ECOLOGY AND POPULATION VIABILITY ANALYSIS

OF THE SOUTHERN CASSOWARY

Casuarius casuarius johnsonii

MISSION BEACH, NORTH QUEENSLAND

Thesis submitted by

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Abstract

This thesis investigates the endangered cassowary population at Mission Beach, north Queensland, and examines the problems associated with determining the population size and density of this keystone species. Using the results of an intensive field survey, it explores the conservation implications of small population size, population demography, densities and distribution, the impacts of identified threatening processes, and the probability of persistence of the population over timeframes of 100 years and 500 years.

The examination and analysis of the factors that place this iconic population at risk of extinction were addressed using population viability analysis. Data resulting from the field survey of the Mission Beach area and augmented by information from previous studies were used to drive the modelling process in this PVA. The analyses assessed the interactive affects on the fate of the population of factors such as the availability of existing cassowary habitat; population size; carrying capacity; population age and sex structure; reproduction and survival; age-sex specific mortalities; adult mortality rates; immigration; genetic influences; and catastrophes.

Population ecology

The Mission Beach cassowary study area was intensively surveyed on foot between June 1 and December 16, 2000. The primary field survey objective was to accurately locate, measure, and map all cassowary sign *ie* footprints, bird sightings, droppings, vocalisations, feet stamping. A total of 101.66 km^2 of rainforest was searched resulting in 345.8 kilometres of search transects and the location of 4729 cassowary sign (sightings, footprints, droppings, vocalisations). The total search effort used in the analyses amounted to 582.54 hours.

The field survey located 110 cassowaries in the study area, approximately 49 of which were adults. This is 27-37% of the maximum number of adults previously estimated for the Mission Beach area. Of the 49 adult cassowaries identified within the Mission Beach study area, 25 were identified as males, 19 as females, and two adult birds were of unknown status. Three other birds, although inadequately sighted, are believed to be

adult males. The available cassowary habitat surveyed at Mission Beach currently appears fully occupied, supporting at least 79 independent cassowaries (49 adults, 28 subadults, and 2 unknowns).

The sex ratio of the Mission Beach cassowary population was 1.47 males to 1 female, greater than that found in the strictly polyandrous emu *ie* 1.26 males to 1 female. Although characteristic of a polyandrous species, the strongly biased adult male to female ratio may be of concern given the small population size and relatively high mortality of the Mission Beach cassowaries. The relative scarcity of females indicates that the males as caregivers should not be the limiting sex *ie* the availability of adult females is likely to be a limiting factor in cassowary population dynamics.

A total of 16 males *ie* 61.5 % of known males (n=25) were recorded escorting 31 chicks. Chick ages ranged from a few weeks to >8 months old, with the majority of new chicks appearing in September 2000. Regular sightings of males foraging prior to being seen with newly hatched young indicate that not all incubating males sit without eating throughout the incubation period.

There was evidence of a widespread distribution of subadults throughout existing adult cassowary home ranges, with twenty-eight subadults located during the survey. The data indicate that subadults maintained home ranges, with most individuals recorded using the same area continually for the entire field program *ie* 6 months. This behavioural feature has not been recorded previously due to the lack of comprehensive field surveys using methodology appropriate for gathering demographic data.

A regression found no relationship between cassowary sign *per se* and the number of birds using an area. This finding confirms that the number of cassowaries in an area cannot be inferred by a simple count of droppings *ie* cassowary density is <u>not</u> related to dropping count.

The mean Indicative Home Range (*ie* each bird's home range at the time of the study and an approximation of its foraging activities over a number of preceding weeks or months) of adult females was 2.13 km^2, while males maintained a slightly smaller IHR of 2.06 km^2. There is an indication that breeding males have an increased area requirement than non-breeding males. Although this relationship was not quite statistically significant, possibly due to the small size of the sample, it has important management implications and needs to be investigated further.

