Satellite tracking of rehabilitated wild Baudin's Cockatoos *Calyptorhynchus baudinii*: A feasibility trial to track forest black cockatoos.

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Abstract

Baudin's Cockatoos, *Calyptorhynchus baudinii,* are a threatened forest black cockatoo species, endemic to the south-west of Western Australia. In this study we fitted tail-mounted satellite transmitters to two female Baudin's Cockatoos that had undergone treatment and rehabilitation at Perth Zoo and Kaarakin Black Cockatoo Conservation Centre, to investigate the feasibility of satellite tracking this species. Both birds were released in Kelmscott, Perth, into an area frequently visited by a flock of wild Baudin's Cockatoos. Both telemetry units provided reliable data sets, with one bird moving approximately 250km south from the release site. The success of this trial opens the way to address key objectives in the Forest Black Cockatoo Recovery Plan including: post-release survival of rehabilitated birds, flock movement, habitat use, and the identification of critical feeding and breeding habitat. Most importantly it demonstrates that satellite transmitters can be successfully used to locate and track forest black cockatoo species, which are otherwise difficult to monitor.

Keywords: black cockatoo, satellite telemetry, forest, recovery plan, habitat, distribution

Introduction

Baudin's Cockatoos, *Calyptorhynchus baudinii,* are a large black cockatoo species found in the south-west forests of Western Australia. Baudin's cockatoos are currently classified as Endangered at the State level, and nominated as such at the National level, using IUCN Red List criteria (DEC. 2007), with the population declining in both range and density in the last 50 years (Garnett and Crowley 2000). While the main historical threat to black cockatoo species inhabiting this region was habitat loss due to clearing for agriculture and forestry, the adverse impacts of an increasing human population in Western Australia (i.e., motor vehicle accidents, illegal shootings) are key threats that are becoming more prevalent (Chapman 2007).

Carnaby's Cockatoos, *C. latirostris*, have been successfully tracked with Argos satellite telemetry to monitor their movements on the Swan Coastal Plain (Groom, C.J.*et al.* 2013, Groom, C.J.*et al.* 2014). This same study also confirmed the suitability of rehabilitated birds in tracking studies of this type. Successful deployment and tracking of forest black cockatoos can provide valuable data in relation to flock movement and habitat use, and facilitate the identification of feeding and breeding habitat, all key elements in the Forest Black Cockatoo Recovery Plan (DEC 2007).Tracking of this type has not been used previously in forest black cockatoos due to the perceived difficulties associated with potential interference of the forest canopy on transmission accuracies. However, recent research addressing the impact of canopy cover and topographic obstruction on observation rate and location error has demonstrated low impact, 12.4% and 3.4% respectively (Sauder*et al.* 2012)

The aim of this study was to investigate the feasibility of satellite tracking Baudin's cockatoos which, unlike the Carnaby's cockatoo, inhabit and migrate through heavily forested areas in the south-west of Western Australia. The criteria that were used to

determine success for this feasibility trial were that transmitters would: 1) remain attached to the tail feathers enabling tracking of the birds and collection of dropped (moulted) tail feathers; 2) determine the likely post-release fate of the birds; and, 3) enable tracking of the birds' movements, including migratory movements.

Methods

Two wild Baudin's cockatoos were fitted with transmitters following treatment and rehabilitation at Perth Zoo and Kaarakin Black Cockatoo Conservation Centre (KBCCC). Both birds had suffered traumatic injuries, most likely associated with motor vehicle accident. Baudin's cockatoos present for rehabilitation and release much less frequently than Carnaby's and Forest Red-tailed cockatoos, *C. banksii naso,* (Le Souef 2012) making these two valuable study birds.

The birds made uneventful recoveries and were assessed to be free of disease (see below) and fit for release. At KBCCC they were transferred to a large (sixty-four metre long) pre-release flight aviary to ensure they had excellent flight ability and adequate flight fitness.

Transmitter attachment:

Two ARGOS transmitters (TAV - 2617) manufactured by Telonics were attached to the birds using ventral tail mounts on 26 September 2012, two days before the planned release date, giving staff at KBCCC adequate time to monitor the birds after attachment. Transmitters were fitted to the birds under isoflurane gaseous anaesthesia, to reduce stress from handling. During anaesthesia, blood was collected from the right jugular vein for a routine blood profile (ZA1 Avian Profile, Vetpath Laboratories, Perth) to check their overall health. No abnormalities were detected. Faecal samples were

collected from the aviary to screen for parasites to determine whether pre-release anthelmintic treatment was warranted. No parasites were detected.

