Estimating the distribution and abundance of Glossy Black-Cockatoo on the Gold Coast, Australia, using a systematic survey

J. Guy Castley and Michelle J. Stock

Environmental Futures Centre, The Griffith School of Environment, Gold Coast campus

Estimating the distribution and abundance of Glossy Black-Cockatoo on the Gold Coast, Australia, using a systematic survey

J. Guy Castley and Michelle J. Stock

Environmental Futures Centre, The Griffith School of Environment, Gold Coast campus, Griffith University, QLD, 4222, Australia. g.castley@griffith.edu.au,

Summary

The persistence of Glossy Black-Cockatoo, *Calyptorhynchus lathami lathami*, in south-east Queensland is threatened by habitat loss associated with ongoing urban development. Effective conservation and management strategies for this species therefore require detailed information on, and regular monitoring of its distribution and abundance at a regional level. To meet this need, we designed a systematic survey held as an inaugural Glossy Black-Cockatoo birding day in May 2009 on the Gold Coast, south-east Queensland, Australia. This survey was the first of its kind for the species. Historical sighting records were first mapped as a sighting frequency within 1km² grid cells across the region. A total of 62 grid cells, representing 35% of the 176 km² area of prior sighting locations, were then surveyed from dawn to dusk on a single day by volunteers. Forty-five birds were observed on the day while a further six birds were heard. Extrapolating the density estimate of 0.82 birds / km² within the surveyed area to the broader area of prior sighting locations yields a minimum population estimate of 145 birds. The majority of feeding activity recorded on the day was from sites which had no birds present. The survey provides the first population census for the species in south-east Queensland and a baseline for future monitoring of trends within this regionally significant population.

Keywords: survey, *Calyptorhynchus*, population demography, monitoring

Introduction

The distribution and abundance of species, and the factors that determine these parameters, remains a central question in current ecological studies (Belovsky *et al.* 2004). Until we are able to increase our understanding of such fundamental questions our ability to implement effective conservation and management strategies will be compromised (Underhill and Gibbons 2002; Guisan *et al.* 2006; Greenwood 2007). Many of the species within the diverse parrot and cockatoo assemblages of Australia are threatened and therefore require strategic conservation actions to ensure their persistence. A species that has been the focus of considerable attention is the Glossy Black-Cockatoo.

The Glossy Black-Cockatoo, *Calyptorhynchus lathami*, is a widespread endemic species occurring throughout eastern and south-eastern Australia (Higgins 1999; Garnett *et al.* 2000). Despite its relatively extensive range, the species is regionally threatened as populations in some areas face ongoing pressure through habitat loss, transformation and climate change (Cameron 2006; 2009). Three subspecies are recognised, differentiated according to beak and wing morphology (Schodde *et al.* 1993; Garnett *et al.* 2000), with non-overlapping ranges. The northern subspecies, *Calyptorhynchus lathami erebus*, occurs in north-eastern Australia (central Queensland), the most widespread subspecies, *Calyptorhynchus lathami lathami*, occupies central and south-eastern Australia (mid Queensland to Victoria), and the most isolated subspecies, *Calyptorhynchus lathami halmaturinus*, is found only on Kangaroo Island in South Australia (Joseph 1982; Pepper 1997; Garnett *et al.* 1999; Pepper *et al.* 2000). Only the Kangaroo Island population is listed as endangered at a federal level (Mooney and Pedler 2005), while *C. l. lathami* is listed as vulnerable under Queensland, New South Wales and Victoria conservation legislation at the State level. As such a recovery plan for the species is only in place for the Kangaroo Island population.

A considerable amount of research has been undertaken on the Glossy Black-Cockatoo, particularly on Kangaroo Island and much has been learned about their highly specialised feeding behaviour (Clout 1989; Crowley and Garnett 2001; Cameron 2005; Chapman and Paton 2005; 2006; Chapman 2007) and breeding biology (Garnett *et al* 1999; Cameron 2006). Glossy Black-Cockatoo feed only on kernels found within the cones of casuarinas (*Allocasuarina* spp. and *Casuarina* spp., Casuarinaceae), often focussing on a single casuarina species in specific regions (Clout 1989; Cameron and Cunningham 2006; Chapman 2007). Like other cockatoos, the Glossy Black-Cockatoo nests only in hollows within large, old eucalypt trees, primarily *Eucalyptus* species. If breeding is successful, they raise a single chick every two years (Garnett *et al.* 1999). Further research has been completed to assess population responses to management interventions aimed at improving breeding success (Mooney and Pedler 2005). Many of these studies focussed on the endangered population on Kangaroo Island, but more recently studies on NSW and QLD populations have focussed on foraging ecology and habitat selection (Cameron 2005; 2006; Cameron and Cunningham 2006). Yet, the nature of daily movements and how the species utilises its habitats at a landscape scale remains poorly understood. Furthermore, while there is historical information on the distribution of the species at a broad landscape level (e.g. Barrett *et al.* 2003), there is little information on abundance and trends in population size in most areas, including the south-east Queensland (SEQ) region. SEQ is thought to be a regional hotspot for the species with birds distributed throughout a range of habitats stretching from the coastal zone to the hinterland. This dearth of information on these ecological parameters makes it increasingly difficult to manage populations in an area that is subjected to ongoing development pressure.

One mechanism whereby researchers and managers can assess the distribution of the species is through using an index to quantify their use of feeding sites across the landscape. This method provides a measure of which areas are important for the Glossy Black-

Cockatoo (Robinson and Paull 2009), but it also has the potential to estimate population size or density within a region. Estimating population size for a cryptic species that occurs at low density, such as the Glossy Black-Cockatoo, is complex and distance sampling procedures can be useful for estimating the density of parrot and cockatoo populations at local scales (Cassagrande and Beissinger 1997; Marsden 1999; Kinnaird *et al.* 2003; Rivera-Milán *et al.* 2005). However, these methods are not necessarily applicable at a larger, landscape scale, particularly when the species of interest may be moving quite large distances. Distance sampling methods also require large numbers of observations to enable robust estimates of population densities to be derived. Alternative methods for monitoring bird population trends over the medium to long-term include atlas projects (Robertson *et al.* 1995; Gibbons *et al.* 2007) and simultaneous counts of certain species within specified time frames at known locations (Pithon and Dytham 1999, Downs 2005). Bird atlasing projects have been used extensively in many countries to reflect not only the distribution of species (Robertson *et al.* 1995; Harrison *et al.* 1997; Barrett *et al.* 2003), but increasingly the likelihood of occurrence and abundance of populations in these areas (Shukuroglou and McCarthy 2006; Gibbons *et al.* 2007; Greenwood 2007). Simultaneous counts provide estimates of population size, and repeated surveys of the same locations enables researchers to monitor trends within these populations. Examples of such surveys include the annual Glossy Black-Cockatoo surveys on Kangaroo Island, Red-tailed Black-Cockatoo surveys in Victoria and South Australia, and an annual co-ordinated count that has monitored population size and trend of the threatened Cape Parrot, *Poicephalus robustus robustus* in South Africa since 1998 (Downs 2005).