The population density of adult cassowaries for the Mission Beach area was 1 adult per 2.09km^2 *ie* 0.48 adults/1km^2, almost half the density of adult birds previously calculated for the Lacy's Creek catchment, and one-sixth the density estimated by Bentrupperbaumer for Kennedy Bay area and coastal areas of Mission Beach. Overall population density of independent birds *ie* adults and subadults and excluding chicks, was 1 bird per 1.29 km^2 *ie* 0.78 birds/km^2. The density of subadults in the Mission Beach area was 1 subadult per 3.63km^2 *ie* 0.28 subadults/km^2. A population density of *Casuarius casuarius* subadults either in the Wet Tropics or New Guinea has not been possible previous to this study.

The practice of surveying small areas at Mission Beach has led to constant over-estimates of cassowary population density. The study results indicate that at a scale of 1km^2 or less there is little or no chance of reflecting true cassowary densities. Depending on the resolution required and the environmental parameters of the target area, it is considered that a sample plot between 5-15km^2 may be necessary to reflect the true cassowary density.

It was found that apart from four adult birds in the Kennedy Bay section of the Hull River National Park, there is no permanent coastal cassowary population at Mission Beach. Field surveys showed that the majority of birds classified in previous work as coastal birds live in the hinterland while making occasional or seasonal use of the coastal areas, thus inflating the earlier population numbers

The current Mission Beach cassowary habitat zones are flawed in their location and\or relevance to the true distribution of Mission Beach cassowary population. The results of this study were used to review the habitat zoning, and recommended that Important Cassowary Habitat Zone, Potentially Critical/Important Habitat Zone, and Natural Corridor/Habitat Zone, be upgraded Critical Cassowary Habitat.

Continued clearing threatens the already tenuous connectivity existing in the Mt. Mackay to Tully Heads Linkage (almost broken) and Mt. Caruchan to Meunga Creek

Linkage of the Wet Tropics Coastal Wildlife Corridors. If connectivity is broken in either of these areas, it will remove the opportunity for cassowary movement in and out of the Mission Beach area, and will permanently isolate the population.

This field study confirmed the presence of 22 cassowary road-crossing points in the 23.6 kilometres of roads between El Arish-Mission Beach and Tully-Mission Beach Roads. It was found that the road crossings were currently being used by approximately 70% of the adult cassowary population of Mission Beach.

Population viability analysis

Baseline PVA simulation modelling, which used a range of mortality rates, breeding cycles, presence and absence of catastrophes, and inbreeding effects, indicates that the Mission Beach cassowary population is in deterministic decline. Under all scenarios but that of Low mortality (considered to be improbable mortality rates), the extinction of the Mission Beach cassowary population appears virtually certain, with a predicted mean time to extinction between 37 to 70 years. Overall, the analyses reveal there is a strong chance that the population may become extinct within the 100 years projection period under most simulated models, with probabilities of extinction ranging from 68% – 99.8%.

Stochastic growth rates in most simulations generally remained strongly negative, although at a slightly higher rate than deterministic growth rate. The small differences between the two rates demonstrate that stochastic influences are outweighed as a threat to population persistence by the severity of the deterministic decline.

It appears that the critical factor for the survival of the cassowaries at Mission Beach is either the preservation of effective immigration from other cassowary populations, or the supplementation of the population with at least four "foreign" birds a year. However, to <u>maintain</u> the current population size of approximately 79 independent birds requires augmenting the population by at least six birds per year (3 males and 3 females <4 years old).

The analyses showed that although the population is predicted to persist for a greater period of time if adult mortality can be kept to 1-2% (≥1 adult/year), the predicted cassowary population size still decreased by 32.7% (at 33% breeding) over 100 years. This finding suggests that the effects of inbreeding depression *ie* deleterious alleles and/or other genetic impacts, will play a significant role in the decline of the Mission Beach cassowary population in the absence of immigration.