Transmitter dimensions were 6.43x2.03x0.84 cm with a weight of 17 gm - approximately 3% of the bird's body weight. The transmitters were a dark green/khaki colour. The transmitters were programmed by attaching each transmitter, via a cable, to a computer prior to attaching the transmitters to the birds.

The method of transmitter attachment and materials used by Groom, C.*et al.* (2015) was followed in this study and is a modified version of transmitter attachment developed by Le Souef *et al.* (2013). Le Souef *et al.* (2013) compared several methodologies and found tail mounting to be the safest. Groom,C.J. *et al.* (2014) subsequently showed that they also provided good retention times.

Each bird was given 15ml warmed subcutaneous fluids (Hartmanns/glucose solution 50:50 mix, Baxter Healthcare, Toongabbie NSW) prior to the end of the anaesthetic, loosely wrapped in a towel and placed into a secure pet carrier to recover. The duration of the procedure was approximately 40 minutes. Supplemental heat was maintained with an infrared heat lamp. The birds were moved back to the flight aviary once fully recovered from anaesthesia.

Behaviour, preening, activity, and flying ability were monitored by KBCCC staff until release on 28 September 2012. The transmitters had no apparent impact on their flight, behaviour or activity in the aviary.

Release and Tracking:

The birds were released on 28 September 2012 at a site in Kelmscott approximately six kilometres from KBCCC. This site was chosen as it was regularly visited by a flock of wild Baudin's cockatoos. Birds were transferred by vehicle to the release site in covered, reinforced pet carriers and released simultaneously, in the late afternoon.

The transmitters were initially programmed to transmit data for 12 hours per day for 12 days (5am-8pm), with an off-period between 10am and 1pm when there were no satellite passes overhead. Thereafter the transmitters were reprogrammed to transmit for 5 hours per day every five days (from 4am). This change was made with the aim of capturing bird movements when they were most active and to prolong battery life and transmission time. Transmitter recovery was facilitated with a radio receiver (Argos AL-1 PTT Locator, Communications Specialists).

Data from the transmitters was decoded using the Telonics Data converter (Telonics, Mesa, Arizona), the data was filtered and only '2' (< 500m) and '3' (<250m) location classes were used. Movement paths were generated in GME (Beyer 2012) and projected in ArcGIS 9.0 (ESRI 1999-2010). Flight paths were visualised using Google Earth 7.1.1.1888 (Google Inc.) and minimum straight-line distance between points was calculated using the elevation profile tool.

Results/Discussion

Baudin's Cockatoo 119055

Based on the satellite tracks, this bird travelled a minimum estimated distance of 19 km from the release site up until 2 October 2012 (Fig. 1). The bird then flew south an estimated minimum of 20 km to the Cardup region that day. The following day the bird was located in the Mundijong region (approximately 30 km south of the release site)

and stayed in this area until the 10 October 2012. This is a peri-urban area and ground-truthing found the bird at the Watkins Road Nature Reserve, a local nature reserve consisting of predominantly Marri, *Corymbia calophylla,* woodland, a preferred food source for Baudin's cockatoos (DEC 2007). Within10 km of this area there are four Marri woodland nature reserves totalling over 150 hectares (Urban Bushland Council WA Inc 2014). Langford Park, a rehabilitated former bauxite mine is located approximately 10 km away. This area completed rehabilitation in 2001 and is now a large expanse of eucalypt (Jarrah, *Eucalyptus marginata*; Blue Gum, *E. globulus*) and pine, *Pinus* sp., forest (Alcoa Inc. 2014). While Baudin's predominantly feed on Marri, they do also feed to a lesser extent on Jarrah seeds (DEC 2007). During this 8 day period, bird 119055 travelled a minimum of 82km (Fig.2). Given the pattern of movement and ground-truthing that indicated significant cockatoo activity (chewed marri nuts) at a night roost where the bird roosted, and the fact that this species roosts communally, it appeared the bird joined a local flock, possibly its flock of origin given it was originally found injured in the nearby Serpentine region.