Here we review the historical distribution of Glossy Black-Cockatoo on the Gold Coast, south-east Queensland, Australia and present the first regional estimate of their abundance, together with information on social structure, and distribution. Adopting the methods described by Downs (2005), an all-day census was conducted across the Gold Coast with the assistance of volunteers. The survey provided an estimate of population density, while

an analysis of historical records were combined with those from the birding day to shed further light on the known distribution of Glossy Black-Cockatoo on the Gold Coast. We discuss the broader application of this survey and mapping methodology throughout south-east Queensland and northern New South Wales.

Study Area

The study was undertaken in the Gold Coast Shire of south-east Queensland (Fig. 1) which extends from (-27.6897S, 153.1702E) in the north-west to (-28.2646S, 153.5530E) in the south-east and covers approximately 1 453 km².

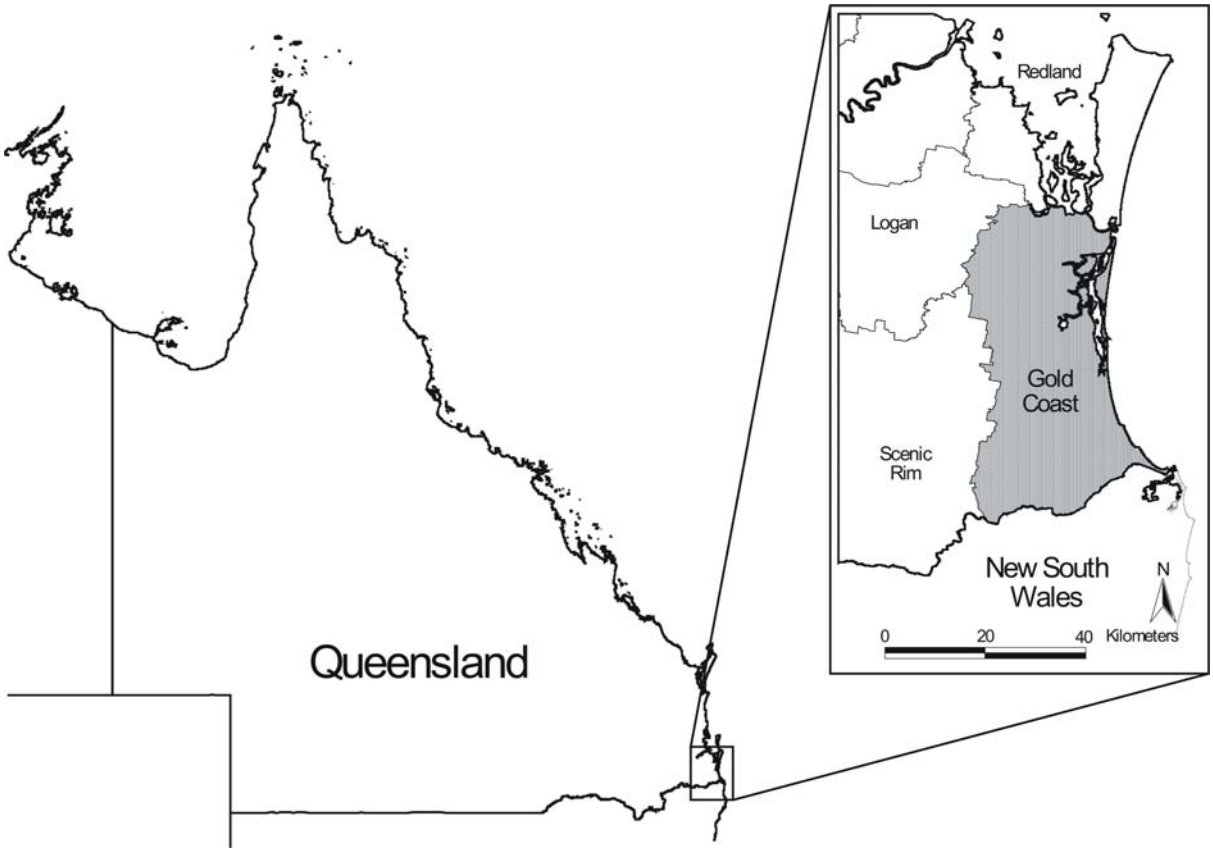

Figure 1: Location of the Gold Coast study area, southeast Queensland, Australia.

The Gold Coast is topographically diverse, incorporating coastal plains in the east and montane forests in the west. Despite extensive clearing following colonisation of the region, it is recognised for its rich biodiversity and conservation values (GCCC 2007). Almost 50% of the area currently persists as natural habitat (Ryan *et al.* 2003; Francis *et al.* 2005), although only 19% of the area is formally protected (Jason Searle, *pers. comm.,* Conservation Officer, Gold Coast City Council). Vegetation communities include dry and wet sclerophyll forests, rainforest, *Melaleuca* woodlands and coastal heathlands of State significance (Francis *et al.* 2005). Many of these regional ecosystems are dominated by eucalypt species and support she-oak communities, notably *Allocasuarina littoralis* and *Allocasuarina torulosa*, favoured feed trees of the Glossy Black-Cockatoo (Chapman 2007). While approximately 510 km² of the remnant habitats on the Gold Coast contain *Allocasuarina* species, not all of these are suitable as forage sites for Glossy Black-Cockatoo.

Methods

Historical sighting records

As a first step to identifying target areas for an intensive survey of Glossy Black-Cockatoo on the Gold Coast, we compiled and interrogated a database of historical sighting records for the area. This database included records obtained from the Department of Environment and Natural Resources (WildNet database), Gold Coast City Council (a variety of faunal databases), the Glossy Black Conservancy (sighting reports, website sightings submissions) and our own personal records. Geographic Information System (GIS) point data layers containing the sighting locations of Glossy Black-Cockatoo were captured from each database and combined into a single consolidated GIS shapefile in ArcView 3.2 (ESRI). We then created a uniform grid over the entire Gold Coast area with a cell size of 1 km² which was within the range of grid sizes used to cover the relevant area (Gibbons *et al.* 2007). Each grid cell was then uniquely identified with an alphanumeric code based on the column and row position. Grid based surveys using similar cell sizes have previously been used to

survey parrot and macaw species in fragmented landscapes (Evans *et al.* 2005). We then enumerated the number of individual sightings of Glossy Black-Cockatoo within each grid cell to provide us with a measure of the relative abundance of the species within the study area. A Google Earth KMZ (zipped Keyhole Markup Language) file was then created of the relative abundance using ArcGIS 9.2 and this was linked to Google Earth via the Glossy Black Conservancy website to enable the interactive interrogation of the survey locations by volunteers. We were then able to prioritise the selection of birding day survey locations based on the relative abundance and distribution of these historical sightings. We used a hierarchical selection process to assign grid cells to volunteers where those with a higher reporting rate were selected first. In addition we reviewed our site selection process to ensure that we incorporated grid cells from as wide an area as possible to maximise the coverage across the entire study area. We also had a number of potential survey areas chosen by volunteers based on their own interrogation of the Google Earth maps.

The historical sightings database has the potential to present a biased interpretation of the distribution and relative abundance of the species given that it is not based on any standardised reporting effort across the region. Nonetheless these historical data provide an adequate basis from which to assess the current distribution and abundance of the Glossy Black-Cockatoo as these records represent sightings from a relatively long period within some sightings reported prior to 1980. The majority of the sightings have been captured within the past 15 years.

