and the nuptial plumes play a crucial role. The more showy the plumes, the more attention-getting the signal. To a considerable extent different heron species make use of the same displays, that is they 'talk the same language'. Displays convey the animal's mood or behavioural inclination and tend to be ritualised and stylised to make their meaning quite clear. Progression towards overt expression of a behaviour, such as attacking or copulating, depends on the exhibitor's mood and the recipient's response.

Studies of the displays of the Great Egret, Little Egret, Intermediate Egret, Cattle Egret and the Striated Heron have been conducted in the USA, Europe and South Africa. In Australia the breeding behaviour of the Intermediate Egret, Cattle Egret and the White-faced Heron have been documented to some extent; information on other species is sparse.

Agonistic displays

Agonistic displays are behaviours showing submission and aggression. A submissive or apprehensive heron, perhaps one that is uncomfortably close to another's nest territory, signals its fear with an 'alert' posture. It stands erect, to give it a good view of its surroundings, but makes itself look less threatening by having its feathers sleeked close to its body and its bill angled down slightly. At the same time it gives a slowly repeated, soft 'kok' sound, accompanied by a visible expansion and contraction of the upper throat (gular region).

An aggressive bird might communicate its tendency to attack by similarly assuming an upright stance in which it stands tall but at the same time it erects its plumes and directs its bill towards the antagonist. For animals generally the erection of feathers (or hair) in such an encounter works for the aggressor by making it look larger and therefore more intimidating. The common full-intensity threat display of herons is called the 'Full forward' display. In the Little Egret, the body is held near the horizontal, the legs bent, wings partly unfolded, neck flexed into an 'S' shape and bill pointed forwards ready to strike. All its feathers are held erect. In the Cattle Egret this noticeably includes the short feathers of the jowl (see Figure 6.1).

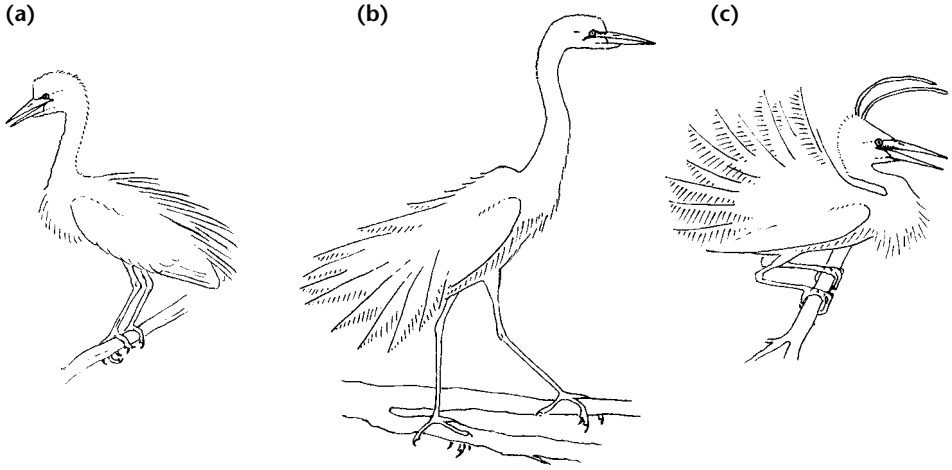


Figure 6.1 The 'Full forward' threat display in three heron species: (a) Cattle Egret (b) Great Egret (c) Little Egret. Redrawn from Voisin 1991 by C. Stephens.

The message can be varied in subtle ways. For example the degree to which the feathers are raised signals the strength of the tendency. In the mildest of responses, for example, to another egret flying past, a Cattle Egret may simply raise its crown feathers slightly. If the interaction becomes more aggressive, a 'Forward' display may escalate into 'Stab and counter-stab', but this is still a display as there is no actual contact.

A posture that may sometimes be a courtship display but is more often interpreted as a camouflage strategy is the 'Bittern stance'. If the bird is alarmed but unable to sneak off it holds its body and neck vertically with the beak pointed skywards. The feathers are sleeked and the eyes bulge, possibly giving it 360 degree vision. With its brown, streaky plumage the bird blends into the surrounding foliage. This stance is assumed by bittern chicks and adults and also by the Striated Heron.

Courtship, mate selection and greeting displays

While herons have a limited number of submissive and aggressive displays, they have a diverse repertoire of breeding displays to help them obtain and keep a mate and nest successfully. Some of these breeding displays show a strong similarity to a routine action or antagonistic display and may have evolved from these.

Having asserted his right to exclusive occupancy of a small territory in the nesting tree the male heron has to continue to defend it and at the same time make it attractive to an acceptable female. At times his aggressive tendency appears to dominate and he chases off males and females alike. In order to

attract a female the male egret gives a 'Stretch display' (see Figure 6.2). A crouched posture is adopted, similar to the agonistic 'Full forward' display described above, but only the back plumes are erected and the head and neck are stretched vertically upwards a number of times, while the bird stabs its bill into the air. This is sometimes accompanied by soft calls.

Various forms of courtship flight are commonly used for self-advertisement, including 'Circle', 'Neck extended' and 'Flap flight'. In 'Flap flight' the male Great Egret will fly out a short distance from its nest territory while making a loud thudding noise with its wings. A very common advertising display in the Cattle Egret is 'Wing touch' where it runs its mandibles down the front edge of the wing in a pretense of preening. It may also make a show of vigorously mandibulating a stick in 'Twig shake', as if it were collecting nest material. Other displays made by the males of one or more heron species are 'Snap' (clacking together of the mandibles), 'Wing spread' and 'Head flick'. Table 6.1 lists the known types of breeding displays for six heron species. Despite the list being very incomplete due to the lack of detailed studies of some of these species, there are many shared displays.

In the heronry the female egrets are free to move from one male to another to assess their quality, but the male has to remain at his nest territory and wait to be 'wooed' so the choice of mate may mostly lie with the female. The Great Egret male is said to choose a female by selective rejection, whereas the female chooses the most aggressive, vigorous male. During courtship among Cattle Egrets, the male Cattle Egret goes through his repertoire of displays while the

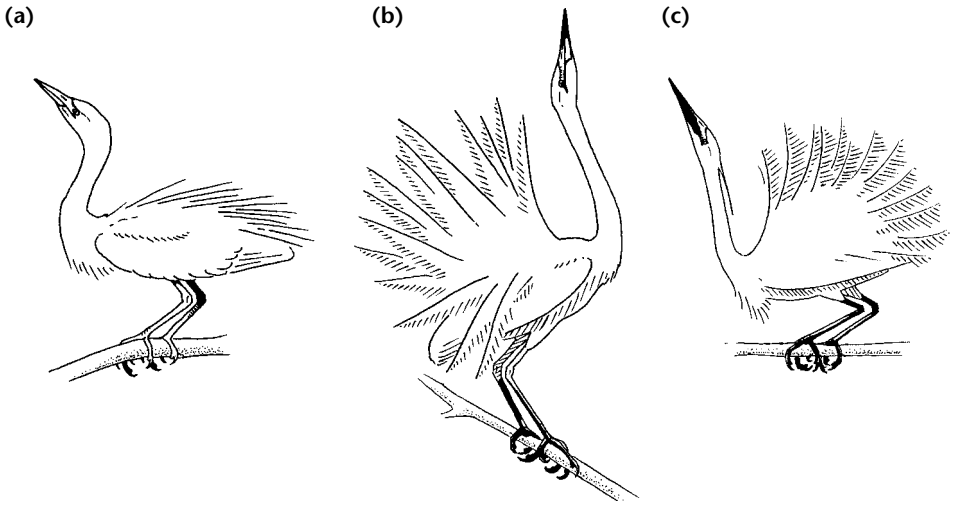


Figure 6.2 The 'Stretch' courtship display of three heron species: (a) Cattle Egret (b) Great Egret (c) Little Egret. Redrawn from Voisin 1991 by C. Stephens.

female perches a few metres away and peers at him with her neck extended and crest feathers partly erected. She flies onto his back and may be repelled initially but may persist and be accepted by him.

Another set of displays are used by mated pairs and seem to be 'designed' to allow mates to get close to one another without causing alarm and to maintain a strong pair-bond. The 'Greeting display' is given whenever one heron approaches its mate at the nest either to deliver a stick or take over the incubation of eggs. It differs somewhat among herons but in the Cattle Egret this display typically involves a slow approach, the partial erection of its crown, neck and back feathers and a soft, repeated one- or two-syllable call. The Intermediate Egret's 'Greeting display' is particularly exotic, with the fanning of its elaborate back plumes. Meanwhile the sitting bird looks towards its mate, arches its neck strongly in an S-shape and stands. It may then give a 'Bob (Curtsy) display'. This is a rapid lowering and raising of the body with the back horizontal. The head may be directed upwards as if in a partial 'Stretch display'. The bird may bob several times in quick succession and the mate may bob in unison. Following this exchange of greetings the sitting bird usually makes way for its mate. If, as sometimes can happen, the sitting bird shows no interest in vacating the nest, the relieving bird may walk onto the nest and push at its mate to force the issue.

	Striated Heron	*Cattle Egret*	*Little Egret*	*Great Egret*	*Intermediate Egret*	*White-faced Heron*
Courtship						
Stretch display	yes	yes	yes	yes	yes	
Twig shake	yes	yes	yes	yes	yes	yes
Snap	yes	yes		yes	yes	
Flap flight	yes	yes	yes	yes	yes	
Courtship flight*	yes	yes	yes	yes	yes	yes
Wing spread		yes				
Wing preen or touch	yes	yes	yes		yes	yes
Head flick		yes	yes		yes	
Pair-bonding						
Greeting display		yes	yes	yes	yes	
Bob display		yes			yes	
Back biting		yes	yes	yes	yes	yes
Bill clappering			yes		yes	yes

Note: * The type of courtship flight was not specified.

Table 6.1 Courtship and pair-bonding displays. Collated from Meyeriecks 1960; Blake 1969a, 1969b; Voisin 1991; Maddock 1991 and author's observations.

Characteristic of the mated pair in some species is 'Bill clappering', involving rapid, small- amplitude movements of the mandibles that may not be audible. 'Billing' is where they gently touch or grasp the ends of the other's mandible. The relieving bird quite often probes its bill rapidly downwards into its mate's back feathers in what is call a 'Back biting' display. Another form of 'Back biting' is grasping its mate's head or neck between its mandibles. Most frequently, 'Back biting' is performed by one bird on its mate, but both may do it.

Study of the more cryptic heron species is difficult as they are concealed from the view of the observer by thick reeds and also from one another. They may depend more on vocal than visual displays. Advertising flights have been described for the Little Bittern in Europe and the Australasian Bittern shows a similar behaviour. The bittern may have to take to the air to demonstrate its qualities to a potential mate.

Voice

Herons do not sing and there is nothing melodious about their calls, which include guttural honks, harsh sounds, croaks, coos and growls. A sonogram may be used to represent bird calls, but in the case of herons, phonetic representation is more usual. This presents a major problem because different observers render the same calls differently. Some consistent renderings of common calls include the low 'kok' given by an apprehensive adult and a harsh croak signaling aggression. Softer croaks are given between mates, which for the White-faced Heron are rendered as 'grok-grok-grok'.

Males of some heron species that nest solitarily advertise themselves with loud, distinctive calls. The Great-billed Heron's call has been described as a throaty roar, the Striated Heron's a 'skeouw' and the Australasian Bittern emits a deep booming sound that carries for 800–1000 m. Colonially nesting herons tend not to rely on calls to advertise themselves so much as on visual displays, although the male Little Egret is said to signal his presence and interest in mating by emitting a long gargling call. When begging, the young chicks of several egret species give a characteristic sharp 'chi-chi' which as they grow older becomes a deeper, 'ke-ke'.

Variation in displays and calls

The accurate description of displays and calls is made more difficult by the fact that they change as time passes. Thus the 'Greeting display' between long-established pairs of Little Egrets becomes subdued as nesting progresses and the female Cattle Egret's greeting call becomes a higher pitched 'kri-kri-kri' as the season passes. Likewise one cannot rely too much on descriptions from overseas studies of the species, especially when these are of different

subspecies. For example, the African Cattle Egret is said to never raise its crown feathers during the 'Greeting display' whereas the Indian Cattle Egret, the subspecies in Australia, most certainly does. The greeting call is described as 'rick-rack' for the former but is better rendered by a single syllable 'kru' or 'krok' in the latter. The 'Stretch display' is apparently quite inconspicuous in the African Cattle Egret, but is very pronounced when performed by the subspecies in Australia.

Copulation and promiscuity

Copulation takes place at or close to the nest. For Cattle Egrets there are no obvious preliminaries. The female simply crouches as the male approaches and mounts her. He grasps the leading edge of her partly extended wing, treads her back and nibbles her neck feathers, while she inclines her head upwards (see photo below). She moves her tail sideways allowing cloacal contact to be made. He may extend and flap his wings to help him maintain his balance for the 10 seconds or so that the copulation lasts. There are some variations to this pattern among other herons, judged by overseas studies. For example, the Striated Heron and Great Egret are said to sometimes perform preliminary feather-nibbling before mounting.

Promiscuity is widespread among close neighbours in a colony, with many extra-pair copulations taking place. In a study of Cattle Egrets marked with dye to identify them individually, 30% of copulations were 'extra-pair'. These are sometimes described as 'rape' in bird literature but the females of this

Copulation takes place on the nest. This female Cattle Egret lacks the orange breeding plumes.

study often seemed compliant. Some did, however, threaten and ward off an advancing male or after the copulation some gave a perfunctory peck towards the departing male and one even chased him over several metres. During an extra-pair copulation one or two neighbouring birds will sometimes join in, piling one on top of the other and perhaps preventing a successful insemination. If the female's mate returns at this point he immediately attacks and drives off the intruder(s).

Heronries and nests

Most egret species nest close to one another in colonies called heronries. The nests of bitterns, the Great-billed Heron and Striated Heron are generally well separated and from a functional aspect they can be said to be solitary nesters. Other heron species may be solitary in some situations but colonial in others. Heronries are usually established near a source of drinking water. White-faced Herons nesting solitarily may choose a nest tree either close to, or remote from, a water source. Egrets often nest near human habitation, perhaps to gain greater security from predators.

Nests are most commonly in trees, bushes, reed beds and rushes, but, depending on the species, also on the ground, on rock-shelves, in caves and on man-made structures. The nest is a platform of sticks with a slightly dished upper surface. Its open fabric allows for good drainage. The structural properties of the vegetation supporting the nest are apparently more important than the plant species involved, the requirements simply being a stable, secure support for the nest in a safe location. Tree nesters build with dead sticks, but they are nothing if not adaptable and will use the materials most convenient to them. Thus, Cattle Egrets and Intermediate Egrets nesting in a reed bed at Sandgate, south-east Queensland, appeared (from a distance) to use reeds. The nests of Little Bitterns and Australasian Bitterns in reed beds are made largely from segments of reeds and rushes. In South Australia and Western Australia, the Little Bittern nests in *Phragmites* (common reed) beds and melaleuca thickets their nest is a flat platform, supported by vertical plant stems (R. Jaensch pers. comm.). This building technique, with its lack of bent reeds, is apparently different from that of the Little Bittern in Europe, where the male is said to commence nest building by bending over reeds to make a base on which to pile loose stems.

As a rule, large, open-structured trees can only provide widely spaced nest sites and these are generally not preferred by colony members, although spreading Coolibah trees, *Eucalyptus microtheca*, growing beside inland water-bodies are used. Bushy trees are preferred, as these can support closely spaced nests making mutual protection by the birds against predators easier.

The nests must not be too close, however, as the territory holders will attempt to steal sticks from nearby nests and harass neighbours engaged in copulation. Egrets build a new nest every season, sometimes on top of an old one, which over a number of years produces quite a massive structure.

Among the tree-nesting herons, dead sticks are preferred because they are easier to collect. Late arrivals to one Cattle Egret heronry were observed being left with no option but to build their nest entirely of live twigs wrested with great effort from the supporting paperbark tree, *Melaleuca tamariscina*.

The Cattle Egret, Great Egret and Little Bittern males start the nest before they have a mate, but some other herons wait until after pair formation. The mates cooperate in nest building but tend to have different roles. The female stands on the nest and does most of the building and the male brings her nest materials. Sticks are most conveniently obtained by robbing a nearby, unattended nest but the male may go several hundred metres to gather sticks from the ground, one at a time. As there are about 400 sticks forming the nest of the Cattle Egret this represents a considerable effort on his part. This division of labour between mates was less apparent in a USA study of the Great Egret where quite atypically the male did most of the nest building while the female foraged. This reversal of the usual roles may have been to give her more opportunities for feeding to achieve the body condition needed for egg production. The nest-building roles of the sexes in Australian bitterns is not known but they may be like their European relatives that apparently differ in some respects from other herons. In Europe, the female Little Bittern collects a substantial amount of the nest material and the female Eurasian Bittern, builds the nest unaided by the male.

Generally, in a heronry the nest must be guarded continuously to prevent it being dismantled by neighbouring birds stealing its sticks. However, in an Eastern Reef Egret heronry where the nests were many metres apart and presumably sticks were not a scarce resource, empty nests were left unattended for long periods without any harm befalling them.

Two basic actions in nest building are common to a number of heron species. To insert the stick into the fabric of the nest the heron executes a 'tremble-shove' action where, holding the stick in its bill, it pushes it slowly into the existing fabric (shove) while shaking its head with a short lateral movement (tremble). To remove a stick it uses a 'push-pull' action, violently jerking it back and forth. A third action described for the Little Egret is where the bird grasps the middle of the horizontal stick and rapidly mandibulates it, allowing it to glide to one side or the other.

Egg and chick development and parental care

Eggs

Herons have oval eggs that are uniformly coloured and either dull or lustrous. They are white, pale green or pale blue except those of the Australasian Bittern, which are pale olive-green or olive-brown. There is some variation within a species: for example, the eggs of the Cattle Egret range in colour from almost white to a very distinct green. Heron eggs range in size from about 30.9 x 26.4 mm for the smallest, the Little Bittern, to 72 x 50 mm for the Great-billed Heron. Very occasionally a Cattle Egret will lay a pygmy egg that is half the usual length and is infertile.

The eggs are most commonly laid one to two days apart but sometimes at longer intervals. A complete heron clutch is likely to be of three, four or five eggs. It is, however, most often two in the Eastern Reef Egret and no more than two eggs have been seen in the few clutches recorded for the Great-billed Heron. An exceptional number of nine eggs found in a Cattle Egret nest may have been due to egg dumping (i.e. laying by a female not otherwise associated with the nest) or polygamy with a male and two females tending the same nest. Accurate determination of mean incubation times requires daily observation of a number of marked eggs and this has only been done for the Cattle Egret in Australia, giving means of 24.2 and 24.4 days from two studies. Among Australian herons, the assessed incubation time of about 20.8 +/- 1 day for the Little Bittern may be the shortest, and about 30 days for the White-necked Heron, the longest. After hatching the empty shells are ejected from the nest by the parent birds. A study of the Striated Heron in Tahiti showed that clutch size may vary considerably within a species and be smaller where food is in short supply. In the island environment the clutches were of only one or two eggs whereas they are three, four or five for the Striated Heron in continental regions.

