Cone production by the Drooping Sheoak *Allocasuarina verticillata* and the feeding ecology of the Glossy Black-Cockatoo *Calyptorhynchus lathami halmaturinus* on Kangaroo Island

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Declaration

The research presented in this thesis was completed by the author while a postgraduate student in the School of Earth and Environmental Sciences at the University of Adelaide, South Australia. The work in this thesis contains no material that has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Abstract

On Kangaroo Island, the Glossy Black-Cockatoo *Calyptorhynchus lathami halmaturinus* relies on the kernels contained in the russet cones of the Drooping Sheoak *Allocasuarina verticillata* as its food source. Clearing of Drooping Sheoak woodland resulted in the decline of the Glossy Black-Cockatoo from the South Australian mainland by the late 1970s and the sub-species is now confined to Kangaroo Island. The purpose of this study was to identify the factors limiting cone production by the Drooping Sheoak and to determine if food was likely to be in shortage by studying the foraging behaviour of the cockatoos.

The number of russet cones on Drooping Sheoak branches was significantly greater during the period from July 1995 to July 1996 than the period from December 1996 to July 1997. Rainfall was lowest during the latter period suggesting that rainfall may limit cone production. The mean number of pollen grains per male catkin was 334,280 in 1996 and 335,809 in 1997 and did not vary significantly between years. These observations show that rainfall probably did not affect pollen production. This may ensure that sufficient pollen is available to female inflorescences each year in a climate where rainfall varies between years.

The period over which male trees dehisced pollen varied from 25 to 74 days each year from 1995 to 1997. Dehiscence accelerated after one to three days of high daily rainfall in 1995 and 1997, but it was protracted in 1996 when daily rainfall was low. Female trees, however, effectively flowered year-round because although the main flowering period was in July each year, inflorescences and cones were present throughout the year. Female Drooping Sheoaks may overcome the variation in the timing and duration of male pollen dehiscence by flowering for a longer period than males and by producing some inflorescences throughout the year.

Catkin production varied significantly between regions on Kangaroo Island and pollen production per catkin also varied significantly between sites within Lathami Conservation Park. Although catkin and pollen production varied between regions and sites, pollen traps showed that female inflorescences would have received sufficient pollen to ensure

pollination of all of their flowers during their receptive phase. The abundance of pollen on Kangaroo Island suggested that pollen availability would be unlikely to limit cone production. A hand pollination experiment showed that the amount of pollen available to female trees did not limit cone and seed production in the Drooping Sheoak.

Of the 8,431 inflorescences marked in 1995, 1,638 or 19% set cones. Of the 3,444 inflorescences marked on the same trees in 1996, 609 or 18% set cones. The majority of inflorescences monitored took seven months to develop into mature russet cones in the first year and eight months in the second year. These patterns of cone development in the Drooping Sheoak suggested that cone production may be nutrient limited because low fruit set and slow fruit maturation typically result from soil nutrient limitation in other plants. The production of inflorescences and russet cones by Drooping Sheoaks was shown to be limited by soil nutrient levels because the application of combined slow-release fertiliser significantly increased female branch growth and inflorescence and russet cone production. Applying slow-release fertiliser to female Drooping Sheoaks could potentially increase the foraging efficiency of Glossy Black-Cockatoos and their food intake rates. This is because fertilising female Drooping Sheoaks significantly increased the number of russet cones per branch and Glossy Black-Cockatoos preferentially foraged on branches with high numbers of russet cones present.

Over a period of 22 months, Glossy Black-Cockatoos returned to forage on individual trees at a greater rate than would be expected by chance, demonstrating that they favoured certain individual Drooping Sheoaks for foraging. A cone removal experiment was conducted to test the hypothesis that harvesting of cones by the cockatoos may allow the sheoaks to direct additional resources into cone and seed production the following year. However, removal of cones from female Drooping Sheoaks did not affect cone, seed or kernel production over the two years of observation. This suggests that the resources allocated to cone retention by Drooping Sheoaks are small in comparison with the resources allocated to flowering and cone maturation.

Glossy Black-Cockatoos favoured large female Drooping Sheoaks for foraging and apparently avoided small trees because foraged trees had significantly larger stem girth and canopy radius than non-foraged trees. The female Drooping Sheoaks adjacent to foraged trees were comparable in height, cone abundance and cone profitability. Although the size

of the cone crop increases linearly with stem girth in Drooping Sheoaks, habitat and tree use by the cockatoos was not related to cone abundance on Kangaroo Island. Large trees must, therefore, be favoured for reasons other than access to more cones or more profitable cones.

The Glossy Black-Cockatoos on Kangaroo Island spent no more than four minutes per day flying, foraged in a mean of five trees per day and harvested cones from no more than five positions (bouts) per tree. Comparison of branches used and not used for foraging by the cockatoos showed that they harvested cones from branches with significantly more russet cones present. The number of russet cones per branch and girth were negatively correlated suggesting that the cockatoos did not forage in large trees because they carry more cones on their branches than small trees. This also suggests that the cockatoos located branches from which to crop cones once inside the canopy. By foraging in large trees and cropping cones from branches with high densities of russet cones, the cockatoos only had to make a small number of movements between Drooping Sheoaks and within the canopies of the sheoaks when foraging. Consequently, the energetic costs of foraging for Glossy Black-Cockatoos on Kangaroo Island were low compared with other Black-Cockatoo species.

When breeding, the cockatoos spent significantly more time per day foraging. They also cropped cones in significantly more bouts per tree and this resulted in the harvesting of significantly more cones per tree than non-breeding birds. This shows that when breeding, the cockatoos increased their energy intake without increasing movement between trees, simply by cropping more cones per tree than non-breeding birds.

Two possible explanations may account for why Glossy Black-Cockatoos spent very little time and energy moving between Drooping Sheoaks and within the canopies of the trees. First, trees and cones may be abundant in the habitats used for feeding so that the cockatoos do not have to make a large number of movements to harvest their food requirements. Non-breeding birds spent only 26% of their time foraging and breeding birds spent only 36% of their time foraging. The cockatoos had cropped cones from only 20% of the trees and 13% of the branches surveyed. The small proportion of time spent foraging by Glossy Black-Cockatoos on Kangaroo Island, combined with the small proportion of trees and branches used for foraging indicates that the amount of habitat and

food available exceeded that required for foraging by the cockatoo population in the habitats used for foraging.

Second, the number of movements made by Glossy Black-Cockatoos between Drooping Sheoaks when foraging may be related to the risk of predation. That is, the cockatoos may reduce the risk of predation by limiting the number of movements they make when foraging. Females appeared to be more wary of predators than males during time-budget observations because they foraged further inside the canopy (where cones are significantly larger) and frequently paused to monitor the movement of avian predators when foraging. Both of these behaviours would have contributed to the significantly longer cone processing times recorded for females than males.

Glossy Black-Cockatoos may not breed in regions of Kangaroo Island where the amount of Drooping Sheoak habitat (i.e. the number of large trees) is limited near nest sites. One reason for this may be because the additional investment of time and energy in movement prohibits the cockatoos from collecting sufficient energy to raise young. Another reason may be that the risk of predation may be too great in regions where the cockatoos have to make a large number of movements between feeding trees per day to collect food. This may account for why few birds raise young on the eastern end of the Island where the area of feeding habitat near the nest sites is relatively small. This study has shown that revegetation with Drooping Sheoak close to nest hollows is likely to increase the number of breeding attempts and nesting success on Kangaroo Island.

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