Cockatoo birding day

Due to the intensive nature of the survey which required the simultaneous surveying of multiple sites across the Gold Coast we enlisted the assistance of volunteers to participate in the birding day, similar to approaches used in other avian population studies (Pithon and Dytham 1999; Downs 2005). The event was promoted using a combination of radio, internet

(Griffith University website, Gold Coast City Council website, Glossy Black Conservancy website), articles in local and community newspapers, printed material (letter drops in known cockatoo concentration areas), and direct solicitation of participants from existing interest groups, including local birding clubs, environmental societies, schools and community groups. We generated a database of volunteers who were then assigned to specific grid cell locations as outlined above. To ensure that all participants were familiar with the survey procedures and species of interest we provided each participant with background information about the Glossy Black-Cockatoo and its identification, a detailed survey protocol, datasheets for reporting observations of cockatoos as well as feed trees, and a map of their assigned grid cell. We also ran a series of workshops where volunteers were instructed on identifying Glossy Black-Cockatoos, *Allocasuarina* species (food trees), and what is expected of them in the field, specifically with regards to recording and capturing information, to ensure consistency in the information collected. Such training is central to the success of surveys enlisting the support of volunteers (Greenwood 2007).

The census was conducted on Saturday 9 May 2009, when volunteers surveyed their grid cell from dawn till dusk, arriving at their assigned location at approximately 6am and surveying the area at hourly intervals until 6pm. A total of 77 volunteer observers took part in the birding day covering 62 areas from those identified in the historical analysis (35%). The observers were well distributed across the Gold Coast and surveyed a range of areas from those with relatively high sighting frequencies to those with low sighting frequencies. Volunteers surveyed their area by following accessible routes through natural habitat, parkland and roadside reserves, looking and listening for Glossy Black-Cockatoo for approximately half an hour every hour. Volunteers were required to report on the number of birds observed, sex (male, female, unknown), age (adult, juvenile), activity of the birds (feeding, perching, flying, drinking, preening, roosting), time of observation, direction of flight. Since volunteers conducted repeated observations of areas within their grid cell we

accounted for possible duplicate sightings by comparing the time, location, sex and age structure of each group observed. Volunteers also indicated whether they felt that these were the same birds or not. Any potential duplicate observations were removed prior to analysis.

Volunteers were also required to search under *Allocasuarina* trees for orts, distinctive cone remnants that feeding Glossy Black-Cockatoos leave underneath the tree after stripping the cone of seeds. Orts vary in their persistence within the environment, and change colour with age. Volunteers recorded approximate abundance (0, 10, 100 or 1000) and ort colour (whitish-green – fresh, few weeks – red-brown, few months – brownish-grey and old – grey). The colour gives us an idea of the age of the orts, and thus how recently the birds have been in the area adding to our understanding of the distribution of the species. Statistical analyses included a combination of descriptive and univariate statistics and geospatial mapping of the distribution of observations using ArcGIS ver 9.2 (ESRI).

Results

Historical sighting records

Glossy Black-Cockatoo have previously been recorded from 11% of the Gold Coast region (n=176 grids squares) where 1200 sightings have been reported (Fig. 2). The majority of these locations (n=142, 81%) had fewer that 5 reported sightings while only four (2%) had more than 50 sightings reported. Birds are more frequently reported from the southern Gold Coast, in the Mudgeeraba, Bonogin and Worongary areas. The majority of Glossy Black-Cockatoo are also reported from the less urbanised regions of the coast with 85% of sightings being reported from locations to the west of the Pacific Motorway in areas of relatively intact habitat (Fig. 2). Those locations east of the motorway are also predominantly to the north of the intensively developed urban centres of the Gold Coast.

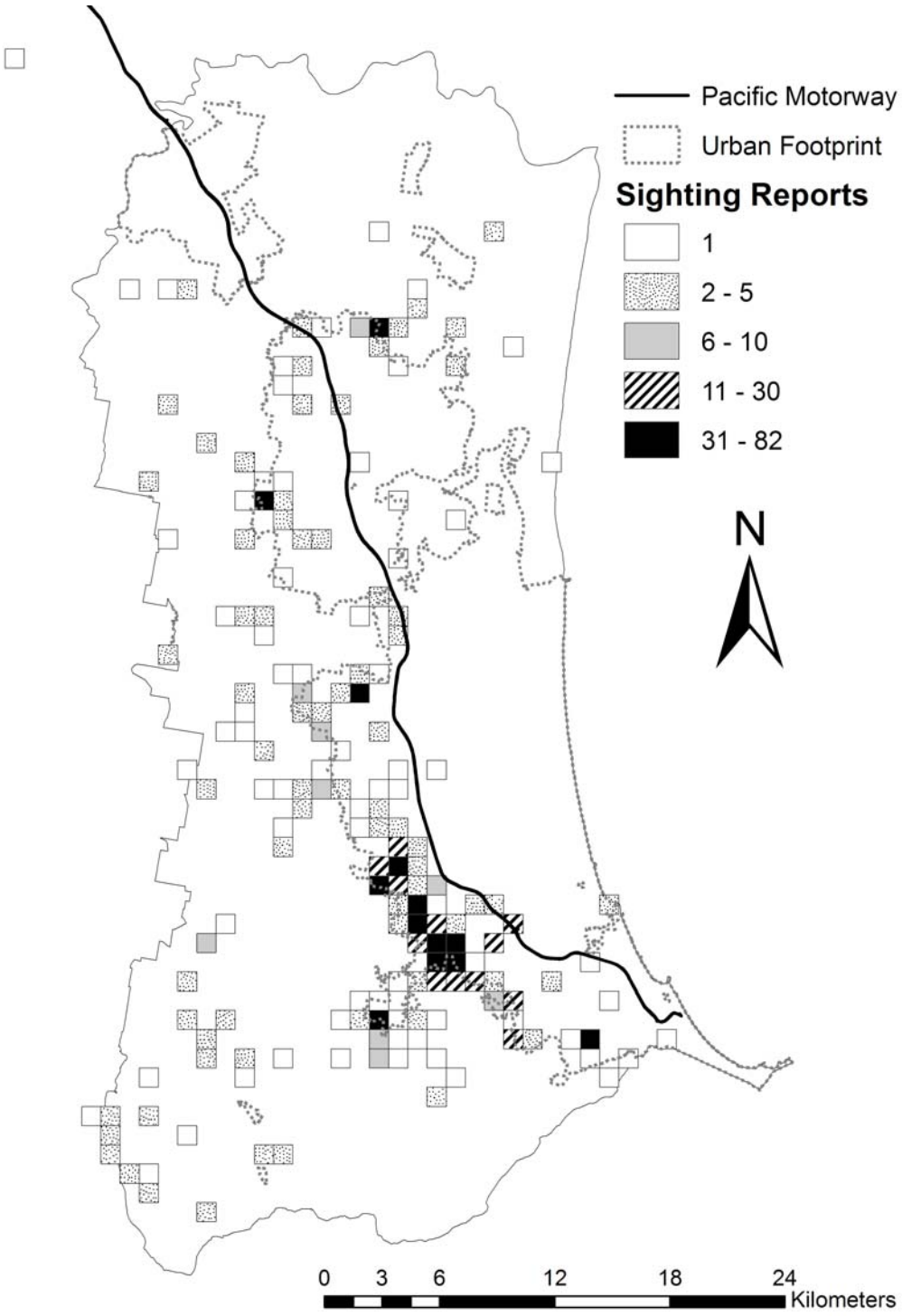

Figure 2: Historical sighting reports of Glossy Black-Cockatoo locations from the Gold Coast, southeast Queensland. Data compiled from GCCC, WildNet (DERM), Glossy Black Conservancy, Griffith University.

