CHAPTER 1

BACKGROUND AND GENERAL METHODS

Systematics and Distribution

The parrot order (Psittaciformes) is a distinct and apparently monophyletic group, with little close resemblance to other extant orders (Smith 1975, Sibley & Ahlquist 1990). The earliest fossil parrots date to about 30 million years ago, and their closest living relatives are usually considered to be the pigeons (Forshaw 1977). The most conspicuous feature of the parrots is their short, blunt, rounded bill. Others include a large broad head and short neck, thick prehensile tongue, zygodactyl feet, and a featherless cere surrounding the nostrils at the base of the upper mandible. The order includes some 330 - 350 species, distributed mostly in or near the tropics, and concentrated in the southern hemisphere. Numbers and diversity are highest in Australia and South America, and much lower in Asia and Africa.

Parrots are noted for their longevity. Little information is available from the wild, but in captivity some species have lived for up to eighty years or more (Hill 1954, Forshaw 1977, p.27). Most species feed on seeds and fruits, but some take nectar or insects. Almost all species nest in tree hollows that they do not excavate themselves. The vast majority are socially monogamous, and most appear to mate for long periods, possibly for life.

The cockatoos are a well-defined and apparently ancient monophyletic subgroup of parrots (Adams et al. 1984, Christidis et al. 1991a). They are most often assigned to the family Cacatuidae, but other authors have assigned the same group to the subfamily Cacatuinae or the tribe Cacatuini (e.g., Smith 1975, Adams et al. 1984, Christidis et al. 1991b). Their most obvious distinguishing characteristic is a feather crest on the head that can be raised and lowered. Other distinguishing physical features include the presence of a gall bladder and powder down, lack of Dyck-texture in the feathers, and features of the carotid arteries and skull.

The distribution of cockatoos is centered in Australia, both in terms of numbers of species and individuals, but some species occur in the islands of Indonesia, the Solomons, and the Philippines. There are six cockatoo genera, including two that contain a disputed number of species. Depending on taxonomic opinion, the number of cockatoo species varies from 18 to 22. The genus *Calyptorhynchus* is endemic to Australia. It includes, in addition to the glossy black-cockatoo *C. lathami*, the red-tailed black-cockatoo *C. magnificus*, and the *C. funereus* complex, containing between one and four species of white-tailed and yellow-tailed black-cockatoos.

The glossy black-cockatoo is a sister species to the red-tailed black-cockatoo (Ford 1980). It contains three subspecies: the core population *C. l. lathami* occurs from southern Queensland through New South Wales to eastern Victoria, *C. l. erebus* occurs along the central east coast of Queensland, and *C. l. halmaturinus* is isolated from the rest of the species in South Australia (Schodde et al. 1993). Although the South Australian subspecies is now restricted to Kangaroo Island, its range included mainland South Australia as recently as the 1960's (Joseph 1989).

The glossy black-cockatoo was first described by Nicholas Baudin while exploring the Australian coastline in 1803 (Cornell 1974). Until the 1980's only occasional notes on their habits and distribution were published (e.g., North 1896,

Mathews 1916, Hyem 1933, Lendon 1946, Hallstrom 1954, Cleland & Sims 1968, Forshaw 1969). The first study of the species was a survey of the Kangaroo Island population, with notes on behavior and natural history (Joseph 1982). Further research has included a quantitative study of foraging ecology in *C. l. lathami* (Clout 1989), and a morphological study of subspeciation (Schodde et al. 1993).

Previous Field Studies on Parrots

Only a few parrot species have been well studied, most of them in captivity. In particular, the budgerigar (*Melopsittacus undulatus*) has been used in dozens of laboratory studies (reviewed in Arrowood & Saunders 1991). Non-cockatoo species that have been studied closely in the wild include the budgerigar (Rothwell & Amadon 1964, Schrader 1975, Wyndham 1980-1983), the monk parakeet (*Myiopsitta monachus*; Humphrey & Peterson 1978, Martella & Bucher 1990, Navarro & Bucher 1990, Martin & Bucher 1993), and the Puerto Rican parrot (*Amazona vittata*; Snyder et al. 1987).

One member of the black-cockatoo genus, the short-billed white-tailed black-cockatoo or Carnaby's cockatoo (*Calyptorhynchus funereus latirostris*), has been quite well studied in the wild (Saunders 1974 - 1986). Field studies have also been conducted on the sulphur-crested or white cockatoo *Cacatua galerita* (Noske 1983), the galah *Eolophus roseicapillus* (Rowley 1990), the Major Mitchell or pink cockatoo *Cacatua leadbeateri* (Rowley & Chapman 1991), and the long-billed corella *Cacatua tenuirostris* (Emison et al. 1994). Parrots are quite difficult to follow and observe away from the nest, and for that reason most field research has focused on the behavior and biology of nesting. Social behavior among known individuals outside the breeding season has not been the subject of any previous study in any parrot species.