Asynchronous hatching and chick growth rates

Since incubation starts with the first egg the chicks hatch asynchronously, separated by intervals of one, two or more days. Asynchronous hatching is a feature of many bird species, but we still don't completely understand its adaptive value (see box, 'Asynchronous hatching', for more detail on page 54).

Cattle Egret and Intermediate Egret chicks' growth rates that have been measured are probably quite typical of herons generally: they grow relatively slowly over the first few days, then gain weight rapidly to about 24 days of age and after that more slowly. In the six weeks from hatching to fledging the Intermediate Egret chick increases its weight 20-fold, from about 20 g to 400 g.

Asynchronous hatching

Herons start incubation when the first egg is laid and consequently the eggs hatch asynchronously – a day or more apart – so that the chicks in a brood are of different sizes. The oldest chicks attack their siblings vigorously, especially when feeding, and the smallest is severely persecuted. These fights stop in the Cattle Egret when the chicks are about three weeks old, by which time the youngest one (or two) in the brood has probably died of starvation or from its injuries. The survivors are more similar in size then and obtain about the same amount of food.

This leaves us with a perplexing question: 'Why not have a synchronised hatching and avoid this trauma for the younger chicks?' The adaptive value of asynchrony remains unclear despite many studies of the phenomenon in the Great Egret in the USA. A popular theory is that in environments where the attainable mean size of the fledged brood varies unpredictably between years, possibly being high one year and low the next, the smallest chicks are 'designed' to be expendable. In a good season they may get enough food and survive to fledge along with their siblings, but when food is scarce it is best that they do not divert so much food from their older siblings as to prejudice their chances of survival. Producing a larger number of young than can reasonably be expected to be reared may also be insurance against loss of chicks from the brood due to accident, disease or predation.

Interestingly, there is intense sibling rivalry for food in some species but not in others and there is some evidence that this might be influenced by the size of the food items presented by the parents. When a bolus comprising small prey items is regurgitated by the parent Great Egret the largest chicks snap them all up leaving little for the smaller ones. On the other hand, where the food is a fish too large for a chick to swallow whole, as with the prey of the Grey Heron, there is a free-for-all in which the smaller is able to get a share.

A recently hatched Intermediate Egret chick and pipping egg (left) and a recently hatched Reef Egret chick (right). Eggs hatch a day or more apart.

These Intermediate Egret chicks are about two days old.

Chick development

The newly hatched heron chick has its eyes closed and can only lift its head weakly. It is described as being 'semi-altricial' and 'nidicolous'. Semi-altricial chicks, such as herons, have a covering of sparse, downy feathers; an 'altricial' chick has no feathers at hatching; and, at the other extreme, a 'precocial' one emerges from the shell well-feathered, like a domestic chicken. Nidicolous means that the chick is confined to the nest, whereas a 'nidifugous' chick can walk out of the nest within minutes of hatching. The vunerability of the heron chick requires the parents to keep it warm and safe for several weeks after hatching.

In the Intermediate Egret the pin shapes of the developing contour feathers start to sprout eight days after hatching and the chick is well-covered by feathers by two weeks of age. Powder-down patches appear at 17 days. At 40 days the chick is well feathered but a fuzz of filoplumes are still seen protruding through the head contour feathers. As in other birds, the larger, contour feathers are confined to skin tracts known as 'pterygia', which are illustrated for the Intermediate Egret in Figure 6.3. Down feathers by contrast grow only on the 'apteria', the zones between pterygia.

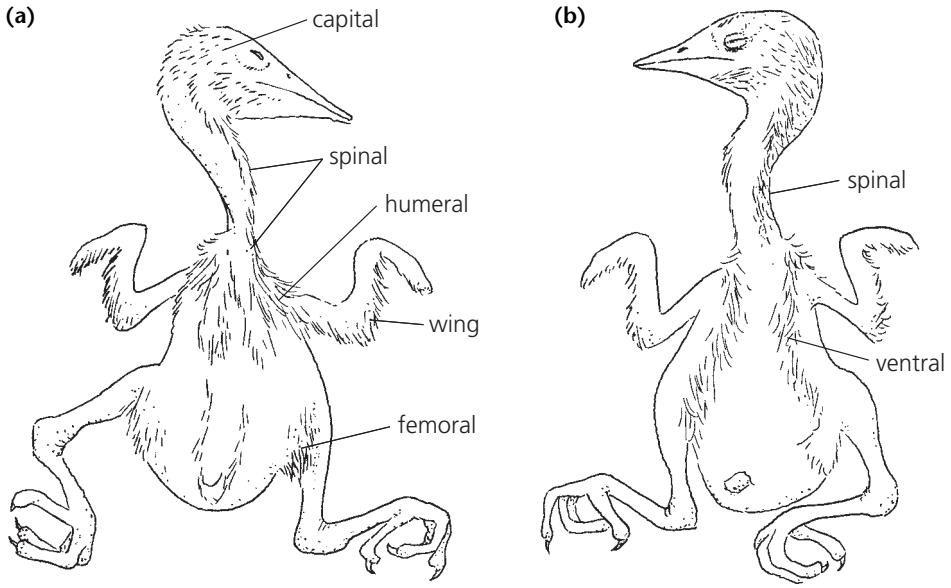


Figure 6.3 Contour feather tracts (pterygia) of the Intermediate Egret at about eight days post-hatching: (a) dorsal side of the body, (b) ventral side.

A nine-day-old Eastern Reef Egret chick. Note the pins of developing contour feathers, most obvious on the wing digits.

Preening was observed in the Intermediate Egret chick at four days post-hatching. It then nibbled its ventral feather tracts. As the chick grew older it progressively preened accessible feather tracts. At 12 days it was standing and alternately stretching one wing sideways to its full extent. At 16 days it raised its wings until they almost touched over its back and tilted its body forwards in a bow, with its head outstretched. It was able to scratch the side of its head with its toes at 17 days. Simultaneous wing and leg stretching on the same side of the body occurred at 26 days.

The heron chick goes through three stages in its responses to a predator such as a human. In the first week it cowers in the nest. In the second week it reacts aggressively, by raising its feathers and stabbing with its bill, and uttering a single sharp 'chee' that later becomes a duller 'thok'. When older still, the chick will scramble away from its nest if it feels threatened, its legs having developed faster than its wings.

These Cattle Egret chicks are about three weeks old.

There is a general correspondence between the adult sizes of heron species and the chick developmental periods. The smallest, the Little Bittern, normally leaves the nest at about eight days post-hatching and fledges at about four weeks of age; the medium–large Intermediate Egret does not voluntarily leave the nest to explore its immediate vicinity until about three weeks old and it fledges at about six weeks old.

Parental care

Male and female herons give approximately equal time to the tasks of incubation and feeding the nestlings, with the likely exception of the male Australasian Bittern. I know of no studies that have followed uniquely marked adults through to the independence of their chicks so it is not possible to be sure that this equal sharing continues beyond the nestling stage. The full-time efforts of both parents appear necessary to successfully raise a brood. Intensive observation of the Eastern Reef Egret and the Cattle Egret indicated that each adult incubated continuously for about 24 hours before being relieved by its mate, leaving aside the possibility of unobserved periods of relief during the night.

The parent broods its small chicks, covering them with its body to provide warmth and protection. On a hot day the adult heron stands with its wings partly unfolded and lifted almost to the horizontal, shading the brood. Brooding gives way to guarding and the adult stands on or near the nest. By then the chicks are well feathered and able to thermo-regulate, but still small enough to be at risk from predators. The Intermediate Egret adult broods its chicks continuously up to about 12 days post-hatching then guards them for a further 8–14 days before leaving them alone so both parents can search for food. When these older chicks begin to voluntarily walk out of the nest a short distance they are described as being at a 'brancher' stage.

Feeding is an infrequent event, with three or four feeds per day for Intermediate Egret chicks when one parent is foraging, increasing to six or seven when both parents forage throughout the day. The parent bird may forage far from the heronry to collect food – up to 29 km in the case of Cattle Egrets in south-east Queensland. It is typically absent for several hours and returns with its lower oesophagus and stomach packed with food. The chicks respond to the arrival of the adult by calling, raising their heads, gaping and touching the end of the parent's bill with theirs. In the first week the adult regurgitates the prey into the nest cup for the chicks to pick up, thus feeding them indirectly. Any food they miss is reingested by the adult.

As the chick grows there is a progressive shift to total reliance on direct feeding. The chicks compete to seize the top of the adult's bill (the pole position) in a scissors grip. Two chicks may seize the adult's bill simultaneously, but only the one in the pole position maintains its grip and is fed. The parent disengages after a few seconds of the scissors grip, then, with its head feathers dishevelled and coated with saliva, it retreats to a more distant branch to recover until it feels ready to endure another onslaught. Advanced chicks, from about three weeks of age, pursue the parent along the branches near the nest, begging vigorously. At this stage begging involves frantically bobbing the horizontally orientated head and bill up and down, flapping the half-

extended wings in an uncoordinated and frenzied way and attempting to grab the parent's bill.

Not all herons appear to feed exactly in this way. For example, the Little Bittern in Europe converts to direct feeding as early as three days post-hatching and there is low sibling rivalry among chicks.

In all herons the young continue to depend on the parents for food for several weeks after fledging. Recently fledged Cattle Egret young forage on the forest floor under the nest trees and spend their day loafing and feeding at a nearby wetland. On the return of their parents they go to the vicinity of their nest to be fed.

An Intermediate Egret feeding an approximately 10-day-old chick that is using a scissors grip.

An Intermediate Egret feeding an approximately 18-day-old chick.

Sources of mortality of eggs and chicks

In south-east Queensland Cattle Egret eggs and chicks died when a windstorm blew whole nests and their contents out of the trees. Violent winds at Seaham in NSW also felled nest trees (Max Maddock pers. comm.). Predation, infertility or infection following damage caused the demise of many eggs. The Torresian Crow, *Corvus orru*, systematically plundered clutches, sometimes eating the eggs in situ but at other times hiding the egg in the adjoining grassland before returning for another.

Starvation is the most common cause of chick mortality in the Cattle Egret and this is probably true of other herons. Typically the youngest in the brood does not survive beyond its second week. A South African study estimated that at this age the chick has its highest food requirement, about 95 g of fresh food daily. For the parents of a brood of three, this hypothetically requires them to catch 1728 grasshoppers daily to sustain themselves and their chicks!

Egret chicks may die following attacks by siblings. Although few carcasses are found in nests, quite a number are sighted on the ground below so presumably the parents ejected them. Cannibalism is perhaps rare, but in one Cattle Egret brood a larger sibling was seen attempting to swallow a dead smaller one. Any chick at the 'brancher' stage of development that makes an incursion into a neighbour's territory is savagely attacked by its occupants and may be driven out of the tree where it is at the mercy of scavengers. In the Lockyer Valley of south-east Queensland such scavengers include the European Fox, *Vulpes vulpes*, Torresian Crow and the Whistling Kite, *Milvus sphenurus*. At Seaham, NSW, eels have scavanged on chicks that have fallen into water.

Unguarded older egret chicks are taken directly from their nests by large raptors such as the Wedge-tailed Eagle, *Aquila audax*, and the White-bellied Sea Eagle, *Haliaeetus leucogaster*. The Australian Raven, *Corvus coronoides* has been observed dismembering chicks in their nest at the Seaham and Shortland heronries. In some parts of Australia, Nankeen Night Herons are reputed to prey on the chicks of other herons nesting in the same heronry, such as the Great Egret, although there is little by way of firm evidence for this (R. Jaensch pers. comm.)

Because of the vulnerability of the advanced chicks to falling out of their tree or becoming ensnared in branches when alarmed, researchers and others should not enter a heronry with branchers or fledglings.

Also in the Lockyer Valley, egret chicks sometimes carried heavy infestations of the bird tick *Argas robertsi*. Experiments there that compared the

survival of infested Cattle Egret broods with those where the ticks had previously been removed using an acaricide revealed heavy mortality when infestations were high, up to 140 larval ticks per chick (see picture below). It was unclear whether the chicks that died succumbed to blood loss, paralysis caused by a toxin in the tick's saliva or a virus transmitted by the tick. Most of these heavily tick-infested chicks died in their first week of life but those that survived through their second week clearly suffered paralysis. In a dry year, that was perhaps unfavourable to the tick, infestations were low and survival in those nests equalled that of control broods.

Other ectoparasites on herons are lice and louse-flies. The louse, *Ciconiphilus decimfasciatus*, is a frequent, but apparently benign, inhabitant of the feathers of egret chicks. This is probably because young chicks do not preen effectively. Advanced chicks and adults preen themselves frequently and have few or no ectoparasites.

A somewhat bizarre cause of death may be inflicted on Eastern Reef Egret branchers that leave their nests where there are *Pisonia* trees. One chick found wandering on the ground in a very distressed condition was thickly covered with the *Pisonia*'s sticky seeds (see picture on page 62).

A cluster of larval ticks infest the axilla of this Cattle Egret chick.

This Cattle Egret chick has an adult bird-tick on its toes.

This 3- to 4-week-old Eastern Reef Egret chick is covered in *Pisonia* seeds and will come to a sticky end, unfortunately.

Breeding success

In order to gauge the overall breeding success of a heron population one would ideally want to know the proportion of adults that nest each season, the proportion of successful pairs and the mean number of viable young per pair. The first of these is difficult (or impossible) to determine in practice but it could be quite a large number if conditions were very unfavourable.

Nest success at a mixed-species NSW egret heronry ranged from 51 to 71% over two seasons of observation. However, some birds may have re-nested and an extreme example of this in south-east Queensland was the wholesale abandonment by Cattle Egrets of their heronry, nests and eggs in several years when their local source of drinking water dried out. Each time they found an alternative site nearby with water and re-nested successfully. Herons will lay a replacement clutch if the first is lost, usually in the same nest. At a Striated Heron nest site in Tahiti, four replacement clutches were laid in a single season, almost certainly by the same pair of birds. A Cattle Egret changed both its nest site and its mate after a failed nesting (Max Maddock pers. comm.)

Under good conditions Cattle Egrets can fledge four chicks and White-faced Herons three, but two or three is more typical for the former and a NSW study of the White-faced Heron gave a mean number of 1.4 fledged young. In WA the Great Egret fledged 1.4 young per nest on average and the Nankeen Night Heron 1.2 young. On Heron Island on the southern Great Barrier Reef, the Eastern Reef Egret laid relatively small clutches and reared only one or, less often, two chicks. These Reef Egrets have a very long nesting season and this may allow them to rear a second brood. If so, they are quite exceptional among Australian herons. A pair of Cattle Egrets that had fledged one brood did in fact lay another clutch but abandoned it, presumably having run out of time (Max Maddock pers. comm.)

Among herons generally there can be considerable variation in the number fledged between years. The Great Egret in Hungary reared a mean number of 1.13 young in a bad year and 3.06 in a good one. In a dry and a wet nesting season at a NSW heronry mean annual fledging success for the Little Egret was 1.47 and 2.69 respectively, per successful nest. Over 20 years the Cattle Egrets of the Lockyer Valley had an annual mean success ranging from 1.8 to 2.9 fledglings per successful pair, their success was lowest in drought years and greatest following wet springs. The population dynamics of this species is summarised in the box on page 64.

Replacement fertility is the number of viable offspring produced by breeding birds in their life span required to replace themselves and the non-breeders of that generation (and thus maintain the population at a constant number). Expressed let us say as the mean number of fledglings per successful nest this might usefully be compared with the actual fertility. Unfortunately this is not possible for herons where we do not know the proportion of non-breeders in

the population. Hypothetically, for the Cattle Egret, whose mean life span of 2.6 years allows it to nest for two or three seasons on average, if all nested their replacement fertility would be about 1.5 fledglings per pair per season, but if only 50% of them did so it would be three fledglings per successful pair. Perhaps the best we can do to detect any downward or upward trends in numbers is to monitor population sizes over a number of years and this is discussed in the next chapter.

Population dynamics of the Cattle Egret

Estimating numbers of herons is rather like chasing shadows. Perhaps the only stable feature of heron populations is their instability! A 20-year study of the Cattle Egret in the Lockyer Valley of south-east Queensland gives the best impression we have of just how variable such a population can be. This sub-coastal region has an average annual rainfall of 785 mm, but there is considerable variation in falls between years and over the 20 years of the study it suffered three periods of drought. Total counts of Cattle Egret nests made at Lockyer Valley heronries gave nest numbers ranging between 1421 and 7953 annually.

High nest-numbers tended to follow years of higher than average rainfall and it became apparent that the size of this Cattle Egret population was mainly limited by rainfall. The rain makes the grass grow and consequently the numbers of grass-eating insects and their predators increase. It also moistens the soil, allowing grasshoppers and locusts to deposit their egg cases and multiply their numbers. The net result is more food for the egrets, allowing higher breeding numbers and brood sizes.

The population was not entirely at the mercy of the elements. They did respond to food shortage by learning to exploit novel food sources. Thus seven years into the study these egrets that had previously fed almost exclusively on pasture land discovered that substantial amounts of food were to be found in young lucerne crops and freshly ploughed fields. The number of nesting egrets grew for several (mostly wet) years following their exploitation of this additional food source. However, those higher numbers were not sustained in the years of severe drought that followed.

There was also a significant tendency for years of high numbers to be followed by years of lower numbers and vice versa, suggesting some process of regulation. Furthermore, in years of high nest- numbers the sizes of advanced broods were relatively small, perhaps due to increased competition for resources.

What emerges is a complex scenario where the number of pairs that nest and their subsequent breeding success are strongly influenced by the direct and indirect effects of rainfall; somewhat enhanced by the Cattle Egret's feeding adaptability; and moderated to an extent by some regulatory process stemming from intra-species competition.

7
Population numbers and conservation

A fundamental goal in animal ecology is to discover the environmental factors that determine a species' average population size and the (possibly different) factors that cause swings away from the average. This knowledge is needed if we are to set sustainable quotas for harvesting fish and wildlife populations and to effectively control the numbers of pest species. It may also help us conserve endangered species if we can ascertain whether a small, remnant population might be viable in the long term and what key factors will influence the population's survival.

Some heron populations may have quite stable numbers but others are known to fluctuate greatly in size. One might intuitively feel that the populations of marine and estuarine herons and of terrestrial herons in regions of reliable annual rainfall, would fluctuate less than those dependent on freshwaters or pastures that are subject to irregular rainfall. However, the rather unsatisfactory situation is that we do not have reasonable insights to the population dynamics of Australian herons, except for one population of Cattle Egrets (see box, 'Population dynamics of the Cattle Egret', page 64).