Cockatoo birding day

A total of 51 Glossy Black-Cockatoo was recorded from the Gold Coast on the day based on 45 being sighted and a further six being heard (Fig. 3) resulting in a density of 0.82 birds / km² within the surveyed area. Extrapolating this density to the total area of known reporting locations (176 km²) yields a population estimate of 145 birds. A further seven groups totalling 22 birds were observed at a drinking location adjoining the Lamington National Park in the adjacent Scenic Rim Shire. Evidence of Glossy Black-Cockatoo feeding was also observed at 11 sites with 60% of this activity being recorded from sites that did not detect birds during the survey itself.

Historical sighting records did not provide a good predictor of Glossy Black-Cockatoo abundance as the observed numbers of cockatoo within grid cells surveyed were significantly different to those expected (Chi-square = 592.7, d.f. = 61, $P < 0.0001$). This was further supported by the weak positive relationship between historical sightings and the number of birds seen during the survey (Fig. 4).

Distinctive traits for sexing, such as the presence/absence of yellow feathers on the face and the presence/absence of barring in the tail, are not always clearly discernable, especially when the birds are flying overhead or foraging in tall trees with dense foliage. More than 50% of all Glossy Black-Cockatoo observed went unsexed, particularly those seen flying overhead (n=11). Of those not flying 32% were male, 24% were female, 9% were juveniles and a further 35% still remained unidentified.

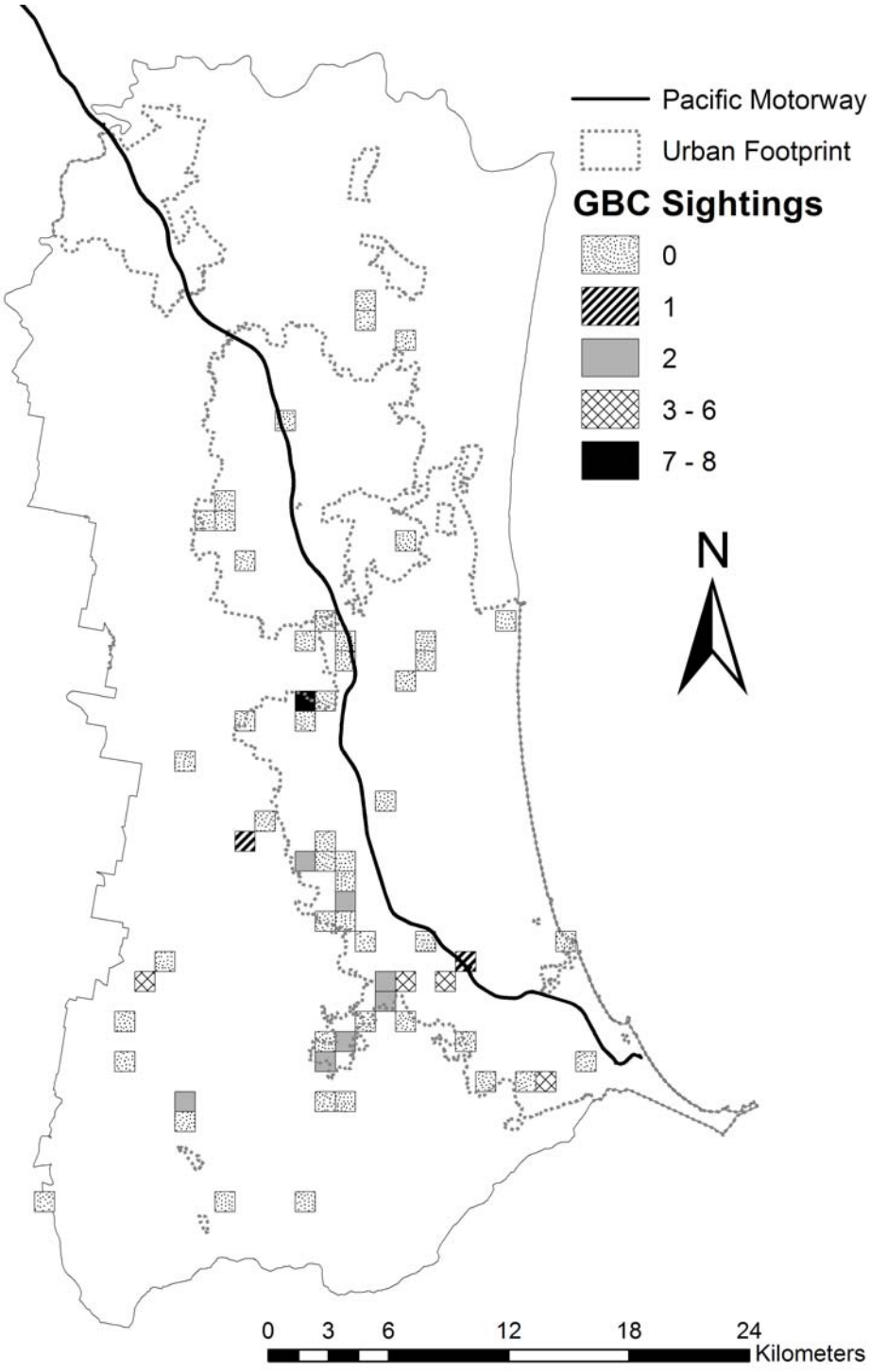

Figure 3: Glossy Black-Cockatoo observations (sightings) made during the birding day.