The Current Study: General Methods

Study site

The research reported here was conducted on Kangaroo Island, South Australia during Feb. - Dec. 1991 and Sept. 1992 - Aug. 1993. Kangaroo Island is located 13 km from the mainland near the city of Adelaide, at 137° E, 36° S. It is Australia's third largest island, with an area of about 4400 square km. Its climate is characterized by mild wet winters and warm dry summers. About one third of the Island is covered in natural vegetation, mostly within National Parks and Conservation Parks. Chapters 3 through 7 are based on observational studies of known individuals in and near Lathami Conservation Park, near Stokes Bay on the Island's north coast (137° 14' E, 36° 37' S). This primary study area comprised about two square km.

General methods

I used the following plumage criteria to assign individuals to age-sex categories (based on Sindel & Lynn 1989, Courtney 1986, Connors & Connors 1988, Joseph 1984): Adult males had little or no yellow on the head, no yellow on the body and tail, and no black bars across the red tail panel. Subadult males were distinguished from adults by partial tail barring. Adult females always had at least some bars on the tail panel (usually fully barred), and almost always extensive yellow head markings. Some adult females also had fine yellow speckling on the wing coverts, larger yellow spots on the under tail coverts, or a yellow wash in the tail panel. Juveniles had only fine yellow speckling on the side of the head (in contrast to the larger irregular spots on adults), and completely barred tail panels with fewer and wider black bands than adult females. A number of behavioral characteristics were also helpful in confirming age-sex categories. Only adult males were paired with females, and only adult and subadult males gave "kwee-chuck"

calls and bow displays (Chapter 3, Joseph 1982, Sindel & Lynn 1989). Adult females were virtually always paired with a male. Only juveniles closely accompanied adult pairs and were fed and preened by them.

Most but not all individuals were recognizable. The prominent yellow head and neck markings on females vary markedly between individuals, making them quite easy to identify individually. Markings on the tail, wing, chest, and abdomen were also helpful. About half of the adult males were recognizable by small yellow spots on the head, usually in the neck area, and a few could be identified by bill markings. To provide a record of identifying marks, individuals were sketched, photographed, and described using a matrix of characters present or absent. In 1993, I also videotaped individuals to record their characteristic markings. In 1991 I collected data on 27 known individuals, including 11 pairs, 4 unpaired males, and one juvenile, and in 1993 I collected data on 23 individuals, including 9 pairs, two males, and one juvenile. Of the total of 36 "known" individuals, 29 could be reliably recognized by their markings, while seven males were usually identified only by their consistent association with a known female.

I was assisted with data collection by one field assistant for four months in 1991, and by two assistants for three months in 1993. To habituate the study population, we arrived at the cockatoos' habitual roosting location before dawn and followed them when they moved away to forage. We were also able to locate cockatoos by listening for their calls, or on still days by listening for the sound of cracking seed cones as they fed. The cockatoos became habituated after we followed them for several weeks, and no longer gave alarm calls, withdrew, or interrupted their ongoing activities at our approach. Thereafter we were able to observe them from as little as 5-10 meters without disturbing them. We observed using binoculars, recorded data on check sheets, and later entered data into computer spreadsheets for analysis. The data collection protocols used included Perch Scans in 1991, Focal Follows and *Ad Libitum* observations in both 1991 and 1993,

and Nest Watches in 1993, as described below. Specific behaviors are described in Chapter 3.

Perch Scans

We conducted scan samples when we found more than one family perching together in a eucalyptus tree. We recorded each occurrence of the following behaviors on check sheets, along with who performed them, when, and who they were directed toward: Join tree, Leave tree, Bow display, Spread-wing Display, Supplants, Lunge, Fence With Bill, Allofeed, Hang Upside-down, and Vocalize. At 10 minute intervals, we recorded the following for each individual present: identity of the nearest neighbor and the nearest non-family member, what individuals were perched in contact or allopreening, and the relative heights of all birds in the tree. We continued observations as long as more than one pair remained in the tree. We conducted 39 perch scans covering about 20 hours, with an average of six individuals per perching group. The 23 known individuals involved appeared in an average of 26 time point samples each.

Focal Follows

Because pairs were very cohesive, we conducted focal follows on them rather than on single individuals. We maintained a "target" list in an effort to sample all pairs equally, and initiated a focal follow on the first bird we encountered from the list. Focal follows lasted 30 minutes in 1991, and as long as possible in 1992-93. We recorded on check sheets all behavioral states and events that were either performed by or directed toward the focal pair. Behavioral states were recorded with start and stop times, and were considered to stop after a lapse of at least five seconds. They included: Eat, Autopreen, Raise Crest, Beg, Call, Sleeping Position, Perch in Contact, Allopreen, Foliage Bathe, and Roost. Behavioral events were recorded without durations, and included: Join tree,

Leave tree, Fly toward, Fly away from, Walk/climb toward, Walk/climb away from, Spread-wing Display, Supplants, Lunge, Fence With Bill, Bob Head, Allofeed, Take Cone, Hang Upside-down, Bow Display, and Kwee-chuck Call. In addition to the "all-occurrence" data described above, we recorded "time point" data at 10 minute intervals, including the behavior of the focal pair (Eating , Flying, Sleeping Position, Autopreening, Allopreening, Foliage Bathing, Perching quietly), and the primary group activity (Eating, Flying, or Perching). We also recorded what species of tree each family member was in, who else was in the tree, and the identity of the nearest individual and the nearest non-family member. For paired birds we recorded the distance to the mate and the nearest non-family member in body lengths (approximately 48 cm; Forshaw 1977), and whether they were oriented toward or away from their mate (based on head orientation, divided into two equal hemispheres). In 1991 we conducted 148 focal follows on 20 individuals totaling 65 hours, and in 1993 we completed 38 follows on 21 individuals totaling 181 hours.