Counting herons

The number of herons at a breeding colony can be determined directly by counting the nests since there is one pair of birds per 'active nest'. These total

nest counts have been undertaken at heronries in eastern coastal Australia with a high degree of accuracy. Nests of similar-sized species are very similar in appearance so in mixed heronries the proportions of each species have been determined by sample counts of the birds present. Breeding numbers may not of course exactly represent total adult numbers as many herons may forego nesting in a year when conditions are sub-optimal. The global database used by The Ramsar Convention on Wetlands offers one type of estimate where the total population equals the number of breeding pairs multiplied by three. However, since breeding numbers among herons can vary greatly over a number of years depending on natality and mortality and the multipier might be expected to vary considerably, many years of data would be necessary to obtain a reasonable estimate of the long-term average.

Aerial surveys have allowed researchers to assess heron numbers at heronries and on their feeding grounds over large tracts of remote country, including the crocodile-infested mangrove swamps of the Northern Territory and the ephemeral wetlands of the arid inland of the continent. In practice though it is very difficult to produce precise estimates since some species, such as the small egret species, are hard to distinguish. Further on-the-ground estimates are needed as a check on the accuracy of aerial counts. Surveys involving simultaneous aerial and ground-based counts have found that the aerial counts underestimated the numbers. Cryptic, solitary species, such as bitterns and the Striated Heron, are much more difficult to census as their nests tend to be dispersed and well hidden. For these species a population census might be done by mapping the number of birds vocalising a particular call, such as the booming self-advertisement call of the Australasian Bittern.

In situations where the total number of herons cannot be determined, repeated surveys of a proportion of the population can give a very useful index to annual variations in their numbers, providing the counts are conducted over sufficiently large spatial and temporal scales. Most notably this has been done by the NSW National Parks and Wildlife Service with aerial surveys of waterbirds along east–west transects from inland Victoria to southern Queensland. These were conducted annually starting in 1983 along six, 30 km wide survey bands centred on every second degree of latitude. This sampled about 10% of the land surface. From a height of 46 m and flying at 294 km per hour, total counts were made of the birds on small wetlands and estimates of those on large ones.

Local bird counts such as the annual, one-day survey of south-east Queensland by members of Birds Queensland also provide this sort of information. Unfortunately, in the case of herons, these types of surveys are probably done too infrequently and on too small a spatial scale to accurately reflect

changes in the numbers of species that readily move from one region to another in search of more favourable feeding conditions. However, because they are conducted over many years they may reveal trends in heron numbers that usefully point to changes in the quality of local habitats.

Regional abundance of colonially nesting herons

Northern Territory – Top End

Aerial surveys of egret breeding colonies across the Top End of the Northern Territory were conducted between 1990 and 1999, during which sampling from ground level was often undertaken as well to determine the proportions of the small egret species. The colonies discovered were all within 40 km of the coast and it is believed they included all or virtually all of the large ones in the area.

These surveys found up to six species of herons nesting at 38 sites. Estimated maximum total numbers by species were: Intermediate Egret – 93 000, Great Egret – 31 000, Little Egret – 18 000, Cattle Egret – 30 000, Pied Heron – 22 600, Nankeen Night Heron – 19 000; making a grand total of 213 600 breeding herons. The egrets and Pied Heron nested very reliably each year at these Top End colonies and this may also be the case for the Nankeen Night Heron.

Eastern Reef Egrets and Striated Herons were surveyed on their feeding grounds due to the difficulty in locating nests. Both species were well distributed along the coast and on offshore islands, with 600 records of the Eastern Reef Egret (4000 birds) and about 76 records of one or more Striated Herons, including one colony of five closely spaced nests.

Aerial and ground surveys of non-breeding birds in dry season refuge wetlands of the Alligator Rivers Region of the NT had estimated a larger total of 354 000 herons, comprising 4000 White-necked Herons, 50 000 Pied Herons and 300 000 'egrets' (mostly Intermediate Egrets). This would have included immature birds and perhaps southern migrants. Seen sporadically and in much smaller numbers at these sub-coastal refuges were Great-billed Herons, White-faced Herons, Striated Herons, Nankeen Night Herons and the Black Bittern.

Northern Territory – Sub-humid Tropics

South of the Top End is a vast semi-arid, inland region termed the 'Sub-humid Tropics' of the Northern Territory. Here heron nesting awaits the flooding of lakes and swamps that are temporary and seasonal and are in fact dry most years. Nevertheless when inundated they cover huge areas and support a very large number and diversity of waterbirds. For example, flooding sufficient to cause lakes Sylvester, De Burgh and Corella, north-east of Tennant Creek, to merge creates a water-body covering over 165 000 ha, and to the north-west

of these Tarabool Lake covers 250 000 ha at its greatest extent, much of it being wooded swamp. In the opinion of Roger Jaensch, who surveyed the wetlands of the sub-humid NT in good years, the Barkly Tablelands wetlands can, during favourable conditions, support relatively large colonies of Great Egrets and small colonies of White-necked Herons, Intermediate Egrets, Little Egrets and Nankeen Night Herons. Thus in 2001, Eva Downs Swamp, east–south-east of Elliot, had at least 1500 pairs of Great Egrets breeding in the River Cooba trees, *Acacia stenophylla*, that lined the water-body. This is the largest colony so far recorded for this species in the bioregion.

From what is presently known, the sub-humid NT cannot match the Top End for numbers of colonially breeding herons but the Barkly Tableland wetlands are potentially vast, extending up to 0.5 million ha when flooded and further investigation is needed to reveal their true importance for heron feeding and breeding (R. Jaensch pers. comm.).

Coastal Queensland and New South Wales

The remoteness of much of northern Queensland may mean that significant heron colonies remain to be discovered there. Two heronries on the western side of Cape York Peninsula, on the delta of the Mitchell River, were reported as having about 700 nests of the Little Egret and smaller numbers of the Great Egret, Intermediate Egret, Pied Heron and Nankeen Night Heron. Even in populated regions, large colonies probably exist but have not been officially recorded. As recently as March 2004, Roger Jaensch found a breeding colony of 'at least a few thousand pairs' of four egret species, mostly Cattle Egrets and Intermediate Egrets, on a mangrove island just north of Rockhampton on the Central Queensland coast.

The best-studied egret colonies are distributed down the coastal plain from Bundaberg in south-east Queensland to just south of Newcastle, New South Wales. In the 1981–82 breeding season there were three known colonies in south-east Queensland, but by 1995–96 this had increased to 15 and a number of colonies had been used and abandoned in the interim. Judged from a combination of total counts and estimates of nest numbers there were roughly 40 000 Cattle Egrets at all colonies both at the start and finish of this 14-year period (from a compilation of data including some from Don Seton and Lester Roy pers. comm.). The numbers were not stable over the intervening years, however. Twenty years of data from a subset of these heronries, in the Lockyer Valley east of Brisbane, showed total annual nesting Cattle Egret numbers varying between 2800 and almost 16 000. Other egret species nested at south-east Queensland heronries in much smaller numbers. Thus in the Lockyer Valley the Intermediate Egret nested only four years out of the 20 and at their

largest nesting there was about 400 birds. Great Egrets and Little Egrets nested in most years in small numbers.

Along the coastal plain of northern NSW in the period 1988–91 there were 13 known heronries and two more have since been reported as being present at that time. Again Cattle Egrets comprised the great majority of heron species. Total counts for the 13 were 18 700 Cattle Egrets, 1600 Intermediate Egrets, 840 Great Egrets and 142 Little Egrets. Between 1989 and 2004 the number of nesting egrets at one of these NSW heronries, the Shortland Wetlands Centre, declined from between 84% (Cattle Egret) to 98% (Intermediate Egret) (Max Maddock pers. comm.). It is not known if these four species have suffered a similar reduction at the other coastal heronries.

Murray–Darling System

In the past when conditions were suitable, very large numbers of waterbirds bred in the wetlands of the Murray–Darling River System where there are about 18 500 wetlands with an area more than 1 ha. Important among these historically are the extensive wetlands over the floodplains of the Gwydir, Macquarie and Lachlan/Murrumbidgee rivers and the Barmah-Millewa Forest on the upper River Murray. There are no regional totals for herons, but to give some examples: in flood conditions up to 6000 pairs of Intermediate Egrets have nested in the Lachlan/Murrumbidgee wetlands, 17 200 pairs of Intermediate Egrets and 4600 Nankeen Night Herons at the Macquarie Marshes and 10 000 Intermediate Egrets in the Gwydir/Gingham watercourses. A climate pattern of successive years of low rainfall in the catchments of these rivers has meant that long periods have elapsed between breeding events at a particular location. Despite the unlikelihood of a natural flood occurring in any one year at a specific wetland, flooding occurs in one or more of the rivers of the Murray–Darling Basin in about 90% of years and the mobility of waterbirds is the key factor allowing them to exploit these scattered wetlands.

In recent decades the effect of low rainfall has been greatly exacerbated by the diversion of water to land being used for crop production, depriving the wetlands of most of the natural flows. The impact of this on heron nesting capability has been devastating. For example the numbers of nests of Nankeen Night Herons at the Macquarie Marshes in the four nesting seasons from 1990–91 to 1993–94 were: 1510, zero, zero and 350, respectively. There has been no breeding of colonial waterbirds in the Macquarie Marshes in the last four years.

Prior to irrigation, egrets reportedly bred in their thousands in the Barmah-Millewa Forest following flooding along the upper River Murray and these forests were said to have the largest known egret colony in southern Australia. Since the diversion of water for irrigation no more than 300 pairs

nested there from the mid-1970s to the late 1990s. Subsequent to this there has been only one year of significant nesting. This was in 2000 when a large natural flood was augmented by environmental flows to complete the breeding. In the NSW component of the forest that year 250 Great Egret, 400 Intermediate Egret, 3 Little Egret, 3 Cattle Egret, 25 White-necked Heron and 2500 Nankeen Night Heron nests were successful, fledging 2–3 young per nest (D. Leslie pers. comm.)

Arid Australia

Only recently has it become apparent that arid parts of Australia support very large numbers of waterbirds. There are reports of colonies of egrets in the inland; and of White-necked Herons breeding everywhere during floods, although not usually in large numbers (R. Kingsford pers. comm.).

The arid-zone wetlands are ephemeral and the vast floodplains of the inland rivers are often dry. Nevertheless, across this immense region floods are frequent, although sporadic and irregular in their occurrence. The result is a constantly changing mosaic of temporary wetlands offering resources that can be exploited by birds with sufficient mobility to move from drying locations to inundated ones.

The Lake Eyre Basin deserves special mention as it covers a vast area of inland Australia (1 140 000 km^2). Its floodplains and lakes offer the continent's largest area of inland wetland, which is a core feeding and breeding habitat for some waterbird populations. There were four major floods of the Lake Eyre Basin between 1986 and 1997 and waterbirds then converged on it from far and wide, following waterways that have their sources hundreds of kilometres distant.

Roger Jaensch (pers. comm.) considers the Channel Country that forms a large part of the Lake Eyre Basin to be of national and international importance for breeding by several species of the heron, ibis and spoonbill group. Its principal waterways are the Cooper Creek, Diamantina, Georgina and Bulloo rivers.

The floods that inundate the Channel Country typically originate far to the north, from monsoonal rain events in summer–autumn, and heron habitats downriver may be revitalised entirely by these floods, even in the (likely) absence of local rainfall. The principal heron colonies are on the vast floodplains with braided channels and swamps where water persists for up to six months after the largest flood peak, and around swamp-fringed sub-terminal lakes. Nests are in inundated woodland and shrub habitats. Heron breeding is principally in summer–autumn with the birds responding quickly to the onset of favourable conditions, some laying their eggs less than a month after the

first floodwaters arrive. Wet meadows and lignum swamps on the floodplains apparently provide the main feeding areas for egrets and Nankeen Night Herons. The large terminal lakes, some of which are saline, attract fewer herons (R. Jaensch pers. comm.)

Aerial surveys in 1989–90, following extensive flooding of Cooper Creek wetlands, discovered large numbers of waterbirds of a wide variety of species, including some egrets. Aerial and ground surveys conducted during 1999–2004, mainly for Wetlands International by Roger Jaensch, Julian Reid and others, provide valuable insights to the populations of herons of this region and their ecology. They show, that after moderate-to-major floods in the Channel Country rivers, large breeding colonies of herons may occur concurrently in each of the Cooper, Diamantina and Georgina rivers. Some colonies have thousands of pairs of Nankeen Night Herons and Great Egrets and hundreds of pairs of White-necked Herons. These are among the largest-ever documented colonies for these species in Australia. The large heron colonies commonly also include ibises, spoonbills and cormorants. Nesting ibises are by far the most numerous.

Western Australia

Relatively small populations of herons have been recorded nesting in Western Australia. Surveys in the south-west over 1986–88 concluded that in a normal rainfall year the seven or eight major colonies there would have had a total breeding population of about 600 Great Egrets. Nankeen Night Herons nested at seven colonies and there were two or three pairs of Little Egrets. During this period Cattle Egrets nested at Kununurra in north-west WA, but with only 65 pairs being counted one year and 45 the next. Two small colonies of Great Egrets have also been recorded for the north-west of WA. It is probable that, in wetter years, other small breeding colonies of herons are active in wetland systems across WA.

Southern, eastern Australia

There are no large colonies of herons in Victoria away from the Murray River. Although of considerable regional significance, Bool and Hacks Lagoons in South Australia support relatively few herons. Tasmania provided breeding records for only the White-faced Heron for the new atlas.

Habitat loss

The conservation of most heron species is synonymous with the preservation of the shallow freshwater wetlands they depend on for food. Very important among these are floodplains that are inundated at times of high rainfall.

Ephemeral fresh water in the Top End, Northern Territory.

The cycle of flooding and drying of these ephemeral wetlands has been shown to produce a temporary abundance of food for waterbirds. Water quantity, quality and the timing of flooding are all likely to be important.

From the time of white settlement to 1970 about 60% of the coastal and sub-coastal marshes and lagoons of eastern Australia were channelled, drained or dammed. By 1964 about 75% of the Swan River coastal plain of WA had also suffered this fate.

Major wetlands west of the Great Dividing Range such as the Macquarie Marshes, Gwydir River, Border Rivers and lower Murrumbidgee River have all declined in area since 1983. The major cause has been the construction of dams, which catch floodwaters and divert them away from their original watercourses for agricultural purposes. In a very wet period in the 1950s, prior to dam construction, the Macquarie Marshes had floods that extended over more than 1 000 000 ha, but in 1990, when the river had its largest flood in the decade, an area of only 130 000 ha was flooded. In 1996 the amount of water in the marshes was so reduced that where there might previously have been 80 000 nests of herons, ibises and spoonbills only 10 000 nests were built. In years of potentially greater floods the loss of nesting capacity might have been much greater.

The Lower Murrumbidgee floodplain of inland southern NSW also provides a sorry illustration of the impact of extreme water resource management on

waterbirds. Across this floodplain it is estimated that at least 76% of the wetlands have disappeared or been degraded since European colonisation. Aerial surveys from 1983–98 showed a decline in the number of herons and ibises from about 30 000 to 4000 over this period. White-necked Herons, White-faced Herons, Great Egret and 'small egrets' (the latter not being distinguishable from the air) were counted. While the trend was significantly downwards the numbers showed considerable year-to-year variation for each type of heron, underscoring the need for many years of survey data to properly assess population changes. Over the same period, wetlands that had not suffered habitat loss, such as the Paroo River overflow lakes, did not show this reduction in the numbers of waterbirds. The Paroo River is one of a dwindling number that have escaped having their waters dammed or diverted. The Queensland Government has made a commitment to keep it in this natural state.

A clear cause–effect relationship has been demonstrated between the interruption of the natural flooding regime by dam construction and water diversion and the subsequent huge decline in egret nesting numbers at the Barmah-Millewa Forest in the latter half of the 20th century. The major impact of this river management has been an 80% reduction in the frequency of successful breeding episodes among the forest's waterbirds.

To date, the ephemeral wetlands of the arid inland of the continent and the seasonal lagoons of the Top End have been mostly spared the calamitous effect of river management. There is, however, a large development in the catchment of the Daly River in the Top End which has some important heronries (R. Jaensch pers. comm.). Mammoth water storage and diversionary projects such as the Ord River Scheme in north-west WA are an ominous forewarning of what might come. Demands from some quarters that Australian agriculture might be 'drought-proofed' by making 'better use' of the waters of the great Queensland rivers that flow north into the Gulf of Carpentaria have fortunately been discredited by scientists and, hopefully, will be rejected by politicians.

The habitats of marine and estuarine herons face somewhat different threats from those presented to freshwater wetlands. The mangrove and littoral melaleuca forest haunts of the Striated and Great-billed Herons have been greatly diminished by the development of port, industrial and residential complexes down the central and southern parts of the east coast of Australia, but hardly at all around our more northern shores. Many of the large Top End egret heronries are in the mangroves of remote estuaries that are in an entirely natural state. Tourism infrastructure and other developments on the Great Barrier Reef have reduced the nesting habitat of the Eastern Reef Egret, although perhaps not to a dangerous level. Certainly tourists and Eastern Reef Egrets seem to coexist quite well on Heron Island!

A small number of heron species have benefited from the changes wrought by humans. For example, tree clearing, pasture improvement and irrigation have increased the area of the feeding grounds available to Cattle Egrets and perhaps also benefited White-faced Herons. Great Egrets and Intermediate Egrets feed in rice fields but research suggests that these are not an adequate substitute for the natural wetlands they replaced. It is fair to point out that dams established on what was previously well-drained land provide feeding opportunities for herons in the shallow water at the edges. However, the huge ring tank dams that have mushroomed across southern Queensland cropping land in recent years provide little food for herons due to their steep sides. These tanks catch overland flows and deprive the local marshes and streams of replenishing waters.

The status of Australian herons

The conservation status of herons across the world is described comprehensively in *Heron Conservation*, edited by James Kushlan and Heinz Hafner. It contains a very useful chapter on the herons of Australasia and Oceania by Max Maddock. This book gives the international status of heron species and that of their regional populations. Some assessed by the International Union for the Conservation of Nature (IUCN) and most also independently by the Wetlands International Heron Specialist Group (HSG).

Using the criteria of the IUCN, in their 2000 *Action Plan for Australian Birds* Stephen Garnett and Gabriel Crowley identify four threatened species of herons. Among these the Great-billed Heron and Black Bittern are of 'Least Concern', the Little Bittern is 'Near Threatened' and the Australasian Bittern is 'Vulnerable'. Least Concern and Near Threatened are low-risk group categories and, of the two, Near Threatened species are more at risk than those of Least Concern. The category Vulnerable is in a high-risk group and Vulnerable species face a high risk of extinction in the wild in the medium-term. Thankfully, by this IUCN assessment, no Australian heron is in the 'Endangered' category of fauna facing extinction in the near future. However, these assessments of status are somewhat subjective and the Wetlands International Heron Specialist Group rates the Australasian Bittern 'Critically Endangered'.