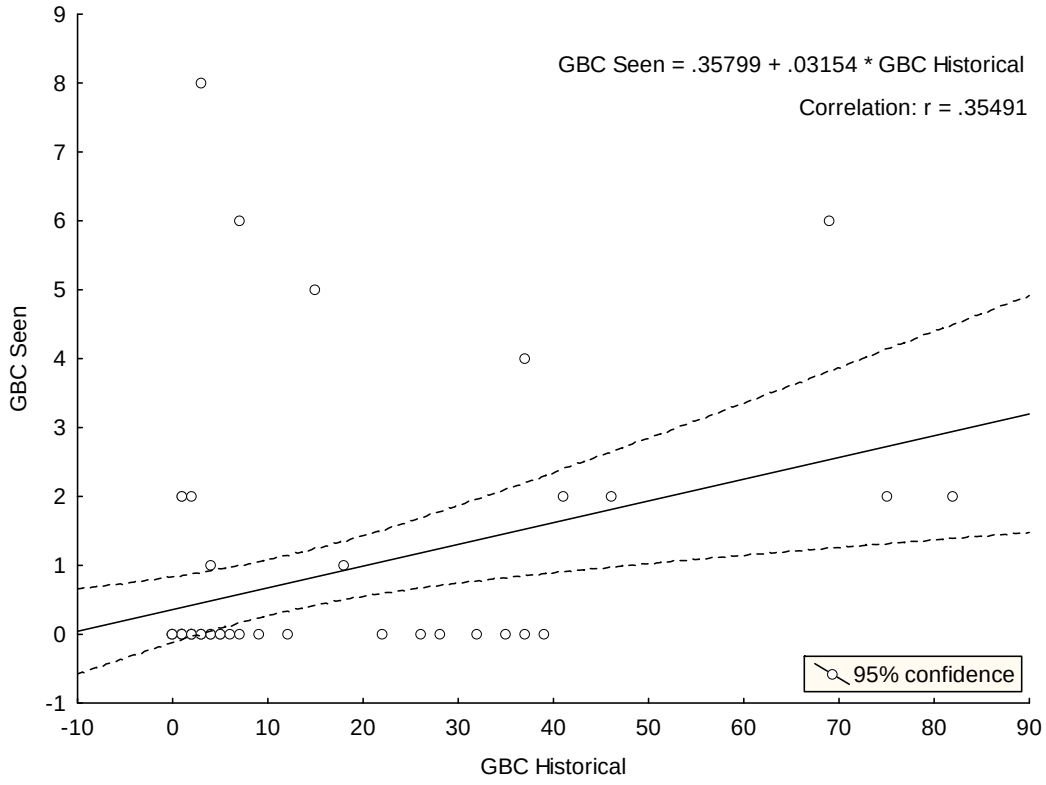

Figure 4: Correlation between historical sighting reports and the number of Glossy Black-Cockatoo seen during the birding day.

Activity patterns of Glossy Black-Cockatoo during the survey were determined from initial and repeated observations of the 45 birds seen throughout the Gold Coast (n = 57 sightings). Most birds were seen either feeding (60 %) or in flight (26 %) (Fig. 5). Feeding also dominated diurnal activity, accounting for 77.8% of all observations made throughout the day ($F = 28.5$; d.f. = 3, 40; $P < 0.0001$) (Fig. 6). Glossy Black-Cockatoos were recorded in flight or calling only in the early morning or late afternoon, whereas perching was only recorded in the middle of the day. No birds were observed at potential drinking sites on the Gold Coast, but 22 birds were observed at a drinking site west of Lamington National Park in the Scenic Rim in the late afternoon (after 16h30).

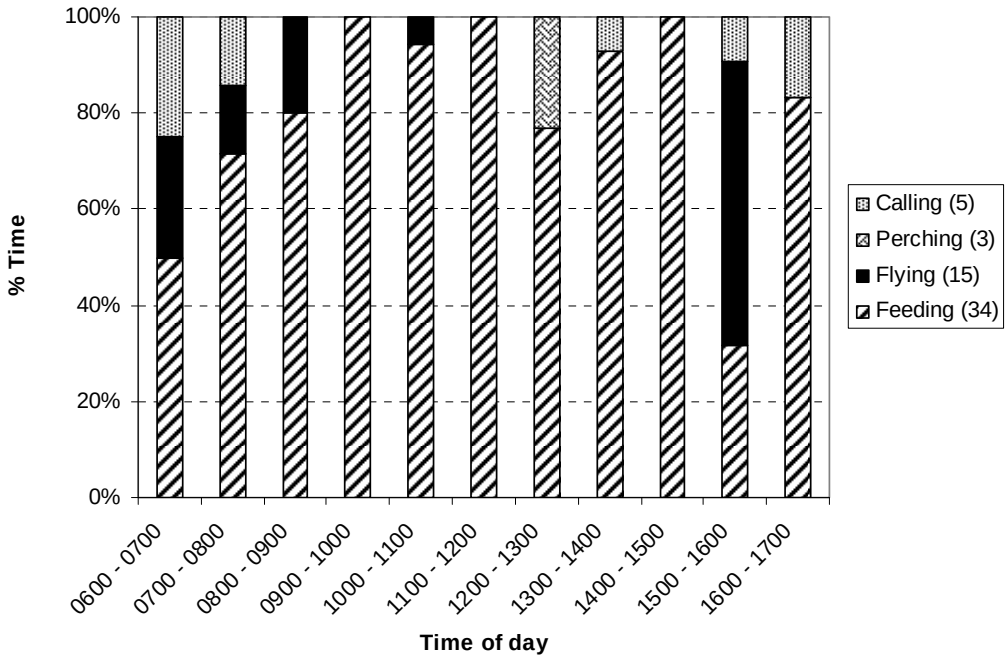

Figure 5: Diurnal activity patterns of Glossy Black-Cockatoo observed on the Gold Coast.

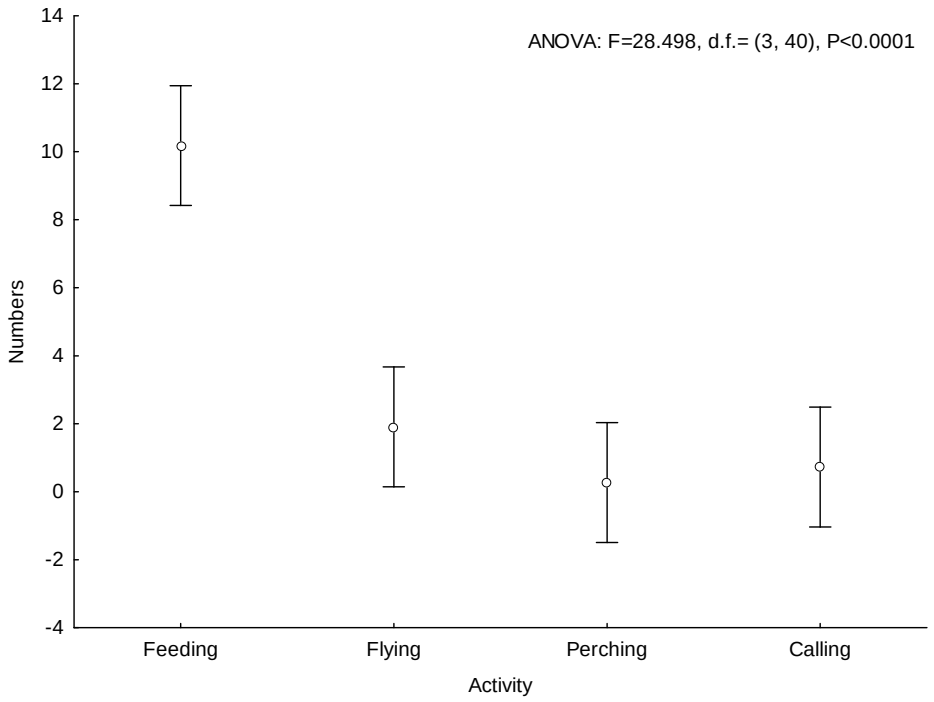

Figure 6: Mean number of observations of Glossy Black-Cockatoo in one of four primary activities, at hourly intervals between 6am and 5pm. 95% confidence limits are depicted.

Feed tree analysis

A total of 35 trees recorded from 11 sites showed signs of Glossy Black-Cockatoo feeding evidence, but volunteers recorded data from only 33 of these. Sixty percent of feeding signs (n = 21 trees) was recorded from sites that did not record any Glossy Black-Cockatoo during the survey. Feeding effort was quantified by the estimated number of orts which totalled 12 036, while the trees themselves were estimated to have in excess of 23 000 cones available. The majority of these feed trees, all of which were *Allocasuarina littoralis*, had either whitish green, or red brown orts, indicating that most of the feeding remnants observed were relatively recent (Table 1). Feed trees identified during the survey had significantly more available cones (t-value = 2.34, d.f. = 30, $P < 0.05$) than a random sample of 272 trees from 21 sites, which included only seven (2.7 %) trees that had signs of previous feeding by Glossy Black-Cockatoo.