The bird flew a further 68 km to the Beela region by 29 January 2013 and this is where it was last located (Fig. 3). In total, 119055 travelled approximately 250 km south of the release site in the 123 days that its tracking device was active. Based on the assumption that 119055 was travelling with a flock, this sustained southern movement indicated possible migration to breeding habitat. Studies byJohnstone and Kirkby (2008) showed large flocks of Baudin's cockatoos flying to known breeding areas in the lower south-west of Western Australia from the middle of August onwards.

Ground-truthing located 119055 at this site in the Beela region in agricultural land with marri paddock trees, which adjoined a large expanse of State forest and a pine plantation. In addition to Baudin's cockatoos inhabiting this area, Carnaby's cockatoos and forest red-tailed black cockatoos were also sighted and heard in the area. Based

on observations there appeared to be several hundred black cockatoos in the area. The marri trees were flowering and there was substantial evidence of feeding on marri nuts by all three types of black cockatoos. Water was available in nearby farm dams. A local land holder owning property at this site confirmed that Baudin's cockatoos had bred in marri trees at this site in previous years (Hardy, personal communication, 2014).

Baudin's Cockatoo 121840

Based on the satellite tracks recorded up until 2 October, this bird travelled an estimated minimum distance of 27 km after release, staying primarily in the Kelmscott area.

On 10 October 2012 the transmitter switched to the five day cycle as programmed. The next transmission on15 October 2012 was from the Cardup region, approximately 13 km south of the previous location. It appears that there was no overlap between this bird and 119055 during the time that they passed through the Cardup area. Between October and December 2012 there continued to be transmissions from the Cardup region. The location was modified agricultural land, not a known Baudin's night roost, and concerns were held for the health of the bird. In early December a ground area search was conducted with a radio receiver and the transmitter was located, attached to dropped tail feathers. Wing feathers were located nearby and DNA analysis of the wing feathers, performed by Australian Wildlife Forensic Services, confirmed the feathers were from bird 121840 which had been previously genotyped. While it is possible the central tail feathers carrying the transmitter were lost during the normal feather moult, in this case the location of the additional wing feathers indicated that it was most likely that the bird had been predated. Discussion with property owners in the area indicated there was history of raven attacks on black cockatoos in the weeks preceding the arrival of 121840 in the area. Apparently healthy black cockatoos

regularly present to Perth Zoo Veterinary Department with severe injuries associated with raven attacks during the raven breeding season (Le Souef, personal communication, 2012. Given the position of the transmitter at the ventral tail base and its neutral colour, the transmitter was not considered to have acted as a visual cue contributing to the fate of this bird.

The satellite transmitter on bird 119055 remained active for five months (123 days) following attachment and release. Based on the programmed schedule, the units transmitted for approximately 144 hours in the first 12 days of tracking (12 hours per day). The units then transmitted for approximately 135 hours until tracking ended in February 2013 (five hours every five days for four and a half months, that is, approximately 27 five hour transmissions), a total of approximately 279 hours. The estimated battery life expectancy of the transmitters operating continuously is 233 hours (Telonics 2014).The time frame of transmitter attachment on this bird was anticipated due to the expected post-breeding season moult of tail feathers. However, our data suggest the possibility of birds carrying tracking units successfully over much longer timeframes. We are currently trialling this in captive, not-for-release birds at KBCCC and studies to date indicate that the transmitter retention time, associated with tail feather moulting, is likely to exceed battery life depending on transmitter programming.

The Forest Black Cockatoo (Baudin's Cockatoo and Forest Red-tailed Black Cockatoo) Recovery Plan emphasises the importance of understanding post-release survival of rehabilitated birds, flock movement, habitat use, and identifying critical feeding and breeding habitat, particularly for forest species (DEC 2007). This trial has shown that satellite transmitters can be successfully used to locate and track forest black cockatoo species, which are otherwise difficult to monitor using conventional observational

approaches (e.g., vehicle based flock follows) in forested regions (Finn, personal communication, 2014).

Baudin's cockatoos prefer dense eucalypt forest, and locating birds in a forest environment is challenging due to limitations associated with road and track access in such regions. Despite research undertaken to date on Baudin's cockatoos (Johnstone and Kirkby 2008, Weerheim 2008) there is still limited knowledge about migratory flock movements and habitat use and selection; and key feeding and breeding sites in the forest regions of the south-west of Western Australia remain unknown. Satellite telemetry could provide a wealth of data in these areas and allow us to develop a better understanding of these birds.