Estimating the numbers of heron species that are difficult to see and tend to nest solitarily presents formidable logistical difficulties. According to the *Action Plan for Australian Birds*, Great-billed Herons are said to number only about 5000 breeding birds, but due to lack of research we cannot say if their numbers are in decline. It is at least reassuring that most of its habitat has survived totally undisturbed. Also in the action plan, Little Bittern numbers

are about 5000; the Black Bittern 20 000 and the Australasian Bittern is estimated as low as 2500. Bittern habitat has suffered major impacts from wetland drainage and diversion of water for irrigation and the populations of the Australasian Bittern and Black Bittern are said to have declined in recent times in Southern Australia and WA.

We should not be complacent about herons that may seem secure nationally if at the same time they are scarce or declining regionally. According to state government reports, in Victoria the Intermediate Egrets and Little Egrets are 'Critically Endangered', the Great Egret 'Endangered' and the Nankeen Night Heron 'Vulnerable'; and in South Australia the Intermediate Egret, Little Bittern and Eastern Reef Egret are 'Rare'.

A comparison of the records gathered for *The New Atlas of Australian Birds* with those for the old atlas has revealed population trends that are very relevant to species' conservation. Heron species that decreased nationally over the 20-year period, judged by reporting rates, were the White-faced Heron, White-necked Heron and Nankeen Night Heron. Only the Intermediate Egret increased. The Great Egret, Little Egret, Eastern Reef Egret and Striated Heron showed no change nationally. The Pied Heron and Cattle Egret showed no significant regional variation in population numbers; whereas the White-faced Heron, White-necked Heron, Intermediate Egret, Little Egret, Great Egret and Striated Heron showed significant regional variation. Long-term research is required for a number of species before we can confidently assess their status.

Heron conservation

There are large areas of neglect in the study of herons and consequently gaps in the data needed for the development of appropriate conservation strategies. Cryptic species have received little attention because of the practical difficulties in finding and studying them. The contribution of the ephemeral wetlands of the arid inland to the maintenance of some heron species may have been greatly underestimated due to the logistical problems of surveying vast tracts of land.

Not withstanding the gaps in our knowledge we know enough about herons' habitat requirements to be able to identify their breeding and feeding grounds and evaluate actual and potential threats to their continued existence. There should therefore be no delay in implementing strategies to protect these habitats. Many of them are on privately owned land and have an uncertain future. Surviving riparian and marsh vegetation should be preserved wherever it occurs and even the smallest wetland is worth saving. It is surprising how many waterbirds a marsh extending over as little as, say, one hectare can support.

Max Maddock also makes a plea for 'community understanding and cooperation' in the conservation of herons. A very good example of this is the Wetlands Australia Reserve, near Newcastle, NSW. This was a degraded wetland, part of which had become a football field and which adjoined a municipal dump. Maddock and others in the local community brought about a change of ownership and went on not only to secure the future of the colony of egrets that had taken up residence there but to also establish an educational centre where school children and the general public can learn about wetland ecology and conservation.

The term 'environmental flows' is widely applied in Australia to describe quantities of water that are returned to a wetland to restore some of its natural qualities. The NSW National Parks and Wildlife Service's plan of management for the Macquarie Marshes Nature Reserve describes recent moves to partially restore natural water flows to this Ramsar-listed wetland in inland NSW. The plan well illustrates the complex requirements of such a management regime. It aims to give a water allocation to the marshes in late winter and spring sufficient to produce at least four to six months of flooding at a time most conducive to waterbird breeding. A continuous flood over this length of time is needed for the growth of plants and the small animal life that sustains the birds and gives a sufficient depth of water around the nest trees, bushes such as lignum, *Muehlenbeckia* spp., and reed beds, to give security to the young until they fledge. A shorter flood period will result in the colony being abandoned and a massive loss of young. On the other hand the flood must not last too long as more than two years of inundation kills nest trees. Dry periods lasting about three months to two years are important stages in the cycle as it is then that decomposition of organic matter occurs, returning nutrients to the soil. Most recently, Richard Kingsford and Kristin Auld have used historical data on river flows through the Marshes and waterbird nesting numbers there to investigate different options for the management of environmental flows in the river. This modelling shows that adaptive management of flows is essential for the marshes to reduce the risks of further environmental damage. The Macquarie Marshes Nature Reserve covers only 18 143 ha so the greater part of this floodplain, totalling about 200 000 ha, is on private property. Obviously the success of the management scheme depends very much on the cooperation of local people. Water alone is not enough and it is vital to preserve the tree, shrub and reedy vegetation that provide nesting sites for waterbirds. The large Red River Gums, *Eucalyptus camaldulensis*, that line many of our inland watercourses are of particular value as nesting 'condominiums' for a variety of birds. In some regions coolibahs and other trees provide these nesting opportunities.

In relation to the Barmah-Millewa Forest, David Leslie identifies three river-flow objectives that are needed if breeding of colonially nesting waterbirds is to persist. These objectives are equally applicable to other flood-dependent nesting sites on managed river systems across Australia. They are:

(1) increasing the frequency of suitably timed, low- to medium-sized floods to allow these species to breed at a frequency better reflecting the natural precedent;
(2) increasing the durations of floods to enable these species to successfully complete their reproductive cycle; and
(3) reducing the length of prolonged droughts so these species have the opportunity to reproduce within their lifetimes.

Of course where they occur in dense concentrations some herons are themselves a threat to their environment. When colonially nesting herons occupy a heronry over many consecutive seasons they may damage or kill their nest trees, forcing them to abandon an otherwise favourable breeding site. This could result from their practice of breaking off live twigs for building their nests when dead sticks are in short supply. Furthermore, if a large number of these sizeable birds amass in a small area they also deliver a potentially dangerous overload of fertiliser to the roots of nesting or roosting trees. Neither of these processes have been proven to degrade heronries in Australia, but at Gatton in south-east Queensland, a few years after the arrival of egrets at a man-made forest, the grevilleas and melaleucas they used for nesting died, whereas casuarinas planted at the same time and lantana that colonised the empty spaces, thrived and supported many nests. Similarly at a heronry at Toowoomba, about 30 km to the west, after four years of nesting by increasingly large numbers of Cattle Egrets and White Ibis, melaleuca nest trees started to look very sick and some fell over.

In this context it is interesting to consider interventions by Greg Baxter and his students at the island heronry at Gatton, that may have enhanced it for the birds. Field trials there and in NSW showed that egrets will use sticks collected for them by humans and left close to the heronry to build their nests. Providing these supplementary sticks might reduce the rate of defoliation of nest trees by the birds. Or it might encourage a larger population of birds! At the Gatton heronry, artificial nesting trees were erected. Each one comprised a thick central pole supporting broad, horizontal wire-mesh platforms at various heights. Cattle Egrets nested on these, and one can imagine them getting a head start to their building with a 'take-away' of nest sticks from the conveniently located stick depot! It appeared that the nests on the platforms were at lower densities than in the nearby trees so perhaps the accommodation was not entirely to their liking.

More usually, nature will be left to take its course and if a heronry is abandoned for whatever reason one would hope there would be a suitable alternative site nearby. For this reason the scope of conservation strategies needs to extend beyond existing heronries to a landscape scale that identifies and seeks to preserve other forests in the area that have the potential to be heronries. Or indeed proactively create other potential sites, as at Gatton, where the local Apex Club planted a second island with trees that grew sufficiently tall within a few years to support egret nests.

The Ramsar Convention aims to protect wetland sites of international importance and a number of Australian freshwater and marine shallow wetlands that are important to herons are listed under it. The criteria used by Ramsar to identify worthy sites recognise the importance of the ephemeral wetlands scattered across inland Australia and these wetlands are eligible for nomination. Individually, ephemeral wetlands may only flood once in three to five years but when they do they provide an abundance of food for waterbirds. Because flood events at widely spaced locations are likely to be independent of one another, in most years a number of wetlands ought to be available as refuges or breeding sites for waterbirds. It is therefore essential to recognise these flood-prone lands as an integral part of the network of important wetlands that span the continent. Since much of this land is held as freehold or leasehold and is in commercial production, a sound, cooperative partnership between governments and landowners is necessary to underpin the water and land management strategies needed to protect the water supplies and ensure ecological sustainability (R. Kingsford pers. comm.)

The extreme mobility of Australia's herons, the complexity of their lifestyles, their diverse habitat requirements and the patchy, 'stop-go' nature of this continent's rain-driven natural production systems, demands a nationwide approach to heron conservation. Herons need a network of suitable nesting habitat and feeding wetlands across the continent. There is a growing realisation in this country that effective management of our land and water resources requires the cooperation of federal, state and regional tiers of government and their agencies and local landholders.

Cattle Egret in breeding plumage Photo by the author

White-necked Heron Photo by Brian O'Leary

Great-billed Heron – juvenile bird Photo by Gary Fisher

Great Egret Photo by the author

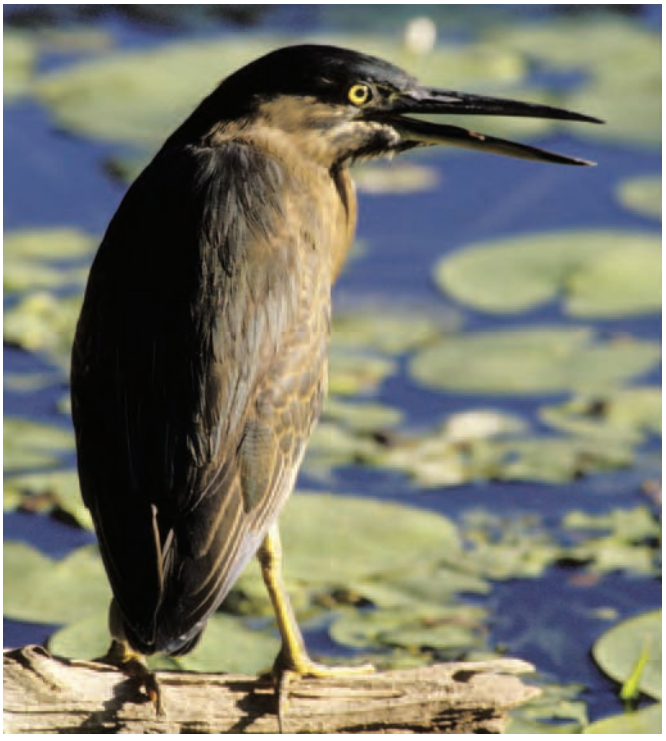
Pied Heron on nest with chick Photo by Neville Male

Intermediate Egret Photo by the author

White-faced Heron Photo by Nick Alexander

Little Egret in breeding plumage Photo by Neville Male

Eastern Reef Egret
Photo by the author



Striated Heron
Photo by Robin Hill

Nankeen Night Heron Photo by Jon Norling

Little Bittern – adult male Photo by Tom Wheller

Black Bittern Photographer unknown

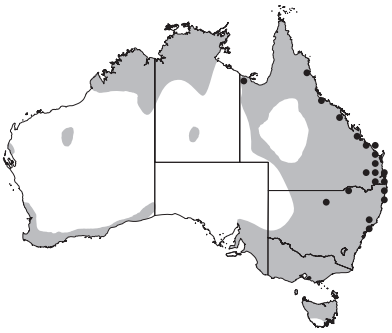
Australasian Bittern
Photo by Brian Chudleigh/
ANT Photo

8
Species resident in Australia

This chapter presents a separate portrait of each of Australia's resident heron species, which includes descriptions about appearance, distribution, movements, feeding behaviour, diet, breeding and population status. Some of the detail on particular species overlaps with information in earlier chapters, but I've included this in order to give a more complete view of the bird and to highlight features that distinguish it from other herons. The first species described are the 10 day herons (subfamily Ardeinae), then the Nankeen Night Heron (subfamily Nyctocoracinae) and finally the three bitterns (subfamily Botaurinae). I begin with a fairly full account of the Cattle Egret because a good deal is known about this species and it is reasonable to assume that other heron species will resemble it in many respects. Less detailed accounts are presented for the other species, partly reflecting our limited knowledge of these, in their Australian context at least.

For each of these species, an image and a map showing its distribution (grey shading) and breeding records (dots) are given. These are adapted from *The New Atlas of Australian Birds*, hereafter referred to as the 'new atlas'. These distributions must be regarded as conservative. For the six colonial species that inhabit the Top End, an additional map is included showing the location and size of the heronries in this region. These heronries were mapped by Ray Chatto in the 1990s and are not adequately represented in the new atlas, although all or most of them must still be used annually by very large numbers of herons.

Cattle Egret, *Ardea ibis*



In its white, non-breeding plumage the Cattle Egret can be confused with other egrets, but it is distinguishable by its more compact build and relatively shorter legs, neck and bill. It also has a faint buff tinge on its forehead. Its bill, lores and irises are yellow and its legs grey-green. A minority of young Cattle Egrets retain a blackish bill colour for a short time after fledging, raising the possibility of confusion with the Little Egret, but the latter has a much more slender build.

Most breeding Cattle Egrets have bright orange or orange-buff plumes on the head, neck and back, but some one-year-olds are less brightly coloured, with less-developed plumes, or even retain the all-white non-breeding plumage. For a week or so at the start of nesting and pair-bonding, the bill is bright red except for a yellow tip, the lore is magenta and the iris is red. These then fade to yellow during egg laying with the bill becoming bright maize-yellow for a time. The tibia, and less often the tarsus, can acquire a reddish colour during breeding.

Males are larger than females (about 390 g and 340 g respectively), but not noticeably so at a distance. They are generally seen in grass paddocks in the company of a cow or similar grazing animal but also feed independently of a host.

Distribution

During the 19th century the Cattle Egret underwent a remarkable range expansion, most likely in response to human activities such as the introduction of irri-

Location and size of Cattle Egret heronries in the Top End in the 1990s.

gation systems, the creation of rice paddies and the worldwide expansion of the cattle industry and accompanying habitat modification. The nominate species, *A. i. ibis*, probably originated in central Africa, but has spread to South Africa, southern Europe, and crossed the Atlantic Ocean to colonise the Americas. It is absent from Iran and adjoining Middle Eastern countries. The subspecies, *A. i. coromanda*, is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-East Asia, Papua New Guinea and Australia.

The early history of this species in Australia is uncertain. An introduction of 18 birds from India to Derby in WA in 1933 was probably unsuccessful. However, it is likely that Cattle Egrets have been visiting northern Australia from the islands to the north since pre-colonisation times. The relatively recent development of the pastoral industry in northern Australia would have changed the landscape to suit the Cattle Egret. We know they were present in large numbers in the NT in 1948, and by 1954 had spread south-east to nest for the first time in north-eastern NSW.

In the last 50 years they have extended their distribution even further to encompass, either permanently or seasonally, most of the higher rainfall pastoral lands of coastal and sub-coastal Australia. Their range takes in south-western WA, where they are still relatively rare; the Top End; the Barkly Tableland; much of eastern and south-eastern Australia, where it extends well inland; South Australia and Tasmania. They have been winter visitors to New Zealand since 1963 at least, but have not been recorded nesting there.

Cattle Egrets breed in large numbers in coastal heronries in the Top End; in a concentration of heronries along the coastal plain of Eastern Australia, from south-east Queensland to mid-coastal NSW; and in some widely scattered heronries in mid-coastal and north Queensland. They have nested well inland along parts of the Murray–Darling River System and there is probably further considerable scope for the establishment of heronries in this vast region.

Movements

The Cattle Egret is a partial migrant in that some individuals stay close to the natal heronry from one nesting season to the next but the majority leave the district in autumn and return the next spring. Recoveries of Cattle Egrets, mostly south of the natal heronry, suggest the birds spend the winter dispersed along the coastal plain as far as South Australia. A small number have been recovered west of the Great Dividing Range.

Some cross the seas to Tasmania or New Zealand, taking advantage of prevailing winds across the Tasman at certain times of the year. The longest recovery distance has been 2500 km, for an egret banded in south-east Queensland and recovered on Stewart Island, off the southern end of New Zealand's South Island, but some unmarked birds have apparently overshot New Zealand and landed in sub-Antarctic islands. It is virtually certain that many return from New Zealand to breed in Australia but proof of this is needed.

Cattle Egrets tend to return to their natal heronry to breed (a behaviour called 'philopatry') but a few have been re-sighted at a different heronry. Both juvenile and mature birds migrate but the juveniles travel further on average. Project Egret Watch revealed a good deal of fidelity by marked birds in returning to the same areas and even using the same foraging sites in successive years (M. Maddock pers. comm.).

Feeding and food

Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes, and they avoid marine environments. They exhibit a wide range of feeding behaviours but for the most part they have to 'Walk rapidly' (see Chapter 5), in order to keep up with their 'host', which may even be a tractor pulling a plough. They quite often feed without a host, for example on young lucerne crops where they position themselves under the irrigation sprays. They are generally seen in small flocks, the size of these being dictated in part by the number of available hosts. As might be guessed, larger-sized host species attract more egret followers than smaller ones. The alpha bird positions itself near the head of the host and enjoys a greater feeding success than those of lower status further back.

Cattle Egrets eat a very wide range of small animals. In the summer in south-east Queensland this includes substantial numbers of the noxious Cane Toad, but few centipedes and no millipedes, which they probably find distasteful. Plant material is found in boluses but this may have been ingested by accident as there are no records of deliberate herbivory. The most important summer prey in eastern Australia, judged both by the number of items and total biomass, are grasshoppers, locusts and field crickets (orthopteran insects). In some environments they eat a substantial number of Cattle Ticks, *Boophilus microplus*, pecking them directly off the cow and perhaps also off the ground. Tick-eating by this species has been disputed in the past but in the 1980s I found many mature Cattle Ticks in regurgates provided by chicks at a heronry in south-east Queensland. The persistence of the cement cone – a secretion by the tick that is used to attach itself to the host – around the mouthparts of some ticks confirmed these as having been taken directly off the cow (D. Kemp pers. comm.). As a tick-eater and a major predator of grass-eating insects, the Cattle Egret probably does good service to local agriculture. Unfortunately they also eat other predators of orthopterans, such as spiders, frogs and lizards.

The effect of the concentrated predation by thousands of nesting Cattle Egrets on local vertebrate biodiversity is unknown, but in inland south-east Queensland about half of the locally occurring species of frogs and reptiles are found among their prey, including rarities such as the Grey Snake, *Hemiaspis damelii*. Parent birds range as far as 29 km from the heronry in search of food.

There are no Australian data on the Cattle Egret's diet outside the breeding season. In South Africa and New Zealand their winter diet includes earthworms taken in large numbers from the rain-soaked soil. The migration of the Cattle Egret south, when other Australian migrants are flying north, may be best explained by their desire to exploit feeding opportunities made available by the winter rains of southern Australia.

Breeding and status

In eastern Australia the Cattle Egret's nesting season typically spans five months, from October to March. In the NT, large flocks start nesting in late November; small numbers start in January, synchronising with the other, more numerous, egret species in the heronry that start at this later date.