Table 1. Age and colour of orts observed from *Allocasuarina littoralis* feed trees at 11 locations on the Gold Coast

Approx. Age	**Colour**	**Number of feed trees**	**Number of orts**
Fresh	whitish green	10	5200
Weeks	red brown / brown	14 / 4	6482
Months	brownish grey	2	54
Old	grey	3	300
	Total	33	12036

Discussion

Distribution and abundance of Glossy Black-Cockatoo

The current survey is the first of its kind that reports on the size of the Glossy Black-Cockatoo population on the Gold Coast, southeast Queensland. The survey has confirmed the concentrated distribution pattern of the species in the southern half of the Gold Coast and that historical sightings may act as a good surrogate for assessing the distribution of the species more generally. While there was a weak correlation of cockatoo numbers with historical sightings the observed distribution patterns were not expected. This suggests that while historical sighting records may be a good predictor of the occasional presence of cockatoos at a site, they are not a good predictor of the number of cockatoos at a particular point in time. These results are indicative of the habitat use by Glossy Black-Cockatoo where spatio-temporal variation in resource availability (cones, water and hollow bearing trees), and ongoing land use or management practices (e.g. planned burns) may affect their habitat use on a day to day basis. It was therefore not expected that birds would be permanent residents at specific sites. In addition, despite historical sightings suggesting that the cockatoo are well distributed across the Gold Coast many of the areas identified as hotspots lie within the future urban footprint for the region (Fig. 2) and may be subjected to increasing urbanisation threats in the near future potentially compromising the long-term persistence of the species in this region.

Further monitoring and compilation of trend data from these sites over time will enable further clarification of these patterns, particularly as atlasing studies that aggregate multiple sightings over extended periods have been able to link these patterns to actual bird abundance (Robertson *et al.* 1995). Gibbons *et al.* (2007) have shown that few atlasing projects attempt to map either the abundance or relative abundance or birds. Therefore, the current survey has further enhanced these historical distribution records by recording the number of birds recorded at these sites. Furthermore, the current study is also able to depict

the distribution and abundance of birds at a finer resolution than most other bird atlasing projects. Within Australia, despite atlasing surveys being undertaken within relatively small areas (e.g. 2 ha), these data are summarised into ¼° and 1° square grid cells (Barrett *et al.* 2003).

Many of these atlasing style projects rely on the participation of avid volunteers and Greenwood (2007) has demonstrated that these important contributions from members of the general public are increasing. In this inaugural survey of Glossy Black-Cockatoo across the Gold Coast in southeast Queensland there was substantial interest from the public in the event and almost 80 people took part in the survey. Volunteers were well spread across the Gold Coast providing a representative sample of the known historical sighting locations. However, given that these efforts covered a relatively small range used by the birds (approximately 62 km^2 of the total available habitat area of 176 km^2) we could conceivably increase these cockatoo population estimates. The population estimate of 145 Glossy Black-Cockatoo should also be seen as a minimum estimate as this is based upon existing knowledge of where birds have been seen previously (i.e. 176 km^2). The assumption made here is that these habitats provide a certain level of resources for the cockatoo, however there may be additional areas that are used by cockatoo but are as yet unreported. We anticipate that future surveys will improve upon these estimates but also provide an indication of trends in the distribution and abundance of the species. Many of those taking part in the survey have already expressed their interest to continue with these efforts in future years, but there has also been interest from other conservation groups and individuals, beyond the survey boundary, who did not take part in the survey. Repeated surveys in the broader SEQ region will not only improve estimates of population size but will also identify any shifts in distribution patterns (Gibbons *et al.* 2007). These shifts in the distribution and abundance of Glossy Black-Cockatoo will be important for conservation and management activities aimed at protecting the species within a fragmented landscape.

Collaborative birding events and future surveys

While many ornithological surveys over broad geographic regions often make use of volunteers (Pithon and Dytham 1999; Downs 2005; Greenwood 2007) it is important that there are sufficient mechanisms in place to educate people about the overall objectives and survey protocols if such surveys are to provide reliable measures of bird populations (Greenwood 2007). The training and education component for the Glossy Black-Cockatoo birding day combined the dissemination of printed materials with workshops to ensure that volunteers were familiar with the survey objectives and requirements. Despite these efforts there is room for improvement as workshops in particular were generally poorly attended. While most volunteers were comfortable with being able to distinguish the species from the closely related Yellow-tailed Black-Cockatoo and Red-tailed Black-Cockatoo, they were less able to sex birds as a more detailed component of the survey. The workshops and written materials stressed the features used to differentiate between males, females and juveniles in this sexually dimorphic species, but this is an area that requires further instruction for future surveys. In responding to the last point we feel that the workshops were well advertised as not only were these promoted through the materials sent to volunteers, but the birding day and its associated activities were afforded considerable media exposure in the lead up to the event. These included a number of local radio interviews, newspaper articles and information on various websites.

While the use of volunteers in bird surveys has demonstrated benefits for surveying bird species (Pithon and Dytham 1999; Downs 2005) there is a need to ensure that such events are well organised (Greenwood 2007). As with many scientific studies, having a clear objective articulated at the outset is important for guiding the survey design. Greenwood (2007) has also identified the need to maintain continuity over the long-term. While this inaugural cockatoo survey was coordinated through Griffith University's Gold Coast School of Environment, future surveys are likely to expand the scope and range of the survey and

would potentially be better coordinated through the existing Glossy Black Conservancy. The Glossy Black Conservancy (www.glossyblack.org.au) is a regional group comprising local councils, conservation agencies and private enterprise committed to the conservation of Glossy Black-Cockatoo in south-east Queensland and northern New South Wales. Future surveys, coordinated through such a collaborative group, will ensure the longevity of the survey, which is essential to monitor the trends in Glossy Black-Cockatoo populations regionally. A fundamental component of any future surveys will be the need to standardise the methodology between regions and over time. Standardised protocols for biodiversity monitoring have been highlighted as a central component of long-term research and monitoring studies (Golumbia *et al.* 2009; Hero *et al.* 2010). However, collaborative efforts across jurisdictional boundaries, as advocated by Golumbia *et al.* (2009), will also be central to the success of future cockatoo surveys. Fortunately, there is considerable interest in the Glossy Black-Cockatoo regionally and local councils from both NSW and QLD are partners within the Glossy Black Conservancy.