These data have shown that the transmitter battery life can be extended by using a conservative programming schedule. We are currently running additional trials, including investigating temporal feather moult patterns to maximise data capture over longer time periods.

This feasibility study is the first time forest black cockatoos have been satellite tracked in the wild and the outcomes provide encouragement for implementing a more comprehensive movement ecology study of forest black cockatoos. Based on the success of the current work, we plan to undertake large scale tracking of all three WA black cockatoo species to investigate habitat use and movement patterns, and to identify feeding, watering, roosting and breeding sites.

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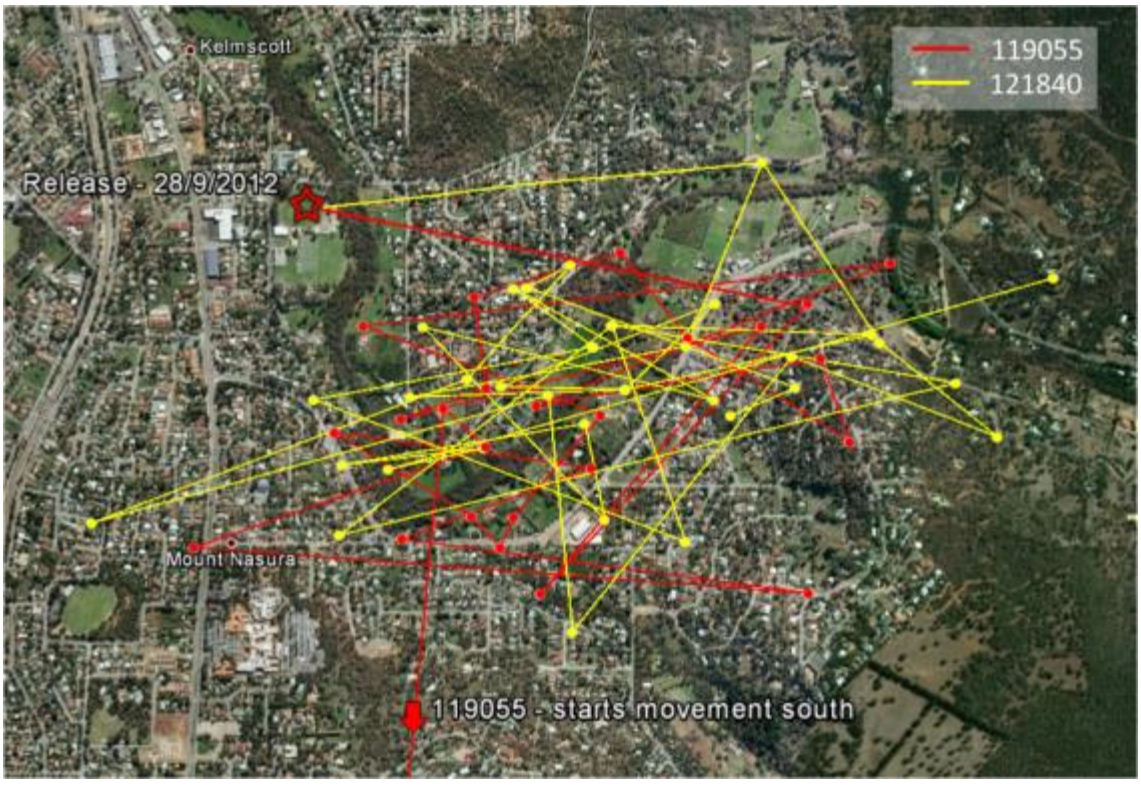

Fig. 1 Satellite tracks showing movement of Baudin's cockatoos 119055 (Red) and 121480 (Yellow) from the point of release in Kelmscott on the 28/9/2012 until the 2/10/2012, at which point bird 119055 commenced dispersal flight south. 121480 remained in the area.

Fig. 2 Satellite tracks showing the movement of Baudin's cockatoo119055 on the morning of the 2/10/2012 to the Mundijong region about 20 km south of Kelmscott.

Fig. 3 Satellite tracks showing the southern movement of Baudin's119055 from the release site (yellow star) to the last known location in the Beela region of Western Australia (yellow arrow).