Genetic diversity of the Mission Beach population dropped significantly even when input parameters kept the population relatively stable. Heterozygosity reduced to between 61% and 85%, and inbreeding depression increased markedly from about 30 years onwards, varying little with decreased adult mortality.

It appears that catastrophes may have a profound impact on the viability of the cassowary population, doubling the probability of extinction under Moderate mortality rates from 35% to 68%.

Mission Beach has only a small population of cassowaries, and a small population can die out entirely by chance even when its members are healthy and the environment favourable. When a population becomes small, isolated, and localised, chance events can become so important as to dominate the long-term dynamics and fate of a population. The small isolated population of cassowaries at Mission Beach, therefore, would appear to face an uncertain future.

Acknowledgments

I have been extremely anxious about the plight of cassowaries since my field survey of the Wet Tropics in 1988, which first established the conservation status and distribution of the species in north Queensland. The results of that work clearly indicated that the species was declining in many areas, with continuing reductions noticeable even over the last decade. The recognised cassowary areas of Innisfail and Kuranda are now in immediate danger of losing their local populations, with the number of surviving adults down to single figures. Similarly, extinction is imminent for the southern-most population of cassowaries in north Queensland (and the world), at Paluma Range just north of Townsville. The loss of this southern population will result in a significant reduction in the geographic range of the species.

Mission Beach has not escaped this downward trend. Known for many years for birds both within the forest and visiting suburban roads and houses, its cassowary population is declining due to road deaths, dog attacks, disease and increased clearing and development leading to fragmentation and habitat loss. I was concerned that more accurate and comprehensive data than was currently at hand be made available to form a sound foundation for any future management strategies and recovery plans. This study, therefore, was designed in consultation with Community for Coastal and Cassowary Conservation (C4), to obtain accurate information on the true population number and distribution and demography of the Mission Beach cassowary population.

My sincere thanks go, therefore, to the Community for Coastal and Cassowary Conservation for sourcing the funding to support the field research at Mission Beach. This committed group has always played a pivotal role in the protection of cassowaries, not just at Mission Beach but also in the Wet Tropics generally. Particular gratitude is expressed to Mary Ritchie of C4, whose personal dedication to conservation, along with her drive to protect the cassowary, was instrumental in initiating the survey work at Mission Beach. Her unfailing friendship and belief in my work often kept a leech-ridden and leg-weary cassowary researcher going. The Mission Beach project itself was made possible by a grant to C4 from the Wet Tropics Management Authority.

I am very grateful to the unique institution that is James Cook University at Townsville, both for their environmental inspiration and unflagging confidence in my work. My supervisors, Dr Chris Johnson and Professor Richard Pearson, were a constant source of encouragement, information, and friendship. They contributed significantly to making this research both enjoyable and productive.

I would also like to express my deep respect for the fraternity of PVA and endangered species people worldwide, including the staff of the Conservation Breeding Specialist Group (CBSG). Many of these dedicated people generously shared their research experiences and responded to my confused email ramblings with kind words and support. Additionally, as I am sure is the case with many other endangered species zoologists involved in researching and/or managing threatened species, I have immense admiration for Robert Lacy, the author of the VORTEX population viability analysis program. His ongoing commitment to conservation biology serves both as motivation and an inspiration to those of us endeavouring to preserve threatened and endangered species.

Using population viability modelling in my research has changed me from being a little sceptical of the usefulness of PVA (which, like most, came from ignorance of the process), to being an enthusiastic advocate of its use in appropriate circumstances. Unfortunately, given the rate at which the natural landscape is being fragmented, thus creating isolated and often small populations of plants and animals, the role of PVA in the assessment and management of viable populations of threatened species in the wild will increasingly become more critical. It is hoped, therefore, that this population viability study on the endangered cassowaries of Mission Beach will join with similar studies to assist those wildlife managers and researchers faced with the task of conserving our declining biodiversity.

Finally, special thanks go to my wife, Nicole, and son Nicholas, who put up with my long absences in the field and my distracted behaviour during the writing of this thesis.

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