Conservation and management implications

This survey provides the baseline for future long-term monitoring efforts in southeast Queensland. The Glossy Black-Cockatoo is listed as Vulnerable in both Queensland and New South Wales and coordinated survey efforts will improve the ability of conservation agencies to take appropriate measures to protect the species. Traditional approaches that make use of distance sampling to survey birds, including parrots and cockatoo, have been used in other areas (Kinnaird *et al.* 2003; Evans *et al.* 2005; Rivera-Milán *et al.* 2005). However, these methods are not always appropriate for some species (Downs 2005), particularly those that are at low densities and have cryptic behaviours, such as the Glossy Black-Cockatoo. The use of a standardised grid to survey locations within a region of interest as done in this study has demonstrated the value of this alternative approach to monitoring this species. The method also has the ability to support future intensive survey

efforts that are concentrated on specific life history parameters of the species. A similar survey design can be used to identify nesting locations and assess the importance of other key resources, such as feeding habitat. However, these requirements should not be seen in isolation, and a holistic appraisal of Glossy Black-Cockatoo nesting, feeding and drinking requirements is needed to inform appropriate land management strategies. There is therefore an ongoing need to identify and locate feed trees as these are likely to shift in their relative value to cockatoo from year to year based on cone availability in response to changing rainfall patterns (Cameron 2009) and seed mass (Maron and Lill 2004). However, this needs to be done in conjunction with population distribution and abundance surveys as the current survey has demonstrated that there are high numbers of feeding locations within the region that were not visited by birds on the actual survey date. This suggests that despite the Glossy Black-Cockatoo being a highly specialised feeder it will make use of a mosaic of feeding resources within its local distribution to fulfil its daily requirements. While not the focus of this survey, Cameron (2006) has highlighted the need to maintain habitat features, specifically suitable hollow bearing trees, within the landscape to ensure that Glossy Black-Cockatoo populations are able to persist. These essential nesting habitat requirements are likely to be protected within large intact remnant forest and woodland environments on both public and private lands. Therefore, adopting a larger landscape view of the requirements of the Glossy Black-Cockatoo is necessary as the bird utilises feeding resources outside of many conservation areas (Robinson and Paull 2009) and could be negatively impacted by climate change and drier conditions (Cameron 2009). Consequently conservation measures cannot be restricted to individual sites with small geographical ranges and a network of protected areas and undisturbed habitats will be required.

Recommendations for future research and monitoring

This simultaneous count has demonstrated that it is possible to estimate the number of Glossy Black-Cockatoo from an extensive area. This first assessment provides an important

baseline population density that will facilitate the future monitoring of population trends for the species. This is particularly important given that the region continues to be developed at an increasing rate. We recommend that the survey effort be increased and expanded into neighbouring shires within southeast Queensland and northern New South Wales as this will provide a broader assessment of the regional population status. Future simultaneous surveys will need to be coordinated among all conservation authorities across jurisdictional boundaries (Greenwood 2007; Golumbia *et al.* 2009) to ensure that volunteers are equally well-trained to ensure consistency in survey effort and data recording. We also recommend moving the survey from May to October each year. While previous research has shown that the number of cockatoo sightings reported peaks during the winter months (Stock and Wild 2005), this may be due to birds being more easily detected as they congregate near water sources during the dry season. In reality there may be fewer birds to detect overall as many females will be nesting during this time and a later survey date would potentially improve counts for the whole population. While our bias towards male birds being detected in the current survey supports this, the high number of unidentified birds limits our ability to infer a general pattern of sex-biased observations during winter months. A further benefit to holding the Glossy Black-Cockatoo survey efforts at the end of the breeding season is that survey data can be used to estimate recruitment post-breeding.

While many of the areas identified by Greenwood (2007) in enlisting the support of volunteers for this survey were followed there are still improvements that can be made in the actual completion of the survey and these include;

1) Holding the survey over two days to enable people to stagger their involvement and thereby potentially encouraging further support. This would require that the survey is run over a weekend starting on a Saturday afternoon (12pm) and finishing on the following Sunday afternoon (12pm), with survey sessions of six hours on each day. While this may

improve the logistical aspects of future surveys it may increase the bias in the estimates as there may be an increased level of double counting where the same birds are recorded from either the same or different areas.

2) Extending the education and training component to include additional online resources to allow people to familiarise themselves with the recognition of the Glossy Black-Cockatoo but also potentially confusing species. A greater emphasis can be placed on differentiating between the sexes to improve our measures of sex-specific population parameters.

3) Developing an interactive data reporting facility to enable volunteers to submit their observations online. This system would serve a dual function in that any observations outside of the survey date could still be reported for inclusion in the general sightings database.

4) Approaching a number of regional, national and international agencies (e.g. Birdlife International) to support the running of the birding days either through the provision of on-ground field assistance or financial support to appoint a regional coordinator for the survey. Such an appointment or oversight role performed by a representative from an established institution will ensure that the surveys maintain their continuity, thereby providing reliable, long-term population data.

5) Investigate opportunities to run counts at known watering point across the region to enumerate birds at these locations on a more regular basis that will be able to supplement the annual census figures. Since Glossy Black-Cockatoo drink daily prior to sunset, future surveys of this nature would provide an indication of localised trends in population numbers that can be related back to the more detailed distribution and abundance measures obtained from repeated intensive counts throughout the SEQ region.

6) Initiating additional identification methods aimed at individual recognition within the female cohort of the population where the unique patterns of yellow feathers on the head can be used to construct a database of individuals. This can be used to estimate numbers of females within the region but could also provide some indication of site fidelity. A critical requirement to facilitate the development of such a database would be the collection and compilation of high resolution close-up images of both sides of the head of female Glossy Black-Cockatoo within the region.

Acknowledgements

The authors would like to thank the many volunteers that took part in the inaugural Glossy Black-Cockatoo birding day. This event has the potential to deliver conservation benefits to the species and the support from concerned members of the public is greatly appreciated. We would also like to thank the Gold Coast City Council (GCCC) for providing ongoing funding to support these research efforts and in particular Blair Prince and Jason Searle who have provided ongoing logistical support and feedback on research activities. We thank Stockland Corporation Ltd for sponsoring t-shirts for birding day volunteers and Jenny Le Neveu for hosting a post-birding day barbeque. Penn Lloyd kindly commented on a draft of this report.

References

Barrett, G., Silcocks, A., Barry, S., Cunningham, R., and Poulter, R. (2003). 'The new atlas of Australian birds.' (Royal Australian Ornithologists Union, Hawthorn East, Victoria.)

Belovsky, G.E., Botkin, DB., Crowl, T.A., Cummins, K.W., Franklin, J.F., Hunter, M.L., Joern, A., Lindenmayer, D.B., MacMahon, J.A., Margules, C.R., and Scott, J.M. (2004). Ten suggestions to strengthen the science of ecology. *Bioscience* 54, 345-351.

Cameron, M. (2005). Group size and feeding rates of Glossy Black-Cockatoos in central New South Wales. *Emu* 105, 299-304.

Cameron, M. (2006). Nesting habitat of the glossy black-cockatoo in central New South Wales. *Biological Conservation* 127, 402 – 410.

Cameron, M. (2009). The influence of climate on Glossy Black-Cockatoo reproduction. *Pacific Conservation Biology* 15, 65-71.

Cameron, M., and Cunningham, R.B. (2006). Habitat selection at multiple spatial scales by foraging glossy black-cockatoos. *Austral Ecology* 31, 597 – 607.

Cassagrande, D.G., and Beissinger, S.R. (1997). Evaluation of four methods for estimating parrot population size. *Condor* 99, 445-457.

Chapman, T.F. (2007). Foods of the Glossy Black-Cockatoo *Calyptorhynchus lathami. Australian Field Ornithology* 24, 30-36.

Chapman, T.F., and Paton, D.C. (2006). The glossy black-cockatoo (*Calyptorhynchus lathami halmaturinus*) spends little time and energy foraging on Kangaroo Island, South Australia. *Australian Journal of Zoology,* 53: 177-183.