They nest colonially, often with other herons or with cormorant species. Cattle Egrets are not known to raise more than one brood of chicks in a season, but they can successfully re-nest after an early nest failure and are said to build a new nest for this purpose. Some breed in their first year and a proportion of these are still in their all-white juvenile plumage. All breeding birds of two years of age upwards have the orange breeding colour.

Heronries are always close to drinking water. This appears most important for the males, who, except for short excursions to drink, attend the nest continuously until the first egg is laid. They nest in trees, bushes, in reed beds and on the ground, preferring bushy trees to open, structured ones as the former allow for closely spaced nests (39–110 cm centre to centre) for mutual protection (N.G. McKilligan pers. obs.).

The male claims the nest site and builds a rudimentary nest before gaining a mate. He then collects the sticks and the female positions them. Dead sticks are preferred, but if these are not readily at hand considerable effort goes into breaking leafy, live twigs off the tree and the nest may end up being built mostly from these. Most nests are multi-layered platforms comprising several hundred sticks with a small amount of leafy material placed in its shallow cup. A few nests are built on top of old ones and make a very solid structure, but others are so loosely constructed that the eggs can be seen through the lattice of sticks. Stick stealing is rife and unattended nests (except those solidly glued together with faeces) quickly disappear. Stick collecting continues through incubation but it is then mostly restricted to the mid-morning and it may have more to do with reinforcing the pair-bond than reinforcing the nest. Advanced chicks occupy their time by making clumsy attempts at rearranging the nest.

A Cattle Egret egg is oval but more rounded at one end. Its surface is finely pitted and a pale greenish-white or a distinct green colour. Typical clutches are of two, three, four or five eggs. Eggs are laid one or two days apart as a rule, the clutch usually being completed within seven days. Incubation starts with the first egg and they hatch asynchronously 24 days after being laid. By three weeks post-hatching the chicks are well-feathered, their legs are well-developed and they explore for a short distance beyond the nest. They make short flights from about five weeks old, then progress to flying to the ground below the nests, and then a hundred metres or more to the nearby wetland, where they feed to some extent but mostly await the return of a parent, whereupon they return to the vicinity of their nest to be fed. They are independent by about eight weeks of age. In south-east Queensland most successful nests fledge two or three young. A brood of four is a rarity that only occurs in favourable years and in very dry years the mean number drops below two.

A proportion of eggs fail to hatch. In south-east Queensland this is due to accidents, infertility or predation by the Torresian Crow, *Corvus orru*. Crows usually fly from perch to perch through the heronry with the aim of scaring a sitting egret off its nest. During one particular observation of a this type of behaviour, the nesting egret being targeted gave the 'Full forward' threat display to the crow, which then seized the end of the egret's wing and a tug-of-war contest commenced. The egret was pulled off its nest but quickly returned

and this happened three times over several minutes. Finally the egret surrendered its nest and the crow proceeded to eat its three eggs with the egret standing nearby, but looking away without any visible sign of concern. When the crow departed the egret returned and ejected the empty shells. This and an observation of three fledgling Cattle Egrets threatening a Brown Goshawk, *Accipiter fasciatus*, disproves the conventional wisdom that herons will not defend their nests.

Chick deaths are most often due to starvation, with the smallest chick dying by the end of its second week, a time when competition among the siblings for food is most intense. During a period of severe drought many advanced chicks may not survive. Smaller numbers may succumb to heavy loads of parasites, such as bird ticks, *Argas robertsi*; predators, such as the White-bellied Sea Eagle, *Haliaeetus leucogaster*, and Wedge-tailed Eagle, *Aquila audax*; or attacks by other egrets. A new arbovirus, the Lake Clarendon Virus, has been found in bird ticks on Cattle Egret chicks in south-east Queensland and this may have caused their sickness or death. The oldest Cattle Egret lived to almost 14 years but mean life span after fledging is between two and three years.

While it seems that variation in rainfall underlies gross fluctuations in the sizes of Cattle Egret populations studied to date, other factors, such as changing agricultural practices and the bird's responses to these, are also important (see Box – Population dynamics of the Cattle Egret, page 64).

Cattle Egrets are numerous and widespread. Combining the estimated nesting numbers given in Chapter 7 for each state suggests a national breeding population of roughly 50 000 breeding pairs or a total of 150 000 birds, using Wetlands International's formula (total number = number of pairs x 3). By contrast Wetlands International estimates the total population to be 100 000, 30% fewer birds.

Taxonomy

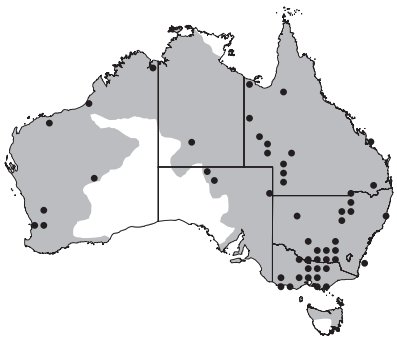
There is considerable disagreement as to which genus the Cattle Egret should be assigned. It has been placed in the genera *Bubulcus*, *Ardea*, *Ardeola* and *Egretta*. In the Northern Hemisphere the monotypic genus *Bubulcus* is presently used. Monotypic means there is only one species in that genus. Christidis and Boles (1994) favour the genus *Ardea* based on the results of DNA studies, and *Ardea ibis coromanda* is used for the subspecies in Australia. Its common name is the Indian Cattle Egret.

For a very full description of the biology of the African Cattle Egret, *Bubulcus ibis ibis*, consult *The Cattle Egret: a Texas Focus and World View* by Ray Telfair, which is based mainly on studies of the migrant population in the United States.

White-necked Heron, *Ardea pacifica*

The White-necked Heron is a large, easily recognised bird with its grey-black back and wings and white head and neck. A white patch of feathers on the wing is often readily seen. Its bill and legs are mostly grey-black and its lore is variously described as grey-black through to greenish-yellow, turning to pale blue at the start of nesting. The breeding bird has reddish bronze, lanceolate back plumes, and white plumes extending from the lower foreneck over the upper breast. It may have an all-white neck or a line of black spots down the front of it. Juveniles have irregular black spotting on the foreneck, and their neck is greyish rather than white.

Distribution and movements



The White-necked Heron is widespread across Australia, although there are no recent records in southern parts of arid WA and SA. It breeds only in mainland Australia but visits southern Papua New Guinea, Tasmania and New Zealand. There are many breeding records for eastern Australia, but just a few scattered across northern Australia. Since the 1950s

it has bred at many wetlands in south-west WA, its heronries there being close to important feeding grounds in the form of the abundant 'wet meadows' that are formed in high rainfall years (R. Jaensch pers. comm.) While there is evidence of regular seasonal movements to what are probably dry season refuges, the species is also subject to irruptive movements following drought. Only seven banding returns are available to reveal movements and these are of young birds that either had not relocated or had travelled only a short distance.

Feeding and food

The White-necked Heron is often seen feeding alone but also in a scattered flock of dozens or even hundreds of their conspecifics. They feed mostly in freshwater shallows and adjoining wet pastures and perhaps occassionally in saline habitats. I have seen them feeding in dry grassland several hundred metres from water. In foraging they most often use the 'Stand and wait' and 'Walk slowly' techniques. They eat a variety of small animals, including mussels and crayfish, and less frequently, fish.

Breeding and status

The White-necked Heron nests in trees, often in a colony with other heron species but is also a solitary nester. Colonies of up to a few hundred occur in the Channel Country but it is also very common to find a solitary pair nesting at an outback waterhole (R. Jaensch pers. comm.). It nests in spring and summer in the south and summer into autumn in inland and northern Australia. The eggs are smooth, dull and greyish blue. The clutch is typically three or four eggs and one study estimated that 0.3 to 1.8 chicks fledged per nest. An estimate of a 30-day incubation period is, if correct, at the top end of the range of times for herons.

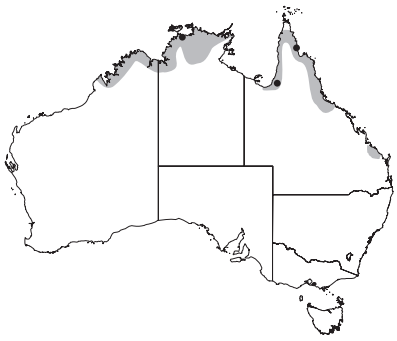
Its numbers were previously thought to be stable, however data in the new atlas suggests an overall decline, but with some regions showing an increase. These regional variations in the population size may be driven by inland flooding, with a build up after wet years followed by a decline. The HSG designate it as 'Lower Risk/Least Concern'.

Great-billed Heron, *Ardea sumatrana*

The Great-billed Heron is Australia's largest heron, growing up to about 110 cm long (bill-tip to tail-tip) and 2.6 kg in weight. It is restricted to the mangrove and melaleuca/pandanus forests bordering tropical estuaries and coastal streams. Its size and predominantly grey-brown plumage distinguish it from other herons. Its bill is mostly grey-black and its legs a variety of dark shades. Breeding birds have silver-grey plumes on their back and neck. The lore may change from yellow to blue-grey for a short time at the start of breeding. The juvenile is a mottled and streaked rusty-brown colour and lacks plumes.

Distribution and movements

The Great-billed Heron has a predominantly coastal distribution from Burma across the islands of South-East Asia to Papua New Guinea and Australia. In Australia it has been recorded along the northern coast, from near Broome in north-west WA (with some sightings well inland) to near the town of 1770 in south-east Queensland. Sparse breeding records occur over this range.



Feeding and food

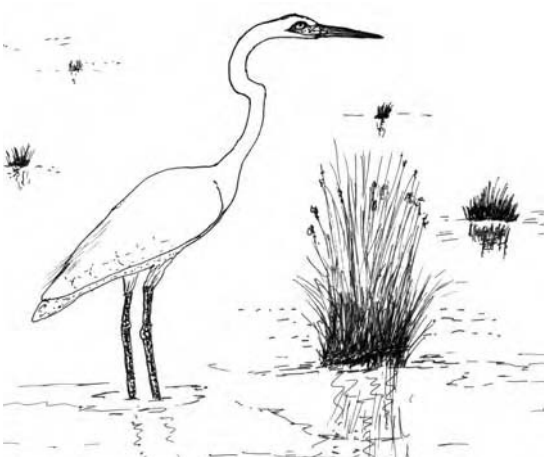
The Great-billed Heron feeds on wet substrates in the vicinity of mangroves and other littoral forests. It is known to eat fish but probably takes a range of aquatic animals.

Breeding and status

Great-billed Herons nest solitarily – at 5 km intervals on the eastern edge of the Gulf of Carpentaria – and with other waterbird species. Nesting takes place through spring and summer in north-east Queensland, but perhaps later on the Gulf and in the NT, sometimes finishing as late as July. Its very large (up to 1.3 m diameter) solidly constructed nest is usually hidden in a mangrove thicket, and the eggs are smooth, dull and pale bluish-grey or green. Clutch sizes of one and two eggs have been reported, rather small numbers for a heron.

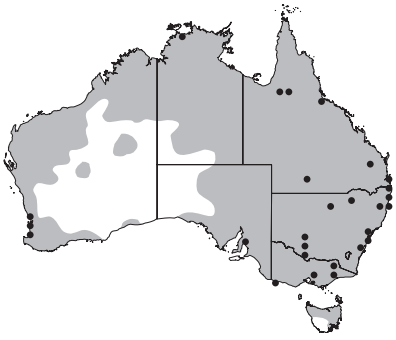
The national population of the Great-billed Heron is estimated to be about 5000 birds and the 2000 *Action Plan for Australian Birds* categorises its status, perhaps optimistically, as being 'Least Concern'. The destruction of mangroves and reclamation of mudflats for the development of infrastructure for the growing human population in south-eastern Australia may have caused this heron species' range to contract north. Its northern habitats remain in pristine condition.

Great Egret, *Ardea alba*



The Great Egret is the largest of the egrets. It has an all-white plumage and a remarkably long, uniformly thin neck. When the bird is relaxed the neck is S-shaped with an obvious kink and when stretched out it can be judged to be about 1.5 times its body length. It is also distinguished from other white egrets by its flatter crown and its gape, which extends to a point behind the eye instead of finishing below the eye as in other egrets. In breeding it has long back plumes (aigrettes) that extend beyond its tail, its bill becomes black, the lores olive-green to blue-green and for a short time during courtship the irises are red. Its legs are black except in breeding when the upper legs may have a reddish wash.

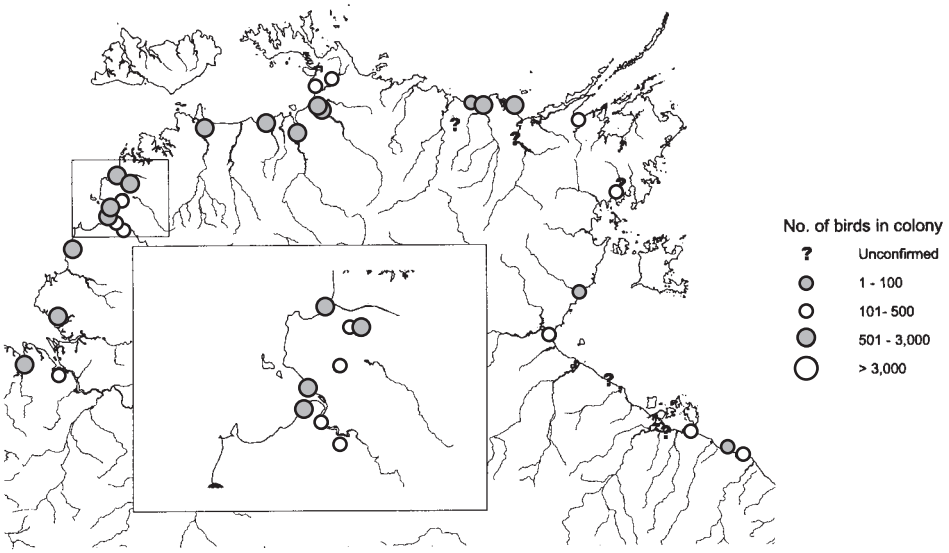
Distribution and movements



The Great Egret is a cosmopolitan species that is widespread in the Americas, Africa, the Indian subcontinent, South-East Asia and Papua New Guinea. It is common and widespread in Australia, even in some arid regions such as the Lake Eyre Basin. Nest records come from scattered locations in south-west WA, coastal northern and eastern Australia, the Murray–Darling River System, the Channel Country, the Barkly Tableland and South Australia. Dispersive and irruptive movements take some of them to Papua New Guinea and New Zealand. Out of 80 recoveries of Great Egrets banded close to fledging in Australia the most distant from the natal site was 3365 km away in Papua New Guinea, but the majority had moved only a few hundred kilometres. The oldest marked Great Egret ever recovered in Australia was about 7.1 years, much below its longest known life span of 22 years.

Feeding and food

The Great Egret feeds in a wide range of wet and dry habitats, including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves



Location and size of Great Egret heronries in the Top End in the 1990s.

and mudflats. It usually feeds alone in open shallows to a depth of about 30 cm (up to their leg feathering). It will also exploit the food resources of quite small ponds. Typically it uses the 'Stand and wait' technique to surprise its prey. It mainly eats fish but also takes a diversity of small vertebrates and invertebrates, including some very small items such as flies.

Breeding and status

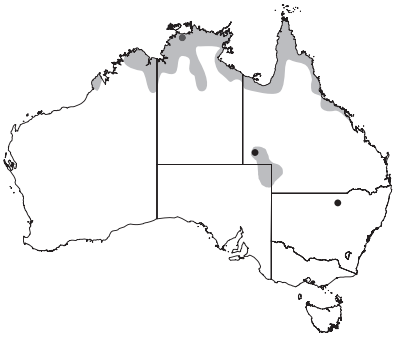
The Great Egret nests in mixed-species colonies where it claims a nest site in a commanding position in the tree, destroying the nearby nests of smaller heron species in the process – the presence of the severed heads of several Cattle Egret chicks was once observed under one Great Egret's nest, suggesting a more sinister activity. The larger size of its nest and nest sticks distinguishes it from the nests of smaller herons in the colony. Eggs are smooth, dull and pale bluish-grey or green. The clutch may have from two to six eggs, but typically three or four.

Generally it seems to be a fairly plentiful species, with its stronghold being in the Top End, where as many as 31 000 birds may have nested at 29 heronries in the 1990s and most colonies were active in every year that they were checked. From recent reports, the Channel Country, where intermittent favourable conditions support huge nesting colonies, is also important. Population studies suggest that the Great Egret has increased its numbers in WA in recent years, but at the same time has suffered a decline of 92% at at least one coastal NSW heronry.

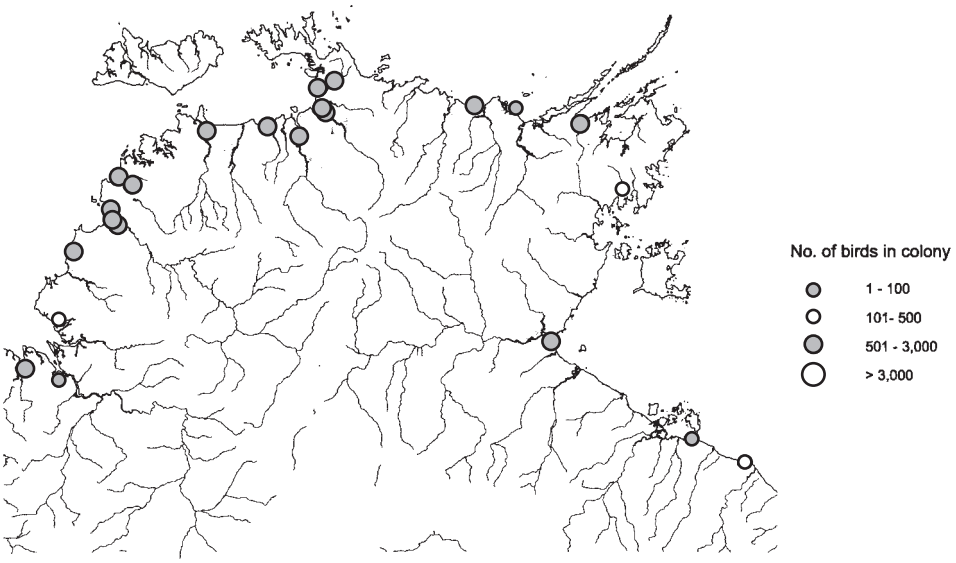
Pied Heron, *Ardea pictata*

The Pied Heron is a small, black-and-white heron of northern Australia. In its first year it might be mistaken for a White-necked Heron because it then has an all-white head, but older birds have a distinctive black crown and crest. When breeding its crest plumes are longer. It has black back plumes and white plumes on its lower neck that fall as a bib over the upper breast. All these plumes are lanceolate. Its bill, lores and legs are grey or yellow, becoming a brighter yellow during breeding.