Nest Watches

During nest watches, instead of following a focal pair we stayed at an active nest from before dawn to after dusk. We recorded all arrivals and departures, all entries and exits from the nest hollow, all social interaction and interactions between the nesting pair and other species, and all social interactions within the nesting pair. We conducted 12 all-day watches at six nests of five different pairs.

***Ad Libitum* observations**

Both between and during other data collection protocols, we recorded rare behaviors on *ad libitum* basis, along with time, location, who the behavior was performed by and directed toward, and the behavioral context. These behaviors included affiliative

behaviors such as allofeeding, taking cones, allopreening, and copulations; and agonistic behaviors such as wingspread displays, lunges, bill fencing, and chases.

Data analysis

Data were entered into computer spreadsheets with database functions (Microsoft Excel) for processing and tabulating. For most statistical analyses I used Systat for Windows (Wilkinson 1992).

Breeding and non-breeding seasons were not delineated by any obvious changes in activity, as in some bird species. To compare behavior between seasons therefore, I designated as breeding season all months in which I observed any nesting activity. The breeding season coincided with the austral autumn and winter (March - August), and the non-breeding season the austral spring and summer (September - February). This division was in accord with the species' breeding season as reported by Forshaw (1977).

Overview of Chapter Contents

Resource distribution and use are foundations of social organization and behavior in any species. In Chapter 2, I survey the South Australian glossy black-cockatoo and its habitat across its current range. The results provide information on the population's size, structure, and habitat requirements, and show that the quality of foraging and nesting resources affects the distribution of cockatoos among habitat patches.

Clear descriptions of behavior are a necessary foundation for all behavioral research. I provide an ethogram for the glossy black-cockatoo in Chapter 3, along with comparisons to the behavior of related species, and discussions of hypothesized functions.

Many of the differences in social behavior between glossy black-cockatoos and their closest relatives are probably due to their unusual foraging ecology. In Chapter 4, I

examine foraging behavior and ecology on a fine scale, and relate it to the broader patterns shown in Chapter 2. The results show that food handling skills are crucial, as the cockatoos are energetically limited by the speed with which they can extract very small seeds from hard woody seed cones.

Chapters 5 and 6 focus on social behavior and social relationships. Chapter 5 provides a quantitative description of how glossy black-cockatoo groups are organized, how agonistic and affiliative interactions are structured within groups, and what kinds of social bonds exist. The most striking result is the very close and cooperative social bonds maintained year round by monogamous pairs. Chapter 6 examines the hypothesis that brain size and intelligence in parrots has evolved to meet the demands of complex social interactions. This hypothesis has received considerable attention among primatologists, but there have been few previous attempts to generalize it to other orders. Parrot social behavior in general, and especially the role of mated pairs as cooperative alliances in resource competition, are in accord with the predictions of the "social cognition" hypotheses regarding unusually large-brained animals.

In Chapter 7, I investigate the nature and extent of lateralized behaviors, including both "footedness", which has been described in other parrots previously, and lateralized use of the bill and tongue, which has not. Based on the results I propose a new hypothesis for the evolution of behavioral laterality based on the advantage laterality provides in learning complex motor skills. This hypothesis may be generally applicable across taxonomic groups, and would explain the correlation across species between behavioral laterality and relative brain size.

Chapter 8 is not about glossy black-cockatoos, but describes a new analytical method I applied in my research. The problem of testing and measuring social preferences among individuals is a very general one, but a lack of adequate methods has long impeded research in this area. I describe a randomization approach using group

composition data that solves these problems, and is widely applicable to studies of social behavior.

In the three Appendix chapters, I address the problem of conserving this endangered subspecies. Chapter 9 reviews both published and unpublished evidence to assess the population's current conservation status. The results show that the population is critically small, and has probably continued its historical decline in recent decades. In Chapter 10, I use computer simulations to examine the population's current viability, what additional information is most needed to manage it successfully, and how effective various management options are likely to be. The results show that loss of genetic variability is not a pressing management concern. Extinction is, however, and the species' long generation time could be masking deleterious demographic trends in an aging population. Finally, in Chapter 11, I present a detailed conservation plan for the species, incorporating additional research, public education, habitat preservation and improvement, use of artificial nest boxes, and ultimately re-introducing the subspecies to its former range on the mainland.

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