Chapman, T.F., and Paton, D.C. (2006). Aspects of drooping sheoaks (*Allocasuarina verticillata*) that influence glossy black-cockatoo (*Calyptorhynchus lathami halmaturinus*) foraging on Kangaroo Island. *Emu* 106, 163 – 168.

Clout, M.N. (1989). Foraging behaviour of glossy black-cockatoos. *Australian Wildlife Research* 16, 467 – 473.

Crowley, G.M., and Garnett, S.T. (2001). Food value and tree selection by glossy black-cockatoos *Calyptorhynchus lathami*. *Austral Ecology* 26, 116 – 126.

Downs, C.T. (2005). Abundance of the endangered Cape parrot, *Poicephalus robustus*, in South Africa: implications for its survival. *African Zoology* 40, 15-24.

Evans, B.E.I., Ashley, J., and Marsden, S.J. (2005). Abundance, habitat use, and movements of blue-winged macaws (*Primolius maracana*) and other parrots in and around an Atlantic forest reserve. *Wilson Bulletin* 117, 154-164.

Francis, D., Searle, J., and Chenoweth, A. (2005). Gold Coast City Nature Conservation Mapping Review, Stage 2 – Significance Mapping (Common Nature Conservation Classification System). (Chenoweth Environmental Planning and landscape Architecture Pty Ltd.)

Garnett, S.T., Pedler, L.P., and Crowley, G.M. (1999). The breeding biology of the glossy black-cockatoo *Calyptorhynchus lathami* on Kangaroo Island, South Australia. *Emu* 99, 262 – 279.

Garnett, S.T., Crowley, G.M., Pedler, L.P., Prime, W., Twyford, K.L., and Maguire, A. (2000). Recovery plan for the south-Australian subspecies of the Glossy Black-Cockatoo (*Calyptorhynchus lathami halmaturinus*): 1999-2003 – Version 4.0. Report to the Threatened Species and Communities Section, Environment Australia.

Gibbons, D.W., Donald, P.F., Bauer, H.G., Fornasari, L., and Dawson, I.K. (2007). Mapping avian distributions: the evolution of bird atlases. *Bird Study* 54, 324-334.

Gold Coast City Council (2007). 'Our Living City Report January 2007: A Sustainability Update' (Gold Coast City Council, Gold Coast, Australia).

Golumbia, T.E., Nysewander, D.R., Butler, R.W., Milner, R.L., Cyra, T.A., and Evenson, J.R. (2009). Status of breeding Black Oystercatchers *Haematopus bachmani* in the Salish Sea. *Marine Ornithology* 37, 29-32.

Greenwood, J.J.D. (2007). Citizens, science and bird conservation. *Journal of Ornithology* 148, Suppl (1) 77-124.

Guisan, A., Lehmann, A., Ferrier, S., Austin, M., Overton, M.C., Aspinall, R., and Hastie, T. (2006). Making better biogeographical predictions of species' distributions. *Journal of Applied Ecology* 43, 386-392.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V., and Brown, C.J. (Eds) (1997). 'The Atlas of Southern African Birds.' (Bird Life South Africa, Johannesburg).

Hero, J-M., Castley, J.G., Malone, M., Lawson, B., and Magnusson, W.E. (2010). Long-term ecological research in Australia: innovative approaches for future benefits. *Australian Zoologist* 35, 90-102.

Higgins, P.J. (Ed) (1999). 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbirds.' (Oxford University Press, Melbourne).

Joseph, L. (1982). The Glossy Black-Cockatoo on Kangaroo Island. *Emu* 82, 46-49.

Kinnaird, M.F., O'Brien, T.G., Lambert, F.R. and Purmiasa, D. (2003). Density and distribution of the endemic Seram cockatoo *Cacatua moluccensis* in relation to land use patterns. *Biological Conservation* 109, 227-235.

Maron, M., and Lill, A. (2004). Discrimination among potential buloke (*Allocasuarina luehmannii*) feeding trees by the endangered south-eastern redtailed black-cockatoo (*Calyptorhynchus banksii raptogyne*). *Wildlife Research* 31 (3), 311-317.

Marsden, S.J. (1999). Estimation of parrot and hornbill densities using a point count distance sampling method. *Ibis* 141, 377-390.

Mooney, P.A., and Pedler, L.P. (2005). Recovery plan for the South Australian subspecies of the Glossy Black-Cockatoo (*Calyptorhynchus lathami halmaturinus*): 2005-2010. (Department of Environment and Heritage, South Australia).

Pepper, J.W. (1997). A survey of the South Australian glossy black-cockatoo (*Calyptorhynchus lathami halmaturinus*) and its habitat. *Wildlife Research* 24, 209 – 224.

Pepper, J.W., Male, T.D. and Roberts, G.E. (2000). Foraging ecology of the South Australian glossy black-cockatoo (*Calyptorhynchus lathami halmaturinus*). *Austral Ecology* 25, 16 – 24.

Pithon, J.A. and Dytham, C. (1999). Census of the British Ring-necked Parakeet *Psittacula krameri* population by simultaneous counts of roosts. *Bird Study* 46, 112-115.

Rivera-Milán, F.F., Collazo, J.A., Stahala, C., Moore, W.J., Davis, A., Herring, G., Steinkamp, M., Pagliaro, R., Thompson, J.L., and Bracey, W. (2005). Estimation of density and population size and recommendations for monitoring trends of Bahama parrots on Great Abaco and Great Inagua. *Wildlife Society Bulletin* 33, 823-834.

Robertson, A., Simmons, R.E., Jarvis, J.M. and Brown, C.J. (1995). Can bird atlas data be used to estimate population size? A case study using Namibian endemics. *Biological Conservation* 71, 87-95.

Robinson, T., and Paull, D. (2009). Comparative evaluation of suburban bushland as foraging habitat for the Glossy Black-Cockatoo. *Corella* 33, 7-12.

Ryan, T.S., Bean, A.R., Hosking, B.B., Wilson, B.A., and McDonald, W.J.F. (2003). Gold Coast City Nature Conservation Mapping Review, Stage 1 – Vegetation Mapping. (Queensland Government, Queensland Herbarium).

Schodde, R., Mason, I.J. and Wood, J.T. (1993). Geographic differentiation in the glossy black-cockatoo, *Calyptorhynchus lathami* (Temminick), and its history. *Emu* 93, 156 – 166.

Shukuroglou, P. and McCarthy, M.A. (2006). Modelling the occurrence of rainbow lorikeets (*Trichoglossus haematodus*) in Melbourne. *Austral Ecology* 31, 240-253.

Stock, M.J., and Wild, C.H. (2005). Seasonal variation in Glossy Black-Cockatoo (*Calyptorhynchus lathami*) sightings on the Gold Coast, Queensland. *Corella* 29(4): 88-90.

Underhill, L., and Gibbons, D. (2002). Mapping and monitoring bird populations: their conservation uses. In 'Conserving Bird Biodiversity: General Principles and their Application.' (Eds) K. Norris and D.J. Pain pp 34-60. (Cambridge University Press, Cambridge).

Project supported by:

Griffith UNIVERSITY

Gold Coast City Council

Stockland

www.glossyblack.org.au