Distribution and movements



In Australia the Pied Heron is largely restricted to northern coastal and subcoastal regions. It is a partial migrant, with a substantial proportion of the population leaving the breeding areas during Australia's dry season, many of whom travel north to Papua New Guinea and some parts of Indonesia. Australia's breeding records mostly come from the Top End and the eastern Gulf of



Location and size of Pied Heron heronries in the Top End in the 1990s.

Carpentaria, but also from north-east Queensland. There is also a record of Pied Herons nesting at the Macquarie Marshes in NSW and in the Channel Country (R. Jaensch pers. comm.), locations well south of its usual range. The only nest record outside of Australia is from Sulawesi.

Feeding and food

The Pied Heron forages in very shallow water (mostly less than 10 cm deep) in freshwater, littoral and estuarine habitats and on dry land. It is an active feeder using a variety of tactics, including 'Foot stirring', gleaning prey from dense vegetation and snatching fish as it flies over the water. It also scavenges for food at garbage dumps and picnic areas. It eats insects for the most part but also fish and frogs.

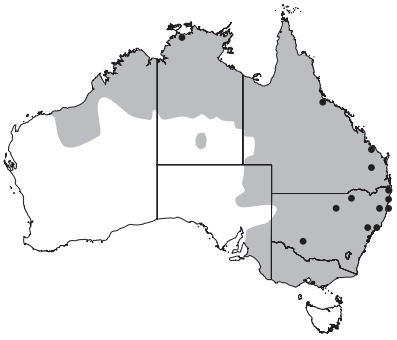
Breeding and status

There is little information available about the ecology of the Pied Heron. It nests in mixed-species heronries. Its nests are described as being neater than the nests of egrets, possibly because they use finer sticks, and their eggs are blue-green and darker than those of other herons. In the Top End the Pied Heron nests at 23 heronries, using these with a high degree of annual regularity and numbering up to 3000 in a single colony. The total Top End breeding population is estimated to be about 22 600 when all sites are occupied.

Intermediate Egret, *Ardea intermedia*

The Intermediate Egret is a medium-sized, all-white plumaged heron with a yellow bill when not breeding and dark legs. Its neck length is about equal to its body length. When breeding it has long, showy aigrettes on its back that cascade beyond the end of the tail and long, dense breast plumes (hence the popular name Plumed Egret). At the start of nesting its bill is red with a yellow tip and it has a green lore and red iris. The upper leg is red. The juvenile is like the non-breeding adult. The Intermediate Egret can be distinguished from other egrets by its body proportions and bill colour.

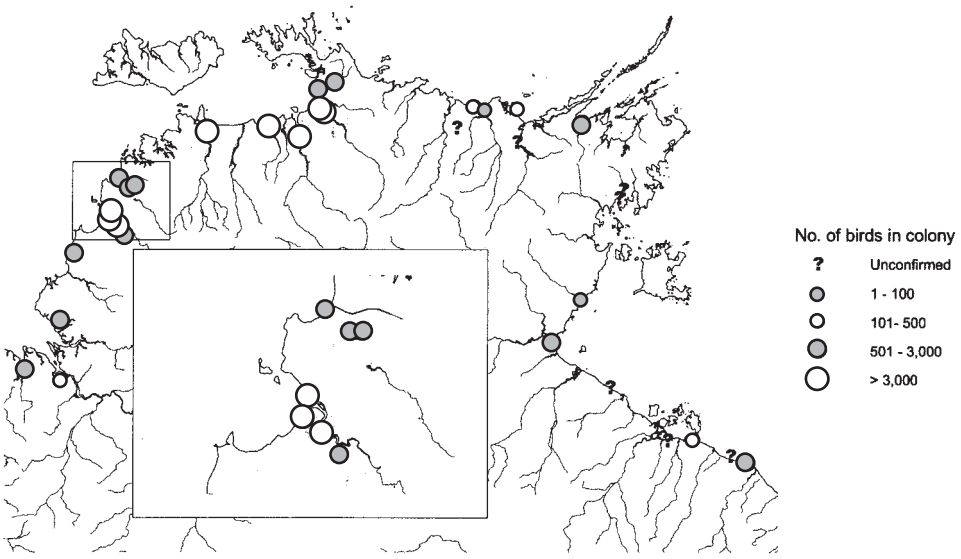
Distribution and movements



The Intermediate Egret is found over much of east and west-central Africa, throughout the Indian subcontinent, in China and Japan and in South-East Asia and Papua New Guinea. In Australia it occurs over the northern and eastern regions, extending well into the inland, but seems to be absent from south-western WA. It is rare in Victoria. It nests at coastal and inland locations over its range. Although probably sedentary at some locations and times, one banded in NSW was recovered 3991 km away in Papua New Guinea. Intermediate Egrets from the Macquarie Marshes apparently travel to drought refuges on the Australian east coast as the marshes dry out.

Feeding and food

The Intermediate Egret feeds mainly in shallow freshwaters (less than about 8 cm deep) and on wet pastures. In contrast to the Great Egret and Little Egret, which prefer open water, it makes more use of well-vegetated wetlands and will walk on emergent plants, such as lily pads floating in deeper water, but when doing so it has to move constantly as they sink under its weight. Although often using the 'Stand and wait' hunting technique it is a noticeably more active feeder than the Great Egret. Foraging alone or in loose flocks it mainly eats fish, but also frogs, skinks and grasshoppers and many aquatic invertebrates.



Location and size of Intermediate Egret heronries in the Top End in the 1990s.

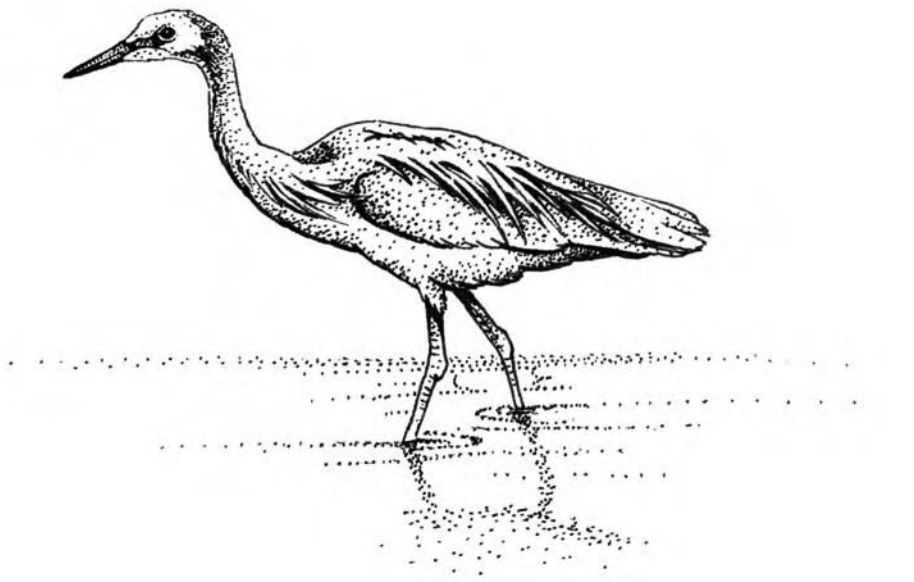
Breeding and status

The Intermediate Egret nests in mixed-species heronries, where it competes successfully with the similar-sized Cattle Egret and Little Egret for a nest site. It typically lays three to five eggs that are distinguishable from those of Cattle Egrets in adjacent nests by being slightly larger and a darker green. An observed incubation period of an egg was 26 days (+/- 1). The chicks are brooded for about 12 days then guarded for a further 8–14 days before both adults leave in their search for food. The young fly at six or seven weeks post-hatching.

The Top End seems to be its stronghold with annual nesting of about 93 000 birds and as many as 6000 at a single heronry. It uses 26 Top End sites for nesting and it may in fact use more than this but it is difficult to distinguish it from other 'white herons' during aerial surveys.

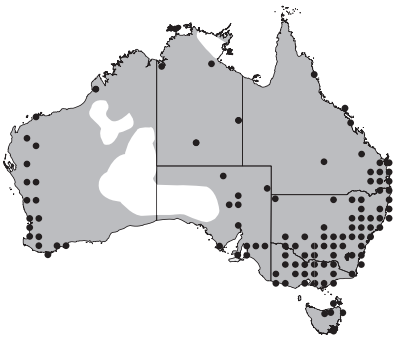
It may not be faring so well elsewhere in Australia. Large numbers have been recorded nesting in inland northern NSW ephemeral wetlands but many years usually elapse between breeding events. The situation at these sites has been greatly worsened in recent times by water diversion for irrigation. As a result of reduced water flows the maximum breeding number at the Macquarie Marshes, previously a major inland site, has been reduced by about 77%. The same sorry fate has befallen the Barmah-Millewa Forest further south, where the Intermediate Egret and other egrets once nested in large numbers but water diversion on a massive scale has drastically reduced their numbers. One heronry in coastal NSW suffered a 98% decline in breeding numbers from 1988 to 2004.

White-faced Heron, *Egretta novaehollandiae*



The White-faced Heron, popularly known as the Blue Crane (although not of course a crane), is a very familiar sight in our rural landscape. It is a medium–large heron with blue-grey plumage except for its conspicuous white facial feathering. (One very atypical bird has been recorded with a white rather than the usual grey neck (M. Maddock pers. comm.).) The breeding bird has lanceolate plumes on its nape, back (but not overhanging the tail), lower foreneck and breast. The rich, pinkish-brown or bronze colour of the neck and breast plumes in particular contrast with the rest of its grey plumage. Shorter plumes persist out of the breeding season. Its bill and lores are grey-black when breeding but paler at other times and its legs are yellow. The juvenile lacks the white face and plumes.

Distribution and movements



The White-faced Heron is found in Papua New Guinea, New Zealand and New Caledonia and throughout Australia except for the most arid regions. It breeds over much of south-eastern Australia, coastal and sub-coastal WA and at scattered inland and northern locations. It is the only heron recorded as breeding in Tasmania in the new atlas.

Its movements are not well understood. Banding returns indicate a sedentary lifestyle for some, with others moving just a few hundred kilometres from their place of origin to a maximum recovery distance of 249 km. The few banding data are mostly of very young birds and are unlikely to represent an accurate picture of movements or longevity.

Feeding and food

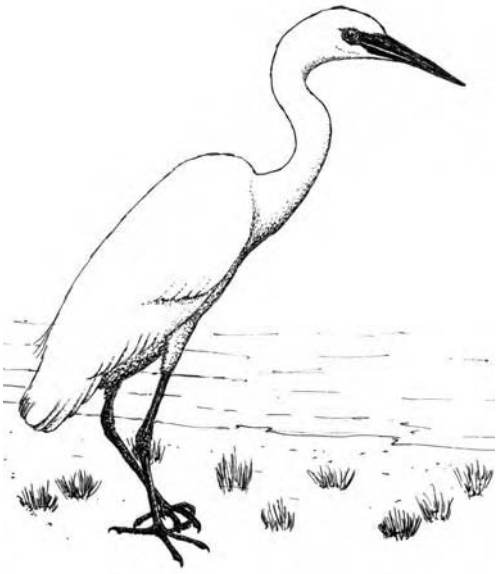
The White-faced Heron feeds in freshwater and saltwater habitats and frequently on dry pastoral land. It also visits suburban gardens, apparently being more tolerant of humans than other herons. They eat a variety of small animals using a variety of feeding methods. On grassland they typically search while walking at a moderate pace.

Breeding and status

The White-faced Heron usually builds a solitary nest high in a tree, but it will also nest in a heronry. It will nest in built structures, and nests have been recorded up to 4 km from water. Because of its exposed, solitary nest we might expect some differences in nesting behaviour and parental care compared with colonial herons, for example the chicks might need a longer period of guarding by the parent birds, but the few data available do not support this. From a study of six nests, incubation was 24–26 days; the chicks were left unattended at the nest from nine days post-hatching, were climbing out of the nest by 20 days and fledged at 43 days. They were fed by the parents for a further 20 days at least.

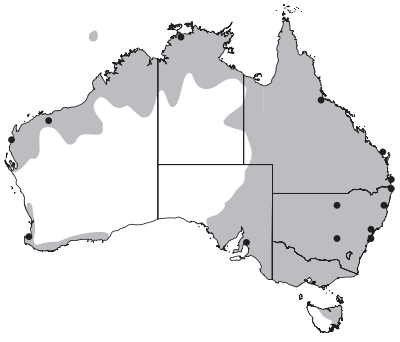
In the old edition of the bird atlas the White-faced Heron was the seventh most-reported bird species but has slipped to 18th in the new atlas. Its reporting rate is down in some regions and significantly down nationally. Nevertheless it continues to be the heron we report seeing most often.

Little Egret, *Egretta garzetta*



The Little Egret is an all-white plumaged heron. It is more slender and lighter in weight than the Intermediate Egret (300 g versus 400 g) and also differs in having a black bill and legs. Its slender form, long stiletto-like bill and feeding behaviour further distinguishes it from other egrets. The breeding bird has two long, fine plumes extending back from the crown over the neck and numerous long filamentous plumes on the lower neck and back. At the start of breeding the lores are purple-red and the irises are red for a short time. Some plumes may persist out of the breeding season. The juvenile resembles the non-breeding adult. The toes of the Australian subspecies *E. garzetta nigripes* are black above and straw-yellow underneath unlike the bright all-yellow toes of the nominate Northern Hemisphere subspecies *E. garzetta garzetta*.

Distribution and movements



Its pan-continental distribution over southern Asia and much of Africa is similar to that of the Intermediate Egret, but it is also found in coastal northern Africa and southern Europe. It now occurs over a wide area of coastal and inland Australia, in small numbers in the Lake Eyre Basin, but it is scarce in the arid central and western regions south to the Great Australian Bight. Apparently it has extended its range since the 1950s into South Australia, Tasmania and New Zealand. The first record in WA is as recent as 1965. It nests at widely scattered locations across its range, including WA. The Little Egret's movements are poorly understood, but birds banded in NSW have been recovered over 3293 km away in Papua New Guinea. Its movements seem more likely to be dispersive and irruptive than migratory.

Location and size of Little Egret heronries in the Top End in the 1990s.

Feeding and food

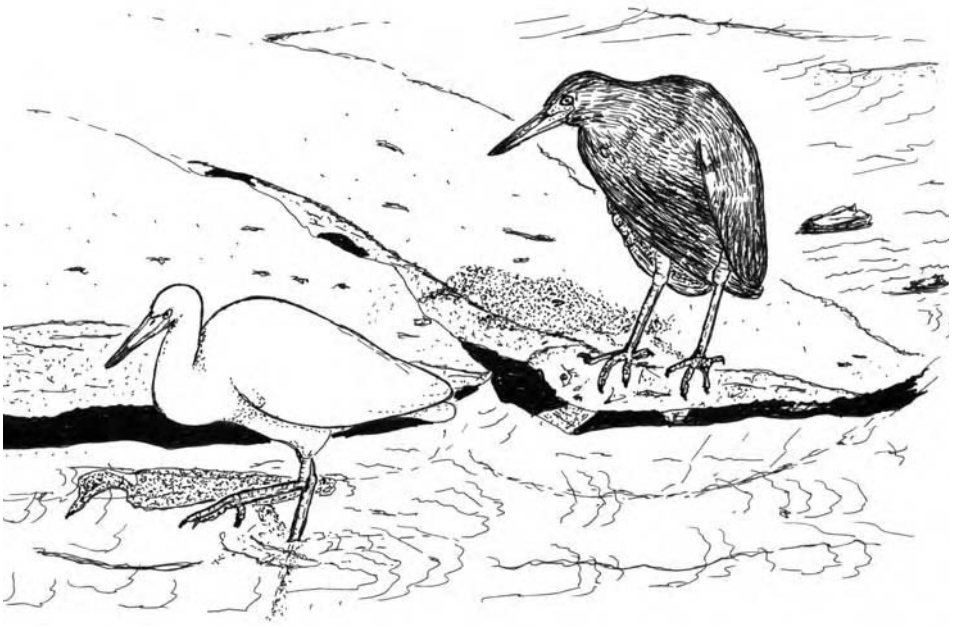
The Little Egret feeds in shallow open waters, fresh and salt, to a depth of about 15 cm, and in wet meadows and mudflats, foraging alone or in a loose flock. It uses diverse feeding methods, including dashing hither and thither through the water with wings raised in pursuit of prey. At times it closely follows other feeding waterbirds, presumably catching items disturbed by the 'host' bird. It eats fish, aquatic insects, crustaceans and spiders.

Breeding and status

Observations of the Little Egret in South Africa and Europe reveal a very similar breeding ecology to other egret species. The Little Egret nests in mixed-species heronries, building a stick nest and usually laying three to four pale blue-green or sea-green eggs. Large numbers nest in the NT using the same heronries as the other egrets there. Despite being the least-common egret species in these heronries the total number of breeding birds may be as high as 18 000. Other sites of importance, in the infrequent years of high rainfall and local flooding, have been the Gwydir wetlands and the Macquarie Marshes in inland NSW. Unfortunately, like the Intermediate Egret, its breeding numbers have probably been severely impacted at these sites by water management schemes.

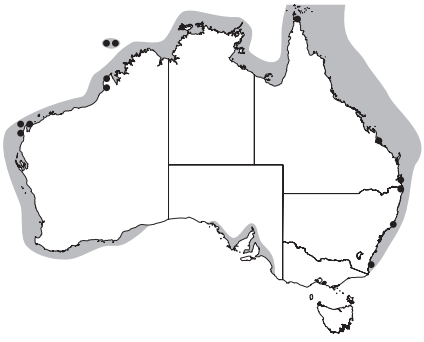
In recent years at least, Little Egret numbers may have stabilised as it has a (non-significant) slightly higher reporting rate in the new atlas compared with the old.

Eastern Reef Egret, *Egretta sacra*



The plumage of this medium-sized (330–450 g), strictly saltwater heron can be grey-black or all-white. The dark morph may have a streak of white feathers down its throat ventrally. This dimorphism is related to latitude and is independent of sex or age: the dark morph is found in New Zealand and along almost all of the southern Australian shores; the white morph becomes the most common morph as you progress north from the southern Great Barrier Reef. At Heron Island on the southern Great Barrier Reef a recent survey indicated rather more white (61%) than black. The Eastern Reef Egret's bill is heavy, either grey-black or yellow or dark above and yellow below and its legs are grey-yellow or greenish-yellow. The breeding bird has lanceolate plumes on its nape, back and lower foreneck that blend inconspicuously into the background colour of its contour feathers.

Distribution and movements



The Eastern Reef Egret is found along the coasts and on the islands of eastern and south-eastern Asia, Papua New Guinea and the south-western Pacific. It has been recorded from most of the Australian coastline and its islands, with some major gaps in the new atlas

such as most of the Victorian coastline and long stretches of the Gulf of Carpentaria and the Great Australian Bight. It used to breed throughout much of its range but may not breed now in south-west and southern Australia. It seems quite sedentary. Out of 17 recoveries of banded birds, the most distant was 536 km. The longest recovery interval was almost 15 years, of a bird recovered at its place of origin.

Feeding and food

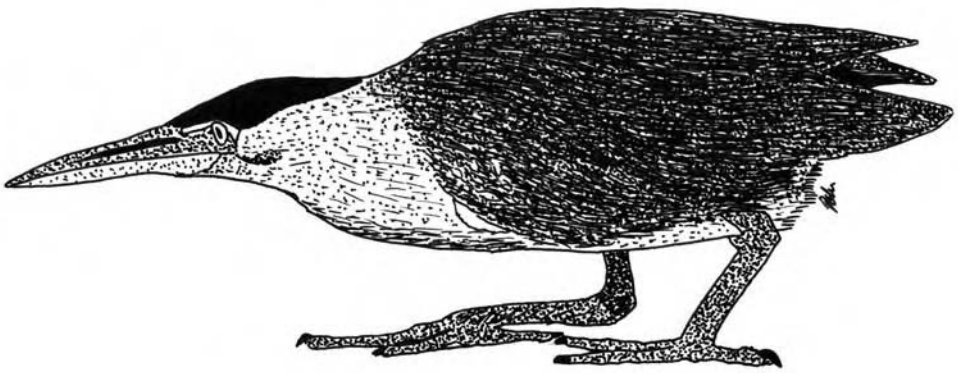
The Eastern Reef Egret feeds in shallow water in marine littoral and estuarine habitats, on rocky and muddy shores, and on reef crests and flats as these are exposed as the tide falls. They mostly feed actively, stalking their prey to take it by surprise. Some fly many kilometres across the sea to access these food sources. At high tide most roost in trees and shrubs along the strand but some scavenge on the forest floor under the nests of other birds. Flocks of several hundred aggregate on Top End beaches to feed on Flatback Turtle (*Natador depressus*) hatchlings in season. Fish are a major food source but also marine crustaceans and molluscs and small land animals, including the chicks of Black Noddy Terns (*Anous minutus*) that have fallen from the nest.

Breeding and status

The Eastern Reef Egret nests on the mainland coast and on islands such as the aptly named Heron Island on the southern Great Barrier Reef where some limited breeding studies have been undertaken. On Heron Island they nest in trees and shrubs, but elsewhere they also build on the ground under some cover, on cliff ledges and on piers. They either nest solitarily or in loose heronries of 20–70 pairs. The nesting season at the Top End seems mostly from August to December. By contrast the season at Heron Island is unusually long: from August through to April or May. This may allow enough time for a second brood to be raised although this has not been demonstrated conclusively. On Heron Island they typically lay only two pale bluish-white eggs and fledge a single chick. This may be related to a chronic shortage of food for the egrets in the coral reef environment as larger clutches have been reported elsewhere. They seem unusual in having a period of 'passive' nest attendance interposed between finishing nest building and laying. This lasted at least six days for one pair under observation. Other egrets lay immediately the nest is built, but this delay may be needed by the Reef Egrets in order to recover their body condition before laying a second clutch.

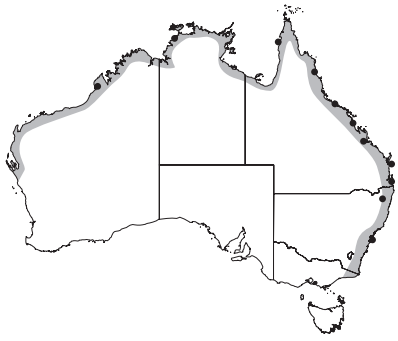
The Eastern Reef Egret is common on many Australian shores and on Great Barrier Reef islands.

Striated Heron, *Butorides striatus*



The Striated Heron is a small (200–250 g), stocky maritime heron. It is named after the streaked appearance of the juvenile. The adult is quite variable in its plumage colour, with its neck, wings and body being essentially grey in some, rufous in others and then some that are intermediates between these two morphs. Except in dark plumaged birds the back and wings are noticeably darker than the neck and underbody. All morphs have a dark streak from behind the eye to below the ear coverts. Adults also have a glossy black crown and a black nuchal crest that becomes more pronounced in the breeding bird. Its bill is large, black on top and yellowish underneath and its legs are yellow but become bright orange-red in some when they are breeding. The juvenile's head, neck and underparts have brown and buff streaks. Its plain, dark olive-brown back and dark crown distinguish it from the juvenile Night Heron with its streaked brown and buff upperparts.

Distribution and movements



The Striated Heron (known elsewhere mostly as the Green-backed Heron) occurs in tropical, sub-tropical and in some temperate regions across the world, including many oceanic islands. There are many discrete breeding populations and about 36 subspecies. As would be expected from this taxonomic diversity there is an enormous variety across the species in the colour of the plumage. Two subspecies are recognised for Australia: the subspecies *B. s. stagnatilis* is found along the coast from the Pilbara region of WA to the eastern Gulf of

Carpentaria where it possibly intergrades with the other subspecies *B. s. macrorhynchus*, which occurs from Cape York south along coastal eastern Australia to the border of NSW and Victoria. *B. s. stagnatilis* may be dimorphic with grey and rufous morphs. The Striated Heron is assumed to be sedentary in the absence of banding data.

Feeding and food

The Striated Heron feeds for the most part in littoral and estuarine habitats among mangroves and adjoining mudflats when these are exposed by the tide, but also in a variety of other marine habitats and even nearby freshwater wetlands. They hunt at night and during the day, often using the 'Stand and wait' method, but they also stalk, run and dive (feet first and head first!). Remarkably, in the USA, this heron has learned to use bait such as picnic scraps to lure fish close enough for it to catch. It eats marine fishes, crabs and other marine invertebrates and also terrestrial insects.

Breeding and status

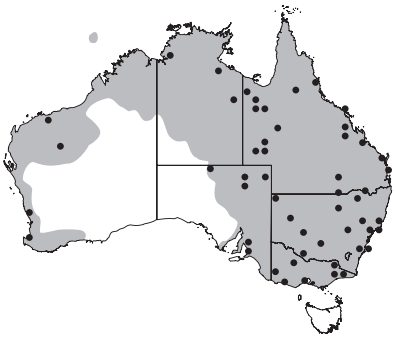
The few breeding records of Striated Herons are for locations scattered across its range. Its breeding biology is not well documented for Australia although it has been well studied overseas. It nests in mangroves or other coastal waterside vegetation, and nesting pairs are usually solitary, but a 'colony' of five close-spaced nests was recorded in the Top End. Its main nesting season may be from September to January in both southern and northern Australia but nests with eggs and chicks were found in the Top End in March. The clutch typically has two to four eggs that are a light green or turquoise colour and not glossy. The chicks can clamber out of the nest by 12 days post-hatching and fly at about five weeks (overseas record). The parents feed them for a further month at least.

The Striated Heron is quite a common bird in the NT, and although not hard to find in eastern Australia, its numbers must have declined in recent decades at locations where its mangrove habitat has been severely diminished by the filling and dredging activities that have accompanied coastal development. The new atlas showed a (not quite significant) 38% increase in its reporting rate compared with the old atlas, suggesting that its population sizes are at least being maintained.

Nankeen Night Heron, *Nycticorax caledonicus*

The Nankeen Night Heron is a medium–large (about 800 g) heron with a stocky build. While not rare it is not a conspicuous heron as it mostly feeds at night and often in dense vegetation. The adult is most distinctive with its black crown and cinnamon-rufous neck, back, wings and tail. Its underbody is paler. It has a dark bill, yellow or green lores and yellow legs. When breeding, two long, narrow white plumes extend back from the nape – although these are also seen in some non-breeding birds – the lores are blue and early in breeding it has pink legs. The juvenile looks very different with its heavily streaked mixture of brown and buff feathering on the head and neck and its mottled wings. Little is known about the voice of the Nankeen Night Heron except for its hoarse croaking calls when flushed. From my observations of a large roost of night herons I found them to be quite noisy and noted that birds competing for a perch either gave a high-pitched 'quak' or sometimes 'qo-quak' or alternatively a low-pitched, throaty 'ko-ko-ko'. When flying out of the roost they emitted a 'kro-kro' call that might be the same as the 'ko-ko-ko' call referred to above.

Distribution and movements



The Nankeen Night Heron is found in parts of South-East Asia, the Philippines and Papua New Guinea, and perhaps only as a vagrant in New Zealand. It is widespread in parts of Australia where there are wetlands. It breeds in south-east, central-eastern, south-west and northern Australia, at both inland and coastal locations, but not in Tasmania. Its movements are not well understood. The longest distance between banding (in NSW) and recovery (in Papua New Guinea) has been 2992 km and the longest elapsed time 10 years 8 months was for a bird that was both banded and recovered at Healesville, Victoria. Birds banded in south-west WA by contrast have been recovered just tens of kilometres from their banding site. It may be that this species opportunistically pursues a dispersive or sedentary lifestyle depending on environmental conditions.

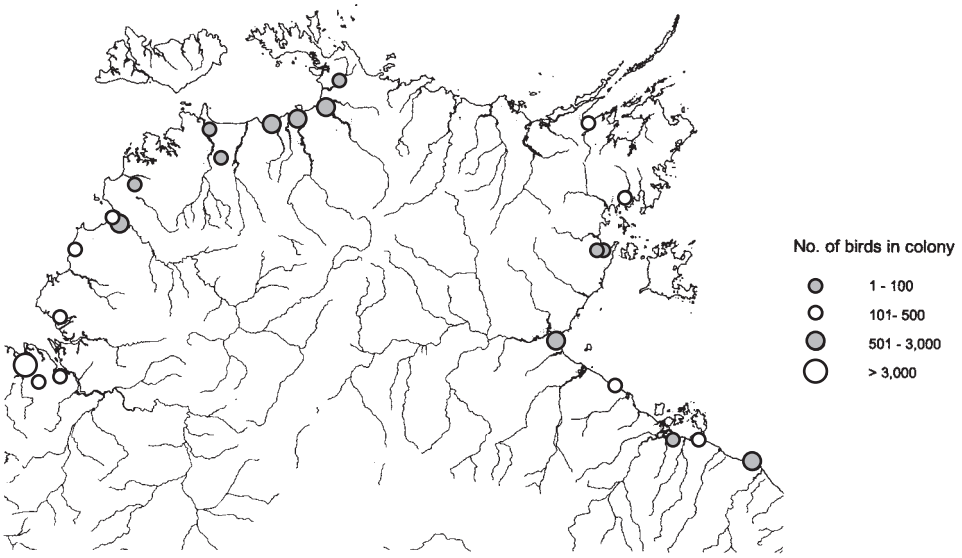
Feeding and food

The Nankeen Night Heron feeds in terrestrial wetlands and grasslands and to a lesser degree in littoral and estuarine habitats. It is also a scavenger, boldly foraging for scraps around human habitations during daylight hours. Both 'Stand and wait' and 'Walk slowly' feeding tactics are used and it consumes a wide range of aquatic and terrestrial invertebrates and vertebrates, including newly hatched turtles taken off the beach. It is believed to prey on the nestlings of other birds.

Breeding and status

The breeding behaviour of the Nankeen Night Heron is poorly known. It breeds in large mixed heronries but also sometimes solitarily. Some breed while still in their juvenile or immature plumage when aged two or three years. There is one report of a pair having a brood in winter and then again in summer. Its eggs are variously described as slightly glossy or not glossy and pale-bluish or green with two, three or four in a clutch. At one heronry of night herons and egrets on the Gingham Watercourse west of Moree, in northern NSW, the nests were spaced several metres apart at heights ranging from 12 to 14 metres in tall belah trees, *Casuarina cristata*. On inland floodplains they commonly nest in cooba trees and lignum shrublands (R. Jaensch pers. comm.).

Twenty-six Top End heronries are known to have had nesting Nankeen Night Herons. One heronry held about 4000 night herons and the total

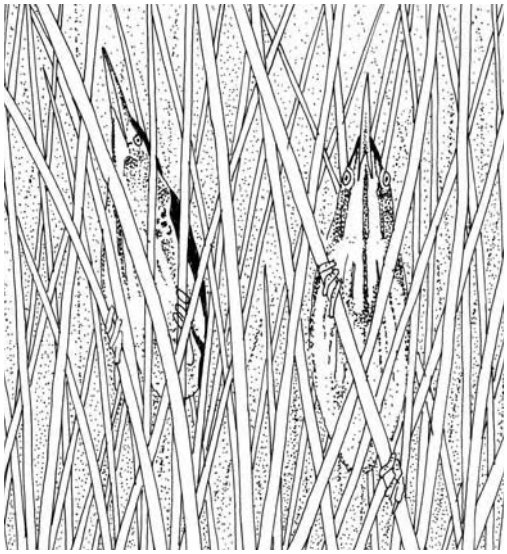


Location and size of Nankeen Night Heron heronries in the Top End in the 1990s.

number breeding in the Top End has been estimated to be about 19 000. Aerial observers have encountered some major problems in counting Nankeen Night Heron breeding numbers as it is sometimes difficult to separate day roosts from breeding sites; the herons are also reluctant to flush when a spotter plane flies over and their nests tend to be hidden below the canopy. The hidden nests especially are said to lead to massive undercounting (R. Jaensch pers. comm.).

Historically, in south-east Australia, several thousand pairs have been recorded nesting at locations such as the Gunbower State Forest and the Macquarie Marshes on the Murray–Darling System. In 2000, a mixed heronry of night herons and egrets nested, near the Gingham Watercourse (B. Southeron pers. comm.) that I subsequently estimated to have had about 4500 nests. In the following year, at the nearby Big Leather Watercourse, about 500 night herons occupied a day roost in a forest of black wattle, where adults outnumbered juveniles 15:1. Some adults had breeding plumes, but the necessary flood conditions required for nesting did not eventuate. An estimated 10 000 pairs have nested on the Channel Country floodplains in recent years. The new atlas indicates a national decrease in the reporting frequency of the Nankeen Night Heron.

Little Bittern, *Ixobrychus minutus*



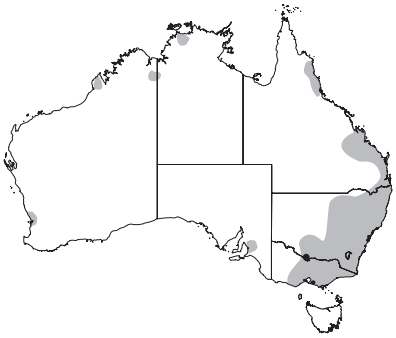
The smallest of the Australian herons, the Little Bittern weighs only about 85 g, tiny even when compared with the next smallest, the Striated Heron. A secretive bird, it is hard to observe as it generally confines itself to the cover of dense waterside vegetation. It may be seen as it flies low over the reed beds or ventures a short distance from cover while walking rapidly with a crouched, rail-like posture. A useful recognition feature of the Little Bittern is its large, conspicuous buff wing-patch. In contrast to other herons the sexes of the Little Bittern are readily distinguishable, the male having a black crown and back and the female a brown one. Both have a rufous-to-buff neck, black tail and underparts that are streaked brown against a whitish background. Its bill is yellow with a dark culmen and its legs are green. Although the Australian species is said not to undergo a seasonal change in plumage, its overseas counterpart is described as having a brighter plumage and longer, looser upper-breast feathers when breeding. Here the only reported change during breeding is that its bill and lores flush red. The juvenile has bold brown streaks on its crown and back and buff streaks on its paler underbody; it has no black on the crown, back or wings.

Given the cryptic nature of this bird, recognising its call would be a useful aid to identifying it. Its advertising call is described as 'croaking or grunting' repeated rhythmically about 10 times. Its alarm call is a sharp throaty, repeated 'quark'.

Distribution and movements

The nominate subspecies of the Little Bittern, *I. m. minutus*, is widely distributed across the European continent and as far east as western Siberia and Kashmir. *I. m. payesii* occurs over much of Africa, south of the Sahara and *I. m. podiceps* occurs in Madagascar. The Little Bittern is rare or absent in South-East Asia. In Australia the subspecies *I. m. dubius* is found over much of the south-eastern part of Australia: along the coastal plain from Mackay in central Queensland to South Australia and inland over much of the

Murray–Darling Basin. It is recorded from scattered near-coastal locations in north-east Queensland, the Top End and north-west WA. It is quite well known in south-west WA, north of Perth. Southern populations of *I. m. dubius* are probably migratory but there are few data to confirm this. It is said to leave the most southern parts of its range in autumn as its swamps dry out, spending winter in more northern, coastal drought-refuges and returning south in late winter and early spring. Its occurrence in the Trans-Fly region of southern Papua New Guinea raises the possibility of these being Australian migrants.



Feeding and food

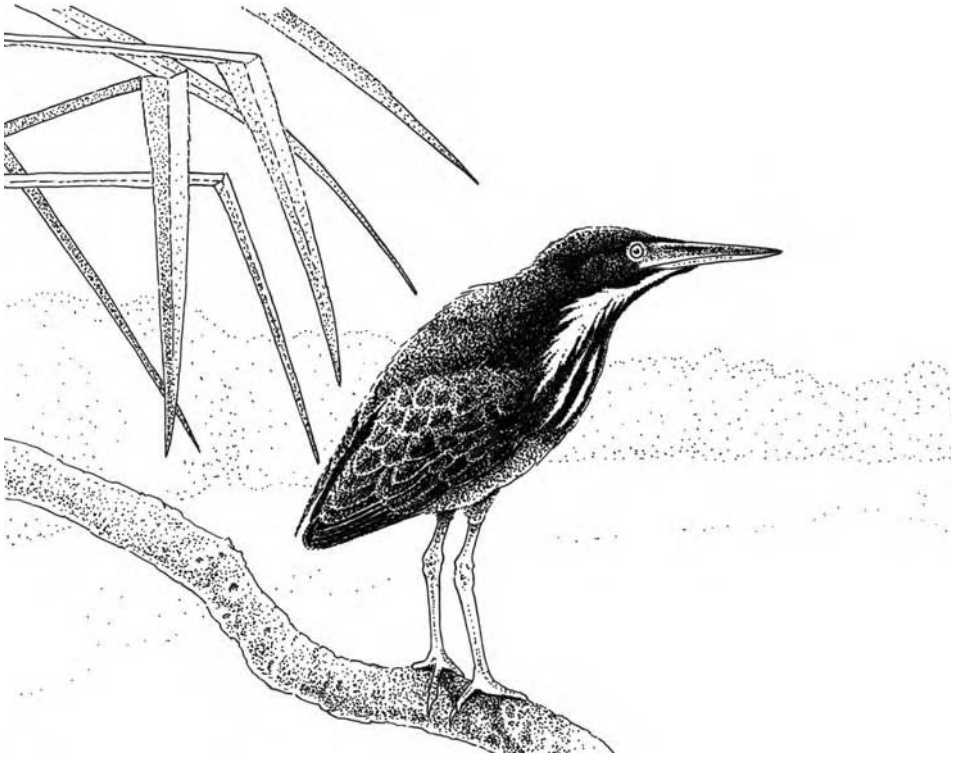
The Little Bittern usually forages alone at night or at dusk and dawn in dense waterside vegetation. It uses the 'Stand and wait' and 'Walk slowly' techniques to capture mainly small aquatic invertebrates, but it also eats fish and frogs.

Breeding and status

Little Bitterns nest solitarily or in loose groupings tens of metres apart. The nests are well concealed in, for example, reeds, sedges or melaleuca trees; built a short distance above water level; and usually more than 5 m from the shore. The nest is a flat or saucer-shaped platform of segments of reeds, fine twigs and other plant materials – presumably what is ready at hand. Little Bitterns breed in spring and summer in its southern habitats. Most records come from the Murray–Darling Basin but it nests regularly in freshwater swamps along the coastal plain and hinterland of WA, from north of Perth to east of Esperance (R. Jaensch pers. comm.). There are sparse breeding records from the tropics, north-west WA and southern Papua New Guinea.

In the short breeding season of Europe only one brood is produced but two broods per season are reported at lower latitudes. Its eggs are chalky white. There are contradictory data about clutch size: some reports suggest clutches of usually four to six eggs, a somewhat larger average clutch than that of other herons; others (R. Jaensch pers. comm.) suggest the usual clutch size is three to four eggs. The chicks of the European Little Bittern are said to leave the nest earlier (eight days) – when they seek shade in surrounding reeds – and fly earlier (four weeks) than the young of other herons. There are no precise data on this for the Australian Little Bittern. The Little Bittern's Australian population size is estimated at about 5000 in the 2000 *Action Plan for Australian Birds* and its status is 'Near Threatened'.

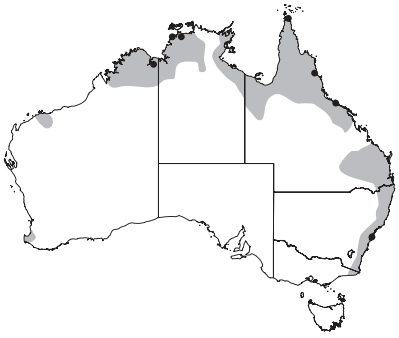
Black Bittern, *Ixobrychus flavicollis*



The Black Bittern is a secretive bird that rarely ventures out into the open. It is a medium-sized heron (300–420 g). The male is predominantly grey-black and the female dark brown. Both have uniformly dark feathers dorsally and a conspicuous buff-yellow stripe from the chin to the base of the neck on each side of the throat. The neck and upper breast are heavily streaked with brown, buff and off-white feathering. The bill is black on top and yellowish underneath and the legs and feet olive-brown. Seasonal variation in skin colour probably occurs but we are yet to ascertain the nature of this. The juvenile's plumage is paler than the adult, with a rufous wash. It has a brown crown and back feathers edged with buff. Its yellow neck stripe is less obvious than in the adult. The Black Bittern's contact call is a loud drawn out booming sound. Its alarm calls are said to be much quieter.

Distribution and movements

The Black Bittern occurs over the Indian subcontinent, east to southern China and through South-East Asia to Papua New Guinea. In Australia there is an isolated population in south-west WA but it is reported more or less continu-



ously from northern WA, across the Top End to Cape York and down the eastern seaboard to just barely entering Victoria. In contrast to the Little Bittern and Australasian Bittern, it is virtually absent from the Murray–Darling Basin. It is found in freshwater, littoral and estuarine wetlands, preferring those with a fringe of dense vegetation. Scattered breeding records come from across its northern and eastern range but none in recent times from south-west WA. Little is known of its movements, but isolated populations are probably sedentary.

Feeding and food

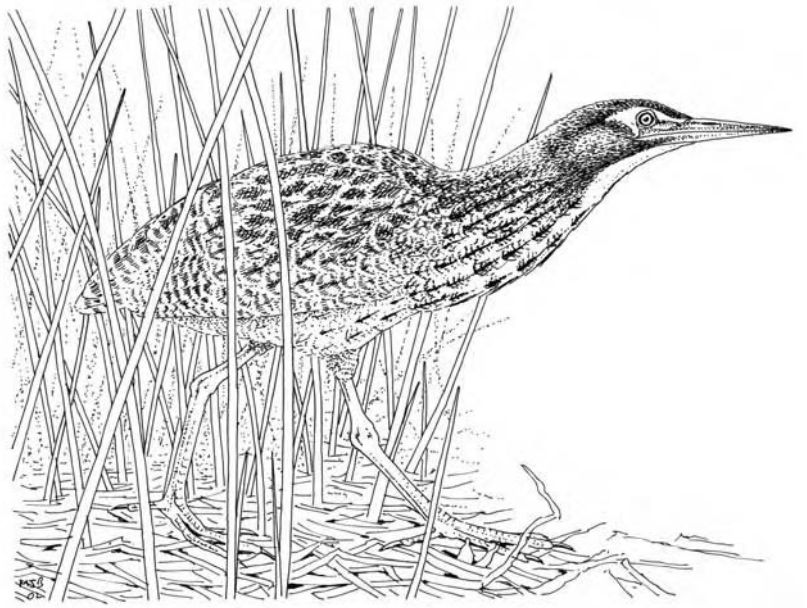
The Black Bittern's haunts are terrestrial wetlands, estuaries and the littoral zone, where it preys on fish, crayfish, mussels and a variety of other aquatic invertebrates. It forages along the edges of still and running water in a similar manner to the Little Bittern. It is most frequently encountered in permanent wetlands fringed by dense vegetation but rarely in open habitats.

Breeding and status

In Australia Black Bitterns are described as being solitary nesters occupying secluded sites in leafy trees overhanging water, but a report from India describes them nesting in a loose colony with their nests interspersed with those of egrets. Its nest is a loose platform of twigs typical of tree-nesting herons. There is very little information on their eggs or young. The eggs are slightly glossy, white externally and pale green inside. Their shape is described as 'swollen oval'; that is, relatively rounded.

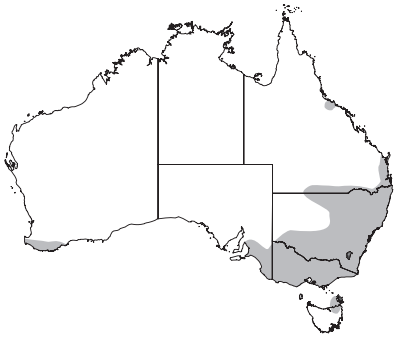
In the past 60 years the Black Bittern has declined in abundance in WA and is no longer seen in parts of Central Queensland. Its Australian population is estimated at roughly 20 000 and is declining in the south due to habitat loss resulting from salinisation, wetland drainage and clearing of riparian vegetation. Its numbers may be little changed in the north (R. Jaensch pers. comm.). Generally for Australia it is listed as 'Least Concern' in the 2000 *Action Plan for Australian Birds*.

Australasian Bittern, *Botaurus poiciloptilus*



The Australasian Bittern is our second-heaviest heron after the Great-billed Heron. The male weighs about 1400 g, not much more than the Great Egret (1200 g), but its build is a lot more compact. It is well camouflaged in its reedy habitats with its plumage of brown on a buff background, mottled on the back but streaked on the throat and breast. It has a white chin and a prominent dark brown stripe extending backwards from below its eyes to expand behind its ear coverts. Its bill is straw-yellow to buff but with a grey culmen and its legs are light green to olive. The female is much lighter (900 g) than the male and the juvenile is paler than the adult with heavy buff flecking on its back. The lore is pale or pea-green or (possibly in the breeding male) blue-grey. It gives a distinctive loud booming sound during the nesting season, which may serve for self-advertisement and territory defence here as it does for the European Bittern, *B. stellaris*.

Distribution and movements



The Australasian Bittern occurs in mainland Australia and New Zealand, some of their offshore islands, including Tasmania, and in New Caledonia. In Australia its range encompasses the Murray–Darling Basin and adjacent coastal regions from south-east

Queensland to South Australia, Tasmania and south-western WA. Breeding was recorded at well-separated locations in southern NSW, Victoria and New Zealand in the old atlas, but was not recorded anywhere in the new atlas. The Australasian Bittern is thought to be largely sedentary but to undertake short-distance movements. In wet years numbers may increase causing movements to isolated ephemeral wetlands.

Feeding and food

The Australasian Bittern feeds alone, mostly at night, in shallow, vegetated freshwater and brackish swamps. It engages in the 'Stand and wait' strategy, crouching or holding its head and neck parallel to the substrate while it stands absolutely still or sways its head from side to side, then lunging at prey by pivoting its legs. Its food includes quite large fish (e.g. a 60 cm long eel), frogs, freshwater crayfish and smaller aquatic invertebrates and terrestrial animals including rats and birds. A 1918 record also indicates that its diet includes leaves and fruit. It has been recorded baiting fish with small pieces of grass. Another curious feature is its feeding platform, a construction of flattened reeds that bears the remains of its prey.

Breeding and status

Little is known about the breeding behaviour of the Australasian Bittern. Pairs nest solitarily but sometimes quite close to other pairs. It typically nests in dense reed beds but also in bushes and trees. In a reed bed, its nest is a platform constructed of pieces of sedges or rushes. The belief that this bittern (and the Little Bittern) weaves a protective canopy from the reeds overhanging the nest requires further investigation. The clutch is usually four or five eggs but it can have three or six. The eggs are a glossy, pale olive-green or olive-brown colour.

There have been substantial contractions in recent times in its ranges in WA, south-east Queensland, SA and Tasmania, and some breeding habitats no longer exist. Its specialised habitat preferences may make it less adaptable to habitat modification than some other waterbirds. According to Roger Jaensch (pers. comm.), the Australasian Bittern has probably declined markedly in the Murray–Darling Basin over the last 50 years due to the extraction and regulation of water flows. Salinisation has destroyed much of its former inland habitat in south-west WA and the WA sub-population may only be a few hundred pairs, which persist mainly in coastal sedge swamps.

The 2000 *Action Plan for Australian Birds* lists the Australasian Bittern as 'Vulnerable' and gives an estimate of 2500 breeding birds nationally. However, the HSG classifies it as 'Critically Endangered'.

9
Occasional visitors

This chapter deals briefly with herons that you would be extremely fortunate to see in Australia but records have been confirmed by the Birds Australia Rarites Committee. These six species include two night herons, three bitterns and one day heron.

Black-crowned Night Heron, *Nycticorax nycticorax*

The Black-crowned Night Heron is a stocky (525–800 g) grey, white and black heron. The juvenile has streaky plumage that is very similar to that of the juvenile Nankeen Night Heron, however, the former is predominantly grey-brown in contrast with the rufous-brown of the latter.

Distribution and movements

The Black-crowned Night Heron is a truly cosmopolitan bird, occurring as it does in temperate and tropical Eurasia, Africa, North America and South America. It has in the past been recorded as a rare vagrant to Cocos-Keeling Island, but it does not appear in the 1998–2002 records submitted to the *New Atlas of Australian Birds*. It is also a rare, non-breeding visitor to southern Indonesia. It may form a super species with the Nankeen Night Heron. If this were the case hybridisation would occur where their distributions overlapped and there are indeed reports of them interbreeding, in, for example, Northern Sulawesi and the Philippines.

Feeding and food

The Black-crowned Night Heron feeds solitarily and mainly at night except when breeding. It forages in a wide variety of habitats, stalking its prey in open waters and reedy swamps. It has a diverse diet that includes the chicks of other species.

Breeding and status

The courtship of the Black-crowned Night Heron has been well studied. Its threat and courtship displays have a number of elements in common with day herons. It roosts and breeds colonially, building its nest from ground level to heights up to 50 m in a tall tree. It is reported living for 16.5 years. The Heron Specialist Group (HSG) rate it 'Regionally Vulnerable' in Europe and North Africa and 'Lower Risk/Least Concern' elsewhere.

Malayan Night Heron, *Gorsachius melanolophus*

The adult Malayan (or Malay) Night Heron is at first sight not unlike the adult Nankeen Night Heron in that both have mostly rufous upper parts and black on the head that extends onto the nape. However, the Malayan Night Heron is a somewhat smaller bird (450 g versus 800 g) and has heavily streaked underparts. The plumage of the juvenile is brown overall with white spots.

Distribution and movements

The Malayan Night Heron breeds only in India and South-East Asia but it occurs in Japan and Taiwan also. It is described as a partial migrant and birds from India fly to Indonesia for the winter months. Juveniles of this species have been recorded on Christmas Island.

Feeding and food

Favoured feeding places of the Malayan Night Heron are wetlands in dense primary and secondary forests, where it preys on insects, molluscs, frogs and lizards.

Breeding and status

There are large gaps in our knowledge of this species. It nests in trees and, perhaps less frequently, in reeds. No data are available on population size. The HSG classify it as 'Vulnerable' in the Philippines and 'Lower Risk/Near Threatened' in other parts of its range. All four of its subspecies have apparently suffered habitat loss.

Yellow Bittern, *Ixobrychus sinensis*

The Yellow Bittern, also known as the Chinese Little Bittern, is very small and lightweight, being only 30–40 cm long and weighing about 54 g. Its low body weight contrasts with the Australian Little Bittern, which is shorter, 25–36 cm, but weighs about 85 g. It has a pale yellow-brown back and black flight feathers that give it a piebald appearance in flight. The adult male Yellow Bittern has a rufous back, which distinguishes it from the black-backed male Little Bittern. The female Yellow Bittern often has a striped throat and foreneck. The heavily streaked juvenile is similar in appearance to the juvenile Little Bittern.

Distribution and movements

The Yellow Bittern's range covers eastern Russia and China, Japan, northern South-East Asia, Papua New Guinea and the Indian subcontinent. There have been rare sightings of it in mainland Australia (one record) and Christmas Island (two records), but not in recent years. Those that breed from Central China northwards are regular migrants, joining resident tropical populations to escape the boreal winter. Evidently some fly very long distances, even reaching as far south as Papua New Guinea.

Feeding and food

The Yellow Bittern feeds solitarily in a variety of densely vegetated habitats including mangrove swamps and rice paddies. Its food includes insects, molluscs, crustaceans, frogs and fish.

Breeding and status

The Yellow Bittern's nesting season starts with the onset of spring in the north of its range and with the rains in more tropical climes. Nests are solitary or in scattered groups where the habitat is favourable. The nest is a pad of marsh vegetation usually overhung with a woven canopy of foliage. It may choose to build in reeds, or wild sugarcane, bamboo or mangrove trees in different parts of its range.

Its extensive migrations make it difficult to determine the status of local populations. The HSG categorise it as 'Lower Risk/Least Concern'.

Cinnamon Bittern, *Ixobrychus cinnamomeus*

The Cinnamon Bittern is a small (41 cm long) bittern that is rufous dorsally except that the female has a sooty-grey crown. The chin and throat are a pale buff-white with a ragged dark brown median streak that in the female is flanked by a more lateral series of broken lines. Both sexes have a tuft of loose

extensible dark feathers on the side of the lower neck that is most prominent when the bird is displaying.

Distribution and movements

The Cinnamon Bittern has a range that extends from Japan, through east and south China and across Asia to India and Sri Lanka, south to Sumatra through peninsular Malaysia, and in Borneo and Sulawesi. It is shown as being absent from the southern islands of Indonesia and the only report for Australia is a recent record from Christmas Island.

Feeding and food

The Cinnamon Bittern utilises paddy fields and drainage ditches as well as natural reed beds, rank grass and riparian scrubs. Its food includes insects, molluscs, frogs and fish.

Breeding and status

Although it has been reported nesting with other species it is doubtful that the Cinnamon Bittern is generally a colonial nester. It nests in reeds and bamboo during July and August, well after the monsoon has set in, at the western end of its range.

A fairly common species, the Cinnamon Bittern is described by the HSG as being 'Lower Risk/Least Concern' in Asia.

Schrenk's Bittern, *Ixobrychus eurhythmus*

The Schrenk's Bittern is a small bittern with a deep chestnut-brown back and a blackish crown and tail. It has a buff-coloured window on the upper wing and lead-grey flight feathers. Females and juveniles are brown, speckled with white, brown and black dorsally and with broad brown and white streaks ventrally.

Distribution and movements

The Schrenk's Bittern has a breeding distribution that includes Japan, Korea and from Hong Kong to Manchuria in northern China. Non-breeding birds are widely but thinly dispersed through South-East Asia. It has not been recorded for mainland Australia but a dead specimen was found on Christmas Island in November 2003.

Feeding and food

Little is known about the Schrenk's Bittern but stomach content analyses reveal fishes, crustaceans and aquatic insects in their diet. They also eat ground crickets.

Breeding and status

The female builds the nest in tall grass or shrubs close to the ground. It is said to be lined with clay to prevent water seepage into the nest! Both parents incubate but the male is reported to do most of the feeding of chicks.

The distribution of the Schrenk's Bittern makes it difficult to obtain accurate population estimates. Only three proven breeding sites were located in a recent survey in Japan. The IUCN rate it 'Lower Risk/Near Threatened' and the HSG as 'Data Deficient'.

Grey Heron, *Ardea cinerea*

The Grey Heron is a large, attractively plumaged heron. Its head, neck and belly are mostly white and its back grey. A thick streak of black feathers extends from above the eye to the back of the crown; two lines of black run down the neck ventrally; and the sides of its belly are black. The juvenile has a more uniformly grey plumage.

Distribution and movements

The Grey Heron occurs over most of the world but is absent from the Americas and until recently, Australia. It has a patchy distribution over South-East Asia but small local populations in Indonesia are augmented by a large winter influx. At least one of these migrants may have overshot its destination to land in south-west WA: a sighting of a Grey Heron at Busselton in May 2002 has been accepted by the Birds Australia Rarities Committee, this committee deciding it was most likely a genuine vagrant from Asia rather than an aviary escapee. In the Northern Hemisphere a complex pattern of movements is revealed by numerous recoveries of banded Grey Herons. Those of northern Britain and parts of Europe tend to stay within about 200 km of their natal heronry, even in Scotland throughout the cold of winter. Members of southern Britain and some European populations undertake a nomadic dispersal after nesting has finished, followed by an autumn migration. They mostly travel at night in a south-west direction. Most remain in Europe with only a small minority crossing the Mediterranean Sea.

Feeding and food

The Grey Heron feeds in the shallows of fresh, brackish water and saltwater, preferring open habitats. It mostly eats fish, using the 'Stand and wait' and 'Walk slowly' techniques, but also feeds on birds, reptiles, frogs and a variety of invertebrates.

Breeding and status

The Grey Heron's breeding biology has been well studied in Britain and Europe. National censuses of its breeding numbers undertaken in Britain from 1928 to 1985 revealed large inter-annual variations in numbers, with downturns that were mainly attributed to increased mortality during unusually cold winters. Numbers recovered over the years of mild winters that followed. The HSG classify it as 'Vulnerable' in South-East Asia and 'Lower Risk/Least Concern' in Europe.

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